RESEARCH

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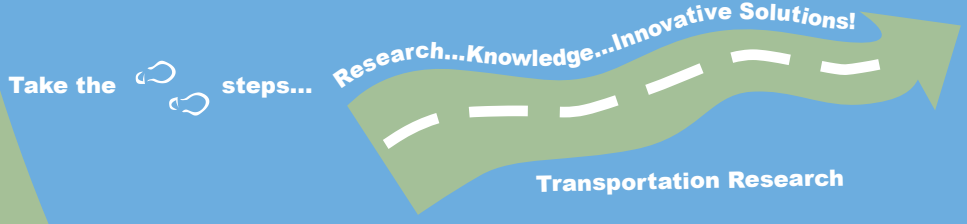
Study of Pile Setup Evaluation Methods



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To expedite more rapid construction of bridges, it has been customary in many states to ignore setup effects when predicting pile group capacities. End of driving capacities have frequently been used as the design capacity for a pile group. For many soil profiles, setup yields pile groups that have significantly higher capacities after some amount of time when compared to the capacity immediately after driving. In order to meet the immediate capacity requirements, piles are often driven deeper than necessary in order to obtain some desired capacity at the time of pile driving, even though substantial increases in capacity may develop in the days and weeks following driving.

Being able to perform in situ or laboratory tests that can predict the magnitude and/or rate of pile setup during the design stage would provide a much more efficient pile design, since the cost of materials and the construction time required to drive the piles would decrease. Piles could be driven to a lower capacity, knowing that after an anticipated amount of time the capacity would increase to the desired target capacity, and restrike analyses could be performed to verify this capacity.

This study has investigated the side shear setup phenomenon and various methods of predicting the magnitude and/or rate of setup. This was done by means of conducting a literature review and a survey of transportation agencies. Several methods have been proposed for dealing with the setup phenomenon and these methods are described briefly in the body of this report.

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Study of Pile Setup Evaluation Methods

Final Report

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EXECUTIVE SUMMARY

To expedite construction of bridges, it has been customary in many states to ignore setup effects when predicting pile group capacities. End of driving capacities have frequently been used as the design capacity for a pile group. For many soil profiles, setup yields pile groups that have significantly higher capacities after some amount of time when compared to the capacity immediately after driving. In order to meet the immediate capacity requirements, piles are often driven deeper than necessary in order to obtain some desired capacity at the time of pile driving, even though substantial increases in capacity may develop in the days and weeks following driving.

Being able to perform in situ or laboratory tests that can predict the magnitude and/or rate of pile setup during the design stage would provide a much more efficient pile design, since the cost of materials would decrease and the construction time required to drive the piles would decrease. Piles could be driven to a lower capacity, knowing that after an anticipated amount of time the capacity would increase to the desired target capacity, and restrike analyses could be performed to verify this capacity.

This study has investigated the side shear setup phenomenon and various methods of predicting the magnitude and/or rate of such setup. This was initially done by means of conducting a literature review for this topic. Several methods (numerical, analytical, and field methods) have been proposed for dealing with the setup phenomenon, and these methods are described briefly in the body of this report.

Once potential methods of predicting either the rate or the magnitude of setup were identified, a survey was conducted to determine which (if any) of these methods have been implemented by transportation departments throughout the United States. The participation rate in this survey was very high, with 41 out of 50 states responding to the survey. The survey provided information as to the extent to which each state uses driven pile foundations compared to other types of foundations (drilled shaft foundations and shallow foundations), along with an assessment of how frequently the state encounters soil profiles in which setup could be significant. The survey shows that driven pile foundations are the most common type of foundation used by departments of transportation and that many states deal with soil profiles where setup is expected to exist. However, very few states have taken steps to predict either the rate or the magnitude of such setup and account for setup in the design process. While several field methods have been investigated for their potential to predict setup behavior, only five states (Florida, Iowa, Maryland, Massachusetts, and Washington) have actually used such methods to predict setup. These states that have attempted to measure setup rate or magnitude have had mixed results, such that confidence in any such methods at this point is small.

There are only limited instances where states are using field or laboratory tests to predict either the magnitude or rate of side shear setup at pile driving installations. However, this certainly does not prevent the Minnesota Department of Transportation (Mn/DOT) from efforts to implement such practices. Based on the responses to this survey and other efforts, it appears that the Standard Penetration Test with torque measurements (SPT-T), while very simple and seemingly practical, does a marginal job at best at predicting setup in soils. Florida, which has the only significant background with the test, reports that the test does a good job predicting the rate of setup but a poor job with respect to the magnitude of setup, which would certainly be critical for setup to be incorporated at the design phase. Studies by the Wisconsin DOT

determined that implementation of the SPT-T test was not recommended due to limitations in predicting both the magnitude and rate of setup. Thus, it would seem that SPT-T investigation would be of questionable worth.

The SPT-uplift tests provided in the literature review seemed to be a fantastic possibility. However, at this point no states have used such tests to deal with setup in driven pile applications, and beyond the initial investigations performed by Rausche et al. (1996), no literature was found to confirm or deny the usefulness of this test. Additional work would be recommended to evaluate the possible benefits of additional efforts to implement such tests to predict setup.

The Cone Penetration Test with Pore Pressure Measurement (CPT-U) tests, which would be easily implementable by Mn/DOT due to the growing fleet of Cone Penetration Test (CPT) rigs, received mixed reviews from the two states that have used such tests to deal with setup. Maryland felt that the test was a poor indicator for both magnitude and rate of setup. Massachusetts felt that the test did a good job of predicting both magnitude and rate of setup. Additional information from other states would be helpful in making a more informed decision with respect to these tests. This is the most appropriate direction for Mn/DOT to pursue and will be addressed further.

Model pile tests seem to be growing somewhat in popularity, although only a few states have implemented such tests at this point, and this implementation is in limited cases. The results appear to be more reliable than other field methods, with the states that have used such model piles reporting that the model piles provide a good prediction of the magnitude of setup, even though one of the states felt it did a poor job predicting the rate of setup.

Apart from Pile Driving Analyzer (PDA) and Case Pile Wave Analysis Program (CAPWAP) analyses of piles during restrikes, no additional information was obtained with respect to additional field tests that could be used to estimate setup. Such tests as the dilatometer and other possibilities were anticipated as responses to the survey. However, no states provided any field tests to indicate use in predicting setup. Similarly, no lab tests (beyond basic classification tests and simple consolidation and shear tests) were presented that have been used to predict magnitude or rate of setup. Such tests have simply been used to estimate whether or not a soil might be expected to witness setup or not.

Overall, a recommendation is made that CPT-U tests be pursued further by Mn/DOT to evaluate whether they could be utilized to predict the magnitude and/or rate of setup in soil profiles that would be expected to be subject to this phenomenon. Since such testing has only been used on a very limited basis, it is suggested that additional contact with such states as Massachusetts (which is familiar with both the model pile testing and the CPT-U tests) be made to determine what course could/should be taken in further study of the application of these tests. CPT dissipation tests should be performed to estimate the pore pressure dissipation characteristics of the soils considered to be susceptible to setup. Such additional effort is cost-effective for projects that meet one or both of the following criteria: 1) the site can be shown (using CPT-U tests or other methods) to have a high probability of relatively large magnitudes of setup occurring, and 2) a large number of piles will be used on a project with measureable setup anticipated such that the extra expense of quantifying setup is justified by cost savings in reduced pile lengths and/or time on the project.

Along with such dissipation tests, restrike analyses should be performed to monitor the increase

in pile capacity with time over an extended period of time. Mn/DOT frequently requires restrikes to be performed after three days. A number of states required restrikes to be performed after one week, which would allow more setup to occur than after a three-day period, especially for large pile groups. The combination of extending the time period before restrikes are performed and perhaps restriking multiple times during that time period would give a better indication of the setup response of the site. Having this information would allow a relationship between pore pressure dissipation characteristics and setup such that a correlation could be developed. Additionally, contact should be made with other states that are researching methods of predicting pile setup (Indiana and Louisiana have such projects underway) to determine whether any states are investigating implementation of CPT-U testing in predicting pile setup. There appears to be a strong demand to develop such a relationship by a number of states. Submission of an NCHRP proposal to address this application and/or participating in a Pooled Fund study with states sharing such interest would be strongly recommended, although such a project would not obtain a very immediate answer.

To summarize, the following recommendations are made to Mn/DOT to move toward incorporating setup into driven pile design:

- Pursue additional studies with respect to CPT use in downdrag prediction (dissipation tests, etc.). Such studies may be within Mn/DOT, as a Pooled Fund study, through an NCHRP investigation, or other potential studies.
- Invest in u_3 pore pressure positions for Mn/DOT cones; require contractors to obtain u_3 measurements in future projects.
- Begin performing dissipation tests on sites where: (1) setup is anticipated and (2) restrikes can/will be performed (ideally multiple times).
- Use such data to develop a database that can be used to refine/improve rate of setup predictions. The combination of restrike data and dissipation test data can be used to calibrate and/or validate the prediction model established by Paikowsky et al. (2004).
- Require series of restrikes (7 days, 10 days, 30 days, etc.) in addition to standard restriking practice (1 day to 3 days) at sites where dissipation tests indicate significant time for pore pressure dissipation (this requires advance cooperation/planning for contractors).
- Obtain data from past test piles to compare capacity at End of Initial Drive (EOID) and Beginning of Restrike (BOR). In appropriate cases (i.e., where significant setup occurred), perform dissipation tests at (or near) the site to obtain appropriate data to validate setup prediction models.
- Transmit all pile driving data (driving records, PDA, CAPWAP, etc.) including electronic files between the Bridge Office and Foundations Unit to allow database development and setup evaluation.
- Implement setup in design to reduce required EOID capacities while maintaining necessary long-term capacity.

Implementing these recommendations will allow Mn/DOT to quantify rate of setup (and potentially magnitude), moving toward the ability to account for setup at the design phase. As extended restrikes are used on projects, justification of lower EOID capacities can be made for

production piles. Significant additional work has yet to be done, but these steps will be a move in the right direction to allow more effective pile design in the future.

CHAPTER 1

INTRODUCTION

To expedite more rapid construction of bridges, it has been customary in many states to ignore setup effects when predicting pile group capacities. End of driving capacities have frequently been used as the design capacity for a pile group. For many soil profiles, setup yields pile groups that have significantly higher capacities after some amount of time when compared to the capacity immediately after driving. In order to meet the immediate capacity requirements, piles are often driven deeper than necessary in order to obtain some desired capacity at the time of pile driving, even though substantial increases in capacity may develop in the days and weeks following driving.

