

CONSTRUCTION WASTE MANAGEMENT: A CASE STUDY OF ALIGARH DISTRICT

¹Akash Prakash, ²Adil Masood

¹ PG Student, Construction Technology & Management, Al-Falah School of Engineering & Technology, Al-Falah University, Faridabad, Haryana, (India)

² Assistant Professor Civil Engineering Department, Al-Falah School of Engineering & Technology, Al-Falah University, Faridabad, Haryana, (India)

Abstract - Construction waste is becoming a serious environmental problem in many metropolitan cities of the world. In India, the construction industry generates lots of construction waste which causes a remarkable impact on the environment, health, and budget for construction. Thus, the minimization of construction wastes has become a critical issue.

No construction project is waste free and almost every project has a substantial amount of waste generated in the form of building material waste or any other type of construction waste. Managing construction project waste is considered rudimentary for any project to be successful. Although managers can not eliminate waste entirely, they can minimize it by monitoring the project's wastes, developing strategies to mitigate them. Thus, this study aims to identify and evaluate the major factors affecting the cost, time and quality of the project.

The excessive wastage of materials, improper management on site and low awareness of the needs for waste reduction are common trends in construction industry India. The work is a case study for various construction sites in Aligarh which is a district in the state of Uttar Pradesh, India, which relates material control on construction sites with high-rise multi-story buildings.

IndexTerms – Construction Waste Management, Questionnaire Survey, Data Management.

I. INTRODUCTION

India is a developing country where a rapid growth rate has been synchronous with high waste generation and this situation calls for an efficient waste management system in the country. Due to increasing demand of infrastructure, commercial buildings and housing development projects which has generated a large amount of construction waste, real estate developers face financial constraint due to the excessive material wastage at construction sites. The harmful effects of the construction waste material can be seen on our health, general environment, philosophy of art, and nature. Excessive wastage, inappropriate management of material, low awareness about reduction and improper utilization of waste is very common in amongst the constructions sites of India, on the contrary European nations recycle up to 80-85% of the total amount of construction waste. There is a growing demand in this sector of construction waste management in our country, as most of cities are struggling to dispose of this waste effectively. There is no proper record or data in India for construction waste management due to lack of interest, focus on this issue, minimal awareness and absence of data regulatory authorities. This work is a case study for various construction sites in Aligarh which is a district in the state of Uttar Pradesh, India. In this study we have collected and analyzed construction waste data at several sites in Aligarh and find the main factors for waste generation and control of construction waste materials. The study also presents data in the form of percentage for the quantity of waste generated at construction sites in Aligarh. This study also takes some help from the 3R (reduces, reuse and recycle) concept of Hierarchy of the management of the waste materials.

II. MOTIVATION FOR THE PRESENT STUDY

This study is conducted in order to know the general factors, which may contribute in the quantity of construction and demolition waste at the construction sites in Aligarh and also get acquainted with various activities for controlling, utilization or recycling and land filling of this waste. The main motive of this study is to assess the degree of awareness in context to the authorized personnel (site in-charge, contractor, engineers and owner) about the waste management of construction materials, utilization and recycling of these materials in adequate amount, which could in turn prove beneficial for the organization.

III. OBJECTIVES AND SCOPE OF THE STUDY

The primary objectives of this study are as follows:

- To make people aware about the wastage of materials that may be used again.
- To know about the general causes of wastage on construction site.
- To know about the various techniques through which the wastage can be reduced and reutilized.
- To collect the actual data of waste materials from various construction sites.
- To make an effective questionnaire for understanding actual percentage of waste materials and awareness of workers about waste management on construction site.

The scope of this study is limited and given below in following lines:-

- To study construction waste management strategies of different construction sites in Aligarh.
- To study the factors in advance, which lead to waste generation on construction sites.

- To suggest the modifications required in regulations for managing construction waste on sites.
- To suggest improved methods of recycling/reuse/disposal of demolition waste in Aligarh.

