Iranian Journal of Engineering Geology
Spring 2020, Vol.13, No.1

Stabilization of a deep excavation using demolition and construction waste materials

A. Cheshomi[1], Z. Sabzi*[2], S. R. Ramezannejad [3]

Abstract

The increasing amount of demolition and construction waste (D&CW) materials has created many problems in large cities. Recycling waste materials helps to protect the environment. D&CW can be used in many projects, especially in road construction, retaining walls, landscaping and pavements. In this research, a project in which, D&CW used as fill materials to stabilize a deep excavation is investigated. The project site is located at the southwest of Tehran and the west of the Kan River. Site soil is basically composed of the C alluvium of Tehran. Strength parameters of soil were determined using recursive stability analysis. By performing an experimental embankment of D&CW (500 m length, 8 m width and 0.5 m height) and compacting it, in-situ density, plate load and dynamic probing tests were implemented and parameters of D&CW were obtained. Then stability analysis of excavation was performed under different conditions using Geo-Slope and the results showed that the D&CW embankment is capable to provide factor of safety. Finally, in order to control the quality of execution, according to the field observations, the guidelines were suggested to use D&CW. The results of this study show that D&CW can be significantly usable in engineering applications.

Keywords: *stabilization, deep excavation, embankment, demolition and construction waste, Geo-Slope*

1. Associate Professor, Department of Engineering Geology, School of Geology, College of Science, University of Tehran, Tehran, Iran.
2. Assistant Professor, Department of Civil Engineering; Islamic Azad University, Karaj Branch, Karaj, Iran, zahra.sabzi@kiau.ac.ir
3. Msc of Geology, Pars Geometry Probing consulting Engineering

*** Corresponding Author**

Extended Abstract:

1. Introduction

The increasing amount of demolition and construction waste (D&CW) materials has created many problems in large cities. D&CW is a product from demolition or renovation of structures and composed of concrete, bricks, wood, metals, plastics and etc. Recycling waste materials helps to protect the environment. D&CW can be used in many projects, especially in road construction, retaining walls, landscaping and pavements. Many experimental studies have been published in literature about using D&CW in civil engineering projects. The objective of this paper is to prove that the replacement of D&CW as aggregates in embankment walls with sufficient factor of safety.

2. Materials and methods

In this research, a project in which, D&CW used as fill materials to stabilize an open trench 70 m excavation is investigated. The project site is located at the southwest of Tehran and the west of the Kan River. Site soil is basically composed of the C alluvium of Tehran. These alluviums include limestone, gravel and sand which are highly cemented. Strength parameters of soil were obtained by triaxial test and adjusted by recursive stability analysis. Soil stiffness was determined by plate load test. Parameters of site soil is presented in Table 1.

Table 1. parameters of site soil

ν	E (MPa)	φ′ (deg)	C’ (kPa)	γ_{sat} (g/cm^3)
0.35	60-40	35	75	1.9

Prior to the performing of the main embankment to protect the trench, using an experimental embankment of D&CW (500 m length, 8 m width and 0.5 m height) and compacting it, in-situ density, plate load and dynamic probing tests were implemented and parameters of D&CW were obtained. Table 2 presents the proposed parameters of compacted D&CW materials.

Table 2. proposed parameters of D&CW materials

E (MPa)	φ′ (deg)	C’ (kPa)	γ_{sat} (g/cm^3)
70	34	7.5	1.8

3. Results and Conclusion

Stability analysis of trench was performed using Geo-Slope. The modelled sections were analysed under different conditions and the factor of safety for each analysis was obtained. Critical wedges of failure and safety factor were obtained under operating conditions (usual static mode for trench and embankment and tensile cracking occurrence and water filling cracking) and earthquake (quasi-static mode for trench and embankment) were investigated and determined. It was found that the embankment created by the 70 m width and the slope of 26.5 ° is capable of providing stability in different conditions.

Finally, in order to control the quality of execution, according to the field observations and experiences obtained during the project, the implementation guidelines were suggested to use D&CW materials as follows:

- Materials such as wood, plastics, fabrics and any other material that is decayed and destroyed over time should be separated. Because of their diminishing, it creates voids in embankment and changes the strength parameters. For this reason, it is necessary to remove deteriorated material during evacuation or distribution phase.
- D&CW materials need to be compacted to determine their maximum dry density and optimum moisture content in the laboratory. This process should be repeated periodically.
- Distribute the material in such a way that its thickness does not exceed 50 cm. For this purpose the material should be dumped by bulldozer and loader and distributed by grader.
- The fine content of the aggregate should not exceed 15%.
- Blocks larger than 30 cm should be removed from the layers. If there are tools for crushing large pieces, they can be used after crushing into pieces smaller than 30 cm.
- After dispersing the material, optimum moisture should be achieved and compaction is performed using vibrating rollers. The determination of the type of rollers and the number of passing in the project has been concluded using the experimental embankment in the D&CW materials.
- To protect the embankment from erosion, coarse-grained cover layer should be executed on the outer surface.
- The thickness of the soil layers should be controlled using a survey camera.

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