

## CONSTRUCTION WASTE MANAGEMENT IN CONSTRUCTION INDUSTRY: CAUSES, EFFECTS, CASE STUDY

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**Abstract — Construction industry is the second largest industry in India after agriculture. Construction industry is one of the largest employers of India with the contribution of 11% to the GDP of India. With the significant growth of India, there has been a considerable growth in the construction industry. As the demand for infrastructure is increasing rapidly, the construction industry is set to flourish in the near future.**

Material waste from the construction industry has been identified as a major problem in the recent times. Studies from different construction sites in different countries have shown that even the materials required in small quantities end in the waste in large quantities. Materials are very important for the construction industry at the construction site but all the materials that are delivered are not used completely, creating piles of unused materials which create waste. This waste has a large effect on the environment and hampers the profitability of the contractors. Construction material waste are difficult to recycle and create problems for the disposal.

With some changes in the practices of the construction industry there might be some reduction in the waste and cut down the environmental effects of the waste. In Indian construction industry currently the management of materials is done manually which is not very accurate, time consuming and unsatisfactory. With the scarcity of the construction materials and the increasing cost of the construction material there is a need of efficient use of construction material.

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### I. INTRODUCTION

India being on the verge of becoming world's third largest construction market by 2025 according to the study of Global Construction Perspectives and Oxford Economics. In India construction industry is the second largest industry after agriculture and its contribution to India's GDP is 11%. The construction industry in India will flourish as it provides infrastructure for growth and India is one of the fastest growing countries. Indian construction industry provides large opportunities for employment with the largest investments, maximum use of natural resources, which results in mass scale manufacture of products. The construction industry contributes to the development of the country but it has adverse impact on environment, facing several challenges such as air and noise pollution, land and water contamination, deforestation and hampering the wildlife and marine life. As construction industry involves the use of large amount of materials, the waste generated is also of large quantity.

India being a country of limited resources, the construction materials are always in shortage. If the materials are wasted in large quantities, the cost of the materials increase

Due to shortage and the cost of the project also increases due to cost over-run. Another major issue is of the disposal of the construction waste. In the recent time there is a need of new techniques for the reuse of the construction waste as we are running out of space for dumping of the construction waste.

Construction waste material has a major impact on the construction industry. It also hampers the environment in many ways. This study is to be conducted so as to reduce the impact of the construction waste on the project and the environment as it also decreases the profitability of the project. In India the work of estimation is majorly done manually which is time consuming, tiresome and uneconomic. The unavailability of the material is also a major issue in recent times and its efficient use will help the project in time bound completion with economy.

### II. "5R" TECHNIQUE

"5R" Technique consult with the management of construction waste in four ways, which is resource reduction, reuse, recycle and refuse (land filling).

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First priority should be given for waste prevention / reduction followed by reuse, recycle, refuse, of construction waste material. The process of recycling of material in reconstruction work reduces the chances of the refused. By using “5R” Technique we can deal with the construction waste problem by proper construction waste management we can achieve prevention / minimization of construction waste along with minimization of cost.



Fig.1. “5R” Technique of construction waste management

### III. OBJECTIVES OF RESEARCH

Following are the detailed objectives:

- To study the construction waste generation in construction projects in Nashik.
- To analyse the amount of the waste generated in the construction projects from the data collected.
- To show the problems and impact on cost of construction project arising due to construction waste.
- To find the general view of the public about the causes, effects, generation and reduction techniques of the Construction Waste.

### IV. NEED OF THE STUDY

Construction industry is a widespread industry. There are many problems in construction industry. Construction waste is one of the major issue. By implementation of proper techniques of management of construction waste, this problem can be solved. By implementing proper techniques of construction waste management we can reach our goal of reasonable construction cost.

- The study aims to help us to minimize consumption of resources.
- The study also aims to reduce the site clearance and landfill cost after the completion of construction.
- The study is to be conducted so that there can be a considerable reduction in the transportation cost.
- Problem of wastage of space on site by construction waste can be solved by construction waste management
- The study aims to avoid and reduce various environmental issues.
- Construction waste management can reduce the use of energy and water thus reducing the greenhouse effect.

