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Use of Industrial Wastes in Geotechnical Engineering

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ABSTRACT

The growing population of the world, which leads to increased production and consumption, result in an significent increase in solid wastes. This increase threatens environmental are human heath and harms the economics of countriesTo counteraction these negative outcomes, both the supply of wastes to the country's economy and the less use of natural resources can be considered. In this study, studies focus on the evaluation of industrial wastes in the geotechnical engineering are examined and discussed.

Keywords: Geotechnical Engineering; Industrial Waste; Recycling

1. Introduction

Solid wastes can be generally divided into domestic, commercial and industrial wastes. Generally, industrial wastes are demanded by manufacturers. Which are usually used in the field of construction due to its large amount of waste. In particular, wastes from iron, copper, zinc, gold and aluminum industries; bricks, fine and rough light aggregates and tiles, waste gypsum, lime mud, limestone waste, broken glass and ceramics, marble processing and kiln dust waste; block, brick, cement clinker, fibrous plasterboard, gypsum plaster and super sulphate cement (Pappu *et al*. 2007) are demanded. There are problems with the storage of wastes in a case of their abandonment to environment, they cause environmental and image pollution (**Figure 1**). Waste has been extensiely used in recent years, especially in road constructions. Consumption of quarry materials used on roads which result in the reduction. At the same time, there is an improvement in the utilitaion of waste materials in seating, permeability, swelling, and transport strength problems. In the USA, 82 million tons of thermal power plant waste and 188 million tons of waste tire are produced annually. For example, in Turkey 30% of 550,000 tons of produced marble would be a waste requiring the use of waste as a sustainable material (Görgülü 1994, Tuncan *et al*. 1998, Uyanık 2008). It is seen that environmental and human health, as well as the impact of the country's economy, are important in the use of these wastes increasing in the world as sustainable materials. We can define the concept of sustainability as the continuation of the function of the society, the ecosystem, or any system in progress, without consuming the main sources, for an indefinite future (Gilman 1992).

Some of the waste materials are in the form of dust and some of them are used as aggregate. Wastes are generally considered as aggregates in geotechnical engineering. Dust wastes generally contribute to the physical, mechanical and physico-chemical properties of the material by entering into a chemical reaction on fine-grained soils. In this way, the use of unsuitable materials and of waste are ensured. The changes in physico-chemical properties are actived clay soils with plus/minus loads. In this study, a general overview of the use of industrial wastes in geotechnical engineering has been discussed.

2. Effect of waste on geotechnical properties

In geotechnical engineering, soils have problems such as seating, swelling, permeability, and transportability. In order to ensure that these properties satisfy desired requirement, improvement works are usually carried out on these soils. Soil remediation is usually applied where inappropriate construction of engineering structures is required. Particularly problematic soils are clayey, peat and marsh areas. Large coarse grounds and the excess of void ratio cause large elastic settlement these soils. When such a situation is encountered, mechanical improvement is made to reduce

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(a) Wheel Waste

(b) Marble Waste

Figure 1; Waste storage**.**

the void ratio, increase the unit volume weight and increased strength. However, fine-grained soils have a high percentage of voids and cause them to settle if groundwater is near to the surface. In such a case, drainage and chemical improvement are applied. Chemical remediation fly ash, blast furnace slag, marble dust are usually provided by materials such as lime, cement, asphalt, or wastes. We can count the wastes used for chemical remediation. If large pieces of desired aggregate break while using, mix of dust wastes the soil is expected which enter the reaction. In this case, the issue of chemical remediation comes into play. The definition of soil improvement can be made entirely as time mechanical and chemical processes to reduce settlement, increase strength, and reduce swelling/shrinkage susceptibility of soils which do not have proper durability. Soil remediation methods can be categorized into dynamic mixing, vibroflotation, preloading, mixing of drains (sand or artificial) and additives. Many studies have been carried out the use of wastes, and as a result of improvements made with the additive material, they have generally been found to change soil properties.

