Lining of industrial water reservoir with HDPE geomembrane

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ABSTRACT: ABC Refinery complex is having a surface water reservoir to feed to various process and power plant of the complex. The capacity of the reservoir is 260 000 cum(approximately). The area of the reservoitr is approximately 60,000 sqm. Initially the reservoir bed was lined with concrete and laid subsequently with bituminous felt membrane. However over a period of operations of the water reservoir for 7 years, the bituminous felt developed cracks and the water started leaking through the concrete. The situation aggravated to such an extent that the unit had to be closed down in dry periods due to shortage of water which coupled with huge evaporation losses. The esimated water loss per day was 3500 cum/day. A complex Lining and anchoring syustem was designed and implemented to eliminate the water loss as well as ensure the hassle free operation of the Lining System.

1. SITE CONDITION

The reservoir has spillways, concrete wall, embankments, in take wells and columns bulit inside for the High Voltage Transmission Line Towers. The management wanted to design a new type of Lining System as well as anchorage to take care of the strcutural hurdles to to achieve the water proofing objective.

A careful analysis of the surface profile and existing structures was studied and the contour was analysed by Garware Wall Ropes Ltd-Design Team. Accordinly the Lining System with HDPE-Geomembrane as the basic water proofing material, was planned. The design had complexities because of the intersections at the following areas:

- Spillway
- Intake Well (Beam/Columns)
- Water Carrying pipe lines on the Embankment with little space for taking and anchoring the geomembrane
- Concrete Parapets along with stepped wall on outer side
- China wall for ingress of water from nearby areas because of higher elevation.
- Approach Ramp for the vehicle movement to remove the silt
- High Voltage Transmission Line Tower Foundations and Walls

Time available for execution of the installation programme was **45 days.** It was extremely challenging because of the procurement, Liner Quality Programme, Testing, anchoring etc.

2. DESIGN OF THE LINING SYSTEM

Subsequent to the design of the bed, slope, concrete walls and all the intersections listed above, the following materials were used:

1. HDPE Geomembrane 1.0 mm
2. Concreting in anchorage
3. Geobags for Point Loads to compensate for wind/other upliftment
4. Geopipes near China Wall
5. Water repellant epoxy on the terminating point of column through aluminum funnel clamping

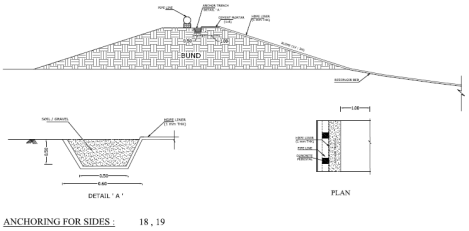
3. DESIGN OF THE ANCHORING SYSTEM

The anchorage at various intersections was designed to keep the Liner Material in stress free condition. The following areas were selected for design as well as drawing preparation:

3.1 *Anchoring at the Slope Termination and below the existing Pipe Lines*

The reservoir structure has 19 sides and each side having different profiles varying from very gentle slopes to medium slope of 1:1.25 and at places concrete parapets. The depth of water storage across the surface of the reservoir also varying from 0.2 m to 8.5 m at the lowest contour where the intake well is existing causing severe drag down force. The drawn out water is taken through the pipelines mounted on small foundations running very close to the slope termination points and the lowest point of the pipe is very close to the bed of the embankment. This posed several challenge for the anchoring of the pipes. The indicative details of the explanation could be seen from the Photograph below.

It was felt that the soil below the pipe lines and across to be excavated and a lean concrete of 1:3:6 of 0. 2 m needs to be laid before the liner is taken over the surface. This was more essential as some boulders were existing on the embankment was ready to puncture the membrane. Subsequently the membrane was covered with similar grade of concrete with higher thickness to keep the system in place and without any expected sliding force. To be very safe, the liner was also taken over the termination point of the outer slope line to avoid emergency stress on the run out membrane. The drawing shows the system developed to take care of the existing complexity of the structures.



