Iranian Journal of Engineering Geology
Summer 2024, Vol.17, No.2

Study the effects of Reinforced Sand by Tire Shreds on Sheet Pile

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Abstract

Excavation and also deep excavation is an important problem in geotechnical engineering projects in urban also non-urban fields. Using sheet piles is one method that is used in soft soils with high ground water level. So using steel sheet piles in soft sand soils, using different methods for rehabilitation and reinforcement of the soft soil is necessary. In this research, using the large direct shear test results based on previous laboratory tests performed on the sand reinforced by waste tire shreds, the characteristics of the mixture of sand and waste tire shreds with weight ratios of 15 and 30%, the behavior of the sheet pile wall with different heights, under the effects of increasing the depth of the reinforced layer in the backfill are performed. The steel sheet piles are analyzed with the PLAXIS finite element software. The numerical obtained results show that using sand reinforced with waste tire shreds in the backfill part of the sheet pile, instead of full height sand backfill, reduces the lateral displacement and the bending moment of the sheet pile and also the anchor force decreases. In this case, the settlement increases to a small amount. Also the results demonstrate that increasing the depth of the reinforced layer, when the entire backfill is reinforced with tire shreds, reduces the lateral displacement and bending moment of the sheet pile.

Keywords: *Sheet pile, Tire Shred, Bending moment, lateral displacement, settlement*

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Extended Abstract:

1. Introduction

Cecich et al. (1996) investigated using of rubber shards as lightweight materials for retaining wall embankments. The observed results showed an increase in the reliability coefficient and good performance of these materials as embankment materials. Amelsakhi (2001) investigated and found the optimal aspect ratio for different percentages of waste rubber in sandy soil by performing CBR and large direct cutting tests. In another software research, from the results of laboratory tests and the results of the parameters of shear strength of soil reinforced with worn tires shreds in the investigation of the settlement of the foundation on reinforced soil, these materials were discussed (Amelsakhi and Zamani, 2013). Ghazavi and Amelsakhi (2005) studied the effect of weight percentage and aspect ratio of waste tires on the shear strength parameters of sand mixed with rubber shreds by conducting large direct shear and CBR tests. The results showed that the mixture of sand and rubber shreds has better shear resistance than pure sand and the use of these materials increases the parameters of soil cohesion and the internal soil friction angle. In the research conducted by these researchers, the optimal aspect ratio for worn tires shreds was also obtained

2. Materials and methods

In this research, three different heights of 6, 9 and 12 meters have been considered for the sheet pile in order to investigate the effects of changing the thickness of the reinforced layer on different heights. The penetration depth of the shield for the 6, 9 and 12 meter walls was 2.5, 4.5 and 5.5 meters, respectively. The depth of the boundary of the numerical model is considered to be twice the height of the wall, from below the dredging line, and the width of the numerical model is considered to be eight times the height of the wall, and the sheet pile wall is located in the middle of the width of the model. These dimensions have been considered for all three different wall heights (6, 9 and 12 meters) which are investigated in this research. For a comprehensive review of the research, several walls with different heights have been examined so that the results can be generalized. It should be mentioned that the characteristics of the soils, whether reinforced with waste tire shreds or unreinforced soil, are used and cited based on the sources mentioned in the titles of the tables. As mentioned, the results of large direct cutting experiments have been used in the selection of soil parameters reinforced with tire chips.

3. Tests results

The results of various numerical analyzes carried out in this research show that when sand reinforced with rubber shreds is used in the upper third of the embankment, the deformations and forces created from the soil side to the embankment have insignificant changes. In other words, the results have shown that using of reinforced sand in only one third of the height behind the sheet pile did not have a large effect on the reduction of lateral forces. This important result can also be obtained from the examination of figures 1 and 2. In these diagrams, it can be seen that most of the displacement and the moments created in the sheet pile is related to the lower third of the sheet pile. Based on this numerical results, we can rely on the accuracy of the results obtained in this research.

