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Restoration of Equalization and Aeration Tanks of Effluent Treatment Plant at the Mysugar Factory, Mandya, Karnataka, India

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RESTORATION OF EQUALIZATION AND AERATION TANKS OF EFFLUENT TREATMENT PLANT AT THE MYSUGAR FACTORY, MANDYA, KARNATAKA, INDIA

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ABSTRACT

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This paper deals with the restoration measures resorted to strengthen the structure and prevent the leakage of the equalization and aeration tanks of effluent treatment plant in a sugar factory. These tanks showed distress at the hydraulic test itself before commissioning due to the failure of the reinforced concrete floor and bund lining on account of loss of support due to excessive deformation of the substratum. Extensive sand piling was resorted to strengthen the substratum before recasting the reinforced concrete floor and bund lining to ensure structural stability and prevent leakage. These tanks are functioning satisfactorily since two years after restoration serving the intended functions of the effluent treatment.

KEY WORDS

Envrionmental geotechnology, Cast in-situ concrete piling, Sand piling, Effluent treatment plant.

INTRODUCTION

The equalization and aeration tanks, which are the two important constituents of the effluent treatment plant of the Mysugar factory, consisted of earthen bunds, although constructed as early as 1987, the work for completion of the plant was temporarily abandoned. Subsequently, in late 1993 the rest of the work of these two tanks were completed to commission them to their full capacity and strat the effluent treatment plant. The capacities of these tanks are 1350cmt and 5500cmt respectively. Figure 1 indicates the plan of these tanks. Photograph of the aeration tank is shown in figure 2.

It can be seen in the plan that a stream runs in the west south direction very close to the bund of the aeration tank. It was imperative that these tanks had to be subjected to hydraulic test before being cleared for their intended purposes. The tanks did not pass through this test. Profuse leaking of water of the order of 2000 liters per hour from the equalization tank and 50000liters per hour from aeration tank were noticed. At this stage detailed investigations were undertaken to find the causes for this leakage and as well as, if possible, to restore these tanks by resorting to suitable measures.

FIELD OBSERVATIONS

The tanks were emptied to make detailed examination of the floor and the bund lining. Despite the reinforced concrete lining and the reinforced concrete floor slab being 100 mm. thick the floor slab had developed deep cracks extending in longitudinal direction in the aeration tank. The reinforced concrete lining on the bund apart from extensive cracking had developed undulated surface. It was also noticed that at few locations where the reinforced concrete floor had slipped along the periphery of the column resulting in the separation between the reinforced concrete lining and the columns supporting agitators (Fig. 3). Similar situation was also encountered even in the case of equalization tank on the reinforced concrete lining of the floor and the column. More prominently severe cracking was noticed at the interfaces of construction joints. The observed profuse leakage could possibly be attributed to severe cracking due to excessive deformation of the soil predominently containing

