

# On Utilization of Construction and Demolition Waste in New Construction Projects Towards Sustainable Growth in India

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**Abstract:**— Sustainability is one of the key issues these days almost all around the world and has drawn attention in any major construction projects. In recent past years, there is significant gap between demand and supply of construction materials. In one hand, natural resources are being depleted rapidly to meet this demand leading to environmental imbalance. On the other hand, huge amount of construction and demolition (C&D) waste is being generated every year and disposed into open land leading to useful space reduction thereby enhancing level of environmental hazards. That's why C & D waste has drawn attention of the investigators. Studies have been performed considering C&D waste as the potential coarse aggregate replacing natural resources for the purpose of producing concrete. Various initiatives e.g. Smart Cities Projects, Swachh Bharat Mission etc. proposed /taken up by Government of India have made Indian construction industries to go for sustainable construction techniques in order to achieve the sustainable growth in construction sector. This paper has reviewed different aspects of C&D waste generated in India and brings out effective utilization of the same towards possible future sustainable growth in the construction industry.

**Index Terms:**— Building materials, C&D Waste, environmental imbalance, Sustainability.

## I. INTRODUCTION

According to the World Commission on Environment and Development of the United Nations, sustainability means “meeting the needs of the present without compromising the ability of the future generations to meet their own needs” [1]. So ‘Sustainable Construction’ can be explained as “meeting the needs of all required construction materials at present without compromising the ability of the future generations to meet the demand of the same in terms of quantity and quality”. Sustainable construction also incorporates elements of economic efficiency, environmental performance and social responsibility [2]-[4].

In India, the construction industry has gained very fast growth in recent decades due to advancement in Science & Technology, rapid industrialization and urbanization [5]. So demand of major construction materials like sand, stone, cement, brick and steel etc. have increased drastically. These major construction materials are obtained from limited natural resources indicating high depletion rate of natural resources leading to alarming sign for our environmental/ecological balance. Still a shortage of aggregate to the extent of about 55000 million m<sup>3</sup> in housing sector and an additional 550 million m<sup>3</sup> in road sector was reported for

achieving the target [7]. These shortages are expected to increase with passage of time. On the other hand, the construction sector is generating a huge amount of waste in the different phases of the construction processes, from the extraction of the raw materials, during manufacture of construction materials, the construction process itself, its demolition and finally the disposal of the waste materials. Lack of properly implemented rules, institutional weakness,

Im-proper choice of technology and public mentality towards Construction and Demolition waste (C&D waste) has caused the practice of uncontrolled dumping of it on the outskirts of towns and cities. This open spaced dumping of C&D waste has created serious environmental problems along with reduction in land area for general work [8]. Considering above mentioned issues along with other secondary issues like cost-effective construction & innovative financing models, energy & resources efficiency and occupational health & safety, it has become essential to find functional substitutes for conventional building materials in order to have environmentally sound growth.

So the main objective of this paper is to know what C&D waste is, present scenario of C&D waste generation in India, effective C&D waste utilization, current initiative taken and future steps to be implemented by government/construction-agencies for effective and eco-

friendly utilization of C&D waste as a sustainable construction material.

**II. CONSTRUCTION AND DEMOLITION WASTE**

**A. General**

Construction and demolition waste is one of the heaviest and most voluminous waste streams generated in India. The waste which arises from construction, renovation and demolitions (controlled and uncontrolled) activities is known as C&D waste and this waste is also generated from extraction of raw materials, processing and manufacturing of construction materials [2],[6]-[8]. C&D waste includes surplus and damaged products & materials during construction and/or on-site activities. C&D wastes are generated in bulk by roads, bridges, flyovers, flats, malls and parks and small generator are houses and small buildings and it is made up of wood, steel, concrete, gypsum, masonry, plaster, metal, and asphalt. It is notable also because it can contain hazardous materials such as asbestos and lead.

**B. Estimates of C&D Waste Production in India**

C&D wastes generally constitute up-to 20-40% of all solid waste generated in India [6],[7],[9]-[11]. However latest estimates regarding the quantum of C&D waste generated in India is not available Even the performance audit of "Management of Waste in India" by CAG in 2008 noted that "No estimates or even guesstimates exist for C&D waste"[11]. A rough estimate prepared by central government agencies/bodies is given in table 1.

