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SLOPE STABILISATION METHOD ON S7 «ZAKOPIANKA» ROAD CASE

Modernization of the Zakopianka Road is probably the most expected investment in Southern Poland. Some problems occurred during the construction stage connected with protection of slopes from failure at the pre-planned highway location. This problem resulted from a relatively small amount of investment and lack of soil stabilization plans in the original construction design. Various slope reinforcing methods for the Myślenice – Pcim highway section are presented in the paper. The results of calculations with Finite Difference Method (FDM) and Limit Equilibrium Method (LEM) are presented as well.

Модернизация шоссе на Закопане является, вероятно, наиболее ожидаемым инвестиционным планом в Южной Польше. Во время строительства возникли проблемы с укреплением откосов дороги. Эти проблемы явились следствием относительно малого объема инвестиций и отсутствия мероприятий по стабилизации почв в первоначальном проекте работ. Предложены различные методы усиления откосов для перегона Мысленице – Пчим и представлены результаты расчетов с использованием конечно-разностного метода и метода предельного равновесия.

Express road S7 is one of the most expected road, because leads to the winter capital of Poland, but most of this road it is road through the agony. We can't everywhere drive a beautiful two-lane road. But thanks money from UE we can see more big progress of work, which instilling optimism in us, that in the sequence of a few recent years Zakopane will have road.

Actually the most advanced works are on the 12 km sections Myślenice-Pcim where are realization different problems of Geoengineering. In it 24 retaining wall and exactly this problem we want approach in this paper.

Three solutions of retaining walls were used in mentioned section:

- gabion retaining wall;
- anchored reinforced concrete retaining wall;
- reinforced concrete retaining wall on the CFA pile.

Gabions are wire mesh baskets filled with ballast material, generally rock. Baskets are made from hardened steel wire net double torsion, thanks this cracks don't propagate. Wire net is plate zinc or PVC in the destination to safe their before the harmful influence of environmental factors. Gabion baskets have some advantages over loose riprap because of their modularity and ability to be stacked in various shapes. They also have advantages over more rigid structures because they can conform to ground movement, dissipate energy from flowing water and drain freely. On the building site gabions are import as a flat elements pack in bundle. Assembly of gabion depend on connection their elements along the corner. Single gabion are connection in the total along the all adherent edges. Connections are made by hand or mechanically. Gabions are filled with heavy material, in general boulders or breakstone.

Volumetric weight of filled gabions is about 1600-2000 kg/m^3.

Gabions are marked of ease forming, permeability, strengths and possibility building about every season, therefore gabion retaining walls are beneficial to stability saturated slopes. Gabions can accommodate nonuniform deformations of subsoil. They enable the development of the flora, what are aesthetic. However with problem at construction of large amounts of walls of gabion along the discuss sections is a lack of appropriate amount material to fill.

The second method used to slope stabilization is anchored reinforced concrete retaining wall. This type of wall is made by stages to provide stability exposed part of slope. Next segment is made after previous is anchored.

Immediately after earth works wire-mesh reinforced shotcrete plates is made. In shotcrete layer four holes of 50 mm diameter are made per square meter. The next is double layer of nonwoven needle punched geotextile and a layer of geomembrane to assure proper dewatering behind wall. The concrete are particular fragment of wall according to fixed sequence. Earlier fragments of wall are monolithic connected with next thanks to ribbed reinforcing bar. Thickness of wall 0,5 m comes from technical specifications safety anchorage strand anchor before damage or destroy. Wall coping is reinforced by concrete girt which is also support for prefabricated sewer which collect water drifting from the slope. In the concrete elements on road level are made weep holes dewatering backfill.

After concrete obtain equivalent strength wall is anchored. Diameter of anchor hole is 15 cm. Angle of anchorage relative to horizontal direction equals 10º. Anchors bar capacity is assumed to be equal 108 kN. Length of anchors was calculated as 10m. Double injection of anchor is predicted, and after inject reach adequate strength, anchors are pre-stressed.

The other method make reinforced concrete wall it wall foundation on the pile. Construction of reinforced concrete wall foundation on the CFA pile consists of two parts: underground and overground. Underground part establish CFA pile of diameter 0,8 m on spacing 1,2 m on changer length dependent on height wall and expected of geological conditions. Pile are reinforced of basket with ribbed reinforcing bar. Overground part it monolithic reinforced concrete wall on the thickness 0,5 m fixed on the CFA pile head behind the help deep seated in pile and wall structural shape I-section.

