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Use of geocells for lining a steep drainage channel in mining area

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ABSTRACT: In the metropolitan region of Belo Horizonte there are several mining companies which extract iron and other metals in the surrounding area. Mining activities result in waste dumps, which are usually constructed in valleys adjacent to the mining area. The waste material is highly heterogeneous, with components from fine soils to large stones and boulders. Drainage control is achieved through peripheral channels, which are usually made of rock fill or lined with concrete. This paper presents an alternative solution to lining a drainage channel, using geosynthetics product. The channel is trapezoidal with side slopes of 1H:1V, 1.5m deep and 6m wide at the base. It has bed slope of 45 degrees and an approximate length of 500m. The solution consisted in lining the channel with an HDPE geocell filled with concrete. Initially the cells were to be fixed by means of steel anchors inserted along the channel slopes and base. However, during installation there was great difficulty in inserting the anchors in the ground due to large amount of stones in the waste pile. For this reason, the anchoring system was modified and consisted of installing the up-slope end of the geocell sections in trenches excavated across the channel slopes and bottom. Two months after completion of the lining, an estimated 500-year rain occurred in the area, totaling 90mm in 5 hours. The lining had already been submitted to a previously heavy rain of 227mm in 14 hours. These events lead to the displacement of large boulders from the waste pile to the channel bed. Some of these stones stopped at an intermediate berm. Even though the lining was submitted to these high stresses, it showed satisfactory performance, with no significant damage.

1 INTRODUCTION

Geosynthetics have been used with significant frequency in civil and environmental engineering works. This paper presents an example of such an application of geosynthetics in Brazil. It discusses the use of geocells for lining a steep drainage channel in a mining area, near Belo Horizonte, MG. The channel passes over mine waste material that is highly heterogeneous, with components from fine soils to large stones and boulders. Environmental restrictions at the dump site led to the evaluation of lined drainage channels to prevent the development of the erosion process.

2 GEOLOGICAL-GEOTECHNICAL ASPECTS

The drainage channel was built over a waste dump at the Mutuca Mine, located in the municipality of Nova Lima, 16 km south of Belo Horizonte. The geological setting of the area is known as the “Iron Quadrangle”, a major deposit of high-grade iron ore, which occurs in the form of hematites and itabirites. The ore deposit was formed after intense weathering, and is surrounded by deposited waste rock, such as phyllites, quartzites and schists. These materials occur in distinct geotechnical classes, but usually have low consistency and strength.

The mine waste generated is deposited in specific waste dumps, which, in most cases, are located in deep valleys or gullies. The waste dumps can reach considerable heights, in the order of 200-300 meters; therefore, control of surface drainage is essential. The waste dump sited in this paper is named “Grota 2”. The drainage channel was built in its left abutment (Figure 1).

Figure 1: General view of channel.

3 HYDRAULIC ASPECTS

The contributing drainage area of "Grota 2" is about 1.2 km^2. The area is covered with underbrush. The elevation difference within the drainage area is 110 meters.

Rainfall data comes from the Belo Horizonte meteorological stations. Using the method of I-Pay-Wu and time-of-recurrence of 100 years, average precipitation intensity is 219 millimeter per hour. At this intensity, rainfall runoff results in a peak discharge of 7 cubic meters per second in the channel. This flow was used for the hydraulic design.

The resulting channel is trapezoidal with two intermediate waste collection basins. The data used to hydraulically size the channel are as follows:
Q = discharge = 7 m^3/s
I = bed slope = 71%
L = channel width= 6 metros
h = depth of flow = 0.11 metros
v = discharge velocity = 11 m/s
n = concrete roughness = 0.017
Waste collection basins have width of 4.5 meters.

4 APPLICATION

4.1 *Characteristics of Geocell*

Geocell is defined according to IGS as a three-dimensional, permeable, polymeric (synthetic or natural) honeycomb or web structure, made of strips of geotextiles, geogrids or geomembranes linked alternately and used in contact with soil/rock and/or any other geotechnical material in civil engineering applications.

The geocell "Geoweb" is a flexible, three-dimensional cellular confinement system manufactured from ultrasonic welding 1.27mm thick, perforated, textured high density polyethylene (HDPE) strips which form the cell walls. The geocell sections are shipped to the project collapsed and when expanded, they form panels similar to the honeycomb of bee. Figures 2 and 3 illustrate the characteristics of geocell, Geoweb.

In hydraulic applications, geocells can be filled with clay-soil-cement, various sized aggregate, and concrete. The correct infill material is defined by project details of: flow velocity, channel slope, depth, and side slope, foundation soil, wave action, etc. In this case, all areas covered with geocells were filled with concrete.

