Swinging the Span

Section 6-03.3(39) is supplemented with the following:

(June 26, 2000)
The Contractor shall measure and submit to the Engineer camber values at the points indicated in the Plans at each of the following times:

1. After the spans are swung.

2. After roadway slab placement.

Measurement

Section 6-03.4 is supplemented with the following:

(August 6, 2007)
Structural low alloy steel contains the following approximate steel quantities:

Bridge	Quantity
*** Bridge No. 5/454N-N Replacement ***	*** 1,700,000 LB. ***

Payment

The second bid item under Section 6-03.5 is supplemented with the following:

(August 6, 2007)
All costs in connection with furnishing and installing steel girder pipe railing as shown in the Plans shall be included in the lump sum contract price for "Structural Low Alloy Steel".

Piling

Materials

Section 6-05.2 is supplemented with the following:

(BSP August 2, 2010)
Micropiles
Materials for micropiles shall consist of the following:

Admixtures for grout shall conform to Section 9-23.6. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout, subject to the review and acceptance of the Engineer. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations and anchorage covers. Accelerators are not permitted. Admixtures containing chlorides are not permitted.

All cement shall be Portland cement conforming to Section 9-01.2(1), except that the Types shall be II, III or V.

Centralizers and spacers shall be fabricated from schedule 40 PVC pipe or tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used. Centralizers and spacers shall be securely attached to the reinforcement; sized to position the reinforcement within 3/8 inch of plan location from center of micropile; sized to allow grout tremie pipe insertion to the bottom of the drillhole; and sized to allow grout.to freely flow up the drillhole and casing and between adjacent reinforcing bars.

Encapsulation (double corrosion protection) shall be shop fabricated using high-density, corrugated polyethylene tubing conforming to the requirements of AASHTO M 252 with a nominal wall thickness of 1/32 inch. The inside annulus between the reinforcing bars and the encapsulating tube shall be a minimum of 1/4 inch and be fully grouted with grout as defined below.

Epoxy coating shall conform to Section 9-07.3. The minimum thickness of coating applied electrostatically to the reinforcing steel shall be 10 mil. Bend test requirements are waived. Bearing plates and nuts encased in the micropile concrete footing need not be epoxy coated.

Fine aggregate for sand-cement grout shall be sand conforming to AASHTO M 45.

Grout shall be a neat cement or sand/cement mixture with a minimum seven day compressive strength of 4,000 psi in accordance with Section 9-20.3(2). Grout shall provide one inch minimum cover over bare or epoxy coated bars (excluding bar couplers) or 1/2 inch minimum cover over the encapsulation of encapsulated bars.

Steel pipe casing for micropiles shall have the diameter and at least the minimum wall thickness shown on the approved working drawings. Steel pipe micropiles shall conform to ASTM A 252, Grade 2 or 3, including tolerances for pipe diameter, edge alignment, end match marking, roundness and straightness and conform to the steel micropile splice welding requirements specified herein. The carbon equivalency (CE) as defined in AWS D 1.1, Section XI 5.1, shall not exceed 0.45. The sulfur content shall not exceed 0.05 percent.

Steel pipe shall not be joined by welded lap splicing. Steel pipe seams and splices shall be complete penetration welds. Partial welds of steel pipe may be restored to complete penetration welds in conformance with AWS D1.1.

The manufacturer or fabricator of steel piling shall furnish a certificate of compliance in accordance with Section 1-06.3 stating that the piling being supplied conforms to these specifications. The certificate of compliance shall include test reports for tensile and chemical tests. Samples for testing shall be taken from the base metal, steel, coil or from the manufactured or fabricated piling. The certificate of compliance shall be in English units.

Welded circumferential joints in pipe shall develop the strength of the pipe section. Threaded pipe joints shall develop at least the nominal resistance used in the design of the micropile.

Structural steel plates and shapes for micropile top attachments shall conform to either ASTM A 36 or ASTM A 572 Grade 50.

Reinforcing steel shall be deformed bars in accordance with Sections 9-07.4 or 9-07.11. When a bearing plate and nut are required to be threaded onto the top end of reinforcing bars for the micropile top to footing anchorage, the threading may be continuous spiral deformed ribbing provided by the bar deformations or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the next larger bar number designation from that shown on the Plans shall be provided, at no additional cost to the Contracting Agency. Reinforcing bars for micropiles shall be epoxy coated in accordance with Section 6-02.3(24)H and 9-07.3.

Bar tendon couplers, if required, shall develop the ultimate tensile strength of the bars without evidence of any failure.

Construction Requirements

Section 6-05.3 is supplemented with the following:

(******)

Micropiles

General Requirements

The Contractor is responsible for furnishing of all design, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for design, installation and testing of micropiles and micropile top attachments for this project.

The Contractor shall select the micropile type, size, micropile top attachment, installation means and methods, shall estimate the ground to grout bond value, and shall determine the required grout bond length and final micropile diameter. The Contractor shall design and install micropiles that will develop the load capacities specified in the Plans. The micropile load capacities shall be verified by verification and proof load testing, and shall meet the test acceptance criteria specified in this Special Provision.

