

POLLUTION AND WASTE REDUCTION MEASURES IN RESIDENTIAL BUILDING

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Abstract - Designing a building to support adaptation, disassembly and reuse can reduce waste and extend its useful life, providing economic and environmental benefits for builders, owners, and occupants, and the communities. This practice can also avoid building removal altogether, and allows materials to be easily, cost-effectively and rapidly taken apart and directed for further reuse. By designing for adaptability, disassembly and reuse, design practitioners are finding new opportunities early in the design process to reduce environmental impacts, conserve resources, and reduce cost. Pollution is an issue that the construction industry cannot ignore. The main types of pollution you need to be aware of are air, water and noise. If you don't put precautionary measures in place to manage harmful waste, it can directly affect site employees and people living nearby. This includes causing irreversible damage to their health, with a concerning link between pollutants and cancer.

Key Words: C&D, waste, pollution, materials, methods, scheduling.

1.INTRODUCTION

In recent years, the construction industry has continued to expand with the global economy. In order to become a developed country, there is a lot of development in infrastructure. Since the past decade the growth in infrastructure has been increasing every consecutive year. But at the same time there is an increase in the waste produced during the construction process. Construction and demolition (C&D) materials are generated when new building and civil- engineering

structures are built and when existing buildings and civil-engineering structures are renovated or demolished (including deconstruction activities). C&D materials often contain bulky, heavy materials such as concrete, wood (from buildings), asphalt (from roads and roofing shingles), gypsum (the main component of drywall), metals, bricks, glass, plastics, salvaged building components (doors, windows, and plumbing fixtures), trees, stumps, earth, and rock from clearing sites. Kulatunga et al. (2006) states that the construction industry consumes 25 percent of virgin wood and 40 percent of raw stone and sand used each year globally. Virgin wood, stone and sand are some of the heavily consumed materials in construction industry according to Kulatunga et al (2006). Lakhs of tonnes of materials are extracted globally each year because of production and manufacturing process involved in construction. Use of recycled products, which ultimately reduce land fill waste, helps in cost reduction as well as save environment by bringing certain guidelines and specifications for usage of certain materials (Chini,2007). Large amount of energy is being used annually in extracting of materials thus causing severe environmental impacts and these needs should be addresses immediately (Cole, 2010). These wastes produced create many problems. The problem includes wastage of project funds, which is one of the important factors, deterioration of environment, disposal of the waste materials from the site location and a lot more. Major companies should implement waste minimization strategies to reduce cost construction and increase the efficiency of the projects. Wastage reduction, reuse and recycle are major ways to achieve carbon savings. Tools

should be developed to minimise wastage thus construction costs and environmental impacts are reduced

2. LITERATURE REVIEW

1. Construction and demolition waste generation rates for high-rise buildings in Malaysia - Chooi Mei Mah

The United States Environmental Protection Agency (USEPA) estimates that 154.2 million tonnes of building-related construction and demolition waste (CDW) materials were generated in 2003 (United States Environmental Protection Agency, 2003). Meanwhile in the European Union, the industry contributed 33% (of 821mt) of the total waste in year 2012 alone (Eurostat, 2015). A total of 50% of the total waste generated in the United Kingdom is CDW, with the discharge amount estimated at 70mt per year (Sealey et al., 2001). In Hong Kong, it is estimated at 23%, which amounts to 20mt (Poon and Chan, 2007). In Malaysia, the CDW accounts for approximately 41% of total solid waste generation (Eusuf et al., 2012). Malaysian CDW is estimated at 161.19t per day in 2009, increasing to 299.69t per day in 2015, and is projected to reach 368.31t per day by 2023 (Fauziah and Agamuthu, 2003).

2. Case study of Construction waste in Pune - (Construction and demolition waste management with reference to case study of Pune - Vaishali Anagal)

There are 44 Sezs in and around Pune. With the development of Sezs since the last decade Pune is experiencing a boom in the construction sector. With the change in culture, change in lifestyles and technology,

in Pune. The C&D waste in Pune constitutes many redevelopment projects are coming up 40% of MSW in Pune. The environment status report of the PMC recently admitted that, illegal dumping of construction rubble in the riverbeds and hills continued in the city. In many instances debris is dumped in the green belt of the river, affecting its natural flow. Pune Municipal Corporation (PMC) with support from United Nations Environment Programme –International Environmental Technology Centre (UNEP-IETC), Osaka, Japan implemented a project to develop an Integrated Construction

