Appendix Data Collection and Load Test Database

The work described in this report required analysis of micropile load test data to develop appropriate design models and to evaluate variability and uncertainty in micropile resistance. Concerted effort was therefore made to acquire a robust collection of micropile load test data from published and unpublished sources. This appendix describes the efforts taken to collect micropile load test data; the general characteristics of the collected data; and a simple load test database developed to facilitate the collection, tracking, and analysis of the load test data.

A.1 PUBLISHED LOAD TEST DATA

Published references documenting micropile load tests from various domestic and international sources were collected and reviewed. Relevant papers and reports were identified using several databases, including the Transport Research International Documentation (TRID) database, proceedings of the International Society for Micropiles (ISM), the OneMine.org database (employed for publications by the Deep Foundations Institute), and the ASCE publications database. Additional references were identified from online search engines and by directly searching within common geotechnical journals (e.g., *Canadian Geotechnical Journal*, *Géotechnique*, *International Journal of Geomechanics*, *Soils and Foundations*). Dissertation and thesis documents, including micropile load test information, were also reviewed.

The collected load test data from published sources are summarized by micropile type and by bond length material in Tables 1 and 2. Table 1 summarizes the load tests reported to achieve failure while Table 2 shows the load tests characterized as proof tests. For both tables, the first number in each cell is the number of tests with results explicitly provided. Some cells have a second number in parentheses, which indicates load tests discussed in the publications but without explicit reporting of individual test results. For example, several documents describe collections of micropile load tests but present either specific results only for select representative tests or average results without listing individual test results.

Table 1 – Number of collected (identified) axial load tests for micropiles achieving failure.

Bond Length Material	Micropile Type					Total
	A	B	C	D	E	
Cohesive soil	7	2	0	3 (3)	5	17 (3)
Sandy soil	4	7	0	3	2	16
Weak rock	4	0	1	2	0	7
Competent rock	4	0	0	0	0	3
Total	19	9	1	8 (3)	7	44 (3)

The quality of provided information varied for the collected load tests. For most of the 44 tests that achieved failure (Table 1) and the 185 tests not achieving failure (Table 2), load-displacement curves were supplied. The documents for most of the remaining tests included values of maximum applied load and maximum displacement, but some documents instead reported average unit bond resistance values. The records for all of the collected tests included at least qualitative information regarding soil or rock type. Documents for about two-thirds of the tests provide at least some quantitative information regarding soil strength, with some reports providing standard penetration test (SPT) information, some cone penetration test (CPT) data, and others laboratory test information.

Table 2 – Number of collected (identified) axial load tests for micropiles not achieving failure.

Bond Length Material	Micropile Type					Total
	A	B	C	D	E	
Cohesive soil	10	16 (536)	8 (1)	60	4 (223)	98 (758)
Sandy soil	5	17	4	15 (527)	8 (179)	49 (706)
Weak rock	14 (3)	5	1	10 (4)	0	30 (7)
Competent rock	4	2	0	0	2	8
Total	33 (3)	40 (534)	13 (1)	85 (531)	14 (404)	185 (1,471)

Several of the large values reported in Tables 1 and 2, such as the following, represent projects involving large numbers of tests:

- In Table 2, the 60 load tests for Type D micropiles in cohesive soil are pullout tests described by Misra et al. (2007). Nearly 700 micropiles were installed for the project, with design capacities between 350 and 450 kips. The static tests were conducted incrementally until either (1) the design pullout capacity of the micropile was achieved or (2) the head displacement exceeded the allowable value of 0.5 inches. Some of the load-displacement curves presented by Misra et al. could arguably be interpreted as having achieved failure, but most did not.

- Gómez et al. (2007a, 2007b) and Gómez et al. (2008a) documented a total of 404 proof load tests on hollow bar micropiles at four soil sites in the Coastal Plain province of New Jersey. Initially, micropiles from two sites were tested (Gómez et al. 2007a), with 180 load tests performed on micropiles installed in sandy soil and 80 load tests performed on micropiles in stiff clay. Subsequently, 144 additional hollow bar micropiles were installed and proof tested, with 64 of the micropiles being in cohesive soil and 80 being in stratified sand and clay (Gómez et al. 2008).