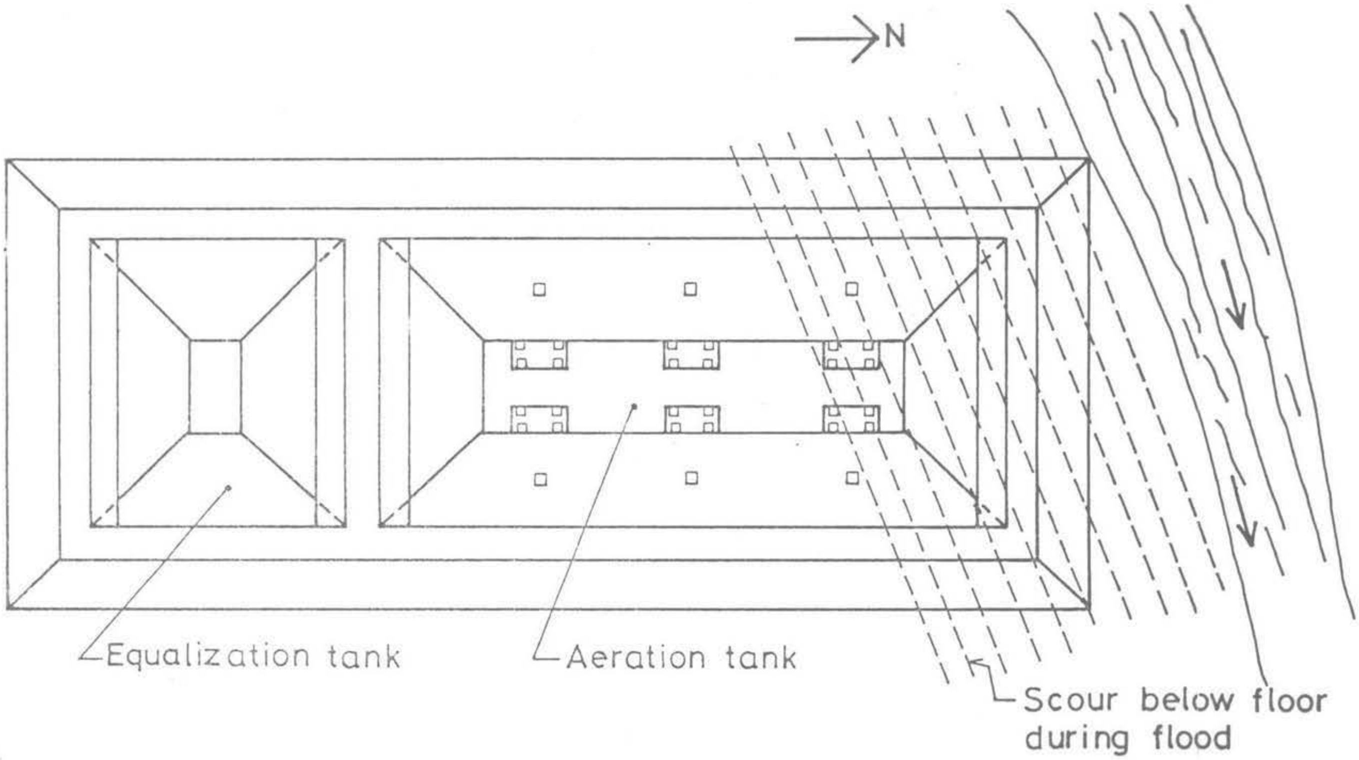

Fig. 1 *Layout plan of equalization and aeration tanks.*

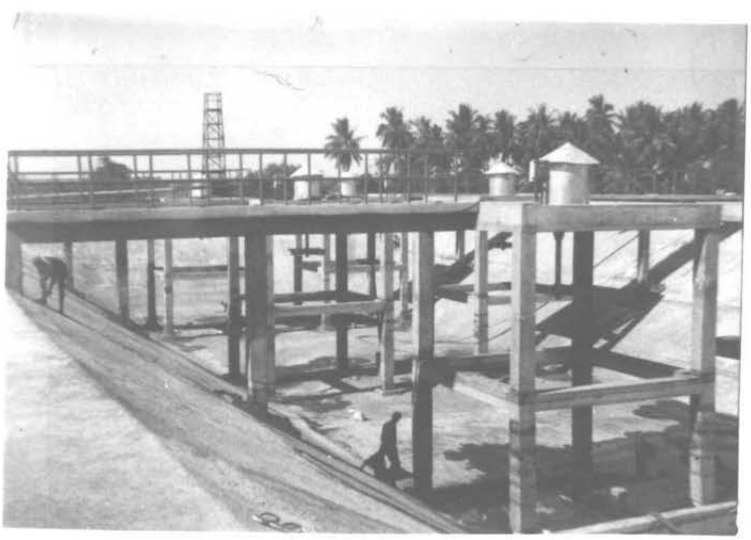

Fig. 2 *Photograph of general view of aeration tank.*

sand below the aeration tank floors and the bund which in turn might have triggered the yielding of the reinforced concrete floor slab and bund lining, as the hydraulic loading progressed. This warranted detailed investigation to unravel the factors responsible for this excessive deformation.