Being able to perform in situ or laboratory tests that can predict the magnitude and/or rate of pile setup during the design stage would provide a much more efficient pile design, since the cost of materials would decrease and the construction time required to drive the piles would decrease. Piles could be driven to a lower capacity, knowing that after an anticipated amount of time the capacity would increase to the desired target capacity, and restrike analyses could be performed to verify this capacity. This literature review will investigate the side shear setup phenomenon and various methods of predicting the magnitude and/or rate of such setup.

1.1 Background on Side Shear Setup

Piles driven into various types of soil may experience an increase in capacity as a function of time. Terms such as "setup" and "freeze" have been used in the literature to describe this phenomenon of time-dependent capacity increase, which more recently has been referred to as "side shear setup" (Bullock et al. 2005a). Such behavior has been found to exist for a variety of pile types and in a broad range of soil profiles. Some of the mechanisms for this occurrence have been well-established, while others continue to be topics of research and debate.

Paikowsky et al. (2005) summarizes what various authors believe to be the two primary mechanisms of setup in cohesive soils. The first mechanism is an increase in the effective stress in the soil surrounding the pile due to dissipation of excess pore pressures generated during pile driving and soil displacement by the pile as it is driven. As the pile penetrates the soil, a combination of remolding and shearing of the soil generates excess pore pressures, which decrease the effective stress of the soil. Over time these excess pore pressures dissipate, leading to an increase in the effective stress and an associated increase in the strength of the soil. Additionally, piles typically displace some amount of soil as they are driven into the ground. This increases the total stress in the soil surrounding the pile. The combination of increased total stress and dissipation of excess pore pressures leads to a higher shear strength of the soil, which in turn leads to an increase in the capacity of the pile.

The second mechanism of setup in cohesive soils as presented by Paikowsky et al. (2005) is categorized as a "stress independent phenomena," which includes an increase in strength due to thixotropy of the soil subsequent to disturbance of the soil from pile driving. Schmertmann (1991) explained further that this "aging" effect on cohesive soils is a combination of thixotropy, secondary compression of the clay, particle interference and clay dispersion. Based on a previous study by Paikowsky (Paikowsky et al. 1995) the first mechanism (excess pore pressure

dissipation) controls the side shear setup. However, studies such as Karlsrud and Haugen (1991) show that significant amounts of setup can occur after excess pore pressures have dissipated.

Research by Titi and Wathugala (1999) recognized that setup of piles in clay soils is a function of both the increase in the effective stress (due to pore pressure generation and dissipation as a result of pile driving) and also the thixotropic gain of soil strength over time. However, their research chose to develop a procedure for modeling setup as a consolidation-based phenomenon, not accounting for any soil thixotropy effects in their model.

Side shear setup has also been significant in sandy soil profiles. The hydraulic conductivity of sands is several orders of magnitude higher than for cohesive soils, such that the pore pressure effects discussed for cohesive soils do not explain the occurrence of setup in sands, especially in cases where setup is measured days and weeks subsequent to pile driving. Tavenas and Audy (1972) published several well-documented cases of setup in sands that were shown to not be a function of pore pressure effects on effective stress during and subsequent to pile driving. Since that time, numerous cases have shown the effects of setup in such profiles, several of which will be presented in Section 1.2.

Chow et al. (1998) provided three possible reasons for an 85% increase in capacity over time at an open-end pipe pile installation in Dunkirk, France. The first possible reason mentioned related to chemical or corrosion effects on the pile. During the course of the project, corrosion of the upper 7 m of the pile was noted. This corrosion was hypothesized to either increase the friction between the pile and the sand or create actual bonding between the sand and the pile that forced the shear band into the sand, increasing the available resistance. However, this hypothesis was not considered to be the principal cause of setup in this case. Shear stress distributions along the pile showed the greatest increase with time in the sand below the water table, where corrosion was minimal. Other reports in the literature had shown setup in sands for both corrodible and non-corrodible piles, so a more satisfying reason was desired.

The second reason discussed by Chow et al. (1998) was the effect of aging on sand properties. Several studies were cited (Mitchell and Solymar, 1984; Mesri et al., 1990; Schmertmann, 1991) that proposed possible reasons for aging effects, including a cementing effect of silica acid gel formation at particle contacts and effects of secondary compression (or creep) causing increased micro-interlocking. Laboratory tests on the Dunkirk sand did not detect any changes in δ_{cv} over a period of two months. However, the shear stiffness and dilation angles both increased with time. Thus, setup due to aging effects for this pile installation was not determined to be a main cause.

The final reason presented by Chow et al. (1998) was a change in the stress surrounding the piles with time. The pile installation process induces an arching effect, where high hoop stresses can develop during pile driving. A reduction/relaxation of these hoop stresses with time could increase the stresses near the pile and cause an increase in the pile capacity. Creep within the sand, allowing relaxation of the arching effect and increased capacity, was considered to be the most plausible reason for the Dunkirk tests. Chow et al. cited studies by Ng et al. (1988) and Axelsson (1998) where measured increases in the radial stress with time suggested that this phenomenon could be a major factor in setup in sands. Axelsson's Ph.D. dissertation (2000) provides much information regarding the lab and field measurements that seem to validate this mechanism. A discussion of the lab and field work by Axelsson will be further addressed in Section 1.4.

To summarize, Yang and Liang (2007) explain that although three possible mechanisms were proposed by Chow et al., stress relaxation and soil aging seem to be the most likely causes of side shear setup. York et al. (1994) states that "practically all of the setup [in piles driven into glacial sands at JFK International Airport] takes place as the soil ages at constant effective stress" (pg. 1508). Debate will continue as to which (if either) is the principal cause, and continuing investigation may provide additional answers.

1.2 Examples of Setup

The literature has many examples of setup occurring in clay, sand, and mixed soil profiles. A discussion of several of these case histories follows, but this is by no means an exhaustive report on all cases provided in the literature. A report prepared by Komurka et al. (2003) for the Wisconsin Department of Transportation includes several dozen short descriptions of papers that were reviewed relating to pile setup, as well as an extensive reference list with additional papers of interest. Many of these references were also reviewed during the course of this research and will be briefly discussed at this time.

Kuo et al. (2006) "A Case History of Pile Freeze Effects in Dense Florida Sands"

This paper presents a study of 24-inch square prestressed concrete piles driven 25 feet into very dense cemented sands. Seventy dynamic load tests with Pile Driving Analyzer (PDA) monitoring were performed on 34 piles and both the PDA results and Standard Penetration Test (SPT)-97 were used to predict pile capacities. The End of Drive (EOD) pile capacities determined from the PDA results were compared to the Beginning of Restrike (BOR) pile capacities, and the majority of pile capacities increased 10% to 120% per log cycle of time.

Long et al. (1999) "Measured Time Effects for Axial Capacity of Driven Piling"

This paper presented information from an extensive database of 80 pile load tests, which included both static and dynamic load tests, and gives information relating to pile setup measured in clay, sand, and mixed soil profiles. The soil profiles within the database were sorted into these three general types, and the results of each soil profile were provided. For the clay profiles, long-term capacities ranged from one to six times the capacity estimated at the end of driving. Low-displacement piles fell within the same range of setup amounts as higher displacement piles. Lastly, increases in pile capacity leveled off after approximately 100 days in the clay profiles.

For the soil profiles that were predominantly sand, long-term capacities ranged from one to two times the capacity at the end of driving. Thus, the magnitude of increase in capacity was in general less than that of clay soils. The paper noted that the increased capacity in sand profiles occurred up to 500 days after driving. Additionally, almost all cases in sand had at least 30 percent setup after 10 days.

For mixed soil profiles (with both sand and clay present), long-term capacities ranged from one to five times the end of drive capacities. One pile in the database showed a decrease in capacity with time, but most piles showed substantial increases in capacity with time. The effect of large displacement versus small displacement piles was also investigated as for the mixed profiles. The data showed no clear evidence of any difference between high- and low-displacement piles with respect to setup magnitude.

Attwooll et al. (1999) "Measured Pile Setup During Load Testing and Production Piling: I-15 Corridor Reconstruction Project in Salt Lake City, Utah

This paper presents data relating to the I-15 Reconstruction through Salt Lake City, Utah. Soil profiles varied from lightly overconsolidated lacustrine clays to granular alluvial materials. Steel pipe piles (12.75 inch and 24 inch diameter) were subjected to nine full scale static load tests and lateral load tests. Setup was observed for each of the test piles, those driven through clays as well as those driven through dense sands. In the clay profiles, the ratios of the load test capacity to the capacity estimated at the end of driving ranged from 4 to 5.5 for load tests conducted about 40 days after driving. One test pile in the dense sand profile showed a comparable amount of setup to the piles in the clays.

Camp and Parmar (1999) "Characterization of Pile Capacity with Time in the Cooper Marl: Study of the Applicability of a Past Approach To Predict Long-Term Pile Capacity"

This paper presents the setup determined for piles driven into the Cooper Marl formation near Charleston, South Carolina. This marl consists of stiff, cohesive calcareous soils and significant magnitudes of setup have been measured in the past. Data presented in the paper show setup factors ranging from 1.7 to almost 8, with numerous tests having factors between 3 and 5.

Bullock et al. (2005a) "Side Shear Setup. I: Test Piles Driven in Florida"

This paper provides a brief review of several examples of setup from the literature. A summary of these examples is given in Table 1 below. For the pile test data presented in the paper for various soil profiles, setup factors ranged from 1.1 to 1.4 after 10 days and from 1.3 to 1.6 after 100 days.

Table 1. Summary of examples of setup provided in Bullock et al. (2005a)

Reference	Soil Profile	Pile Type	Magnitude of Setup
Kehoe (1989)	Mixed Cohesive Soils	Prestressed Concrete Piles	58% and 200% increase at two sites
Karlsrud and Haugen (1985)	Overconsolidated Clay	Closed-end Pipe Piles	30% increase
Fellenius et al. (1989)	Sandy Clay and Silty Sand	Steel Pipe and H-piles	50% increase
Tavenas and Audi (1972)	Sand	Hexagonal Concrete Piles	70% increase
Seidel et al. (1988)	Alluvial Sands	Prestressed Concrete Piles	80% increase

York et al. (1994) "Setup and Relaxation in Glacial Sand"

This paper presents the results of an investigation at John F. Kennedy International Airport in New York City. Several meters of soft and highly compressible organic marsh deposits exist above a thick layer of glacial sand. Monotube piles were the focus of the paper and capacity increases ranging from 40% to 80% were measured with maximum values occurring within approximately three weeks.

As mentioned, numerous additional references are available relating to side shear setup. The report by Komurka et al. (2003) contains many of these additional references, in addition to many of those included in this report.

1.3 Numerical and Analytical Prediction Methods

Various methods have been developed to predict the magnitude and/or rate of side shear setup in recent years. Several of these will be discussed at this time.