- Vanderpool et al. (2002) described the installation and proof testing of 536 Type B micropiles in cohesive soil. A total of 667 compression load tests were attempted on the 536 micropiles. Of these, 56 tests were aborted (e.g., for reasons such as instrumentation failure, jack or frame misalignment or distortion, hydraulic leaks); 74 micropiles were retested for failing to achieve the creep acceptance criteria in the first test.

- Small and Jameson (2010) document the testing of 542 Type D micropiles installed in silty and clayey sand overlying bedrock. All of the micropiles were tested according to FHWA procedures for testing ground anchors (Sabatini, Pass, and Bachus 1999). Most micropiles were proof tested, using one load cycle to 1.33 times the design load, but 13 micropiles were tested using six load cycles up to a maximum load of 1.33 times the design load (a performance test). None of the tests was reported as achieving failure.

Not all load tests identified in the literature review were included in Tables 1 and 2. Some tests were excluded for the following reasons:

- The primary cause for exclusion was insufficient information. For example, Cushing et al. (2004) summarized axial compression tests of 22 micropiles in rock, but no details were provided regarding the micropile type or the method of micropile installation. In another example, Jeon and Kulhawy (2001) reported axial compression tests of 21 Types B, C, and D micropiles in various soil types but reported interpreted results based on hyperbolic extrapolation rather than the actual applied loads from the tests.

- Load tests reported by Valentino and Stevanoni (2017) were not included because the tested micropiles were installed by driving hollow bars—an installation procedure that fundamentally differs from common practices used in the United States.

- All tests of physical model micropiles were excluded. Results from some model studies are described in Chapter 1 (e.g., Hong and Chim 2015), but model test results were not used for development of empirical design methods or for characterization of variability.

- Some load tests were reported in multiple publications (e.g., results from the FOREVER national project in France, as described by Juran et al. 2002). Care was taken to count each load test only once among the numbers reported in Tables 1 and 2.

Several publications, including the following, discussed results of load tests on micropile groups:

- Han and Ye (2006a, 2006b) describe three sets of load test results: (1) tension and compression tests for four individual micropiles, (2) a plate load test for a steel plate at the ground surface, and (3) a compression load test of a group consisting of the four micropiles tested for the first set and the plate tested for the second test. These tests indicate that the plate carried all of the applied load for loads up to about one-third of the ultimate resistance of the group. As the group load increased, the proportion of the load carried by the micropiles increased. The results presented by Han and Ye did not indicate a significant difference in the ultimate resistance of the micropiles tested individually and as a group, but the influence of reloading the micropiles during the group test makes it difficult to draw conclusions from this observation.

- Bishop (2006) describes load tests of micropile groups from three projects in Salt Lake City. In contrast with the results from Han and Ye (2006a, 2006b), Bishop reported that individual micropiles in a group exhibit greater unit resistance than the corresponding single micropiles.

- Martin (2009) presented results from a load test of a micropile group performed as part of a foundation reuse project.

- Kyung and Lee (2017) proposed group effect factors for micropiles based on tests of centrifuge models and physical models and on a field load test of a group of four micropiles.

The number of load test measurements identified in published literature fell short of the number desired for rigorous calibration of resistance factors. Additional load tests measurements were therefore solicited from unpublished sources, as described in the remainder of this appendix.

A.2 DATA COLLECTION PLAN AND EXECUTION

A detailed data collection plan was developed based on the least adequate and most desirable information needed to calibrate resistance factors for micropiles. The least adequate information included the basic information (micropile type, soil or rock type, and unit bond resistance) necessary to calibrate resistance factors for presumptive models of micropile resistance. The most desirable information additionally included site characteristics, micropile geometry and structural properties, and load test measurements, thus providing comprehensive information to calibrate resistance factors for predictive models of micropile resistance. A single-page form was developed and organized into sections addressing site characteristics, micropile geometry and structural properties, and load test measurements. Respondents were also asked to submit more detailed project information, including load-displacement measurements for all tests and geotechnical reports.

The site characteristics section requested information on site type and ground water depth and also qualitative information regarding soil or rock type for the bonded and unbonded lengths of the micropile. The section also requested quantitative information about design parameter values that could be used to estimate the geotechnical resistance of the micropile. Such design parameters included total unit weight (γ_{tot}); strength parameters such as effective stress friction angle (ϕ') for cohesionless soils, undrained shear strength (s_u) for cohesive soils, and uniaxial compressive strength (q_u) for rock; rock quality designation (RQD); core recovery (CR); geological strength index (GSI) for rock; and any other available information related to design parameters.

