

# Waste Minimisation in Construction Industry

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**ABSTRACT:** Construction industry is one of the major consumers of resources and energy. Waste in the construction industry is important not only from the perspective of efficiency, but also concerns have been growing in recent years about the adverse effect of the waste of construction materials on the environment. More ever it has been revealed that construction materials on the environment. More ever it has been revealed that construction sector producing unacceptable level of waste. Waste generated may be on-site or off-site. This both waste generating activities result in the increase in project cost, decrease in profit margin, create environmental management and the mission of sustainable development have exerted the pressure demanding for the adoption of proper methods to protect the environment across all industries including construction. Construction by nature is not an environmental-friendly activity. Effective waste management is of growing significance for the construction industry. Adding the cost of storing and transporting construction waste, along with the loss of revenue from not reclaiming waste materials, it makes financial sense for construction companies to take actions to minimize waste.

**KEYWORDS:** Waste Management, Recycling of material waste ,Techniques used to reduce impact of waste, waste reduction techniques.

## I. INTRODUCTION

Wyatt (1978) stressed the consequences of high levels of waste, both in reducing future availability of materials and energy and in creating unnecessary demand on the transportation system. In fact, some building materials and components use large amount of renewable energy, as well as resources that are in danger of depletion, such as timber, sand and crushed stone.

Indian economy is creating demand for residential and non-residential schemes as consumer demands more house production units and amenities. Rapid growth of population, mechanisation and urbanisation has resulted in generation of large quantity of waste every day. More ever growth in construction activities adds to be the waste generated. Hence waste minimisation at source itself has prime importance. The construction industry cannot wait until the goals of sustainable development have been identified and tools to achieve them have proved practical. A proactive is needed in research and education, precursors for lowering environmental burdens while maintaining sustainable growth.

In order to achieve this construction, companies can adopt variety of materials and methods for reducing wastage of this materials using application of technology evolving innovative designs efficient construction management, efficient programming of work, improved skill of labour force, online monitoring etc. some of the important aspects need to be considered while trying to minimise wastes are durability and design life of construction products that is longer life facilities reduce construction process requirements and waste. However, old facilities may become functionally obsolete. Many issues arise like period of use of facilities, rate of obsolescence for our facilities, planning period for the economic analysis of construction products. Another aspect need to be considered is good planning.

Designs should be based on standard sizes and materials should be accurately ordered in sufficient quantities. This approach can reduce the amount of material wastage and increases profitability reasonably by 1 to 2% of total project

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Generally, the economic interest in re-using or recycling building materials is governed by three factors listed below.

1. The availability and thus the cost of natural or new materials.
2. The availability of disposal space, the tipping charges and the taxes for dumping.
3. The transportation cost.

Materials, as one of the resources employed by the construction industry, pass through a number of processes before they are finally incorporated in construction. These processes bring about inadequacies of the materials such that the end not all the materials procured and - delivered to sites are used for the purposes for which they are ordered. This excessive loss in materials what is called Waste. Material wastage is any extra cost over and above the materials used, plus their handling as contained in the estimated price for the job. Today, most of our building waste ends up in landfills increasing the burden on landfill loading and operation. The practice of minimizing and diverting construction waste, demolition debris, and land-clearing debris from disposal and redirecting recyclable resources back into the construction process is commonly referred to as construction waste management (CWM). Waste management affects carbon reduction efforts by impacting one or more of the following.

Energy consumption (specifically, combustion of fossil fuels) associated with manufacturing, transporting, using, and disposing the product or material that becomes a waste.

Non-energy-related manufacturing emissions, such as the release of carbon dioxide when limestone is converted to lime (which is needed for aluminum and steel manufacturing).

## II. LITERATURE REVIEW

Ohno focused for process improvement in the Toyota Production System in 1988. This study resulted in more dramatic performance improvements. Ohno (1988) divides the movement (operations) of workers into waste and work. Waste is the movement that does not add value and is not needed. It is often called unproductive time. Work includes both non value-adding and value-adding work. This definition assumes that some non-value-adding work is necessary in production systems, due to current working conditions-for example, walking to another location to remove parts, removing wrappers from parts, and so on.

