

# Management of Construction Waste Materials: A Review

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**Abstract:** *With the advancement of science and technology, a wide range of new building construction materials has been developed for the construction of civil engineering structures. Depending upon the type of the structure, the cost of construction materials may be up to 65% or more of the total cost. Utilization of appropriate construction materials coupled with effective management of these construction materials largely help successful completion of the structure. Due to mushrooming of big construction industries/companies, disposal of construction wastes has become an environmental issue these days, especially in big cities. A large quantity of various types of construction wastes with different characteristics is generated every day. However, this environmental problem may be minimized by introducing a systematic management of construction wastes. Such a system coupled with appropriate construction techniques minimizes generation of waste construction materials and consequently helps in achieving economic and environmental benefits. In this study, a review on systematic investigation on the management of construction materials and construction wastes is presented.*

**Keywords:** Construction material, Management, Construction Waste, Construction techniques, Environment.

## 1. Introduction

Construction industry is one of the fastest growing economies in India. Accordingly, introduction of appropriate management system in terms of construction materials and organizational set up may be beneficial to not only the construction companies but also the society and environment. The success of a construction company is substantially dependent upon the implementation of an effective management system of the construction material. During the last few decades, this industry has evolved along with the ever growing requirements and complexity of projects. Construction materials constitute a major cost component of a civil engineering structure. The cost of construction materials may be upto 65% of the total cost incurred in the construction of a civil engineering structure. However, it is dependent upon the type of project, and the construction technique and plant used [5]. Appropriate planning and construction management reduces wastage of construction materials substantially. This in turn improves the performance and economy of the organization. Material management functions in coordination with planning and control of material flow. One of the major challenges faced by construction companies is keeping the progress as per schedule. Poor progress of construction may in majority of cases be due to poor planning and management of construction material. It is concerned with planning, procuring, receiving, stacking and distribution of construction materials at appropriate time and place. The main objective of material management is to make available the right construction materials are in the right place, in the right quantities when needed so as to avoid wastage of construction materials and time. The phenomenal increase in

construction wastes. Millions of tons of construction materials are generated all over the world annually. It has become one of the serious problems in construction industry. Hence proper management of waste construction materials from construction sites has now become very crucial. Management of waste construction materials encompasses reusing construction materials which could otherwise become wastes, disposal of the unusable wastes wherever possible, and minimizing waste generation wherever feasible. A large quantity of various types of waste with different characteristics is created at all the stages of construction right from the start of construction site preparation, and demolition of existing structures. The estimation of the exact quantity and composition of construction wastes generated during different stages of construction is difficult due to the dynamic nature of the construction activities. The nature of waste composition might be different at various construction stages. Thus waste generation throughout the construction stages needs to be identified and quantified for proper management.

## 2. Management of Construction Materials

An essential factor which adversely affects the performance of construction projects is the improper management of construction materials during the execution of construction activities. Therefore, if the flow of construction materials is not managed properly it may result in a major variation in project cost. The total cost of the project can be reduced to a certain extent by taking corrective measures in cost variance. Studies by the Construction Industry Institute (CII) have shown that construction materials and installed equipment can make up to 50– 60% of the total project cost. Fundamental principles of construction site material management enlighten the factors considered during construction site layout and planning for efficient material management. Ineffective material management practices are evident on many projects and cause considerable waste in

infrastructural development, economic growth as well as urbanization have led to generating large amounts of

time and money. Material management system in any project ensure that the right quality of material and quantity of construction materials are appropriately selected, effectively purchased, properly delivered and safely handled on construction site in a timely manner and at a proper reasonable cost. Any organization needs to put their efforts for proper construction materials management systems for the effectiveness of project execution. There should be a centralized material management team co-ordination between the construction site and the organization so that effective material management strategies can be applied and monitored. Construction materials management may present similarities at the conceptual level but the implementation details vary. Material planning considers construction materials in the order of requirement at construction site [6]. Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of material shortage or excessive material inventory on-construction site deficiencies in the supply and flow of construction material were often cited as major causes of productivity degradation and financial losses [5]. It is observed that construction materials are less homogeneous, less standardized, and more numerous than those of manufacturing, and that the characteristics of demand are different. There should be awareness about material planning & scheduling at every stage of material management [2].