Ural 2001 worked on the evaluation of the ceramic waste and waste dump sand in the design of an garbage storage area. Physical experiments on different mixtures have shown the ability to use wastes by performing the standard reaction, free pressure, permeability and leachet experiments. Zorluer 2003 stated that the use of waste marble dust on the ground reduces the potential for clay swelling. Güney and Koyuncu 2002 worked on the use of waste foundry sand in road sub-structures. Within the scope of the study, samples of casting sand, kaolin, crushed stone and cement were mixed with different ratios and samples were prepared. Standard Proctor test, free pressure, California bearing ratio (CBR), permeability and freeze-thaw experiments were carried out. At the end of the study, the researchers stated that appropriate additive materials and waste sand can be used easily in sub-structures. They also said that a certain amount of cement and lime additive could be used as a sub-base material with the addition of crushed stone. Özkan 2007 investigated the properties of mortars containing binder waste glass bottles and industrial by-products as binders. For this purpose, mortar specimens were produced by replacing the blast furnace slag with cement in various proportions. The highest result was obtained when 10% colorless glass-blast furnace slag displacement in pressure resistance. In other endurance tests, the reference results were high at all displacement rates.

Jauberthie *et al*. 2010 carried out CBR and unconfined pressure testing using lime and cement at different rates on a silt bed. Firstly, X-ray diffraction and semi-analysis were performed and then experiments were carried out on mixtures. At the end of the work, they stated that silt is a potential to be stabilized for use as a sub-base. Fırat *et al*. 2012 investigated fly ash, marble dust and waste sand as a potential alternative filling materials in the road sub-base. The amount of work soils was replaced with 0%, 5%, 10%, 15%, 20% of fly ash, marble dust and waste sand. They conducted Standard compaction, permeability, soaked CBR tests, X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) analysis. At the end of the work, they stated that that the fly ash, marble dust, and waste sand have a good effect. Kiran *et al*. 2014 studied improvements in the properties of clayey soil with fly ash and steel slag. By conduct of an Atterberg's limit, Compaction test and CBR test on admixture. They observed improvement in admixture with fly ash and steel slag. Jan *et al*. 2015 studied soil with different percent and sizes shredded rubber tire and the steel belting. Researchers carried out CBR test. Finally, they stated that with increased increased CBR value, total cost can be decreased. Chauhan *et al*. 2015 investigated utilization of cut waste plastic and glass in the soil a with different proportions. At the end of the work, they stated that improved the strength parameter of soil. Joe and Rajesh 2015 studied industrial wastes as an alternative to conventional aggregate materials for highway construction. This purpose was used waste sand copper slag, cement, and lime. They conducted specific gravity, sieve analysis, Proctor compaction test, unconfined compressive strength and CBR test. They stated that stabilization improves the strength behavior of sub-base and so can potentially reduce soil improvement costs. Fauzi *et al*. 2016 investigated the engineering properties on utilizing waste plastic high-density polyethylene and waste crushed glass as the additive on subgrade improvement. The researchers carried out physical properties, standard compaction, soaked CBR and triaxial test on some clayey soils. In addition, integrated electron microscope and energy-dispersive X-Ray spectroscopy (SEM-EDS) were conducted. At the end of the work, they said that engineering properties and CBR of stabilized soils were improved when the content of waste HDPE and glass were increased.

3. Conclusions

In this study, the use of marble wastes in geotechnical engineering has been examined and discussed. In many countries, industrial works are being carried out and waste arises as a result. With the demand of more beautiful and comfortable environmental, the case of wastes have increased in recent years. The progress of the technology naturally also leads to an increase in the amount of waste produced after production. Many studies have shown that the assessment of industrial wastes is appropriate to reduce storage problems improve the environment and human health. Thus, the contribution to the country's economy can't be denied, considering that the waste used in the construction sector, leads to the reduction of the raw materials and the decrease of the material transportation.

Conflict of Interest

No conflict of interest was reported by the author.

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