Reinforced soils walls for platforms of the interoceanic roadway Peru-Brasil

Author(s)

Hugo Egoavil Perea - Maccaferri de Perú S.A.C, Lima, Perú, hugo.egoavil@maccaferri.com.pe

Nelson Berrospid Aguilar - Maccaferri de Perú S.A.C, Lima, Perú, nelson.berrospid@maccaferri.com.pe

Winston Villagomez - Odebrecht, Lima, Perú, wvillagonmez@conirsa.com.pe

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ABSTRACT: The interoceanic roadway Peru - Brasil is a very important way of communication that allows a better interaction between these two countries, this project has a lot of structures such as: ways, drainage, channels, river protections, retaining walls, etc. Those roadway crosses part of the Amazonia of Peru, which have soils characteristics like soft soils, clays, presence of water, rough topography, etc. In some retaining walls has been used reinforced earth wall, because of the advantages technical - economic of this solution offers over than the traditional solution; to make the best alternative in some places. In "Garganta Del Diablo" was built reinforced earths wall of 20.0 meters high, approximately, to create a platform of a roadway.

This article shows a Mechanically Stabilized Earth Wall structure, combining double twisted hexagonal wire steel mesh with polymeric geogrids as reinforcements. This kind of solution is the better in areas with soils problems, because combine resistance, flexibility, versatility and cost effective.

1 INTRODUCTION

The Peru-Brazil Interoceanic highway is one of the greatest works of infrastructure in the last 25 years in Peru, this project crosses the Peruvian departments of Madre de Dios, Cuzco, Puno, Apurimac, Arequipa, Ica, Tacna, Moquegua, Ayacucho and the Brazilian states of Acre, Rondonia, Mato Grosso and Manaus.

This road crosses part of the Amazon of Peru, which has characteristics of soil such as clay, presence of water, variable topography, etc. what makes the project a great piece of engineering.

The stretch III of the Interoceanic road located in the city of Madre de Dios which is at an average altitude of 300 meters, has an approximate length of 400km across critical areas such as the "Garganta del Diablo" in which there was originally a platform where passing vehicles but this one was not wide enough for the future interoceanic highway, which was required to perform a widening of the original platform. Is where one of the alternatives considered was to make a platform of reinforced soil wall combining the Terramesh System with high strength uniaxial geogrids.

2.- DESCRIPTION OF THE PROBLEM

The area known as the "Garganta del Diablo" originally had a width of approximately 4.0m platform where it could only pass one vehicle at a time, the road project included extending the width of 4.0m to 11.20m.

This extension of the platform has generated a problem because the slopes adjacent to the platform had a very steep incline which would use a large amount of compacted filler addition to the area by topographical features is an area of difficult access.

Figure 1 .- Left Side of the zone (initial)

Figure 2.- Right Side of the zone (initial)

As can be seen in Figures 1 and 2 the initial slopes of the platform are quite pronounced which generated a problem in order to make the widening of the road.

One alternative was to make a bridge towards a city Mazuco the way to Puerto Maldonado, but the cost of performing this work was very elevate, is there where are proposed alternatives for solving the problem described above.

3.- SOLUTION TO THE PROBLEM THROUGH THE USE OF A PLATFORM WITH REINFORCED SOIL WALLS

A survey of the site was performed to get updated topography, soil tests were made to determine the soil parameters to design the reinforced soil walls, the stability designs were made in the way of Pseudo Static and Static analysis.

Was raised using 3 reinforced soil walls, two of which were to walk across the platform and third party support is a wall of reinforced soil type on both sides.

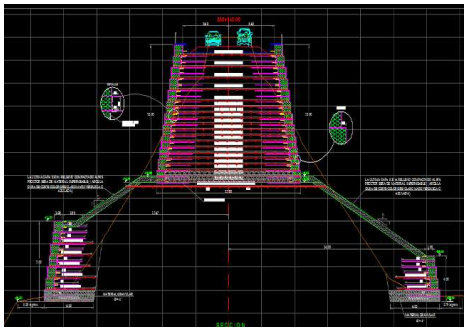

Figure 3 .- Reinforced Soil Wall critical Section of Garganta del Diablo

In Figure 3 can be seen the two reinforced soil retaining walls that form the toe of slope with a height of 7m (left wall) and 4m (right wall). On these walls that make up the toe of embankment is located the third double-sided wall with a height of 12m, the total height from the bottom to the top is approximately 21m, the length of the wall in right side of the road is 76m and 46m on the other side.

The retaining walls used a combination of the reinforced soil slope system denominated terramesh system with high resistance uniaxial geogrids and non-woven geotextiles. The Terramesh System is a type of reinforced soil formed by a double twisted hexagonal wire mesh that forms a unique piece between the gabion's box and the tail of reinforcement. The frontal face is filled up with stones that vary between 6" and 10", whose function is to avoid the superficial erosion of the reinforced filling.

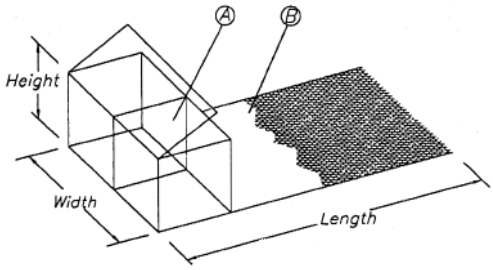

Figure 4.- Reinforced Soil System with a double twisted hexagonal wire mesh.

