Testimony of H. Singh on S.W. Structure, Rec'd 4/8/82
Requires coordination with Steve Poulos' testimony 7/85

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSUMERS POWER COMPANY	)	Docket Nos. 50-329-OM & OL
	)	50-330-OM & OL
	)	
(Midland Plant, Units 1 and 2)	)	

TESTIMONY OF HARI NARIN SINGH CONCERNING
SERVICE WATER PUMP STRUCTURE

Q.1. Please state your name and position with the U.S. Army Corp of Engineers.

A. My name is Hari N. Singh. I am a Civil Engineer in the Geotechnical Branch of the Engineering Division, NCD Chicago District of the U.S. Army Corps of Engineers.

Q.2. How did the U.S. Army Corps of Engineers get involved in the review process of the Midland Plant, and what are the areas of its responsibilities?

A. Pursuant to an interagency agreement between the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Army Corps of Engineers (the Corps) which became effective in September 1979, the Corps undertook to provide technical assistance to the NRC. The Corps provides assistance on the geotechnical engineering aspects of the Midland Plant.

Q.3. Have you prepared a statement of your professional qualifications?

A. Yes, a copy is attached.

Q.4. Please state the nature of your responsibilities with respect to the Midland Plant.

A. My involvement with the Midland Plant began in May 1980, when I was assigned the responsibility as the Corp's lead reviewer for the geotechnical aspects of engineers and geologists of the Geotechnical Section of the Detroit District, who were engaged in reviewing the materials used in the foundation design of the plant. As the full-time lead reviewer, my responsibilities were to coordinate with all the reviewers, examine their comments, perform my own review, discuss comments with the Section Chief and prepare a final letter report to be transmitted to the NRC. The structures being reviewed include the following: 1) Auxiliary Building, 2) Reactor Building Units 1 and 2, 3) Diesel Generator Building, 4) Borated Water Storage Tanks Units 1 & 2, 5) Service Water Pump Structure, 6) Diesel Fuel Storage Tanks, 7) Seismic Category I Piping and Conduits, 8) Retaining Walls, and 9) the dikes adjacent to the Emergency Cooling Water Reservoir (ECWR).

Q.5. Did you receive Woodward-Clyde consultant's (WWC) report containing the details of the soil exploration and the test results of the samples obtained from the area of the Service Water Pump Structure (SWPS)? If yes, what information was included in the report?

A. Yes, the WWC report entitled "Test Results - Service Water Pump Structure - Soil Boring and Testing Program - Midland Plant - Unit 1 and 2, Midland, Michigan" has been received by the Corps of Engineers. The following information was included in the report:

1. Log of Boring (COE 16, COE 16A) - Appendix A
2. Index Properties Test results - Appendix B
3. Particule - Size distribution curves - Appendix C
4. Unconsolidated Undrained (UU) Triaxial Compression Test results - Appendix D

5. Consolidated Undrained (C $\overline{I}$ U) Triaxial Compression Test results - Appendix E

6. Consolidation Test results - Appendix F

7. Supporting data for UU tests - Appendix G

8. Supporting data for C $\overline{I}$ U tests - Appendix H

9. Supporting data for Consolidation tests - Appendix I

Q.6. Has Corps of Engineers completed its review of the information provided in Woodward-Clyde consultant's report? If yes, what review comments does the Corps have on the contents of the report?

A. Yes. Based on our evaluation of lab test results, the following comments are provided.

1. The results of the Unconsolidated Undrained (UU) tests indicate that peak shear strengths of the natural materials (between El 554.8 and El 573.5) vary from 11.438 ksf to 18.176 ksf. The samples tested were selected on the basis of the results of the index tests (Atterberg tests, Pocket Pentrometer test, etc). Although no samples were tested from the potential zone of influence of the underpinning foundation (El 587.00 to 580.00), the index properties indicate that the material within the zone of influence are identical to those of sample tested. Therefore, bearing capacity of the soils supporting the underpinning walls could be reasonably predicted using the UU test results of the sample tested.

2. Presentation of C $\overline{I}$ U test results as provided on page 2 of the forwarding letter, dated 6 November, 1981, is misleading. The ranges of the shear strengths from 18.2 ksf to 29.5 ksf for soil stratum between elevations 600' and 597', and from 20.5 ksf to 26.6 ksf for soil stratum between elevations 567' and 565' are not correct. The samples have been

tested at various consolidating pressures, therefore, a range of shear strengths increasing with the consolidating pressure has been obtained. The actual shear strength of the soil in strata mentioned above should be obtained from the shear strength envelope curve obtained from the C $\overline{I}$ U test results.