The micropile characteristics section asked about micropile type; micropile designation; whether the micropile was a test or production pile; and the nominal diameter, length, and axial stiffness for the bonded and unbonded lengths of the micropile. If the micropile was reinforced with a central reinforcing bar, the type, diameter, and yield stress of the bar were requested. If the micropile was reinforced with a pipe, the outer diameter, wall thickness, and yield stress were requested. For information regarding grout, the water to cementitious materials ratio, compressive strength of grout at 28 days, and maximum sustained grout pressure during micropile installation were requested.

The load test section requested all available information regarding the load test measurements. Load information included (1) the maximum applied load during the test and (2) the failure load corresponding to a respondent-specified failure criterion (e.g., Davisson’s criterion, plunging). The form also asked for the displacement of the top of the micropile at the maximum applied load and the maximum unit bond resistance observed during the test. Design information—including the design load, proof load criterion, failure criterion, availability of load-settlement and load transfer data, uplift or compressive loading type, and any additional relevant information—was also requested. The specific site location, project type, and owner information were optional depending on the confidentiality of the projects.

The data request was distributed to all 50 state transportation agencies; the transportation agencies for Washington, DC, and Puerto Rico; and the three divisions of the FHWA Office of Federal Lands. In addition, the request was distributed to 18 micropile contractors and 18 consulting firms with micropile design experience. In response, micropile load test data were received from 21 state agencies, Eastern Federal Lands, eight consultants, and four contractors. The collected load test data were organized according to site characteristics, micropile information, and load test information and entered into an Excel spreadsheet for subsequent processing and analysis.

A.3 GEOGRAPHIC DISTRIBUTION OF COLLECTED LOAD TEST DATA

Data were collected from 110 project sites across the United States and Canada. The sites are shown in the map in Figure 1, which includes sites identified from the data request solicitation as well as 16 micropile test sites identified based on published literature. The distribution of sites across the map is evidence that the data collection effort resulted in a geographically diverse set of project sites. The map in Figure 1 does not incorporate sites without specific reported location information. The symbols used for the micropile test sites indicate the predominant type of material along the micropile bonded length: cohesive soil, sandy soil, weak rock, or competent rock. In addition to the sites in Figure 1, seven sites outside of North America were included from published literature: two in Asia (one cohesive soil, one weak rock), two in Italy (both sandy soil), and three in South America (two cohesive soil, one weak rock).