Womack and Jones (1996) describe waste as any human activity that absorbs resources but creates no value, such as mistakes that require rectification, production of items no one wants, process steps that are not needed, unnecessary movement of employees, and people waiting for the conclusion of upstream activities.

Ohno (1988) presents seven categories of waste that were identified in the Toyota production system:

1. Unnecessary movement of people (including waste of human energy).
2. Waiting by employees for process equipment to finish its work or an upstream activity.
3. Defects in products.
4. Overproduction of goods not needed.
5. Inventories of goods awaiting further processing or consumption.
6. Unnecessary processing.
7. Unnecessary transport of goods.

The first two categories are related to operations (work by people) while the last five refer to the flow of materials (process). These are some of the conclusions derived from TPS and suitable measures are taken to improve performance in respective industry. Thus concept of Lean Production is developed and strengthened.

Koskela incorporated concept of Lean Production to construction industry. According to Koskela (1992), to implement the concepts of the Lean Thinking in the Civil Construction is necessary, initially, understand the existing concepts, and then implement them in the new environment.

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The first extensive investigation of material waste in the building industry reported in the literature was carried out by Skoyles (1976) at the Building Research Establishment, UK. This study was based on data obtained from 114 building sites during the 1960s and 1970s. Both direct and indirect wastes were investigated in that study. For each category a fairly comprehensive classification of the main causes of Waste was proposed. Among the causes of indirect waste, Skoyles (1976) pointed out that material waste may be incorporated into buildings, since materials are often used in excess of designed quantities, or for a different purpose than what is specified, replacing materials of inferior quality. Regarding the control of waste, Skoyles (1976) admitted that there is an acceptable level of waste, which can only be reduced through a significant upgrade in production system conditions. Thus, waste was classified into, unavoidable Waste and natural waste, in which the investment necessary for its reduction is higher than the economy produced, and avoidable waste, when the cost of waste is significantly higher than the cost to prevent it. Thirty-seven materials had their direct waste measured. The number of sites for each material varied from 1 to 68, most consisting of residential building projects. The percentage of wasted materials ranged from 2 to 15% in weight in relation to the amount of materials defined by design.

### III. WASTE AND WASTE MANAGEMENT

Any substance or object that you discard, intend to discard, or are required to discard is waste and as such is subject to the number of regulatory requirements. Construction waste consists of unwanted material produced directly or incidentally by the construction or allied industries.

#### Categories of Construction Waste

**Process Waste:** The waste generated in the process of construction activities, called as process waste. There are various types of waste that are occurred during the process of construction activities. Such as steel, bricks, equipment's, etc.

**Demolition Waste:** The waste generated in the demolition activity is called demolition waste.

Types of Construction Process Waste:

Construction waste can be broadly classified into four types.

1. **Natural Waste:** Waste to certain extent is inevitable on building sites and this is generally recognised by everybody in a construction industry. This acceptable level of waste is referred to as natural waste.
2. **Direct Waste:** This is the waste which can be prevented and involves the actual loss.
3. **Indirect Waste:** Indirect waste is also known as cost waste. Indirect waste is distinguished from direct waste by the fact that, materials are not lost physically.
4. **Consequential waste:** Cost of wasted materials is greater than their value. These additional costs involved with construction waste is related to consequential waste, and this is usually hidden.

#### Waste Management

Management is the collection, transport, processing, recycling or disposal and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, environment and aesthetics. Waste management is also carried out to recover resources from waste. Being specific to construction industries, construction waste management deals with waste generated during construction and allied activities. Various techniques are adopted in waste management viz.

1. Reduction, 2. Reuse, 3. Recycle

#### Waste Reduction

Waste reduction is a primary step in waste management. Since reduction can be implemented without special efforts, a rather small improvement in process can show substantial waste reduction. In order to reduce the cost of the project and to increase profit margin, all the organizations of the industry need to have a positive attitude towards waste prevention. Since the wastage at construction site is sometimes in the range of 20-30 percent of the total project cost, hence it is better to have control on material wastage as it directly affects the project cost and so to profit.

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## **Waste Reduction Techniques**

**Good operating practices:** Good operating practices generate less waste by making existing processes more efficient. Therefore, they are also good business practices. Since many good operating practices are easy and inexpensive to implement, they are practical for businesses of all sizes.

