Use Of Recycled And Waste Material For Sustainable Construction- A Review

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ABSTRACT: The main objective of this study is to investigate the potential use of various recycled and wastes for producing materials for Construction. More production equals more waste, more waste creates environmental threat. An economical viable solution to this problem should include utilization of waste materials for new products which in turn minimize the heavy burden on the nation's landfills. Recycling of waste construction materials saves natural resources, saves energy, reduces solid waste, reduces air and water pollutants and reduces greenhouse gases. The construction industry can start being aware of and take advantage of the benefits of using waste and recycled materials. This paper discusses the environmental implications caused by the generation of various solid wastes, and highlights their recycling potentials and possible use for producing construction materials. This paper generally deals with the use of recycled and other waste materials in the construction and their different application in the field of construction.

KEY WORDS: Recycled material, Environment, Construction Material, Sustainable.

INTRODUCTION:

The waste materials that are commonly known are blast furnace slag, fly ash, silica fume (from Power Plants) recycled aggregates (from Demolition sites), solid waste, plastic waste (Domestic waste) and rubber waste (commercial waste).

India alone generate more than 1,00,000 metric tonnes of solid waste every day, which is higher than many countries' total daily waste generation taken together, Several issues exist regarding reducing waste. A key environmental issue is waste incinerators, furnaces for burning trash, garbage and ashes. These incinerators produce 210 different dioxin compounds plus mercury, cadmium, nitrous oxide, hydrogen chloride, sulfuric acid and fluorides. This is damaging the environment due to continuous exploration and depletion of natural resources. Produced also in incinerators is particulate matter that is small enough to remain permanently in the lungs.

As the problem of disposing these waste materials became a big environmental problem, the proper utilization of these materials again in construction activities will be a great relief to the society. The output of these waste materials in India are more than double the production of cement and other construction material used in all the civil engineering activities. Some of the important elements in this respect are the reduction of the consumption of energy and natural raw materials, systematic consumption and use of waste materials to a great extent. Research & Development activities have been taken up even in India for proving its feasibility, economic viability and cost effectiveness for the use of waste materials in all the construction activities.

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 06
May 2017

Table 1. Different types and sources of solid wastes and their recycling and utilization potentials for construction materials (adapted from Pappu et al., 2007).

S/No.	Type of solid wastes	Source details	Recycling and utilization potentials
1.	Agro-waste (organic)	Baggage, rice and wheat straw and husk, saw mill waste, ground nut shell, jute, sisal, cotton stalk, vegetable residues	Cement boards, particle boards, insulation boards, wall panels, roof sheets, binder, fibrous building panels, bricks, acid-proof cement, coir fiber, reinforced composites, and polymer composites.
2.	Industrial waste (inorganic)	Coal combustion residues, steel slag, bauxite red mud, construction debris.	Bricks, blocks, tiles, cement, paint, fine and coarse aggregates, concrete, wood Substitute products, ceramic products.
3.	Mining/mineral waste	Coal washeries waste; mining waste tailing from iron, copper, zinc, gold and aluminium industries	Bricks, fine and coarse lightweight aggregates, tiles
4.	Non hazardous waste	Waste gypsum, lime sludge, lime stone waste, broken glass and ceramics, marble processing residues, kiln dust	Blocks, bricks, cement clinker, hydraulic binder, fibrous gypsum boards, gypsum plaster, super-sulfated cement
5.	Hazardous waste	Contaminated blasting materials, galvanizing waste, metallurgical residues, sludge from waste water and waste treatment plants, tannery waste.	Boards, bricks, cement, ceramics, tiles

WASTES AND THEIR USE IN CONSTRUCTION MATERIALS:

Growth of population, increasing urbanization, and rising standards of living due to technological innovations have contributed to increase the quantity of a variety of wastes generated by industrial, mining, domestic and agricultural activities. Different types and sources of solid wastes are shown in Table 1.

There is a growing awareness even in India about extensive damage being caused to the environment due to accumulation of waste materials from industrial plants, power houses, colliery pits and demolition sites. Use of waste products is not only a partial solution to environmental and ecological problems; it significantly improves the microstructure, and consequently the properties of concrete. Because of the above factors, there is a need and increasing demand for better understanding the behavior of waste material properties as well as better control of the microstructure developing in the construction material, to increase the durability. Following are some waste material with common use in construction activity.

Plastic:

In 2010, plastic waste generated approximately 31 million tons, representing 12.4% of total Municipal Solid Waste. Uses of recycled plastic in the construction industry include plastic strips to add to soil embankments, which has positive results of increasing the measured strength in reinforcement of soils. HMA mixture has a higher stability, reduced pavement deformation; increase fatigue resistance and provide better adhesion between the asphalt and the aggregate (Awwad and Shbeeb, 2007).

Malagavelli and Paturu (2011) carried out an experimental investigation on the performance of the concrete using solid waste fibers and found that the increase in the load carrying capacity of concrete. It was further reported that the maximum 2% of fibres could be used for strength purpose and that up to 6%, for disposal purpose.

Rubber Waste:

An estimated number of one billion scrap tires have been disposed of in huge piles across the United States. An additional 250 million tires unaccounted for are discarded yearly (RMA, 2011). Whole tires have been used in artificial reefs, break waters, dock bumpers, soil erosion control mats and play ground equipment.