### 3. Construction Material Management Techniques

Construction materials management is categorized to 5 processes these processes are majorly followed on construction site they are namely 1.Planning, 2. Procurement, 3. Logistics, 4. Handling 5. Waste control processes. Construction materials planning include quantifying, ordering and scheduling. Companies may have two major levels in planning- micro and macro level. Procurement is described as the purchase of construction materials and services from outside organizations [5]. Purchasing procedure can be described as Step 1: Material Indent, Step 2: Enquiry to Vendors, Step 3: Vendor Comparison, Step 4: Vendor Selection and Negotiations, Step 5:Purchase Order, Step 6: Vendor Evaluation. Receipt system can be divided into 1. Receipt from outside suppliers 2. Receipts from internal divisions. Inspection can happen in two ways 1. Pre-dispatch inspection 2. inspection on the construction site. There are three methods of inspection 1. Visual 2. Tactile 3. Statistical. Logistics is a concept that emphasizes movement of construction materials. Construction materials handling encompasses virtually all aspects of various movements of raw construction materials, work in process, or finished goods within a construction site [5]. For effective material management the most important construction materials management functions are (I) Primary Functions: the primary functions of the construction materials management are defined as construction materials requirements planning (MRP), purchasing, inventory planning and control, ascertaining and maintaining the flow and supply of construction materials, quality control of construction materials, departmental efficiency. (II)

Secondary functions are standardization and simplification, make buy decisions, coding and classification of construction materials, forecasting and planning [5]. Some other functions in the context of material management are: Project Acquisition Strategy, Subcontracting, Expediting, Supplier Quality Management. Construction site Construction materials Management, Construction materials Management for Operations and Maintenance, Implementing Construction materials Management Programs [3]. For effective execution of material management following process can be followed first of all material need generated from construction site, then material ordered in store after that indent is generated, then check availability in the store after that check for the balance Items after that vendor selection from the approved list then Material Inspection from received stock at last issue of material to the department [4]. Implementation of IT in construction materials management could facilitate the effective and efficient control of construction materials on construction site reducing the human efforts. Implementation of IT includes construction materials planning system, material handling equipment selection advisor, construction materials exchange, and bar-code system [3]. Experimental methodologies which can also be adopted for management of construction materials are analysis of construction site and management, analysis on inventory controlling, analysis on purchasing procedures, analysis on procurement and tracking, analysis on costs [2].

### 4. Present Trend of Material Management

Research has shown that construction materials and equipment may constitute more than 65% of the total cost for a typical construction project [5]. In Indian construction industries currently manual construction materials management practices are prevalent and control procedures are unsatisfactory as they are labour intensive, inaccurate and error prone. All these factors contribute to wastage and surplus supply of construction materials, delays in construction projects, decrease in labour productivity and lack of up-to-date and real time information of the project. An initial assessment of the tools and techniques currently in use in construction materials management suggests that most of them are under development with a few being used on a commercial basis [6]. New emerging technologies such as wireless communication system, bar-coding readers and Radio Frequency Identification (RFID) are being adequately used on construction site to overcome human error and are well integrated with project management systems on construction projects to make the tracking and management of construction materials easier and faster [6]. It has found that scheduling delays occurred in 70%, 40% and 50% of government contracted construction projects in the United Kingdom, India, and United Arab Emirates (UAE) respectively due to improper material management [3]. Currently all over the globe the main reason in cost variance and problematic management of material are due to overstocked construction materials because of improper planning, damaged construction materials due to logistics, handling or in application, loss of construction materials because of improper supervision, waiting of the construction materials to arrive in location due to improper tracking

