Assessing the Role of Waste Materials in Construction Industry May Prevent Natural Disaster.

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Abstract

The aim of the present paper is generalizing the vital issue about growing of waste materials and their disposal globally. For the last couple of decades, it is being observed that due to the swift growth of industries worldwide (or rapid industrialization) there is huge quantity of waste generated. Fast-growing, developing country like India, where sector wise industrial development is at peak, is experiencing the problem of waste material from various sources. The safe disposal of the waste material which is classified as 'a hazardous waste' is essential for the protection of the environment and maintaining the ecological balance. At the same time, it has been observed that the using of huge quantity of natural materials in civil engineering construction (CEC) Industry increases the frequency of natural disaster. In this circumstances we can replace the natural materials with industrial waste is being safely recycled and utilized. Indeed, the wide variety of waste components available can be used as extensively as construction material. Therefore, varying degrees of these wastes may be mixed with cement, sand, tar, granulates and clay to obtain cement, mortar, bitumen, bricks, geopolymers, lightweight materials, etc. For utilization of wastes in civil engineering construction industry, we are in need to use innovative techniques especially for safe disposal of hazardous wastes for protection of our environment.

Key words: CEC, Fly Ash, Hazardous Waste

Introduction

Waste taken into account for the above purpose include fractions separated from municipal solid waste streams (e.g. glass, paper, plastic), residues from thermal treatment (fly ash, bottom ash, exhausted sands from fluidised bed incinerators) and special wastes (scrap tyres, C & D waste, WEEE, sludges) at times classified as hazardous waste. The characteristics of the above-mentioned wastes indicate their suitability to carry out specific functions in the preparation of various products applied in the construction of roads, bridges, buildings and other civil engineering works. The recycling of waste in construction materials implies a significant reduction in amounts destined to disposal by landfilling, which enhances the achievement of recycling rates established by law, leads to a reduction in the use of non-renewable resources, promotes closure of the material cycle with immobilization of elements (particularly heavy metals) that would otherwise have been available to the environment and produces a positive outcome on climatic change both by acting as a carbon sink and through a lower consumption of fossil fuels. Additionally, in several socio-geographical situations, conventional building materials may prove to be too expensive and insufficient to face the worldwide growing need for housing development. Accordingly, the use of waste as alternative material may help to meet the above shortage. Suitable wastes may be derived from the selection and treatment of municipal solid wastes or special wastes, or from industrial processes (coal ash, foundry sand, blast furnace slags, etc.).The mixing of wastes with inert fractions to produce construction materials should be undertaken to improve functionality rather than merely to dilute wastes. Only in this way will an effective waste recycling be achieved. The materials produced must necessarily comply with technical construction (resistance, compression, etc.) and environmental requirements. "Some natural disaster has been caused by unplanned development. It is the result of mindless misuse of the state's natural resources. The dams, barrages and tunnels built in the name of hydel projects have influenced the course of the rivers, which led to the tragedy consequently; we are in need of advanced material technology for using the waste materials in CEC Industry without any harmful adverse effects on our civil engineering structures. Therefore, papers dealing with the alternative use of waste in building materials involve numerous areas of scientific interest and technological applications representing two distinct fields: the field of waste management and environmental protection and the field of material science and building materials. In the light of the above, we can safe our natural materials, which will otherwise be used in civil engineering construction and causes natural disaster.

Key building materials in CEC industry

Limestone

Limestone is perhaps the most prevalent building material obtained through mining. It is used as a cladding material and plays an important role in the production of a wide range of building products. Concrete and plaster are obvious examples of products that rely on limestone; less obvious is the use of limestone in steel and glass production. An abundant natural resource, limestone is found throughout the world. In the U.S., the states of Pennsylvania, Illinois, Florida, and Ohio are the largest producers [1]. Most limestone is crushed at the quarry, then converted to lime, by burning, at another location. The burning of limestone creates sulfide emissions, a major contributor to acid rain. Limestone (primarily calcium carbonate) is converted to quicklime (calcium oxide) through prolonged exposure to high heat. This removes water and carbon from the stone and releases carbon dioxide into the atmosphere.

Steel

Steel requires the mining of iron ore, coal, limestone, magnesium, and other trace elements. To produce steel, iron must first be refined from raw ore. The iron ore, together with limestone and coke (heat-distilled coal) are loaded into a blast furnace. Hot air and flames are used to melt the materials into pig iron, with the impurities (slag) floating to the top of the molten metal. Steel is produced by controlling the amount of carbon in iron through further smelting. Limestone and magnesium are added to remove oxygen and make the steel stronger. A maximum carbon content of 2% is desired. Other metals are also commonly added at this stage, to produce various steel alloys. These metals include magnesium, chromium, and nickel, which are relatively rare and difficult to extract from the earth's crust. The molten steel is either molded directly into usable shapes or milled.

