Confined and Reinforced Sand Retaining Walls resisted VIII Grade Seismic MM Intensity.

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ABSTRACT: Geosynthetic solutions, as the Confined and Reinforced Soil (Sand) Retaining Walls, are proving to be more technical and cost efficient compared against traditional structures each day; however there are just few cases where we can compare their behavior under the natural disasters are more relevant, due to their flexibility and the use of local raw material, as the same local soils, performed pretty much friendly environmental, and overall keep well their own function and saves money for countries on development process.

1. INTRODUCTION

This paper describes a Sand Banks Stabilization Project at Cerro de Arena, located in the South Pan-American Highway, 715+000 to 774+000 Km., between Atico and Ocoña close to Arequipa, Peru.

The complete work contemplated the execution of walls for sand retention. A consortium of North American and Peruvian association consultant engineers considered and finally use the indented surface Geocellular confinement system (IGCS), infilled with the local sand in order to obtain the required walls.

The structure shown in the picture corresponds to a wall of 250m of long located in the km 731+000.

2. THE DESIGN

The design indicated a structure of internally reinforced and confined soil wall using a GCS, the one that finally should be economic and of high yield.

Confined & Reinforced Sand Retaining Walls in a range of heights among 2.00 m and 2.40 m were established, they were analyzed to possess the enough stability against sliding, overturning and enough bearing capacity for the characteristics of the place.

As the designer knew that some elements like cement, reinforce bars, aggregates, and even water, would be expensive for building at that location; and also, in the face of the abundance of sand and absence of stony material, it was considered appropriate the use of the IGCS.

The IGCS is formed with indented surface strips of high-density polyethylene (HDPE). The individual strips are inter-connected by a series of offset, full-depth, ultrasonically welded seams.

The IGCS sections, once expanded, show a honeycomb structure shape made up of a large number of cells; this whole area received sand material in a thickness of 0.20m of depth, with an appropriated compaction; and placing a section above the other, allowed to had an identical body to a gravity wall made of raw concrete; although with some comparative advantages.

The foundation required an improved floor, which was achieved with borrow material of similar grain coarse to one used in highway pavement; and also the same one was applied at the first levels of the IGCS wall to assure an appropriate drainage system.

The wall was conformed from a similar sand material, available at the slope job site; such that its behavior in front of seismic situations can be more uniform than any other type of traditional structure.

The friction among levels assures the internal integrity of the resulting structure.

The face and top of the structure had a fill material with uniform gravel no more than 2"; to avoid piping problems and sand washing.

It was clear that the structure is a good drainage system by itself and provides good flexibility for what is not necessary a parallel drainage system, neither the use of construction joints.

3. THE BUILDING PROCESS

Excavation proposed for the structure was the main problem, the one that consisted on the use of a temporary wooden sheet piling system anchored in sand, what had been made independently of the earth retention system chosen.

Once carried out the excavation, the preparation of the area for foundation began with the use of loan material like it is shown in the detail plane.

The IGCS were installed with a crew of 6 people: 2 specialized workers and 4 men, in charge by specialist engineers from ANDEX.

The good yield of this crew in the installation only was about 180 square meters to 200 square meters by day working at 35°C.

It was required the use of a pneumatic stapler, wooden stretcher frames, metallic stretcher bars and other tools.

The compaction work was carried out with the support of a front loader and 2 little flat compaction equipments, a cistern that provided the water necessary and a portable set of field density test.

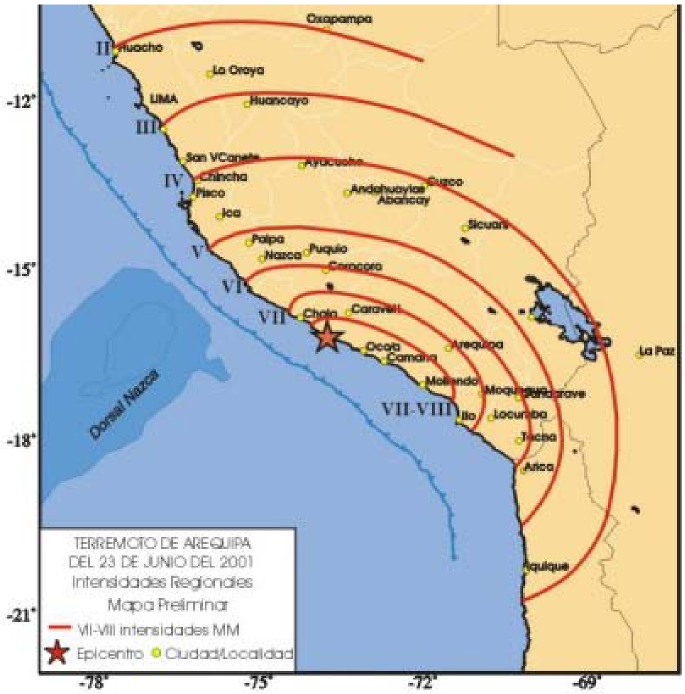
The total quantity of square meters that was required was of 8,010 m2 it means a structure volume of about 1,602 cubic meters.

Some walls were also placed to retain the highway platform, where the top of the wall would be the sideway and where metallic guiderails were installed.

4. Arequipa Earthquake:

On June 23rd, 2001, an earthquake at Peruvian southern region occurred, epicenter was 80km N.W. Ocoña district in Arequipa, with an intensity VII –VIII according to Mercalli scale.

Location was just in front of coastal area where Cerro de Arena IGCS walls were built. Here was the worst part where earthquake affect many structures.



All IGCS wall structures resisted such event, pavement was the worst affected. IGCS Walls proved to be structures more adequate to support earthquake effects and stresses.

To re-open highway traffic, stopped due to the earthquake, some parts of the Pan American Southern Highway, and also km 731 required widening. According to this some walls were removed and an important quantity of IGCS sections were rescued and stored for later construction.

Actually many walls exist between km 728 and km 735 stations and are still in service, receiving every day permanent heavy load traffic and had survived an extreme event.