FIELD INVESTIGATIONS

The first step was to probe whether any subsurface investigations had been carried out prior to construction. The furnished report revealed that the strength parameters of the soil below the floor and that of the compacted soil in the bund portions were such that the adequate bearing capacity for the floor and bund stability could be expected. If this were to be so, what was observed did not corroborate with the information provided in the soil test report. Hence actual soil conditions had to be determined.

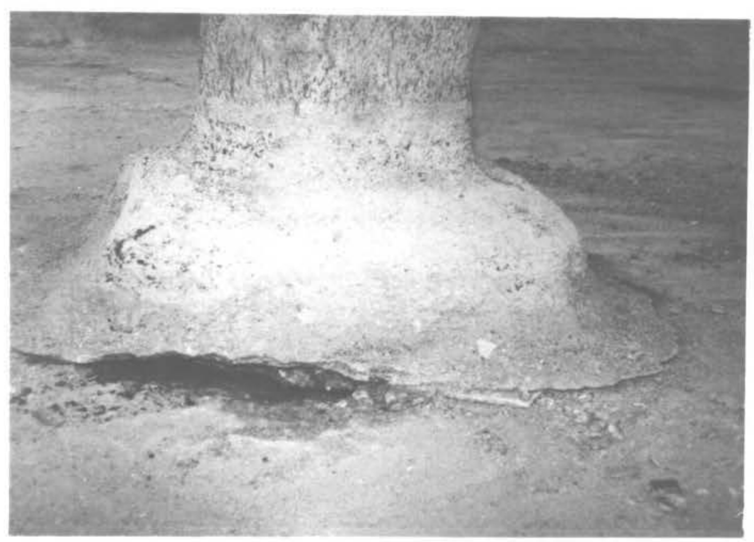

Fig. 3 *Photograph of slippage between reinforced concrete floor and column.*

The samples collected from the bund at various locations and depths, as well as from the floor of these tanks, indicated that it was predominantly comprised of boiler ash, which is basically a cohesionless material, mixed with murum. The density of the soil was very low with low strength parameters. A detailed stability analysis of the bund indicated that these bunds were structurally unsafe for the designed depths of effluent in both these tanks. It was also observed that such cohesionless material towards the north west corner of the aeration tank was considerably eroded since the stream bed was 1.5 meters lower than the floor level of the aeration tank. Due to cyclic fluctuations in the water level in the stream the material below the floor slab progressively got eroded resulting in loss of support for the reinforced concrete floor slab to a greater degree which resulted in severe cracking far more than at other places.

RESTORATION WORK

To make the equalization and aeration tanks to perform its intended functions it was found necessary to restore the design configuration with adequate structural strength and to make it leak proof for carrying out the intended effluent treatment. It was realized that unless the floor and bund lining supports are strengthened any structural repair or relaying of new floor slab and the bund lining would be futile.

Strengthening of the soil below the floor of aeration tank by sand piling was examined. Examination of the substratum below the floor revealed that strengthening of loose fill was required up to 2 m depth. It was found that a toe wall had been constructed below 1.5m all along the periphery of the floor slab of these tanks with the intension of providing brick lining alternative to reinforced concrete lining. Later it was decided to adopt reinforced concrete lining. As such any piling at the boundary could be restricted to top 1.5 m since the toe wall could serve to provide needed confinement. To obtain necessary confinement cast in-situ concrete piles were resorted to. Figure 4 shows the details of the piling all around.

