

Waste Management of Building Materials for Sustainable Development

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ABSTRACT : *The building materials are an essential component in the building industry but unfortunately improper planning is associated with them. This paper aims to bring forward and highlight the important considerations of the factors associated with materials. The proper waste management of building materials on construction sites can save various environmental hazards and cost also. The paper will discuss the definition, important waste materials, and the benefits of waste minimization and finally bring forward certain recommendations for waste minimization based on site studies.*

Keywords–Waste, C&D waste, Waste minimization, Sustainability

I. INTRODUCTION

With the rapid urbanization, many factors associated with construction industry came into light. The increase in global warming has brought into light many factors associated with construction industry, which are contributing towards environmental hazards. The Indian construction industry is also facing major challenges, which are multi-dimensional, and construction waste is one such area of concern. The role of building materials play a very significant role in making the construction process sustainable altogether. With the aggression of sustainability the concept of Green Buildings, Green building material and zero waste came to light. As the usage of building materials increased rapidly, so did the generation of waste. The waste materials generated during the process are of great environmental hazard. During the construction process, there are many factors that negatively affect the performance and generate different types of waste. It is important to concentrate on the waste of important building materials, to have sustainable development.

II. NEED OF STUDY

The construction and demolition waste has very serious negative impact on environment. This leads to all types of pollution and GHG emissions. Apart from this, these have an impact on the economy also. In India, construction industry is the second largest economic activity after agriculture. The construction and demolition waste generation is very high in other countries also. Many countries in the world have taken initiatives in this field. U.K, USA and Germany have successfully developed technologies to recycle 80-90% of C & D waste[1]. India also needs to work in this direction and focus on minimization of waste.

III. DEFINITION OF WASTE

Waste has many definitions in construction industry. Waste can be understood as any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered as necessary in the production of a building. Waste includes both the incidence of material losses and the execution of unnecessary work, which generates additional costs but do not add value to the product. Waste is “that which can be eliminated without reducing customer value” [2].

The waste generated in construction industry mainly consists of inert and bio-degradable materials like concrete, plaster, wood metal, masonry etc. Apart from these, wastes are generated at pre-building phase and post building phase also. Wastes are identified as of seven types-over production, waiting time, transportation, processing itself, having unnecessary stock on hand, using unnecessary motion and producing defective goods.[3]

IV. CONSTRUCTION AND DEMOLITION (C&D) WASTE

The waste generated in construction, maintenance and disposal phases of a building is called construction and demolition (C & D) waste. Globally, cities generate around 1.5 billion tons of solid waste/year and expected waste generation is 2.2 billion tons by 2025. Building materials account 50% of the solid waste generation worldwide.

In India, there is no systematic database on C&D waste available to the Government (MoEF). But as a thumb rule, TIFAC (Technology Information, Forecasting and Assessment Council) on the basis of studies, suggests that a new construction generates, 40-60 kg of C&D waste per sq. mt. [4]

If C & D waste is quantified, it will be more than all the other types of solid waste put together. So the question is, "How to utilize this huge amount of resources associated with C&D waste?"

Table 1. A distribution of C&D waste generated from various sectors

Non-Residential demolition	33%
Residential demolition	15%
Non –Residential renovation	21%
Residential renovation	23%
Non –Residential new construction	3%
Residential new construction	5%

Source [5]

V. TYPES OF CONSTRUCTION WASTE

Construction material waste is defined as any material apart from earth materials, which needs to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process [6].

C & D waste can be categorized in four types at source level [7].

1. **Design** – lack of proper thinking, selection of proper materials, lack of market survey etc.
2. **Operational**- lack of knowledge, negligence, improper communication etc.
3. **Material handling**- transportation, packing, unfriendly attitude etc.
4. **Procurement**-ordering errors, specifications mismatch etc.

