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ARTIFICIAL GROUND FREEZING: HEAT AND MASS TRANSFER PHENOMENA

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The method of artificial ground freezing is a waterproofing technique and/or temporary consolidation procedure used to realize the excavations of solid or fractured rock soils under ground water in order to build tunnels, shafts and connecting galleries. The artificial freezing technique consists of circulating a coolant fluid with a lower temperature of the surrounding ground inside probes positioned along the perimeter of the gallery. In this way, the water contained in the soil pass from the liquid phase to the solid one by forming a block of frozen ground in surrounding area of the tubes.

There are not several studies concerning the thermal calculation and analysis of AGF. The nitrogen behavior within the probe is instead still unknown. In particular, Colombo [1] makes a comparison between the results obtained by an analytical model and those obtained from both a two-dimensional numerical analysis and an experiment performed during the excavation of the Naples metro. Pimental et al. [2] illustrate the possibilities, limitations and practical implications of numerical simulations of AGF through three case studies, while Papakostantinou et al. [3] present the temperature histories of the ground monitored during the freezing process.

The freezing of two tunnelling, by means of 43 freezing pipes with a length of 40 m. The ground is made of two layers. Both the layers are under ground water. The cross section of the tunnels is about 35 m^2 and the length is about 40 m.

The authors have developed a 2D numerical model to analyze the heat and mass transfer phenomena in the ground, taking into account the water phase change process. The two-dimensional numerical model has been employed to analyse the phenomena occurring in five cross sections of the galleries.

The aim of the work is to analyse the complex thermal phenomena occurring in the ground during the freezing stages and optimize the freezing process. The authors take into account different alternative to speed up the freezing of the soil, such as increasing the number of probes, varying the freezing fluids or using other probes configurations.

REFERENCES

[1] Colombo G., Il congelamento artificiale del terreno negli scavi della metropolitana di Napoli: valutazioni teoriche e risultati sperimentali, *Rivista italiana di geotecnica*. pp. 42-62, 2010;

[2] Pimentel, E. Papakonstantinou, S. and Anagnostou, G. [2012], Numerical interpretations in urban tunnelling, *Tun. and Und.Sp. Tech.*, Vol. 28, pp. 57-69, 2012;

[3] Papakonstantinou S., Pimentel E. and Anagnostou G., Analysis of artificial ground freezing in the Pari-Duomo platform tunnel of the Naples metro, *Numerical Methods in Geotechnical Engineering-Benz & Nordal* (eds) 2010 Taylor & Francis Group, London, ISBN 978-0415-59239-0, pp. 281-284, 2010.