To resort to piling in a grid pattern it was necessary to remove the damaged floor slab. It was a difficult proposition since it needed considerable time and effort. Instead the possibility of using the same as support to the new slab and lining was examined. By using profometer the disposition of the reinforcement was determined. After this, the grid pattern for piling were decided. This is as shown in figure 5. In this diagram the pattern of sand piling in the agitator supporting column area has also been shown. These were the locations free from the reinforcement of the damaged column. The existing slab was cored by using the core cutting device to obtain 100 mm. diameter holes for the full depth to facilitate to carry out skirting and sand piling up to a depth of 2m. which happened to be the depth to reach hard stratum. Along the periphery of the floor slab of aeration tank a row of reinforced concrete piles on toe wall as well as a row next to these inwards was provided in order to ensure adequate confinement of the substratum below the floor slab. To reach 2m. depth, the displacement technique adopted to advance the hole, densified the soil in the vicinity of the hole created. The compaction of sand resulted in further densification. In fact the gap between the damaged floor and the substratum as well as between the lining and the bund considerably reduced. After sand piling the sand upto a depth of 0.5m was scooped for cast in-situ concrete pile with adequate reinforcement projecting out. In figure 6 the details of the sand piling and the top 0.5m concrete pile with reinforcement projecting out are shown. In figure 7 the photograph of the simple fabricated arrangement for sand piling and other details are shown. On the raft of agitator columns the type of piling was different. This is shown in figure 8. It consisted of reinforced cast in-situ concrete piles after sand piling for confinement which subsequently was removed by scooping.

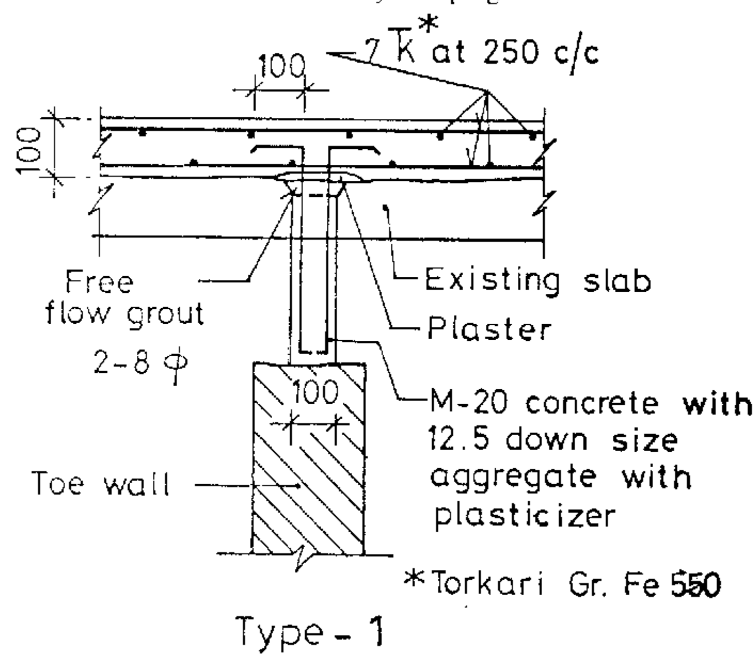

Fig. 4 *Concrete piling above the toe wall all along the periphery of the floor of the tanks.*

In order to make the entire system integral all the projecting reinforcement of the cast in-situ concrete piles were blended with the reinforcement of the additional 90mm thick reinforced floor slab and bund lining cast as a part of restoration to achieve desired leak proof condition. In addition cement slurry grouting with expansive admixture at the interfaces of the colums with floor slab and bund lining was adopted to ensure water tightness. Apart from providing reinforced concrete overlay, a layer of gunite was sprayed for a width of about 400mm at the interface of all construction joints and the intersection of all columns with floor slab and bund lining to make the system absoutely leak proof. In addition the remaining gap between the bund lining and compacted soil was effectively filled by pouring cement mortar of flowable consistency mixed with expansive admixture.

All the above restoration measures were carried out in June 95. The equalization and aeration tanks of the effluent plant were subjected to hydraulic and load tests and finally commissioned. In figures 9 and 10 the photographs of the above tanks of the treatment plant after commissioning into operation are provided. Since then a satisfactory performance of the treatment plant was obtained.