Contractor's Experience Requirements And Submittal

The micropile Contractor shall be experienced in the construction and load testing of micropiles and have successfully constructed at least three projects in the last five years involving construction totaling at least 50 micropiles of equal or greater capacity than required for this project.

The micropile Contractor shall have previous micropile drilling and grouting experience in soil/rock similar to project conditions. The Contractor shall submit construction details, structural details and load test results for at least three previous successful micropile load tests from different projects of similar scope to this project.

A Professional Engineer, licensed under Title 18 RCW State of Washington, employed by the micropile Contractor and having experience in the construction of at least three completed micropile projects over the past five years of similar scope to this project, shall supervise the work. The Contractor shall not use consultants or manufacturers' representatives to satisfy the supervising Engineer requirements

of this section. The on-site foremen and drill rig operators shall also have experience on at least three projects over the past five years installing micropiles of equal or greater capacity than required for this project.

The micropile Contractor shall design the micropile system. The micropile system shall be designed by a Professional Engineer, licensed under Title 18 RCW State of Washington, with experience in the design of at least three successfully completed micropile projects over the past five years, with micropiles of equal or greater capacity than required in these plans and specifications. The micropile designer may be either an employee of the Contractor or a separate Consultant designer meeting the specified experience requirements.

At least 30 calendar days before the planned start of micropile construction, the Contractor shall submit in writing the completed project reference list, including a brief project description with the owner's name and current phone numbers. The Contractor shall also submit a personnel list for the micropile system designer, supervising project Engineer, drill rig operators and on-site foremen to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications. The Engineer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete submission Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals shall be borne by the Contractor.

Work shall not be started, nor materials ordered, until the Engineer's written approval of the Contractor's experience qualifications is given. The Engineer may suspend the Work if the Contractor uses non-approved personnel. If work is suspended, the Contractor shall be fully liable for all resulting costs and. no adjustment in contract time will result from the suspension.

Definitions

Admixture: Substance added to the grout to control bleed and/or shrinkage, improve flowability, reduce water content, or retard setting time.

Alignment Load (AL): A minimum initial load (5 percent DL maximum) applied to micropile
during testing to keep the testing equipment correctly positioned.

Bonded Length: The length of the micropile that is bonded to the ground and conceptually to transfer the applied axial loads to the surrounding soil or rock. Also known as the load transfer length.

Bond-breaker: A sleeve placed over the steel reinforcement to prevent load transfer.

Casing: Steel tube introduced during the drilling process in overburden soil to temporarily stabilize the drill hole. This is usually withdrawn as the micropile is grouted although in certain types of micropiles, some casing is permanently left in place to provide added micropile reinforcement.

Centralizer: A device to support and position the reinforcing steel in the drill hole and/or so that a minimum grout cover is provided.

Coupler: The means by which the micropile load capacity can be transmitted from one partial of reinforcement to another.

Creep Movement: The movement that occurs during the creep test of a micropile under constant load.

Design Load (DL): The design load expected to be applied to the micropile during its service life. The design load (DL) is as specified in the bridge Plans.

Encapsulation: A corrugated or deformed tube protecting the reinforcing steel against corrosion.

Free (unbonded) length: The designed length of the micropile that is not bonded to the surrounding ground or grout.

Micropile: A small-diameter, bored, cast-in-place composite pile, in which the applied load is resisted by steel reinforcement, cement grout and frictional grout/ground bond.

Maximum Test Load: The maximum load to which the micropile is subjected during testing. The load shall be 2.0 x DL for verification load tests and 1.67 *x* DL for proof load tests.

Nominal Grout-to-Ground Bond Strength: The estimated ultimate geotechnical unit grout-to-ground bond strength selected for use in design. Same as $\alpha_{\text{Bond Nominal Strength}}$ (SLD and LFD).

Overburden: Material, natural or placed, that may require cased drilling methods to provide an open borehole to underlying strata.

Post-grouting: The injection of additional grout into the load transfer length of a micropile after the primary grout has set. Also known as regrouting or secondary grouting.

Primary Grout: Portland-cement-based grout injected into the micropile hole prior to or after the installation of the reinforcement to direct the load transfer to the surrounding ground along the micropile.

Proof Load Test: Incremental loading of a production micropile, recording the total movement at each increment.

Reinforcement: The steel component of the micropile that accepts and/or resists applied loadings.

Sheathing: Smooth or corrugated piping or tubing that protects the reinforcing steel against corrosion.

Spacer: A device to separate elements of a multiple-element reinforcement to ensure full bond development of each steel element.

Verification Load Test: Non-production micropile load test performed to verify the design of the micropile system and the construction methods proposed, prior to installation of production micropiles.

Water: Water used in the grout mix shall conform to AASHTO T 26 and shall be potable, clean, and free from substances that may be injurious to cement and steel.

