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MIDLAND PROJECT
DOCKET NOS 50-329, 50-330
TEST RESULTS OF THE SOIL BORING AND TESTING
PROGRAM FOR THE SERVICE WATER PUMP STRUCTURE
FILE 0485.16, B3.0.8 SERIAL 14280
REFERENCES: (1) R B PECK, W E HANSON AND T H THORNBURN, FOUNDATION ENGINEERING, JOHN WILEY AND SONS, INC, SECOND EDITION, 1974, FIGURE 18.2
(2) K TERZAGHI AND R B PECK, SOIL MECHANICS IN ENGINEERING PRACTICE, JOHN WILEY AND SONS, INC, SECOND EDITION, 1967
ENCLOSURE: TEST RESULTS, SERVICE WATER STRUCTURE SOIL BORING AND TESTING PROGRAM, MIDLAND PLANT UNITS 1 AND 2

We are forwarding thirty (30) copies of the enclosed Woodward-Clyde Consultants (WCC) report dated October 1, 1981 entitled "Test Results, Service Water Structure Soil Boring and Testing Program, Midland Plant - Units 1 and 2." This report describes the scope of the boring and sampling program and the subsequent laboratory testing program for the fill and foundation materials at the service water pump structure. Detailed supporting data for the triaxial and consolidation tests are also included. The results of laboratory shear strength and consolidation tests along with related engineering characteristics of the natural soil are discussed below.

GENERAL

Two borings, COE-16 and COE-16A, performed by WCC were located near the northeast corner of the service water pump structure. Boring COE-16 was carried to a total depth of 76 feet (El 558') below the general ground surface which is at Elevation 634'. Supplementary Boring COE-16A was drilled adjacent to Boring COE-16 and was carried to a total depth of 80 feet (El 554').

Essentially, the soil strata indicated by the two borings (COE-16 and COE-16A) was the same. These borings encountered fill extending from the present ground surface at Elevation 634' to Elevation 600' which is the original ground surface in the area before construction of the service water pump

structure. Between Elevations 600' and 588', a sandy natural soil strata underlying the fill was encountered. Based on the previous plant fill exploration, ie, the SW series and CH series borings performed during the period October 1978 to July 1979, the maximum fill depth penetrated by the SW series borings extended to Elevation 593'. The depth of fill penetrated by the CH series borings was to Elevation 588', except for Boring CH-2 which revealed very dense sand fill to Elevation 584' which was first encountered at Elevation 596'. For further reference, the SW series boring logs can be found in MCAR 24, Report No 6, the 50.55e report dated June 11, 1979, and the CH boring logs are located in the 50.54(f) Question 36 (Volume 8) dated September 14, 1980. Based on the preceding discussion, the subsurface profile revealed by the COE, SW and CH borings is summarized below.

Between the ground surface elevation of 634' down to elevation range of 600' to 588' (34 to 46 feet from ground surface) the soil encountered consisted of mixed clay and sand fill. In some areas, natural soil 12 to 14 feet thick was encountered between approximate Elevations 600' and 588' and consisted of very dense interlensed till composed of clay, sand and silt. From approximate Elevation 588' to the bottom of the borings at Elevatins 558' and 554', highly preconsolidated silty clay till was encountered.

SHEAR STRENGTH AND BEARING CAPACITY

It is planned to construct the underpinning piers on the highly preconsolidated till at or below Elevation 587'. In order to evaluate the shear strength of the soil, unconsolidated undrained (UU) and isotropically consolidated undrained (CIU) shear strength tests on selected undisturbed soil samples, obtained from Borings COE-16 and COE-16A, were performed by WCC. The results of triaxial strength tests provided the following values of undrained shear strength.

Test Type - Elevations	Material Type	Shear Strength, (Su) ksf Range	Average
3 CIU Tests - From El 600' to El 597'	(Till)	18.2-29.5	24.8
4 UU Tests - From El 574' to El 555'	(Till)	11.4-18.2	15.0
3 CIU Tests - From El 567' to El 565'	(Till)	20.5-26.6	23.7

For natural soil stratas, the undrained shear strength, presented in FSAR Figure 2.5-33 is on the order of 6 ksf down to Elevation 560' and a value of 8 ksf below Elevation 560'.

A comparison of average shear strength values for natural soil, presented in FSAR Figure 2.5-33, and the average values summarized above and obtained in recent Woodward-Clyde Consultants' tests indicate that the average shear strength values obtained from the recent WCC tests are higher than the values presented in the Midland FSAR.

In accordance with Subsection 2.5.4.10.1 of the Midland FSAR, the allowable bearing capacity for the foundation design requires a safety factor of three against dead load plus sustained live load and requires a safety factor of two for those loadings plus the transient seismic load. For the strip footing which will represent the mode of load application from the continuous underpinning piers, the bearing capacity factor (N_c) for a $\phi = 0°$ foundation soil ranges between six and seven, depending on the depth of embedment in the natural soil (refer to Reference 1). If bearing capacity is calculated using a bearing capacity factor of 6.0 and an average strength (S_u) of 15 ksf, the ultimate bearing capacity will be $N_c \times S_u = 90$ ksf. The allowable bearing capacity under sustained load thus equals 30 ksf. The ultimate bearing capacity under sustained load using an undrained shear strength of 6 ksf (refer to FSAR Figure 2.5.33) is about 36 ksf and the allowable bearing capacity is about 12 ksf. The allowable bearing capacities for the dead and live loads plus the transient seismic load are 45 ksf and 18 ksf using an average shear strength based on the WCC tests and the values presented in FSAR Figure 2.5-33, respectively. It can be seen from the foregoing discussion that the allowable bearing capacity based on shear strengths obtained from the WCC tests is higher than the allowable bearing capacity based on the Midland FSAR shear strength data.

PRECONSOLIDATION PRESSURE

Two consolidation tests were performed on the natural foundation soil stratas to estimate preconsolidation pressure values for the natural soil. The estimated values of preconsolidation pressures from the resulting strain versus log pressure curves were evaluated using the method recommended by Arthur Casagrande in Reference 2. Based on this evaluation, the preconsolidation pressures were about 96 ksf for the sample at Elevation 580' from Boring COE-16A and were 164 ksf for the sample at Elevation 568' from Boring COE-16. These values indicate that the natural soils are heavily overconsolidated. These values are much higher than those previously estimated values of 15 to 20 ksf given in FSAR Subsection 2.5.4.2.9.

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