Paikowsky et al. (2004) developed a summary of both static- and dynamic-based capacity gain with time based on a database of measured setup. The slope of the semi-logarithmic relationship between the static capacity at some given elapsed time after driving and the maximum static capacity for a 1 ft diameter pile is denoted as C_{gt}. A similar relation exists for dynamic capacity, C_{gtd}. The time required for this "standard" 1 ft pile to gain 75% of it maximum capacity is denoted at t_{75}. Table 2 provides the summary of these values. The time required for 75% of the maximum capacity to develop for any pile size is given by the relationship $t_{75(pile)} = 4r^2 t_{75(table)}$. Thus, based on the data available in the database, for a given pile size the time required for 75% if the maximum capacity to develop can be estimated.

Table 2. Summary of capacity gain with time parameters (after Paikowsky et al. 2004)

	Static Data Set C_{gt}	Static Data Set t_{75}*	Dynamic Data Set C_{gtd}	Dynamic Data Set t_{75}**	All Data C_{gt}	All Data t_{75}**
No. of Cases	15	5	7	6	22	11
Average for All Piles in Set	0.389	385.0	0.348	21.3	0.376	186.6
Standard Deviation	0.119	226.3	0.068	7.9	0.106	237.9

* Closed-end pipe piles only

** t_{75} = time for a standard pile (1 ft diameter) to gain 75% of its maximum capacity

C_{gt} = rate of pile capacity gain with the logarithm of time

For the above relationships, pile capacity is normalized with respect to the maximum pile capacity, allowing one to compare the setup of different pile types and sizes. On a logarithmic scale, the relationship between the ratio of the end of drive capacity to the maximum capacity and the time from driving is linear between 40% and 90% maximum capacity. The slope of the

curve, as mentioned, was designated as pile capacity gain parameter C_{gt}, representing the rate at which the pile's capacity increases (Paikowsky et al. 2005).

Skov and Denver (1988) proposed the most widely used relationship between capacity gain and time (Paikowsky et al. 2005). This relationship, and various other relationships, is given in Table 3.

Table 3. Empirical formulas for predicting set-up (after Jeon and Rahman, 2007)

Authors	Equation
Skov and Denver (1988)	$\mathbf{Q_t=Q_o[A \log(t/t_o) +1]}$ where: Q_t = pile capacity at time t Q_o = pile capacity at $t=t_o$ t_o A Sand 0.5 0.2 Clay 1.0 0.6
Huang (1988)	$\mathbf{Q_t = Q_{EOD} + 0.236(1+\log(t)(Q_{max}-Q_{EOD}))}$ where Q_{max} = maximum pile capacity
Svinkin (1996)	$\mathbf{Q_t = 1.4Q_{EOD}t^{0.1}}$ Upper Bound $\mathbf{Q_t = 1.025Q_{EOD}t^{0.1}}$ Lower Bound
Long et al. (1999)	$\mathbf{Q_t=Q_o[A \log(t/0.01) +1]}$ where A is the same as above in Skov and Denver (1988)
Svinkin and Skov (2000)	$\mathbf{Q_t/Q_{EOD} - 1 = B[\log_{10}(t)+1]}$ where B is the same as A above in Skov and Denver (1988)

Thus, for any time of interest following pile driving, the expected magnitude of setup can be predicted by any of the provided relationships. Paikowsky et al. (2005) cautions that although the widely used Skov and Denver relationship fits many of the case histories available in the literature, there are some limitations that must be recognized that prevent its general use in deep foundation design. The first limitation is that pile size was not taken into account. Skov and

Denver used a database that included piles of one size, such that no effect of pile size was incorporated into the equation. Since pile size is a major factor in pore pressure generation, the Skov and Denver relation cannot serve as a standard solution at sites with low permeability soils (Paikowsky et al. 2005).

Secondly, parameters t_o and A must be back-calculated for each soil, pile type, and pile size for any given site. So, to predict the rate of capacity at a site, testing must be performed for a period of time, which defeats the entire purpose of having a prediction method (Paikowsky et al. 2005).

Third, ultimate capacities are not predicted from the equation, only relative capacities with respect to an end of drive capacity. Thus, no timeframe is obtainable for reaching the ultimate capacity (Paikowsky et al. 2005).

Soderberg (1962) suggested that radial consolidation theory could be used to predict the increase in strength of clays with time by predicting the rate of dissipation of excess pore pressures. He recommended that the increase in strength could be related to the dimensionless time factor T_h as given in the following formula:

$$\mathbf{T_h = (4c_h t)/(B^2)}$$

where:

c_h = coefficient of horizontal consolidation,
t = time since the end of pile driving, and
B = pile width.

Several additional numerical relationships have been developed for predicting pile capacity. Titi and Wathugala (1999) developed a procedure to predict the variation in capacity with time of friction piles in saturated clay. They based the procedure on steps throughout the life stages of a pile, ranging from installation to consolidation and subsequent loading. The Hierarchial Single Surface model (HiSS-δ^*_{2i} model) was used to model effective radial stresses at the pile-soil interface during and immediately after pile installation. The strain path method (SPM) was then used to compute strain paths around the driven pile, after which a finite element analysis was used to simulate the consolidation phase and pile load tests on the pile. Field experiments were used to verify the numerical procedure, and the provided results appear quite convincing. The authors admit that additional full-scale pile load tests are required to validate the procedure, followed by parametric studies to evaluate the effect of various pile and soil properties. Once this has been completed, design charts could be prepared to allow the designer to account for pile setup in the design phase.

Whittle and Sutabutr (1999) also applied the strain path method (SPM) to describe the pile installation process, specifically addressing installation disturbance of the soil. They incorporated the MIT-E3 effective stress soil model to describe the constitutive behavior of normally to slightly overconsolidated clays. This model predicts the effective strength properties throughout installation and setup, based on various material and stress state/history parameters. A finite element model simulates radial consolidation around the pile shaft to provide capacity.

1.4 Field Methods of Prediction

Several field methods have been developed in recent years in an effort to predict the setup magnitude and rate at pile installations. Some of these techniques have been quite successful for

a range of soil profiles, others have had limited success in select conditions, and some have been ineffective in predicting setup altogether. Several of the field methods that have been developed will now be addressed. Such tests may be generally divided into two categories: modifications of existing in situ field tests for setup evaluation purposes, and development of model pile shafts/rods to predict setup values.

Bullock et al. (2005b) discussed application of a modified Standard Penetration Test (SPT) used to investigate setup in driven piles, as well as other tests that were considered for possible implementation. The SPT test with torque measurements (SPT-T) proved to be the most practical for soil profiles evaluated in Florida in their study. The SPT-T test is fairly simple, with a torque wrench, an instrumented torque rod or similar mechanism at the top of the drill rod that can be used to measure the torsional shear resistance of the soil along the sides of the split spoon sampler. SPT-T tests showed semilog-linear time versus setup behavior similar to nearby pile segment responses, such that the SPT-T test was considered an acceptable predictor test for the time rate of setup in cohesive soils studied in the University of Florida research (Bullock et al. 2005b).

Another modification of the SPT test was proposed by Rausche et al. (1996) where instead of providing torque at the top of the drill rod, staged uplift tests are performed after the SPT sampler has been driven into the soil. This method also provides a means of determining the rate of setup that can be expected in soils.

The Bullock et al. (2005b) study also investigated two additional field investigation tests for possible implementation. They considered staged measurements of the cone penetrometer sleeve side shear as well as a staged Marchetti Dilatometer thrust measurement using a load cell immediately above the blade. In tests in sands, these two tests, in addition to the SPT-T tests, gave unsuitable results and were not recommended as being satisfactory in sandy profiles. Thus, the overall recommendation was that SPT-T tests were determined to be practical and acceptable for evaluation of cohesive materials, but neither SPT-T tests, Cone Penetration Test (CPT) tests, nor dilatometer tests proved useful in sand profiles. Additional research may provide more useful methods of applying such field methods more adequately, as each method shows promise in predicting setup.

Several model piles have been developed in recent years with the intent of predicting the magnitude and rate of setup in pile foundations. A Federal Highway Administration (FHWA) report prepared by Paikowsky et al. (2000) presented several of the model piles developed for this purpose and details the development of the Multiple Deployment Model Pile (MDMP).

The first "model pile" discussed by Paikowsky et al. (2000) was the original and subsequent versions of the cone penetrometer. Mechanical and electric cone variations of this basic idea have been applied for over 60 years. Current cone penetrometers have load cells and pore pressure transducers that can be located at various positions on the cone. Such instrumentation makes it possible to monitor pore pressure dissipation and may also be used (as with the Bullock et al. (2005b) study) to perform staged side shear measurements to measure and predict setup with time.

The next model pile discussed by Paikowsky et al. (2000) was the Piezo-Lateral Stress (PLS) cell. The authors cite Wissa et al. (1975) as the original developers of this pile. The PLS cell has three components, rather than the two provided by the cone penetrometer. The PLS cell measures total lateral stress, pore pressure, and axial load in the pile. The ability of this cell to

measure the lateral stress acting on the pile over time makes it much more practical in evaluating setup potential in soils. Whittle and Sutabutr (1999) make use of the PLS cell in validating their numerical model for pile setup.

The Grosch and Reese model pile is next discussed by Paikowsky et al. (2000). This pile was developed at the University of Texas for the American Petroleum Institute and was designed to simulate the cyclic environmental loading often experienced by offshore oil rig structures. While the device is quite practical for evaluating the cyclic reduction of load transfer for offshore structures, it has limitations with respect to evaluation of setup.

Paikowsky et al. (2000) next discuss the Norwegian Geotechnical Institute (NGI) Model Pile. Similar to the Grosch and Reese pile, the NGI pile was developed to investigate uplift on pile anchors used for offshore platforms. Strain gages provide skin friction measurements along the pile. Earth and pore pressure cells allow effective stresses to be calculated at four locations. This instrumentation allows effective stress and skin friction to be evaluated during pile installation and consolidation. However, due to its relatively large size, transporting the model pile is difficult, making it less practical for repeated use.

Paikowsky et al. (2000) also provide information relating to the X-Probe and 3-Inch Model Pile developed by the Earth Technology Corporation, the In Situ Model Pile (IMP) developed at Oxford University, and the Imperial College Pile (ICP) before providing information relating to the Multiple Deployment Model Pile (MDMP) developed during the course of the study. The MDMP was designed to be able to record each of the following values during driving, static load tests, and restrikes:

- Axial loads at multiple locations along the pile
- Pore pressures (static and dynamic)
- Tip resistance (static and dynamic)
- Total radial stresses (static)
- Local displacement (static)
- Accelerations (dynamic)

This information provides total capacity, load transfer, and time-dependent information that are essential in predicting setup in soils. A full discussion of the MDMP is beyond the scope of this review. However, the full FHWA report will be provided as an Appendix to this report, for Minnesota Department of Transportation (Mn/DOT) reference.