IV. SOURCES OF WASTE GENERATION

The construction industry is the largest economic expenditure in India. According to eleventh five-year plan, it is the second largest economic activity after agriculture. Construction industry consumes the high volume of raw materials and products. It generates high employment opportunity. Based on an analysis of the forward and backward linkages of construction, the effect of the construction on an economy is estimated to be significant.

All over the India, the growth of construction industry is enormous in the past decade. In general, there are two main sources for generation of waste materials, namely, bulk generators (Roads, Flyovers, Flats, Parks, Malls, Bridges, multistory buildings) and retail or small generators (Houses, Small Buildings, Small Workshops). The classification of sources is given in Fig 1. The contributors of C&D waste on a project are given in Fig 2, who are responsible for project activities at every stage of planning and minimize the overall waste generation [2].

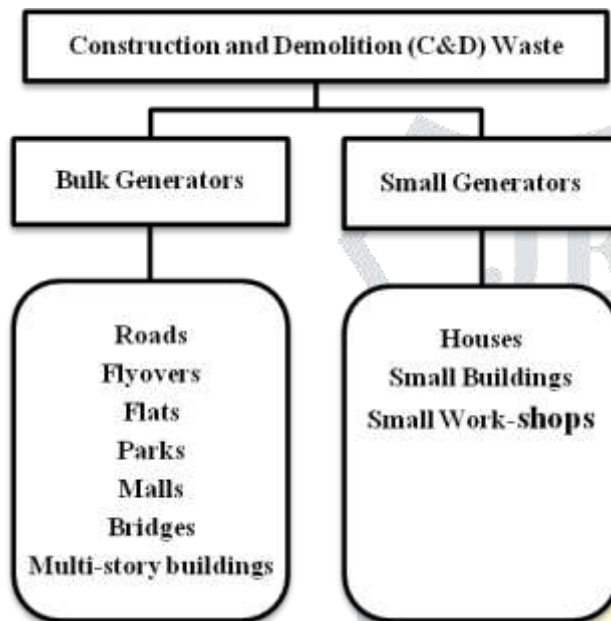


Fig 1



Fig 2

Construction waste is also classified on the base of site observations into two categories, major components and minor components [8].

Major components

- Cement concrete
- Cement plaster
- Bricks
- Steel (from RCC, door/window frames, roofing supports, railings of staircase etc)
- Stone (marble, granite, sandstone and Kota stone)
- Timber/wood (especially in timber forming and demolition of the old building)

Minor components

- Pipes (Iron, plastic)
- Electrical fixtures (copper/ aluminium wiring, wooden baton, switches, wire insulation)
- Panels (wooden, laminated)
- Others (glass panels of window/door, rubber)

V. CONSTRUCTION WSATE MANAGEMENT HIERARCHY

There is some hierarchical order for the waste management that is reduces, reuse and recycle and that is mainly related with the production and consumption today. This hierarchical order is such as that of making of new product. That method can be applied on the entire life cycle of the product that is start from the extraction of raw material, manufacture, construction and disposal.

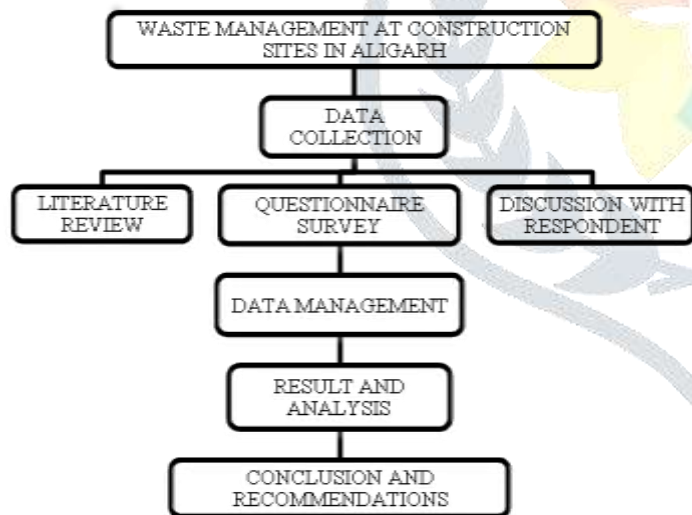


Reduce- It is the process of reduction of waste generation in various stages of construction of efficient material planning. Wastage generation can be identified during the design process itself and care should be taken during the execution stage to decrease the waste that may generate. Waste reduction can be achieved by design, by considering adequate sizes for all required building materials. Designed to be flexible and adaptable to changing uses and design for reconstruction

