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EXTENDED ABSTRACT

Effects of Waste Plastic Strips (PET) on Improvement of Fine-grained Soil

Yashar Dehghan, Rouzbeh Dabiri *

Department of Civil Engineering, Tabriz Branch, Islamic Azad University, Tabriz, Iran

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Environmental geotechnic, Fine-grained soil, Waste plastic strip (PET), Improvement, Bearing capacity.

1. Introduction

Geotechnical and engineering structures transfer their loads to soil by foundation. Therefore, structures should be constructed on soil with high bearing capacity. Demand for suitable soil in civil engineering projects is high, but soil with high quality in terms of bearing capacity provides from long distance and uses. Although, this operation is extensive and time consuming. Social, economical and environmental challenges have been caused researchers find new method for improving soil behavior in terms of bearing capacity and strength. In the other side, waste materials such as plastic, wood, glass and etc. in terms of high volume production due to urban development and urbanization with high cost in disposal and maintenance have been caused serious researches for application of recycled waste materials in soils for improvement performed. Polyethylene Terephthalate (PET) is one of the waste material which is permanent and causes environmental pollution. As regard to supply and demand of plastic waste (PET) is increasing, so recycling and re-use is one of the major purpose in engineering and environmental protection (John and Rodwan, 2012). Nowadays, about the use of waste plastic strip and PET different studies have been performed such as (Sivakumar Babu and Vasudevan, 2008), (Sivakumar Babu and Chouksey, 2011), (Dutta et al., 2012) and (Soltani-Jigheh, 2014) can be mentioned. Main idea of this research is evaluation of flexible waste plastic strips (PET=Polyethylene Terephthalate) effects on mechanical and geotechnical behavior of fine-grained soil.

2. Methodology

2.1. Materials

In present study, flexible PET plastic waste strips were prepared from bottles of mineral water. So that, strips in 1×1 and 2×2cm dimensions provided. Then, in 0.5, 1 and 1.5 percentage (by weight) (Fig. (1-a) and (1-b) mixed to fine-grained soil from Aras free zone in Jolfa city. In order to preparing uniform and homogeneous mixtures, fine-grain soils were passed from sieve No.100. and grading curve was determined using ASTM D421 and ASTM D422. Which are shown in Fig. (2-a) and (2-b). Furthermore, Atterberg limit were estimated according to ASTM D4318-95a. Specific gravity value (Gs) was determined based on ASTM D854. As it is shown in Table 1, the fine-grained soil is in accordance with unified classification is CL-ML.

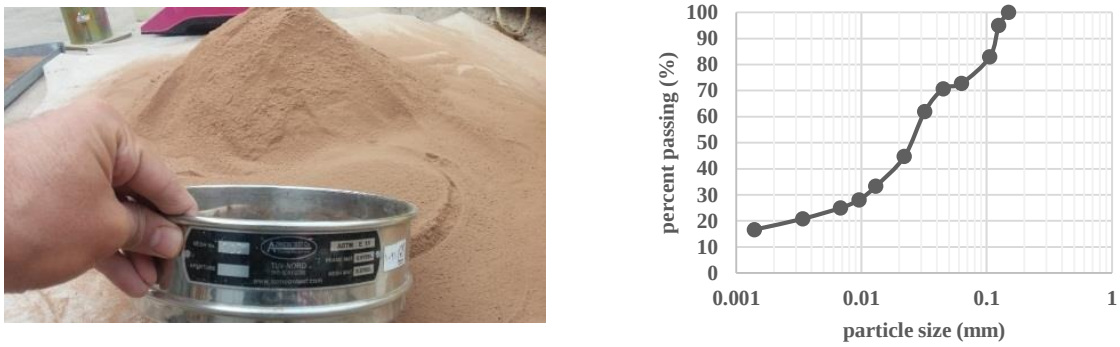
Table 1. Geotechnical properties of fine-grained soil

G_s	*LL*	*PL*	*PI*	Classification
2.65	24.2	17.55	6.65	CL-ML

* Corresponding Author:
E-mail addresses: yashr.dehghan@gmail.com (Yashar Dehghan), rouzbeh_dabiri@iaut.ac.ir (Rouzbeh Dabiri).

(a) (b)

Fig. 1. Image of PET plastic waste strips: a) 1×1cm, b) 2×2cm



(a) (b)

Fig. 2. Image of fin-grained soil in present study: a) passed from sieve No. 100, b) grain size distribution

2.2. Methods

In present research, uniform and homogenous soil specimens were prepared based on ASTM C305-14. Then, to evaluate the geotechnical behavior and properties of the improved of soils some tests were performed. First, the compaction test was performed according to ASTM D698. Second, uniaxial compressive strength test was carried out based on ASTM D2166-16. Third, direct shear test was conducted in both dry and saturate condition based on ASTM D3080-11. In this test, specimens were prepared in 10×10 cm mold. In addition, loading was performed in saturate condition at a slow speed (0.05mm/min) and in dry position at medium speed (1.25mm/min) using a vertical stress equal to 1, 2, and 3kg/cm2. Forth, for evaluating permeability in mixed soil specimens heading fall test according to ASTM D5084-03 was performed. In final, effects of PET plastic waste on swelling and settlement of improved soil consolidation test based on ASTM D2435 was carried out.