4. Conclusion

A very important point in this research is that by increasing the thickness of the reinforced layer, so that the entire embankment is sand reinforced with waste rubber shreds, the lateral displacement and bending moment are reduced. It is important to note that using of these materials not only has no cost for the project, but also significantly reduces the environmental costs caused by this pollutant. Another point is that the presence of waste tire shreds in sandy soil, in addition to reinforcing the soil, has reduced the effective weight of the reinforced soil mass, which is also very effective in reducing the lateral pressures of the soil, so it will be economical and affordable in the design of guard structures, sheet piles and walls. Another important point to be mentioned in conclusion is the discussion of drainage behind the sheet piles.The presence of sand reinforced with waste rubber shreds provides the possibility of drainage and even makes it easier.

References:

Ahmadpour, B., Amelsakhi, M., Kamalian, M., 2018. "Study of Loose Soil Layer Effects on Excavations Supported by Steel Sheet Pile Walls-A Numerical Study," Journal of Engineering Geology, vol. 12, pp. 31-54.

Amelsakhi, M., “Influence of optimized tire shreds on strength of sand-reinforced with tire shreds”, 2001, In Partial Fulfillment of the Requirements the Degree of Master of Science, Faculty of Engineering, Isfahan University of Technology, Isfahan, Iran (in Persian).

Amelsakhi, M., Zaeri, F., 2011. “Numerical investigation of dynamic behavior of soil tire shred mixture”, Journal of Engineering Geology, 4(2). 1011-1030 (in Persian).

Amelsakhi, M., Zamani, M., 2013, “Settlement investigation of shallow foundation located on sand reinforced with tire shreds using pseudo-static analysis”, Bulletin of Earthquake Science and Engineering, 15(4), pp. 37-44 (in Persian).

Bilgin, Ö., 2010. "Numerical studies of anchored sheet pile wall behavior constructed in cut and fill conditions," Computers and Geotechnics, vol. 37(3), pp. 399-407.

Bilgin, Ö., 2022. "Effect of potential swell pressures on anchored sheet pile walls," International Journal of Geotechnical Engineering, pp. 1-10.

Cecich, V., Gonzales, L., Hoisaeter, A., Williams, J., Reddy, K., 1996. "Use of shredded tires as lightweight backfill material for retaining structures," Waste Management & Research, vol. 14(5), pp. 433-451.

Dammala, P. K., Sodom, B. R., Adapa, M. K., 2015. "Experimental investigation of applicability of sand tire chip mixtures as retaining wall backfill.," IFCEE, pp. 1420-1429.

Das, B. M., 2016. principles of foundation engineering 8thedn, United States: CENGAGE learning.

Day, R. A., Potts, D. M, 1993. "Modelling sheet pile retaining walls," Computers and Geotechnics, vol. 15(3), pp. 125-143.

Djadouni, H., Trouzine, H., Gomes Correia, A., Miranda, T. F. D. S., 2019. "2D numerical analysis of a cantilever retaining wall backfilled with sand–tire chips mixtures," European Journal of Environmental and Civil Engineering, vol. 25(6), pp. 1119-1135.

Emarah, D. A., Seleem, S. A., 2018. "A numerical study of anchored sheet piles subjected to different types of sandy soils backfill," HBRC journal, vol. 14(3), pp. 422-430.

Ghazavi, M., Amelsakhi, M., 2005. "Influence of optimized tire shreds on shear strength parameters of sand", International Journal of Geomechanics, vol. 5(1), pp. 58-65.

Ghazavi, M., Amelsakhi, M., 2005. "Optimization of aspect ratio of waste tire shreds in sand-shred mixtures using CBR tests", Geotechnical Testing Journal, vol. 28(6), 564-569.

Sabatini, P. J., Pass, D. G., & Bachus, R. C., 1999. Ground anchors and anchored systems (No. FHWA-IF-99-015), United States: Federal Highway Administration. Office of Bridge Technology.

Samadhiya, N. K., 2019. "Evaluation of model sheet pile wall adjacent to a strip footing–an experimental investigation.," International Journal of Geotechnical Engineering.

Singh, C. K., Chatterjee, A. P., 2020. "Lateral earth pressure and bending moment on sheet pile walls due to uniform surcharge," Geomechanics and Engineering, vol. 23(1), pp. 71-83.

Reddy, S. B., Krishna, A. M, 2015. "Recycled tire chips mixed with sand as lightweight backfill material in retaining wall applications: an experimental investigation," International Journal of Geosynthetics and Ground Engineering, vol. 1(4), pp. 1-11.