

# Construction Waste from Housing Projects

## – A Field Study

Dr. Suresh Singh Kushwaha & Dr. Arun Kumar Dwivedi

**Abstract**— Construction and demolition waste results from the construction, renovation and demolition of manmade structures. The types of materials found in construction and demolition waste include not only the elements used as primary building materials but also various secondary materials such as paints, sealants, adhesives etc. including the packaging materials. The unscientific management of construction and demolition waste such as land fillings may have the ill impact on quality of groundwater due to leaching of rainwater through landfills. The recycle and reuse, which is common practice in management of solid waste, has entered in the field of construction and demolition waste too. It is estimated that the construction industry in India generates about 10-12 million tons of waste annually. The projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about 55,000 million cu.m. The recycling and reusing of aggregate material from construction and demolition waste may reduce the demand-supply gap in both these sectors, thus preserving non-renewable resources, is one of the key benefits. In this study, the average quantity of various construction waste for construction of individual residential housing are estimated. A total of 60 houses are surveyed and the owners are interviewed, out of which 22 house owners fulfilled the selection criteria and shown their willingness to cooperate and only those houses are selected for study. It is observed that on an average the total cost of all construction wastes ranges from 5.4% - 7.79% of total cost of construction materials..

**Keywords**— Construction and Demolition Waste, Housing Projects, Waste Recycling and Reuse, Management

## I. Introduction

The construction and demolition (C&D) waste in general cover a very wide range of materials, which are termed as waste in construction industry. The most obvious categories in which C&D waste can be further grouped are waste arising from the total or partial demolition; waste arising from the construction; soil, rocks and vegetation arising from land levelling, civil works and/or general foundations and associated materials arising from road maintenance activities. C&D waste may be originate from a range of different site types[3].

**Dr. Arun Kumar Dwivedi**

K.V.N.N. Institute of Engineering Education & Research  
Canada Corner, Nashik, MS, India, 422 002.

**Dr Suresh Singh Kushwaha**

Institute of Technology, Rajiv Gandhi Technological University,  
Gandhinagar, Bhopal, MP, India, 462 037.

This category of waste is complex due to the different types of building materials being used but in general may comprise the different materials such as cement concrete, bricks, cement plaster, steel from RCC, door/window frames, roofing support, railings of staircase etc., rubble, stone (marble, granite, sand stone) and timber/wood especially demolition of old buildings. The conduits and pipes made of iron or plastic, electrical fixtures made of copper / aluminium wiring, wooden baton, bakelite / plastic switches, wire insulation, the panels (wooden, laminated), glazed tiles or glass panes may also be constituent of C&D waste, however their quantity may be small[6].

Being predominantly inert in nature, C&D waste does not create chemical or biochemical pollution. The material can be used for filling/leveling of low-lying areas. In the industrialized countries, special landfills are sometimes created for inert waste, which are normally located in abandoned mines and quarries. The same can be attempted for cities, which are located near open mining quarries or mines where normally sand is used as the filling material. However, proper sampling of the material for its physical and chemical characteristics is essential for evaluating its use for this purpose.

The nature of C&D waste is directly influenced by the building techniques and materials which are being used in civil engineering structures and associated infrastructure. The nature and volumes of demolition waste also reflect the solidity and flexibility of the structures of past years. The nature and volume of today's construction waste, by contrast, reflects today's building materials and activity levels[5].

## II. Management of C&D Waste

It is evident from the various case studies and literature reviews that there are lack of robust data available on C&D waste management. The knowledge base relating to C&D waste is presently very poor or can be said almost absent in undeveloped and developing nations. However it can be improved by proper planning, education and training, implementing reduction measures at the time of design and development, developing a C&D waste management information system, taking reduction measures during construction and development of market for secondary material[1].

