"Use of Waste Materials in Construction Work: Step Towards waste Minimization"

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ABSTRACT

Waste material has been defined as any type of material by product of human and industrial activity that has no lasting value. The re-use of waste materials is an essential step in creating a sustainable future, and research into the re-use of different byproducts has often led to new materials that provide superior service or greater economy than those traditionally used. Marginal soils, including loose sands, soft clays, and organics are not adequate materials for construction projects. These marginal soils do not possess valuable physical properties for construction applications. The current methods for remediation of these weak soils such as stone columns, vibro-compaction, etc. are typically expensive. Stabilization of soil with adding these waste materials are new & cheaper method of utilization. There are many method of waste management but recycling of them is one of the best methods of utilizing the waste material.

Keywords: - Fly Ash, MSW, Pavement, Recycling, RCA.

1. INTRODUCTION

Waste material has been defined as any type of material by product of human and industrial activity that has no lasting value. The growing quantities and types of waste materials, shortage of landfill spaces, and lack of natural earth materials highlight the urgency of finding innovative ways of recycling and reusing waste material additionally; recycling and subsequent reuse of waste materials can reduce the demand for natural resources, which can ultimately lead to a more sustainable environment. A sustainable construction has become a great concern over construction practice at the expense of the future of our planet. This is due to the fact that the construction industry is a massive consumer of natural resources and a huge waste producer as well High value of raw material consumption in the construction industry becomes one of the main factors that cause environmental damage and pollution to our mother earth and the depletion of natural and mineral resources. The resources such as coarse aggregates, sands and cements will be at a disadvantaged position, as these resources are not able to cope with the high demand in the construction industry .Therefore, utilizing the recycled aggregate may be one of the significant efforts in achieving a sustainable construction.

2. LITERATURE REVIEW

In recent years, the public and government have been major driving forces in promoting the recycling of waste products and materials. As a result, there has been a rapidly accelerating trend towards recycling agricultural, industrial, chemical, and domestic residuals by both private and public organizations. State highway agencies across the country are currently advocating incorporation of usable residual materials into the highway system wherever possible. The U.S. Environmental Protection Agency (EPA) estimates that the U.S. generates roughly 13 billion tons of non-hazardous waste each year. The potential use of nonhazardous solid waste in the construction of highways, roads, and bridges suggests that valuable benefits in terms of economic and environmental gains are possible. However, a major obstacle in the identification of possible application areas for waste materials is the lack of expertise in assessing non-hazardous materials for recycling and re-use among personnel of state and local highway agencies, construction contractors, and consultants. One possible solution to overcome this obstacle is the use of computer-assisted tools such as expert systems.

3. IMPORTANCE OF RECYCLED AND WASTE MATERIALS

3.1 Importance

- To minimizing waste and Saving of fossil fuels due to recycling,
- To Optimized use of available resources and reduced cost.
- Enhanced organizational performance, credibility and sustainability,
- Reduction of the usage of fresh raw materials.
- Preserving natural resources and Reduction of energy usage.
- Reduction of air, water and solid waste pollution.
- Reduce financial expenditure in the economy.

3.2 Benefits of Recycling

- ***Recycling Saves the Earth.*** Recycling different products will help the environment. For example, we know that paper comes from trees and many trees are being cut down just to produce paper. By recycling it, we can help lessen the number of trees that are cut down. Products made from raw materials that came from our natural resources should be recycled so that we can help preserve the environment.
- ***Recycling saves energy.*** It takes less energy to process recycled materials than to process virgin materials. For example, it takes a lot less energy to recycle paper than to create new paper from trees. The energy from transporting virgin materials from the source is also saved. Saving energy also has its own benefits like decreasing pollution. This creates less stress on own health and our economy.