The MDMP was first deployed during March 1996 (Paikowsky et al. 2005). The excess pore pressure dissipation rates for both the MDMP and the test pile monitored in the study were nearly identical. Data obtained with respect to the pile capacity gain parameter were reasonable, such that good correlations can be developed for implementation of the model pile in predicting setup for various soil profiles.

Finally, Axelsson (2000) presented his dissertation research relating to predicting pile behavior using driven rods. Dynamic testing of these rods, along with Case Pile Wave Analysis Program (CAPWAP) analyses and torque testing, were used to develop relationships that can be used to predict setup for pile installations.

CHAPTER 2

CONCLUSIONS FROM LITERATURE REVIEW

The phenomenon of side shear setup has been acknowledged for many years. Although the evidence of setup is easily seen, the mechanisms behind such behavior are not as well-defined. Several of the causes of setup have been established, while others require additional effort to improve our current understanding. Setup in clay soils is generally caused by increased effective stresses after pile driving due to soil displacement and pore pressure dissipation, as well as thixotropic effects that cause increased strength with time under constant effective stress. Setup in sands is less definitive, but seems to be related to aging effects of the sand and/or relaxation of arching effects with time.

Various examples in the literature show setup occurring in most soil types, with all types of piles and for many sizes of piles. Setup effects can vary from increases in capacity of as little as 20% to as much as 8 times the end of driving capacity. Some groups are working towards a goal of implementing setup into pile design in order to produce more cost-effective foundations. However, this requires an ability to predict the magnitude and rate of setup in various soil profiles.

To that end, several numerical and analytical prediction models have been developed to analyze setup in pile foundations. In addition to these prediction models, field evaluation methods are being developed to improve our ability to predict the magnitude and rate of setup. While many of these methods are still being investigated and improved, there is great optimism that such tools will provide valuable information relating to setup in the near future.

CHAPTER 3

SURVEY METHODOLOGY

In order to determine which field and/or laboratory tests are currently in use nationwide to estimate the magnitude and rate of side shear setup, this project has prepared and delivered a survey to each of the state Departments of Transportation with the intent of finding out about the basic pile driving practice of the state, expectations in each state with respect to setup, and a brief survey of methods used to determine the magnitude and/or rate of setup. This survey was prepared with input from Mn/DOT, taking into account the test methods determined during the course of the Task #8 Literature Review. The survey was sent to DOT contacts via e-mail correspondence and to date the response rate has been positive. As of 16 May 2008, 35 of the 50 states had responded with completed surveys, with several additional states still providing an intent to respond. At the time of submission of the Draft Final Report (08 August 2008), another six states had responded to the survey, bringing the total number of respondents to 41 of the 50 states. Puerto Rico and the District of Columbia were also contacted, but neither of these entities has responded to date. The basic survey is provided in this report along with the results of the surveys received to date. The complete responses from each state are provided in the Appendix (refer to Appendix D), with the summary of the results contained in the body of this report.

3.1 Mn/DOT Setup Survey

Based on the literature review conducted during Task #8 of this research project, several test methods were identified that were considered to be appropriate in identifying the magnitude of side shear setup, the rate of setup, or both. Thus, a key component of the survey was to establish if any of the states were currently using such tests, and if so, how well they considered the tests to work in predicting the magnitude or rate of setup. Prior to asking about such tests, it was considered prudent to obtain a general background on pile driving practice in each state and also gain a feel for the extent to which setup and/or relaxation of soils was expected in each state. A state that either had minimal use of driven piles or infrequent soil profiles that would be expected to experience setup would not be expected to have an overwhelming need for determining the extent of pile setup. On the other hand, states using driven piles extensively and having many soil profiles that are known to experience setup would be much more likely to make the effort to pre-determine the effects of setup and possibly incorporate such effects in the design stage.

In the 07 January 2008 Technical Advisory Panel meeting for this project, a draft survey was discussed prior to distribution. With some minor modifications, this survey was sent to DOT contacts for their input. The final version of the survey is included in this report in Appendix A.

3.2 Survey Process

The original plan of the investigator was to find an appropriate contact person (either a Foundations Engineer or a Geotechnical Engineer in each state) by searching each state DOT webpage and finding the name and contact information for each individual. After many hours of such effort, and after quickly realizing the extreme range of user-friendly websites with easily accessible information to very painful websites with almost no contact information available, it was determined that another approach might be more effective.

To that end, the Geotechnical contact in the St. Paul office of the Federal Highway Administration was contacted about the possibility of using an existing contact list of such engineers nationwide. This message was passed along to the FHWA headquarters, and Jerry DiMaggio contacted Aaron Budge by phone to discuss the options. Mr. DiMaggio expressed some concerns about the number of surveys that each state received on a frequent basis and whether a survey on behalf of the Minnesota Department of Transportation was justifiable and/or useful. He recommended that several current and recent studies might already have the information desired and that it would be counterproductive to submit another survey to obtain such information that was already available. He provided two studies that he felt might contain the information desired and asked that these studies be researched before another survey was conducted. He also mentioned that a DOT representative would be more likely to obtain the results of such surveys that a university faculty member.

Gary Person contacted the individuals responsible for such surveys to see how much overlap of information existed. It was determined that although these projects did indeed address pile driving practice and to a minor extent side shear setup, that they by no means made an effort to identify field or laboratory methods of predicting the magnitude or rate of setup, which was the critical component of this project.

Rather than approaching the FHWA again regarding a contact list, the investigator on this project decided to approach Dr. Sam Paikowsky at the University of Massachusetts – Lowell about any contact lists to which he might have access (due to his involvement on several previous and current studies where such information would certainly be available.) Dr. Paikowsky was more than willing to provide such information on the condition that the people for which the studies were prepared were willing to share such information. He was unsure of the cooperativeness of those involved, but mentioned the possibility of working through the American Association of State Highway and Transportation Officials (AASHTO) to obtain their contact list for each of the states. Dr. Paikowsky made an initial contact to the AASHTO person responsible for such lists and the investigator followed up with this person to explain the purpose of the study and to request a contact list. This individual was very helpful and provided a list of the AASHTO representatives for each state. In most cases the AASHTO representative was obviously (by inspection of their title) not a geotechnical or foundations engineer. The investigator sent an e-mail message to each AASHTO contact (see Appendix B) explaining the project and asking that person to refer the name and contact information of a person with that DOT that would be most appropriate to respond to the survey. Of the 52 message sent (to each of the 50 states along with the District of Columbia and Puerto Rico), 31 responses were received either providing the name and contact information of an appropriate individual or providing a survey response directly. For those providing names of an appropriate individual, another e-mail message was sent to that individual requesting their help with the survey (see Appendix C). Of the original 31 responses from the AASHTO list contacts, all 31 full responses have been received to date (two were received subsequent to 19 May TAP meeting, at which time 29 of the 31 had responded.)

To obtain additional surveys, additional work was done to obtain contact information for geotechnical and/or foundation engineers in those states not responding to the initial AASHTO e-mail contact. This was quite time-consuming, but certainly required less time than determining this information for EACH of the 50 states as had originally been planned. Following a substantial amount of time searching for such contact information, 16 additional contacts were made in hopes of obtaining surveys from these states. Four messages (including the District of

Columbia) were sent to "customer service" e-mail contacts with a request to provide information for an individual to help with the survey. Since the Puerto Rico website was in Spanish, and since the investigator's fluency in the Spanish language is poor, no additional effort has been made to contact representatives in Puerto Rico.

From these additional contacts, six additional surveys had been completed at the time of the May TAP meeting (16 May 2008) with several additional surveys pending with an intent to respond. Following the May meeting, four additional states responded to such subsequent contacts. This brings the total number of surveys received to date to 41 states. The complete results of these surveys are included in Appendix D.

3.3 Survey Results

The survey results are addressed question by question as given below. As mentioned, at this point 41 states have responded to the survey. No additional survey results are anticipated.

3.3.1 Section 2 of the Survey – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

0	0%	☐ Our agency never uses Driven Piles for transportation applications
1	2%	☐ Our agency rarely uses Driven Piles for transportation applications
2	5%	☐ Our agency occasionally uses Driven Piles for transportation applications
34	83%	☐ Our agency often uses Driven Piles for transportation applications
4	10%	☐ Our agency almost exclusively uses Driven Piles for transportation applications

As seen, the vast majority of the states responding to the survey (38/41 or 93%) either often or almost exclusively use driven piles for transportation-related projects. The states responding with minimal use of driven piles are Arizona (rarely uses), Hawaii and Nevada (occasionally use.) The four states almost exclusively using driven piles are Iowa, North Dakota, South Dakota, and Wyoming. (However, for setup purposes, Wyoming is always able to drive to bedrock, such that setup is not a factor.) Thus, many of the states have significant experience with driven pile design and application.

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

0	0%	☐ Our agency never uses Drilled Shafts for transportation applications
3	7%	☐ Our agency rarely uses Drilled Shafts for transportation applications
22	54%	☐ Our agency occasionally uses Drilled Shafts for transportation applications
16	39%	☐ Our agency often uses Drilled Shafts for transportation applications
0	0%	☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

As might be expected from the high percentage of states using a significant amount of driven piles, the numbers for states using drilled shafts are slightly lower, although a large percentage of the states use drilled shafts to some extent.

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

0	0%	☐ Our agency never uses Shallow Foundations for transportation applications
8	20%	☐ Our agency rarely uses Shallow Foundations for transportation applications
17	41%	☐ Our agency occasionally uses Shallow Foundations for transportation applications
16	39%	☐ Our agency often uses Shallow Foundations for transportation applications
0	0%	☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

The use of shallow foundations was also quite common, but again had more limited application than driven piles in most states. In general, driven piles appear to be the most widely-used foundation type with respect to transportation applications.

