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Research on reinforced soil and geosynthetics in Poland

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ABSTRACT: The main programme on mechanics of reinforced soil was initiated in Poland in the late 1970s and carried out at the Geotechnical Department of Hydro-engineering Faculty at the Technical University of Gdansk and simultaneously in the Institute of Hydro-Engineering of the Polish Academy of Sciences in Gdansk.

1 INTRODUCTION

The main results of research carried out by Polish Academy of Sciences were summarized in the review article (Sawicki, 1998) and in Sawicki's publication (2000). The results of research have also been dispersed in many professional journals and conference proceedings.

1.1 Results overview

The first group of results deals with original models of reinforced soil treated as a macroscopically homogenous composite material. The properties of such a composite depend on mechanical properties of the constituents (soil and reinforcement), their partial fractions and geometrical arrangement. These models were elaborated for the elastic, elastoplastic, rigid plastic and elasto-visco-plastic ranges of reinforced soil behaviour.

The second group of achievements deals with applications of particular theoretical models of reinforced soil to the analysis of various RS structures, including reinforced subsoil loaded by footing, RS retaining walls and slopes. Bearing capacity of such structures was estimated and some methods enabling the analysis of development of failure and estimation of stresses proposed. Theoretical solutions were extensively tested against experimental data, and satisfactory agreement has been obtained. Many of analytical results have been obtained in a simple mathematical form, and therefore they can easily be applied for designing purpose. The methods elaborated have been used for designing of some RS structures in Poland.

The third group deals with investigation of mechanical properties of geosynthetics, including rheology and other time effects as influence of strain rate on the stress-strain characteristics. Extensive experimental programme has been carried out theoretical description of experimental data proposed. Some original application of geosynthetics for the bottom protection purpose in harbour was proposed and applied in practice.

2 OTHER INVESTIGATIONS

2.1 Short-term investigations of horizontal flow through geotextiles

Experimental device and results of short term in plane permeability tests of geotextiles were made. Test with changeable normal load and different hydraulic gradient were carried out. Practical and theoretical aspects of the problem are discussed Attempt of the mathematical description of in plane water flow through the geotextile is presented. System of coupled differential equations describing balance of porous medium and continuity of the flow is used. Examples of finite element calculations with computer program TOCHNOG are presented.

2.2 Frictional reliability of textured geomembranes

The series of laboratory tests on sand-textured geomembranes interface friction under cyclic tangent loading with modified direct shear apparatus were conducted. Three commercial available textured geomembranes are tested in direct contact with dry sand. Investigations were focused on frictional reliability of textured geomembranes connected with the surface degradation of applied texture and its influence on interface strength during cyclic tangent loading. Roughness profiles of new and worn surfaces are compared for various loading conditions. Results shoe that manufacturing process of textured geomembranes is veiy important for surface frictional reliability.

2.3 *The capacity of reinforced subsoil loaded by uplifted foundation*

The uplift behaviour of mushroom foundations embedded in cohesionless soil media, with and without geosynthetics reinforcement, was investigated in small-scale model tests. Two configurations of geomaterial reinforcement and four types of geomaterials are compared. The most effective is geocomposite located directly at the base of a foundation.

Based on the laboratory investigations carried out on model mushroom foundations with two different height embedded in sand without and with four types of reinforcement placed in two different layers, the following main conclusions are drawn:

- the load displacement relationship in the unreinforced case is similar to that observed in the reinforced one,
- the reinforcement placed directly at the base of foundation give noticeable increase of uplift resistance,
- the geocomposite reinforcement was the most effective in enhancing uplift resistance of mushroom foundations embedded in reinforced soil,
- the maximum increase in capacity was over 200% of that in unreinforced conditions for the geocomposite placed on the base of the foundation with 40 cm height.

The observations and conclusions drawn in this study are valid only for the type of foundations and reinforcement proposed by the authors

2.4 *The pull-out testing of geogrid reinforcements*

Basic aspects of pull-out testing concerning the equipment used and procedures applied were presented in Bolt & Duszynska paper (2000). The experiments aimed at the analysis of the conditions included in draft European Standard prEN13738 entitled: Geotextiles and geotextile related products – Determinations of pull-out resistance in soil". The testing device was designed and constructed in Geotechnical Laboratory of Gdańsk Technical University. In thirty experiments carried out for a biaxial polypropylene geogrid embedded in coarse sand, the influence of such factors as dimensions of geogrid specimen, confinement pressure, soil density, displacement rate and sleeve distance are analysed and discussed.

Pull-out resistance of geosynthetics, which are anchored in the soil, is a function of many factors such as the soil and the reinforcement properties, the stress in the soil as well as the model test conditions related to the parameters of the experimental apparatus.

The experimental device constructed according to the recommendations of European Standard prEN 13738 allows for the reliable assessment of the active reinforcement length, values of confinement pressure applied and the distribution of strains along the anchored part of the reinforcement. Additionally there is a possibility of the analysis of other factors such as displacement rate, the range of soil-reinforcement interaction zones, etc

3 REFERENCES

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