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MIDDLE SOUTH UTILITIES SYSTEM

May 14, 1984

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3-A1.16.07

Director of Nuclear Reactor Regulation
Attention: Mr. G.W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: Waterford SES Unit 3
Docket No. 50-382
Responses to Requests for Additional
Information on NPIS Basemat

The NRC staff presented LP&L with two sets of questions during a technical meeting in Ebasco's New York offices on April 4, 1984. These informal requests concerned the issue of hairline cracks within the basemat of the Nuclear Plant Island Structure (NPIS).

The attachment provides responses to the requests for additional information from Geotechnical Engineering and Structural Engineering Branches.

If you have any questions regarding these responses, do not hesitate to call me.

Very truly yours,

K W Cook

K. W. Cook
Nuclear Support & Licensing Manager

KWC/ch
Attachment

cc: E.L. Blake, W.M. Stevenson, J.T. Collins, D.M. Crutchfield, J. Wilson, G.L. Constable

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REQUEST FOR ADDITIONAL INFORMATION
WATERFORD NPP - GEOTECHNICAL ENGINEERING
(Note: No. 2 through 5 are confirmatory)

1. Are there any additional loads (dead or live) to be added on the foundation mat? Indicate magnitude and distribution of these loads.

Response

The additional loads to be added on the foundation mat are the weights of refueling pool water of Reactor Building and spent fuel pool water of Fuel Handling Building.

The water loads are calculated to be 3,900 and 2,700 Kips respectively for the refueling and spent fuel pools. Total sum of these loads is less than 1% of the total loads carried by the foundation mat.

2. Based on the construction records (NCR W3-5997), the foundation soils and shell filter appear to have experienced quite a few construction difficulties, i.e., standing water in the excavation, mud spurts during compaction, "liquefaction," over-compaction, slope cave-ins, and variable degrees of compaction of the shell filter strips.

(a) Assess the effects of those factors on the differential settlement, cracking, and leaking of the mat.

(b) Also analyze the shear stress developed in the foundation mat as a result of mat (i.e., shell blanket) settlement effect. (Editors Note: Settlement due to shell blanket).

Response

As part of the nuclear plant island, "Floating Foundation Principle," a clam shell filter blanket was incorporated as part of the foundation design. The filter blanket, connected to a series of recharge wells was designed to provide buoyancy

uniform' ' en'th the common foundation mat through the control' ' recha'ge of groundwater, sufficient buoyancy was provided to maintain soil pressures on the foundation materials which were approximately equal to or slightly greater than the existing overburden pressure prior to the start of construction.

In accordance with Ebasco Technical Specification, Section 6 and Construction Procedure CP-203, a clam shell filter blanket test fill was conducted in September-October, 1975. The goals of the test fill were to determine the construction procedures which would generate a high permeability blanket with low post construction settlement. The rest of the test fill, documented in the "Clam Shell Filter Blanket Test Fill Report" dated November, 1975 indicate that these goals could be obtained with 10 passes of a 12 ton smooth drum vibratory roller moving at 1.5 to 3.0 m.p.h.

In specific:

a) The permeability of the compacted clam shell was found to be 1.6 $x10^{-1}$ cm/sec or greater. (This value was the limit of the test apparatus).
b) The average density of the clam shell after compaction was measured to average 93% of the modified proctor density.
c) After compaction, 88% of the total settlement possible in the clam shell had taken place with the remaining 12% (.1 inches ±) to take place during construction of the foundation mat.

The resulting construction methodology generating these properties was attached to the Ebasco Technical Specification LOU 1564.482 as an attachment.

The construction of the clam shell filter blanket was performed in accordance with this specified construction method. Inspection was performed in accordance with

Ebasco Quality Control Procedure, QCIP-1 (Form QC-93) and J. A. Jones site inspection and test procedure No. 2, W-SITP-2 (Form W-SITP-2.1).