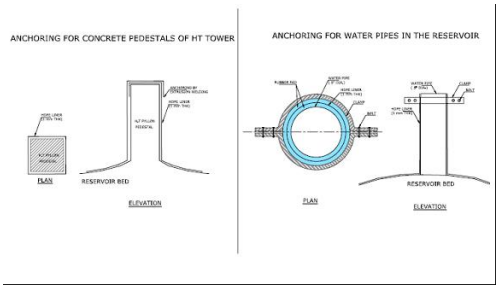
ANCHORING FOR SIDES : 18 , 19

3.2 *Anchoring concrete pedestals of HT Tower*

It was also observed that a HT Tower is existing inside the reservoir having pile on. It was necessary to imagine that the lowest contour of the reservoir was not far away from this structure and also observed that the whole pile on gets submerged when the water is full at the spill way level. It was important to have some system designed so that there is no leakage as well as stress around this structure.

The other aspects was the steel coming out of the foundation pile on which needs special joints at the intersection.

Efforts were made to understand the vertical load and the drag down forces on the membrane during fill condition.

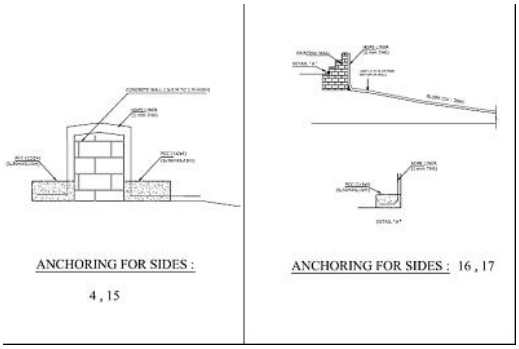


3.3 *Anchoring for Water Pipes in the Reservoir as well as side parapets*

One of the biggest obstacle was to look at a very robust lining system is also the existing projected pipes inside the reservoir to release any water rising through the ground surface. They were also lined as major existing liner failure was observed during the initial site walkover survey.

Secondly on the opposite side of the spill way, parapets were constructed of height varying from 1.5 to 3.0 m to stop ingress of water from the adjoining small tank. In fill condition, the water level at the parapet was o.5 m from the top ht kept as free board.

It was felt that two levels of anchoring were essential to reduce the stress on the membrane which was laid on a sloped surface till the parapet. The first was to keep adequate frill on the laid out membrane and keep a small concrete anchoring system to keep the stress up to that point balanced out and subsequently take the membrane over the parapet wall and keep a run out 2 m in excess of the height of the wall to take care of future tension if at all arise due to the hydrostatic head as well as the drag down forces.



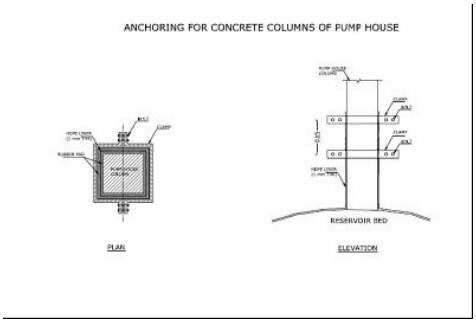
3.4 *Anchoring for concrete columns of the Pump House*

The biggest difficulty for laying the liner was the intake well columns and bars as well as the supporting columns with height up to 9m. As this was the lowest point and the industry wanted that no leakage should happen because of the force anticipated at this point is highest as well as the anticipated stress developed in the membrane is the maximum.

It was decided that the laid on membrane will not stick to the concrete wall and neither the bolting system will eliminate the annular space between the wall and the membrane. Secondly the column's height was too high to take out the stress from the membrane and it may fall out on its own stress over a period of time and may get ruptured.

Hence for the intake well columns, an aluminum clap was fabricated and water repellant epoxy resin was applied to the mouth of the membrane and sealed. It was observed that the idea worked and the mouth came out to be complete water proof.

Secondly for the supporting structures the membrane was cut into two wrapping portion one to be taken from the bottom to the mid way where as the other one is to be laid with wrapping arrangement and will be laid from top to the mid way. The jointing is to be done at centre to keep the tensions at equilibrium. This idea also worked and the system after installation appeared to be in line with the expected outcome.



4. FINANCIAL BENEFITS

Cost of Water: USD 0.4/cum

Cost of Water Loss/d: USD 1400

Cost of Water Loss/Yr: USD 0.5 Million

Investment: USD 0.3 Million

Payback: 7 Months

Intangible Benefit: No Shut Down
No product Loss

5. CONCLUSION

After the installation was complete, the water was allowed to enter slowly to the reservoir. Continuous monitoring is being carried out since last four months and the as per the monitoring results, the leakage through the lining system is NIL.

This system was done in a record time with complete satisfaction of the client and they are extremely satisfied.