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POTENTIAL APPLICATION OF GEOSYNTHETICS IN RIVER VALLEY PROJECTS

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ABSTRACT

Application of Geosynthetics in River Valley Projects has been gaining momentum all over the world in the recent past. The Geosynthetics have many applications in the construction of dam embankments, canals, approach roads, runways, railway embankments, retaining walls, slope protection works, drainage works etc. The use of Geosynthetics in River Valley Projects in India and other countries has been reported to be considerably improved the strength and permeability characteristics of even problematic soils viz. expansive soils, dispersive soils etc. The paper presents a brief over-view of the applications of Geosynthetics in River Valley Projects besides few cases histories.

INTRODUCTION

Application of Geosynthetics has significantly increased over the last few decades both in developed as well as developing countries. The application of Geosynthetics provides a sound, efficient and cost-effective solution to a broad range of problems in different ground conditions in water retaining structures like dams and canal embankments. Geosynthetics is a common term which may contain geotextiles, geogrids, geomembrane, geonets, geocomposits and all other similar materials to improve or modify soil/rock behaviour depending upon the specific requirements of the projects, the particular type of geosynthetics are being used so as to overcome the problems due to expansive soils, sensitive/soft soils and dispersive soils.

APPLICATION OF GEOSYNTHETICS IN RIVER VALLEY PROJECTS.

Geosynthetics have many applications in dams, canals, roads, runways, railways, retaining walls, slope protection works, foundation improvement and many other areas. There is a vast potential for application of Geosynthetics in River Valley Projects. Based on the properties of geosynthetics, the following uses are indicated (Dr. U.D. Datir, 1997):

* as horizontal and/or inclined filter in earth dam.
* as filter between foundation soil and loading berm.
* as separator between soil zone and rockfill zone.
* as drainage in toe drain.
* as reinforcement in small earth embankments like that in saddles
* as mattress in underwater canal lining
* as separator in canal lining.
* as reinforcement in retaining walls.
* as reinforcement in foundation of appurtenant structures.
* as filter in slope protection below riprap.
* as composites performing more than one function.
* as separator on poor foundation.
* as drainage in command area field drainage works especially in waterlogged areas.
* as a separator/filter in command area roads.
* as a filter in tunnel lining.

CASE HISTORIES

DHAROI DAM, Gujarat

Dharoi Dam (Dalal H.C. et al., 1992) is a major dam which is built across river Sabarmati in Gujarat. Earthen dyke No.1 of the dam is about 15 m high which is situated on the left bank. During the year 1980, the reservoir was filled nearly upto full reservoir level. Soil boiling and slurry flow phenomena were observed at different places on the downstream immediately after first reservoir filling. The seepage was identified to be through foundation level below the dam seat or bed of cut-off trench. To control this seepage, a loading berm over the affected strip and a series of relief wells were planned as an initial measure. To prevent piping action during seepage flow, a filter was required between the loading berm and natural ground. Indigenous non-woven needle punched fabric was laid in an experimental area of 400 sq.meter between ground and loading berm. To experiment the performance of geotextile as a cost-effective measure, its use was extended to relief wells replacing thick granular filters (Fig.1). Geotextile used was of GPB-127 variety to suit filter criteria with base soil. Performance of GB-127 was assessed after subjecting it to complete reservoir cycle and nearly full hydraulic head. Sufficient discharge passed across the plane of geotextile during this period. Drained water coming out through geotextile was frequently observed which was found to be clear and free from turbidity.

