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DEPARTMENT OF THE ARMY
MISSISSIPPI RIVER COMMISSION, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI 39180

ADDRESS REPLY TO:
PRESIDENT, MISSISSIPPI RIVER COMMISSION
CORPS OF ENGINEERS
P. O. BOX 80
VICKSBURG, MISSISSIPPI 39180

CEMRC-ED-GS (1105-2-10c)

24 JUL '89

MEMORANDUM FOR Commander, New Orleans District, ATTN: CELMV-ED-F

SUBJECT: Sheet Pile Wall Design Criteria

1. Reference:

a. CEMRC-ED-GS letter, subject as above, dated 23 Dec 87.

b. CELMN-ED-DD letter, entitled "Phasing in of New I-Wall Design Criteria into NOD's Design/Construction Program," dated 26 Jan 88, and endorsements thereto.

c. CELMN-ED-DD letter, entitled "I-Wall Deflection," dated 18 Nov 88 and endorsements thereto.

d. WES final report entitled "Development of Finite Element-Based Design Procedure for Sheet Pile Walls" (encl 1).

2. The first two referenced letters (ref 1a and 1b) set forth revised criteria for determining the penetration of sheet pile floodwalls founded in soft clays. The third letter (ref 1c) primarily involved discussions concerning estimating sheet pile deflections and design of I-walls to withstand these deflections. The purpose of this letter is to summarize the guidance for determining sheet pile wall penetrations, deflections, and moments based on the referenced letters and an evaluation of the referenced report.

3. The following criteria should be followed to determine the penetration of sheet pile floodwalls founded in soft clays:

Q-Case

F.S. = 1.5 with water to flowline or SWL.

F.S. = 1.25 with water to flowline plus approved freeboard for river levees or with SWL and waveload for hurricane protection levees.

F.S. = 1.0 with SWL plus 2-ft freeboard for hurricane protection levees.

S-Case

F.S. = 1.2 with water to flowline or SWL and waveload. If a hurricane protection floodwall has no significant waveload, determine the penetration using Q-case criteria only.

F.S. = 1.0 with water to flowline plus approved freeboard for river levees.

ENCL 1

Select the maximum penetration from the applicable cases above using a limit equilibrium analysis such as CANWAL. In some cases, especially Q-case penetrations derived for low heads, the theoretical required penetrations could be minimal. In order to ensure adequate penetration to account for unknown variations in ground surface elevations and soil conditions, penetrations should be arbitrarily increased, as necessary, to achieve a penetration to head ratio (for flowline or SWL) of about 2.5 to 3:1. Engineering judgement should be exercised in selecting appropriate loading cases and penetration to head ratios. For certain projects, penetration to head ratios of less than 2.5 to 3:1 may be appropriate.

4. Moment and shear forces computed for design of the sheet pile wall sections should be based on the most critical loading case set forth in para 3 above and a conventional limit equilibrium analysis such as CANWAL. Based upon comparisons presented in reference 1d using the Finite Element Method and soft clay conditions, there is no significant increase in moment due to increasing pile penetration (see plots in reference 1d, pages A-26, A-28, and A-30). Consequently moment and shear forces computed for design of sheet pile wall sections need only be based upon the critical load case set forth in paragraph 3 above and the resulting pile penetration, even if the selected penetration is greater than the computed required penetration. As stated in reference 1d, displacements of sheet pile walls founded in soft clays are likely more the result of deep seated soil movements than due to flexural deflection of the sheet pile. Therefore, in addition to the calculation of flexural deflection based on the critical loading case and the limit equilibrium analysis, the finite element derived recommendations outlined on page 43 of ref 1d can be used to help estimate total wall deflections. Of course, the closer the actual project site conditions are to those assumed in the WES report, the more applicable the finite element derived deflections. In any case, estimated sheet pile deflection should not control the selection of the sheet pile section for walls founded in soft clays. A flexible connection should be designed to accommodate the estimated relative deflections between I-walls and adjacent pile or soil founded monoliths.

5. It should be noted that the finite element estimated wall deflections in the WES final report are somewhat less than those in its draft report. This is primarily due to the selection of a higher "K" value (soil stiffness) to calibrate the finite element model to the E-99 field test data. Due to sensitivity of the computed and actual deflections to soil stiffness, the actual deflections experienced in the field can only be estimated with limited accuracy. If the I-wall/levee is designed for a minimum F.S. = 1.30 for sliding stability, deep seated foundation movements should not normally be excessive.

6. In future design reports and design memorandums, the following information should be shown on each I-wall Stability Plate:

a. Summary of load cases considered in the design.
b. Moment Diagram for controlling load case.
c. Shear Diagram for controlling load case.
d. Deflections computed by both CANWAL and the WES report method (if applicable.
e. Sample computations illustrating the selection of the required sheet pile section.

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If space permits show items b and c on levee cross-section immediately adjacent to sheet pile soil pressure diagram.

FOR THE PRESIDENT OF THE COMMISSION:

Encl

FRED H. BAYLEY III
Chief, Engineering Division