

REVIEW OF FHWA MICROPILE IMPLEMENTATION MANUAL
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Handout
for
FHWA
“Micropile Design and Construction Guidelines”
Implementation Manual

prepared by
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1 **☐ FHWA Micropile Manual PTP Project**

- Title: FHWA “Micropile Design and Construction Guidelines” Implementation Manual.
- Objective: Facilitate implementation and use of micropiles on USDOT projects. Will be “Practitioner - Oriented.” Includes two worked design examples- heavy emphasis on construction QA/QC, inspection & testing - example plans & guide construction specifications (for both Owner-Design & Design-Build projects).

2 **☐ Micropile Definition & Description**

- A micropile is a small diameter-typically less than 300 mm (12 inch)-drilled and grouted pile that is reinforced with reinforcing bar and/or thick wall structural casing. Common size 175 mm (7 inch) o.d. Also known as minipiles, pin piles, needle piles or root piles.

3 **☐ Micropile Definition & Description (cont'd)**

- Installed with small compact high-powered drill rigs that cause minimal disturbance to ground, existing structures and environment and minimal vibrations or noise.
- Can be installed in any type of ground, including difficult ground with cobbles, boulders or obstructions.
- Manual Impetus from FLH (Fed Lands Hwy Divs) -NPS/Forest Hwy/ Scenic Byway Projs

4 **☐ Historical Background**

- First developed in Italy in 1950s by Dr. Fernando Lizzi of Fondedile, Inc. Now available from several U.S. Foundation Specialty Contractors.
- Can achieve Design Loads of 50 kN to 2500+ kN (5 to 250+ tons). Higher capacities achieved by pressure grouting bond zone.

5 **☐ Micropile Applications**

- Main transportation applications include:
 - Structural Support
 - Foundations for New Structures
 - Underpinning of Existing Foundations
 - Seismic Retrofitting of Existing Foundations
 - Insitu Reinforcement
 - Slope Stabilization
 - Earth retention

6  **U.S. Micropile Cost Data**

- Cost Range: \$165-\$500 per lineal meter (\$50-\$150 per lineal foot) installed.
- Although typically more costly than conventional piling on per unit length basis, can offer viable cost effective "total cost" alternative to conventional piling - particularly for restricted access, low headroom, difficult ground or environmentally sensitive sites. Provide one more tool in fdtn engr "toolbag".

7  **Funding Coop Partners**

- 5 Specialty Contractors and 1 Materials Supplier
- Donald B. Murphy Contractors Inc. (DBM)
- Hayward - Baker Inc. (HBI)
- Kulchin - Condon & Assocs. Inc. (KCA)
- Malcolm Drilling Inc. (MDI)
- Nicholson Construction Co. (NCC)
- Dywidag-Systems Intl. (DSI)
- FLH & FHWA Region 10

8  **Coop Funding Summary**

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 \$ 25,000 (CD-ROM)

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- FHWA FLH \$44,000 (PTP-OTA)
- FHWA Region 10 \$52,000 (PTP-OTA)

9  **Contracting and Schedule**

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- Interactive CD-ROM Preparation By:
 Prof. Sunil Sharma, Univ. of Idaho
- TWG Members: CONTRACTORS/FHWA
 CALTRANS/ODOT/WSDOT (17 Folks)
- Schedule: Manual Available Fall 1997
 CD-ROM Available Spring 1998

10 **CD-ROM Version of Manual**

FEATURES

- Will be INTERACTIVE (Hypertext Links)
- Full Table of Contents
- 10 Chapters-Individual Table of Contents
- Figures/Photos/Tables/References
- Design Equations & Design Examples

11 **CREDITS**

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- Special Thanks to Tom Armour & Paul Groneck of DBM - who did the "Heavy Lifting" on manual preparation!
- Any Questions??

