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L i d i a W A N I K

GEOMETRICAL AND MECHANICAL PROPERTIES OF JET GROUTING COLUMNS: EXPERIMENTAL INVESTIGATIONS AND PREDICTION

D o c t o r a l T h e s i s

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ABSTRACT

Jet grouting technology is undoubtedly one of the most popular techniques for subsoil improvement. In spite of a generally wide knowledge about the technology issues, still there is a need for improvement, both in designing and construction practice, mostly with the regard to the relation between technological factors and mechanical effects. The presented doctoral thesis aims to bridge this gap pointing out on two crucial outcomes of the jet grouting technology: geometrical and mechanical characteristics.

At the beginning, the jet grouting mechanisms are explained focusing on the phenomenon taking place when a jet of incompressible fluid is injected in a still mass. In particular, the turbulent diffusion of the submerged flows is studied with a numerical model to describe the energy losses under different boundary conditions (nozzle diameter and outlet velocity) and fluid (density and viscosity). These analyses start to be the basis for the study of the jet-soil interaction.

Another significant part of the research was devoted to the design, execution and interpretation of a trial field in Bojszowy Nowe (Poland). In this experimental activity, a total number of 16 jet grouting columns were created: 8 with single fluid and 8 with double fluid jet grouting system. Each column, of about 4 m length, was formed varying the set of parameters (system of injection, injection pressure, nozzle diameter and rotational speed of the monitor) in order to observe the effects of injection on the geometrical characteristics of the columns and on the mechanical properties of the jet grouted material. After treatment, the columns were discovered up to the depth of 1.7 m below the ground level and the diameters were directly measured. Additionally, samples of material were cored from the top part to the upper medium sand layer and subjected to uniaxial and triaxial compressive tests in the laboratory. Moreover, during the injection process, a cubic spoils samples were taken and then tested in the laboratory.

The measured diameters were served to validate a number of relations proposed in the literature to predict the dimension of columns based on the geotechnical properties of the soil and on the injection parameters (Flora et al., 2013; Shen et al., 2013 and Ochmański et al., 2015). This comparison was served to propose some improvement for the above methods.

The last part of the thesis concerns on the strength in correlation with the mineralogical composition of jet grouted material. To this aim, the analyses like X-ray diffraction, differential thermal analysis (DTA), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM) were performed on samples cored from the columns to explain the various mechanical response observed on columns formed with single and double fluid injection system.