Any measures that can be undertaken to reduce the amounts of waste generated in the first place will provide the most sustainable solutions. The reduction of waste could be enhanced by the designing of buildings to avoid waste wherever possible. This can be achieved by more attention to building material types and dimensions, by using prefabricated elements and components wherever possible, employing modular construction based design techniques. Many

construction projects could divert more C&D waste from landfill by implementing measures that would not add a considerable time or cost impost to the project. The measures could include -

- [a] Waste Management Plans (WMP) as supporting documentation in the tendering process for any project[2].
- [b] Appointing a Waste Management Officer and giving him the authority and accountability for ensuring cost effective results.
- [c] Including waste minimization outcomes as key performance indicators (KPI) to be reviewed at all site management meetings[5].
- [d] Accurate estimation of quantities to prevent excess materials being delivered to site and making it mandatory to material suppliers to take back surplus materials, if any.
- [e] Employing just in time (JIT) techniques so only the required materials arrive on the construction site at the appropriate time. This will allow increased space allocation for waste separation and the positioning of skips for recyclable waste products.
- [f] Matching the skips for recyclable products to the different stages of construction, thus optimizing space.

The market for C&D materials, are limited, particularly in developing nations and also in many of the developed nations. The traditional higher value materials such as ferrous and non-ferrous metals and quality timber have, in many cases, a viable market. High volume materials such as concrete, masonry products etc. do not have an outlet in most areas. However, concrete and asphalt recycling is quite successful. There is scope to develop markets for many construction and demolition materials. Many initiatives such as the review of specifications, improved education and information dissemination, and increased landfill pricing, will help in increasing an underlying demand for recycled products[4].

### III. Case Study of Housing Project

In the case study a survey is conducted for residential buildings which are constructed in last two years and the actual construction waste generated from construction of them is estimated by a pre-defined methodology.

#### A. Methodology

Around 50 houses is surveyed and the owners of houses are interviewed. The houses whose owner have maintained the record of quantities of material purchased and expenditure are selected for study. Out of 50 house owners initially interviewed only 22 house owners fulfilled the selection criteria and have shown their willingness to cooperate for providing the information, thus only those houses are selected for study. The generation of construction wastes depend upon various factors, some of prominent factors are skill of person supervising the work, financial condition of owner, duration of execution of work. The houses which were selected for the study belongs to the owner of medium income group, supervised by the professional engineer and completed in one

stretch. Hence, it is assumed that in all houses the conditions which may affect the generation of construction waste are constant. The methodology for survey and estimation of construction waste is shown in following steps –

- [a] The actual measurement of house is done and quantities of different materials such as cement, sand, aggregate, bricks, tiles and steel required is calculated.
- [b] The actual quantities of cement, sand, aggregate, bricks, tiles and steel purchased for construction is taken from the records of the house owner.
- [c] The difference between the quantity purchased and quantity required is termed as construction waste in this study.
- [d] The cost of construction waste may be estimated on the basis of existing schedule

#### B. Field Survey for Construction Waste

The actual measurements of 22 houses are done and the quantities of construction material which are actually consumed are calculated as per standard practice. The construction materials viz cement, sand, aggregate, bricks, MS bars, internal & external flooring are considered for this study. The market rates of materials are taken for estimation of cost. The in-visible items are measured on the basis of construction record (measurement book) of consultant. The quantities of construction materials which are consumed as calculated on the basis of measured items. The actual quantities of construction materials, which are purchased, are obtained from owners' purchase record. The quantities of construction waste are estimated as the difference of quantities of different construction material purchased and actual quantities of construction material consumed.

#### C. Data Analysis

The cost of the construction wastes and the cost of the construction materials purchased material wise e.g. cement, sand, aggregate, bricks, MS bars, internal and external flooring are shown in Appendix A.4. The % of cost of different types of construction waste with respect to the total cost of construction waste and total cost of construction material are calculated and are shown in Table – 1.