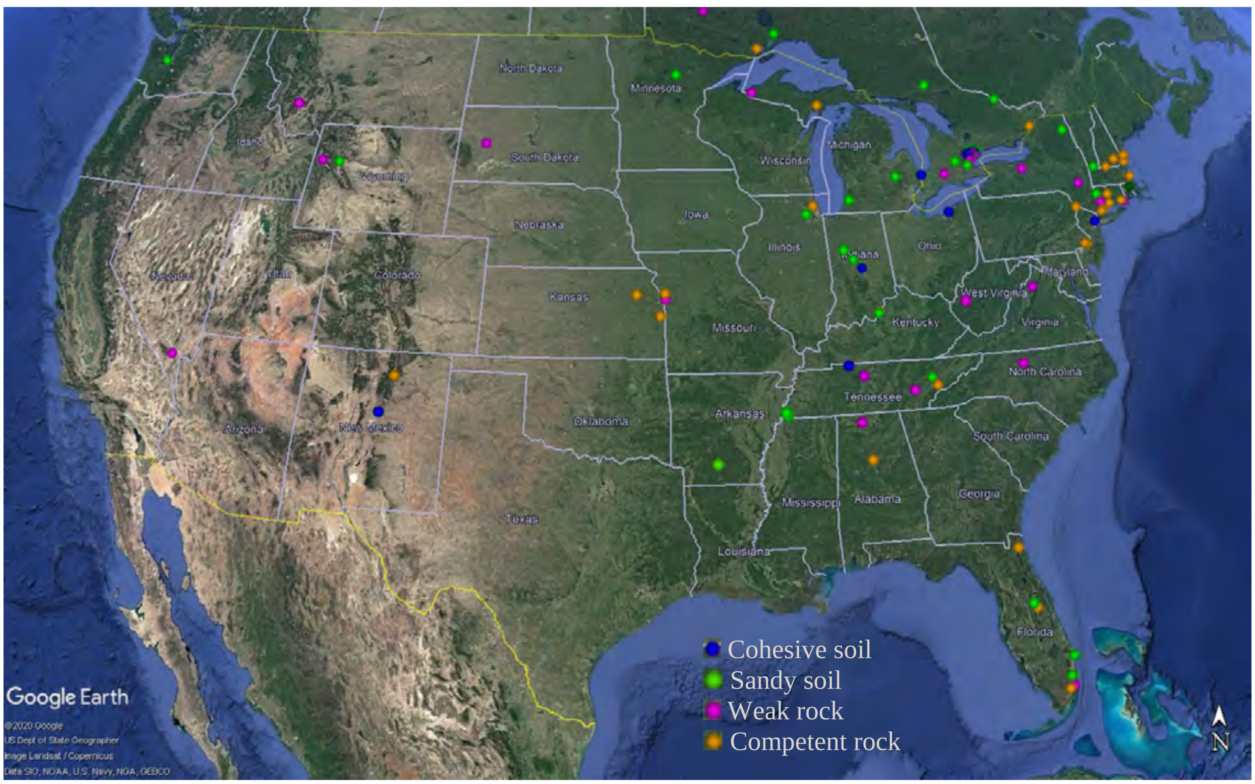

Figure 1 – Micropile load test sites.

A.4 SUMMARY OF LOAD TESTS BY MICROPILE TYPE, MATERIAL TYPE, AND LOADING DIRECTION

The total numbers for collected micropile load test records are summarized in Tables 3 through 6. The data in the tables include load test data collected from unpublished sources as well as data from published literature. Tables 3 and 4 list the number of micropile load tests that achieved failure under compressive loading and uplift loading, respectively. Tables 5 and 6 similarly present the number of collected micropile load tests that did not achieve failure under compressive loading and uplift loading, respectively. Each table includes rows for different bond length materials and columns for different micropile types. Within each cell of the tables, the first number indicates the number of micropiles tested, and the second number (in parentheses) represents the number of project sites where the tests were recorded. The numbers in the tables do not include tests where the micropile type was not specified. The majority of load tests were loaded in compression (58%) versus uplift (42%). A strong majority of the load tests did not achieve failure; in total, 85 (16%) of load tests reached failure while 461 (84%) did not. Load transfer data were provided for 27 of the load tests.

Table 3 – Summary of micropile load test records for compression tests achieving failure.

Bond Length Material	Number of Micropile Tests[1]					
	Type A	Type B	Type C	Type D	Type E	Total
Cohesive soil	1 (1)	4 (2)	0	3 (1)	2 (2)	10 (6)
Sandy soil	4 (3)	2 (2)	0	2 (1)	7 (6)	15 (12)
Weak rock	10 (7)	2 (1)	0	1 (1)	4 (1)	17 (10)
Competent rock	3 (3)	3 (3)	0	0	0	6 (6)
Mixed	0	0	0	0	0	0
Total	18 (14)	11 (8)	0	6 (3)	13 (9)	48 (34)

[1] Numbers in parentheses indicate the number of distinct project sites.

Table 4 – Summary of micropile load test records for uplift tests achieving failure.

Bond Length Material	Number of Micropile Tests[1]					
	Type A	Type B	Type C	Type D	Type E	Total
Cohesive soil	0	2 (1)	0	0	0	2 (1)
Sandy soil	2 (1)	4 (3)	0	6 (3)	9 (2)	21 (9)
Weak rock	1 (1)	1 (1)	0	1 (1)	0	3 (3)
Competent rock	6 (4)	4 (2)	0	0	1 (1)	11 (7)
Mixed	0	0	0	17 (1)	0	17 (1)
Total	9 (6)	11 (7)	0	24 (5)	10 (3)	54 (21)

[1] Numbers in parentheses indicate the number of distinct project sites.

Table 5 – Summary of micropile load test records for compression tests not achieving failure.

