Investigation of Construction Waste- A Case Study of Jaipur City

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***Abstract–* Concrete continues to be the most consume construction material in the world only next to water. Due to rapid increase in construction activities, it is important to assess the amount of construction and demolition (C&D) waste being generated and analysis the particle need to handle this waste from the point of waste management and disposal & also with regard to waste utilization in concrete. Construction & demolition waste constitutes a major portion of total waste production in the world & most of it is used in landfills. Due to high demand for construction activities in recent year of India and all over the world the natural aggregate resources are remarkably waning day by day on the other hand, millions of tonnes of construction and demolition residues are generate. The useful of such residues be useful for both environmental and economic aspects in the construction industries**

Keywords—Construction waste,demolation waste, renovation of contruction waste.

I. INTRODUCTION

The construction industry in India is booming. Already at 10 per cent of the GDP, it has been growing at an annual rate of 10 per cent over the last 10 years as against the world average of 5.5 per cent per annum. Almost 70 per cent of the building stock in India is yet to come up. The built-up area is expected to swell almost five times from 21 billion sq ft in 2005 to approximately 104 billion sq ft by 2030. This immense surge will have fallouts. Buildings are at the core of all our demands water, energy and material — but they also create waste. This waste, generated in the construction, maintenance and disposal phases of a building, is called construction and demolition (C&D) waste. This includes waste from demolished structures, renovations in the real estate sector and construction and repair of roads, flyovers, bridges, etc. To this is added the enormous debris that follows disasters such as during the Uttrakhand floods in 2013 globally cities generate about 1.3 billion tonne of solid waste per year. This volume is expected to increase to 2.2 billion tonne by 2025, says a 2012 report by the World Bank. Building materials account for about half of all materials used and about half the solid waste generated Worldwide. But C&D waste can be an invaluable source of building material. In fact, the recent controversy in India over sand mining has put the spotlight on the need to recycle, reuse and substitute naturally sourced building material TIFAC also says building repair produces 40-50 kg per sq m of waste.

Assuming that one-third of the existing building stock underwent some sort of repair or renovation in 2013, India must have generated an average of 193 MT of C&D waste just from repair and renovation in that year. Thus, 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. Imagine the scenario if the waste generated by Infrastructure projects such as roads and dams are added. Not surprisingly, in India, if C&D waste is quantified, it will be more than all the other types of solid waste put together.

Waste, rubbish or garbage, depending upon the type of material or the regional terminology, is an unwanted/undesired material or substance. It is an unavoidable by-product of most of the human activity. It can be classified as, depending on its area of origin-

- Residential
- Industrial
- Commercial
- Construction and Demolition
- Institutional
- Municipal Services
- Agricultural

Construction and Demolition Waste comprise of building materials, dredging materials that are produced in the process of constructions, remodeling, repair, or demolition of residential buildings, commercial buildings and other structure and pavements. These don’t include materials identified as solid waste, infectious waste or hazardous waste.

They consist mainly of –

- Concrete
- Bricks
- Timber
- Sanitary waste
- Glasses
- Steel
- Plastic

The management of C&D waste is a concern due to increasing quantum of demolition’s rubble, shortage of dumping sites, increase in transportation and disposal cost and escalating concern about pollution and environmental deterioration.

Recycling of demolition waste was first carried out after the Second World War in Germany to tackle the huge waste generated by war and simultaneously generate raw materials for reconstruction. Subsequently considerable research has been carried out in Japan, Denmark, U.S.A, U.K etc. The current concrete construction practice is thought unsustainable because, not only it is consuming enormous quantities of stone, sand, and drinking water, but also two billion tons per year of Portland cement, which releases green-house gases leading to global warming. Far more concrete is produced than any other man-made material. Annual production represents

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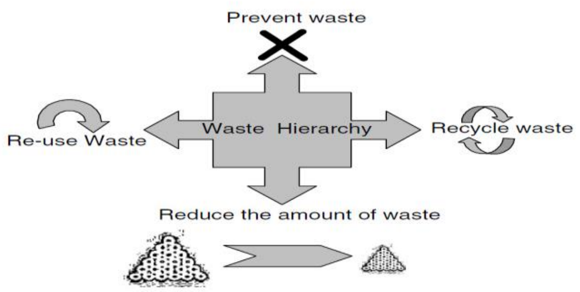
one ton for every person on the planet. It is incredibly versatile, and is used in almost all major construction projects. Indian Construction Industry is highly employment intensive and accounts for approx. 50% capital outlay in successive 5-year plans of the country. The projected investment in this industrial sector exhibits a growing trend.

Aggregates are used in concrete for very specific purposes. Aggregates typically make up about 60% to 75% of the volume of a concrete mixture, and as they are the least expensive of the materials used in concrete, the economic impact is significant.

Over the few years there has been a vast increase in the production of C & D waste materials basically due to the spur in infrastructure development for better economy and demolition of age old structures. Debris due to natural disasters also counts in it.