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

0	0%	☐ Our agency does not use Driven Piles for transportation applications
33	80%	☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
13	32%	☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity If checked, approximately what percentages of the production piles do you restrike?
0	0%	☐ Our agency requires a restrike analysis on the majority of production piles
20	49%	☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity If checked, approximately what percentages of the production piles?
1	2%	☐ Our agency requires dynamic measurements on the majority of production piles
4	10%	☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity If checked, approximately what percentages of the production piles are load tested?
0	0%	☐ Our agency requires static load tests on the majority of production piles

The survey asked the respondent to mark each of the statements that applied to their agency. Thus, in many cases several of the statements applied in each state. It is quickly noticed that the majority of the states estimate pile capacity by some fashion at the end of the initial driving. Many states require dynamic measurements on piles either during the initial driving or at subsequent restrikes to confirm the capacity predicted by means of other methods. However, very few states require dynamic measurements or static load tests on many of their production piles. In fact, most states commented that they only require dynamic measurements on test piles. The question was perhaps somewhat vague – an additional point should have been included to assess the testing of "test piles" specifically. However, based on comments in the surveys, it appears that most states typically perform restrikes (and usually dynamic measurements) only on test piles, which range from 0% to 25% of the production piles, but more commonly on the order of 5% to 10% of the production piles. South Dakota responded that they require dynamic measurements on the majority of production piles, although this may have been mistaken for test piles. Maine, New Hampshire, New Mexico, and Ohio require static load tests on some basis for a certain percentage of their driven piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

1	3%	☐ Our state does not have soil profiles that appear to be subject to side shear setup
14	35%	☐ Our state has a few localized regions where soil profiles are subject to side shear setup
19	48%	☐ Our state has many regions where soil profiles commonly experience side shear setup
6	15%	☐ Much of our state has soil profiles that are subject to side shear setup

As a note, for an unascertained reason, the survey submitted by West Virginia did not complete the remainder of the survey. A follow-up message has been sent, but no response has yet been received. Thus, for the remainder of the survey results, the number of responses will be 40 rather than 41.

Almost two-thirds of the states responding to the survey (63%) note a large portion of their state having soil profiles that are believed to be subject to side shear setup. Only one state (Arizona) did not seem to have soil profiles that would be suspected of such behavior. However, Arizona was also the state that responded as "Rarely Using" driven piles, so setup behavior may simply not have been a consideration. Mississippi, Montana, Nevada, New York, Utah and Wyoming each reported having soil profiles through much of the state that were subject to setup.

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

22	55%	☐ Fat clay deposits	16	40%	☐ Loose sand deposits
24	60%	☐ Lean clay deposits	8	20%	☐ Dense sand deposits
33	83%	☐ Silty clay deposits	3	8%	☐ Gravel deposits
23	58%	☐ Silty sand deposits	4		☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

1 (3%) Clayey Sand
1 (3%) Clay Till
1 (3%) Glacially Overconsolidated Soils
1 (3%) Shale

This question shows that the soil profiles that would be predicted to experience setup indeed appear to do so. However, soils that might not be anticipated to experience setup are also shown to have a tendency to be subject to setup. While the soils with a significant amount of fines clearly seem prone to setup, even loose and dense sands have a significant amount of setup based on the survey results, and three states have seen setup in gravel deposits.

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

13	33%	☐ Our state does not have soil profiles that appear to be subject to relaxation
26	65%	☐ Our state has a few localized regions where soil profiles are subject to relaxation
0	0%	☐ Our state has many regions where soil profiles commonly experience relaxation
0	0%	☐ Much of our state has soil profiles that are subject to relaxation

Note - One state (Oklahoma) not responding to this question.

All of the states responding to the survey either had no reported soil profiles subject to relaxation or only a few localized regions that might be subjected to reduced pile capacity with time after driving. From this it appears that relaxation is quite localized, or perhaps that the effects of setup may counteract the effects of relaxation at construction sites.

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

1	3%	☐ Fat clay deposits	4	10%	☐ Loose sand deposits
1	3%	☐ Lean clay deposits	11	28%	☐ Dense sand deposits
3	8%	☐ Silty clay deposits	4	10%	☐ Gravel deposits
5	13%	☐ Silty sand deposits	5		☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

3 (8%) Shale and sandstone
1 (3%) Weathered shale
1 (3%) Dense sandy silts and silty sands
1 (3%) Metasiltstones

The highest percentage of relaxation-related conditions is present in the sand deposits, mostly in dense sands but with significant relaxation also noted in silty sands and loose sands. Again, as per the previous question these were localized regions.

3.3.2 Section 3 of the Survey – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

38	95%	☐ Our agency has never used the SPT-T test in predicting setup rate or magnitude
1	2.5%	☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
0	0%	☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
0	0%	☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
1	2.5%	☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

The hope of the survey was to determine which states currently use some of the available methods of determining setup magnitude and/or rate in practice. The SPT-T test seemed to be the most plausible test that might be in use throughout the United States based on the frequent use of SPT testing nationwide. However, from these results, it appears that the use of the SPT-T test is extremely limited, with only Florida showing use of the test in practice (sometimes).

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

39	97.5%	☐ Our agency has never used the SPT-T test to predict setup rate or magnitude
0	0%	☐ The test does a poor job of predicting both the rate and the magnitude of setup
1	2.5%	☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
0	0%	☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
0	0%	☐ The test does a good job of predicting both the rate and the magnitude of setup

Florida provided the response that the SPT-T test does a good job predicting the rate of setup but does not do a good job predicting the magnitude of setup. This seems to have been substantiated in the literature review, where Florida research found that the test was appropriate in some soil conditions but was certainly not applicable in all cases. Regardless, there does not appear to be a well-established support for using this test in practice at this point. Work for the Wisconsin DOT seemed to coincide with Florida's assessment that the SPT-T test was not justifiable in predicting setup to a useful extent.

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

39	97.5%	☐ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
0	0%	☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
0	0%	☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
0	0%	☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
1	2.5%	☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

Although the SPT-uplift test as discussed in the literature review seemed like a strong possibility in predicting setup, at this point no states are using such a test to predict either the magnitude or rate of setup.

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

40	100%	☐ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
0	0%	☐ The test does a poor job of predicting both the rate and the magnitude of setup
0	0%	☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
0	0%	☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
0	0%	☐ The test does a good job of predicting both the rate and the magnitude of setup

Again, no states surveyed have used the SPT-uplift tests in evaluating setup.

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

36	90%	☐ Our agency has never used the CPT-U test in predicting setup rate or magnitude
3	7.5%	☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
0	0%	☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
0	0%	☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
1	2.5%	☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

Most states have not used the CPT-U test in evaluating setup in soils. However, Maryland, Massachusetts, and Washington State have sometimes used CPT-U tests in setup assessment.

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

37	92.5%	☐ Our agency has never used the CPT-U test to predict setup rate or magnitude
1	2.5%	☐ The test does a poor job of predicting both the rate and the magnitude of setup
0	0%	☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
0	0%	☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
1	2.5%	☐ The test does a good job of predicting both the rate and the magnitude of setup

Maryland felt that the CPT-U test did a poor job overall in predicting both the magnitude and rate of setup, where Massachusetts had experienced a good job predicting both the rate and magnitude of setup. Thus there is a discrepancy between the two states as to how well the CPT-U test works in predicting setup. Washington State, which had responded to the previous question as having used CPT-U on a limited basis, did not respond to this question. However, an explanation for this was provided in the e-mail message sent containing the completed survey.

This message noted that although the state has used the CPT-U test to predict sites where setup is likely, no additional testing (restrikes, etc.) has been performed to confirm either the rate or magnitude of this projected setup. Thus, no comparison of the prediction to the actual has been made, such that no substantive evaluation can be provided at this time.

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

37	92.5%	☐ Our agency has never used model pile tests to predict setup rate or magnitude
2	5.0%	☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
0	0%	☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
0	0%	☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
1	2.5%	☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

Most states have not used model piles (similar to that developed by the University of Massachusetts – Lowell) to estimate pile setup. However, Iowa and Massachusetts responded that they had used model piles in predicting setup on a limited basis. Initially, North Dakota and Oklahoma also responded in the affirmative, but this was thought to be due to confusion about exactly what a model pile is (as compared to a test pile, perhaps.) Oklahoma has since confirmed that they do not use model piles to predict setup. North Dakota has not yet confirmed this, but continued efforts will be made to verify whether or not model piles have been used in North Dakota to predict setup. Regardless, it appears that at this point model piles have not been used extensively anywhere.

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

38	95.0%	☐ Our agency has never used model pile tests to predict setup rate or magnitude
0	0%	☐ The tests do a poor job of predicting both the rate and the magnitude of setup
0	0%	☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
1	2.5%	☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
1	2.5%	☐ The tests do a good job of predicting both the rate and the magnitude of setup

Iowa commented that the model pile tests do a good job predicting the magnitude of setup but did poorly in the rate at which that setup occurred. Massachusetts felt the model piles did a good job predicting both the magnitude and rate of setup. It appears as though additional research will be required before model piles become more frequently used.

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

9	22.5%	☐ Yes
31	77.5%	☐ No

The majority of the states responding in the affirmative to this question responded that they used field restrikes with PDA and/or CAPWAP analyses anywhere from 12 hours to 7 days since the initial drive. In some cases, responses stated that the time required before restriking the piles was extended in cases where setup was anticipated.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

3	7.5%	☐ Yes
37	92.5%	☐ No

The three states responding in the affirmative on this question commented that in very limited cases they had used grain-size distribution, Atterberg Limits indices, consolidation parameters, and/or strength parameters to determine whether setup might be a factor or not. These tests appeared to be based more on past experience than any well-established relationships. Oregon's response stated that they use a three-stage CU triaxial test with pore pressure measurements to determine the undrained shear strength and provide an idea as to the time of setup based on experience and empirical relationships.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

13	32.5%	☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
17	42.5%	☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
4	10.0%	☐ Increased pile capacities are estimated during the course of design based on local experience with setup
1	2.5%	☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
5	12.5%	☐ Other (please explain)

Most states seem to allow for increased capacities when these capacities are verified either by a restrike analysis or a pile load test. (As seen in the earlier discussion, dynamic tests are much more prevalent than static load tests in practice.) A few states incorporate setup during the design stage based on local experience, with even fewer states estimating increased capacities based on field or lab tests.

3.4 Conclusions of Survey

Overall, the initial section of the survey was not surprising. Many states use driven piles for transportation applications, and the majority of these states estimate pile capacity at the end of the initial drive. However, many do perform restrike analyses on test piles, which typically range from 5 to 10 percent of the production piles. Also, many states require dynamic measurements either during the original drive or on restrikes in order to confirm capacity.

Most states feel that they have quite a broad region in which setup is expected to occur. The soil profiles that are expected to be subject to setup vary widely, including both the traditional fine-grained soils and also the coarser sands and gravels. A few states stated they had limited regions where pile relaxation could be expected, most commonly in dense sand, loose sand and gravel deposits.

Unfortunately, the most important portion of the survey did not lead to as many helpful insights as hoped with respect to field and/or lab tests that can be (and are currently being) used to estimate setup in pile driving. The tests obtained from the literature review in Task 8 were found to be used on a very limited basis by a handful of states. However, several of these tests were not considered to be very effective in estimating the magnitude or rate of setup in soils. Although certainly more information might be available, it appears that only a small amount of implementation has occurred to this point with respect to predicting soil setup.