## V. PREPARE YOUR PAPER BEFORE STYLING

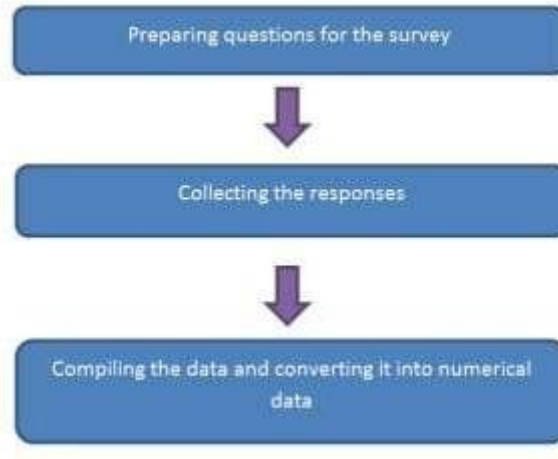


Fig.2. Flowchart of Methodology for questionnaire survey

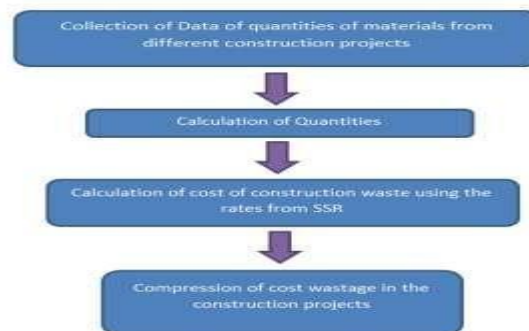


Fig.3. Flowchart of Methodology for Case Study

## VI. DATA COLLECTION

Data collected from questionnaire survey.

This chapter presents a data collection details from the questionnaire survey. Questions in Google Form are circulated and feedback is received from various persons associated with the construction industry. The questionnaire survey was conducted among the people related to construction industry about causes, effects, awareness and role of construction waste.

Data Collection from Site

Data collection of the waste materials were collected from inventories of three construction projects and work done.

Data from the inventory of following three projects is collected to work out the Construction Waste Material for each project.

Due procedure has been followed to collect the data from three different projects. Data of Materials that have major contribution in the project has been collected actually from site of work.

## VII. DATA ANALYSIS

Analysis of Data collected from Questionnaire Survey

From the data collected by Questionnaire Survey following analysis is done as per the various question.

1. Profession?  
The questionnaire survey was conducted among the people related to construction industry about causes, effects, awareness and role of construction waste. All professionals related to the construction industries i.e. Engineers, Builders and Developers, Architects, Professors who were handling various types of construction project at their various cadre level. Out of the 117 responses 16 are contractors, 34 are Architects, 43 are Engineers, 9 are Builders and Developers, 15 are others that include construction field investors, owners, surveyor etc.
2. Who is most responsible for the generation of Construction Waste?  
The persons who are most responsible for the generation of construction waste is find out from the survey. Its come to know that out of 118 responses 58 are management peoples, 17 area Technical staff, 6 are Skilled labours and 37 area Unskilled labours.
3. Is there any need of implementation of Construction Waste Reduction Techniques?  
From the survey out of 118 responses 110 persons realised that there is need of implementation of Construction Waste Reduction Techniques whereas 7 persons don't response and 1 person responded that there is no need of implementation of Construction Waste Reduction Techniques.
4. Do you believe contractor plays an important role in Construction Waste Generation?  
To find out the role of contractor in generation of construction waste, a question was asked in survey in which out of 118 responses 101 persons says that contractor is responsible for generation of construction waste whereas 8 persons don't think so and 9 persons doesn't finalised there decision.
5. Do you believe over-reliance on sub-contractor is a major cause of Construction Waste?  
From the 118 responses of the survey 64 persons believe that over reliance on sub-contractor is a major cause of construction waste, 23 persons doesn't consider sub-contractors role in construction waste whereas 31 persons can't give their opinion
6. Is there any awareness on Construction Waste Management?  
From the survey 117 responses of the survey 43 persons believe that awareness on construction waste management is necessary but 66 person's opinion that there is no need of awareness on construction waste management whereas 8 persons can't give their opinion
7. Which building material contributes maximum amount of wastage according to you?  
It is necessary to determine that which building material contributes the maximum amount of wastage. From the survey Conducted out of 119 responses 3 persons opinion that steel causes maximum contribution to the wastage, 16 persons thinks that cement causes maximum contribution to the wastage, 19 persons says that bricks causes maximum contribution to the wastage, 19 persons says that Aggregate causes maximum contribution to the wastage, 15 persons opinion that Ready mix concrete causes maximum contribution to the wastage, 6 persons opinion that Formwork causes maximum contribution to the wastage, whereas 40 persons opinions that other than these material other material contributes maximum amount of wastage.
8. What are the causes of Construction Waste Generation?  
Survey was conducted to determine the causes of construction waste generation as its play a very important role. Survey shows that poor site management, Improper handling and storage of material, Negligence in supervision, Poor workmanship, Design Lacuna are the causes of construction waste generation chronologically from higher percentage to lower.
9. Does difficulty in calculation of quantity of supplies and excesses lead to Construction Waste?  
Calculations of quantity of supplies and excesses plays very important role in construction waste. Survey shows that 66 persons agree with and 28 persons disagree with this whereas 24 persons area neither agree nor disagree.
10. Does expectations and demands of client result in excessive Construction Waste?  
Client of the project has many expectations and demands from the project which results in excessive construction waste, From the survey it is concluded that 50 persons believe that expectations and demands of clients result in excessive construction waste whereas 40 persons are disagree with this and 28 persons are Neither Agree Nor Disagree.
11. Does Construction Waste result in Cost and Time Over-run?

