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By

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The 50 MW Kotri Gas Turbine Extension Project of units 5 and 6 was prepared by WAPDA. After its approval by ECNEC, it was completed by 15th May 1981. The contractors (M/s Marubeni), the Consultants (M/s EPDC) and the manufacturers of major equipment (M/s Hitachi) were all from Japan. The estimated cost of the project was Rs. 201 millions with a Foreign Exchange Component of Rs. 108 millions.

The contractor was also responsible for investigation and design. He drilled three bore holes, upto 15 meter depth by rotary method, at locations selected to help in design of foundations. The SPT tests were performed at 1 meter intervals upto the depths of 4,9 and 14 meters respectively in bore holes 1,2 and 3. The SPT values varied from 48 to refusal. Chalky lime stone was encountered during drilling necessitating strength tests on rock cores. The crushing strength of lime stone for 15 out of 18 samples averaged at 2.5 kg/sq.cm proving it to be a very weak rock. The investigated subsoil was divided into three layers. The top layer upto 1 meter thickness was brown clayey silt, and the middle layer varying from 3 to 4.5 meter depth from ground level was brown weathered limestone. The bottom layer was brown chalky limestone with the exception of 0.6 meter thick seam of shale at a depth of 7 meters in bore hole No. 1 and 1.5 meter thick layer of chalk at a depth of 10.5 meter in bore hole no. 3. No water samples were collected for testing because the bore holes were dry.

The bearing capacity of 2 and 2.5 kg/sq.cm was recommended for depths 1.5 and 2 meters respectively. Considering the possible interaction of rain water during heavy rains with weathered limestone, a low bearing capacity 0.5 kg/sq. cm (approximately 0.5 T/sft) was estimated while the computed bearing pressure under the turbine load was 1 Kg/sq.cm. The contractor proposed to provide a shallow foundation consisting of 1.35 meter thick R.C.C. with compressive strength of 4000 psi over 150 mm thick lean concrete laid at a depth of 1.1 meter below the ground level. The author as the representative of WAPDA as the employer rejected this proposal because of anticipated low bearing capacity of soil under possible wet conditions.

Alternative proposal of the contractor for providing 12 number 22 inch dia., 3.9 meter deep cast-in-situ concrete piles under each Turbine foundation was also rejected because of additional cost and more execution time required. On Author's suggestion weathered rock 1.35 meter below the R.C.C. foundation was excavated and replaced with uniformly graded Bholari sand mixed with 2% cement by weight with a maximum slump of 1.5 inches. The cost comparison of the three types of foundations showed piles to be the costliest and sand as the cheapest. Additional weight of 1:3:6 lean concrete under contractor's first proposal was another disadvantage of that proposal.

A 2% cement sand mix was selected on the basis of achieved maximum dry density of 1.74 gm/cc in the trial tests carried on 1%, 1.5% and 2% cement sand mixes filled in 3x3x2 ft. deep pits reflecting the actual site conditions. The selected mix was also good for avoiding liquefaction. Chemical tests indicated a low sulphate content of 0.03 to 0.15% in the subsoil allowing for the use of normal Portland Cement. Low content of Calcium Oxide (0.03 to 0.16%) and of Magnesium Oxide (0.01 to 0.03%) was found to pose no threat to the durability of the concrete.

The cement sand mixed in the standard concrete mixer was placed in 150 mm thick layers compacted with vibrating plate compactor with a minimum target of 85% relative density according to USBR Relative Density Test. The achieved relative density varied from 87 to 100%. The compaction was started from the outer ends and moved towards the centre providing overlaps and covering the whole area. The moisture content was controlled continuously with the speedy moisture testing equipment. The entire operation was carried out

round the clock in three shifts. There was a saving of Rs. 282,000 as compared to the pile foundation alternative.

The plate load test confirmed the increase of foundation bearing capacity from 0.5 T/sft to 5 T/sft. The improved bearing capacity is expected to be long lasting with a life longer than the life of the gas turbines.