**Material Substitution:** Using non-hazardous or less hazardous materials in products and services can reduce or even eliminate waste generation. If you're thinking about a substitute, be sure to obtain a Material Safety Data Sheet. Various agencies can help you determine how any industrial wastes must be managed.

## **Process or Technology Modification**

Production changes that can decrease your company's generation of wastes include:

Changing the production process, Changing the placement or layout of equipment, Replacing existing equipment with more efficient models and Automating the production process.

## **Site sorting of waste**

Being specific to construction industry this technique can be implemented in construction industry. All the material wasted or could not be used by any reason should be dumped at a single place and later the sorting of the material shall be done so that the material, which can be reused like bricks, bar pieces, stones, concrete at the site itself, are taken away before the scrap goes for recycling process. In this way we can save some quantity of material without re-transporting it to the site after the recycling process. The main problem in sorting out the waste is even when high tipping fees imposed, they have little incentive to perform onsite waste sorting which is considered to be time and labour demanding. Only through contractual requirements or legislation can onsite waste sorting be fully implemented and becomes a long-term solution to the landfill shortage problem.

## **Recycling of material waste**

Many construction and demolition wastes can be recycled into new materials. Keep in mind that local recycling options vary across the world. Construction waste recycling is the separation and recycling of recoverable waste materials generated during construction and re-modelling. This is the most common way of minimizing the material waste. Some materials which can be recycled and then reused at site are transported to the place where these materials are recycled and made ready to use according to the requirement of the site. In the recycling process the main task for the people working at site, is to make out whether the material can be recycled or not, as these people are not aware of the recycling process and hence require a different team that.

Commonly known as C&D debris, this material is produced during the construction, renovation or demolition of structures. Structures include buildings of all types (both residential and non-residential) as well as roads and bridges. components of C&D debris typically include asphalt, bricks, concrete and other masonry materials, soil, rock, Wall coverings, drywall, plumbing fixtures insulation, roofing, shingles, plate glass metal, wood waste, carpet, and electrical wires. Scrap lumber or wood can be processed and used for landscaping, compost, animal bedding, boiler fuel, or engineered building products. Metals such as aluminium, copper, steel, and brass can be sold to scrap metal yards. This is some of the easiest and most cost effective materials to recycle. Cardboard can be kept separate in cardboard-only dumpsters at the job site and picked up by a local recycling firm. Gypsum drywall can be collected for use as a soil amendment or a substitute for lime on lawns.

Waste is a shared responsibility between all parties of the supply chain, from the client down to the waste contractor. This guidance focuses on the role of contractors and subcontractors, taking into account the fact that they cannot work in isolation to reduce and manage waste. In order to ensure that everybody works towards a common goal leadership is required from clients together with effective interaction between main contractors and subcontractors.

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## IV. CASE STUDY

The brief view of the case is, for any country its infrastructure development is the matter of pride, Indian infrastructure sector is also at the level today with the good initiatives in the areas of roadways, railways, airports and other smart city projects. In the last five years the phenomenal changes in this sector has been done. Due to the increase in the economic growth after development and redevelopment projects in the Country and subsequent increase in the Urbanization in the Cities has made Construction sector to increase drastically, but also Environmental impacts from Construction waste are increasingly becoming a major issue for Construction waste management. In this review paper the today's construction waste generation rate as well as the management practice scenario is explained with some of the suggestions which will be helpful to deal at site and helps to handling. It also covers various rules and regulations currently in practice in India and how it get bifurcated from the solid waste management.

All over the world, the construction industry has gained very rapid growth in recent decades. Due to the increase in infrastructures & industrializations the generation of waste also increased drastically. In general there are two source of generation of construction waste materials, namely bulk generators & retail or small generators. The Infrastructure development sector involves bridges, flyovers, roads etc. Similarly real estate sector involves industrial, commercial & housing building constructions, which are considered as bulk generators. While small commercial enterprises and individual house building teams are considered as retail or small generators. The construction projects must be well planned and must be properly executed to minimize the construction wastes.

Technical & Regulatory Requirements

Policy is required for mandating the following:

Each urban local bodies should keep track of construction activity and generate data regarding quantity and characteristics continuously for at least one year and then once in 3 years.