Several investigations were carried out on the use of scrap tire particles in portland cement concrete. The processed rubber tires were used to replace fine and coarse aggregates depending on the fineness of particles (Li et al., 1998). As concrete has become the most widely used construction material, the incorporation of rubber tire particles in concrete would be a very good and promising way to utilize the large quantities of waste rubber. The use of scrap rubber tire particles in concrete would not only make a good use of such waste materials but also help to improve some concrete properties. The rubberized concrete shows excellent flexibility, ductility and energy absorbency as compared with conventional concrete (Li et al., 1998; Topcu, 1995).

Construction and demolition debris:

Huge quantity of construction and demolition (C&D) debris is produced during the construction and development works. As the construction industry grows, it generates more and more C&D debris, which create a major portion of solid wastes. The amount and type of C&D debris depend on many factors such as the stage of construction, type of construction work, and nature of construction practice on site. Most of the C&D debris are generally disposed of in landfills or openly dumped into uncontrolled waste pits and open areas (Rao et al.,2007).

The processed concrete rubble is now well-known as recycled concrete aggregate (RCA). It can be utilized in producing concrete (Collins, 1994). RCA can also be used in road and airport pavement constructions (GTAA, 2007; Sherwood, 1995).also these aggregates can be re-used in all the construction activities with some % of volume of construction, in order to have the same mechanical properties of hardened concrete, without disposing these waste materials in to the environment.

Waste glass:

Glass is composed of silica or sand and contains some amounts of limestone and soda ash used to produce uniform quality and color.

Glass cullet creates workability problems in concrete mix and the likely hood of alkali-silica reaction. Beneficial uses are in the secondary applications, such as in the manufacture of fiberglass insulation, roadbed aggregate, driving safety reflective beads and decorative tile. Demir (2009) investigated the effect of waste glass addition on the properties of fired clay brick. The compressive strength of the fired samples was significantly improved by the addition of waste glass. The amorphous nature of waste glass particles enhances the sintering action, which leads to achieving a better strength in bricks (Demir, 2009).

A clean dry glass powder is useful as a substitute for portland cement in concrete. The finely ground glass having a particle size finer than 38 μm contain a high amount of amorphous silica, which exhibits a pozzolanic behavior (Shao et al., 2000).

Slag:

The blast furnace slag is the by-product obtained during the process of manufacturing of steel that mainly consists of about 35% calcium oxide. The nonmetallic waste that develops simultaneously with iron in a blast furnace consists essentially of silicates and alumina silicates of calcium and other bases. At present, a fairly large

quantity of granulated blast-furnace slag is being consumed in the manufacture of portland slag and supersulfated cements (Malhotra and Tehri, 1996). The use of ground granulated blast-furnace slag with cement improves the microstructure, final strength, and durability of hardened concrete (Aitcin and Laplante, 1992;Malhotra, 1987). Moreover, the research carried out using small briquettes (Malhotra and Tehri, 1993) revealed that good quality bricks can be produced by pressing the slag-lime mixture (Malhotra and Dave, 1992) at sufficiently low pressure.

Fly Ash:

Fly Ash (FA) is the by-product of coal combustion in power generation. Coal provides more than half of the nation's electricity and continues to be the fuel of choice for generating power. Fly Ash is a powdery substance laced with heavy metals such as arsenic, mercury and lead. Ramesh et al. (2003) reported that the replacement of cement with high volume fly ash up to 20% has been in practice for several years for durability and economy for concrete roads. Basak et al. (2004) indicated in their studies that the part replacement of cement with fly ash is accepted and pointed out further that approximately 25% of the volume of cement of actual consumption is expected to be saved; thereby 15% of cost of construction could be saved if fly ash is collected properly.

Organic fibers:

Organic fibers can be produced from a number of solid wastes such as bamboo, coconut, date palm, oil palm, sugar palm, sugarcane, and vegetable wastes. Some of these fibers are chemically more inert than either steel and glass fibers. They are also cheaper and more importantly most of them can be natural.

Bamboo fibers can be extracted from the bamboo wastes. This kind of fibers is useful to produce polymeric composites such as bamboo fiber reinforced plastic and polyester composites (Jain and Kumar, 1994; Deshpande et al., 2000).

Coconut fibers can be used with portland cement to manufacture fiber-cement board. In a recent research, coconut fibers were used in reinforced concrete beam along with rice husk and sugarcane waste fibers (Sivaraja and Kandasamy, 2009).

USE OF WASTE MATERIALS IN REAL CONSTRUCTION:

Significant studies have been conducted on the development of new construction materials using different kinds of waste materials. However, the application of these construction materials in real construction is limited. More research is needed to study the actual behavior or performance of solid waste based construction materials under field conditions to encourage their practical applications.

CONCLUDING REMARKS:

During different industrial, mining, agricultural and domestic activities, huge quantity of solid wastes are being generated as by-products, which pose major environmental problems as well as occupy a large area of lands for their storage/disposal. There is a tremendous scope for setting up secondary industries for recycling and using such huge quantity of solid wastes as minerals or resources in the production of construction materials.

Review of several studies suggested that the use of recycled materials has positive impact through different aspects. This include the benefits in enhancing sustainability of the construction industry while reducing cost, providing solutions to environmental pollution and reducing the need for natural resources. A maximum use of waste materials may be applied to businesses, communities, industrial sectors, schools and homes. Also the utilization of waste materials like solid waste, hazardous waste will protect the environment and lead to a much more productive, efficient, and sustainable future.

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