In addition, the construction, inspection and testing of the clam shell filter blanket were personally observed and reviewed by the Ebasco Site Soils Engineer, M. Temchin. Only after a complete review of documentation was made, was a strip of clam shell documented as acceptable and released for mud mat placement by the site soils engineer.

In June, 1983 the clam shell filter blanket was reviewed again by the former Site Soils Engineer, M. Temchin during his disposition of Noncomformance Report NCR-W3-5997. The conclusions of the review were documented as "Accept As Is" for the As Built Filter Blanket.

During construction, and again during the 1983 review, construction difficulties were found to be exceptionally localized and randomly located conservatively accounting for less than 3% of the total blanket area. Thus:

1) Taking into consideration the localized nature of the documented difficulties
2) The random locations of the difficulties
3) The exceptionally high permeability of the constructed blanket
4) The high density of the construction blanket and
5) The large % of consolidation achieved during construction of the blanket itself.

It was concluded that the As Built Clam Shell Filter Blanket was constructed and has performed in accordance with the design requirements, and that the minor construction difficulties have had no adverse effect on the common foundation mat. Therefore, no significant differential settlement or resulting shear stresses occur as a result of shell blanket placement and localized minor construction difficulties.

3. During the shell placement of the eastern half of strip #2, mud was reported to have come through the shell blanket in numerous spots. This appears to indicate that the function of the filter cloth is compromised.

Evaluate the situation and determine the effects on the support of the mat over affected foundation soils.

Response

Reference is made to NCR W3-5997, Attachment II Pages 32 through 53 and to the engineers disposition, Section VI-A-2d, on Page 10. These documents indicate that the foundation of the south half of the east half of strip #2 contained the clam shell filter blanket, rain-water from the foundation was vibrated up through the clam shell to the surface after 4 passes of the 12 ton roller. Five shell drainage sumps were excavated and pumped to remove the excess water. Upon further compaction (2 passes of the roller) foundation silts were pumped up through the clam shell causing a small localized "MUD SPURT."

The sketch on Page 36 of the NCR shows the effected area to be 8 feet by 15 feet wide or a total of 120 ft^2. This constitutes 0.75% of the surface area of strip #2 and 0.12% of the total surface area of the entire filter blanket: A truely localized condition.

According to the sketch on Page 35 of the NCR, the mud spurt surfaced from 24' to 40' into the strip from the south edge of strip #2. The filter cloth was supplied on 300' long rolls, 15' wide and installed with 2 foot overlaps at the longitudinal seam to this particular strip, two filter cloth overlap seams were located at 28' and 41' into the strip from the south edge. During vibratory compaction of the shell blanket, foundation silts migrated to the surface of the shell layer due to the overlap seams in the filter cloth below it (which coincide with the location of the mud spurt). In this case the filter

cloth was pressed down to conform to the shape of the foundation under the weight of the roller. This shortened the amount of overlap at the ends of the cloth and allowed the water and silt to move between the seams and into the clam shell. In this situation, although some small amounts of water and silt did penetrate the clam shell during vibratory compaction, the filter cloth was not actually damaged or compromised; but rather bypassed in a localized area of the seam.

After the mud spurt had formed, compaction of the area was stopped and the area was staked off (Pg. 36). The clam shell thickness in the spurt area was measured and found to be thin (4") of clean clam shell due to partial contamination by the foundation silts (Pg. 36). The area was left alone for a day to allow the excess hydrostatic pressures to discipate (Pg. 37). Two additional layers of shell 3" to 4" thick were feathered over the disturbed area and compacted to achieve a final thickness of 12" of clean clam shell (Pg. 35, 37, 42). The next day, a small trench was hand excavated around the entire mud spurt area and inspected by the site soils engineer. The hydrostatic pressures had been alleviated and a 12" thick layer of clean compacted clam shell was found to exist. The small trench was backfilled and compacted with a pan vibrator.

In summary, a condition of localized contaminated clam shell blanket was detected. By providing drainage and waiting periods between successive smaller lifts, the specified clam shell filter blanket was eventually constructed, inspected and finally approved by the site soils engineer.