Referenced Codes and Standards

The following publications form a part of this specification to the extent indicated by the references. The latest publication as of the issue date of this specification shall govern, unless indicated otherwise.

1. American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and WSDOT Standard Specifications:

ASTM Specification	WSDOT Std. Spec. Section, or AASHTO Specification or Test	
A 36, A 572		Structural Steel
	9-07.9	Cold-Drawn Steel Wire
A 252		Welded and Seamless Steel Pipe
	9-07.3	Deformed Steel Reinforcing Bar
	9-07.11	High-Strength Steel Reinforcing Bar
	9-07.4	Epoxy -Coated Steel Reinf. Bar
	M 80	Concrete Aggregate
	T 106	Compressive Strength of Hydraulic Cement Mortar
	T 133	Density of Hydraulic Cement
	M 45	Aggregate for Masonry Mortar
	9-01.2(1)	Portland Cement
	9-23.6	Chemical Admixtures for Concrete
D 1784		Polyvinyl Chloride (PVC) Pipe (Class 13464-B)
D 3350	M 252	Polyethylene Corrugated Tubing
	9-25.1	Water for Concrete

2. American Welding Society (AWS) AWS/D1.1/D1.1M Structural Welding Code-Steel and AWS/D1.2 Structural Welding Code-Reinforcing Steel.

3. American Petroleum Institute (API) 5CT Specification for casing and tubing.

Construction Site Survey

The Contractor shall conform to Sections 1-02.4 and 1-07.18.

Micropile Design Requirements

The micropiles shall be designed to meet the specified loading conditions, as shown in the Plans and the working drawings as approved by the Engineer. The Contractor shall design the micropiles in accordance with the Service Load Design (SLD) design method, and shall design the micropile top to footing connections using Load Factor Design (LFD) design method.

Steel pipe used for micropile permanent casing shall incorporate an additional 3/16 inch thickness of sacrificial steel for corrosion protection. Where required as shown in the Plans, corrosion protection of the internal steel reinforcing bars, consisting of either encapsulation (double corrosion protection), epoxy coating, or grout, shall be provided in accordance with Section 6-05.2 as supplemented in these Special Provisions. Where permanent casing is used for a portion of the micropile, encapsulation shall extend at least five feet into the casing.

Micropile Design Submittals

At least 30 calendar days before the planned start of micropile structure construction, the Contractor shall submit complete design calculations and working drawings to the Engineer for approval in accordance with Section 6-01.9. The submittal shall include all details, dimensions, quantities, ground profiles, and cross-sections necessary to construct the micropile structure. The Contractor shall verify the limits of the micropile structure and ground survey data before preparing the detailed working drawings.

Design Calculations

Design calculations shall include, but not be limited to, the following items:

1. A written summary report which describes the overall micropile design, and its compatibility with the anticipated subsurface conditions as described by the contract test hole boring logs, the Summary of Geotechnical Conditions provided in the Appendix to the Special Provisions, and the geotechnical report(s) prepared for this project.

2. Applicable code requirements and design references.

3. Micropile structure critical design cross-section(s) geometry including soil strata and piezometric levels and location, magnitude and direction of design applied loadings, including slope or external surcharge loads.

4. Design criteria including, soil shear strengths (friction angle and cohesion), unit weights, and ground-grout bond values and micropile drillhole diameter assumptions for each soil strata.

5. Partial safety factors/strength factors (for Service Load Design) or load factors (for Load Factor Design) used in the design of the ground-grout bond values, surcharges, soil/rock and material unit weights, steel, grout, and concrete materials.

6. Design calculation sheets with the project number, micropile structure location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. An index page shall be included with the design calculations.

7. Design notes including an explanation of any symbols and computer programs used in the design.

8. Other design calculations.

Working Drawings

The Contractor shall submit working drawings in accordance with Section 6-01.9.

The working drawings shall include all information required for the construction and quality control of the piling. Working drawings shall include, but not be limited to, the following items:

1. A plan view of the micropile structure identifying:

    a. A reference baseline and elevation datum.

    b. The offset from the construction centerline or baseline to the face of the micropile structure at all changes in horizontal alignment.

    c. Beginning and end of micropile structure stations.

    d. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures or other potential interference. The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the micropile structure.

    e. Subsurface exploration locations shown on a plan view of the proposed micropile structure alignment with appropriate reference base lines to fix the locations of the explorations relative to the micropile structure.

2. An elevation view of the micropile structure(s) identifying:

    a. Elevation view showing micropile locations and elevations; vertical and horizontal spacing; batter and alignment and the location of drainage elements (if applicable).

    b. Existing and finish grade profiles both behind and in front of the micropile structure.

3. Design parameters and applicable codes.

4. General notes for constructing the micropile structure including the overall construction sequence, micropile installation sequence at each footing, means and methods to prevent damage to existing adjacent piles and micropiles, and other special construction requirements.

5. A listing of the summary of quantities on the elevation drawing of each micropile structure showing pay item estimated quantities.

