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Chilean experience with geosynthetics applied as reinforcement

L. Paredes
Universidad de Chile, Santiago, Chile

ABSTRACT: Since 1977 geotextiles have been used in Chile mainly as filters and separators in roads. Geogrids are known since 1980, but first reinforcement applications are from the beginning of the 90. Non-wovens geotextiles were the first geosynthetics applied in walls 3 to 6 m height. Later, geogrids and wovens geotextiles were specified in diverse projects. The main problem to apply geosynthetics is the seismicity of the country and that designs shall complies with life expectancies for more than 20 years.

1 INTRODUCTION

1.1 *Chilean Seismicity*

An important part of the total seismic energy dissipated by the earth in the recent century was located in Chile. The recurrence period of earthquakes with magnitude Richter greater than 7 is 10 years in most important cities.

Design accelerations for rigid structures are defined according to Chilean Standard NCh 433, based in the soil type and properties. The design code was established after the 1985 earthquake and included the experience recovered from it. but was defined for buildings and structures, not for flexible walls. Recents designs for walls reinforced with steel strips according to H. Vidal assumes a performance equivalent to one of the cases of the NCh 433 code.

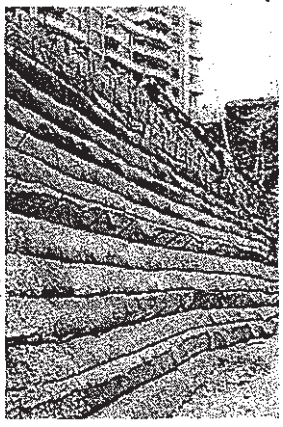

Figure 1. Reina Victoria Wall, Valparaiso

1.2 *Chilean geosynthetics background*

First laboratory investigations and numerical analysis were performed in 1979 and focused in the frictional stresses mobilized between strips and soils including seismic analysis (1). At the same time other research with different geosynthetics and analysis with finite elements model started (2). In 1988 a large scale shear box device was completed, capable to perform test with 1 x 1 m geosynthetic samples for reinforcement (3).

More than six students got their engineering degree studying interfaces both numerical and laboratory analysis since 1979 to date.

2 CASES

2.1 *Reinforced wall Nudo Vial Vespucio Independencia*

A 10 m wall reinforced with HDPE geogrids is one of the first projects designed with geosynthetics for a urban public highway. Other urban projects were designed with steel strip reinforcement, or concrete structures. The wall was designed according to AASHTO design criteria and with 0.30 seismic coefficient for the pseudo-static analysis.

2.2 *Reinforced wall Reina Victoria, San Roque Hill, Valparaiso*

The wall is the highest constructed with nonwoven polyester geotextiles. The 12 m height wall designed according to AASHTO criteria as part of a private condominium. Figure 1 shows a general view.

Table 1. Summary of walls constructed with geosynthetics.

Type of geosynthetic*	Cases	Max. height	Remarks
	N° of walls	m	
GGR HDPE	10	10	permanent
GTX NW PP therm.bonded	2	5	failures
GTX NW PET mech.bonded	18	12	permanent
GTX NW PP mech bonded	2	8.5	permanent
GTX W PP	1	5.5	temporary

* According to IGS recommended subscript terminology

2.3 *San Antonio port gates 1,2 and 3*

The first important reinforced wall was designed in 1992, resulting in a 8 m height, 85º and 200 m length structure. The design was oriented to reduce the backfill loads to a concrete wall where a big port crane was installed. The reinforced wall was exposed to big forklift live loads. In the design numerical methods (FLAC) were applied and the geosynthetic suggested and specificd was a woven polyester geotextile. Nevertheless the wall was finally constructed with a nonwoven mechanically bonded polyester geotextile. Even now, the performance of the structure was good since 1993 and two strong motions have been registered.

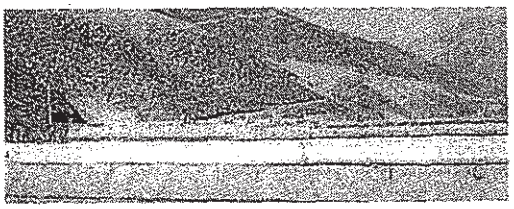

Figure 2 Tailing raising wall

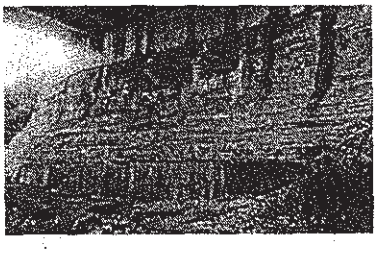

Figure 3 Reinforced Wall in Laja Falls Highway bridge

2.4 *Tailing Dam raising wall at copper mine*

An important mine located in the central Andes had troubles to continue filling a tailing dam because their crusher did not produce enough sand to continue the dam. The solution was to build a temporary 6 m height wall with local soils and woven polypropylene geotextiles. The 85ºwall design was based in the AASHTO criteria and verified with finite elements. Figure 2 shows the 500m length wall that was completed in 30 days.

2.5 *Reinforced wall in Laja falls Pan american highway bridge.*

A 8.5 m height 3:1 (V: H) permanent wall was constructed in year 2000 with nonwoven mechanically bonded polypropylene geotextiles. The 20 m length wall and 0.40 m layers is the first wall designed as abutment of bridge in a main Chilean highway.

3 COMMENTS

It is interesting to reflect how the practice for reinforcement soil has not advanced at the same time over the 24 years period the geosynthetics have been in use in Chile. Other applications like geotextiles as separators and filters has been widely used and the annual per capita use is the biggest in Latin America. Geosynthetic clay liners were introduced in 1993 and more than 300,000 m2 have been installed to date. Geomembranes were produced and installed since 1978 and more than 100 millions m2 were installed in the past 24 years.

The conservative criteria for structures designed because of the seismicity is one cause. During the past 50years few damages or victims were produced by the earthquakes.

The unique three failures in reinforced walls were produced under static conditions. Soil fill erosion at construction stage, foundation problems and wrong procurement practices were the probable causes.

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