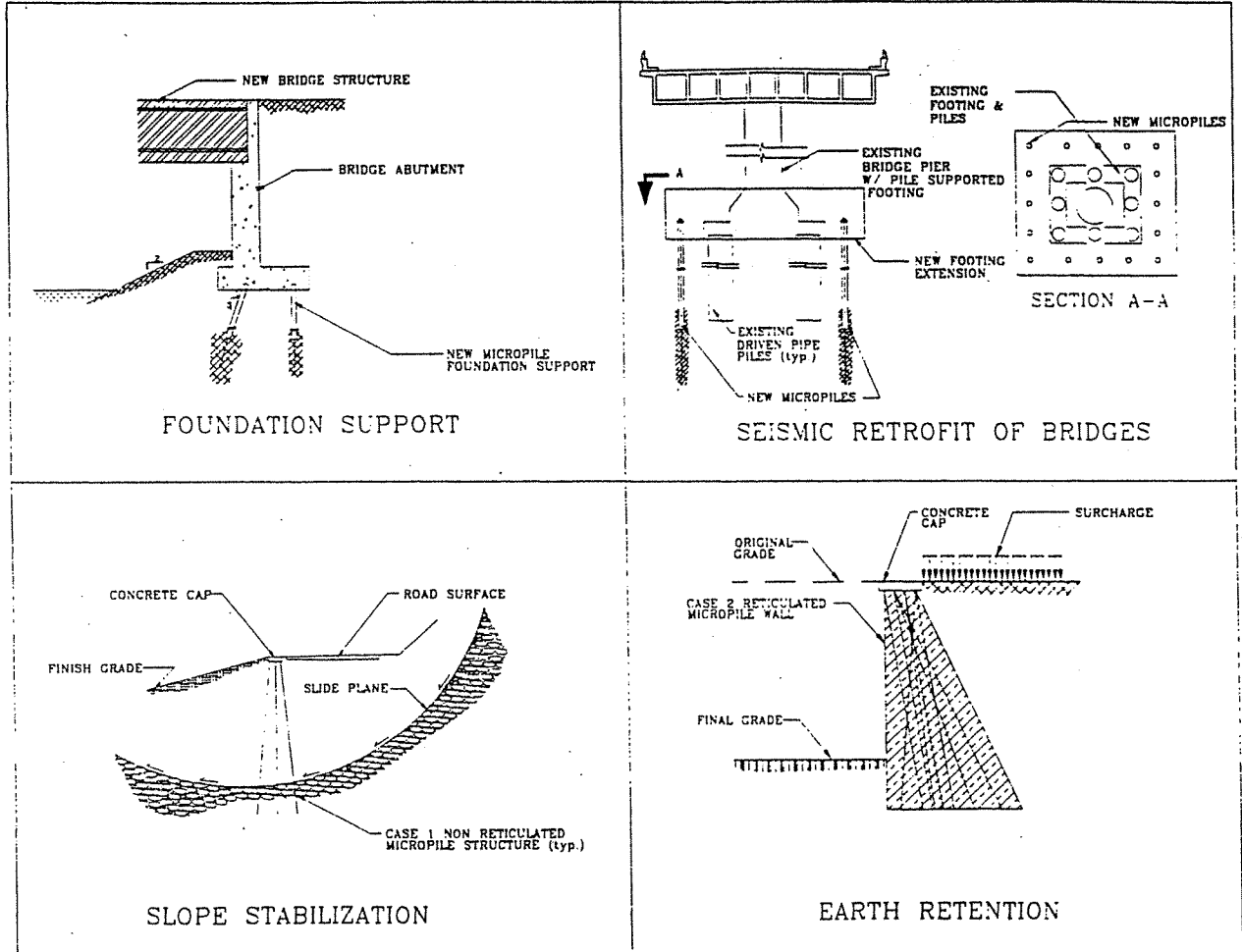


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IMPLEMENTATION MANUAL

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16. Abstract <p>The use of micropiles has grown significantly since their conception in the 1950s, and in particular since the mid-1980s. Micropiles have been used mainly as elements for foundation support to resist static and seismic loading conditions and as in-situ reinforcements for slope and excavation stability. Many of these applications are suitable for transportation structures.</p> <p>Implementation of micropile technology on U.S. transportation projects has been hindered by lack of practical design and construction guidelines. In response to this need, the FHWA sponsored the development of this Micropile Design and Construction Guidelines Implementation Manual. Funding and development of the manual has been a cooperative effort between FHWA, several U.S. micropile specialty contractors, and several State DOT's. This manual is intended as a "practitioner-oriented" document containing sufficient information on micropile design, construction specifications, inspection and testing procedures, cost data, and contracting methods to facilitate and speed the implementation and cost effective use of micropiles on United States transportation projects.</p> <p>Chapter 1 provides a general definition and historic framework of micropiles. Chapter 2 describes the newly developed classifications of micropile type and application. Chapter 3 illustrates the use of micropiles for transportation applications. Chapter 4 discusses construction techniques and materials. Chapters 5 and 6 detail design methodologies for structural foundation support and slope stabilization, respectively. Chapter 7 describes micropile load testing. Chapter 8 reviews construction inspection and quality control procedures. Chapter 9 discusses contracting methods for micropile applications. Chapter 10 presents feasibility and cost data. Appendix A presents sample plans and specifications for both Owner Controlled Design and for Contractor Design-Build type contracts.</p>					
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PREFACE