Aluminum

Aluminum, derived from bauxite ore, requires a large amount of raw material to produce a small amount of final product. Up to six pounds of ore may be required to yield one pound of aluminum. Bauxite is generally strip-mined in tropical rainforests, a process that requires removing vegetation and topsoil from large areas of land. When mining is completed, the soil is replaced. The land may then be allowed to return to rainforest, but is more likely to be used as farmland. Aluminum manufacturing is a large consumer of electricity, which in turn comes from burning fossil fuels. The refined bauxite is mixed with caustic soda and heated in a kiln, to create aluminum oxide. This white powder, in turn, must undergo an electrolytic reaction, where direct electrical current is used to separate out the oxides and smelt the material into aluminum. The material must be heated to almost 3000°F for this process to occur. The processing of bauxite into aluminum results in large quantities of waste (called "mud") that contain traces of heavy metals and other hazardous substances.

Bricks and Tile

Clay and adobe soil must also be mined. They are usually found in shallow surface deposits, and manufacturing is often done nearby, reducing extraction and transportation costs. With the exception of adobe, bricks and tiles must be fired to be useful building materials. The firing process exposes the formed clay to high, prolonged heat, producing a hard, waterproof, permanent brick or tile. The firing process can take hours or even days and requires a large amount of energy. Glazed bricks and tiles are fired twice: first to make the shape permanent and then to melt and adhere the glazed finish, which usually contains glass. The product has much embodied energy but is also very long lasting. Even without firing, properly maintained adobe bricks can last 350 years or more.

Petrochemicals

The building industry is highly dependent on materials derived from petroleum and natural gas. These are used in a wide range of products including plastics, adhesives for plywood and particleboard, laminated countertops, insulation, carpeting, and paints. Drilling for oil and gas is both hazardous and expensive. Heavy machinery is required, and contamination of the groundwater and soil is common.

Wood

Wood is the harvested material most commonly used in buildings and building products. Dimensional lumber is used in framing the majority of residential buildings and many commercial structures. Wood products such as plywood, particleboard, and paper are used extensively throughout the construction industry. The reasons behind most deforestation are many each cause is equally as bad. Wood is cut down for furniture and fuels. Firewood and coal are things made from wood, which are used for cooking/heating etc. Loggers have a great role in deforestation, illegal and legal. Loggers cut down the trees for more space and wood for anything whatsoever! The reason behind is the metro cities are becoming bigger and bigger day by day. The people from villages are coming to big cities because they are not getting the facilities in the villages, which they need. So to make houses the trees are been cutting down, so to make houses, malls, cinemas etc. for the people.

Utilization of waste in CES industry

Flyash

The different types of industrial waste directly or indirectly used by Civil engineering construction industry. Now-a-days utilization of fly ash is a very common waste material in CEC industry. Due to industrialization and rapid economic growth, demand for electricity has been rise tremendously. To meet this demand, a number of coal based thermal power plants have been set up. The aftermath of thermal power plants is the production of Fly ash as waste material, whose disposal is a big problem. At present, in India thermal power plants produce about 112 million tons of Fly ash per annum and hardly 13 percent of it is utilized. Fly ash causes environmental pollution, creates health hazards and requires large areas of precious land for disposal. Due to ever increasing population and industrialization, need of electricity has increased many fold which has led to installation the number of thermal power projects, raising concerns over environmental pollution. The bulk of Fly ash generated is the one which is collected in the ponds by using water as a carrier in the form of slurry, called as pond ash, the utilization of pond ash is possible in the field of civil-engineering especially in construction of road embankments in place of borrowed earth which are scarce and expensive. Moreover, many power plants are situated in urban areas and therefore Fly ash can provide an environmentally viable alternative to borrowed earth. Large number of innovative alternate building materials and low cost construction techniques developed through intensive research efforts during last three to four decades satisfies functional as well as specification requirements of conventional materials/techniques and provide an avenue for bringing down the construction cost.

Table.1 Utilization of fly ash in different sector

S. No.	Utilization	Fly Ash Consumption (in Million Tonne / year)	Savings per year (Rs. in Crore.)
1	Cement production	25	2500
2	Road and embankments	15-20	100
3	Minefills	15-20	150
4	Bricks	5	20
5	Agriculture	200	3000
Total		5770≈1.2 billion US$	

Fly Ash Based Innovative & Commonly Produced Building Product in India

Some of the innovative and commonly manufactured eco friendly building material utilizing Fly Ash.