6. Micropile structure typical sections including micropile spacing and inclination; minimum drillhole diameter; pipe casing and reinforcing bar sizes and details; splice types and locations; centralizers and spacers; grout bond zone and casing plunge lengths and corrosion protection details; and connection details to the substructure footing, anchorage, plates, etc.

7. A typical detail of verification and production proof test micropiles defining the micropile length, minimum drillhole diameter, inclination, and load test bonded and unbonded test lengths.

8. Details, dimensions, and schedules for all micropiles, casing and reinforcing steel, including reinforcing bar bending details.

9. Details and dimensions for micropile structure appurtenances such as barriers, coping, drainage gutters, fences, etc. (if applicable).

10. Details for constructing micropile structures around drainage facilities (if applicable).

11. Details for terminating micropile structures and adjacent slope construction (if applicable).

The Contractor shall revise the approved working drawings when plan dimensions are changed due to field conditions or for other reasons. Within 30 days after completion of the work, submit as-built drawings to the Engineer.

The Contractor shall also provide revised design calculations signed by the approved Registered Professional Engineer for all design changes made during the construction of the micropile structure.

Construction Submittals

The Contractor shall prepare and submit to the Engineer, for review of completeness, 5 copies of the following for the micropile system or systems to be constructed:

1. Detailed step-by-step description of the proposed micropile construction procedure, including personnel, installation tolerances, testing, and equipment to assure quality control. This step-by-step procedure shall be shown on the working drawings in sufficient detail to allow the Engineer to monitor the construction and quality of the micropiles.

2. Discussion of how the Contractor's construction methods accommodate and are compatible with the anticipated subsurface conditions as described in the contract test hole boring logs, the Summary of Geotechnical Conditions provided in the Appendix to the Special Provisions, and the geotechnical report(s) prepared for this project.

3. Proposed start date and time schedule and micropile installation schedule providing the following:

Micropile number
Micropile design load
Type and size of reinforcing steel
Minimum total bond length
Total micropile length
Micropile top footing attachment

4. If welding of casing is proposed, the Contractor shall submit the proposed welding procedure for approval by the Engineer.

5. Manufacturer's information, model, size, and type of equipment to be used for installing micropiles, with appropriate manufacturer's literature for review. Include detailed description of the drilling equipment and methods proposed to be used to provide drillhole support and prevent detrimental ground movements.

6. Information on headroom and space requirements for installation equipment that verify the proposed equipment can perform at the site. Plan describing how surface water, drill flush, and excess waste grout will be controlled, contained, collected, and disposed of.

7. Certified mill test reports for the reinforcing steel and for the casing used in micropile installation. The ultimate strength, yield strength, elongation, and material properties composition shall be included. Tag sample verification may be substituted in place of certified mill test reports for micropile casing.

8. Proposed Grouting Plan. The grouting plan shall include complete descriptions, details, and supporting calculations for the following:

    a. Grout mix design and type of materials to be used in the grout including certified test data and trial batch reports.

    b. Grouting equipment, including capacity and relation to the grouting demand and working conditions as well as provisions for back-up equipment and spare parts.

    c. Types and sizes of grout hoses, connections, and grout delivery systems.

    d. Methods and equipment for placing, positioning, and supporting the steel pipe casing and reinforcing bars.

    e. Methods and equipment for accurately monitoring and recording the grout depth, grout volume and grout pressure as the grout is being placed.

    f. Procedures and schedules for grout batching, mixing, and pumping including provisions for handling drilling fluid and for post grouting.

g. Grouting rate calculations, when requested by the Engineer. The calculations shall be based on the initial pump pressures or static head on the grout and losses throughout the placing system, including anticipated head of drilling fluid to be displaced.

h. Contingency procedures for handling blockage of ducts or equipment breakdowns.

i. Estimated curing time for grout to achieve specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance and start of production work. During production, grout shall be tested in accordance with the **Grout Testing** subsection of this Special Provision.

j. Procedure and equipment for Contractor monitoring of grout quality.

9. Detailed plans for the proposed micropile load testing method. This shall include all drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and micropile top movements in accordance with the **Micropile Load Tests** subsection of this Special Provision.

10. Calibration reports and data for each test jack, pressure gauge and master pressure gauge and electronic load cell to be used. The calibration tests shall have been performed by an independent testing laboratory, and tests shall have been performed within 90 calendar days of the date submitted. Testing shall not commence until the Engineer has reviewed and accepted the jack, pressure gauge, master pressure gauge and electronic load cell calibration data.

11. Discussion of the Contractor's contingency plan if a verification load test or a proof load test fails.

Work shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer. The Contractor shall provide submittal items 1 through 6 at least 21 calendar days prior to initiating micropile construction and submittal items 7 through 11 at least 7 days prior to start of micropile load testing or incorporation of the respective materials into the work. The Contractor shall allow the Engineer 7 calendar days to review the construction submittals after a complete set has been received. Additional time required due to incomplete or unacceptable submittals shall not be cause for delay or impact claims. All costs associated with incomplete or unacceptable Contractor submittals shall be the responsibility of the Contractor.

