LOUISIANA POWER AND LIGHT CO.

WATERFORD SES UNIT NO. 3

ALLOWABLE MAT BEARING PRESSURE

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1. PURPOSE

The purpose of this report is to present the rationale for EBASCO's recommendation that the maximum effective mat bearing pressure be increased from 4000 psf to 4500 psf during construction. The original bearing pressure of 4000 psf presented in the Waterford SES PSAR will be accordingly updated in the FSAR to 4500 psf.

2. SCOPE

This report first provides background on the foundation design principle utilized at Waterford. It then presents predicted as well as measured foundation response resulting from construction and accounts for any discrepancies. The effect of the proposed pressure increase relative to minimizing the effects of these discrepancies is presented. Finally, the report discusses the effects of the increase from 4000 psf to 4500 psf maximum allowable bearing pressure.

3. DISCUSSION

3.1 Foundation Design Background

Generally the foundation soils below El.-40 at the Waterford site are overconsolidated. The existence of the only slightly overconsolidated Pleistocene clays at El.-92 ft, indicated that significant long term and differential settlements could be expected for structures founded on individual spread footings. To eliminate differential and long term settlement

considerations, all Class I structures were located on a common mat foundation. The floating foundation principle was utilized with the combined structure foundation applying an effective load to the bearing stratum clays equal to the existing overburden pressure.

The soil conditions at the site were evaluated in terms of vertical effective stresses. These original stresses were initially on the order of 3300 lbs per sq foot at the mat bearing level. The effective stress is defined as the total weight of the existing overburden soils minus the uplift due to groundwater pressure. The effective stress is considered with the groundwater table at El.+8 ft.

Upon completion of Excavation Phases I through IV, the effective stresses at the mat bearing level were reduced to 0 psf. During the period of excavation and up to concrete placement the foundation soils rebounded or heaved in response to the relief of overburden stresses. 3yr delay

Presently, concrete placement has been in progress for more than a year and backfilling is active. With this increasing load on the foundation soils the rebound previously experienced is being compressed. The schedule as presented in the PSAR allows for this effective loading to reach 4000 psf or a 700 psf overload beyond the initial 3300 psf loading. The objective of the overload is to accomplish the total recompression during the construction period and minimize or eliminate any post construction settlements.

To maintain this maximum allowable effective bearing pressure a procedure of throttling down the dewatering system and possible pumping into recharge wells has been planned and provided for. This release of dewatering will result in increased buoyant or uplift forces acting on the foundation soils as well as the concrete structure and backfill material. The introduction of buoyant forces will be controlled so that additional construction and backfill loads are equally balanced with uplift. Thus the maximum allowable bearing pressure can be maintained during the construction period.

At a construction stage, approximately 6 months prior to termination of active construction and backfill imposed loads, the entire dewatering system will be released. This will result in a final effective bearing pressure of 3100 psf, slightly less than the initial 3300 psf. This 200 psf reduction of effective pressure will preclude the possibility of having any settlement considerations when the plant becomes operable.

3.2 Foundation Response

3.2.1 Predicted Behavior

The foundation rebound or heave calculated during the PSAR preparation, to occur between the time of excavation and start of concrete placement was approximately 2 inches. This rebound was anticipated to be nearly recompressed at the time the 4000 psf maximum allowable load was reached. Any further recompression would be controlled through manipulation of the dewatering system and recharge wells.

increasing the uplift on the foundation soils and caused more heave than calculated for the dewatered excavation procedure. The original scheme envisioned a balanced effective pressure system for the Phase I excavation, which would have resulted in no heave and potentially a settlement under the dewatered condition. This balance would have come about by the increased weight of dewatered soil and the decreased pressure due to Phase I excavation. When the dewatering was started the foundations responded by recompressing; however, the short duration of the dewatering prior to project shutdown was not effective in recovering the heave. This long shutdown period simply allowed complete relaxation of soils to the stress relief.

The differential heave from 1.5" along the south to 3.5" along the north during the Phase I excavation is attributed to the excavation procedure which essentially handled the material from north to south as well as the fact that the grade along the south, east and west sides of the excavation was raised four to five feet for construction facilities. The north side was not surcharged with the additional fill which in essence allowed more relaxation along the north. Additionally, the piezometric pressures along the north are always somewhat higher due to the recharge from the Mississippi River. All of the above factors tend to increase the heave potential of the north side of the excavation, as is the case seen on Figure 1 for heave point H1.