Reuse - It is the process of reuse of generating waste material as landfill. This involves identification of waste that can be segregated for reuse on the current project or another project and that can be donated. A comparison of the value of the materials “as it is” for salvage and to their value as materials for recycling may be considered prior to reuse in most of the cases. Some of these materials may be valuable to reuse on-site during construction other may be sold to be used for other construction sites.

Recycle- The process of converting waste material to usable construction material replacing the natural materials in some proportion is called Recycling process. After adopting all the options to prevent waste, salvage and reuse materials, the next step is to recycle as much of the remaining waste material as possible. Recycling saves money by minimizing disposal costs and replacing fresh materials to some extent.

VI. METHODOLOGY



VII. QUESTIONNAIRE SURVEY

A list of 25 Questions was circulated amongst the seven Construction sites in Aligarh out of which five construction sites give responded. The rate of response was observed as 71%, which may be considered to be fair for data analysis.

VIII. DATA MANAGEMENT

The data and information collected from varied construction sites in the form of the interviews and questionnaires will be

Fig 3

considered primary data for our study. All of the data is preprocessed and tabulated accordingly prior to result analysis. This collected data is the crux of whole study and management in proper sequence. The key words of data management are description of site locations, percentage of waste materials and re-utilization of waste materials on construction sites and method of dumping wastage.

IX. CONSTRUCTION WASTE MATERIAL DETAILS

It is an important portion of data collection, in which we discuss about all necessary details related to waste materials of construction sites such as percentage of waste materials with an actual view of wastage. This data collected by personal interviews of authorized persons (contractors, site-in-charge, engineers and architectures) and regular site visits. The general waste materials are steel, concrete, bricks\blocks, digging clay, cement, timber, tiles, glass, plastic, and pop.

Steel-

Steel is essentially an alloy of iron and carbon, it is the most suitable building material among metallic materials. By suitably controlling the carbon content, alloying elements and heat treatment, a desired combination of hardness, ductility and strength can be obtained in steel. We well known, steel bars are used in the huge amount in multi-story buildings and a large amount of money spent on purchasing of steel bars. The size of the main bar used on site 25mm, 20mm, 16mm and 12mm and ties bars are the size of 10mm and 8mm on construction sites in Aligarh. The average percentage waste of steel varies from **5 to 7% of total amount of steel** according to by different construction sites because mostly waste steel bars of sufficient length can be used in making of rings of the small size of beams and columns and also used as the tie bar.



Fig 4 – Steel Waste

Concrete-

Concrete is an artificial building material, which is obtained by mixing together certain inert materials called coarse and fine aggregates with the active constituents such as cement and water. Concrete uses in making of various building components like beams, columns, slabs, foundation etc. with helping of formworks. The average percentage of waste of concrete varies from **5 to 8% of the total amount of concrete** according to different construction sites. The waste concrete is only utilized in dumping, flooring and filling of spaces along foundations.



Fig 5 – Concrete Waste Bricks/Blocks-

The bricks are obtained by molding clay in rectangular blocks of uniform size and then by drying and burning these blocks. Bricks are one of the oldest building material brick continues to be a most popular and leading construction material because of being cheap, durable, and easy to handle and work with. The average percentage of waste of bricks is varied from **5 to 8% of per 100 bricks** according to different construction sites.

The blocks are the building material, specifically masonry units, containing fly ash and water. ACC-Block of 625mm x 230mm x 240mm (lxbxh) is used on some construction sites. The price of one block is Rs105 and total consumption of blocks per day on site is varies from 65 to 150. The wastage comes per day in blocks **approx 3 to 5 %** and it is the utilized in filling of holes in walls and the gap between walls and beams.



