TIERED GEOSYNTHETIC REINFORCED SOIL RETAINING WALLS AT VIJAYAWADA, INDIA

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ABSTRACT

It is a known fact that, the design of retaining walls is influenced primarily by height of the backfill. As the height increases, several issues and challenges need to be addressed in the design and construction of geosynthetic reinforced soil walls, which may lie outside the available standards. One such experience is presented in this paper. Tired walls of 20 m and 40 m were provided for retaining the steep slopes of the road leading to a temple located on top of a hill in Vijayawada, India. The design methodologies, the construction details are presented in this paper.

Keywords: Tired reinforced wall, design and construction, case study

INTRODUCTION

Most Reinforced soil walls worldwide that exceed 20 m high are constructed using metallic reinforcements in the reinforced volume. Construction of geosynthetic reinforced soil retaining walls of heights of 20 m and 40 m in project related to the widening of a ghat road leading to Sri Durga Malleswara vari Devasthanam (SDMC), Vijayawada is described in this paper.

BRIEF DESCRIPTION OF PROBLEM

Vijayawada is the third largest city in Andhra Pradesh, India, located on the banks of the Krishna River and bounded by the Indrakiladri Hills on the West and the Budameru River on the North. Sri Kanaka Durga,(also known as Vijaya Durga) is believed to be the presiding deity of Vijayawada and visited regularly by number of devotees, from all-round Andhra Pradesh, as well as throughout the country. The temple of Sri Kanaka Durga and the Devasthanam are located on the Indrakila hill abutting the river Krishna.

The motorable approach road to the Temple Complex was built about 40 years ago by blasting and clearing the rocks. The road is open to motor traffic round the year. The road is a typical hill road with several sharp bends and a beautiful scenery. Due to the difficulties encountered in blasting the rocks and the nature of the terrain, the road could not be laid with uniform width over the full length.

The hill road is a broad two lane road for major portion except for two locations where the road becomes very narrow as shown in Fig. 1.

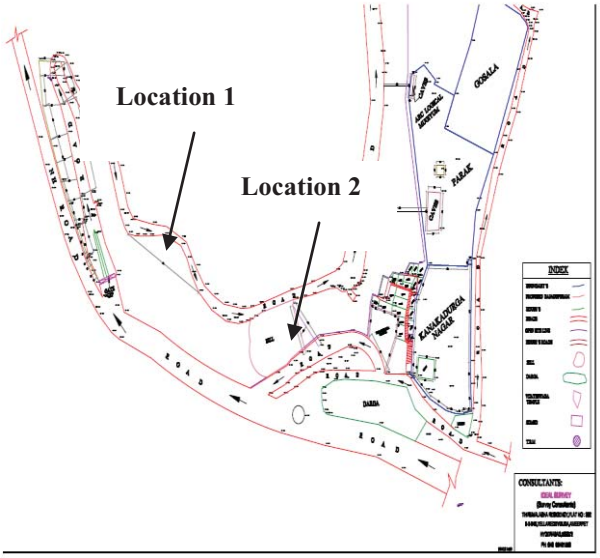

Fig. 1 Site plan

This narrowing of the road leads to frequent traffic congestions during festival seasons (Vijaya Dasami and Bhavani Deeksha) when large number of pilgrims visit the temple. On one such occasion, during the heavy congestion of traffic on the hill road resulted in some fatalities. This incident has prompted the temple authorities to widen the narrow stretches of the road in order to provide for smooth traffic on the hill road.

Several options were considered for widening the road at the two locations. One is blasting of the rocks and removing some overhang from the existing formations. This was attempted in the year

March 2008, but the acquired width of road was found to be insufficient. Another option of widening of ghat road is by constructing conventional retaining wall or bridge across two points. These two critical locations are approximately at a height of 24 to 40 m above the existing base level. There were various restrictions for deep foundations for bridge structures. M/s GeoSol Associates, Hyderabad suggested to the Andhra Pradesh Endowment Department a feasible solution comprising of reinforced soil retaining walls at these locations, which was finally accepted for design and construction.

DESCRIPTION OF TIERED STRUCTURE

The typical cross section of tired structure provided at location-1 is presented in Fig. 2 and that for location-2 is provided for Fig. 3.

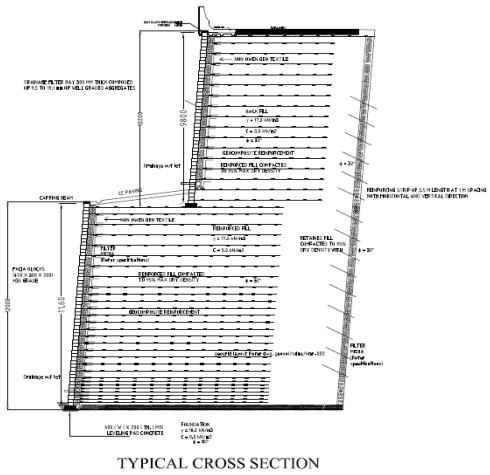

Fig. 2 Typical cross section of tired reinforced soil structure provided at location-1

