Study on Utilization of Waste and Recycled Materials

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Abstract:- *More production and construction equals more waste, more wastes create environmental concerns of toxic threats. A feasible solution to this problem is to reuse these waste materials, which reduces solid wastes which in turn minimizes the heavy burden on landfill spaces. Various research studies have been carried out to identify the potential waste and recycled materials that can be reused in place of conventional raw materials in construction. The construction industry, however, needs awareness regarding the benefits of using the waste and recycled materials and the methodology on how they can be used in different construction applications. This paper presents the study on the utilization of waste and recycled materials in different construction practices.*

Key Words: **Waste Materials**, **Recycled Materials, Construction Materials, Environmental Concerns, Natural Resources.**

1. INTRODUCTION

If disposal of a material is an expense, one naturally thinks of ways to turn it into something useful. The better way to dispose such materials that are otherwise useless, or nearly so, is to recycle them. Interest has been developed regarding this research area. Various types of recyclable materials are currently being used in civil engineering applications such as silica fume, fly ash, ground granulated blast furnace slag, steel slag, crushed glass, ground rubber tires, cement-kiln dust, crushed marbles, recycled concrete aggregates, rice husk ash, etc. Civil engineering applications require large volumes of materials and thus reutilization of potential waste and recycled materials in place of conventional raw materials proves beneficial as it reduces the demand for natural resources, which can ultimately lead to a more sustainable development, and expensive and potentially harmful waste disposal is also avoided.

The research study conducted by Begum *et al*. (2010) suggests that the adoption of prefabrication and Industrialized Building Systems (IBS) can reduce large volume of waste generation and various management problems in construction sector[5]. In addition to a reduction of the construction waste generation, Hassim (2009) identified and discussed the other advantages of applying prefabrication in the building and construction activities[8].

Malakahmad *et al*. (2010) suggested the implementation of Integrated Solid Waste Management (ISWM) systems which includes the selection and application of suitable techniques and technologies management programs as a means for achieving sustainable development. They concluded that one of the key element of this ISWM approach is the characterization of different solid wastes, which contributes to a more efficient and successful recycling program[1].

James *et al.* (2011) conducted a research to evaluate the feasibility of using recycled concrete aggregates (RCA) and fly ash (FA) in rigid pavements. Their research results showed no significant difference in strength as compared to concrete containing virgin aggregates, when only small amounts i.e. 25% of RCA and 15% of FA, were used in the study. Thus RCA and FA might be used in rigid pavements, promoting economical and environmental benefits[4].

Kumaran et al. (2008) investigated the feasibility of using waste tires in forms of chips and fibers in concrete to improve its strength. In their study, they outlined the use of rubberized concrete in different structural and non-structural members and also discussed their suitability for use in concrete, its uses, barriers and benefits and ways to further future studies in this area[2].

Hamoush *et al*. (2011) conducted research to investigate the techniques to manufacture an improved engineered stone with better physical and mechanical properties. Their research concluded that use of recycled crumb rubber reduces the material unit weight, enhances toughness and ductility and improves thermal resistance, thus providing a combined solution for energy saving and environmental concerns[7].

Kaosol (2010) conducted a research to increase the value of water treatment sludge from water treatment plants by making hollow load bearing concrete blocks. The research findings indicated that the production of hollow concrete blocks mixed with water treatment sludge waste could serve as a profitable and economical alternative for waste disposal in the future[9].

The main objective of the present study is to investigate the effective use of waste and recycled materials in various construction applications.

2. MATERIALS AND THEIR APPLICATIONS

a) Tire Rubber

The disposal of waste tire rubber is becoming a major environmental issue in all parts of the world causing a serious threat to the ecology. One of the feasible solution is to utilize this waste material is to incorporate it into different construction applications. Several research studies have shown that tire waste can be successfully used as aggregate replacement as well as cement replacement in the production of concrete[6]. This waste material can also be used in asphalt mix, grass turfs, embankments, stone claddings, flow able fills and clay composites.

b) Reclaimed Asphalt Pavement

Reclaimed Asphalt Pavement (RAP) is defined as the removed or reprocessed pavement materials containing asphalt and aggregates which is being used in transportation sector for many years. RAP is a useful alternative to virgin aggregates as it helps to reduce cost and environmental impacts of road construction. RAP can be used for backfilling of pavement edges, for construction of road bases and sub- bases.

c) Recycled Concrete Aggregate

The use of recycled concrete aggregate (RCA) in concrete as partial and full replacement of natural coarse aggregate is increasing nowadays as it reduces the demand for virgin aggregates. In addition, the use of RCA helps to reduce the negative environmental impact of the aggregate extraction from natural resources. The crushed aggregates can be used in construction industry for variety of applications such as for constructing gutters, pavements, building revetments etc. Production of RCA also results in generation of many by-products having many uses such as a ground improvement material, a concrete addition, an asphalt filler etc.