**Table 1: Estimate of C&D waste generation per year [9]-[13]**

Year	Authority	Estimates in million tonnes
2000	Ministry of urban development(MOUD)-GOI	10-12
2000	Technology Information, Forecasting and Assessment Council (TIFAC)	12-15
2010	Ministry of environment & forest (MOEF)-GOI	10-12
2016	Ministry of Environment & Forest(MOEF)-GOI	530*

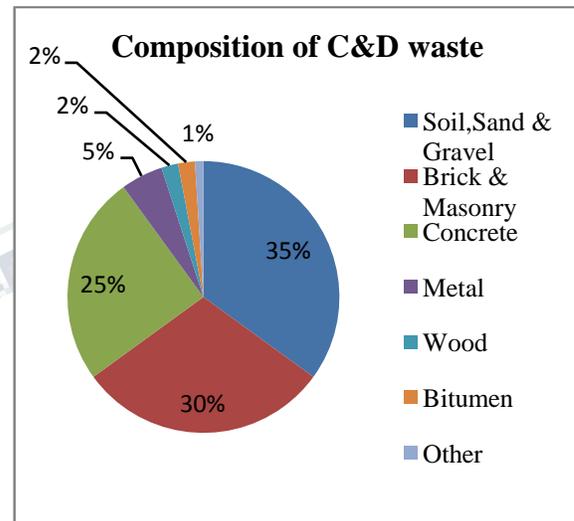
\*This estimate has been made by TIFAC's thumb rule [12] and supported by MOEF

After observing carefully the Table 2 one can reach on general consensus that there was neither construction work executed nor demolition work

happened or these works were executed in very low amount during 2000 to 2010 because C&D waste is generated by construction and demolition activities. This estimates stress on only representative not actual values. The estimate made on the basis of TIFAC's thumb rule and supported by MOEF in 2016 approaches towards actual but still lacks of comprehensive estimates. Approximated Quantity of different constituents of waste that arise from Construction Industry in India is given in Table 2 & fig.1

**Table 2: Quantity of different constituents of C&D waste [10]**

Constituent	Quantity generated in million tons p.a.(range)
Soil, sand and gravel	4.20-5.14
Bricks & masonry	3.60-4.40
Concrete	2.40-3.60
Metals	0.60-0.53
Bitumen	0.25-0.30
Wood	0.25-0.30
Others	0.10-0.15



Source- Technology Information, Forecasting and Assessment Council (TIFAC)-2000 [13]

**Fig.1: Composition of C&D waste in India**

**III. REVIEW ON C&D WASTE AS RECYCLED AGGREGATE AND RECYCLED AGGREGATE CONCRETE**

One of the highest potential forms of C&D waste to be utilized in new construction is Recycled Aggregate (RA) obtained by recycling of this C&D waste. Utilization of C&D

waste in new construction is not a new concept as first trace of utilization of C&D waste as pavement construction at significant scale was found after Second World War in Germany because Germany had to find disposal solution of huge amount of C&D waste generated during war along with ensuring the availability of raw materials for new construction [14]. A number of research works have been carried out and complied on mechanical properties of RA obtained from C&D waste and Recycled Aggregate Concrete (RAC) [14]-[31]. RAs are produced by processing of the debris generated from the demolition of concrete structures, rejected precast concrete members, broken masonry, concrete road beds, leftover concrete from ready mix concrete plant and the waste generated from different laboratories [15]. RA, derived from C&D waste generally consists of natural coarse aggregate and adhered mortar. The most distinguished feature of RA is its old adhered mortar which makes it porous due to high mortar content, inhomogeneous and less dense [16]-[18]. The volume of the residual mortar in RA varies from 25% to 60% according to the size of aggregate [19]. The presence of attached mortar is greatly responsible for its anomalously high water absorption capacity [16],[20]-[21]. The water absorption capacity of RA is 2–3 times higher than natural aggregate and it may range up to 12% for coarse and fine RA [16],[22]. The density and specific gravity of the attached mortar is quite less and accounts for the low specific gravity, bulk density and saturated surface dry (SSD) density of RA [18],[23].