3. The Corps of Engineers does not see any advantage of collecting samples from two borings (COE-16 and COE-16A) approximately at the same location. Corps of Engineers was not aware of Boring COE-16A until the WWC's report was received. Corps' personnel did not observe the drilling and sampling operation of Boring COE-16A. The applicant should clarify why samples of glacial till obtained from COE-16 have not been tested.

4. The ultimate bearing capacity of 90 ksf reported on page 2 of the transmittal letter contradicts the ultimate bearing capacity value reported on page 48 of the Applicant's testimony, where a 52 ksf value has been reported. The value of 90 ksf is based on undrained shear strength of 16 ksf and is not acceptable.

5. The results of the consolidation tests are so divergent from those of the Dames & Moore's results provided in FSAR that it cast many doubts about the applicant ability to perform the work within reasonable accuracy. It is not known at this stage that which of the two results are closer to the actual value.

Q.7. What are the sequence of various remedial measures proposed by the applicant?

A.1. To stabilize the fill supported portion of the Service Water Pump Structure (to eliminate cantilever action), the applicant originally planned to support the northern wall of the structure with 16 number of 100 tons capacity, 13" diameter, concrete filled steel piles. Attachment.... shows the plan view of the piles as well as the method of transferring vertical loads from the wall to the piles by a system of reinforced concrete corbels. The piles were to be driven in to the natural soil through pre-drilled holes in the compacted fill materials. This proposal was furnished to the NRC through 50.55(e) report (Interm report 6 dated 11 June 1979).

The Corps of Engineers reviewed the proposal, but because of insufficient information it could not evaluate the adequacy of the proposal. In its letter report of 7 July 1980 (Attachment ●), the Corps of Engineers requested the information required for the review. A brief description of the information required are as follows:

(i) Analysis for capacity of the piles against vertical as well as lateral loads.

(ii) Engineering properties of the natural soils as well as compacted fill materials through which the piles were to be driven.

(iii) An analysis for the negative skin friction on piles which were inevitable due to future settlement of the fill materials.

(iv) Total actual load to be transmitted to the ground through the piles.

(v) Analysis for possible settlement that could occur between the pile supported end and the portion of the structure placed on natural material.

(vi) Dynamic analysis of the 100 tons capacity piles.

The applicant response to these requests was not satisfactory. The Corps of Engineers report of 15 April 1981 (Attachment ●) provides the details.

2. During the NRC structural audit in March 1981, the applicant gave an indication that it had revised its remedial measures for the Service Water Pump Structure. Preliminary drawings for the new proposal were displayed during the audit, but details were not provided. During two subsequent meetings, one in first week of May 1981 and another on 17 September 1981, the applicant provided the following details:

The current remedial measures consists of providing continuous 4' wide concrete underpinning wall under the outer walls of the fill supported portion of the Service Water Pump Structure. The foundation wall will be carried down from the underside of the existing foundation slab through the fill materials to the natural soil. Thus, the structure loads will be carried by the foundation walls to the natural soil without stressing the problem fill materials. The walls will be 30' high with a belled bottom of 6' width to distribute the load on larger area. The walls will be constructed in small sections from tunnels which will be advanced simultaneously from access shafts located at northeast and northwest corners of the building. Further details and the adequacy of this proposal has been discussed in Dr. S. Poulus testimony.

8. Conclusions:

1. The soil exploration (extraction of undisturbed samples) and the testing have been carried out according to the current state-of-the method; therefore, the test results are appropriate for, (1) evaluating bearing capacity analysis of the soils supporting the underpinning wall; (2) computing downward drag on the underpinning walls due to potential settlement of fill material; and (3) and computing present and future settlements of the structure.

2. The drained shear strength parameters, C = 0.73 ksf and $\bar{\emptyset} = 36^{o}$, used by Applicant for determination of long term bearing capacity of soils are based on average results of C $\bar{I}$ U tests on samples taken from natural materials considerable below the zone of influence of the foundation. However, in view of the identical index properties of the sample tested and the soils within the zone of influence, in Corps' opinion the use of above shear strength parameters for long term bearing capacity analysis is appropriate.

3. Since the consolidation test results have indicated that the foundation soil is heavily preconsolidated, a recompression of foundation soil under the structure load is expected. Therefore, the settlement evaluation by the Applicant, using elastic approach is justified. Also the value of the Modulus of Elasticity of 600X undrained shear strength of the soil used in analysis is appropriate.