CHAPTER 4

RECOMMENDATIONS FOR Mn/DOT TEST METHOD EFFECTIVENESS EVALUATION

As discussed, unfortunately there are only limited instances where states are using field or laboratory tests to predict either the magnitude or rate of side shear setup at pile driving installations. However, this certainly does not prevent Mn/DOT from efforts to implement such practices. Based on the responses to this survey and other efforts, it appears that the SPT-T test, while very simple and seemingly practical, does a marginal job at best at predicting setup in soils. Florida, which has the only significant background with the test, reports that the test does a good job predicting the rate of setup but a poor job with respect to the magnitude of setup, which would certainly be critical for setup to be incorporated at the design phase. Studies by the Wisconsin DOT determined that implementation of the SPT-T test was not recommended due to limitations in predicting both the magnitude and rate of setup. Thus, it would seem that SPT-T investigation would be of questionable worth.

The SPT-uplift tests provided in the literature review seemed to be a fantastic possibility. However, at this point no states have used such tests to deal with setup in driven pile applications, and beyond the initial investigations performed by Rausche et al. (1996), no literature was found to confirm or deny the usefulness of this test. Additional work would be recommended to evaluate the possible benefits of additional efforts to implement such tests to predict setup.

The CPT-U tests, which would be easily implementable by Mn/DOT due to the growing fleet of CPT rigs, received mixed reviews from the two states that have used such tests to deal with setup. Maryland felt that the test was a poor indicator for both magnitude and rate of setup. Massachusetts felt that the test did a good job of predicting both magnitude and rate of setup. Additional information from other states would be helpful in making a more informed decision with respect to these tests. This is the most appropriate direction for Mn/DOT to pursue and will be addressed further.

Model pile tests seem to be growing somewhat in popularity, although only a few states have implemented such tests at this point, and this implementation is in limited cases. The results appear to be more reliable than other field methods, with the states that have used such model piles reporting that the model piles provide a good prediction of the magnitude of setup, even though one of the states felt it did a poor job predicting the rate of setup.

Apart from PDA and CAPWAP analyses of piles during restrikes, no additional information was obtained with respect to additional field tests that could be used to estimate setup. Such tests as the dilatometer and other possibilities were anticipated as responses to the survey. However, no states provided any field tests to indicate use in predicting setup. Similarly, no lab tests (beyond basic classification tests and simple consolidation and shear tests) were presented that have been used to predict magnitude or rate of setup. Such tests have simply been used to estimate whether or not a soil might be expected to witness setup or not.

Overall, a recommendation is made that CPT-U tests be pursued further by Mn/DOT to evaluate whether they could be utilized to predict the magnitude and/or rate of setup in soil profiles that would be expected to be subject to this phenomenon. Since such testing has only been used on a very limited basis, it is suggested that additional contact with such states as Massachusetts (which is familiar with both the model pile testing and the CPT-U tests) be made to determine what course could/should be taken in further study of the application of these tests. Dr. Sam Paikowsky at the University of Massachusetts – Lowell has offered his services to provide additional information relating to CPT-U dissipation tests and their usefulness in predicting rate of setup. CPT dissipation tests should be performed to estimate the pore pressure dissipation characteristics of the soils considered to be susceptible to setup. Such additional effort is cost-effective for projects that meet one or both of the following criteria: 1) the site can be shown (using CPT-U tests or other methods) to have a high probability of relatively large magnitudes of setup occurring, and 2) a large number of piles will be used on a project with measureable setup anticipated such that the extra expense of quantifying setup is justified by cost savings in reduced pile lengths and/or time on the project. Table 4 shows a summary of recommended situations where setup identification and prediction can be justified and should be pursued.

Along with such dissipation tests, restrike analyses should be performed to monitor the increase in pile capacity with time over an extended period of time. Mn/DOT frequently requires restrikes to be performed after three days. A number of states required restrikes to be performed after one week, which would allow more setup to occur than after a three-day period, especially for large pile groups. The combination of extending the time period before restrikes are performed and perhaps restriking multiple times during that time period would give a better indication of the setup response of the site. Having this information would allow a relationship between pore pressure dissipation characteristics and setup such that a correlation could be developed. Additionally, contact should be made with other states that are researching methods of predicting pile setup (Indiana and Louisiana have such projects underway) to determine if any states are investigating implementation of CPT-U testing in predicting pile setup. There appears to be a strong demand to develop such a relationship by a number of states. Submission of an NCHRP proposal to address this application and/or participating in a Pooled Fund study with states sharing such interest would be strongly recommended, although such a project would not obtain a very immediate answer.

Table 4. Setup investigation recommendations

	Project Size		
Anticipated Extent of Setup	Small (<20 Piles per Site)	Medium (20-100 piles per Site)	Large (>100 Piles per Site)
<10 percent	No implementation of setup design	No implementation of setup design	No implementation of setup design
10-25 percent	No implementation of setup design	May implement setup design	May implement setup design
25-50 percent	No implementation of setup design	Implement setup design	Implement setup design
50-100 percent	May implement setup design	Implement setup design	Implement setup design
>100 percent	Implement setup design	Implement setup design	Implement setup design

"Setup Design" would require the contractor to wait a specified time to verify setup and/or perform additional testing to verify increased capacity.

To summarize, the following recommendations are made to Mn/DOT to move toward incorporating setup into driven pile design:

- Pursue additional studies with respect to CPT use in downdrag prediction (dissipation tests, etc.) Such studies may be within Mn/DOT, as a Pooled Fund study, through an NCHRP investigation, or other potential studies.
- Invest in u_3 pore pressure positions for Mn/DOT cones, require contractors to obtain u_3 measurements in future projects.
- Begin performing dissipation tests on sites where:

  1 – Setup is anticipated (based on past performance and/or Table 4),

  2 – Restrikes can/will be performed (ideally multiple times).
- Use such data to develop a database that can be used to refine/improve rate of setup predictions. The combination of restrike data and dissipation test data can be used to calibrate and/or validate the prediction model established by Paikowsky et al. (2004).
- Require series of restrikes (7 days, 10 days, 30 days, etc.) in addition to standard restriking practice (1 day to 3 days) at sites where dissipation tests indicate significant time for pore pressure dissipation (this requires advance cooperation/planning for contractors).
- Obtain data from past test piles to compare capacity at EOID and BOR. In appropriate cases (i.e., where significant setup occurred), perform dissipation tests at (or near) the site to obtain appropriate data to validate setup prediction models.
- Transmit all pile driving data (driving records, PDA, CAPWAP, etc.) including electronic files between the Bridge Office and Foundations Unit to allow database development and setup evaluation.
- Implement setup in design to reduce required EOID capacities while maintaining necessary long-term capacity.

Implementing these recommendations will allow Mn/DOT to quantify rate of setup (and potentially magnitude), moving toward the ability to account for setup at the design phase. As extended restrikes are used on projects, justification of lower EOID capacities can be made for production piles. Significant additional work has yet to be done, but these steps will be a move in the right direction to allow more effective pile design in the future.

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APPENDIX A

Mn/DOT SETUP SURVEY

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name:
State Agency Represented:
Title:
Mailing Address:
Telephone Number:
E-mail Address:

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☐ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☐ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

APPENDIX B

SAMPLE E-MAIL CORRESPONDENCE TO AASHTO CONTACT LIST

Dear Richard,

My name is Aaron Budge. I am a geotechnical engineering faculty member at Minnesota State University, in Mankato, Minnesota. My background includes driven pile analysis and design, MSE wall design, and various other geotechnical interests.

I am currently working on a project for the Minnesota Department of Transportation in conjunction with Dr. Sam Paikowsky at the University of Massachusetts – Lowell. A portion of this project relates to determining what laboratory or field methods are currently being utilized by transportation departments throughout the United States that predict the magnitude and rate of side shear setup (an increase in pile capacity with time) with respect to driven pile design. Mn/DOT would like to implement such methods if they have proven to be effective.

An extensive literature review has provided a number of tests that might have such application. However, we would like to get a feel for which (if any) of these methods are actually being used nationwide, along with an idea of how well such methods do at predicting the magnitude and rate of setup. To this end, I have worked with Mn/DOT to prepare a very brief (<10 minute) survey to be completed by each state to provide some information about such tests. I have attached this survey to this message for your reference.

For the majority of the questions given, the Geotechnical Engineer or Foundations Engineer for your state would be most appropriate as a reference. The intent of this message is to find out from you whom I should contact to discuss the survey further. I realize that you are likely not the person who would be most familiar with the soil conditions, the presence (or lack) of soil setup, and the general practice of driven pile design in the state, although I'm sure you have a good idea of such topics.

Please reply to this e-mail to give me the contact information (name, position, e-mail address) for the individual you feel would be most appropriate to respond to this survey. I realize that the DOT's receive a number of such requests on a regular basis, but Mn/DOT feels that this is an important step in being able to implement a critical feature in their design procedure. As mentioned, the survey is very brief, but will provide valuable information that is not available elsewhere. I have already reviewed several past and current studies that are of a similar nature, but none of these provide adequate information as to the methods used to predict setup.

If possible, please respond to this message by Tuesday, 06 May so that I can proceed with the survey. Thank you very much for your time. Please let me know if you have any questions or concerns.

Aaron

****
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****

APPENDIX C

SAMPLE FOLLOW-UP E-MAIL CORRESPONDENCE TO SECOND CONTACTS

Dear Athar,

My name is Aaron Budge. I am a geotechnical faculty member at Minnesota State University. I was given your name by Anne Rearick, Manager of the Office of Structural Services for INDOT. I asked her to provide contact information for someone at the Indiana DOT that could help me with a survey I am conducting for the Minnesota Department of Transportation, and she felt that you were the person for the job. Some additional information about me and this project is given in my original message to Anne below.

In a nutshell, Mn/DOT is interested in finding out what (if any) methods the state DOT's are using to predict the magnitude and rate of side shear setup with respect to pile driving. Mn/DOT and I have developed a short (<10 minute) survey to obtain an idea of how setup affects projects in your state and how (if at all) you incorporate setup into driven pile design.

I have attached this survey to this message and would ask you to please take a few minutes to complete it. I would be happy to share the results with you once the data has been collected, and I hope it will help us better understand any methods that are available for incorporating setup into pile design.

Please let me know if you have any questions or concerns. If possible, please complete the survey by Wednesday (07 May) so that I can move forward with compiling the information collected. I certainly know that your time is valuable and very much appreciate you taking time to help with this.

Thank you!

Aaron

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Aaron S. Budge, Ph.D.
Assistant Professor
Minnesota State University, Mankato
Dept. of Mechanical and Civil Engineering
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Mankato, MN 56001
Tel: (507) 389-3294
Email: aaron.budge@mnsu.edu
****

APPENDIX D

RESULTS OF STATE SETUP SURVEY

Appendix D-1

Alabama Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Kaye Chancellor Davis
State Agency Represented: Alabama Department of Transportation
Title: Assistant Geotechnical Engineer
Mailing Address: 3700 Fairground Road, Montgomery, AL 36110
Telephone Number: 334.206.2277
E-mail Address: chancellork@dot.state.al.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: Clayey or Sandy Silts below water table.