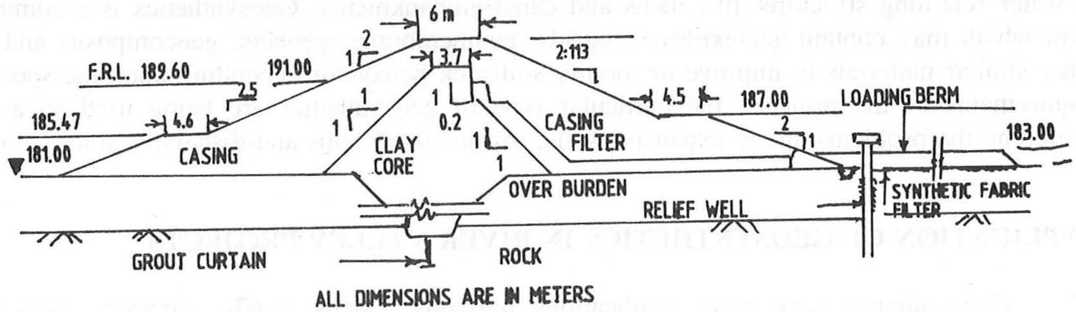

FIG. 1 : SYNTHETIC FABRIC FILTER AT DHAROI DYKE I AND RELIEF WELL

Geotextile samples of 600x600 mm size were cut and subjected to various tests after its performance in soil. The strength and elongation tests indicated loss of elasticity by 30% without rupturing. In spite of clogging, an increase in air permeability was observed due to elongation of fabric under load. However, overall performance of geotextile filter was not affected adversely. It was possible to eliminate about 600 mm thick granular filters which reduced dia of relief well to 150 to 200 mm by introducing 3 mm thick geotextile thus reducing the cost by about 50%. Discharge through geotextile filter in comparison with traditional filters was more or less equal. Quality of drained water in both the cases was similar. Performance of relief well was monitored over a period of ten years which confirmed satisfactory performance of geotextile in relief wells.

HIRAN - II DAM, Gujarat:

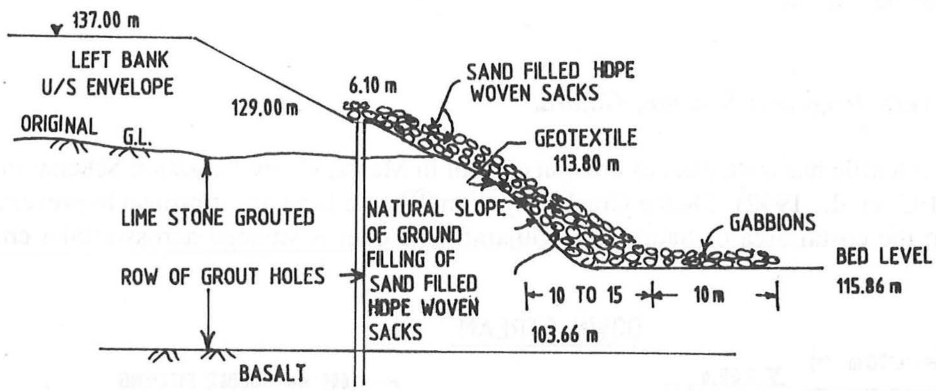

FIG. 2 : CROSS SECTION OF PROTECTIVE MEASURES AT HIRAN II DAM

Earthen dam of Hiran-II Irrigation Scheme (M.G. Raichur et al., 1992) is a classic example where Geosynthetics is applied as an immediate remedial measure to arrest the soil particle erosion and subsequent problem of development of sinkhole. Hiran-II Irrigation Scheme is constructed across the river Hiran near village Umerethi in Gujarat. This scheme comprises a masonry spillway across the river gorge of Hiran river and earthen dams on either flank (Fig.2). during the cyclone of November, 1982, the upstream slope at few places sloughed. The damage started from the upstream edge of the top width and upstream slope was eroded. In October, 1984, first sinkhole was observed in the left bank earth dam near the end of left side. Also water was found seeping through the lime-stone beds below the foundation of the left bank downstream guide wall, and along with water soil particles were also coming out. All these damages were observed to have cropped up due to seepage problems and possible piping either through the embankment or through the foundation. At this juncture, it was necessary to take immediate preventive measures to stop the damages. Various studies were undertaken to diagnose the problem. The extent of damage taken place due to piping was also assessed by echosounding technique. Based on this study, countour map covering an area of 60m x 30m near left earthen envelope was prepared and treatment of geotextile was finalised. To make the protective slope of about 2:1, it was necessary to fill up soil near steeply sloping ground towards river channel. This was done by dumping sand filled HDPE woven sacks and arranging them properly below water. The sand filled HDPE woven sacks were arranged on the river bed extending to about 10 m beyond the toe of modified slope and also on the envelope slope with a berm. On these sand filled HDPE woven sacks geotextile was spread right from berm to 10 m distance on the river bed channel. The geotextile laid in position was properly anchored by laying a layer of sand filled HDPE woven sacks and also by gabions. Geotextile used was of GPB 132 variety. After the execution of protective measure, site was inspected from time to time. No damage was noticed in the left envelope either in the form of sinkholes or damage to pitching. It has been reported that the system is performing satisfactorily. Geotextile sample of GPB-132 was collected from the site in the year 1989 and subjected to various tests for evaluating its strength and other characteristics. It was found that the strength had increased from 400 gm/m^2 to 469 gm/m^2 while air permeability had reduced from 0.04 cc/sec to 0.03 cc/sec. Thickness was reduced by 0.1 mm; which may be due to compression under loading of gabions. There was marginal reduction in breaking strength. The overall performance of geotextile is reported to be very well.