TABLE – 1 : “% of Cost of Different Types of CW”

Sr	MATERIAL	% of Total Cost of Waste	% of Total Cost
1	Cement	17.81	1.29
2	Sand	23.48	1.60
3	Aggregate	9.31	0.59
4	Brick	41.27	2.87
5	Ms Bars	2.77	0.18
6	Flooring (Internal)	4.12	0.27
7	Flooring (External)	1.25	0.09

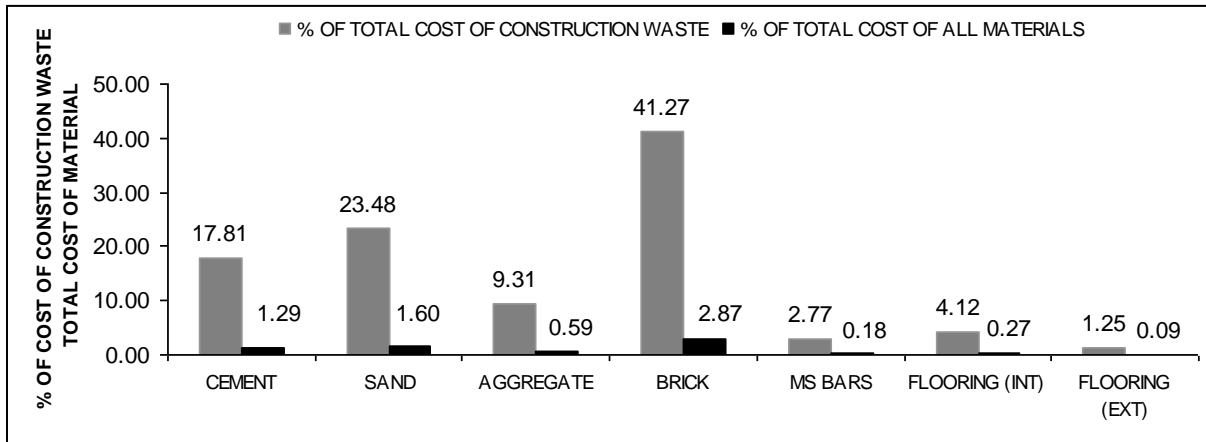


Figure – 1 : “% of Construction Waste Versus Total Cost of Waste & Total Cost of Construction Material”

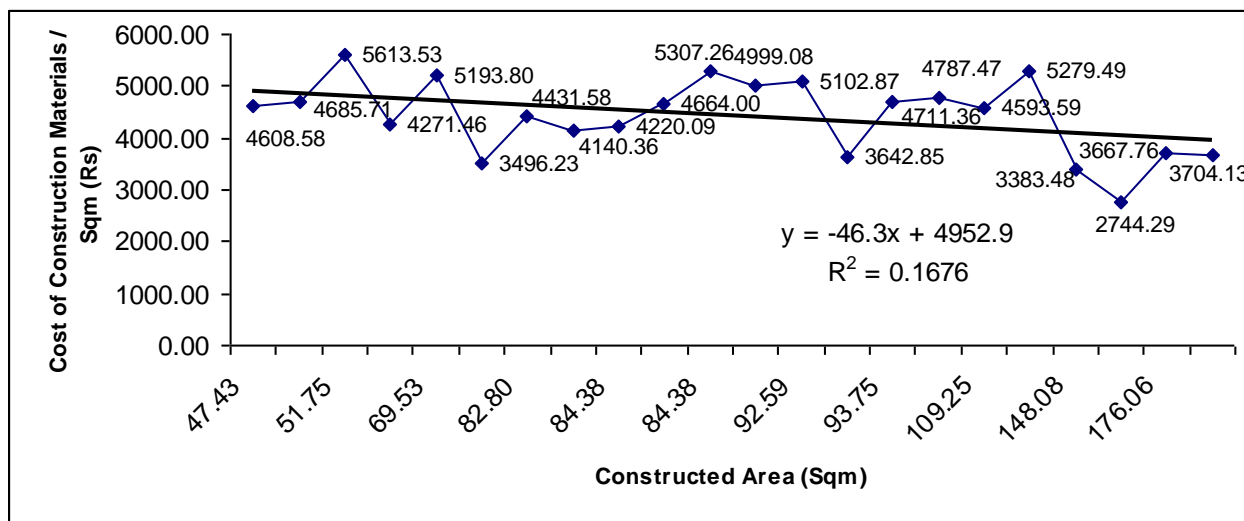


Figure – 2 : “Cost of Construction Material per Sqm”

It is clear from Figure - 1 that brick wastes are maximum among all types of construction material studied, whereas the external flooring are minimum.