The Hierarchy for C & D waste management in their decreasing favour is-

1. Reduce - The prime objective is to minimize waste generation through sustainable use.
2. Reuse -The materials should be used repeatedly if suitable.
3. Recycle - The most of the materials should be made by making them into new materials.
4. Recovery - Recovering energy from waste materials.
5. Landfill -Safe disposal of waste materials unused.



II. METHODOLOGY

In our research work: -

- Various places are to be selected in Jaipur and location chosen comprises of different kind of construction work.
- Different data are to be collected are to be performed to know about the quality, strength, and other engineering properties.

Major study area chosen is Jaipur.

i.	Malviya Nagar	Choti Chopper
ii.	Agra Road	Badi Chopper
iii.	Delhi Road	Bramhpuri
iv.	Ajmer Road	Ramganj
v.	Tonk Road & Etc.	Amer

TABLE I. DETAILS OF BUILDING

Type of building	**Residential building**	**Residential building**
Location	Near SKEMA, Sitapura, Jaipur	Unique emporia ,Near SKIT
Purpose Of Building	Flat	Flat
Foundation	Square footing	Raft foundation
Aggregate	coarse aggregate 20mm sand	Coarse aggregate 20mm
Reinforcement	foundation =16mm,20mm Column=16mm,20mm Slab = 12mm Spacing = 8 inch Ring = 8mm	Foundation =16mm,20mm Column =12,16,20,25mm Slab = 8,10,12mm Spacing=8 inch Ring = 8mm
Cement	OPC 43 Grade	OPC 53 Grade
Mix Design	Foundation = M25 P.C.C =2.5:3:1	Foundation= M25 P.C.C 2:4:1
masonry	Brick masonry (2^{nd} class brick used)	Brick masonry (2^{nd} class brick used)
Rain water	Disposal at road	Rain water harvesting system
drainage system	Underground piping to tank	Through pipelines to Sevier lines
Thickness of wall	4.5 inch	4.5 inch
No. of floor	G+4 1 BHK=4 rooms 2 BHK=6 rooms	G+12 120 flats
wastes	Steel = 4% Brick = 5% Tiles = 6% Mortar =1-2% Wood waste = 6%	Steel = 2-3% Brick = 2-3% Concrete = 1-2% Tiles = 4% Wood waste=4.5%
Type of building	**Commercial building**	**Commercial building**
Location	Near SKEMA, Sitapura ,Jaipur	India Gate, Jaipur
Purpose Of Building	Furniture factory	Nazar paan Masala Factory
Foundation	Square footing	Raft foundation
Aggregate	coarse aggregate 20mm sand	Coarse aggregate 20mm
Reinforcement	foundation =12mm Column=20mm,25mm Slab = 12mm Spacing = 200mm Ring = 8mm	Foundation=16mm,20mm Column =32,25mm Slab = 8,10,12mm Spacing=200mm Ring = 8mm
Cement	OPC 43 Grade	OPC 43 Grade
Mix Design	Foundation = M25 P.C.C =M10	Foundation= M25 P.C.C 1:8:6
masonry	Brick masonry (2^{nd} class brick used)	Brick masonry (fly ash brick used)
Rain water	Disposal at road	Rain water harvesting system
drainage system	Underground piping to tank	Through pipelines to Sevier lines
Thickness of wall	4 inch	9 inch
No. of floor	G+1	G+4
wastes	Steel = 2% Brick = 7.5% Tiles = 5% Aggregate =10% Wood waste = 6%	Steel = 2-3% Brick = 2-3% Concrete = 1-2% Tiles = 4% Wood waste=4.5%

III. EXPERIMENTAL PROCEDURE

A. Cementitious material

Portland Pozzolana cement and fly ash were used as the cementitious materials. Both materials are commercially available in India. Cement was confirming to IS 1489 (Part 1). Fly ash is locally available as a waste product of thermal power generation plant located at Koradi, near Nagpur, India and was observed as siliceous material confirming to class F

B. Aggregate

Waste material was collected from a local demolition site of a concrete structure located in Nagpur. Concrete and masonry waste was segregated from recyclable waste, i.e., steel, plastic etc. at the source itself. Bigger pieces of collected C&D waste were crushed manually into small particles. Crushed material was sieved with standard sieve of 4.75 mm size to separate fine and coarse material. Aggregate of size more than 4.75 mm and less than 10 mm was used as coarse aggregate and less than 4.75 mm was used as a replacement to fine aggregate in the mix. Properties of aggregates are given in Table 1. The waste was then transported to brick manufacturing plant site. Transportation distance from thermal power plant to manufacturing plant for fly ash and from the demolition site to manufacturing plant for C&D waste was less than 50 km.