Walls are marked: fast and cheap execution, need engage much heavy construction equipment and skilled worker. Progress of works is conditional from weather conditions. Walls need also equivalent dewatering.

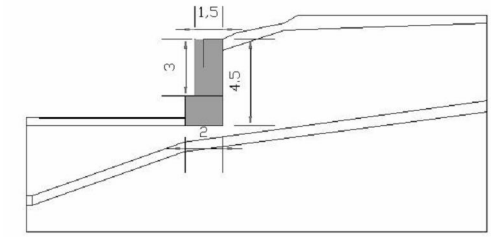
In the next part of the article analyses performed by us for existing anchorage wall and alternative solution – gabions – are presented. Calculations were performed on slope o nastepuj, ących warstwach hale and low plasticity clay, silt and clay brief, shale clay and sandstone. Wall stay design in distance 4 m from road and in order to present stages to his realization realize some analysis. Calculations were performed in two popular computer programs which use two different calculations method. First of them, SLOPE/W, is based on the Limit Equilibrium Method with Coulomb – Mohr theory. Second program, FLAC Slope, is based on numerical method called Finite Difference Method. For factor of safety calculations Shear Stength Reduction method is used.

In order to determinate factor of safety analized slope construction some analysis were performed. Factors of safety received from both program (FLAC and Slope/W) shows that existing wall is stable. Also gabion proposed by us would accomplish his task and assure stability of slope.

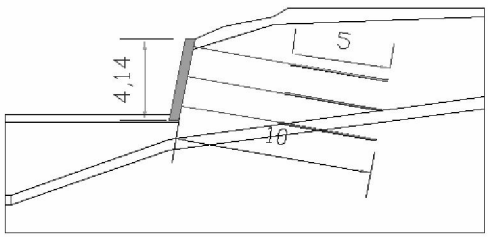
Results of analysis

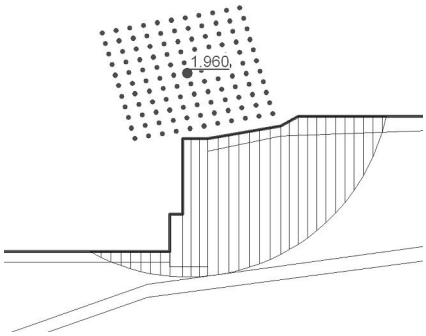
Analysing received FS we can conclude that proposed solution is overdesigned. Provided thickness of wall is excuse protect head of anchor, construction of gabion need precisely analysis different setting to decrease material.

Gabion retaining wall

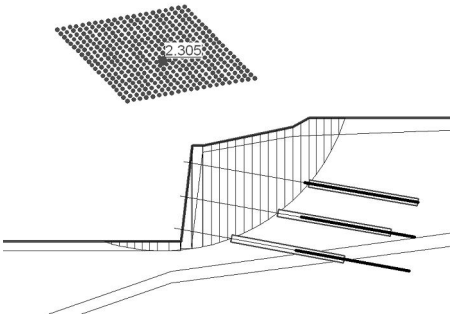


Anchored retaining wall

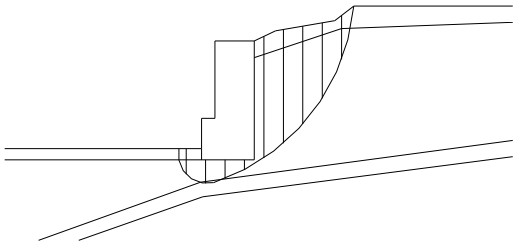




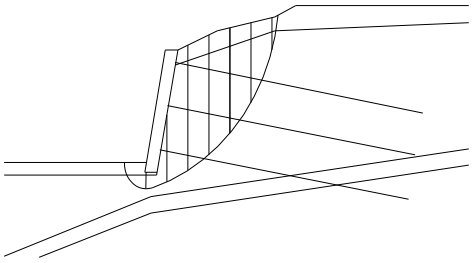
Slope/W



Slope/W



FLAC



FLAC

Results of analysis

Programme	FLAC (SSR)	Slope/W
Gabion retaining wall	1,87	1,96
Anchored retaining wall	2,31	3,05

Three methods of slope stabilization where presented in this paper. One of them – retaining wall – is very popular but currently we tend to decrease influence on natural environmet, limiting use of material and raising beauty. Cause that more often design engineering are inclined to the light building structure like a gabion. This paper near process engineering execution of construction and also show use different program to design, planning and verify construction stability. It should be remember that to the reliability of analysis we must possess good geotechnical reconnaissance and understand how the construction works.

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