Bond Length Material	Number of Micropile Tests[1]					
	Type A	Type B	Type C	Type D	Type E	Total
Cohesive soil	5 (3)	6 (2)	0	2 (2)	5 (4)	18 (11)
Sandy soil	9 (5)	55 (14)	13 (1)	7 (3)	8 (6)	92 (29)
Weak rock	72 (15)	8 (4)	0	5 (1)	1 (1)	86 (21)
Competent rock	59 (15)	10 (5)	0	2 (1)	2 (2)	73 (23)
Mixed	0	0	0	0	3 (2)	3 (2)
Total	145 (38)	79 (25)	13 (1)	16 (7)	19 (15)	272 (86)

[1] Numbers in parentheses indicate the number of distinct project sites.

Table 6 – Summary of micropile load test records for uplift tests not achieving failure.

Bond Length Material	Number of Micropile Tests[1]					
	Type A	Type B	Type C	Type D	Type E	Total
Cohesive soil	12 (5)	1 (1)	0	3 (1)	4 (2)	20 (9)
Sandy soil	10 (5)	18 (8)	0	10 (5)	17 (8)	55 (26)
Weak rock	66 (18)	9 (3)	0	0	0	75 (21)
Competent rock	30 (14)	12 (6)	0	0	0	42 (20)
Mixed	0	0	0	160 (1)	0	160 (1)
Total	118 (42)	40 (18)	0	173 (7)	21 (10)	352 (77)

[1] Numbers in parentheses indicate the number of distinct project sites.

Bond length material was initially categorized into cohesive soil, sandy soil, weak rock, competent rock, and mixed material (where mixed material designated bonded lengths that extended through multiple strata composed of significantly different types of material). Without load distribution measurements, it is impossible to apportion the observed micropile resistance among the various bond length materials, so tests for micropiles in mixed material were excluded from analyses for model development and resistance factor calibration. The vast majority of micropiles tested in mixed material (160 of 180) were installed for a single project. Of the remaining tests, more than half were installed in rock, with 181 micropiles in weak rock and 132 in competent rock. As described in Chapter 2, the broad categories of "weak" and "competent" were divided into more specific categories for model development. Similarly, micropiles in sandy soil were also subdivided during model development. The sandy soil category included the most micropile load tests (183). The fewest micropile load tests were identified in cohesive soil and were not subdivided during model development. Although the cohesive soil category had the fewest tests, the 50 load tests in cohesive soil were identified from 28 different project sites, which is sufficient for model development.

As shown in Tables 3 through 6, the collected records include tests for all micropile types. Importantly, the distribution of tests among the various micropile types is reflective of practice. Cells in the tables indicating no micropile load tests represent conditions where specific micropile types are rarely used. For instance, Type C micropiles are rarely used in the United States, so it is unsurprising that only one project with tests for Type C micropiles was identified. Also, the vast majority of micropile load tests in rock were Type A or Type B, which was foreseeable because post-grouting (Type D) is generally not effective in rock and because hollow bar micropiles (Type E) are most cost-effective in soil. Just over half of the collected load test records addressed Type A (gravity-grouted) micropiles. About one-quarter of the load tested micropiles were Type B (grout injected under pressure). Only 13 (2%) of the micropiles were Type C (gravity grout followed by pressure grouting), which are rarely used in the United States. Just 42 (8%) of the micropiles were Type D (gravity grout with pressure grouting after the primary grout hardens), and 60 (11%) of the micropiles were Type E (hollow bar). As explained previously, the distribution of micropile type varied with bond length material in a manner reflective of practice.

A.5 COLLECTED LOAD TESTS FOR MICROPILES IN COHESIVE SOILS

A total of 50 load tests were collected for micropiles constructed with bonded lengths in cohesive soils, and the associated load test data reflect a broad distribution of micropile type: 18 Type A micropiles, 13 Type B micropiles, eight Type D micropiles, and 11 Type E micropiles. Of the 50 total tests in cohesive soils, 28 were subjected to compressive loading, with 10 tests achieving failure. The other 22 tests were subjected to uplift loading, with only two tests from a single research site reaching failure. The 10 compression tests achieving failure represent a wide range of geographic locations, with micropile load tests performed in Ohio, Mississippi, New Jersey, and Puerto Rico. A total of 17 load tests were conducted for micropiles installed for bridge rehabilitation or road widening, while29 load tests were performed for micropiles constructed for building foundations, and four load tests were performed for research.