VI. IMPORTANT BUILDING MATERIALS AND THEIR WASTAGE

The total quantum of waste from construction industry is estimated to be 12 to 14.7 million tons per annum. Quantity of different constituents of waste that arise from Construction Industry in India are estimated as follows: [8]

Table 2. Tones of C&D WASTE [8]

Constituent	Million tonnes/year
Soil, Sand and gravel	4.20 to 5.14
Bricks and masonry	3.6 to 4.40
Concrete	2.4 to 3.67
Metals	0.6 to 0.73
Bitumen	0.25 to 0.30
Wood	0.25 to 0.30
Others	0.10 to 0.15

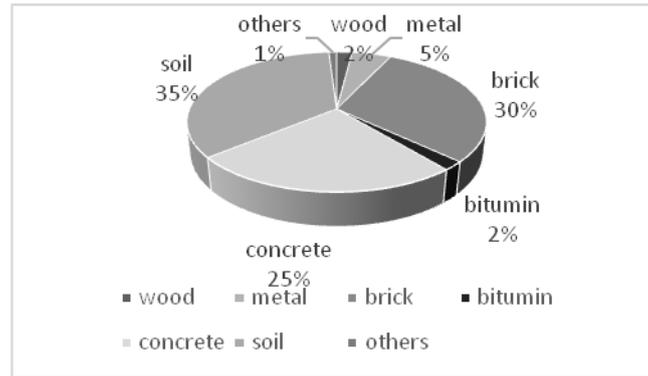


Figure1. Various constituents of construction WASTE [8,9]

A lot of building materials are wasted at different levels on construction sites. Some major ones include steel reinforcement, concrete, formwork, blocks, cement, mortar, tiles, pipes, aggregate.

- Wastage of steel as a result of cutting, damages during storage and rusting. The reasons of likely waste of steel reinforcement are damage to mesh and bars, loss in mud and excess use of tying wire [9].
- Wastage in concrete mainly results from the mismatch between the quantity of concrete ordered and that required because of imperfect planning, leading to over-ordering. Concrete wastes also result from project delays and unnecessary waste handling processes [9].
- Timber wastage is mainly due to natural deterioration and cutting waste.
- Wastage of cement in multiple applications like brick work, plastering, and floor screed because of poor handling, weather conditions etc.
- Mortar wastage in delivery operations.
- Bricks and blocks wastage in cutting, improper dimensioning etc.
- Electrical pipes, electrical wires, and hydraulic and sewage pipes wastages are difficult to manage during installation.

As the construction industry involves a number of consultants, the chance of waste generation at each level increases. There are a number of possible reasons for waste generation, those which can be checked, if taken care of at the right time.

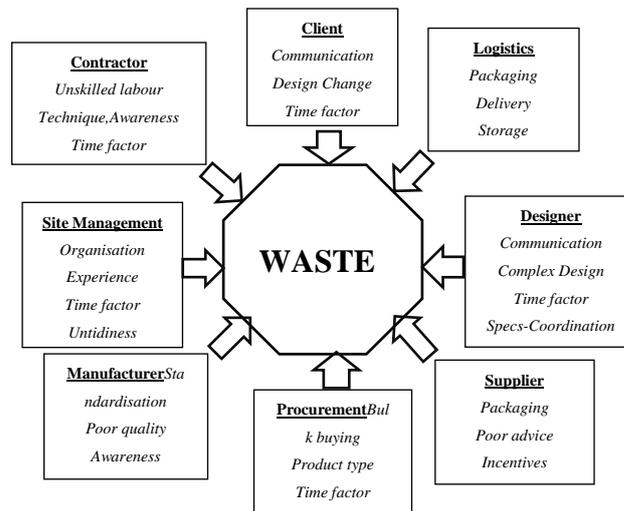


Figure2. Waste Generation from different stakeholders [10]

VII. CONSTRUCTION WASTE MANAGEMENT

Haghi (2010) defined waste management as “the collection, transport, processing, recycling or disposal, and monitoring of waste material” [11]. Management software can help in keeping a check on the amount of material used in the project but generally the companies are not employing these methods and checking the waste manually on site, which leads to time wastage. Waste management has not gained importance in Indian construction industry. Based on severity, certain causes of waste have been identified [12].