3. Results and discussion

Results of this study showed that optimum value and dimension of flexible PET waste plastic strips for improvement of fine-grained soil respectively is 1×1cm with 0.5 percentage (by weight). So, these values has been caused that maximum dry weight density 1.07% increased and optimum water content 1.4% reduced (Fig. (3-a) and (3.b)). Also, uniaxial strength at failure amount in improved specimens 37% go up and Similarity, elastic modulus 2.15% rised. In continue, variations of internal friction (φ) and cohesion (c) in mixed specimens demonstrates shear strength at failure due to presence of PET waste plastic strip can be growth respectively by 21% (in dry condition) and 11.5% (in saturate condition). On the other side, locating PET waste plastic strip in fine-grained soil can be affected in consolidation parameters. So that, waste material reduce both swelling potential and compression index (Cc) (by 15.3%) in improved specimens. In final, heading fall permeability test result on specimens showed that PET waste plastic strip can growth drainage and water flow (Fig. 4).

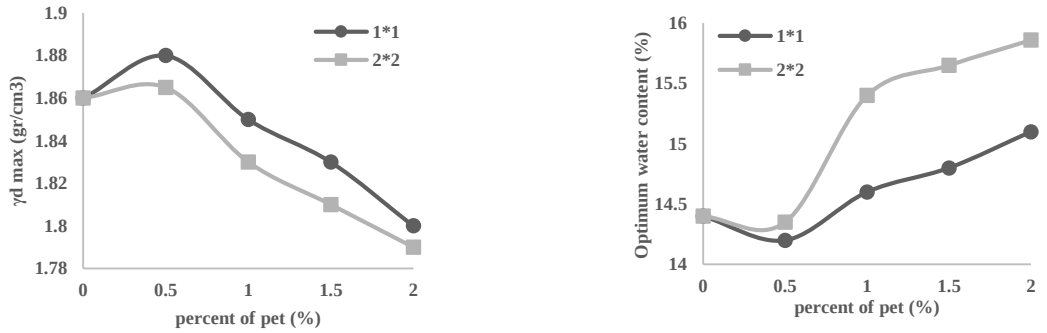


Fig. 3. Effects of PET waste plastic strip on compaction tests results: a) Maximum dry density, b) Optimum water content

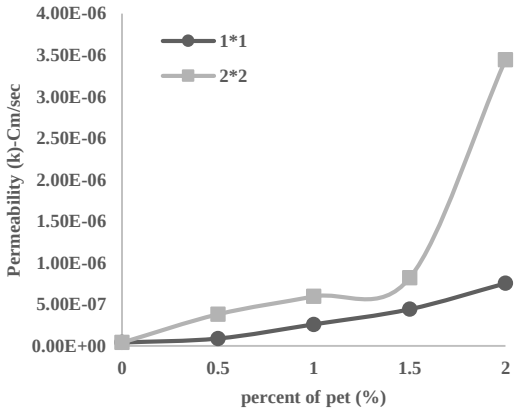


Fig. 4. Effects of PET waste plastic strip on permeability of improved specimens

4. Conclusions

In this research effects of flexible waste plastic strips (PET=Polyethylene Terephthalate) in different dimensions on mechanical and geotechnical behavior of fine-grained soil were studied. With considering to results mentioned above, it is explained that generally PET waste plastic strips are effective in geotechnical properties of fine-grained soil. Especially, in present study demonstrated strips with 1×1cm with 0.5% (by weight) content in fine-grained soil can cause improvement in soil from point of view bearing capacity, strength and swelling potential. Reasons of this behavior in mixed soil with regards to changes in minimum void ratios and skeleton and particle structures can be described. While, 0.5% PET waste plastic strips with 1×1cm added to fine-grained soil, minimum void ratio value than to unimproved condition 5.7% decreased. Therefore, with increasing contact between strips and soil particle bearing capacity and strength rise. Although, consolidation test on improved specimens illustrated that with increasing PET waste plastic strips more than 0.5%, soil compressibility coefficient go up. It means that, application of PET strips for soil improvement can have negative effects on bearing capacity of foundation and structures. In final, it proposed that type of plastic strip effects in terms of flexibility and rigidity on soil behavior under dynamic and static loading should be considered.

5. References

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