The heave experienced, in excess of the 2 inches predicted, is felt to be attributed to more rapid rebounding of the foundation clays than

became more effective consequently lowering the piezometric levels 15 feet below their lowest 1972 position. This additional piezometric drop initiated further recompression of the foundation material.

With the exception of the north end of the site, the grade around the excavation was raised approximately four feet which apparently increased the compression of the dewatered site in all areas except on the north end.

In January, 1975, the remainder of the excavation was started. As a result, foundation heave readings increased to values between 4 inches and 9 inches. The heave rate leveled with commencement of concrete placement, reversed, and has been recompressing since. Presently, the heave remaining is between 1 inch and 6 inches.

3.2.3 Discrepancies

It is evident in a comparison of predicted rebound verses actual measured rebound that there is a 2 to 4 fold difference. These differences have been continuously monitored and evaluated during the construction and do not seriously affect the design of the plant. Only the recompression phases of the foundation-soil system are affected and are presently being addressed.

As described above, the initial excavation of 20 feet of soils without lowering of piezometric levels decreased the effective pressures by

At the completion of construction with the groundwater back to its initial position the foundation material will experience an effective stress 200 psf less than the initial effective stress experienced prior to construction. This slight and apparent "net unloading" was considered due to the slight uncertainties in total loading during the early design PSAR stage.

3.2.2 Measured Behavior

Refer to Figure No. 1 for an extended time plot of the foundation response.

With the initial removal of 20 feet of material in 1972 (Phase I excavation), the site experienced between 1.5 and 3.5 inches of heave. This initial excavation was done without the benefit of the dewatering due to scheduling difficulties. This resulted in more heave than would have occurred if the dewatering were operative. As shown on Figure No. 1, the effective stresses during this Phase I excavation reduced to 1200 psf very rapidly and initiated the rapid rebound of the foundation clays. With increase in effective stress due to installation and operation of the dewatering system approximately 1 inch of this heave was recompressed. However, the dewatering was not in operation long enough to balance the Phase I excavation and the release of the dewatering system due to the job shutdown caused elastic foundation rebound to its pre-dewatered position maintaining this position for two subsequent years.

The dewatering was reinstated in November 1974. Due to the complete on-off-on operation of the system the wells essentially were purged and

anticipated. Early calculations, formulated during the PSAR stage, considered that approximately 20% of the rebound would be realized during a 10 to 12 month excavation phase. The actual measurements indicated that a more rapid rebound has been experienced, perhaps on the order of 70 to 80% of full rebound, under the relaxed stresses of full excavation.

In order to ensure the full compression of this rebound, the foundation must be overloaded and controlled in order to minimize post construction settlements.

3.3 Justification of Increased Pressure

The intent of increaseing the allowable bearing pressure is twofold. It allows us to maintain a fully operative dewatering system while the turbine building backfilling continues and it further recompresses, at a faster rate, the soil heave incurred during and subsequent to Phase I through Phase IV excavation. The increase pressure will still adequately maintain a factor of safety, against a bearing capacity failure in excess of 3.

Presently, the turbine building backfill is only at about El.-25^{+} (MSL). To start throttling down the dewatering system and recharging through the wells would cause groundwater difficulties with backfill construction and possibly additional heave of the insitu soil and backfill material in this area.

To ensure the uninterrupted backfilling of the turbine biulding excavation and still maintain the original 4000 psf allowable bearing pressure, would restrict increases in mat pressures. This would result in serious and unnecessary curtailment of concrete placements in the combined structure.

The previously specified 4000 psf allowable bearing pressure was realized during the last week in March, 1977, however, a significant portion of the higher than anticipated heave remains. Conveniently the area of the largest heave is along the northern portion of the excavation and is coincident with the area of anticipated bearing pressures above 4000 psf. Thus, the additional loading resulting from a 4500 psf limit will not only increase the rate of recompression but also has the potential of reducing the differential heave experienced from north to south along the excavation.

Thus, an increase in the allowable bearing pressure to 4500 psf is justified in that it allows construction to proceed uninterrupted on both the main plant island and the turbine building; it also affords the opportunity of more efficiently recompressing the foundation heave experienced, and thereby ensures the design intent.

