Construction, closure & capping of geosynthetic lined slurry pond at Vishakhaptnam-India-15 year experience

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ABSTRACT: Design and development of slurry pond having in adequate space and having soft soil at the base was a big challenge for the Hindustan Zinc-Vishakhapatnam in 1999. Further, because of limited space, capacity enhancement and optimization could only be done with steepening the slope. The construction of steep slope of 1:1 of dyke height of 9 m means, you need extremely strong soil material and reinforcement geosynthetics interspersed at designed depths to arrest the failure of the slopes. In addition to this, the double lining system with HDPE Liner of 2.0 mm thickness and Non-Woven Geotextile laying and anchoring had to be designed in such a way so that, the inner pressure of slurry during operational period would not pull it out of the anchor trench. The effluent management system at the bed was also designed to evacuate the water through the slope riser. After 10 years of operation, the site had to be closed as per the environmental guidelines and the challenge was to create a cover on a slurry bed.
As the sludge surface is soft and having no strength to withstand the fill material, liner and cover vegetative soil, and special techniques were deployed to strengthen the strength of the underlying sludge. This was be done using high strength geotextiles and filling the same with fill material. Once the stabilization process was over, the lining system was constructed in such a manner to promote surface water runoff without causing ponding or severe erosion of the final cover. The slope or grade of the land and the length strongly affects soil erosion of the slope. Final slopes of filled portions of the landfill site was constructed with 3-5% percent in grade. Terraces, waterways, diversions will be constructed for smooth transportation of the rainwater precipitation
This case study deals with the 15 years of experience in design, construction, operation and closure of the slurry pond in HZL-Vishakhapatnam.

Keywords: HDPE geomembrane, GCL, Geotextile, Geocomposite Drainage Net

1 BACKGROUND

The design and construction of the pond was done from 2000-2002 having an earmarked area of 75,000 sqm approximately with an estimated capacity of 5,00,000 cum. It was impossible to design with conventional slope geometry considering the slope stability factors of 1.5. As for that capacity, minimum land area required was more than 1,00,00 sqm which was not available. Hence, it was decided to design the dyke with 1:1 slope and the slope would be in continuity to avoid further space issues. With this background the structure was to be designed and constructed, operated and closed on a slurry surface having no strength.

1.1 *Dyke construction*

However, as the getting the right quality of bund material was also an issue, it was decided to mix the slag from the plant along with burrow material and construct the dyke. The dyke was a reinforced dyke with biaxial geogrid inserted across the dyke width at regular depths. The geogrid was further wrapped around with non-woven geotextile to avoid dyke soil slipping out. The dyke was expanded in stage wise construction method with each lift of construction not exceeding 0.3 m. The reinforcement geogrid was inserted at every 0.6 m depth.

Reinforcement with Geogrid

While the dyke construction as in progress, in parallel, the bed preparation was also done. The bed preparation was done by carefully preparing the sub grade with slope towards the effluent evacuation corner fitted with slope riser and pumping main.

Sub-grade Preparation

The bed and the slope of the facility was lined with clay liner, HDPE Geomembrane 2.0 mm thick and further protected with non-woven geotextile.


Geomembrane Installation

The perforated HDPE Pipes were laid as per the drawing and all the perforated pipes were connected to main header which was connected to the suction main of the slope riser system.


Perforated Pipe and Main connected to pumping system

1.2 *Design fundamentals of Jarosite pond closure*

As the Jarosite slurry is very soft in nature, the core soil cover layer had to be formed with Geotextile reinforcements. The Geotextile reinforcements are required for the following reasons.