- ***Recycling Helps Mitigate Global Warming and Reduce Pollution*** By saving energy in industrial production through recycling, the greenhouse gas emission from factories and industrial plants are lessened and the use of fuels that emit harmful gasses during production is also minimized.
- ***Recycling Reduces Waste Products in Landfill.*** Landfills are mostly composed of non-biodegradable waste which takes long time to decompose. By recycling, we can lessen the waste materials that are placed into landfills and we are able to make the most out of these materials. If we don't recycle, more and more garbage will go to landfills until they all get filled up. If that happens, where will the rubbish be placed? How would you like a land fill in your backyard?
- ***Recycling helps to save Money.*** Recycling provides ways to save money. Recyclable materials may be sell to organizations that are willing to buy it. Using products that are recycled lessens expenses. Products that are made from recycled materials are less expensive than products made from fresh materials.

3.3 Type of Waste Materials Used in Construction Work

For the current research, five materials were considered for beneficial reuse in soil stabilization applications. These materials included: municipal solid waste (MSW) incinerator ash, recycled glass, fly ash crumb rubber tires, and recycled crushed aggregates. In other words, these materials were mixed with soils and tested in order to determine whether or not the addition of the material enhanced the engineering properties of the soil itself.

3.3.1 Glass

Glass aggregate is a relatively new construction aggregate material. In general, glass aggregate is durable, strong, and easy to place and compact. This best practice presents typical geotechnical parameters for aggregate consisting of 100% glass as well as mixtures of glass and natural aggregate. The geotechnical parameters of cullet aggregate are largely dependent upon the percentage of glass content, gradation and compaction level, and to a lesser degree on the type or source of glass. The experience gained from construction and lab results indicate that moisture and debris content within reasonable ranges have a relatively minor effect on the geotechnical performance.

Recycled glass is a mixture of different colored glass particles and is often comprised of a wide range of debris (mainly paper, plastic, soil, metals, and food waste). The presence of different colored glass particles and diverse types of debris are the primary obstacles in reusing recycled glass in bottle production industries. Recycled glass particles are generally angular shaped and contain some flat and elongated particles. It is believed that the waste stream from which the glass particles have been produced controls the quality of the material, especially the amount of debris in the mixture. Recycled glass characteristics indicate that it is suitable to be used as a fill (backfill) material in structural and non-structural applications. Recycled glass on its own or in a mixture with natural or recycled aggregates (such as crushed rock and crushed concrete) can be used in a range of road work applications including sub base, embankments material and drainage media in roads. To improve the shear strength performance of recycled glass in case of its application in sub base layers of roads, measures such as mixing it with natural aggregate and also stabilizing the material with additives such as lime, cement or fly ash can be investigated.

Fig.1 Glass bottle with debris **Fig.2 Crushing of glass**

3.3.2 Scrap Tire

Due to the developing industry and growing population, huge amounts of tire wastes are produced. As the amounts increase, it becomes harder and more expensive to dispose them safely without threatening human health and environment.

Civil engineering applications for scrap tires include lightweight fill, conventional fill, retaining wall and bridge abutment, insulation layer and drainage applications. Construction of highways requires large volumes of construction material, so highway agencies are frequent participants in efforts to recycle and reuse waste materials. Proper utilization of waste and by-product materials in transportation applications requires experience and knowledge regarding the use of these materials.

Fig.3. Scrap tire

3.3.3 Municipal Solid Waste (MSW) Ash

MSW ash is a by-product that is produced as a result of burning municipal solid waste. There are two different types of facilities that produce MSW ash, mass burn and refuse derived fuel (RDF). Mass burn facilities basically incinerate all the waste entering in the waste stream.