4. RECOMMENDATION

Based upon the actual foundation response and the above rationale and discussion, it is recommended that the allowable effective bearing pressure be increased to 4500 psf. Presently it is anticipated that this pressure will be adequate to recompress the foundation to its original position or lower, as anticipated in the design; however, the effective bearing pressures will be closely monitored and adjusted as necessary to fulfill the design intent.

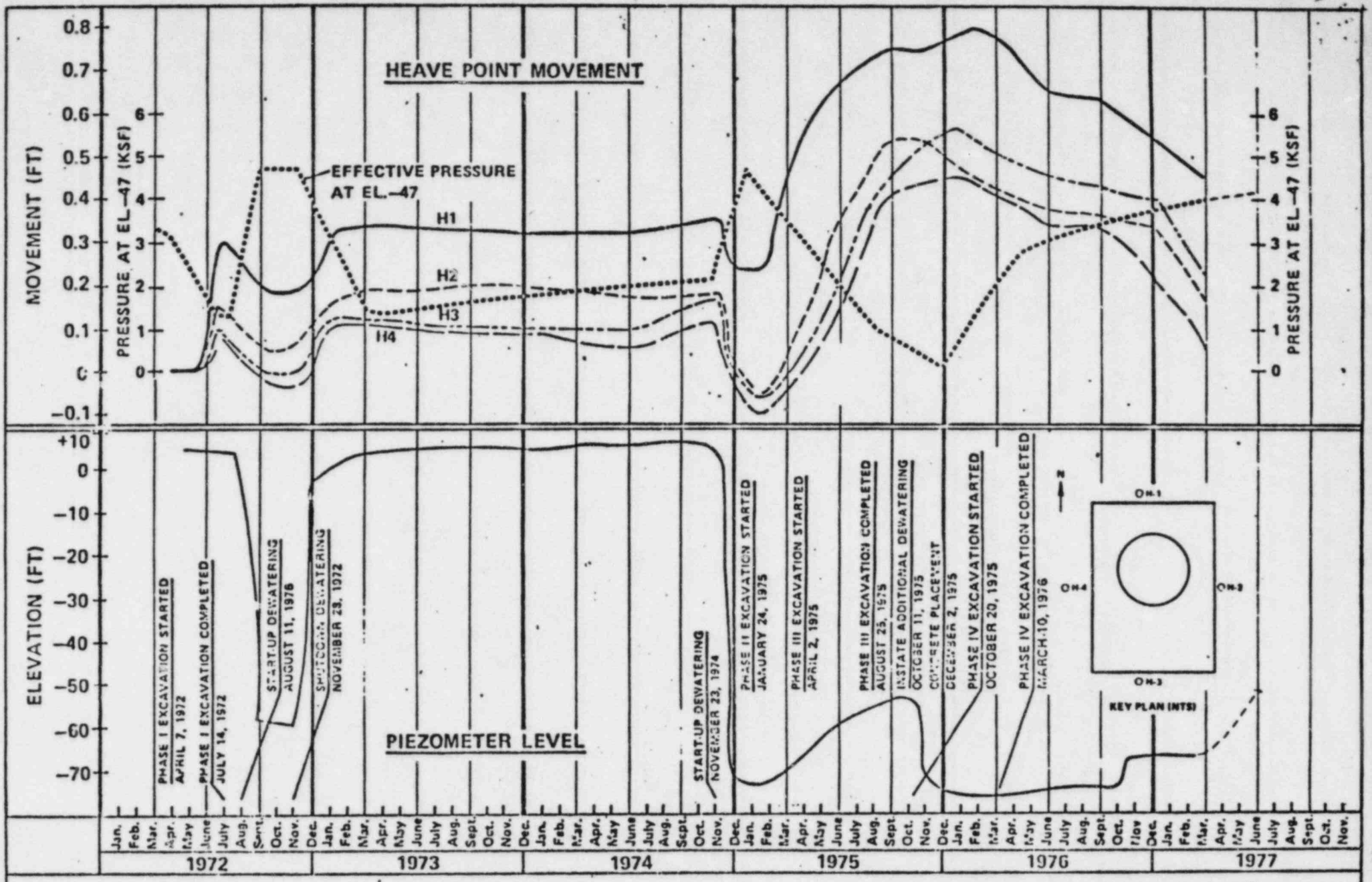

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FIGURE 1