Due to the localized condition of the area and the high permeability and density of the clam shell blanket eventually constructed, the area was accepted as providing the design requirements and the east side of strip #2 was released for mud mat placement by the site soils engineer.

A similar situation was found to exist on the west half of strip #2 (Pg. 46). The situation was treated as described above and the finally constructed filter blanket was inspected and approved by the site soils engineer (Pg. 45 and 53).

In conclusion, no adverse effects were realized on the common base mat as a result of these minor construction difficulties.

4. Settlement records (drawings SK 1564-15 10 G-14.1 thru 4) show that at heave points H2 through H4 the foundation soils rebounded about 6 inches while at heave points H1 and H5 the foundations rebounded about 11 inches during excavation and dewatering. However, when the nuclear island was constructed at the heave point H1, the foundation settled the same amount as its rebound, while at heave points H2 thru H4, the foundation settled 3 to 4 inches more than they rebounded.

   Since the final structural loads on the foundation are the same as the replaced soil loads, explain how settlements greater than the rebound values could take place.

   Response

   During construction, the major amount of recompression of sub-soil system was induced by applying a maximum effective loading of nearly 4,500 psf (Refer to Section 2.5.4.11, FSAR). This maximum effective loading which is greater than the in-situ net soil pressure (3,300 psf.) prior to construction had been monitored to accomplish some degree of overconsolidation of the sub-soil system. Therefore settlements greater than the rebound (heave) value had taken place.

5. Based on the results of groundwater monitoring (drawings SK 15564 - 15.10 G-14.1 thru 4), the groundwater level is affected by the fluctuation of the Mississippi River, probably in the range of 10 to 20 feet. This change in the groundwater level will affect the "floating mat" and the differential settlements on the mat.

   Assess the effects of groundwater fluctuation on the present and future differential settlement of the mat.

   Response

   The Waterford site area is relatively flat topographically with an elevation of +12 ft. MSL (Refer to Section 2.4.13.1.3, FSAR). The minimum groundwater level of the site,

5. (Cont'd)

at low water level in the Mississippi River elevation +5 ft. MSL, and normal groundwater is at elevation +8 ft. MSL (refer to Section 3.8.4.3.1, FSAR). The site groundwater is expected to fluctuate from normal level in the range of two (2) to three (3) ft. and not 10 to 20 ft.

The range of the groundwater fluctuation contributes mainly to the change of over-all net pressure under the mat, and not to the change of pressure distribution within the mat because of highly permeable 12 inch thick shell blanket under the mat. Therefore, the effects of groundwater fluctuation on the present and future differential settlement of the mat will be negligible. Since the actuation in ground water level never increases the net soil pressure above the in-situ original pressure no further settlements are anticipated.

REQUEST FOR ADDITIONAL INFORMATION

WATERFORD NPP - STRUCTURE ENGINEERING

J. Ma's Question on 4/4/84

Provide shear capacity and design shear stress in the mat in two regions:

A. Bounded by column line 12M and 7FH in N-S direction and T2 and R in E-W direction. This shear stress and shear capacity is measured along the 45^{o} line from R column line toward column 12M.

B. Bounded by column line 12M and 7FH in N-S direction and column line R and P. This shear capacity and stress should be E-W direction.

Response

A. The design shear stress under normal operation condition (Load Factor = 1.0) along the 45° line as defined is 64 K/ft. The ultimate shear capacity of the mat is 274 K/ft which includes 98 K/ft. from shear reinforcement (#11 @ 3'-0 center each way), and 176 K/ft. from concrete. The allowable concrete unit shear stress is calculated based on $2\emptyset\sqrt{fc'}$, where $\emptyset$ = 0.85 and fc' are 4,000 psi.

The design shear stress under DBE loading combination is 166 K/ft.

B. The design shear stress under normal operation condition is 52 K/ft, and the ultimate shear capacity same as "A", 274 K/ft.

The design shear stress under DBE loading combination is 210 K/ft.