The long-term performance of micropiles has been proven after 25+ years of use in Europe and North America. The purpose of this "practitioner-oriented" manual is to facilitate the implementation of micropile technology into American transportation design and construction practice and to provide guidance for selecting, designing and specifying micropiles for those applications to which it is technically suited and economically attractive. A comprehensive review of current design and construction methods has been made and results compiled into a guideline procedure. The intent of presenting the guideline procedure is to help ensure that agencies adopting use of micropile technology follow a safe, rational procedure from site investigation through construction.

Chapter 1 provides a general definition and historic framework of micropiles. Chapter 2 describes the newly developed classifications of micropile type and application. Chapter 3 illustrates the use of micropiles for transportation applications. Chapter 4 discusses construction techniques and materials. Chapters 5 and 6 detail design methodologies for structural foundation support and slope stabilization, respectively, including worked design examples. Chapter 7 describes pile load testing. Chapter 8 reviews construction inspection and quality control procedures. Chapter 9 discusses contracting methods for micropile applications. Chapter 10 presents feasibility and cost data. Appendix A presents guideline plans and specifications for Owner Controlled Design and Contractor Design-Build type contracts.

MANUAL LIMITATIONS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof. The contents of this report reflect the views of the authors, who are responsible for the accuracy of the data presented herein. The contents do not necessarily reflect the official policy of the Department of Transportation. This report does not constitute a standard, specification, or regulation.

The United States Government does not endorse products or manufactures. Trade or manufacturers' names appear herein only because they are considered essential to the objective of this document.

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Malcolm Drilling Company, Inc.
Nicholson Construction Company
Schnabel Foundation Company

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ENGLISH TO METRIC (SI) CONVERSION FACTORS

The primary metric (SI) units used in civil and structural engineering are:

- meter (m)
- kilogram (kg)
- second (s)
- newton (N)
- pascal (Pa = N/m²)

The following are the conversion factors for units presented in this manual:

Quantity	From English Units	To Metric (SI) Units	Multiply by	For Aid to Quick Mental Calculations
Mass	lb	kg	0.453592	1 lb(mass) = 0.5kg
Force	lb	N	4.44822	1 lb(force) = 4.5N
	kip	kN	4.44822	1 kip(force) = 4.5kN
Force/unit length	plf	N/m	14.5939	1 plf = 14.5N/m
	klf	kN/m	14.5939	1 klf = 14.5kN/m
Pressure, stress, modulus of elasticity	psf	Pa	47.8803	1 psf = 48 Pa
	ksf	kPa	47.8803	1 ksf = 48 kPa
	psi	kPa	6.89476	1 psi = 6.9 kPa
	ksi	MPa	6.89476	1 ksi = 6.9 MPa
Length	inch	mm	25.4	1 in = 25 mm
	foot	m	0.3048	1 ft = 0.3 m
		mm	304.8	1 ft = 300 mm
Area	square inch	mm ²	645.16	1 sq in = 650 mm ²
	square foot	m ²	0.09290304	1 sq ft = 0.09 m ²
	square yard	m ²	0.83612736	1 sq yd = 0.84 m ²
Volume	cubic inch	mm ³	16386.064	1 cu in = 16,400 mm ³
	cubic foot	m ³	0.0283168	1 cu ft = 0.03 m ³
	cubic yard	m ³	0.764555	1 cu yd = 0.76 m ³

A few points to remember:

1. In a “soft” conversion, an English measurement is mathematically converted to its exact metric equivalent.
2. In a “hard” conversion, a new rounded, metric number is created that is convenient to work with and remember.
3. Use only the meter and millimeter for length (avoid centimeter).
4. The pascal (Pa) is the unit for pressure and stress (Pa and N/m).
5. Structural calculations should be shown in MPa or kPa.
6. A few basic comparisons worth remembering to help visualize metric dimensions are:
 - One mm is about 1/25 inch or slightly less than the thickness of a dime.
 - One m is the length of a yardstick plus about 3 inches.
 - One inch is just a fraction (1/64 inch) longer than 25 mm (1 inch = 25.4 mm).
 - Four inches are about 1/16 inch longer than 100 mm (4 inches = 101.6 mm).
 - One foot is about 3/16 inch longer than 300 mm (12 inches = 304.8 mm).

**MICROPILE DESIGN AND CONSTRUCTION GUIDELINES
IMPLEMENTATION MANUAL**

TABLE OF CONTENTS

<u>Chapter 1 -- Introduction</u>	<u>Page</u>
A. Purpose and Scope of Manual.....	1
B. Micropile Definition and Description	2
C. Historical Background.....	5
<u>Chapter 2 -- Micropile Classification System</u>	
A. Micropiles Types in Current Use.....	9
1. Design Application Classification	9
2. Construction Type Classification.....	14
<u>Chapter 3 -- Micropile Applications In Transportation Projects</u>	
A. Introduction	18
B. Structural Support	21
1. New Foundations	21
2. Underpinning of Existing Foundations	24
3. Seismic Retrofit	28
C. In-Situ Reinforcement (Slope Stabilization and Earth Retention)	29
D. Factors Influencing the Choice of Micropiles	36
1. Physical Considerations	36
2. Subsurface Conditions	37
3. Environmental Conditions	38

	Page
4. Existing Structure Adaptation	40
5. Micropile Limitations	40
6. Economics	40
<u>Chapter 4 -- Construction Techniques and Materials</u>	
A. Introduction	42
B. Drilling	43
1. Drill Rigs	45
2. Drilling Techniques	49
3. Overburden Drilling Techniques	50
4. Open-Hole Drilling Techniques	55
C. Grouting	57
1. Grout Equipment	60
2. Grout Mixing	63
3. Grout Placement Techniques	63
a) Gravity Fill Techniques (Type A Micropiles)	64
b) Pressure Grouting Through the Casing (Type B Micropiles)	64
c) Postgrouting (Type C and D Micropiles)	67
4. Top-Off (Secondary) Grouting	71
D. Reinforcing Steel	72
1. Placement of Reinforcement	72
2. Reinforcement Types	72
3. Reinforcement Corrosion Protection	82

Chapter 5 -- Design Methodology-Micropiles for Structure Foundations
(CASE 1 Piles)

A. Introduction	86
B. Comment on the Use of This Manual	88
C. Geotechnical Investigation Requirements	89
D. Pile Geotechnical Capacity.....	90
1. Introduction	90
2. Summary of Ultimate Bond Values.....	92
3. Factors of Safety on Ultimate Bond Capacity.....	92
4. Evaluation of Group Effect on Bond Capacity.....	94
E. Pile Structural Design.....	95
1. Notation	97
2. Pile Cased Length Structural Capacity.....	97
a) AASHTO-Pile Cased Length (Service Load Design).....	98
b) AASHTO-Pile Cased Length (Load Factor Design).....	99
3. Pile Uncased Length Structural Capacity.....	100
a) AASHTO 92-Pile Uncased Length (Service Load Design).....	101
b) AASHTO 92-Pile Uncased Length (Load Factor Design).....	101
4. Grout to Steel Bond Capacity.....	101
5. Transition Between Reinforcement Types.....	102
6. Strain Compatability Between Structural Components.....	105
7. Reinforcement Splice Connections.....	105
8. Pile to Footing Connection.....	106
F. Additional Geotechnical/Structural Considerations.....	112