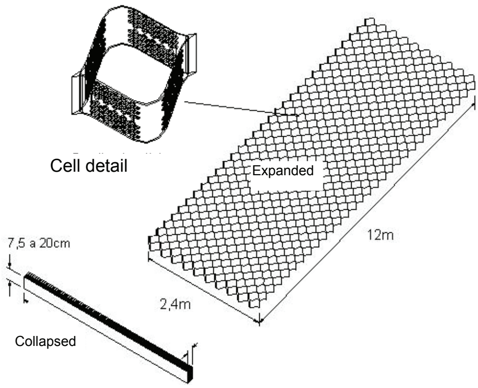

Figure 2. Characteristics of geocell Geoweb.

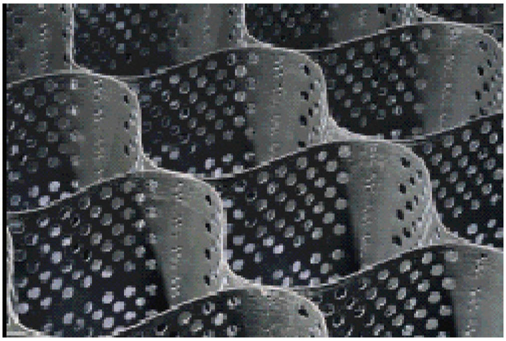

Figure 3. Detail of Geocell Geoweb.

Normally the geocells are 20 to 45cm wide and 7.5 to 20cm deep. In this application the channels were lined with 10cm deep and 45cm wide cells infilled with 15MPa concrete.

Initially the cells were to be secured in place using 10mm diameter and 70cm long steel anchors inserted along the channel slopes and base. However, during the geocell installation there was great difficulty in driving the anchors into the waste pile due to large amount of stones. For this reason, the anchoring system was modified in order to adequately secure the lining in the channel. The

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modified anchoring system consisted of installing the up-slope end of the geocell sections in an anchor trench excavated across the channel bottom and side slopes. The anchor trench and the geocell lining were infilled simultaneously with concrete.

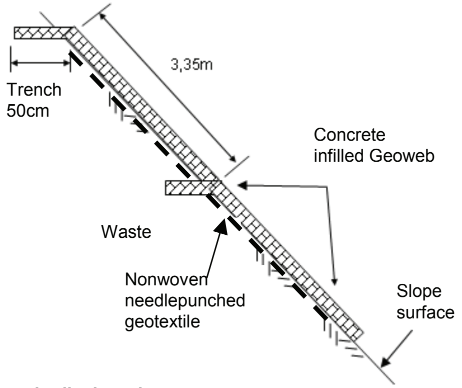
4.2 *Characteristics of Channels and Installation*

The 1.5m deep trapezoidal channel has a 6m wide invert with 1H:1V side slopes.

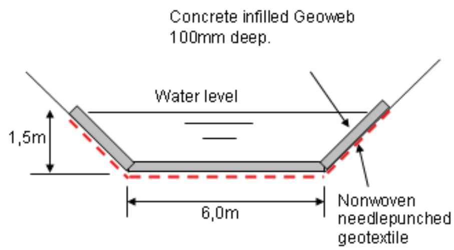
The bed slope of the channel is 45 degrees and the length is approximately 500m.

The solution used in this case study consists of lining the channel with a geocell using a non-typical technique of anchoring the full geocell section and filling it with concrete.

Figure 4 illustrates the installation detail of the geocell on the slope. Between the geocell and the slope is a spunbond PET nonwoven needlepunched geotextile (Bidim) which is used as a filtration layer and for possible drainage. Figures 5 to 9 show the installation process.



Longitudinal section



Cross section

Figure 4. Installation of Geocell Geoweb.

Figure 5. Opening the trenches and installing the geotextile.

Figure 6. Infilling the geocells and the trenches with concrete.

Figure 7. General view of the inclined portion of the channel.

Figure 8. View of the intermediate berm.

Figure 9. General view of the slope.

4.3 *Performance During Intense Precipitations*

Two months after completion of the lining, an estimated 500-year rain occurred in the area, accumulating 90mm of rainfall in 5 hours. The lining had previously been subjected to an accumulated rainfall of 227mm in 14 hours. These events lead to the displacement of large boulders from the waste pile to the channel bed. Some of these large boulders stopped at the intermediate waste collection basins. Even though the lining was submitted to these high stresses, it showed satisfactory performance, with no significant damage. Figure 10 illustrates the accumulation of boulders at one of the intermediate waste collection basins.

Figure 10. Stones deposited in the intermediate berm after intense precipitation.

5 CONCLUSIONS

Unique geosynthetics solutions are being used more and more in large constructions projects throughout Brazil. Among the advantages of the geocell solution presented herein, the following are significant:

- all geosynthetic materials were manufactured with strict quality control;
- site specific details determine the details of geosynthetics used;
- site specific details determine the details of the final design;
- installation procedures can be quickly modified to adjust to site conditions;
- once procedures are established, installation is quick;
- the system is highly cost competitive when compared with conventional materials.

These recognized advantages have resulted in continual growth in this use of geosynthetics in major civil works both in Brazil and the world.

REFERENCES

Koerner, R. M. (1998) “Designing with Geosynthetics”. Prentice Hall, 761pp.