Pre-construction Meeting

A pre-construction meeting will be scheduled by the Engineer and held prior to the start of micropile construction. The Engineer, prime Contractor, micropile specialty Contractor, and excavation Contractor shall attend the meeting. Attendance is

mandatory. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the prime Contractor and the various Subcontractors - specifically those pertaining to excavation for micropile structures, anticipated subsurface conditions, micropile installation and testing, micropile structure survey control and site drainage control.

Site Drainage Control

The Contractor shall control and properly dispose of drill flush and construction related waste, including excess grout, in accordance with Section 1-07.5(3) as supplemented in these Special Provisions and all applicable local codes and regulations. The Contractor shall provide positive control and discharge of all surface water that will affect construction of the micropile installation. The Contractor shall maintain all pipes or conduits used to control surface water during construction. The Contractor shall repair damage caused by surface water in accordance with Section 1-07.13. Upon substantial completion of the work, the Contractor shall remove surface water control pipes or conduits from the site. Alternatively, with the approval of the Engineer, pipes or conduits that are left in place may be fully grouted and abandoned or left in a way that protects the structure and all adjacent facilities from migration of fines through the pipe or conduit and potential ground loss.

Excavation

The Contractor shall coordinate the work and the excavation so the micropile structures are safely constructed. The Contractor shall perform the micropile construction and related excavation in accordance with the Plans and approved submittals.

Micropile Allowable Construction Tolerances

The centerline of piling shall not be more than 3 inches from indicated plan location.

The micropile shall be plumb within 2 percent of total-length plan alignment.

The top elevation of micropile shall be plus 1 inch or minus 2 inch maximum from vertical elevation indicated.

The centerline of reinforcing steel shall not be more than 1/2 inch from indicated location.

Micropile Installation

The micropile Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the micropiles. The micropile Contractor shall also determine the micropile casing size, final drillhole diameter and bond length, and central tendon reinforcement steel sizing necessary to develop the specified load capacities and load testing requirements. The micropile Contractor is also responsible for estimating the grout take. There will be no extra payment for grout overruns. The bond zone for micropiles shall be below the following elevations:

MMFD 10+00 to 10+68, Elev. -29.0
MMFD 10+68 to 11+12.25, Elev. -17.0

Drilling

The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to any overlying or adjacent structures or services. The drillhole shall be open along its full length to at least the design minimum drillhole diameter prior to placing grout and reinforcement. Temporary casing or other approved method of micropile drillhole support will be required in caving or unstable ground to permit the micropile shaft to be formed to the minimum design drillhole diameter. The Contractor's proposed method(s) to provide drillhole support and to prevent detrimental ground movements shall have received the approval of the Engineer. Detrimental ground movement is defined as movement which requires remedial repair measures. Use of drilling fluid containing bentonite is not allowed.

Ground Heave or Subsidence

During construction, the Contractor shall observe the conditions in the vicinity of the micropile construction site on a daily basis for signs of ground heave or subsidence. The Contractor shall immediately notify the Engineer if signs of movements are observed. The Contractor shall immediately suspend or modify drilling or grouting operations if ground heave or subsidence is observed, if the micropile structure is adversely affected, or if adjacent structures are damaged from the drilling or grouting. If the Engineer determines that the movements require corrective action, the Contractor shall take corrective actions necessary to stop the movement or perform repairs.

When due to the Contractor's methods or operations or failure to follow the specified/approved construction sequence, as determined by the Engineer, the costs of providing corrective actions will be borne by the Contractor in accordance with Section 1-07.13. When due to differing site conditions, as determined by the Engineer, the costs of providing corrective actions will be addressed in accordance with Section 1-04.4.

Pipe Casing and Reinforcing Bars Placement and Splicing

Reinforcement may be placed either prior to grouting or placed into the grout - filled drillhole before temporary casing (if used) is withdrawn. Reinforcement surface shall be free of deleterious substances such as soil, mud, grease or oil that might contaminate the grout or coat the reinforcement and impair bond. Micropile cages and reinforcement groups, if used, shall be sufficiently robust to withstand the installation and grouting process and the withdrawal of the drill casings without damage or disturbance.

The Contractor shall check micropile top elevations and adjust all installed micropiles to the planned elevations.

Permanent casing shall be installed to the following minimum tip elevations:

MMFD 10+00 to 10+68, Elev. -29.0
MMFD 10+68 to 11+12.25, Elev. -17.0

Centralizers and spacers shall be provided at 10 feet centers maximum spacing. The upper and lower most centralizer shall be located a maximum of 5 feet from the top and bottom of the micropile. Centralizers and spacers shall permit the free

flow of grout without misalignment of the reinforcing bar(s) and permanent casing. The central reinforcement bars with centralizers shall be lowered into the stabilized drill hole and set. The reinforcing steel shall be inserted into the drill hole to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole. The Contractor shall redrill and reinsert reinforcing steel when necessary to facilitate insertion.