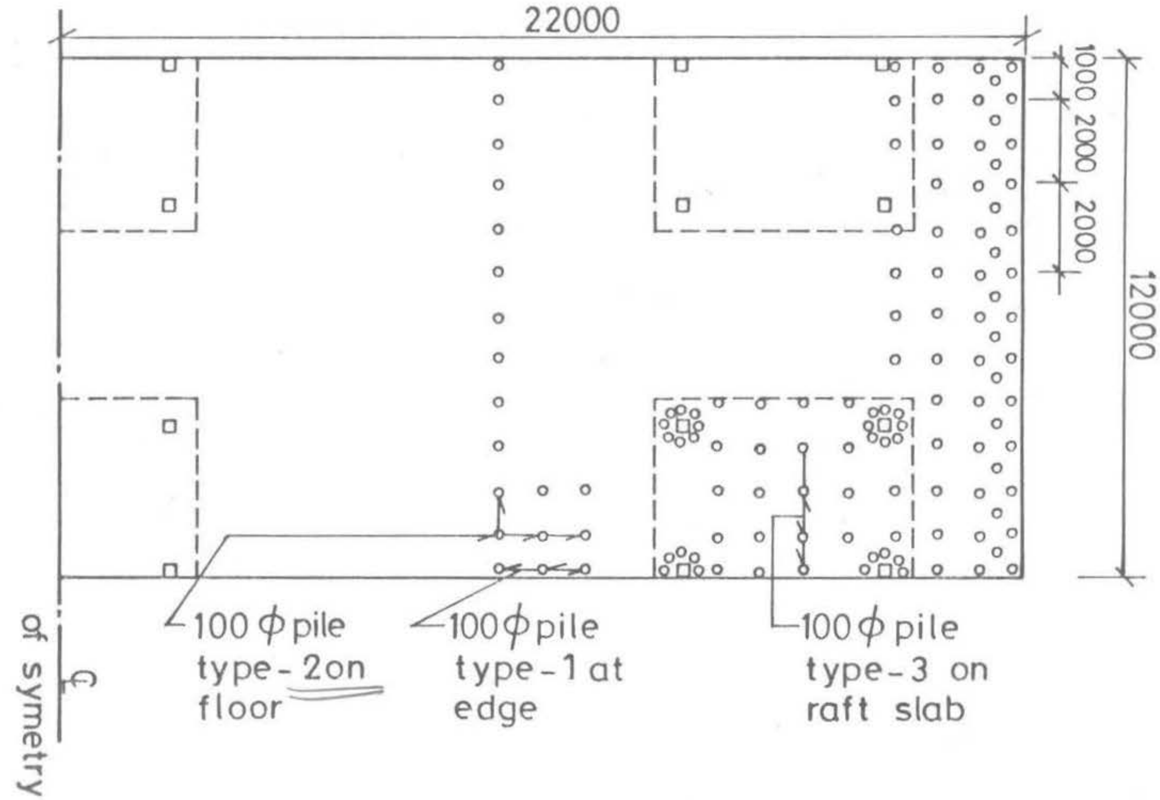

Fig. 5 *Details of the location of sand piling resorted to as restoration measure.*