Medha Creek Irrigation Scheme, Gujarat

Geotextile has been used as erosion control in Medha Creek Irrigation Scheme in Gujarat (Dalal, H.C. et al., 1992). Medha Creek Irrigation Scheme is a part of project to prevent salinity ingress in the costal area of Saurashtra, Gujarat. The dam is situated across a tidal creek very

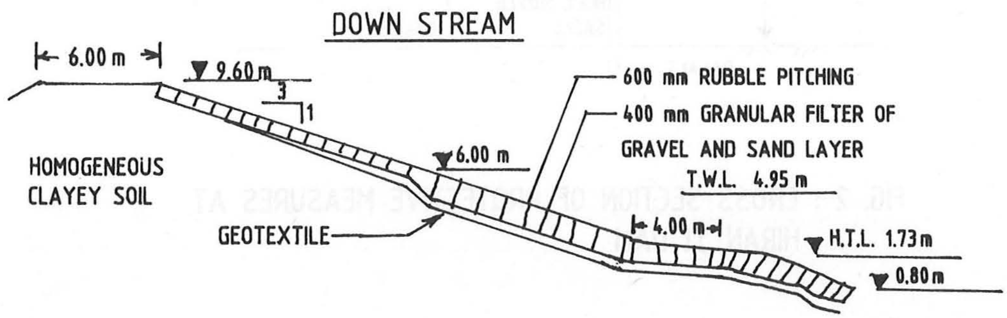

FIG. 3 : COMPOSITE PITCHING WITH GEOTEXTILE AT MEDHA CREEK

near to the Arabian sea. The soil for construction of earth dam was required from nearby surrounding borrow area. As this area is very near to sea, the soil contains predominantly clay fractions. As a result, homogeneous embankment has been constructed. Downstream slope is subjected to tidal currents and waves. Further, the area being plain, tail water level is high. It was therefore, necessary to protect downstream slope of fine grained soil with thick pitching. As the embankment soil being very fine, filter criteria with filter below pitching could not have been easily satisfied. Application of geotextile was thus, made to protect the base soil by providing layer of geotextile between embankment soil and conventional filter below pitching (Fig.3). No erosion or watering away of soil particles has been reported so far even after 6 years of application of geotextile. Drainage is also satisfactory. Geotextile used was of GPB-132 variety, satisfying the filter criteria, permeability and piping criteria.

CONCLUSIONS

Due to its versatility, geosynthetics has a vast potential to be used in River Valley Projects for improvement of ground conditions. The development and advancement of better design methods are making it easier to identify the desirable properties for each type of application. The use of geosynthetics material as a substitute of traditional practices, could not be still picked up even after years of R&D efforts due to its high cost and non-availability of standard publication for design practices besides lack of feedback studies on their durability. Its initial cost may be more but looking at its long term satisfactory performance, this may prove to be less expensive. In India also, the scope of geosynthetics material is being increased and gaining popularity. The production of geosynthetics in India has been taken up recently and as such the useage of these materials in River Valley Projects and connected civil engineering structures where problematic soils have to be used as construction/foundation materials in the absence of suitable materials is gaining momentum.

References:

1. Dr. U.D. Datir; (1997); Use of Geosynthetics in Water Resources Projects. Indo-US Workshop on Ground Improvement using Geosynthetics, New Delhi, March 1997.

2. Dalal, H.C., et al. (1992), Application of geotextile in earth dams of Gujarat. Proc. of National Seminar on Geosynthetics and Reinforced Earth, Baroda.

3. Desai, N.B. et al. (1989), Application of geotextiles for agricultural drainage in Mahi Project. International Workshop on Geotextiles, Bangalore.

4. Desai, N.B., et al. (1989), Geosynthetics in Civil Engineering works in Gujarat. International Workshop on Geotextiles, Bangalore.

5. Raichur, M.G., et al. (1992), Geosynthetics application in Gujarat. Proc. of National Seminar on Geosynthetics and Reinforcement, Baroda.

6. Dr. J.N. Mandal (1994); Geosynthetics in Civil Engineering. ASCE-IS News. Bimonthly Technical Journal, India Nov. Dec. 1994.

7. L.V. Kumar; (1989), Geotextiles in Water Resources project. Use of Geosynthetics in India - Experiences and Potential, A state-of-the-art Report. Publication No.209, Central Board of Irrigation and Power, New Delhi.

8. Dr. G.V. Rao et al. (1992). Geotextiles and Geomembranes in Earthfill Dams. National Workshop "Role of Geosynthetics in Water Resources Projects", 20-24 January, 1992, New Delhi.

9. K.R. Saxena; (1992); Filtration and Drainage in Earth and Rockfill Dams. National Workshop "Role of Geosynthetics in Water Resources Project, 20-24 January, 1992, New Delhi.