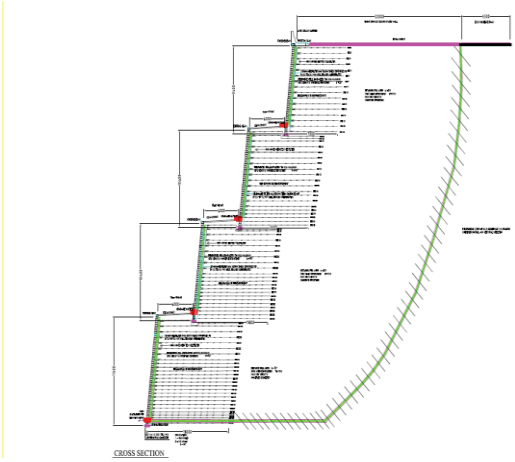

Fig. 3 Typical cross section of tired reinforced soil structure provided at location-1

The important design details of the reinforced soil retaining walls are presented below :

Set Back and Interface

Construction of single wall height of 24 m and 41 m in two different locations was found to be economically and technically feasible. At Location - 1 a 24 m high wall with two tiers (Fig. 2) and at Location – 2, 41 m high wall with 4 tiers were proposed. The setback between tiers was decided based on the space availability and cost of the project and also the large set-back also results in lesser influence of the upper tiers on the lower tiers and in relatively low stresses and low densities of reinforcements, at least for structures of this height. The 4 m to 5 m set-back between the different tiers was proposed based on site conditions. The set back for walls was analysed and fixed in for getting maximum of widening at minimum of project cost. The Owner chose to have this space left flat and practically horizontal, for easier maintenance and in order to let rain water drain away the space between tiers in paved with gentle slope out wards . To avoid probable development of failure plane at the interface of existing ghat and reinforced soil mass it was proposed use metallic strip reinforcement grouted to the existing surface extending into reinforced volume. A view of the setback provided and the metallic strips provided are shown in Figs. 4 and 5, respectively.

Fig. 4 Aerial view of the offset

Fig. 5 A view of the steel strips provided at the interface of existing ghat road

Design Methodology

The retaining wall is designed as per the relevant clauses in BS 8006-1995 and NCMA manual (2009) on design of segmental retaining walls. The design process is similar to that for lower height walls, though composite stability evaluations and deformation analyses play a more substantial role in developing the internal stability and external stability.

The design of tiered walls involves approximation of surcharge of upper wall on lower wall. The design of wall is analyzed for internal stability, external stability and global stability (Fig. 6) by applying all possible loading combinations.

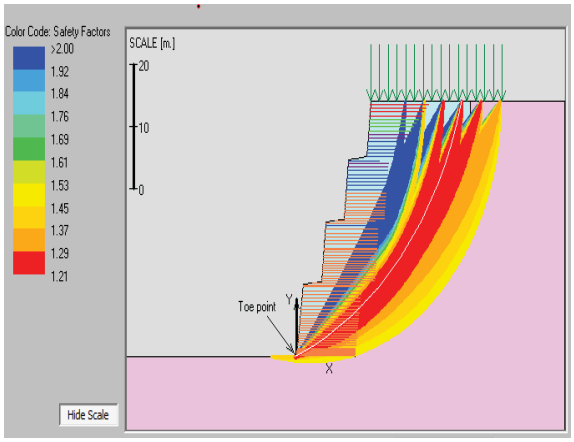

Fig. 6 A view of the output of global stability analysis

Materials Used

The walls were constructed using Ten Cate geogrids using selected gravelly, sandy,silty fill soil, as per codal provisions,

Drainage

This proposed locations for construction of reinforced soil walls anticipated seepage from the fissures in the existing rock surface. The drainage of the reinforced fill and retained fill is properly designed. The drainage media consist of stone aggregate of size 19.9 to 9. 1 mm. This fill is used all over the mass of the backfill behind the tiered walls and up to the benches excavated into the bedrock. The same material extends above, at the interface of the current embankment material and the bedrock. This is completed with a network of perforated drain pipes, of 160 mm diameter, wrapped in filter cloth, and outlet pipes (Fig.7).

Fig. 7(a) Arial view of Chimney

Fig. 7(b) Aerial views of facia drainage system

PERFORMANCE

The first wall of 24 m height, as shown in Fig.8, was opened for traffic during October 2008 (for Dasara festival) and it is continuously monitored for post construction strains. The wall has shown no sign of any distress. The 41 m high wall, as shown in Fig. 9, completed in the year 2009. The lateral deformation and settlements of this wall monitored for two years with help of laser station. The total settlements in the wall at the surface are in the order of 40 cm to 50 cm in the unreinforced portion of wall. It is also observed that the vertical cracks in the blocks are observed in the segmental blocks where the wall intercepts with rock mass due to differential settlements at the interface. The structure has not undergone any structural distress except some facial distress.

Fig. 8 A view of the completed tired reinforced soil wall at location-1

Fig. 9 A view of the completed tired reinforced soil wall at location-1

CONCLUSIONS

Tiered reinforced soil walls provide an increased opportunity to take advantage of the superior economy and ease of construction afforded by reinforced soil wall technology. Geosynthetic reinforced soil walls have proven to be an economical, reliable system for tall wall applications, with materials that meet the demands of greater loading while maintaining flexibility and ease of construction.

REFERENCES

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