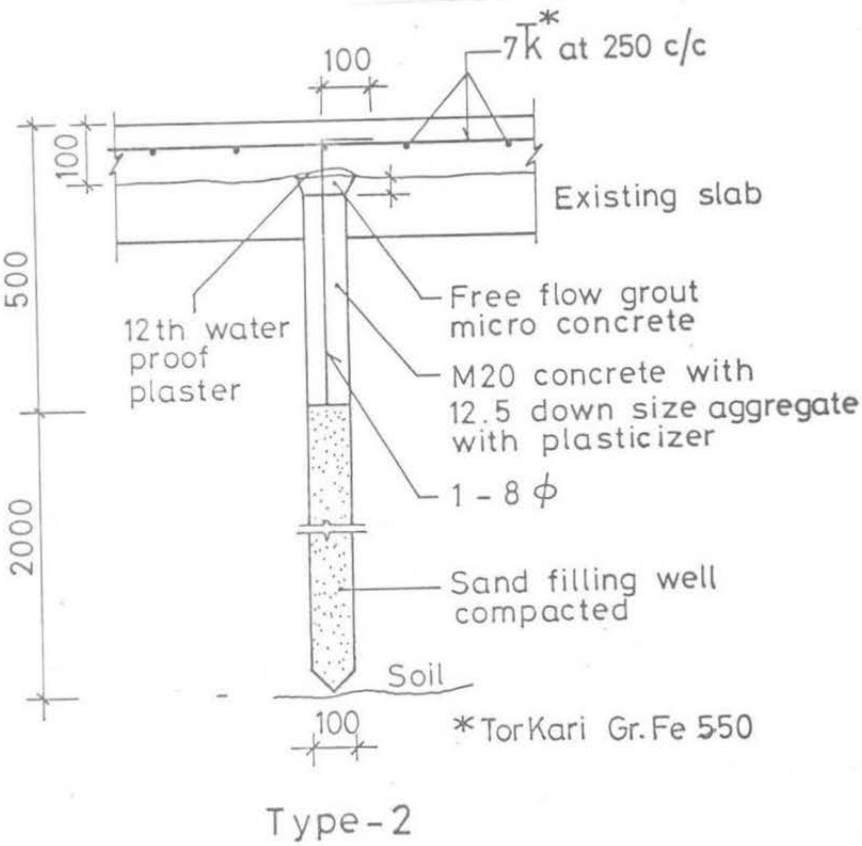

Fig.6 *Details of sand piling along with the concrete pile with the projecting reinforcement.*

Fig. 7 *Photograph of the arrangement for sand piling.*

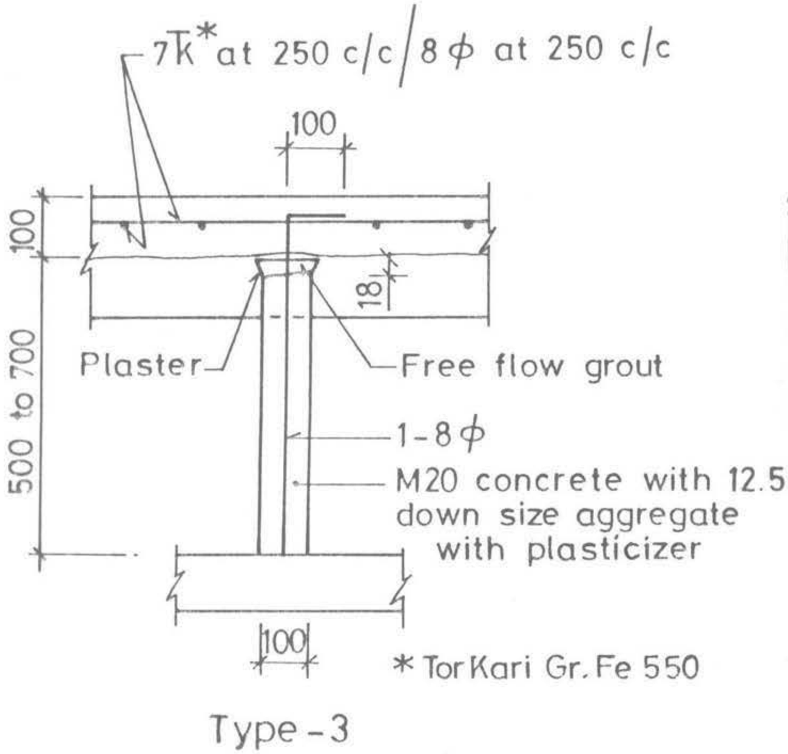

Fig. 8 *Details of concrete pile with reinforcement over the raft slab of agitator columns..*

Fig. 9 *Photograph of the restored equalization tank after commissioning into operation.*

Fig. 10 *Photograph of the restored aeration tank after commissioning into operation.*

CONCLUDING REMARKS

The profuse leakage of equalization and aeration tanks of the effluent treatment plant was prevented by adoption of the following restoration scheme.

(i) Strengthening of the soil below the floor of aeration tank. by sand piling. The area below the agitators where raft foundation was provided for columns was also strengthened by the same technique.

(ii) Providing additional 90mm thick reinforced concrete lining both for the floor and the bund.

(iii) Cement slurry grouting with expansive admixture at the interface of the bund lining and columns.

After carrying out the above restoration measures in June 95, the equalization and aeration tanks were subjected to hydraulic and load tests before being finally commissioned. Since then a satisfactory performance of the treatment plant has been realized.