The highly severe causes are:

- Improper planning
- Poor management
- Improper quality control
- Lack of individual responsibility
- Overall negligence

The moderately severe causes are:

- Improper designs
- Improper specifications
- Improper labour and supervision to faulty systems

The low severity causes are:

- Lack of technological know-how
- Unavailability of resources
- Unhygienic working environment
- Lack of standardization

VIII. CONSTRUCTION WASTE MINIMIZATION

The concept of construction waste minimization is based on 3R's, namely reduce, reuse and recycle.

- Reduce or source reduction, means preventing the creation of the waste in the first place
- Re-use is a form of waste reduction that: (1) extends resource supplies; (2) keeps high-quality-matter resources from being reduced to low-matter-quality waste; and (3) reduces energy and pollution even more than recycling
- Recycling is commonly defined as a process of separating recyclable materials from non-recyclable materials and supplying them to a hauler or business so they can be processed to make new products

Following is the waste management hierarchy suggested by Kibert & Chini, 2000 [13]

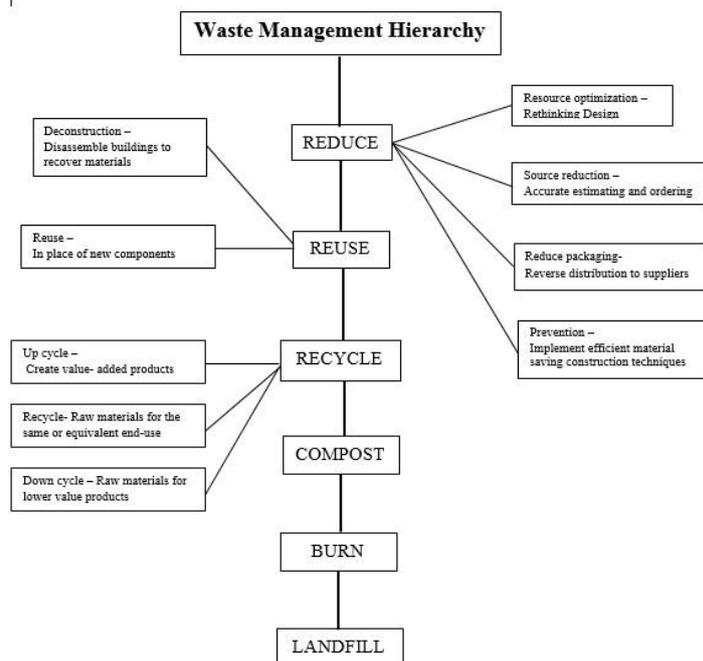


Figure3. Hierarchies for construction and demolition [13]

IX. BENEFITS OF CONSTRUCTION WASTE MINIMIZATION

In construction industry, all the stakeholders share equal responsibility for C & D waste minimization as the C & D waste constitute a significant cost to the business. The consideration of waste minimization can generate advantages such as financial and environmental benefits:

Financial benefits include:

- Reduced transportation costs for waste materials (less transportation because of less material wasted). This includes transportation to and from the site and disposal.

- Reduced disposal costs of waste materials.
- Reduced purchase quantity and price of raw materials by waste minimization.
- Reduced purchase price of new materials when considering reuse and recycling (depending on materials).
- Increased returns can be achieved by selling waste materials to be reused and recycled.

Environmental benefits include:

- Reduced quantity of waste generated.
- Efficient use of waste generated.
- Reduced environmental effects as a result of disposal, e.g. noise, pollution.
- Reduced transportation of waste to be disposed of (less noise, vehicle emission pollution, and energy used).

X. SUSTAINABILITY

Building materials play an important role towards sustainable construction. A number of organisations (Govt. and non-Govt.) are working in these areas and have developed strategies to overcome the environmental concerns. The properties and attributes of building materials should be checked at *pre building phase, construction/maintenance phase, and post building phase* to achieve sustainability.

For sustainable development, it is important to note, that there must be a balance between levels of development and the stock of natural resources. i.e. development must be at a level that can be sustained without prejudice to the natural environment or to future generations [13].

