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EXTENDED ABSTRACT

Investigation of Foam Characteristics and Its Effect on Shear Strength of Granular and Mixed Soils (Case study of Tabriz Metro)

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1. Introduction

In earth pressure balanced tunnel boring machine (EPBM) operation, soil conditioning is critical for effective performance. Foam as a soil conditioning agent has been widely used in EPBM tunneling to modify the mechanical and hydraulic properties of excavated soils. Soil conditioning involves the injection of improvement materials from the mechanized tunneling machine to the work field and excavated soils. The purpose of this process is to change the properties of excavated soils so that the excavation process can be possible for different types of soils. But the performance of this modification is not the same for all types of soils and depends on some factors. Some of these factors are related to the geotechnical properties of excavated soils and some other are related to the injection system.

2. Methodology

This paper describes a comprehensive set of tests that has been performed to evaluate the effect that foam, foam types, and foam parameters have on the shear strength of sandy soil. For this purpose, direct shear tests were applied. Soil samples, at four stations, were prepared from the tunnel route of line 2 of the Tabriz subway. The total length of the excavation line is about 22 km between the Tabriz International Fair and Kara Malek. In this study, two types of foam which known as KOMEYL (KF168B-KF159A), CHEMIC (UGC-N2), and a type of polymer with the name of (RHEOSOIL 211) have been used. Fig. 1 presents the structure of used foam generating device.

3. Results and discussion

Based on foam characteristic tests, it can be concluded that the main difference between these materials is their stability time that the foam KF168B exhibits more stability time than the others. Also, adding a small amount of polystyrene polymer to foam solution induces a significant increase in the foam stability time, but not significantly increases the FER.

Table. 1 presents the results of direct shear tests for soil samples of S01 and S02 stations. The obtained results show that there is no significant difference between these foams in terms of their effect on the final shear strength of soil and foam mixtures.

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Fig. 1. The foam generating device

Table 1. Results of direct shear test

Foam Type	FIR	FER	C (Kg/cm2)	Ø (Degree)	Ø (Degree)	C (Kg/cm2)	Ø (Degree)	Ø (Degree)
			M=10%		Saturated	M=10%		Saturated
			Station S01			Station S02		
---	---	---	0.064	35.3	34.3	0.066	35.03	35.5
UGC-N2	20	15	0.034	29.3	27.2	0.047	32.6	30.3
UGC-N2	40	15	0.022	27.2	25.2	0.035	30.6	27.3
UGC-N2	60	15	0.019	26.8	24.4	0.031	28.6	26.06
---	---	15	0.068	35.03	34.5	0.068	36.6	36.3
Kf168B	20	15	0.031	28.2	26.8	0.039	31.2	28.2
Kf168B	40	15	0.023	27.4	24.5	0.035	28.9	27.03
Kf168B	60	15	0.018	25.3	23.6	0.027	28.3	25.06

4. Conclusions

The shear strength test results on foam- soil samples show that the injection of foam above a standard ratio did not significantly affect its shear strength and the use of FIR higher than the required level may cause disorientation in the homogeneity of the soil-foam mixture. Based on the results, the effect of foam on shear strength decreasing ratio is strongly influenced by soil aggregates, so that for the tested soils, in fine-grained soils, the effect of foam on shear strength is significantly more than coarse-grained soils.