A.6 COLLECTED LOAD TESTS FOR MICROPILES IN SANDY SOILS

A total of 183 micropile load tests were collected for micropiles with bonded lengths in sandy soils. Of the 183, 107 micropiles were subjected to compressive loading, with 15 load tests achieving failure. The other 76 micropiles were subjected to uplift loading, with 21 load tests reaching failure. Sandy soils were further categorized into clean sand, silty/clayey sand, and gravelly sand for development of presumptive and predictive models, as described in Chapter 2. This categorization was based on material descriptions provided in the load test records and, for a limited number of tests, on grain size distribution information.

The eight load tests in clean sand that achieved failure were performed in five different geographic regions: three tests in Indiana; one test in Florida; one test in Alabama; one test in New Jersey; and two tests in Ontario, Canada. Six of the eight micropiles were Type B; one was Type D; and one was Type E. In clean sand, 50 load tests did not reach failure. The load tests were performed in Florida, Tennessee, New Jersey, Oregon, Wyoming, Indiana, and Vermont and in several regions of Canada. The tests that did not achieve failure included nine Type A, 29 Type B, five Type D, and seven Type E micropiles. The collected data are consistent with the common application of Type B micropiles in clean sand.

A total of 96 of the collected micropile load tests were performed on micropiles with bonded lengths in silty or clayey sand. Of the load tests in silty or clayey sand, 20 achieved failure. Eight load tests were performed in North Carolina, three in California, and the remaining nine in Canada. Two Type A micropiles, five Type D micropiles and 13 Type E micropiles were tested to failure in silty or clayey sand. The other 76 micropile load tests in silty or clayey sand did not reach failure. These tests were collected from project sites in Tennessee, Michigan, Indiana, Arkansas, and New York and from multiple locations in Canada. Six micropiles were constructed as Type A micropiles, 33 as Type B, 13 as Type C, 10 as Type D, and 14 as Type E. Type C micropiles are rarely used in North America; all 13 Type C micropiles in silty or clayey sand were installed at one site in Ontario.

A total of 20 load test records were collected for micropiles with bonded lengths in gravelly sand. Eight of the load tests achieved failure: (1) four were Type A micropiles in Italy, with two subjected to compressive loading and the other two to uplift loading; (2) one was Type B, tested under uplift loading in California; (3) two were Type D, with one in New York subjected to compressive loading and the other in Ontario subjected to uplift loading; and (4) the remaining test was a Type E micropile in Canada subjected to compressive loading. A total of 12 micropile load tests with bonded lengths in gravelly sand did not achieve failure: three were Type A (two in Vermont and one in Massachusetts); three were Type B (from project sites in Massachusetts, California, and Ontario); two were Type D (from a site in Washington); and four were Type E (from Indiana, Kentucky, and Canada).

A.7 COLLECTED LOAD TESTS FOR MICROPILES IN ROCK

Load test data for micropiles in rock were initially separated into two categories, weak rock and competent rock. During subsequent modeling, data for micropiles in rock were further subdivided into more precise categories for specific rock types: argillaceous rock, limestone, karstic limestone, sandstone, gneiss, and granite and basalt. Such categorization is supported by the data as described in Chapter 2. Five load tests achieving failure and 19 tests not reaching failure had bonded lengths in unspecified rock. Because the rock information was not sufficient to subcategorize the data, these tests were summarized in the data collection file but were not used in calibrating resistance factors.

Data collection produced records for 18 load tests of micropiles in argillaceous rock that achieved failure. The collected load test records reflect all micropile types except Type C: six Type A micropiles (two from one project site in Kansas, one in Missouri, two from one site in Massachusetts, and one from Canada); five load tests for Type B (from two sites in Canada); two load tests for Type D; and five Type E (all from Canada, with four tests at one research test site and the other at a project site). Records were also collected for 80 micropile load tests in argillaceous rock that did not reach failure. Type A micropiles accounted for the majority of the 80 records: 38 from a large project site in South Dakota; 11 from a project in Nevada; six from a project site in Tennessee; and load tests from individual sites in New York, Massachusetts, Kansas, and Canada. In addition, four load tests were gathered for Type B micropiles from a bridge project in Montana, three from a single site in Wyoming, two from Massachusetts, two from Alabama, and four from Ontario. Only one Type E micropile load test data was collected from a site in Toronto. No Type D micropile load test data were collected with bond lengths in argillaceous rock.