Fig 6- Bricks/Blocks Waste

Digging clay-

According to site engineers in the starting of the project, a large amount of clay is generated after digging the foundation because the foundation is extra dig with extra width approx. 1m to 1.5m for dumping the wastage in future. This clay can be utilized for making an embankment at sufficient height from ground level for placing other construction materials like pipes, reinforcement bars(different diameters), scaffolding(MS-Pipe), MS-Plates(Shuttering) and tiles. Almost all digging clay uses on site, so it doesn't waste.



Fig 7- Digging Clay Waste

Cement-

Cement in general sense is adhesive and cohesive materials which are capable of bonding together particles of solid matter into a compact durable mass. Generation of cement waste is less, waste cement is only used in dumping, in some cases at the time of storing by moisture effect 4 to 6 bags of cement may waste. Mostly, J.K Laxmi cement is used on construction sites in Aligarh and the price of one beg(50kg) is Rs-320/beg. The average percentage of waste of cement is varied from **3 to 4% of per bag** according to different construction sites. The wastage of cement beg is sold out at Rs-1.5/bag in the market.



Fig 8- Wastage of Cement and Cement Bag

Timber-

Timber, being a natural product available in abundance in India, is used for the construction of doors, windows, roofs, partitions, beams, posts, cupboards, shelves etc. In Aligarh metal shuttering is mostly used, so, there is less wastage generated by timber. The timber purchases for doors, windows, roofs, partitions, beams are required size, which is used in construction work, so there is less wastage of timber created **approx 3 to 4 % per site**, but at the site where timber shuttering is used the approx percentage of waste reached to **15%**.



Fig 9- Wastage of Timber

Tiles-

Tiles are made more or less in the same manner as bricks but they are made thinner for the sake of lightness and larger so that the number of joints may be reduced. These are the common building materials used for roofing, flooring, walls etc. The Broken tiles can be used in skirting of walls. The average percentage of waste of tiles varies from **10 to 15% of the total amount of tiles** according to different construction sites.



Fig10- Wastage of tiles

Glass, Plastic & P.O.P-

A Glass is an important building material, the varieties of glass are being used in building industries for various purposes such as walls, windows, doors, bathroom fittings, glazing etc. The wastage of glass is very less on construction sites, because glasses are purchased only the required size.

Approx percentage of glass wastage is **1%** of the total utilized glass on site and its waste use only in dumping.

Plastics are replacing glass, ceramics and other building materials due to the low-temperature range in which they can be brought to the plastic state and the consequent ease of forming and fabrication and for their low cost and easy availability. The wastage of plastics is very less on construction sites, because plastics pipes are purchased only required size. Approx percentage of plastics wastage is varied from **3 to 4%** and this waste use only in dumping and its waste selling like a scrape.

P.O.P is also known as stucco, it is produced by incompletely dehydrating pure finely ground gypsum at a temperature somewhat lower than 185°C. It is commonly used to precast and hold parts of ornamental plasterwork placed on ceiling and cornices. The average percentage of waste of P.O.P is varied from **35 to 40% of per bag** according to different construction sites.

Sr.	Waste	Percentage of wastage
1	Steel	5 to 7% of the total quantity
2	Concrete	5 to 8% of the total quantity
3	Bricks/Blocks	3 to 5% of per 100 bricks
4	Digging clay	No waste
5	Cement	3 to 4% of per bag
6	Timber	3 to 4%(metal) & 15%(timber
7	Tiles	10 to 15% of the total quantity
8	Glass	1% of the total quantity
9	Plastic	3 to 4% of the total quantity
10	P.O.P	35 to 40% of per bag

Table 1- Percentage waste of materials

X. CAUSES OF CONSTRUCTION WASTE MATERIALS

In general there are various categories of waste on construction sites such as waste of energy, time, manpower and material etc. However, excess utilization and waste of material is the main factor of construction waste with regards to increased cost. The sources of large amounts of waste are related to design changes, leftover material scraps, design or detailing errors and

poor weather. A study conducted on the attitudes of architects and contractors toward the sources of construction waste analyzes that construction material waste is due to design, site operation, procurement routes, material handling and subcontractor's practices. Following are the general causes of material waste which is mostly found on the sites [7].