Finding out the effect of construction waste on cost and time over run is one of the major factor of this project. From the conducted survey responses' shows that 98 persons believes in that the construction waste result in costand time over run whereas 6 persons are disagree with this and 14 persons neither agree nor disagree with this.

12. Is Construction Waste Management a big challenge?

From the survey out of 118 responses 79 persons realised that Construction Waste Management is a big challenge whereas 13 persons don't response and 26 person responded that Construction Waste Management is not a big challenge.

13. Is there a need to include study of Construction Waste Management in college syllabus?

From the survey 118 responses of the survey 110 persons believe that there is a need to include study of construction waste management in college syllabus but 5 persons opinion that there is no need to include study of construction waste management in college syllabus whereas 3 persons can't give their opinion

14. Does Construction Waste hamper environment?

From the 118 responses of the survey 107 persons believe that construction waste hamper environment, 9 persons doesn't consider construction waste hamper environment whereas 2 persons can't give there opinion

15. At what level does Construction Waste affect the environment?

Survey was conducted to determine at what level construction waste affects the environment. Survey shows that out of 117 persons 79 persons thinks that construction waste affect the environment highly and 38 persons thinks that construction waste not affect the environment so much.

16. Do you believe Construction Waste Management techniques are effective in practical?

From the responses to the survey conducted it's come to know that out of 118 responses, 91 persons believes that construction waste management techniques are effective in practical whereas 7 persons not believes that construction waste management techniques are effective in practical and 20 persons cannot say on these.

**Analysis of Data Collected from the case study**

**Project 1:** Name of project: Design, Construction, Supply, Erection, Testing, Commissioning, Start-up and Performance run of 3 month followed up by 0 & 60 months for following works on lump sum turnkey basis at Gangapur in Nashik City under AMRUT programme



**Table 1 – Analysis of data collected from Project 1**



| Sr. No. | Description                         | Cement in Bags | Steel in Ton     | Bricks in No. | Sand in Cu. M    | Metal In Cu. M   |
|---------|-------------------------------------|----------------|------------------|---------------|------------------|------------------|
| 1.      | Material Brought On Site            | 7800           | 272              | 370000        | 1392             | 377              |
| 2.      | Material Available On Site          | 149            | 28               | 3000          | 70               | 1                |
| 3.      | Actual Consumption Of Material      | 7651           | 244              | 367000        | 1322             | 376              |
| 4.      | Theoretical Consumption Of Material | 7341           | 231              | 341000        | 1151             | 328              |
| 5.      | Difference in Consumption           | 310            | 13               | 26000         | 171              | 48               |
| 6.      | Percentage of wastage               | 4.05           | 5.33             | 7.08          | 12.93            | 12.76            |
| 7.      | Rate of Material as per SSR         | 335.0 per bag  | 60000.0 Per ton. | 5.7 per no.   | 1500.0 Per cu m. | 800.0 Per cu. m. |
| 8.      | Cost of Material                    | 2563085        | 14640000         | 1943700       | 1983000          | 300800.0         |
| 9.      | Cost of Wastage                     | 103850         | 780000           | 148200.0      | 256500.0         | 38400.0          |

**Project 2:** Name of project: Augmentation to Nashik Supply scheme Under Jnnurm (Muknne Dam Project).



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| Sr. No. | Description                         | Cement in Bags | Steel in Ton.    | Bricks in No. | Sand in Cu. M     | Metal in Cu. M   |
|---------|-------------------------------------|----------------|------------------|---------------|-------------------|------------------|
| 1.      | Material Brought On Site            | 11987          | 3231             | 611050        | 13042             | 15825            |
| 2.      | Material Available On Site          | 38             | 144              | 00            | 00                | 00               |
| 3.      | Actual Consumption Of Material      | 11949          | 3086             | 611050        | 13042             | 15825            |
| 4.      | Theoretical Consumption Of Material | 11643          | 3002             | 544500        | 12363             | 15150            |
| 5.      | Difference in Consumption           | 306            | 84               | 66550         | 679               | 675              |
| 6.      | Percentage of wastage               | 2.63           | 2.8              | 10.89         | 5.21              | 4.27             |
| 7.      | Rate of Material as per SSR         | 335.0 per bag  | 45785.0 Per ton. | 5.7 per no.   | 1500.0 Per cu. m. | 800.0 Per cu. m. |
| 8.      | Cost of Material                    | 4015645        | 193860000        | 3482985.      | 19563000          | 12330000         |
| 9.      | Cost of Wastage                     | 102510         | 5040000          | 379335.0      | 1018500           | 540000.0         |