This data should be collated by the Nodal Agency (may be urban development bodies/Municipal Administrative Department of the concerned state government)

- Expert organizations/institutions should analyse the data and evolve ways to use the material in the best possible way.
- Pilot demonstration projects in each state.
- Change in the relevant regulations and by-laws etc.
- There should be charges for disposal in landfills, which should be sufficiently high to encourage processing and recycling of construction wastes.
- For new constructions, permission from municipalities should include a clear waste management strategy, including use of recyclable building materials. The emphasis will be on reduction of wastes and deconstruction instead of demolition.

From the above paper we understood that, proper and detailed rules & regulations needed to handle the huge mass of construction waste and detail guidelines for the management of various type of construction waste which helps to deal with the quantum of waste, which is nowadays unutilized and partially utilizing in some of the areas.

All the stockholders who are directly dealing with the sites and handling the material they should have detailed legislations and information, So in future optimal utilization can be done and saving rate also increase.

It also helps to increase sustainability and helps to develop market for recycled products.

## V. RECOMMENDATIONS

After identifying the prime causes, next step is to stay aloof from such causes by paying heed to the following recommended solution. This potential recommended solution might help in reducing the wastage of construction material to a great extent, thus augmenting the profit margin and avoid the project delay. As natural construction materials are on the verge of depletion, this solution will help in preventing the depletion of natural resources.

Ways to Control Wastage of Cement at Site.

These solutions have been ranked according to the ranking given to the respective causes.

1. Improper storage and issuance of cement.



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Probable measures to minimise wastage of cement due to this causes are as follows:

- The cement should be used on first come first used basis.
- Materials reconciliation should be done on monthly basis and not to left to be done at the end of the project.
- Proper inventory management of cement. Make use of Just in time order technique.
- During monsoon season cement bags should be covered with polythene.
- The cement bags should be kept close together to reduce air circulation.
- The cement bags should not be hand stitched.
- Do not purchase cement bags which are partially set due to moisture.
- Do not purchase if there are small lumps in the bags.
- Cement should be stacked in a shed, which should be dry, leak proof and moisture proof.
- Cement should be placed on dry brick floors, on wooden crates or on the planks.
- Cement from different manufacturers should be stacked separately.

2. Construction flaws (like structures not in line and level, larger mortar joint & bed thickness in case of brick work).

Probable measures to curtail wastage of cement due to these causes are as follows.

- If the joints of brickwork and bed thickness are more than specified it would lead to wastage of material. So adhere to minimum thickness as specified in specifications.
- Make use of mortar which falls down while doing brickwork by keeping jute bags adjacent to wall to carry such mortar.
- Provide proper thickness of cement plaster to walls by constructing masonry wall in plumb.
- Taking bulking of sand into account to avoid wastage of cement.

3. Due to faulty and/or repair work.

Probable measures to curtail wastage of cement due to this cause are as follows:

- Try to finish the work in line with the principle of "Right work in first time".
- Proper study of drawings and specifications before starting of actual execution of work.
- Stringent supervision at the time of execution to avoid dismantling of the newly cast structures.
- Avoid defective work causing rejects and redoing.
- Proper mixing, transportation, laying & compaction of concrete to avoid honeycombing and rough in order to avoid repair to the same.
- It has been observed at many sites that concrete is filled to an excess height then required and then chipping of that excess concrete is done

4. Due to extra work than the theoretical (e.g. increase in slab thickness, filling the column with concrete to a height more the required).

Probable measures to curtail wastage of cement due to this causes are as follows.

- Proper study of drawings and specifications before starting of actual execution of work.
- Employment of skilled mason on site for finishing work.
- Stringent supervision at the time of execution.
- Make use of levelling instrument while doing finishing work to achieve desired thickness as per drawing.
- Strong support to formwork to avoid sagging of structural members in order to avoid wastage.
- Required quantity of materials should be planned and ordered as per schedule. No extra order should be given then required, if not avoidable work should be properly planned to achieve minimum wastage of material.

5. Poor handling (hook used while unloading from truck) of cement at site.

Probable measures to curtail wastage of cement due to this causes are as follows.

- Lay importance on minimum use of hooks while loading and unloading of cement from trucks.

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Preferably order cement in bulkers to avoid wastage due to this cause.