- Lack of information while preparing construction drawings
- Errors in contract document and design
- Waiting for design documents and drawings
- Changes in Design
- Incomplete contract documents during the commencement of project
- Damage to materials on the site
- Damage to the material due to improper loading and unloading techniques
- Use of excessive quantities of materials than required
- Lack of onsite material management plans
- Damage to the material due to improper packing
- Improper handling of material on site
- Improper storage of materials while execution which leads to damage and deterioration
- Inadequate space for storage of materials
- Theft of materials
- Unavailability of equipment which leads to carrying out the work without equipment
- Lack of waste management plans
- Improper material management on the site
- Improper planning and scheduling of project
- Decision making problem

XI. QUESTIONNAIRE SURVEY

A list of a questionnaire was developed and circulated on construction sites in Aligarh for procuring details of construction waste. These questions have been listed as follows-

- Q-1 what is the total cost and total duration of the project?
- Q-2 which type of concrete and steel grade is used on site?
- Q-3 what type of materials, mostly wastage on site?
- Q-4 what is the expected percentage of steel waste on site?
- Q-5 what is the expected percentage of concrete waste on site?
- Q-6 what is the expected percentage of cement waste on site?
- Q-7 what is the expected percentage of timber waste on site?
- Q-8 what is the expected percentage of bricks\blocks waste on site?
- Q-9 what is the expected percentage of P.O.P waste on site?
- Q-10 How much labor quality, effective the wastage of materials?
- Q-11 How much material can reuse and recycle on site?

- Q-12 Can proper training, proper guidelines and proper site monitoring reduce wastage on site?
- Q-13 which type of material wastage cannot control and reuse?
- Q-14 Does equipment performance plays an important role in waste generation?
- Q-15 Does waste management play a decisive role in waste generation?
- Q-16 Does weather conditions play a decisive role in waste generation?
- Q-17 How much the factor last minute client requirements affect waste generation?
- Q-18 How much the factor uses excessive quantity than required affect waste generation?
- Q-19 How much the inadequate space on site affects waste generation?
- Q-20 May the long project duration cause of waste generation?
- Q-21 How much the factor improper loading and unloading affect waste generation?
- Q-22 How much the factor theft of materials affects waste generation?
- Q-23 Does the construction method play a significant role?
- Q-24 Does the lack of supervision affect waste generation?
- Q-25 Does the lack of waste management plan affect waste generation?

XII. CONCLUSION

The findings of this research indicate that timber formwork, bricks and tiles are still the major waste producing construction process on building sites in Aligarh. Long project duration, errors in construction drawings, lack of communication, construction method and lack of supervision are the factors, which having high importance by respondents, so it is necessary to focus on these factors more on construction sites in Aligarh. Waste generation and management are rated as the least important consideration among authorized persons on construction sites, which affecting the waste management process. A good material control strategy throughout the construction process viz. design, material procurement and on-site handling and accounting should be implemented to control wastage. An effective material control scheme would need the commitments of all parties involved in the construction process.

The contractor should develop effective materials control, waste management plan, proper material handling strategies and good decision making approach, which include educating the workers on waste minimization and communicating with the supplier. The site worker should be made aware of the environmental problems caused by waste and the value of the material with which they are working and handling.

XIII. RECOMMENDATIONS

Following are some of the practical recommendations suggested after our profound study over the construction waste management scenario in Aligarh district.

- Making a daily sheet report of material wastages on sites.
- Spreading awareness with respect to environmental problems caused by waste to workers.
- Minimizing the errors in construction drawings for reducing waste.
- Supervision should be strong and better.
- Overcoming lack of communication on construction sites for improving the working and reducing waste.
- Using good quality equipments and concentrate regular servicing of these equipments.
- Collecting waste from different materials should store separately for better waste management.
- Improving the quality of management system for less waste generation.

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