	<u>Page</u>
1. Prediction of Anticipated Axial Displacements	112
2. Long-Term Displacement Performance	115
3. Settlement of Pile Groups.....	115
4. Lateral Load Capacity.....	116
5. Lateral Stability(Buckling).....	117
6. Scour.....	118
7. Downdrag and Uplift Considerations.....	118
G. Sample Problem No. 1 - Bridge Abutment Foundation Support	119
1. Problem Statement	119
2. Step 1 - Abutment Design Loading.....	124
a) Active Earth Pressure - P_E	124
b) Earth Pressure Due to Live Load Surcharge - H_L	124
c) Seismic Earth Pressure - P_{EQ}	125
3. Service Load Design Method-(SLD).....	127
a) Step 2 (SLD) - Determine Pile Loading	127
1) Pile Axial Loading for Group VII Loading Combinations	128
b) Step 3 (SLD) - Pile Design Calculations.....	131
1) Pile Cased Length Design.....	132
2) Pile Uncased Length Design.....	133
3) Geotechnical Bond Length Design.....	134
c) Step 4 (SLD) - Anticipated Axial Displacement.....	136
d) Step 5 (SLD) - Pile Connection Design.....	137
4. Load Factor Design Method (LFD).....	142
a) Step 2 (LFD) - Determine Pile Loading	142

	<u>Page</u>
1) Pile Axial Loading for Group VII Loading Combinations.....	143
b) Step 3 (LFD) - Pile Design Calculations	146
1) Pile Cased Length Design.....	147
2) Pile Uncased Length Design.....	148
3) Geotechnical Bond Length Design.....	150
c) Step 4 (LFD) - Anticipated Axial Displacement.....	151
d) Step 5 (LFD) - Pile Connection Design.....	152
5. Step 6 - Complete Detail Drawings.....	155

Chapter 6 -- Design Methodology: Micropiles for Slope Stabilization and Earth Retention

A. Purpose and Scope	158
1. CASE 1 Non Reticulated Micropile Groups	159
2. CASE 2 Reticulated Micropile Networks	160
B. Current Micropile Slope Stabilization Techniques	162
C. Design of CASE 1 Micropile Slope Stabilization Systems	170
D. Sample Problem No. 2 - CASE 1 Nonreticulated Micropile Slope Stabilization. ...	179
E. Design Concept of CASE 2 Reticulated Micropile Networks	225

Chapter 7 -- Pile Load Testing

A. Introduction	231
B. Determination of Project Testing Requirements	232
1. Micropile Load-Testing Guidelines	237
C. Load-Test Setup and Instrumentation	239

	Page
D. Data Recording and Presentation	251
E. Pile Load Test Report	263
F. Test Pile Failure	264

Chapter 8 -- Construction Inspection/Quality Control

A. Introduction	265
B. Quality Control Inspection	266
1. Material Handling and Storage	266
2. Construction Monitoring	271
C. Quality Control Documentation	280
1. Pile Load Testing	280
2. Production Piles	280

Chapter 9 -- Contracting Methods

A. Introduction	287
B. Specifications	288
1. Owner-controlled Design Methods	289
2. Contractor Design/Build Methods	294
3. Other Methods	296
C. Contract Plans	297

Chapter 10 -- Feasibility and Cost Data

A. Feasibility	298
B. Cost	299

	<u>Page</u>
C. Sample Problems Cost Estimates	301
<u>Glossary Terms</u>	309
<u>References</u>	314
 <u>Appendices</u>	
A. Example Plans and Specifications.....	A-1
A-1 Owner Controlled Design Guide Construction Specification and Sample Plans	A1-1
A-2 Contractor Design/Build Guide Construction Specification and Sample Plans	A2-1
B. Reference Information on Grout to Ground Bond Capacity Values.....	B-1
B-1 H. Ostermayer-Construction, Earrying Behaviour and Creep Characteristics of Ground Anchors (1975).....	B1-1
B-2 Post-Tensioning Institute-Recommendations for Prestressed Rock and Soil Anchors (1996 Edition).....	B2-1
C. AASHTO Design Criteria (1992).....	C-1
C-1 Combination of Loads (Section 3.22 and Table 3.22.1A).....	C1-1
C-2 Allowable Stresses-Structural Steel (Table 10.21.1A).....	C2-1
C-3 Miscellaneous Criteria (Section 8.16.4, 10.36 and 10.54).....	C3-1
D. Reference Information on Estimating Settlement of Pile Groups (FHWA Publication No. FHWA HI-97-013, December 1996, Section 9.8.2).....	D-1