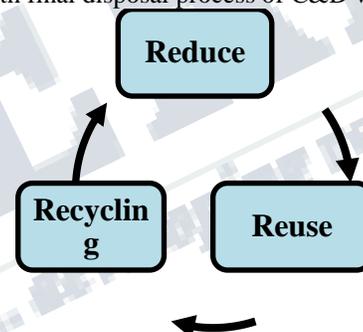
In case of RAC, the slump loss is more than natural aggregate concrete and it is difficult to meet the required workability because of high moisture absorption capacity of RAs [22], [24]. In most of the research works it was found that reduction in compressive strength of RAC (made by recycled coarse aggregate only) was 5-40% of the strength of conventional concrete [20],[24],[26],[28]-[29],[31]. Compressive strength reduction up-to 76% has also been reported in some literature [16]. Past investigations on RAC shows that the effect of RA content on split tensile strength and flexural tensile strength is less than that on compressive strength [29],[31]. Some authors in their study have mentioned that the decrease in split tensile strength & flexural strength is up to 30% with respect to conventional concrete at full RA replacement level [24],[29],[31]. It is found in different literature that the modulus of elasticity of RAC with 100% RA can be lowered up to 45% than that of Natural Aggregate Concrete (NAC) [28]-[29]. In general, performance of RAC is poorer than that of NAC. The lack of technical data, lack of specifications and quality control guidelines are some of the other reasons

why utilization of C&D waste is restricted to non- structural purpose in most of the countries including India. Some countries for example in the United States, ACI-555R provides some preliminary guidelines for proportioning of concrete mixes using recycled aggregate concrete but does not provide any mix design methods [32].

#### IV. C&D WASTE MANAGEMENT

##### A. General

Management of C&D waste is a comprehensive methodology starting from collection of C&D waste, optimal utilization by recycling, reuses and then disposal in eco-friendly manner. C&D waste management stresses primarily on (i) preservation of potential of C&D waste to save natural resources (stone, river sand, soil etc.), (ii) maintain the quality of derived materials from waste (ii) minimum land area required for its disposal at sanitary land fill sites. The basic features of C&D waste management are 3R's (reduce, reuse and recycling) [2, 8]. A line diagram has been shown in figure 2 along with final disposal process of C&D waste.



**Fig. 2: Cycle of C&D management (3 R's)**

Since land fill or disposal of C&D waste is least recommended feature of C&D waste management, it is last option to be followed. Fig. 3 also suggests that process of reducing, reusing & recycling can be done till it fulfils desired criteria and at last minimum amount of C&D waste should be generated for disposal

##### B. Objective of C&D Waste Management

C&D waste management is very broad term and utilization of C&D is a part of it. Major objective of C&D waste management are as following

- 1) An attempt to provide a viable and cost effective solution of sustainable construction using improved method of recycling, reusing and disposal of C&D waste.

- 2) To provide a better approach in construction activities in order to minimize the waste generation during construction and material preparation process.
- 3) If waste is generated during construction, renovation or demolition process, maximum of the usable elements to be reused in new construction.
- 4) Waste which can be used in after modification/conversion could be utilized as much as possible using recycling processes. Minimum area of landfill is to be utilized ensuring the absence of toxicity of disposed C&D waste

#### **V. PRESENT STATUS OF C&D WASTE UTILIZATION IN INDIA**

So far in India there is very little effort to manage and utilize construction and demolition waste [6]-[7], [9]-[13] because private contractors remove this waste to privately own low-lying land for a price or more commonly, dump it in an unauthorized manner along roads or other public land. Small quantities of construction and demolition waste usually get mixed with domestic waste due to lack of segregated storage and collection facilities.

Even though legal reform is taking a long time in India, several architects have already taken steps to reuse C&D waste in buildings. For example, a school building in Rajkot designed by Ahmedabad based architect Surya Kakani that has been built from the debris from Bhuj earthquake. The Institute Of Rural Research And Development (IRRAD) building in Gurgaon (Haryana) has innovatively recycled and utilized its own construction waste in the building itself [13]. But these are limited steps and need to be encouraged with policy & fiscal support.

Maharashtra has taken a pioneering step and notified the "Maharashtra Non-Biodegradable Solid Waste (Proper Scientific Collection, Sorting and Disposal in Areas of the Municipal Corporation) Rules, 2006" wherein C&D waste is included in the action plan [33]. though this rules does not provide any method to use C&D waste.

