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ANALIZA WSPÓŁPRACY GRUPY KOLUMN INIEKCYJNYCH Z PODŁOŻEM GRUNTOWYM

ROZPRAWA DOKTORSKA

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ABSTRACT

Analysis of interaction between group of jet grouting columns and subsoil

Rapid development of geoengineering technologies, which has recently taken place in Poland, has led to introduction of numerous subsoil strengthening methods. One of the most popular is a jet grouting method. Performance of jet grouting elements consists of a high-pressure injection of a cement grout stream into the subsoil, which cuts and disintegrates the soil massif, after that mixes with the soil particles and finally after cement binding forms cement-soil solid structure, similar to concrete. Jet grouting columns allow for transferring substantial loads through the strengthened subsoil and reduce the structure's settlement.

The main problem with application of this technology to strengthening of subsoil is the explanation of the real interaction between jet grouting columns and soil massif. The solution of the problem will allow to optimize the dimensioning of jet grouting columns. There are a lot of practical applications of jet grouting columns but no theoretical research of the behavior of loaded group of columns. In an engineering practice trial loading tests of individual columns are usually performed to verify the design assumptions of subsoil strengthening. A value of a force and other details of a loading test are specified similarly as for piles. Testing of individual elements seems of little reliability due to the nature of columns operation, which strengthen the subsoil interacting within the group. The single jet grouting column - interacting as an individual structure with subsoil - is an idealized aim.

The final goal for the presented research is an estimation of an influence of interaction between columns working in a group. The broad spectrum of experimental tests in real conditions and numerical analyses were conducted to achieve the goal.

During the experimental part of the research a series of tests on the trial test site was carried out to explain the scope of interactions between jet grouting columns and subsoil. A trial loading of a single column was carried out first. Then, trial loading was applied to a group consisting of 3 jet grouting columns. The results of the loading tests, geotechnical parameters of the subsoil and strength parameters of the cement-soil solid structure were applied to numerical explanation of an interaction between the jet grouting columns and strengthened subsoil.

The numerical analyses were performed with the use of the finite element method (FEM). The models were calculated in Z_Soil.PC computational program. The computational model was divided into 3 particular zones: subsoil massif, material of jet grouting columns and contact layer, formed between the columns and the soil. The

elastic-perfectly plastic material model with Coulomb-Mohr boundary condition and non-associated flow rule was used to characterize the parameters of all material zones.

The dissertation consists of 7 chapters. It contains: a brief description of the jet grouting method, examples of practical applications, numerical methods for modelling of strengthened subsoil and description of soil constitutive models used to solve this problem. Moreover there are: characteristic of research procedure on the trial test site, description of parameters of the subsoil layers, details of the tested jet grouting columns, results of both trial loading tests, extracted from the numerical analyses. As a result of the experimental tests a comparative analysis between the "load-settlement" curves obtained during in situ tests of a single column and of a group of 3 jet grouting columns was made. The comparison between the results of loading tests of a single column and the group of columns, formed in the same subsoil conditions, allows to estimate the impact of cooperation in load transferring between jet grouting columns working in real conditions in situ. Details of the comparative analyses between the results of the numerical analysis and experimental results of the trial loading tests are also presented in the dissertation.