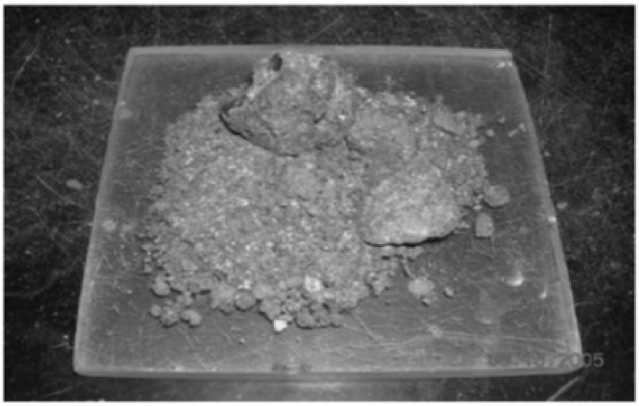

Fig.4 Municipal solid waste ash

Road pavement is a stratified, multi-layered structure consisting of a surface layer (made of bitumen or asphalt), a middle layer (base course and sub base) and the lowest layer (sub grade). MSW fly ash possible application in road pavement is as a substitute for sand and/or cement in cement stabilized bases and sub bases. Environmental issues related with this application are the contamination of the underlying soil and groundwater by substances leached from the road base.

3.3.4 Recycled Crushed Concrete Aggregates

Recycled concrete aggregate (RCA) or crushed concrete is produced from construction and demolition debris. Common projects that produce RCA include demolition of curbing and building slabs, concrete pavements, as well as concrete-block and reinforced-concrete structures. RCA is a material composed by nearly 60 to 75 percent of high quality, well graded aggregates bonded by a hardened cemented paste. RCA may include 10 to 30 percent sub-base soil materials removed with the concrete pavement or asphalt from the shoulder or composite pavement surface. The RCC used in this study is a zero slump soil–cement type mixture that is generally laid with a paver and compacted with a roller to an appropriate density. RCA use as a base and sub-base is more prevalent in the construction of city- and county jurisdiction roadways that typically have lower traffic volumes. Approval of these materials is also done on a case-by-case basis, with most local agencies requiring documentation of material properties and contaminant content prior to use in a new roadway.

3.3.5 Fly Ash

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately ignites, generating heat and producing a molten mineral residue. Boiler tubes extract heat from the boiler, cooling the flue gas and causing the molten mineral residue to harden and form ash. Coarse ash particles, referred to as bottom ash or slag, fall to the bottom of the combustion chamber, while the lighter fine ash particles, termed fly ash, remain suspended in the flue gas. Prior to exhausting the flue gas, fly ash is removed by particulate emission control devices, such as electrostatic precipitators or filter fabric bag houses. There are three types of fly ashes, namely, fly ash, bottom ash and pond ash. Fly ash and bottom ash when transported and disposed to the pond it is termed as pond ash. Fly ash is used in concrete admixtures to enhance the performance of concrete roads and bridges. Portland cement contains about 65 percent lime. Some of this lime becomes free and available during the hydration process. When fly ash is present with free lime, it reacts chemically to form additional cementitious materials, improving many of the properties of the concrete. Some of the advantages of fly ash in concrete are: provide higher ultimate strength, Improved workability, Reduced bleeding, Reduced heat of hydration, Reduced permeability, Increased resistance to sulphate attack Increased resistance to alkali-silica reactivity (ASR). Fly ash is an effective agent for chemical and/or mechanical stabilization of soils. The properties of soil which can be change by using of fly ash are density, water content, plasticity, strength and compressibility performance of soils, hydraulic conductivity, and so on. Typical applications include: soil stabilization, soil drying, and control of shrink-swell. Fly ash provides the following advantages when used to improve soil conditions:

- Eliminates need for expensive borrow materials.
- Expedites construction by improving excessively wet or unstable sub grade.
- By improving sub grade conditions, promotes cost savings through reduction in the required pavement thickness.
- Can reduce or eliminate the need for more expensive natural aggregates in the pavement cross-section.

4. CONCLUSIONS

The reuse of recycled materials in civil engineering applications is favorable because of the suitable engineering properties of the materials, the lower cost compared to traditional construction materials, and the fact that reusing these materials keeps them from being dumped into landfills. There are however, several issues and concerns that arise with the reusing waste materials. The biggest concerns probably are the environmental impacts associated with reusing these materials. A good majority of the materials showing potential for reuse come from industrial waste sources. A good majority of the materials showing potential for reuse come from industrial waste sources. These materials will typically have some environmental concerns associated with reusing them in civil engineering applications.

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