d) Glass

Glass is composed of silica or sand and contains some amounts of limestone and soda ash used to produce uniform quality and color. Colored glass may be used as an exposed aggregate to impart deep hues with brilliance. Therefore, the broken glass is found to be valuable for use in exposed aggregate concrete applications when used properly, but it is found to be insignificant for use in structural concrete. The secondary applications include the manufacture of fiber glass insulation, roadbed aggregates, driving safety reflective beads and decorative tiles.

e) Plastic

Recent studies showed that the polythene scrap can be used successfully as partial replacement for sand in concrete construction. Uses of recycled plastic in construction industry include plastic strips to add to the soil embankments which results in increasing the measured strength in reinforcement of soils. Also, it is found that recycled plastic products require minimal upkeep and repair.

f) Cement Kiln Dust

Cement Kiln Dust (CKD) is a byproduct obtained while manufacturing Portland cement. It is fine grained, highly alkaline waste, removed from the cement kiln exhaust gas by air pollution control devices. CKD may also be used in soil stabilization, wastewater treatment, waste remediation, low strength backfill, cement replacement and asphalt pavement and its usage minimizes work and cost.

g) Foundry Sand

Foundry sand is a byproduct of ferrous and non-ferrous metal castings. It is a high quality silica sand having uniform physical characteristics. Foundries successfully recycle and reuse the sand many times in a foundry and when it can no longer be reused in the foundry, it is removed from the foundry and is termed as waste foundry sand. This waste material can be used as aggregate replacement in asphalt mixtures, Portland cement concrete, source material for Portland cement, sand used in masonry mortar mixes, embankments, retaining walls, sub-base, flow able fills, barrier layers and hot mix asphalt mixtures.

h) Silica Fume

Silica fume or condensed silica fume is composed of ultrafine powder of silicon dioxide (SiO_2) produced during the manufacturing of silicon metals or ferrosilicon alloys by electric arc furnaces. The most important application of this waste material is in concrete production because of its pozzolanic properties. Silica fume improves the characteristics of both fresh and hardened concrete. It was also found that it also reduces the permeability of the concrete to chloride ions, thus protecting the steel reinforcement present in concrete from the harmful effects of corrosion. Thus, this waste material is found to be useful for construction of high strength structures, for structures built in chloride-rich environments like coastal regions, humid continental roadways, saltwater bridges, etc.

i) Fly Ash

Fly Ash is a finely divided residue powder produced from industrial plants that uses pulverized coal or lignite as fuel. In the past, fly ash was generally dispersed into the atmosphere thereby creating air pollution but later on various researches conducted on this waste material shows that it can be successfully used in concrete production, clinker production, brick construction, soil stabilization, waste stabilization, road sub base construction, agricultural field, as a mineral filler in asphaltic concrete construction, etc.

j) Slag

Slag is a glass-like by-product left over after a desired metal has been separated from its raw ore. Ground granulated slag is often used in concrete in combination with Portland cement as part of a blended cement and reacts with water to produce cementitious properties. The

research studies shows that concrete containing ground granulated slag shows reduced permeability and better durability characteristics. It is also found that concrete containing glass granulated slag is less vulnerable to alkali- silica and sulfate attack. Once scorned as useless, it is now recognized as a valuable material with many uses in agriculture, environmental applications and in the construction industry.

k) Sewage Sludge

Course solids and bio solids accumulated in the wastewater treatment processes must be treated and disposed of in a safe and effective manner that creates sewage sludge. The research studies have been conducted to find the effective usage of sewage sludge wastes in construction industry and it has been made evident from the reviewed literatures that the major application of waste sewage sludge is in construction of bricks while the least application is in the production of glass and ceramics. Sewage sludge ash, however, has been found useful in the production of concrete. Sewage sludge ash may also be used as a mineral filler substitute or as a portion of the fine aggregate in hot mix asphalt paving.

Thus, research study in this area regarding waste and recycled materials shows that their reuse of is very beneficial to society and also to the environment. **Figure 1** shows the benefits of using recycled materials[3].

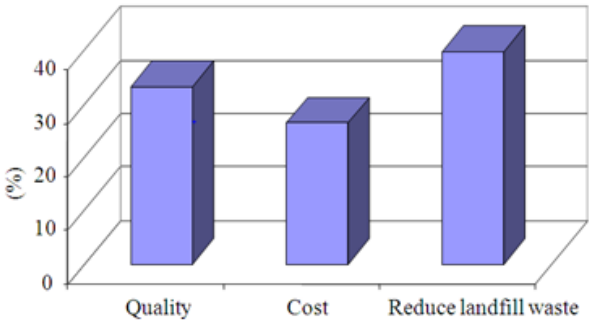

Fig -1: Benefits of using Recycled materials

3. CONCLUSION

Several research studies have indicated that the use of waste and recycled materials has positive impact through different aspects. This include the benefits in enhancing sustainability of the construction industry with reduction in cost, providing feasible solutions to environmental concerns and reduction in usage of raw materials thereby reducing the need for natural resources. The construction industry needs to be innovative in their use of recycled materials and reduce their dependency on raw materials. However, to make it possible, better documentation connecting considerable researches and construction industry with an overview of what recycled materials are available in nature and how they can be utilized in different construction applications, is required.

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