The cost of construction material per sq m of construction is calculated for all the 22 houses surveyed. The constructed area of the houses varies from 47.43 sqm to 176.06 sqm. A graphical plot of constructed area (sqm) versus cost of construction material per sqm is shown in Figure – 2, which shows that the cost of construction material/sqm decreases slightly with increase in constructed area which is obvious.

#### IV. Conclusions

The study of 22 houses is done for construction waste. The survey data are analyzed and following conclusions are drawn from analysis –

[a] There is no definite relationship between the different construction waste generated and constructed area. However, the minimum cost of

construction waste is 3.521% of total cost of construction material for house 13 (92.59 sqm) and is as high as 10.993% for house 8 (51.75 sqm) as shown in Figure – 3.

[b] It can be observed from Figure – 3, that on an average the total cost of all construction wastes ranges from 5.4% - 7.79% of total cost of construction materials. This range can be taken as best practice, although the number of houses surveyed are too less to make such final comment.

[c] It is concluded that the proportion of brick waste is maximum i.e. 41.27% of total cost of construction waste and 2.87% of total cost of construction material. The waste of other construction materials viz. sand, cement, aggregate, internal flooring, MS bars and external flooring are 23.28%, 17.81%, 9.31%, 4.12%, 2.77% and 1.25% w.r.t total cost of construction waste and are 1.60%, 1.29%, 0.59%, 0.27%, 0.18% & 0.09% w.r.t. total construction material respectively as shown in Figure - 4.

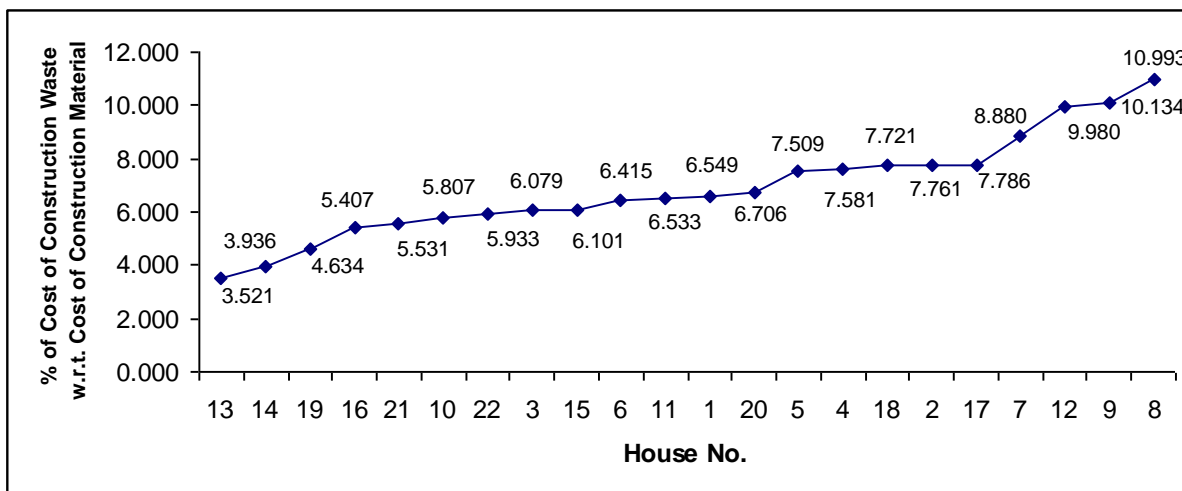


Figure – 3 : “% of Construction Waste Versus Total Cost of Waste & Total Cost of Construction Material (Average of 22 houses data) (Ascending Order)”