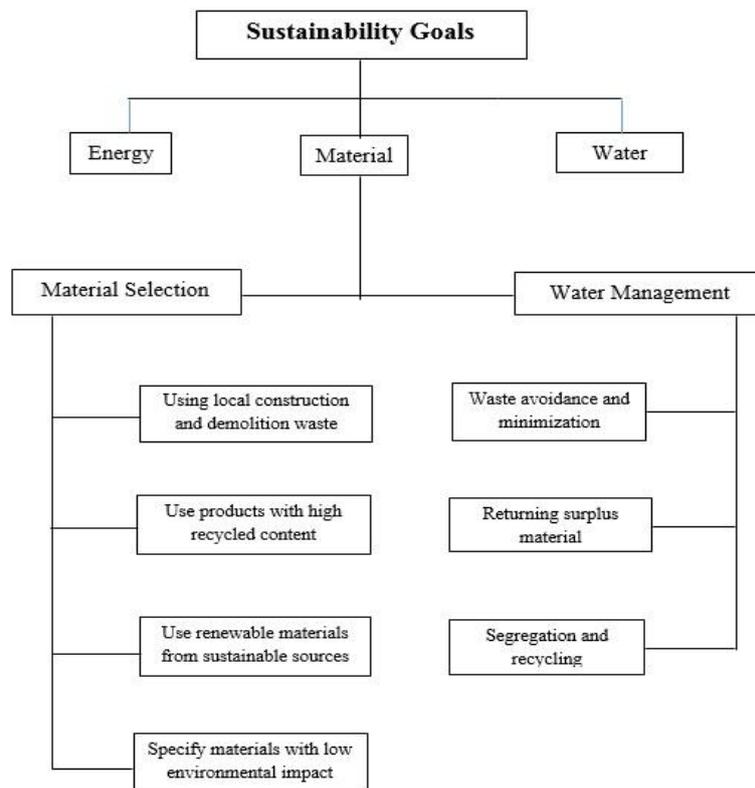


Figure4. Materials resource as a part of sustainable construction [14], WRAP (b) 2009

XI. RECOMMENDATIONS

On the basis of site studies, certain recommendations are worked out for different building materials on site, which can be listed as follows:

- ✓ Shifting of materials should be avoided to reduce the waste and maintain the quality.
- ✓ Minor accidents like scratches, fall of materials should be avoided by using proper safety measures.
- ✓ Appropriate tools and equipment should be used for handling of materials.
- ✓ Material loss should be avoided, which occur because of over stacking and improper storage.

- ✓ RMC can be employed for saving wastage on site.
- ✓ Daily check and maintenance of the tools, equipment, plants and machinery before the start of the day's work and after the end of the day's work.
- ✓ Material loss can take place because of huge buffer of materials. Pressure from the client to complete the project in time force the contractor to increase the buffer stock. Proper inventory and timely supply is necessary.
- ✓ Proper scheduling of construction project should be done.
- ✓ Proper storage spaces, like yards, should be created for placing the fresh building materials.
- ✓ Misuse of scrap material can result in quality deprivation, financial losses and the major constraint of the project. Proper storage for scrap is essential.
- ✓ Proper layout of the site is important to improve the proper flow of materials. The materials should be stacked near the actual area of operation.
- ✓ Circulation pattern for movement of material and labour should be planned beforehand. This will help manage the inflow and outflow of the building materials.
- ✓ Proper stacking of waste material should also be planned, so that the scrap can be reused or recycled.

XII. CONCLUSION

The importance of building materials as source of waste generation is highlighted in this paper. Various definitions of waste, C & D waste and Waste management have been discussed. Important building materials and their wastage proportions have been highlighted. The concept of 3 R's i.e. Reduce, Reuse and Recycle is elaborated with respect to building materials. The environmental and financial benefits of waste minimization are worked out. Finally recommendation are derived on the base of site studies, which can be employed for waste minimization. The paper brings a clear profile of C&D waste and its management practices in India.

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