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

We will wait an extended time on our test piles and then perform a dynamic restrike to determine if the pile has gained capacity in the time allowed. Many times the increase in capacity from EOID are quite significant.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-2

Alaska Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: David A. Hemstreet
State Agency Represented: State of Alaska DOT/PF
Title: State Geotechnical Engineer
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Telephone Number: 907.269.6233
E-mail Address: dave.hemstreet@alaska.gov

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

Primarily use grain size distribution and PI. We don't usually count on setup to occur, but if capacity is not achieved at EOD, then we look at BOR to see if capacity has improved.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-3

Arizona Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Norman Wetz
State Agency Represented: Arizona Dept. of Transportation
Title: Geotechnical Design Engineer
Mailing Address: 1221 N. 21st Ave., Phoenix, Arizona 85009
Telephone Number: 602-712-8093
E-mail Address: nwetz@azdot.gov

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☒ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☒ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☒ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☒ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-4

Arkansas Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
  Generally used on large quantity jobs for test piles only
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: **We have no specific data to justify answers. The few problems that have been reported by field personnel are within areas with silts and loose sand deposits.**

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: **See item 6 above**

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-5

California Response

No Response as of 13 August 2009

Appendix D-6

Colorado Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Colorado DOT
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? 5%
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: Shale with H-pile, other above marked soils with pipe pile..

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: shale

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-7

Connecticut Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
  Generally test piles will be restruck, but not typically production piles (unless end of driving resistance is less than expected).
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
  The dynamic monitoring or static load testing is typically performed on test piles, but not production piles. Number of test piles will vary by site, but on the order of 2-3%
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☒ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-8

Delaware Response

No Response as of 13 August 2009

Appendix D-9

District of Columbia Response

No Response as of 13 August 2009

Appendix D-10

Florida Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **Varies, usually 5% - 10%**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: **Clayey Sand**

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☒ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☒ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☒ Other (please explain)

Use of setup is limited to projects where driving to achieve capacity at EOID is too expensive or difficult. When such conditions exist, restrike analyses and/or static load tests are required.

Appendix D-11

Georgia Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-12

Hawaii Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☒ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☒ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-13

Idaho Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Idaho Transportation Dept.
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Telephone Number: 208 334 8448
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **1-5 %**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☒ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-14

Illinois Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☒ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

We retap piles when they do not get bearing at the ordered length after 24 hours. No help on rate and gives snap shot of magnitude at 24 hours.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-15

Indiana Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: INDOT
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Telephone Number: 317-610-7250
E-mail Address: msmadi@indot.in.gov

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? 30%
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☒ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: Shale

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-16

Iowa Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Kyle Frame
State Agency Represented: Iowa Department of Transportation
Title: Foundations Field Engineer
Mailing Address: 800 Lincoln Way, Ames IA 50010
Telephone Number: (515) 239-1619
E-mail Address: kyle.frame@dot.iowa.gov

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☒ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☒ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☒ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☒ Other (please explain) **See e-mail discussion by Kyle Frame**

Appendix D-17

Kansas Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Kansas DOT
Title: Chief Geologist
Mailing Address: 2300 Van Buren, Topeka, KS 66611
Telephone Number: 785-291-3860
E-mail Address: Roberth@ksdot.org

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **< 1%**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: Loess

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-18

Kentucky Response

No Response as of 13 August 2009

Appendix D-19

Louisiana Response

No Response as of 13 August 2009

Appendix D-20

Maine Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Maine Dept of Tranportation
Title: Snr Geotechnical Engineer
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Telephone Number: 207-624-3441
E-mail Address: laura.krusinski@maine.gov

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☒ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? 1-2%
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? 2-5%
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: Dense sandy silts and silty sands with gravel. These are mostly glacial tills with a high fines content. Also, end bearing piles on weathered metasiltstones.

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

Restrikes 24 hrs after EOD test

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-21

Maryland Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: John Narer
State Agency Represented: Maryland State Highway Administration
Title: Project Engineer
Mailing Address: 707 North Calvert Street, Baltimore, MD 21202
Telephone Number: 410 545 8368
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: Loess

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☐ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☒ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☒ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

Occasionally pile restrikes with dynamic monitoring are used to estimate the magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-22

Massachusetts Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **10%**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **10%**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude **(being considered)**
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☐ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☒ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☒ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☒ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☒ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

Using PDA measurements, on various piles, at times from EOD, restrike, at 3 and 7 days.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-23

Michigan Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Michigan Dept of Transportation
Title: Supervising Engineer
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **10**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-24

Minnesota Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Mn/DOT
Title: Foundations Engineer
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E-mail Address: gary.person@dot.state.mn.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **10-25%**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-25

Mississippi Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Mississippi Department of Transportation
Title: State Geotechnical Engineer
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Telephone Number: 601-359-1795
E-mail Address: sferguson@mdot.state.ms.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **All PDA test piles**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☒ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

The test piles are PDA monitored on larger bridge projects. All PDA test piles require a 1 day and 7 day restrike. Setup is estimated using data obtained from the initial drive and restrikes. We've had good success in predicting / estimating pile setup particularly in clays as evidenced by static load tests performed along with dynamic monitoring.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☒ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-26

Missouri Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Missouri Department of Transportation
Title: Geotechnical Engineer
Mailing Address: 1617 Missouri Boulevard, Jefferson City, MO 65109
Telephone Number: 573-526-4340
E-mail Address: thomas.fennessey@modot.mo.dot

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
  (never on soil & occasionally where rock is shallow)
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup

(This is based on anecdotal experience but little measured and documented experience.)

- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

(This is based on anecdotal experience but little measured and documented experience.)

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: **clay till**

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state? **(This is personal opinion with no known measured and documented experience.)**

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)? **(I am anticipating that we could experience relaxation in dense sands and gravels but have no known measured and documented experience.)**

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

(See Wisconsin Highway Research Report 03-05 "Estimating Soil/Pile Set-Up", http://www.whrp.org/Research/publications/Final%20Reports/WHRP%2003%2005%20Estimating%20SoilPile%20Setup.pdf)

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude

(See Wisconsin Highway Research Report 05-16 "Investigation of Standard Penetration Torque Testing (SPT-T) to Predict Pile Performance", http://www.whrp.org/Research/Geotechnics/geo_0092-04-09/WHRP_05-16_SPT-T.pdf)

☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
☐ The test does a poor job of predicting both the rate and the magnitude of setup
☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
☐ The test does a poor job of predicting both the rate and the magnitude of setup
☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
☐ The test does a poor job of predicting both the rate and the magnitude of setup
☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-27

Montana Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☒ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-28

Nebraska Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Omar Qudus
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Title: Geotechnical Engineer
Mailing Address: 1400 HWY II Lincoln Ne 68509
Telephone Number: 402-479-4394
E-mail Address: oqudus@dor.state.ne.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: **Shale and sand stone**

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-29

Nevada Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Parviz Noori
State Agency Represented: Nevada DOT
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☒ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **5**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **5**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☒ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-30

New Hampshire Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: NHDOT
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E-mail Address: tcleary@dot.state.nh.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **1% for friction piles**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **3 to 5 %**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☒ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
  1 test per project for friction pile site
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

restrike testing with PDA for friction pile sites

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☒ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-31

New Jersey Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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E-mail Address: jack.mansfield@dot.state.nj.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **10%**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **5%**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

Restriking of test piles with PDA monitoring.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-32

New Mexico Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: New Mexico
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **1 per bent**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☒ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
  1 per bridge if FS=1.9
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:
Loose saturated sands and silty sands of the Rio Grande and Pecos River channels.

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

PDA/CAPWAP analysis of test pile at 48 and 72 hour restrikes

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

N/A

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☒ Other (please explain)

FS of 2.0 is applied to any measured setup and applied to the ultimate capacity at EOID.

Appendix D-33

New York Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: New York State Department of Transportation
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Telephone Number: (518) 457-4767
E-mail Address: pwalton@dot.state.ny.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **5%**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **5%**
  Dynamic tests not done on all pile projects.
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☒ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation: **Weathered Shale**

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

Rarely: atterberg limits, consolidation, and strength tests. Normally, these are only performed if justified by additional geotechnical concerns.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☒ Other (please explain)

Initial drive WEAP criteria and estimated length from static analysis are used to stop driving of first piles. After 12 to 24 hour set-up, first blows on set-up pile compared to after set-up (assumes strength gain) WEAP prediction. If blow count criteria are met, use initial drive WEAP criteria to control pile driving. Use dynamic testing and engineering judgement if results are not satisfactory. Guidance provided by GRL has proven reliable for strength gain predictions.

Appendix D-34

North Carolina Response

No Response as of 13 August 2009

Appendix D-35

North Dakota Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☒ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☒ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☒ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☒ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☒ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-36

Ohio Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Title: Assistant Administrator
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Telephone Number: 614-728-2057
E-mail Address: jsiddiqi@dot.state.oh.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles? **5%**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☒ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested? **<1%**
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:
End Bearing piles driven to refusal on soft shales prone to degradation when in contact with water.

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

Restrike Tests utilizing PDA Testing Procedures

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-37

Oklahoma Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Telephone Number: 405-522-4998
E-mail Address: vreidenbach@odot.org

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles do you restrike?

- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles?

- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles are load tested?

- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☒ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-38

Oregon Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☒ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☒ Yes
- ☐ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

For cohesive soils (clays) use three-stage triaxial CU test with pore pressure measurements to obtain drained shear strength parameters for use in static pile analysis (relative to the undrained shear strength). Drive piles to estimated depths based on drained static anaylsis, then restrike. Rate of set-up (number of days to restrike) based on experience and empirical relationships (24 hour minimum).

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☒ Other (please explain) see explaination in 6b.

Appendix D-39

Pennsylvania Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Beverly Miller
State Agency Represented: Pennsylvania Department of Transportation
Title: Civil Engineer Consultant Bridge
Mailing Address: Commonwealth of PA, Department of Transportation, 400 North Street, Harrisburg, PA 17120
Telephone Number: (717) 783-4338
E-mail Address: bevemiller@state.pa.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles do you restrike?
  - **If a restrike is specified at the time of design, it is generally performed for test piles, typically two per substructure unit.**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles?
  - **When friction piles are used in Pennsylvania, dynamic monitoring is typically specified. The dynamic monitoring is performed on the test piles (typically 2 per substructure unit). For more difficult soils/geology additional dynamic monitoring may be considered, including a portion of the production piles. However, construction sites where an increased frequency of dynamic monitoring is required are rare.**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-40

Puerto Rico Response

No Response as of 13 August 2009

Appendix D-41

Rhode Island Response

No Response as of 13 August 2009

Appendix D-42

South Carolina Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles?