**Project 3:**Shree Balaji Height, Kamathwada, Nashik.



| Sr. No. | Description                         | Cement in Bags | Steel in Ton.  | Bricks in No. | Sand in Cu. M    | Metal in Cu. M   |
|---------|-------------------------------------|----------------|----------------|---------------|------------------|------------------|
| 1.      | Material Brought On Site            | 10370          | 95.4           | 3019500       | 2159             | 354              |
| 2.      | Material Available On Site          | 0              | 0              | 0             | 0                | 0                |
| 3.      | Actual Consumption Of Material      | 10370          | 95.4           | 3019500       | 2159             | 354              |
| 4.      | Theoretical Consumption Of Material | 10000          | 90             | 3000000       | 2081             | 311              |
| 5.      | Difference in Consumption           | 370            | 5.4            | 19500         | 78               | 43               |
| 6.      | Percentage of wastage               | 3.7            | 6.00           | 6.5           | 3.75             | 13.82            |
| 7.      | Rate of Material as per SSR         | 335.0 per bag  | 60000 Per ton. | 5.7 per no.   | 1500.0 Per cu m. | 800.0 Per cu. m. |
| 8.      | Cost of Material                    | 3473950        | 5724000        | 17211150      | 3121500          | 283200           |
| 9.      | Cost of Wastage                     | 123950         | 324000         | 111150.0      | 117000.0         | 34400.0          |

## VIII. FINDINGS

Followings are the Findings from the questionnaire surveys feedback data analysis.

- 1) Management peoples are most responsible for generation of Construction Waste.
  - 2) Implementation of Construction Waste Reduction Techniques is essential.
  - 3) Contractor plays an important role in Construction Waste Generation.
  - 4) Over-reliance on sub-contractor is a major cause of Construction Waste.
  - 5) There is not any awareness on Construction Waste Management.
  - 6) Building material that contributes maximum amount of wastage according to survey are bricks, aggregate, cement, ready mix concrete, steel, formwork and other remaining material chronologically.
  - 7) Poor site management, improper handling and storage of material, Negligence in supervision, Poor workmanship, Design Lacuna are the causes of construction waste generation chronologically.
  - 8) Calculations of quantity of supplies and excesses plays very important role in construction waste.
  - 9) Client of the project has many expectations and demands from the project which results in excessive construction waste.
  - 10) Construction Waste result in Cost and Time Over-run.
  - 11) Construction Waste Management is a big challenge.
  - 12) There is a need to include study of Construction Waste Management in college syllabus so as to reduce Construction Waste.
  - 13) Construction Waste hamper the environment.
  - 14) Construction Waste affect the environment very extensively.
  - 15) Construction Waste Management techniques are effective in practical in reduction of Construction waste.
- Followings are the findings from the analysis of data collected from case study.
- 1) Project 1 shows that percentage wastage of cement is 4.05%, steel is 5.33%, bricks is 7.08%, sand is 12.93% and metal is 12.76%. Out of theses material cost of steel waste is found maximum.
  - 2) Project 2 shows that percentage wastage of cement is 2.63%, steel is 2.80%, bricks is 10.89 %, sand is 5.21 % and metal



3) Project 3 shows that percentage wastage of cement is 3.7 %, steel is 6.00 %, bricks is 6.5 %, sand is 3.75 % and metal is 13.82 %. Out of these material cost of steel waste is found maximum.

#### **IX. CONCLUSIONS**

The present research on the 'Role of Construction Waste Material Management in Construction Industry: Causes, Effects and Case Study' arrived at following conclusions from the Questionnaire Survey and after all data analysis of case study. Construction industry is one of the major industry involving prominent use of materials, manpower, plants, machinery and money. Out of these, concentration is given on material and its waste in these study. Construction waste is mostly generated due to improper management, non-implementation of waste reduction techniques, contractors and sub-contractors non responsibility, non-awareness on Construction Waste Management, Poor site management, Improper handling and storage of material, Negligence in supervision, Poor workmanship, Design Lacuna, clients demand and unreasonable changes during execution of project. Construction waste has an adverse impact on environment. All these should be taken care off. Construction waste leads to rise in cost of project which may hamper the budget provisions. Construction waste causes wastage of limited resources.

From the case study of three different project it is concluded that due concentration should be given to reduce Construction waste as different materials waste leads to wastage of money. Cost of Construction waste material varies according to quantity and basic cost of materials.

It is very difficult to deal with waste. The study focus on management of construction waste and implications to cost saving. Effective implementation Construction waste reduction technique such as 4R technique. 4R technique consult with source reduction, reuse, recycle, reuse of Construction waste material is effective in Construction waste reduction.

It is necessary to include study of Construction Waste Management in college syllabus so as to reduce Construction Waste. Also it is necessary to generate awareness of reduction of Construction Waste among the persons related to construction industry.

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