As part of ongoing efforts under Swachh Bharat Mission, the Union government has now permitted substantially enhanced use of C&D waste in construction. In consultation with ministry of consumer affairs, the Ministry of Urban Development has decided to allow use

of C&D waste to the extent of 20% of coarse and fine aggregates, known as 'Bajri' in construction of load bearing items and up to 100% for non-load purposes[34].

India's first and only recycling plant for construction and demolition (C&D) started by Municipal Corporation of Delhi with Infrastructure Leasing & Financial services (IL&FS) is at Burari (Jahangirpuri) in North Delhi. This plant started in 2009 with processing capacity of 500 tonne per day (TPD) is now processing 1200TPD which is likely to reach the limit of 2000 TPD [13].

Environment Ministry Notifies Construction and Demolition Waste Management Rules-2016 (Applies to everyone who generates construction and demolition waste) [35] for the first time stating that segregating construction and demolition waste and depositing it to the collection centers for processing will now be the responsibility of every waste generator. As per this rule local bodies will have to utilize 10-20% material from construction and demolition waste in municipal and government contracts and large generators of waste will have to pay relevant charges for collection, transportation, processing and disposal, as notified by the concerned authorities

#### **VI. FUTURE PLANNING FOR EFFECTIVE C&D WASTE UTILIZATION IN INDIA**

Though there are no factual and official records of total amount of C&D waste utilization in new concrete, it can be said without any doubt that very less amount of C&D waste are utilized compared to the amount of C&D waste generated in India. It means India needs urgent intervention to protect its land, water, public space and environment from the egregious construction expected to explode with the urban boom. Policy delay is no longer an option. There are following possible steps to be taken for effective C&D waste management in India

##### **A. Awareness**

This is the first step to be launched at large scale among people of India. Everyone must feel that C&D waste is not a waste but a resource. Even today, C&D waste collected from different areas is dumped along with municipal solid waste at large scale. Proper distinction between C&D waste and municipal solid waste has to be made so that C&D waste can be taken easily for recycling process.

##### **B. Legislation of Comprehensive Policy**

Though Construction and Demolition Waste Management Rules-2016 has been passed recently by Ministry of Environment and Forest (which is applicable for all C&D waste generators), there must be certain mechanism

& measures to make it implemented effectively throughout India as soon as possible because most of the people do not follow such rules because of less awareness, narrow mindedness and habitual to get rid of the waste products etc.

### ***C. Promotion of Efficient Construction Management Practices along with Recycled Construction Materials***

National regulation and municipal rules need to push for optimal use of building space and materials, waste prevention, use of recycled content, on-site segregation and collection & disposal system. Currently amount of recycled C&D waste is very less as compare to its generation. The Effort must be made to recycle the sufficient C&D waste and to use it in new constructions (structural and/or non-structural purposes) under certain guidelines.

### ***D. Fast Track Formation/Amendment of BIS Codes on Recycled Materials.***

Though there is no BIS standard on properties and usage of C&D waste till today, a lot of research work is going on for recycled materials processed from C&D waste. This research should be leveraged quickly to formulate standards and to intensify the reuse of recycled materials obtained from processing of C&D waste.

### ***E. Encouragement to Market of Recycled Construction Materials***

A market of recycled construction materials obtained by C&D waste needs to be started and promoted at large scale. These materials should be bounded by optimal market value (for both seller and buyer) so that competition can be made with natural construction materials in terms of quantity and quality. Time to time market of recycled construction materials should be analyzed properly and it should be financially supported whenever required.

## **VII. CONCLUSION**

The idea of Effective C&D waste utilization i.e. reusing and recycling of C&D waste material is very exciting and encouraging especially when it will be helpful in minimizing the destruction of earth's crust and green forest cover by virtue of reduce mining. So utilization of C&D waste will protect the environment and may lead to a much more productive, efficient and sustainable future. Recycling and reuse of the C&D waste materials are found to be an appropriate solution to the problems of dumping of huge amount on natural soil. A minimum C&D waste strategy improves upon cleaner

production and pollution prevention strategies by providing a visionary endpoint because waste is a sign of inefficiency. Effective C&D waste management can only be achieved with the active participation of all those involved in the construction industries as well as the public administration agencies with a strong enforcement program.

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