Lengths of casing and reinforcing bars to be spliced shall be secured in proper alignment and in a manner to avoid eccentricity or angle between the axes of the two lengths to be spliced. Splices and threaded joints shall meet the requirements of Section 6-05.2 as supplemented in these Special Provision. Threaded pipe casing joints shall be located at least two casing diameters (OD) from a splice in any reinforcing bar. When multiple bars are used, bar splices shall be staggered at least 1 foot.

Grouting

Micropiles shall be primary grouted the same day the load transfer bond length is drilled. The Contractor shall complete the load transfer bond length drilling and primary grouting of a micropile before beginning work on another micropile in the same footing or pile cap.

Prior to grouting, the drillhole shall be flushed with water and/or air to remove drill cuttings. The Contractor shall use a neat cement grout or a sand cement grout with a minimum seven day unconfined compressive strength of 4000 psi. Admixtures, if used, shall be mixed in accordance with manufacturer's recommendations.

The grouting equipment shall be colloidal mixers only (paddle mixers and other non-colloidal types of mixers shall not be used), and shall produce a grout free of lumps and undispersed cement. Contractor shall have means and methods of measuring the grout quantity and pumping pressure during the grouting operations. The grout pump shall be equipped with a pressure gauge to monitor grout pressures. A second pressure gauge shall be placed at the point of injection into the micropile top. The pressure gauges shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used, whichever is greater. The grout shall be kept in agitation prior to mixing. Grout shall be placed within one hour of mixing. The grouting equipment shall be sized to enable each micropile to be grouted in one continuous operation.

The grout shall be injected from the lowest point of the drill hole and injection shall continue until uncontaminated grout flows from the top of the micropile. The grout may be pumped through grout tubes, casing, hollow-stem augers, or drill rods. Temporary casing, if used, shall be extracted in stages ensuring that after each length of casing is removed the grout level is brought back up to the ground level before the next length is removed. Additional grout shall be placed by the use of a tremie pipe at all times. The tremie pipe shall always extend below the level of the existing grout in the drillhole. The grout pressures and grout takes shall be controlled to prevent excessive heave or fracturing of rock or soil formations. Upon completion of grouting, the grout tube may remain in the hole, but must be filled with grout.

If the Contractor elects to use a postgrouting system, working drawings and details shall be submitted to the Engineer for review in accordance with the **Construction Submittals** subsection of this Special Provision.

Grout Testing

Grout within the micropile verification and proof test micropiles shall attain the minimum specified seven day design compressive strength prior to load testing. Previous test results for the proposed grout mix completed within one year of the start of work may be submitted for initial verification of the required compressive strengths for installation of pre-production verification test micropiles and initial production micropiles. During placement of initial verification micropiles, proof test micropiles, and production micropiles, micropile grout will be sampled and tested by the Engineer for compressive strength in accordance with WSDOT Test Method 813 and AASHTO T 106 at a frequency of no less than one set of three 2 inch grout cubes from each grout plant each day of operation or per every 10 micropiles, whichever occurs more frequently. The compressive strength will be the average of the 3 cubes tested.

If a compressive strength test fails, the Engineer may require the Contractor to proof test some or all of the production micropiles installed since the last grout batch that met the specified compressive strength.

Grout consistency, as measured by grout density, shall be tested by the Contractor just prior to the start of micropile grouting in accordance with API RP-13B-1 at a frequency of at least one test per micropile. For the grout to be approved for use, the specific gravity reported by the test shall be between 1.8 and 1.9. The Contractor's grout consistency test equipment shall be calibrated by an independent testing laboratory. The Contractor shall not use test equipment greater than 180-calendar days past the most recent calibration date, until such equipment is recalibrated by an independent testing laboratory.

Micropile Installation Records

The Contractor shall prepare and submit to the Engineer full-length installation records for each micropile installed. The records shall be submitted within the same work shift that micropile installation is completed. The data shall be recorded in the micropile installation log. A separate log shall be provided for each micropile.

Micropile Load Tests

The Contractor shall perform verification and proof testing of micropiles at the locations specified in this Special Provision or as otherwise specified by the Engineer. All load testing shall be performed in compression in accordance with ASTM D 1143.

While completed production micropiles may be used as part of the reaction frame for proof load testing, no reaction bearing elements of the load test frame for verification and proof load testing of micropiles shall bear on existing structure elements.

Verification Load Tests

The Contractor shall perform pre-production verification micropile load testing to verify the design of the micropile system and the construction methods proposed prior to installing any production micropiles. Sacrificial verification test micropiles

shall be constructed in conformance with the working drawing submittal as approved by the Engineer. A verification test micropile shall be installed at each of the following locations:

MMFD 10+18 ± 3-feet, 13-feet left ± 3-feet

Verification load tests shall be performed to verify that the Contractor installed micropiles will meet the required compression and tension load capacities and load test acceptance criteria and to verify that the length of the micropile load transfer bond zone is adequate. The micropile verification load test results shall verify the Contractor's design and installation methods, and be reviewed and accepted by the Engineer prior to the installation of production micropiles.