Waste Management (ISWM) action plan for Pune in September 2007. The action plan proposes various innovative ideas and approaches in line with the current national and international trends to ensure an efficient, cost-effective and sustainable solid waste management. These approaches include, for instance: 3R (Reduce, Reuse and Recycle) Following figure gives projection regarding C & D waste in Pune. According to DNA, Wednesday, Apr 18, 2012, dumping of construction debris at both sides of the Mula river resulted in flash floods of 2010. On both the Pune and Pimpri-Chinchwad side of the bridge, dumping of debris has reduced the width of the river. Similarly, the debris causing the obstruction to the free flow of water has resulted in reduction of width to its half and caused flash floods during the monsoon. The river is losing its flora and fauna, the migratory birds are also disappearing because of the pollution of the river.

Graph Showing C&D waste for Pune

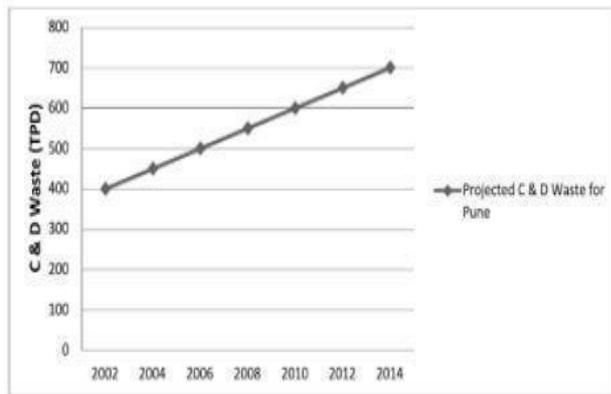


Fig. 1. Projected C & D waste in Pune. Source- Action plan for ISWM developed by IINEP-IETC, FMC.

3. A perception on waste material minimization in Construction industry - R. Shreena Shankari - (2017)

The paper highlighted the importance of waste management in construction, amount of waste generated in construction projects, methods of minimizing waste and best methods involved in construction industries to minimize waste. Identifying the factors that can contribute to materials that are minimum wasted. Which is a need to concentrate even on materials that are least wasted as any small improvement in reduction of waste generated adds to the advantage in improving the overall efficiency of the project and enhances the construction industries performance with cost saving benefits. And suggested waste management plan which only minimizes the material waste but also improves the profitability and decreases the cost overrun.

4. Recycled aggregates : A solution of Construction and Demolished waste - Sumit Arora ET AL. (2015) stated that natural resources are limited in nature and will be depleted with time. In order to conserve the natural resources, unnecessary

wasting of natural resources should be restricted and regulated. Formulation and implementation of proper waste management plans throughout the life cycle of the projects can minimize C&D waste. With an integrated resource management scheme, most of the construction and demolition material can be recycled or reused and more natural resources can be conserved for our next generations. The success of recycling requires promotion by means of education and information, in addition to judicial rules from the concerned governing body.

5. Factors Of Waste Generation throughout the Construction life cycle (Nor Solehah Md Akhir, I. Rahman.): This paper states that the construction industry has an adverse impact on the environment due to its generation of construction waste. Besides the environment, the waste generated also affects the cost, productivity, time, social and economy of the industry. This waste generation is resulted from various factors at different stages of the construction lifecycle. Current study has identified 46 factors of waste generation based on extensive literature review. These factors were classified into 7 groups and clustered according to their occurrence relative to various phases of construction lifecycle. It was found that most of these factors occur during the construction phase. The significant factors that occur during the construction phase are error ordering and poor workmanship. By identifying the crucial occurrence phase of factors which contribute to waste generation, it will help the construction community to avoid or lessen

the construction waste generation.

6. Implementation of Waste management and minimisation in the construction industry - Rawshan Ara Beguma ET AL. (2007), identified some waste minimization factors which are helpful for implementation for construction waste management systems in the construction industry. And provided proof on the important stage of contribution and the stage of construction practices among the waste minimization factors the model of weighted average of factors and minimization and practiced index value of factors and analyzed indicate the most important, less important and important factor that contribute to waste minimization and the maximum construction practiced, less practiced waste minimization factors in the construction industry of Malaysia.

