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Innovative construction with solid waste materials_ A Sustainable approach towards waste management

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Abstract: **- Urban areas have been recognized as "engines of inclusive economic growth" as it brings with itself enormous opportunities. Urbanisation also creates various challenges. In India urbanisation is taking place at a faster rate. Along with several opportunities this rapid urbanisation has also created great challenges especially the environmental issues. One among them is solid waste management. This paper aims to focus on the present trend of solid waste generation in India through different sources like domestic, industries and from construction site waste generation and most of these waste goes to the dumping sites with very less utilization and reuse of the same. Recycling which is regarded as the third most preferred waste disposal option, with its numerous environmental benefits, stand as a viable option to offset the environmental impact associated with the construction industry. The paper aims to highlight the possible ways of recycling and compilation of different methods of utilizing these solid waste in to building industry**

INTRODUCTION

Rapid urbanisation in India, in one hand has created enormous opportunities; in other hand it has raised several challenges in various sectors like housing, sanitation, slum and squatter settlements, environment, transport, water, waste disposal etc.

As per Census 2011, 377.11 million people live in urban area in India. This huge population creates tremendous stress on urban infrastructure. Solid waste management is one them. Presently, 1,27,486 tons per day of municipal solid waste is being generated due to various household activities and other commercial & institutional activities in India (CPCB, 2012).Different types of solid waste include refuse from the households, non-hazardous and hazardous solid waste discarded by the industrial, commercial and institutional establishments, market waste, yard waste and street sweepings which are collected by the municipal authorities for disposalmanaging such huge quantityis difficult task.Present practices of solid waste management and disposal of waste in the outskirts of the city is inviting serious environmental issues for the citizen.

To achieve sustainable Solid Waste Management, emphasis should be given on Reduce, Recycle and Reuse.Along with reduction of solid waste at household level, serious thought should be given on various ways by which solid waste can be recycled and reused.One of the effective ways of Reuse is utilisation of solid waste as building material. Utilization of these solid waste materials as construction material is a sustainable solution to environmental and ecological problems in urban areas.

2.TYPE OF CONSTRUCTION WASTES AND THEIR USE IN BUILDING CONSTRUCTION

There are different type of solid wastes which can be used for building construction. Following are some examples. The table 1 shows major solid waste and their uses as construction material.

2.1 Fly ash

Fly ash is a byproduct generated from steel plant during combustion of coal .It is a waste product and mostly dumped near the industries as landfill.It is used as mineral admixture in Portland cement can be used to manufacture low-cost compressed earth bricks, which are useful as a construction material. In addition, there is substantial scope to reduce the disposal problem caused by SCFBCA.

2.2 Rubber/Tire waste

Kaush Kal Kishor (1993) found that the rubber concrete reduces the concrete strength; however, this may be used where M10 and M15 grade concrete is needed. With proper mix design, about 20 percent density will be reduced in comparison to control mix when 30 percent rubber aggregate is replaced with coarse aggregate of control mix. Khatib and Bayomy (1999) reported that the rubber waste should not exceed 17-20% of the total aggregate in volume for better results in cement concrete.

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Table.1. Major solid wastes and their uses as construction materials.

S/ No.	Name of waste	Type of waste	Use in construction materials
1	Fly ash, bottom ash, rice husk ash, palm oil fuel ash, organic fibers	Agro-industrial	Aggregate, concrete, supplementary cementing materials, blended cement, bricks, tiles, blocks, particle boards, insulation boards, cement boards, wall panels, roof sheets, reinforced polymer composites
2	Phosphogypsum, waste glass, granulated blast-furnace slag, waste steel slag, plastic waste, rubber tire	Industrial	Aggregate, concrete, supplementary cementing materials, blended cement, bricks, tiles, blocks, 3particle boards, insulation boards, cement boards, wall panels, roof sheets, reinforced polymer composites
3	Quarry dust	Mining/mineral	Fine and coarse aggregates, concrete, bricks, tiles, blocks, surface finishing materials
4	Construction and demolition debris (concrete rubble, tiles, waste bricks, etc.)	Industrial	Fine and coarse aggregates, concrete, bricks, blocks, sub-base pavement materials
5	E- Waste	Industrial	utilizing shredded-plastic particles as partial replacement of coarse aggregate

2.3 Quarry waste

Usually quarry waste is used in large scale as a surface finishing material in highways. Quarry waste has also good potential for producing normal and lightweight concretes. Quarry waste can also be used in special concretes such as high-performance and self-consolidating concretes.