The drilling-and-grouting method, casing length and outside diameter, reinforcing bar lengths, and depth of embedment for the verification test micropile(s) shall be identical to those specified for the production micropiles at the given locations. The verification test micropile structural steel sections shall be sized to safely resist the maximum test load. The maximum verification and proof test loads applied to the micropile shall not exceed 80 percent of the structural capacity of the micropile structural elements, to include steel yield in tension.

The jack shall be positioned at the beginning of the test such that unloading and repositioning during the test will not be required.

Testing Equipment and Data Recording

Testing equipment shall include dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame. The load cell is required only for the creep test portion of the verification test. The Contractor shall provide a description of test setup and jack, pressure gauge and load cell calibration curves in accordance with the **Working Drawings** subsection of this Special Provision. Additionally, the Contractor shall not use test jacks, pressure gauges and master pressure gauges, and electronic load cells greater than 90 calendar days past their most recent calibration date, until such items are recalibrated by an independent testing laboratory.

The Contractor shall design the testing reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. The Contractor shall align the jack, bearing plates, and stressing anchorage such that unloading and repositioning of the equipment will not be required during the test.

The Contractor shall apply and measure the test load with a hydraulic jack and pressure gauge. The pressure gauge shall be graduated in 75 psi increments or less. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to allow the test to be done without resetting the equipment. The Contractor shall monitor the creep test load hold during verification tests with both the pressure gauge and the electronic load cell. The Contractor shall use the load cell to accurately maintain a constant load hold during the creep test load hold increment of the verification test.

The Contractor shall measure the micropile top movement with a dial gauge capable of measuring to 1 mil (0.001 inch). The dial gauge shall have a travel sufficient to allow the test to be done without having to reset the gauge. The Contractor shall visually align the gauge to be parallel with the axis of the micropile and support the gauge independently from the jack, micropile or reaction frame. The Contractor shall use two dial gauges when the test setup requires reaction against the ground or single reaction micropiles on each side of the test micropile.

The required load test data will be recorded by the Engineer.

Verification Test Loading Schedule

The Contractor shall test the verification micropiles designated for compression load testing to a maximum test load of 2.0 times the micropile Design Load shown in the Plans or the working drawing submittal as approved by the Engineer. The verification micropile load tests shall be made by incrementally loading the micropile in accordance with the following cyclic load schedule:

AL = Alignment Load DL = Design Load

LOAD	HOLD TIME
AL	1 minute
0.25 DL	1 minute
0.50 DL	1 minute
AL	1 minute
0.25 DL	1 minute
0.50 DL	1 minute
0.75 DL	1 minute
1.00 DL	1 minute
AL	1 minute
0.25 DL	1 minute
0.50DL	1 minute
0.75 DL	1 minute
1.00DL	1 minute
0.25 DL	1 minute
0.50 DL	1 minute
0.75 DL	1 minute
1.00DL	1 minute
1.25DL	1 minute
1.50DL	1 Minute
1.67 DL	60 minutes (Creep Test Load Hold)
1.75 DL	1 minute
2.00 DL	10 minutes (Maximum Test Load)

The test load shall be applied in increments of 25 percent of the DL load. Each load increment shall be held for a minimum of 1 minute. Micropile top movement shall be measured at each load increment. The load-hold period shall start as soon as each test load increment is applied. The verification test micropile shall be monitored for creep at the 1.67 Design Load (DL). Micropile movement during the creep test shall be measured and recorded at 1, 2, 3, 4, 5, 6, 10, 20, 30, 40, 50,

and 60 minutes. The alignment load shall not exceed 5 percent of the DL load. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for micropile verification load tests are:

1. The micropile shall sustain the first compression 1.67 DL test load with no more than 0.50 inch total vertical movement at the top of the micropile, relative to the position of the top of the micropile prior to testing.

2. At the end of the 1.67 DL creep test load increment, test micropiles shall have a creep rate not exceeding 0.03125 inch/log cycle time (1 to 10 minutes) or 0.0625 inch/log cycle time (6 to 60 minutes). The creep rate shall be linear or decreasing throughout the creep load hold period.

3. Failure does not occur at the 2.0 DL maximum test load. Failure is defined as load at which attempts to further increase the test load simply result in continued micropile movement.

The Engineer will provide the Contractor written confirmation of the micropile design and construction within three working days of the completion of the verification load tests. This written confirmation will either confirm the capacities and bond lengths specified in the working drawing submittal as approved by the Engineer or will reject the micropiles based upon the verification test results.