Load test records were obtained for four Type A and four Type B micropiles in limestone that achieved failure. Load test records for the Type A micropiles were collected from two sites in Tennessee while records for Type B micropiles were from one site in Florida and one in Missouri. The other 75 load test records for micropiles in limestone did not reach failure. The vast majority of these micropiles (65) were Type A from sites in Tennessee, Alabama, Virginia, Michigan, Missouri, and Canada. Of the remaining 10 micropiles that did not achieve failure, records for four Type B micropiles came from a project in Missouri while Florida and Pennsylvania had two each; two Type E micropile load tests were documented (one from Kentucky and one from Canada); and no Type C or D micropile load test data were gathered.

Six Type A micropiles in karstic limestone achieved failure—four from two different sites in Virginia, one from Puerto Rico, and one from Asia. A total of 14 micropile load tests with bond lengths in karstic limestone did not reach failure: eight were for Type A micropiles from Missouri, New Jersey, Pennsylvania, and Virginia; one was a Type B micropile from Puerto

Rico; and the other five were Type D micropiles (four from a single site in Pennsylvania and one from Puerto Rico).

For micropiles in sandstone, gneiss, and granite and basalt, none of the load tests achieved failure. In sandstone, 21 load tests for Type A micropiles were collected, 19 from a large project in Tennessee and the other two from a site in Michigan. The 19 load tests for Type A micropiles in gneiss were acquired from six bridge project sites in Connecticut and one site in Pennsylvania. For granite and basalt, 44 load tests for Type A micropiles and five load tests for Type B micropiles were collected. Of the Type A micropile load tests in granite and basalt, 40 were collected from one large project in North Carolina, and the other four tests were from a bridge project site in Massachusetts. The Type B micropiles were tested at four project sites in New Mexico and one bridge site in Massachusetts.

A.8 CONSIDERATION OF DATA QUALITY

Consideration of data quality constituted an important component of the research effort, starting with data collection and continuing through model development. Use of a standard form and detailed instructions likely contributed to collection of complete records for all provided micropile load tests that minimally included load-displacement data and a description of bond length material. In total, load-displacement information or load-displacement curves were collected for 626 load tests. Assessment of data quality for research involving load test databases is frequently performed in a binary manner, with data deemed to be of sufficient quality being included in analyses while data deemed to be of insufficient quality are excluded. For this research, all data meeting the minimum standards—i.e., all data including load-displacement data and specifying a single bond length material—were included in the model development. To account for varying data quality among the collected records, uncertainty values were assigned to important values from the records used in model development, with the magnitude of the uncertainty corresponding to the quality of the data. For example, all values of unit bond resistance were assigned a value of uncertainty that reflects the quality of information provided for computing bond resistance (namely, the applied loading information and the bond length diameter). For most test records, consideration of bond stress uncertainty resulted in assigning a small coefficient of variation (0.05) to account for uncertainty in unit bond resistance values.

For predictive model development, it was also necessary to characterize the quality of information provided to characterize relevant design parameters (e.g., SPT N-value, undrained shear strength). Consideration of the uncertainty associated with subsurface information was less straightforward because the manner of subsurface investigation and characterization varied widely among the records. For example, some micropile load test records included undrained shear strength information for bonded lengths in cohesive material. Records that included explicit laboratory measurements of undrained shear strength were assigned a relatively low uncertainty (coefficient of variation equal to 0.2) whereas records with undrained shear strength derived from correlations with SPT measurements were assigned significantly greater uncertainty (coefficient of variation equaling 0.7).

A.9 LOAD TEST DATABASE

The scope of work for the current research did not include development of a formal load test database but did require that collected load test data be provided in a form that would enable use in future research. A simple load test database therefore was developed in Microsoft Excel (and is included as an electronic attachment to this report). Although relatively simple, the Excel database does fully document all information gathered during the data collection efforts. In addition, the Excel database offers capabilities for sorting and filtering data to facilitate additional investigation and future use. For example, using the simple Excel data filtering tools, it is possible to easily identify all tests of a particular type (e.g., compression or uplift, achieving failure or not, tests in clay), so users can readily sort the records according to values in any field. The database is generally true to the information supplied as part of the data collection efforts; that is, values in the database are those reported by the source for each load test record. In cases where project information (e.g., geotechnical reports, load test reports) was provided by the data sources (in lieu of completing the data collection form), the values recorded in the data fields are those interpreted by the authors of this report.