- Order cement bags which are packed in paper bags
- Make sure of weigh bridge before and after unloading to account for wastage due to this cause

6. Any other reason (miscellaneous cause).

Some ways to reduce down wastage caused by such reasons are as follows:

- No change should be allowed in drawings and specifications after work has commenced.
- Proper planning for storage and procurement during rainy seasons
- Because of suspension and stoppage of work.
- Use of cement in temporary and labour colony construction by labours.
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## VI. CONCLUSION

Material waste has been recognized as a major problem in the construction industry that has important implications both for the efficiency of industry and for the environmental impact of construction projects. Moreover, waste measurement plays an important role in the management of construction projects since it is an effective way to assess their performance, allowing areas of potential improvement to be pointed out.

Construction industry produces more amount of the construction waste every year. Companies related to the various construction project concentrate on the increasing profit by adopting improved productivity and compressing scheduled of the project without concentrating on management of construction waste. This is also observed that not only the cost of the project get increased due the construction waste material but also significant amount of valuable land is got occupied with waste generated by construction industry which have negative impact on our environment.

Due to least priority given to appropriate site waste minimization and management systems in Indian construction industry leads to generation of huge quantities of material waste every year. This problem is not only detrimental at environmental level as most of the waste is disposed off in landfills but also in economic terms as waste materials have their specific economic values before getting mishandled. Examining various reasons for the problem, lack of awareness among clients and contractors, lack of skilled labour, lack of proper training and education, minimal Government interventions etc. are few of the many reasons that significantly affect the Industry as a whole. Proper site waste management reveal that it is economically viable to do significant cost savings from the whole process. In which total benefits exceeds totals cost by incorporating appropriate methods. And widespread adoption can significantly save huge amount of money which otherwise goes into landfills in form of waste materials. First step towards mitigating this problem would be the Government's interventions like Landfill tax, higher tax for using virgin materials, tax credits for recycling etc. can act as an initial momentum towards seeking various other cost saving measures through waste minimization at source and appropriately managing it on site.

Institutions and local organization can create awareness among clients and contractors which will initiate the demand for material waste minimization from clients and voluntarily from contractors.

Several challenges, opportunities and strategies are identified to increase the building waste management. Recycling and reuse of building waste is a sustainable approach which reduced cost, environmental pollution, energy demand, and conservation of natural resources.

The various factors listed above will serve as guidance for engineers and material scientists to develop standards and specifications for alternate building materials utilising building waste.

This study emphasizes the need to plan and develop waste management strategies for construction projects. Further research is needed on environmentally-friendly and energy efficient recycling methods and new reuse applications in infrastructure projects.

In this project the study of construction waste generation at different types of construction sites like commercial, residential and industrial sites was studied and the data regarding waste generation sources and average waste generation was done. Waste is classified in 3R (Reduce, Reuse, Recycle) principle due to this we can minimize cost of project.

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The sources of waste generation are found out like Design, Operational, Material handling, and Procurement. Classifying construction waste material within 3R principal.

This guidance provides a summary for construction clients, design teams and main contractors for achieving good practice WMM on their construction projects. This will help reduce the amount of construction waste sent to landfill, thus demonstrating a contribution to sustainable development and reducing project costs.

Construction waste minimisation can be viewed as a threat requiring ever-increasing expenditure on end of pipe recycling tools and technologies to meet ever-increasing legislation, or as an opportunity to cut cost and improve. The choice should be obvious but there is a need for a culture change. Rethinking waste management in construction requires adopting 'cyclic' rather than 'linear' approach to design and construction. This requires reengineering current practice to contribute to a cleaner environment through efficient and cost effective sustainable waste minimisation to be effective and self-sustaining, it is important that all stakeholders along the construction supply chain embrace a more proactive approach in dealing with waste. In recognition of the responsibility of the architectural profession, through its leading role in project management and a key player in the construction industry, architects should move beyond the concept of 'eco-friendly' through bolt-on environmental strategies and strive to adopt 'eco-effective' practices by implementing a holistic approach to design out waste, which will be reinforced in tender documents and implemented during the construction stage, in addition to the capture and dissemination of lessons learnt to inform construction waste reduction baselines and benchmarking in future projects.

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