Verification Test Micropile Rejection

If a verification tested micropile fails to meet the acceptance criteria, the Contractor shall modify the design, the construction procedure, or both. These modifications may include modifying the installation methods, increasing the bond length, or changing the micropile type. Any modification that necessitates changes to the structure will require the Engineer's prior review and acceptance. Any modifications of design or construction procedures or cost of additional verification test micropiles and load testing shall be at no additional expense to the Contracting Agency. At the completion of verification testing, test micropiles shall be removed down to an elevation two feet below finished ground line, except as otherwise specified by the Engineer.

Proof Load Tests

A minimum of two successful proof load tests shall be completed at each footing at micropile locations as specified by the Engineer. Additional proof tests will be required if modifications are made in the micropile installation methods subsequent to the first production micropile.

Proof Test Loading Schedule

Test micropiles designated for proof testing shall be compression proof load tested to a maximum test load of 1.67 times the micropile Design Load shown in the Plans or the working drawings as approved by the Engineer. Proof tests shall be conducted by incrementally loading the micropile in accordance with the following schedule, to be used for both compression and tension loading:

AL = Alignment Load DL = Design Load

LOAD	HOLD TIME

AL	1 minute
0.25 DL	1 minute
0.50 DL	1 minute
0.75 DL	1 minute
1.00DL	1 minute
1.25DL	1 minute
1.50DL	1 minute
1.67DL	10 or 60 minute
DL	1 minute

Depending on performance, either a 10 minute or 60 minute creep test shall be performed at the 1.67 DL Maximum Test Load. Where the micropile top movement between 1 and 10 minutes exceeds 0.03125 inch, the Maximum Test Load shall be maintained an additional 50 minutes. Movements shall be recorded at 1, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes. The alignment load shall not exceed 5 percent of DL. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for micropile proof load tests are:

1. The micropile shall sustain the compression maximum test load applied (1.67 DL) with no more than 0.50 inch total vertical movement at the top of the micropile, relative to the position of the top of the micropile prior to testing.

2. At the end of the 1.67 DL creep test load increment, test micropiles shall have a creep rate not exceeding 0.03125 inch/log cycle time (1 to 10 minutes) or 0.0625 inch/log cycle time (6 to 60 minutes). The creep rate shall be linear or decreasing throughout the creep load hold period.

Proof Test Micropile Rejection
If a proof-tested micropile fails to meet the acceptance criteria, the Contractor shall proof test another micropile within that footing as selected by the Engineer. For failed micropiles and further construction of subsequent micropiles, the Contractor shall modify the design, the construction procedure, or both. These modifications may include installing replacement micropiles, incorporating micropiles at not more than 50 percent of the maximum load attained, post grouting, modifying installation methods, increasing the bond length, or changing the micropile type. Any modification that necessitates changes to the structure design will require the Engineer's prior review and acceptance.

Measurement

Section 6-05.4 is supplemented with the following:

(BSP August 2, 2010)
Micropiles will be measured per each, for each micropile installed and accepted.

Micropile verification load testing will be measured per each for each successfully completed and accepted micropile verification load test.

Micropile proof load testing will be measured per each for each successfully completed and accepted micropile proof load test.

Payment

Section 6-05.5 is supplemented with the following:

(August 2, 2010)
"Micropile", per each.
The unit contract price per each for "Micropile" shall be full pay for performing the work as specified, including drilling the hole for the micropile, furnishing, and placing the casing, steel reinforcing bar, grout (including grout overruns), and micropile top attachments.

"Micropile Verification Load Testing", per each.
"Micropile Proof Load Testing", per each.
The unit contract price per each for "Micropile Verification Load Testing" and "Micropile Proof Load Testing" shall be full pay for performing the work as specified, including furnishing and installing verification load test micropiles, performing all additional verification load tests and proof load tests required due to previous test failures, performing all design and construction procedure modifications of design or construction procedures required as a result of the load test results, and providing any increase in strength of the verification test micropile elements above the strength required for the production micropiles.

Bridge Railings

Materials

Section 6-06.2 is supplemented with the following:

(BSP March 3, 2014)
Bridge Railing Type Snow Fence and Bridge Railing Type Wire Fabric Fence
Wire fabric shall be 6.5 gage diameter, 2 inch square wire mesh conforming to ASTM F 2453 Type 2 and galvanized after fabrication in accordance with AASHTO M 111.

HSS tubes shall conform to ASTM A 500, Grade B.

Steel bars, plates, and shapes shall conform to either ASTM A 36 or ASTM A 992.

HSS tube caps shall conform to ASTM A 53 Grade B Type E or S, or may be fabricated from material conforming to ASTM A 36.

HSS tubes, HSS tube caps, and steel bars, plates, and shapes, shall be galvanized after fabrication in accordance with AASHTO M 111.

Bolts, anchor bolts, threaded welded studs, nuts, and washers shall conform to Section 9-06.5(3), and shall be galvanized after fabrication in accordance with AASHTO M 232.

Hex head bolts shall conform to ASTM F 593, Type 304. Nuts shall conform to ASTM F 594, Type 304. Washers shall conform to ASTM A 240 Type 304 stainless steel and the geometric requirements of ASME B18.22.1.