2.4 Construction and demolition waste

The total C&D waste generated in India just by buildings in one year — 2013 — amounts to a humungous 530 MT, 44 times higher than the official estimate. A lot of it is being used by land sharks to illegally fill up water bodies and wetlands around urban centres for real estate development. The rest is just being dumped into rivers and open spaces.Recently there are best practices in abroad and also in India where C&D waste is being recycled into aggregates at the waste management facility, which is in turn converted to Ready Mix Concrete (RMC), pavement blocks, kerb stones .The given table(table 2) show the C & D waste generation in Indian Cities.

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Table 2: C&D waste generation in select Indian cities7

City	Population (Census 2011)	Daily CDW generation (tonnes/day)	Annual CDW generation* (million tonnes/annum)
Mumbai	12,442, 373	2,500	0.75
Delhi	16,787, 941	4,600	1.38
Bengaluru	8,443, 675	875	0.26
Chennai	6,500,000	2,500	0.75
Kolkata	4,496, 694	1,600	0.48
Jaipur	3,471, 847	200	0.06
Patna	2,514, 590	250	0.08
Ahmedabad	6,063, 047	700	0.21
Bhopal	1,917,051	50	0.02
Coimbatore	2,618,940	92	0.03

2.5 E-Waste

"Electronic waste" or "E-Waste" may be defined as discarded computers, office electronic equipment, entertainment devices, electronics, mobile phones, television sets, and refrigerators. This includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal. The utilization of E-waste as partial replacement of aggregates in production of bricks reduces the cost of the brick attaining a good compressive stress and also can produce light weighted bricks as compared to conventional bricks.

3 INTERNATIONAL AND NATIONAL BEST PRACTICES OF USING SOLID WASTE IN CONSTRUCTION

In the United Kingdom practices, recycled glass is used as a fine material for cement replacement called "ConGlassCrete", which is used for improving the strength of concrete, aside this, the product obtained from the 100% utilization of recycled glass in the United States for the production of tiles, exhibited an attractive reflective appearance on the surface after polishing.

In India, the blast furnace slag, categorized as group I waste and has been used in the manufacture of blended cement to improve its soundness, strength, morphology, and abrasion resistance.

More than 2500 km of Plastic tar road were laid in India at different States like Tamil Nadu, Kerala, Andhra Pradesh, Maharashtra, Pondicherry and Himachal Pradesh from 2002 to till date by various authorities like DRDA, Tamil Nadu; High Ways; Tamil Nadu; National Transport Planning and Research Centre, Kerala; Public works Department of Pondicherry, Private sectors, etc., These roads are functioning well without pothole, raveling and rutting.

The Nalawala Hall, Fairfield City CouŶĐil's SustaiŶad'ility Hud', iŶĐorporates the world's first concrete load-bearing foundation slab which is 95 per cent recycled. International Best Practice on Recycled Products for use in Structural Applications ERC-Tech, a Czech Company, has patented technology for strengthening the structural properties of C&D waste particles by use of nano-additives in a highly controlled way. The technology makes it possible to use C&D waste aggregates in structural applications. Recycled concrete was used in the construction of the South Seas apartment building in Greenpoint, Cape Town.

MCD-ILFS-IEISL initiative in Delhi: C&D waste is being recycled into aggregates which are converted to Ready Mix Concrete, pavement blocks, kerb stones and concrete bricks. YUVA and CIDCO initiative in Navi Mumbai: This has recycled 1500 tonnes of C&D waste between 2002-06. But operations shut down as no policy and market support

4 FUTURE TREND AND INNOVATION IN BUILDING MATERIAL AND TECHNIQUES OUT OF SOLID WASTE

The 70% material recycling of C&D waste in Finnish

circumstances will become difficult to accomplish, which is why research on separation and recycling technologies for C&D waste should be of specific research interest in the future. There is a special need for new ways of recycling waste wood, but also for the development of recycling of smaller fractions, such as plastics, insulating materials, glass and waste gypsum. Other wastes like electrical and electronic equipment (WEEE) originates from households and industry, it is a very versatile waste fraction and includes a vast variety of different electrical and electronic items. x End-of-Life vehicles (ELV) is motor vehicles which have reached the end of their useful lives and are collected for controlled dismantling.These are some waste which needs more research and innovation to be included in to the construction industry.

5 CONCLUDING REMARK

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, there is need of technology-enabling centers for effective commercialization. Also there is requirement of technologies emphasizing cost-benefit analysis, and feasibility assessment .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.

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