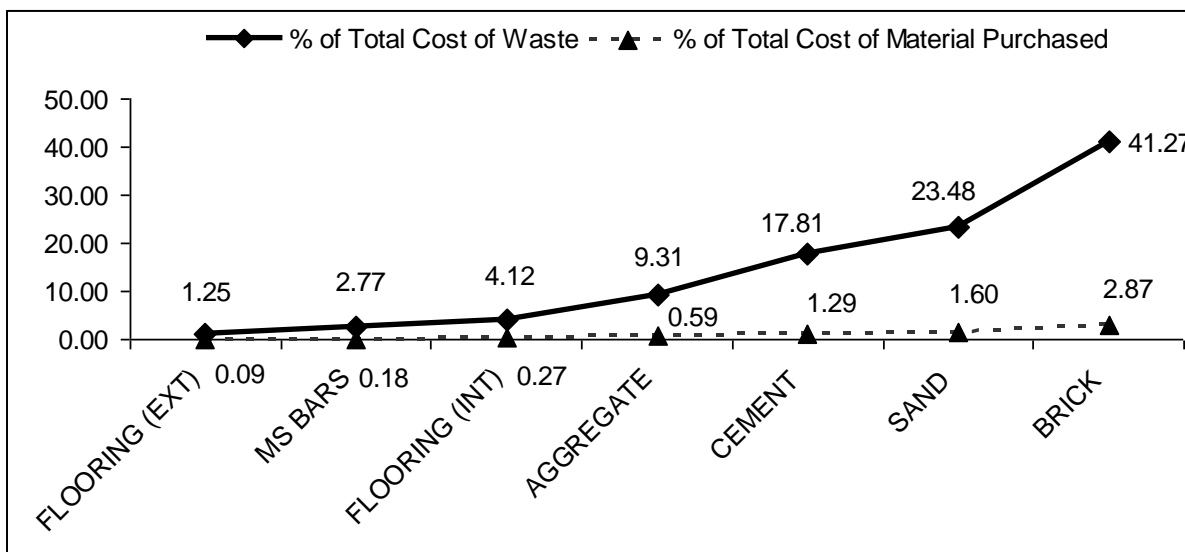


Figure – 4 : “% of Construction Waste Versus Total Cost of Waste & Total Cost of Construction Waste (Average of 22 houses data) (Ascending Order)”

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About Author (s):



Dr. Suresh Singh Kushwaha, graduated and post graduated from Samrat Ashok Technological Institute, Vidisha, MP, obtained his doctoral degree from Rajiv Gandhi Technological University, Bhopal, MP, India is currently associated with Institute of Technology, RGTU, Bhopal, MP, India as Professor in Civil Engineering. He is having experience of 25 years in teaching at UG and PG level in engineering education. He is also having experience as technical expert in the building material and waste management. He has published many research papers in different journals and conferences. He is the life fellow member of CIDC. His area of research is waste management, concrete technology and life cycle cost analysis of infrastructures. .



Dr. Arun Kumar Dwivedi, graduated from Govt. Engg. College Rewa, post graduated from Indian Institute of Technology, Mumbai, MS, obtained his doctoral degree from Rajiv Gandhi Technological University, Bhopal, MP, India is currently associated with KVNN Institute of Engineering Education & Research, Nashik, MS, India as Principal and Professor in Civil Engineering. He is having experience of 28 years in teaching at UG and PG level in engineering education. He is also having a vast experience as technical and project management consultant in the field of water supply systems management. He is the life fellow member of IWWA and IWRS and life member of many organizations. He has published 27 papers in different journals and 30 papers in different conferences. His area of research is waste management in construction, pond ash management and infrastructure management in the field of water supply and sanitation.