C. Physical and mechanical Tests

Various physical and mechanical tests, viz. block density, efflorescence, water absorption and compressive strength were conducted to check the suitability of developed material as recommended in prevalent Indian standard codes. Similar tests were carried out on commercially available fly ash bricks to compare the properties of developed bricks. Compressive strength A set of three specimens for each mix of eco-bricks was tested for compressive strength. Test was carried out as recommended by IS 3495(1). Dimensions were measured to the nearest 1 mm and recorded. Samples were immersed in water at room temperature for 24 h. On removal of the specimen after 24 h, surplus moisture was drained out. Frog and voids on bed faces were filled with cement-sand mortar (1:3). Samples were then stored under the damp jute bags for 24 h and then immersed in clean water for 3 days. Before testing, the samples were removed and excess moisture was wiped off. Samples were then placed in compression testing machine and load was applied axially at a uniform rate of 14 N/mm ^{2}/ min. Maximum load at failure was recorded

IV. RESULT AND ANALYSIS

A. Brick Test (Strength test)

Concrete Brick
Load = 35 KN
Area = 11.3 X 7.4 = 83.62 mm^2
Strength = load/ area
= 41.8 N/ mm^2

Reconstructed brick test
Load 19.5KN
Area = 10.9 X 7.25= 81.75 mm^2
Strength = Load/Area
= 23.2 N/ mm^2

B. Concrete cube test

Size of mould 15cm x 15cm x 15 cm.
For M 20 Grade of Concrete

Cement =1.225 kg
Sand = 1.922 kg
Coarse Agg = 3.66 kg
W/C = 0.5
Strength =12.4 N/mm^2 (7 Days)
=19.78 N/mm^2 (28 Days)

TABLE II. PROPERTIES OF COARSE AGGREGATE AND DEMOLISHED WASTE

Parameters	**Coarse aggregate**	**Demolished waste**
Specific gravity	2.65	2.51
Water absorption	0.3%	4.54%
Sieve analysis	Conforming to table-2 of IS 383-1970	Conforming to table-2 of IS 383-1970
Crushing value	22%	35.25%

V. CONCLUSION

This project would help in better utilization of construction waste and property in respect to concrete and will also improve different properties of materials. The research relates to construction waste material by physical means with cost analysis so as we can utilize the construction waste for reconstructing and paving roads and construction of low rise buildings and many other construction work.

All of these construction wastes decrease the cost of building and also beneficial for environment and natural resources. The possibilities of using C&D waste as aggregate for development of eco-bricks were presented in this paper. From results of this study, the following conclusions can be drawn:

1). Reuse of C&D materials in development of new building material answers the issue of solid waste management as well as contributes to the increasing demand for the construction material in a sustainable way.

2).C&D (concrete and masonry) can be successfully used to produce bricks, which develop properties at par conventional building bricks.

3).With increase in the proportion of fly ash in binder, reduction in density and increase in water absorption for the eco-bricks was observed.

4). With an increase in aggregate to binder ratio, density of bricks was decreased and water absorption of brick was increased. For similar size of bricks average density of eco-brick was higher than fly ash brick. When compared to fly ash bricks, average water absorption was found to be lesser.

5). Compressive strength of bricks reduced with increased percentage of fine aggregates. A 10% increase in proportion of waste fines, resulted in 15% reduction in compressive strength. Similarly, around 12% increase in waste coarse aggregate resulted into further 14% reduction in compressive strength.

6). Increase in both fine and coarse waste aggregates resulted in reduction of compressive strength by 30%.

7). Use of recycled material in the brick resulted into reduction in embodied energy of brick. Embodied energy of eco-brick with 5:1 aggregate to binder ratio was found to be 16.8% lesser as compared to fly ash bricks.

8). Eco-brick composition BR90-6 had achieved least embodied energy (1.93 MJ/brick), which is 16.8% lesser as compared to fly ash brick.

REFERENCES

[1] Collins, R.J. 1994, "The use of recycled aggregates in concrete" BRE Report, Building Research Establishment, U.K. May.
[2] Hansen, T.C. 1992, "Recycling of demolished concrete and masonry". RIELM Report No. 6, E and FN Spon, UK.
[3] ACI Committee 522, Pervious Concrete, 522R – 06, American concrete institute, Farmington Hills, Michigan, 2006, 25 pages.
[4] ASTM C 78-02, 2004. Test method for Flexural Strength of concrete
[5] Crouch, L.K., Smith, N., Walker, A.C., Dunn, T.R., and Sparkman A. 2006, "Determining Pervious PCC Permeability with a simple Triaxial Wall Constant Head Permeameter", TRB 2006 Annual Meeting.
[6] M. Chakradhara Rao, S. K. Bhattacharyya, and S. V. Barai. 2010), "Influence of field recycled coarse aggregate on properties of concrete", Materials and Structures, DOI 10.1617/s11527- 010-9620.
[7] Khatib J M. 2005, "Properties of concrete incorporating fine recycled aggregate". Cement Concrete Research, Vol: 35(4); pg-763-769.
[8] Ghafoori, N., Dutta, S. "Laboratary Investigation of Compacted No-Fines concrete for Paving Materials".
[9] IS 10262: 2009, "Concrete mix proportioning – Guidelines".
[10] IS 456: 2000, "Plain and reinforced concrete – code of practice".
[11] IS 12727: 1989, "No fines in-situ cement concrete- code for practice".
[12] IS 516:1959, "Methods of Tests for Strength of Concrete".