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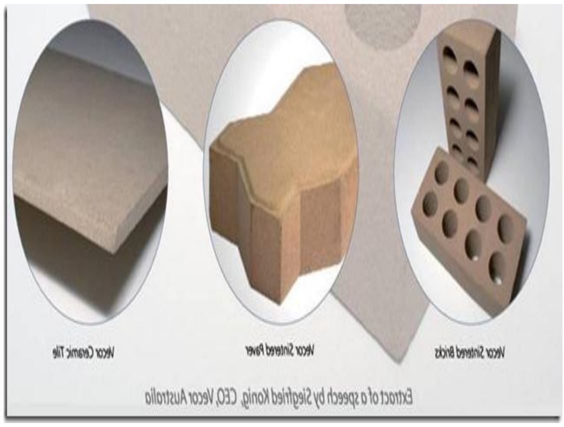

Fig.1 Cellular Light Weight Concrete (CLC) Blocks
Fig.2 Ready mixed Fly Ash concrete

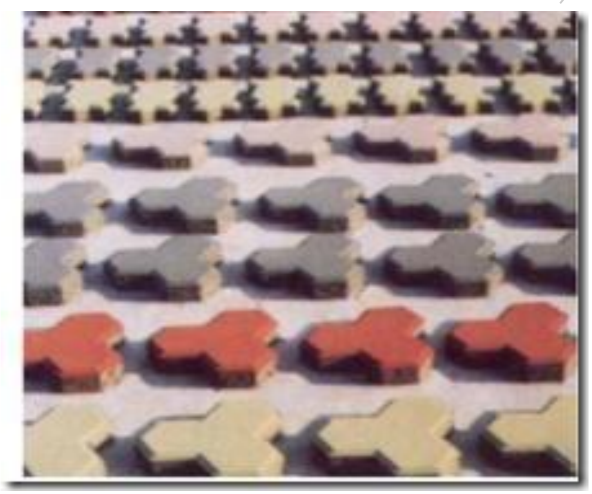

Fig.3 Fly Ash- Sand-Lime-(Gypsum /Cement) Bricks

/Blocks Fig.4 Asphalt concrete

Fig.5 Portland Pozzolana Cement (Fly Ash based)
Fig.6 Roller compacted concrete

Used of Slag

Granulated blast-furnace slag Blast-furnace slag is obtained during the manufacture of iron and steel, and possesses inherent hydraulic properties. It can be utilized for making different types of construction materials. Some of the construction materials such as portland slag cement (Chopra and Tanjea, 1966) and super-sulfated cement (Chopra and Lal, 1961) are produced in India as well as in many industrial advanced countries. At present, a large quantity of granulated blast-furnace slag is being consumed in the manufacture of Portland slag and super-sulfated 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. The manufacturing process is quite simple as it does not require firing or autoclaving. Yet significant strength is obtained by humid curing. Malhotra and Tehri (1996) conducted an experiment and observed that good quality bricks can be produced from the stipulated proportions of slag-lime mixture and sand without needing any firing or autoclaving, and specialized plant or machinery, thus saving energy and solving the problem of environmental degradation [2].

Construction and demolition debris

Construction and demolition (C&D) debris is produced during new construction, renovation, and demolition of buildings and structures. C&D debris includes bricks, concrete, masonry, soil, rocks, lumber, paving materials, shingles, glass, plastics, aluminum (including siding), steel, drywall, insulation, asphalt roofing materials, electrical materials, plumbing fixtures, vinyl siding, corrugated cardboard, and tree stumps. In 1996, the U.S. produced an estimated 136 million tons of building related C&D debris. This estimate excludes road, bridge, and land-clearing materials, which can be a significant portion of total C&D materials discarded. C&D materials can be recovered through reuse and recycling. In order for materials to be reusable, contractors generally must remove them intact (windows and frames, plumbing fixtures, floor and ceiling tiles) or in large pieces (drywall, lumber). Some materials may require additional labor before they can be reused. For example, lumber may need to be denailed and window frames may need some new panes. In order to be recyclable, materials must be separated from contaminants (e.g., trash, nails, and broken glass). This can be accomplished if contractors require workers to sort materials as they remove items from buildings or as debris is produced. Many contractors simply use labeled roll-off bins for storage of source-separated materials. For projects where on-site source separation is not possible, contractors often use C&D materials processing firms. Benefits of recovering construction and demolition materials. [3]

- Reduces the environmental effects of extraction, transportation, and processing of raw materials.
- Reduces project costs through avoided disposal costs, avoided purchases of new materials, revenue earned from materials sales, and tax breaks gained for donations.
- Helps communities, contractors, and/or building owners comply with state and local policies, such as disposal bans and recycling goals.
- Enhances the public image of companies and organizations that reduce disposal.
- Conserves space in existing landfills.