7. Designing out waste in Highrise Residential buildings and Analysis of Precasting and methods and traditional construction(2006): The construction industry is a major generator of waste material. Construction waste should be minimised. If we are to significantly reduce the level of construction waste designers should consider reducing construction waste during the design process. The majority of construction waste generated from the construction process. In general, any reduction in on-site concreting leads to waste reduction. Pre-casting and prefabrication therefore offers significant opportunities for the reduction of waste. If pre-casting is adopted there are significant implications for the design phase of the

project. Additional information is needed by design staff, construction expertise is required as part of the design process. Precast construction in buildings includes precast concrete frames, precast flooring units and other components such as walls, floors, stairs and lift towers. More recent developments have focused on volumetric components, e.g., bathroom and kitchen modules which, can be laden onto the floor slab as the structure is erected.

8. Types of Construction waste - (Study on Construction waste management in construction site - Mohid Faizul B Yusof)

Construction waste can be classified into excavation waste and complex waste depending on the stage at which it is produced. Inert waste includes waste such as concrete, brick, stones etc. It is important to have a knowledge on the different waste so that it can be easy to salvage, recycle and reused. It also enables to segregate all correctly and remove it from the site properly and safely. Site management audit can also be easily done. Below is the different types of waste from the construction site:

9. Effect of Construction waste on the environment - (The Impact of construction and demolition waste on environment - Sakshi Gupta and Malik RK)

A lot of construction waste is used by the land sharks to illegally fill up water bodies and wetlands around urban centres for real estate development. the rest is just being dumped into rivers and open spaces. illegal disposal sites have been discovered in gravel pits and ground water recharging areas, on farm land

and prime residential property and low-lying areas. potential groundwater contamination results from small amounts of hazardous materials such as organic compounds, heavy metals that may be present in the substances that have been applied to construction materials, or by improper disposal of residues or bulk chemicals in the waste stream. Degradation of ground water quality may also result from larger amounts of generally nontoxic chemicals such as chloride, sodium, sulphate and ammonia that may be present in leachate generated from C and D waste materials, when land is filled. Therefore we can say that improper disposal of construction waste does pose a threat to ground water quality. An illegal disposal site may also attract illegal disposal of other types of waste including conventional municipal waste, industrial waste and hazardous waste. These would further impact the site and increase further cost for cleaning up the contaminated site.

10. Government rules and guidelines (A review on waste material minimization in construction industry- R. Shreena Shankari, D. Ambika, S.S Kavithra) :
Construction agencies like CPWD say that Indian laws permit the use of only naturally sourced building material. The IS:323-1970 Indian standard specification related to aggregates for concrete, laid down by the Bureau of Indian Standards(BIS), stipulates that concrete can be made only with naturally accessed materials. Construction agencies cite this rule to avoid using recycled C&D waste. C&D waste finds a brief mention in

schedule III of the rule for separate collection, in the Municipal Solid Waste (Management and Handling) (MSWM) Rules, 2000. Additionally, the union ministry of urban development (MoUD) has a 2000 publication titled the manual on municipal solid waste management that includes a chapter on C&D waste, the chapter provides some basic guideline on its handling.

11. ANALYSIS OF WASTE: Reduce, Reuse and Recycle - (Paper on Reduce, Reuse and Recycle in sustainable construction waste management - M.A Kazerooni sadi, Arham Abdullah, Masoud Navazandeh):

Construction waste can be classified as the excavation waste and complex waste. Burning these construction wastes at the landfills lead to air pollution and land pollution so it is better to reuse and recycle the waste. The materials waste used in the construction can be reduced, reused and recycled based on their properties by segregating waste at its source. Some of the items such as soil, cement, sand , aggregate etc are mentioned in the below table based on how they can be managed.

3. PROPOSED METHODOLOGY

The research methodology adopted for this study is through floating a questionnaire to the various working professionals in the industry. The idea of this questionnaire is to collect the causes for waste generation based on their work experience. Then based on the data collect sorting of the causes will be carried out. The wastage caused due to these causes

will be calculated and then analysis is carried out and then the statistics will be prepared.

The preparation of the questionnaire is done by taking few references from the literature reviews mentioned in the earlier section. We had come to a conclusion that waste generation is a result from various factors at different stages of the construction life cycle. So, we had the stages of construction cycle where wastage is caused into four different stages, they are:

1. Procurement Phase
2. Handling of material
3. Culture of the organisation
4. Construction phase

Then we had a further study on each stage mentioned, so that they can be classified and major factors of causing wastage in each stage were sorted.