In figure 4 it can be seen the reinforced soil system with a double twisted hexagonal wire mesh with a tough PVC coating whose characteristics for this project are the following:

Width = 2.0m
Height = 0.5m
Length = 4.0m
10 x 12cm Mesh with Ø = 2.70mm (PVC)

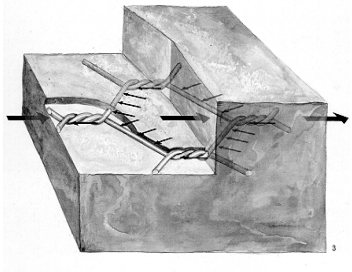

Figure 5.- Reinforced Soil System with a double twisted hexagonal wire mesh.

By tests it was determined that the capacity of anchorage of double twisted hexagonal wire mesh oc-

curs due to the combined action between the friction, shear and lock.

Uniaxial geogrids used were made of high strength polyester fibers which is covered with PVC coating for protection against aggressive agents of soil or plant damage during construction, these geogrids are high modulus resistance due to efforts to which they are subjected by the high wall height.

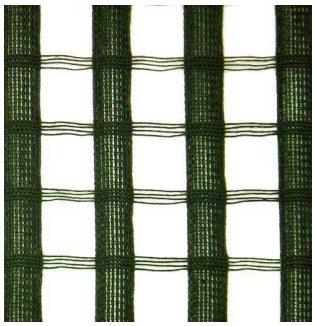

Figure 6 .- high strength uniaxial polyester geogrid.

The nonwoven geotextil's function in the reinforced soil wall is as a filter and avoids the migration of compacted fill through gaps of the gabion in the front facing.

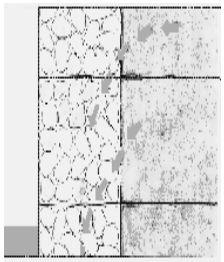

Figure 7 .- geotextile applied as a filter between the fill and the frontal face.

Criteria of Design

The design of the reinforced soil system was performed using the software MacStars 2000 where internal stability, checks of sliding, flipping, bearing capacity and overall system failures both static and pseudo static were analized.

In this case where we used a combination of reinforcements that are the double twist mesh with an average ultimate strength design of 30kN/m and high strength geogrids with different tension values according to the design done.

In general the design safety factors were obtained above 1.50 in the static case and greater than 1.20 for the Pseudo Static one.

Global Failure

Verifications of possible failures were made which were overall acceptable safety factors.

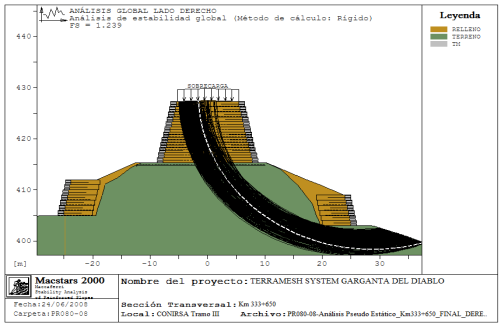

Figure 8 .- Global Analysis of Reinforced Soil Systems

Internal verifications

Internal verifications by each level of reinforcement were realized, these internal verifications allowed us to obtain the space and strength of the main and secondary reinforcements.

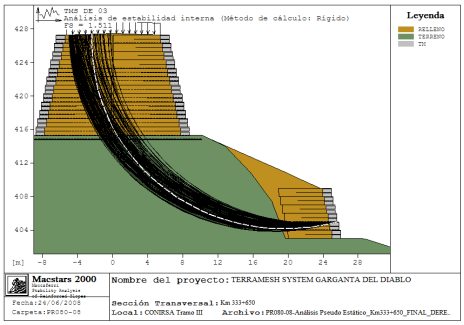

Figure 9 .- Internal Stability Analysis

Verification as Wall

The behavior of the reinforced soil wall was verified individually calculating the safety factors to sliding, overturning and bearing capacity.

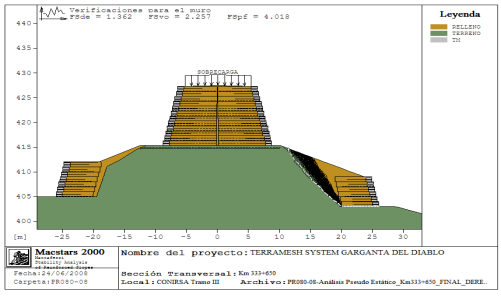

Figure 10 .- Verification as Wall

Final Structure

The proposed structure was built under strict supervision, the construction lasted approximately 5 months and was carried out under extremely difficult weather conditions.

Figure 11 .- Left Side of the zone (final)

Figure 12 .- Right Side of the zone (final)

4.- CONCLUSIONS

• The project is located in an area of difficult access and therefore sought an alternative that is easy to install, stable and economical.

• In comparison with the initial solution to build a bridge the alternative of the reinforced soil walls is more economical while maintaining a stable behavior.

• The designs were made taking into account the different
factors to which the structure will be subjected during its useful life considerations such as soil type, topography, earthquake, overloads, etc..

• The safety factors obtained by the calculations show that the structure has a stable behavior to static effects as well as pseudo static ones.

• This project looked at the use of different types of reinforcement with different resistance characteristics according to the stresses of each wall.

GRATEFULNESS

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