- To provide initial access for construction materials and equipments on to the top surface of the Jarosite slurry
- To support the load coming from the Soil cover layer and the top liner system

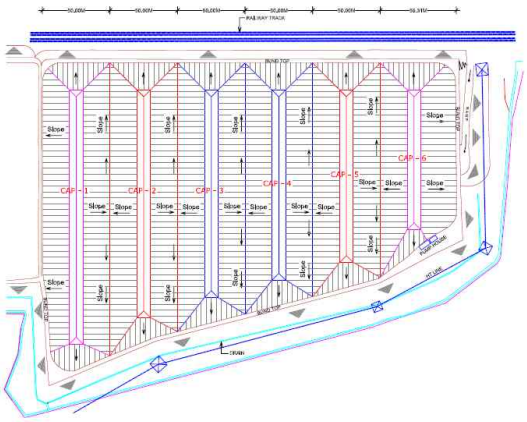
Both in-situ field testing and laboratory tests were carried out to ascertain the following properties of the Jarosite deposit. Laboratory tests were carried out on Disturbed and Undisturbed samples collected at various depths.

1.2.1 *Design of the soil cover system:*

The geotextile stabilised soil cover system was designed based on the design procedure given by Espinnoza and Sabatini (2008). The Geotextile reinforced soil cover system was be formed by the finger and palm filling type as described

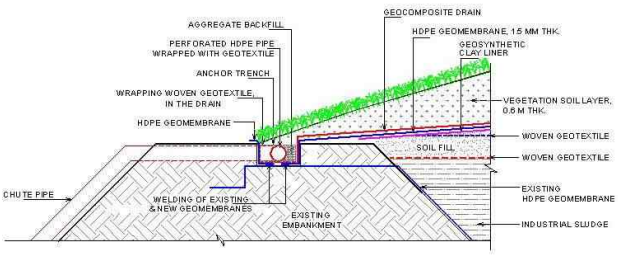
1.2.2 *Geotextile Reinforcement:*

It was recommended to use Polypropylene Woven Multifilament Geotextile, (GWF 80-350) for the first layer of the Geotextile reinforcement which would be in direct contact with the Jarosite. More over this first layer predominantly functions as temporary reinforcement in providing initial access to the construction materials and equipment's, and as a separation layer. For subsequent layers of reinforcement, Polyester Woven Multifilament Geotextile, GWF PET 70/70 was used.



1.2.3 *Geometry of closure:*

After closure of landfill facility, to allow drainage of precipitation by gravity, a slope of 3% to 5% was required. Considering pond area of 55705 Sq.M and weak base of Jarosite slurry a single soil cap would lead to heavy surcharge. Hence the total top area of the pond is suitably bifurcated into 6 cells/caps (each one 50 m wide) as shown in the drawings. Thus the maximum height of any cap (including 0.6 m vegetation layer) was not more than 2.15 m



1.2.4 *Liner system*

The Liner system which was laid over the geotextile stabilised soil cover comprised of the following in the order of its laying.

1. Geosynthetic Clay Liner (GCL) - 6 mm thick
2. High Density Polyethylene (HDPE) Geomembrane – 1.5 mm thick
3. Geocomposite Drainage layer
4. Vegetative Soil cover of 600 mm thick.
5. Vegetation

The periphery of the liner system was properly finished at the top bund of the existing pond to enable proper drainage of the precipitation. The Geomembrane of the cover liner system was welded with that of the existing liner at suitable location on the top anchorage of the exiting lining on the bund top.

Strengthened surface and HDPE Liner Liad

Capped Surface, Vegetated with irrigation system to maintain greenery

2 CONCLUSION

It is almost more than 15 years since the Jarosite Slurry Pond was opened for operation and got closed in 2015 and since then also 3 years have gone by. This is probably the first slurry pond in India to be built with t=reinforcement technology with geosynthetic lini ng system, operated smoothly and got closed with reinforcement technology and lining system with GCL, HDPE, Geocomposites etc. There is no parallel and successful experience in India where in all modern geosynthetic material used in a single project from design, commissioning and decommissioning after operation and hence gave a boost and confidence to geotechnical engineers to extensively use geosynthetic in complex engineering projects with unique challenges.

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