Use of Non-Toxic or Less-Toxic Materials

Non- or less-toxic materials are less hazardous to construction workers and a building's occupants. Many materials adversely affect indoor air quality and expose occupants to health hazards. Some building materials, such as adhesives, emit dangerous fumes for only a short time during and after installation; others can contribute to air quality problems throughout a building's life. Air Quality and Reduced Toxicity: The rush to make buildings airtight in the wake of the 1970s oil crises created a new health problem "sick building syndrome." This occurs when natural or artificial ventilation is inadequate to remove odors and chemicals emitted by certain building materials. These substances may be hazardous, even carcinogenic. The resins in plywood, particleboard, and the chemicals used in foam insulation have been implicated in sick building syndrome. Formaldehyde, benzene, ammonia, and other hazardous or cancer-causing chemicals are present in many building materials, furnishings, and cleaning solutions. Previously, the infiltration rate of outside air through the gaps and cracks in a building's envelope compensated for contamination of the inside air by human respiration, bacteria or molds, and material emissions. The problem of indoor air contamination is magnified by the increasing airtightness of buildings. Super-insulating buildings in attempts to conserve energy has caused reduced air infiltration, meaning occupants are exposed to higher concentrations of toxins for longer time periods. The health effects of these toxins must be considered when selecting materials and calculating air exchange rates. By selecting materials with lower or nonexistent levels of these materials, environmental health problems can be avoided and the need for expensive air scrubbers reduced. Material toxicity is of increasing concern with the growing number of building products containing petroleum distillates. These chemicals, known as volatile organic compounds (VOCs) can continue to be emitted into the air long after the materials containing them are installed. The severity of this process, called "outgassing," is dependent on the chemicals involved, rate emission, concentration in the air, and length of exposure. Many adhesives, paints, sealants, cleaners, and other common products contain VOCs. Often, the substances are only exposed for a short time during and after installation; the outgassing diminishes drastically or completely once the offending materials have cured or been covered by other building materials. Therefore, higher air cycling rates are recommended during installation of these materials and for several months following building occupation.

Pollution and hazardous substances in the natural and built environment

Around half of all non-renewable resources mankind consumes are used in construction, making it one of the least sustainable industries in the world. However, mankind has spent the majority of its existence trying to manipulate the natural environment to better suit its needs so today our daily lives are carried out in and on constructions of one sort or another: we live in houses, we travel on roads, we work and socialise in buildings of all kinds. Contemporary human civilization depends on buildings and what they contain for its continued existence, and yet our planet cannot support the current level of resource consumption associated with them.

Table.2 Estimate of global resources used in buildings [4]

Resource	(%)
Energy	45-50
Water	50
Materials for buildings and roads (by bulk)	60
Agriculture land loss to buildings	80
Timber products for construction	60 (90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction	25(indirect)

Table.3 Estimate of global pollution that can be attributed to buildings [5]

Pollution	(%)
Air quality (cities)	23
Climate change gases	50
Drinking water pollution	40
Landfill waste	50
Ozone depletion	50

Conclusion

CEC Industry utilizing the Fly ash and other waste materials but only the utilization of waste materials is not enough for the protection of environment safe and effective disposal of waste materials is needed. In this way, we looked-for Innovative Techniques for safe disposal of Waste Materials in (CEC) Industry. 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. Fly Ash has become an important raw material for various industrial and construction applications. It is widely used in manufacturing of bricks, cement, asbestos-cement products and roads/embankments. In order to maximize the use of alternative construction materials produced from different types of solid waste and to make the lab-based production processes feasible in real world, the

Good mechanical and durability performance of the newer products dissemination of technologies emphasizing cost-benefit analysis, and feasibility assessment report will significantly contribute to the successful commercialization of the innovative processes. The alternative construction materials obtained from industrial, agro-industrial and mining solid wastes have ample scope for introducing new building components that will reduce the cost of construction to some extent. Utilization of waste as a construction materials also save our natural materials otherwise be used in construction and disturb our ecological balance. Therefore, the entrepreneurs and construction agencies must be encouraged to develop new products and processes using the solid wastes as raw materials, thus paving the innovative way for setting up secondary industries.

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