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Technical Letter
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Engineering and Design
USE OF SPIRAL WELDED PIPE PILES

1. Purpose. This engineer technical letter establishes guidance for expanded use of spiral welded pipe (SWP) piles Corps-wide to include sites having soft soils and low probabilities for seismic shaking and extreme cold temperatures.

2. Applicability. This engineer technical letter applies to U.S. Army Corps of Engineers commands having design and/or construction responsibilities for civil works.

3. Distribution Statement. Approved for public release; distribution is unlimited.

4. References.

a. Spiral Welded Pipe Piles for Coastal Structures, 1 February 2010, https://ten.usace.army.mil/Files/5/9/7/3/Spiral%20Welded%20Pipe%20Piles%20for%20Coastal%20Structures.pdf.

b. AWS D1.1, Structural Welding Code – Steel.

c. ASTM D1143, Standard Test Methods for Deep Foundations under Static Axial Compressive Load.

d. ASTM D3689, Standard Test Methods for Deep Foundations under Static Axial Tensile Load.

e. EM 1110-2-2906, Design of Pile Foundations.

f. ASTM D4945, Standard Test Methods for High-Strain Dynamic Testing of Piles.

5. Background. Improvements to the Hurricane and Storm Damage Risk Reduction System (HSDRRS) for New Orleans and its vicinity include many coastal structures on pile foundations. Design and construction of several miles of floodwalls and major structures provided the opportunity to evaluate innovative practices such as spiral welded pipe (SWP) piles instead of straight seam pipe (SSP) or H-piles to reduce construction cost. SWP piles are readily available but the helical, skelp, and/or splice welds in SWP piles raised concerns for potential failure during driving and/or reduction in the axial and flexural pile capacities. The key issues were:

welds may fail due to high dynamic stresses during pile driving; a weld bead that protrudes about one-eighth inch beyond the surface of the pile may reduce the frictional resistance along the pile-soil interface; fabricating or handling operations may distort the round shape and make field splicing difficult and costly, or may significantly reduce the structural capacity; and a weld bead and the mismatched pipe walls at a field splice may protrude one-half inch beyond the surface of the pile and cause curvature in the driven pile. In October 2008, CEMVD commissioned a series of SWP studies, analyses, and field or laboratory tests that resolved these issues and developed the engineering guidance and construction specifications needed to achieve satisfactory weld quality and pile performance.

6. Fabrication and Installation. CEMVN has fabricated and installed SWP piles in accordance with Appendix E of reference 4.a., with or without the weld bead ground-down.

a. Dimensional Tolerances. Tolerances for diameter and wall thickness, roundness, straightness, radial offset, weld reinforcement, and misalignment of weld beads have been coordinated with the SWP industry and should be specified for SWP piles. The out-of-roundness tolerance shall be within 1% of the nominal outside diameter; the straightness, in units of inches, shall not exceed 0.001 times the length of the pile; a maximum radial offset of 1/8 inch shall be permitted, and the offset shall be transitioned with a taper weld at the slope not less than 1 times the thickness on 2.5 times the length; the weld reinforcement (bead height) shall not be greater than 3/16 inch; misalignment of the weld beads for double-sided welded pipe shall not exceed 1/8 inch; and wall thickness shall be as indicated on the Contract Drawings except that up to a 10% greater thickness will be acceptable.

b. Weld Quality. The welding procedure for producing SWP piles shall be qualified in accordance with AWS D1.1, Clause 4, Qualification. Tests shall include reduced-section tension tests (2 coupons) for joint strength; guided bend tests (4 coupons) for weld ductility that pass the AWS D1.1, Provision 4.8.3.3, or the minimum required strain level at the onset of ductility level 2, whichever is greater; Macroetch tests (3 samples) for weld penetration; and Charpy V-Notch (CVN) tests (5 samples) at zero degrees Fahrenheit for fracture toughness. The acceptance threshold for the five CVN tests is that the test results shall meet or exceed both criteria for an average value of 20 ft-lb CVN for the set of test coupons, and a minimum value of 15 ft-lb CVN for any individual test coupon. An effective weld quality assurance program (WQAP) is required during production to achieve acceptable weld quality and structural performance of the production SWP piles. The weld quality assurance program shall include testing, procedure and performance qualifications, production verification qualifications, certification, and joint tracking requirements in accordance with Section 9 of reference 4.a.

7. Structural and Geotechnical Performance. The acceptance threshold for flexural pile capacity shall be ductility level 2 as described in Section 7 of reference 4.a. The maximum D/t ratio shall be limited to 55 unless the special provisions stated below are satisfied.

a. SWP piles may only exceed a D/t ratio of 55 if the manufacturer provides results of Four Point Flexural Test (FPFT) equal in testing scope and accuracy to those performed at North Carolina State University that meet or exceed the ductility level 2 (Appendices D and M of reference 4.a.), and the mechanical testing requirements for joint strength, weld ductility, weld

penetration and fracture toughness stated above. Designers shall develop local buckling design criteria based on appropriate experimental data and analytical models for combined axial compression and bending stresses in SWP piles with D/t exceeding 55.

b. In addition to structural testing requirements stated above, all test piles shall be subjected to static axial load testing and dynamic pile testing to determine whether or not the weld bead of the SWP pile will influence or adversely affect the load carrying capacity along the pile shaft in comparison with the conventional SSP pile for site specific soils. Structural and geotechnical testing requirements can be found in Appendix M of reference 4.a.

8. Expanded USACE Application. The results described in reference 4.a. were specifically developed for the coastal structures in New Orleans and vicinity and are not intended for general application. Similar acceptable applications elsewhere shall be limited to sites with soft soils and low probabilities of seismic shaking or extreme low temperatures.

9. Future Guidance. Little is known regarding the manufacturing and performance requirements necessary to further expand the use of SWP piles to sites with greater driving resistance, greater probability of seismic shaking, and extreme low temperatures. Research should be conducted to investigate existing data addressing prior use and performance of these products, particularly at sites where these characteristics of concern are present. For first time use at sites with characteristics outside the scope of what is currently approved, the project should show a potential for cost effectiveness, and the district should partner with the division and industry suppliers to generate the manufacturing and performance requirements, characterize a standard for satisfactory results, and produce a specification that meets the requirements.

FOR THE COMMANDER:

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