In procurement phase the factors causing wastage are:

- a. Deliver Methods
- b. Delivery Schedules
- c. Purchase of inadequate materials
- d. No take back schemes
- e. Poor advice from the suppliers.

In Handling phase the factors causing wastage are:

- a. Damages due to Transportation
- b. In-appropriate Storage
- c. Poor product knowledge by Labours
- d. Equipment Failure

- e. In-appropriate tools to handle the material.

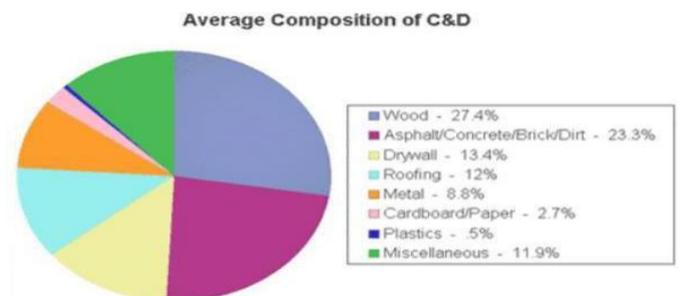
In Culture of Organisation the factors causing wastage are:

- a. Lack of awareness
- b. Lack of support from senior management
- c. Lack of Training
- d. Lack of will work
- e. Lack of Incentives

In Construction phase the factors causing wastage are:

- a. Poor Workmanship.
- b. Design, Rework and variation.
- c. Inexperienced staff.
- d. Poor Communication & management.
- e. Act of god.

Depending on these factors a questionnaire was prepared and circulated. The responses obtained will help understand the main contributing factor of wastage in each stage.



3. CONCLUSIONS

From the responses we got, we were able to know the main reasons for wastage in each phase categorized as shown in earlier chapters. So, we have given the reasons for that particular wastage and also a few recommendations which can be implemented to reduce wastage. The reasons recommendations are given for top two factors of wastage in each phase:

In Procurement Phase:

1. Purchases:

Unfortunately, some construction purchase orders are poorly written which results in the supplier delivering the wrong item, or delivering the items to the wrong address or at the wrong time. Sometimes the purchases made are faulty or not satisfying to the client which leads to rejection ultimately causing wastage. This can also lead to misunderstandings, additional costs and even delays to the project.

2. Poor advice from suppliers:

In the industry, finding a good supplier for all of those items and sticking with those providers to streamline our material sourcing process is very difficult. Randomly trusting suppliers leads to procuring ample amounts of materials, faulty materials or delivery of materials after the due date which ultimately cause wastage.

Handling Phase:

1. In-appropriate Storage:

Improper storage can lead to damage of raw materials or any kind of materials which will be used in future. In the construction industry it is essential that storage of materials and equipment is considered for the entirety of the project.

This is due to the vast amount of materials, tools and machinery that they use for construction projects. Inappropriate storage leads to misplacement and damage causing wastage.

2. Wastage due to transportation:

In this phase waste is generated due to internal movement of materials on site. Excessive handling, the use of inadequate equipment or bad conditions of pathways can cause this kind of waste. It is usually related to poor layout, and the lack of planning of material flows.

The movements may involve one jobsite to another, or from supplier to the site or from a yard to a material laydown area and then again to the actual work area. Transportation waste is especially counterproductive, as it not only adds time to the whole construction process but exposes the material to handling damage.

Culture of organization:

1. Lack of awareness:

Lack of awareness creates confusion and misunderstandings. This leads for unnecessary movement and also usage of materials which will be again redone or left for no use. Improper planning, communication gap and lack of knowledge creates a lot of issues and ultimately material wastage.

2. Lack of training:

Employed staff without proper training and knowledge causes wastage due to various reasons. The usage of equipment in an improper way and not handling the materials in a proper manner and taking decisions may lead to a lot of wastage.

Construction Phase:

1. Poor workmanship:

One of the major areas of concern is poor workmanship. In simple terms, workmanship is the skill and quality put into making a product or completing a project. Workmanship is about quality; good or bad. If workers are careless or don't follow proper protocol you can end up with a finished product that lacks the quality that is anticipated. If the workmanship is poor, even if the final quality is acceptable there would be a lot of waste generated during the process.

2. Design rework and variation:

Whenever there is change in the given design or there is any change in the plan or if there are any executional mistakes carried out in the project, there would be a lot of material wastage. The unwanted or the changed items have to be demolished and rebuild again. During the whole process there would be some or the other wastage caused throughout the process

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