  AASHTO recommendations
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☒ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☐ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☒ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-43

South Dakota Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Title: Foundation Engineer
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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☒ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles do you restrike? **1**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles?
- ☒ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☒ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☒ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-44

Tennessee Response

No Response as of 13 August 2009

Appendix D-45

Texas Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: Texas DOT
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Telephone Number: 512-416-2226
E-mail Address: mmcclell@dot.state.tx.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles do you restrike?
  - **0-5% depending on structure**
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-46

Utah Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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State Agency Represented: UDOT
Title: Geotechnical Engineer
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Telephone Number: 801-965-4326
E-mail Address: jonbischoff@utah.gov

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☒ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles? **10**
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity
  - If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☒ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-47

Vermont Response

No Response as of 13 August 2009

Appendix D-48

Virginia Response

No Response as of 13 August 2009

Appendix D-49

Washington Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

Name: Jim Cuthbertson
State Agency Represented: Washington DOT
Title: Chief Foundations Engineer
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Telephone Number: 360.709.5452
E-mail Address: CUTHBEJ@WSDOT.WA.GOV

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☒ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☒ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☒ Gravel deposits
- ☒ Other (please specify below)

List any other soil profiles in your state that commonly experience setup: **Glacially overconsolidated soils**

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☐ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☒ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

I left this blank. We have used CPT methods for estimating pile capacity. We have also looked at porewater pressure dissipation tests to help assess drainage characteristics which can give you an idea of setup. We have not confirmed setup in the piles we have designed using CPT methods, so I can not say if the methods are good, bad, or indifferent. – Jim Cuthbertson

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☒ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-50

West Virginia Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☒ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

If checked, approximately what percentages of the production piles do you restrike? 1% soft shale & claystone

- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☒ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

If checked, approximately what percentages of the production piles? 1% on project with 50 piles or more

- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☒ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

If checked, approximately what percentages of the production piles are load tested? .01% only when nominal cap is +1000 kip

- ☐ Our agency requires static load tests on the majority of production piles

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☐ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☐ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☐ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☐ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☐ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☐ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)

Appendix D-51

Wisconsin Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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Title: Foundation and Pavement Engineering Supervisor
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E-mail Address: Robert.Arndorfer@dot.state.wi.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☒ Our agency often uses Driven Piles for transportation applications
- ☐ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☒ Our agency rarely uses Drilled Shafts for transportation applications
- ☐ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☐ Our agency rarely uses Shallow Foundations for transportation applications
- ☒ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☒ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles

SEE COMMENTS ON FOLLOWING PAGE.

COMMENTS: **In certain situations WisDOT counts on set-up and retaps approximately 10% of piles. This is done on a fairly limited basis, generally at the time of construction to limit excessive pile lengths during driving. We sometimes also perform dynamic testing (PDA) on a very limited number of projects. This is also generally 10%. PDA testing can be incorporated into the plans or done during construction, similar to retaps.**

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☒ Loose sand deposits
- ☒ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☐ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☒ Other (please explain)

Generally only base capacity on EOID, but sometimes use setup with retaps during construction to limit excessive pile lengths.

Appendix D-52

Wyoming Response

Minnesota Department of Transportation Research Project
Methods of Predicting Magnitude and Rate of Side Shear Setup

Please contact Aaron Budge at Minnesota State University, Mankato
with any questions/problems regarding this survey.
aaron.budge@mnsu.edu or (507) 389-3294

Section 1 – Contact Information

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E-mail Address: kirk.hood@dot.state.wy.us

Section 2 – Basic Pile Driving Practice Information

1 – For transportation applications in your state, which of the following best describes the use of Driven Piles:

- ☐ Our agency never uses Driven Piles for transportation applications
- ☐ Our agency rarely uses Driven Piles for transportation applications
- ☐ Our agency occasionally uses Driven Piles for transportation applications
- ☐ Our agency often uses Driven Piles for transportation applications
- ☒ Our agency almost exclusively uses Driven Piles for transportation applications

2 – For transportation applications in your state, which of the following best describes the use of Drilled Shafts:

- ☐ Our agency never uses Drilled Shafts for transportation applications
- ☐ Our agency rarely uses Drilled Shafts for transportation applications
- ☒ Our agency occasionally uses Drilled Shafts for transportation applications
- ☐ Our agency often uses Drilled Shafts for transportation applications
- ☐ Our agency almost exclusively uses Drilled Shafts for transportation applications

3 – For transportation applications in your state, which of the following best describes the use of Shallow Foundations:

- ☐ Our agency never uses Shallow Foundations for transportation applications
- ☒ Our agency rarely uses Shallow Foundations for transportation applications
- ☐ Our agency occasionally uses Shallow Foundations for transportation applications
- ☐ Our agency often uses Shallow Foundations for transportation applications
- ☐ Our agency almost exclusively uses Shallow Foundations for transportation applications

4 – With respect to Driven Pile design, mark EACH of the following that apply at your agency:

- ☐ Our agency does not use Driven Piles for transportation applications
- ☐ Our agency estimates pile capacity at the end of initial driving (based on various methods)
- ☐ Our agency requires a restrike analysis on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles do you restrike?
- ☐ Our agency requires a restrike analysis on the majority of production piles
- ☐ Our agency requires dynamic measurements on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles?
- ☐ Our agency requires dynamic measurements on the majority of production piles
- ☐ Our agency requires static load tests on a certain percentage of production piles to confirm capacity

  If checked, approximately what percentages of the production piles are load tested?
- ☐ Our agency requires static load tests on the majority of production piles
- ☒ N/A. **We only test pile if it is a friction pile design in alluvium which is about once a year. Our pile designs are 99% end bearing designs into bedrock**

The phenomenon known as side shear setup, soil freeze, or setup (describing an increase in pile capacity with time) has been documented in many soil types, showing increased pile capacities compared to the End of Initial Drive (EOID) capacities after some period of time has elapsed. This effect has been witnessed in both cohesive and cohesionless soil profiles, although the extent of the increased capacity is typically more pronounced in cohesive profiles. Soil relaxation (or a decrease in pile capacity with time) has also been experienced in various soil profiles. Please answer the following questions with respect to pile setup and relaxation as experienced in your state. (Obviously soil profiles may vary greatly throughout your state. Try to answer the questions on a statewide basis, if possible.)

5 – Which of the following best describes your experience with setup with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to side shear setup
- ☐ Our state has a few localized regions where soil profiles are subject to side shear setup
- ☒ Our state has many regions where soil profiles commonly experience side shear setup
- ☐ Much of our state has soil profiles that are subject to side shear setup

6 – Which of the following general soil profiles has been most affected by soil setup in your state (mark all that apply)?

- ☒ Fat clay deposits
- ☒ Lean clay deposits
- ☒ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☐ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience setup:

7 – Which of the following best describes your experience with relaxation with respect to Driven Pile applications in your state?

- ☐ Our state does not have soil profiles that appear to be subject to relaxation
- ☒ Our state has a few localized regions where soil profiles are subject to relaxation
- ☐ Our state has many regions where soil profiles commonly experience relaxation
- ☐ Much of our state has soil profiles that are subject to relaxation

8 – Which of the following general soil profiles has been most affected by relaxation in your state (mark all that apply)?

- ☐ Fat clay deposits
- ☐ Lean clay deposits
- ☐ Silty clay deposits
- ☐ Silty sand deposits
- ☐ Loose sand deposits
- ☐ Dense sand deposits
- ☒ Gravel deposits
- ☐ Other (please specify below)

List any other soil profiles in your state that commonly experience relaxation:

Section 3 – Methods of Predicting Magnitude and Rate of Setup

Several methods have been or are currently being developed as tools to estimate the magnitude and rate of setup in pile driving installations. Some states have implemented such tools for several years, while other states may not have used such tools at all. Please answer the questions below to provide feedback on which (if any) of the following tools your agency currently uses and/or has used in the past, and how helpful the tool(s) has (have) been in your pile driving practice.

1a – Which of the following describes your use of the SPT-T test (torque mechanism applied to a traditional SPT sampler) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT-T test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT-T test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT-T test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

1b – Regarding the use of SPT-T tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT-T test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

2a – Which of the following describes your use of the SPT-uplift test (dynamic upward measurements to standard SPT system) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the SPT- uplift test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the SPT- uplift test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

2b – Regarding the use of SPT- uplift tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the SPT- uplift test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

3a – Which of the following describes your use of the CPT-U test (Cone Penetration Test with Pore Pressure Measurements) in predicting the magnitude and/or rate of setup (mark all that apply)?

- ☒ Our agency has never used the CPT-U test in predicting setup rate or magnitude
- ☐ Our agency has sometimes used the CPT-U test to predict setup rate and/or magnitude
- ☐ Our agency has frequently used the CPT-U test to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use the CPT-U test to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

3b – Regarding the use of CPT-U tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used the CPT-U test to predict setup rate or magnitude
- ☐ The test does a poor job of predicting both the rate and the magnitude of setup
- ☐ The test does a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The test does a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The test does a good job of predicting both the rate and the magnitude of setup

4a – Which of the following describes your use of instrumented model pile tests (such as Paikowsky et al., 2001) in predicting the magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ Our agency has sometimes used model pile tests to predict setup rate and/or magnitude
- ☐ Our agency has frequently used model pile tests to predict setup rate and/or magnitude
- ☐ It is common practice for our agency to use model pile tests to predict setup rate and/or magnitude
- ☐ Not Applicable – we do not use Driven Piles and/or do not have soil profiles that are known to experience setup

4b – Regarding the use of model pile tests to predict magnitude and/or rate of setup, which of the following best describes your evaluation of the effectiveness of the test in predicting magnitude and/or rate of setup?

- ☒ Our agency has never used model pile tests to predict setup rate or magnitude
- ☐ The tests do a poor job of predicting both the rate and the magnitude of setup
- ☐ The tests do a good job of predicting rate of setup but a poor job of predicting magnitude of setup
- ☐ The tests do a good job of predicting magnitude of setup but a poor job of predicting rate of setup
- ☐ The tests do a good job of predicting both the rate and the magnitude of setup

5a – Does your agency use any other field testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

5b – If yes, please provide information as to the type of test performed and comment on how effective you feel the test is at predicting rate and magnitude of setup.

6a – Does your agency use any laboratory testing procedures to predict either the rate or magnitude of setup at pile installations?

- ☐ Yes
- ☒ No

6b – If yes, please provide information as to the type of laboratory test(s) performed and comment on how effective you feel the test(s) is (are) at predicting rate and magnitude of setup.

7 – Does your agency incorporate setup into driven pile design, such that an increased pile capacity with time will override an End of Initial Drive (EOID) capacity?

- ☒ Our agency bases pile capacity on the EOID capacity only – no setup effects are applied
- ☐ Increased pile capacities are allowed when a restrike analysis or static load test is performed on the pile
- ☐ Increased pile capacities are estimated during the course of design based on local experience with setup
- ☐ Increased pile capacities are estimated based on field and/or lab procedures as specified above
- ☐ Other (please explain)