systems, frequent moving of construction materials due to improper construction site layout, inflation, material changes in buying/purchasing situation starting from the prepared cost estimation, bulk construction material, shortages and changes in the quantity of construction materials, construction materials inefficiency on construction site, stealing and loss of construction materials, material shipment, work repairing, delay in updating/posting storage system on construction site, inaccurate measurement of work location on construction projects, material off take, inaccurate estimation of shipment quantity of construction materials, uneconomic order quantity of construction materials, poor shipping time, inadequate tools/equipment needed on construction site, increasing transportation cost of construction materials, material over usage in location of project, choosing the wrong construction materials for construction, the increasing storage cost of construction materials, the poor buying ability of managers, delay of payment for construction materials, and the poor policy in purchasing the construction materials [3]. It is found out that administrative causes are 30% which affects directly and 5% reasons due to unavailability of material for faulty material management. "A" category consists of 10% of total material involved in construction but that cost 70% of the total cost [6]. Research has shown that construction materials and handling equipment may constitute more than 50% to 70% of the total cost for a typical construction project. Firms employing proper material management system are seen to have increased their overall efficiency by 35% [5].

## 5. Construction Waste Management

Construction waste consists of unwanted material produced directly or incidentally by the construction or industries. Construction and demolition waste is generated whenever any construction/demolition activity takes place [1]. Construction wastes in any project are in the form of building debris from demolition activities, rubble, earth material, concrete wastes, steel wastes, timber wastes, and construction site clearance construction materials, arising from different construction activities of project including land excavation or formation on construction site, civil and building construction materials, construction site clearance waste, demolition activities waste, roadwork waste, and building renovation waste. The management of construction wastes is a global environmental issue experienced by countries all over the world [5]. Vigorous literature review identified 81 factors for causing construction waste and clustered in 7 groups of factors namely design of project, handling of construction materials and equipment, construction workers, project management, construction site condition and procurement of construction materials and external items [4]. The term "wastage" refers to the variance if any between the estimated and actual consumption of an individual item and total factor consumption of all inputs in a construction project. Material waste has been recognized as a major problem in the construction industry that has important implications both for the efficiency of the industry and for the environmental impact of construction projects [7]. For managing the waste their must be efficient waste management system which can control the waste at source

and manage the waste at every stage or phase of construction project [5]. Moreover, waste measurement plays an important role in the management of production systems since it is an effective way to assess their performance. The increasing awareness of environmental impacts from construction wastes has led to the development of waste management as an important function of construction project management [4]. Waste management in construction activities has been promoted for the aim of protecting the environment in line with the recognition that the wastes from construction works contributes significantly to the polluted environment [3]. Various approaches for managing construction wastes have been developed in the existing research works and simultaneously practices, and these project works can be grouped largely into three areas mainly classification of waste, management strategies for waste and disposal technologies for waste. Construction activities generally have negative effects on the environment, which includes the exploitation of natural land and other resources for development and the generation of waste and various forms of pollution [2]. Other negative impacts to the environment are generation of waste, ecological imbalance, changes in living environment, sewage, reduction in environmental resources and energy usage [5]. To reduce this impact on environment construction practitioners need to determine significant contributory factors of waste generation before engaging with construction works [1].

## 6. Control of Construction Waste

Reduction of waste can be done by practicing attitude towards Zero wastage, proper decisions at design stage, construction site management, proper standardization of construction materials, and Codification of the same [5]. Construction waste can also be reduced by using waste management system on project. The project activities are to be planned at every stage by every construction personnel, who are involved, in minimizing the overall waste generation at project [4]. Waste rate estimation method can be used to improve the handling material, reduce the waste rate, and improve productivity [5]. Concept of 3R and 4R can be also beneficial to reduce the wastage of construction materials, which includes reduce, reuse, recycle, and recovery. These can be applied to the entire lifecycles of products and services [4]. The free-flow mapping presentation technique can be adopted in the study for investigating the waste flow practice on construction sites. The technique has been considered advantageous in presenting flows of processes logically, clearly, and in the simplest way. The prediction of waste flow can be modeled through the building elements at the construction stages [7]. For effective reduction of material waste management strategy for construction waste can be used such as reduce waste generation, maximize reusing, and recycling, reduce the intake of mixed construction waste at landfills. The use of environmental friendly construction methods has been encouraged, such as using a large panel system on any project construction site, applying prefabrication components for enhancing effectiveness, and reducing the application of wet trade. A management strategy for construction waste also involves the maintenance of a well-managed public filling programme with sufficient facilities and access. Sort mixed construction

waste and not just dispose of it in any single place, reuse and recycle as of construction materials as far as possible, design better and construct more efficiently to minimize waste etc. [1]. Various strategies for Construction and Demolition waste reduction also include standardization of design, stock control for minimization of over ordering, environmental education to workforce etc. [2]. Government implemented construction waste disposal charging scheme (CWDCS) can provide financial incentives to C&D waste generators to reduce waste and encourage reuse and recycling. Government's interventions like Landfill tax, higher tax for using virgin construction materials, tax credits for recycling etc can be used on construction site for waste minimization [7].

## 7. Present Situation of Construction Wastes

Due to least priority given to appropriate construction site waste minimization and management systems in Indian construction industries leads to generation of huge quantities of material waste every year. Presently, awareness of resource-efficient construction practices is lacking in most countries [3]. Currently, existence of national policies as well as the regional policies, laws and regulations governing reuse and recycle principles for construction waste is minimal as far as India is consent [2]. At present, private contractors remove this waste to privately owned construction site, low-lying land for a price purpose, or more commonly dumping it in unauthorized locations along roads or other public land or the region [1]. Central Pollution Control Board has estimated current quantum of solid waste generation in India to the tune of 48 million tons per annum of which waste from Construction Industry accounts for 25% [1]. Recent studies as in pointed out the waste generated in China are around 40% and 39.27 million tons in Spain. Malaysia and Singapore is facing the problem of illegal dumping and the issue has become more serious recently throughout the country. According to government statistics, in Hong Kong, soft inert construction materials (such as soil, earth, and slurry) account for approximately 70% of all C&D waste, which can only be reused as fill construction materials in reclamation and earth filling works [7]. Investment in construction accounts for nearly 11 per cent of India's Gross Domestic Product (GDP) (Market, 2009). Technology Information, Forecasting and Assessment Council (TIFAC) study mentions that total construction work for five years during 2006-2011 is equivalent to \$847 billion. Therefore material waste generation from construction activity is also huge in monetary terms. Statistical data shows, construction, and demolition (C&D) debris frequently makes up to 30% of the waste received at many landfill construction sites around the world. According to European Topic Centre on Resource and Waste Management (EIONET, 2006) construction and demolition waste represents around 25% of all waste generated. Indian buildings in 2013 must have generated more than 53 million tons. Demolitions of buildings generate 300-500 kg per sq meter (TIFAC. 2013). Considerable research has been carried out in country like United States of America, Japan, United Kingdom, France, Germany, and Denmark etc. for recycling of waste concrete from construction sites, Materials like masonry, bricks, bituminous and other constituents of waste are collected from

Construction Industry. These studies have shown possibility of using construction waste to substitute new construction materials of recycling. Today, in most European countries use recycled materials up to 80–90% of the total amount of construction wastes and most advanced demolition and recycling technologies are generally implemented [7].

## 8. Control of Construction Waste

The presented systematic literature review revealed the requirement of a change in management processes of construction materials. Introduction of mechanized handling of construction materials will improve efficiency and cost effectiveness on the construction site. This is because of the fact that poor handling of construction materials affects the overall performance of construction projects in terms of cost, time, quality, and productivity. From the literature review it is understood that this area require further research to find some detailed and feasible management strategies to minimize the total project cost. In absence of proper system for procurement and management of construction materials, no project can be completed economically and efficiently. Also, it is revealed that minimization of wastage of construction materials during the construction phases is important in order to avoid losses. It is observed that considerable research has been conducted to investigate individual construction waste management strategies at a specific stage of a construction project. Currently, the majority of research efforts have been given to the material loss in construction activities rather than the non-value adding work as an intangible waste. Waste Generation Rate is an effective indicator for measuring construction waste and benchmarking construction waste management performance.

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