Construction and Demolition Waste Recycling - Current Scenario and Future Need in India

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Abstract: In recent decades the world has seen rapid urbanization in need of work, education and a better lifestyle. This has led to the requirement of planned urbanization to meet the needs of the growing population. Urbanization includes a major part of infrastructure development and redevelopment which increases the demand for the construction industry. This paper concentrates on the importance of proper management of Construction and Demolition waste (C&DW) through the process of recycling in India. It further talks about the success of various countries following the path of C&DW recycling and moving towards sustainable development. In India, Indore city is already practicing the zero-waste model, which means complete recycling and reuse of the C&D waste generated each day. India is among the fastest developing countries and therefore it plans to work on various infrastructure and development projects. Smart City Mission is one such project which focuses on developing smart solutions through technology and infrastructure. Currently, India is recycling only 1% of the C&DW generated. This comprehensive study examines the need for C&DW recycling in the current scenario in India.

Key Words: —*Construction and demolition waste, recycling, infrastructure, Smart City Mission, future perspective.*

I. INTRODUCTION

In recent few years, the world has seen rapid growth in industrialization and urbanization leading to an immense rise in demand for construction materials. It is expected that in the period 2018 to 2023, the expected growth in the construction industry will be around 4.2% CAGR [1]. It is because of rising concrete infrastructure in the form of housing requirements for an ever-increasing population and to enable transport on the land, sea, and air, supporting energy generation as well as industry and providing protection. The worldwide use of concrete is anticipated to be over 11.5 billion tons per year, with an increase to 18 billion tons per year by 2050 [2].

Construction and demolition (C&D) waste is described as solid waste created during the construction, maintenance, alteration, or destruction of residential, commercial, or institutional buildings, as well as infrastructures such as roads, bridges, dams, tunnels, rails, and airports.

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Concrete accounts for 30-40% of the world's building waste. C&D waste generation is an issue for developing and impoverished countries [3]. The main reasons for the continuous increase in the volume of demolition concrete/masonry waste are as follows: -

- Many historic buildings, concrete pavements, bridges, and other structures have outlived them usefulness owing to structural degradation that is beyond repair and must be removed. (Example: Notre Dame Fire in France 2019).
- Structures that are fit for purpose are being demolished since they are no longer needed in the current situation.
- New buildings for increased economic growth. (Example: Shanghai Building 2015).
- Natural calamities such as earthquakes, cyclones, and floods, among others, transform structures into debris. (Example: Gujarat earthquake 2001).
- The generation of construction waste as a result of a man-made disaster/war. (Ukraine-Russia War 2022).

CDW accounts for more than 30 percent of total solid waste created globally [4]. Every year, large amounts of CDW are produced across the world.

China, for example, is the world's top CDW manufacturer, with over 2300 million tons in 2019 [5]. Meanwhile, in 2018, the United States and the European Union generated over 600 and 834 million tons of CDW, respectively. A large amount of CDW is recyclable [6,7].

Looking at the statistics of India, it generates 150 million tons of C&D waste every year but is able to recycle only 1% of the generated waste according to Building Materials and Technology Promotion Council (BMTPC). We can see this drastic gap because only 13 cities have established recycling facilities to recover material from C&D Waste by 2020, despite the fact that 53 cities were anticipated to do so by 2017. (Source: CSE report 2020) [8]

India launched its Smart City Mission in 2015, aiming for 100 cities as an initial target for the project. The Mission's major goal is to support communities that offer basic infrastructure, a clean and sustainable environment, and a reasonable quality of life for their residents by implementing "smart solutions."[9]. This paper is focusing on how proper recycling of C&D waste can benefit Smart City Mission in India.

This project is divided into various heads and subheads. They are as follows: Sections 2 and 3 consist of the methodology used to prepare this study as well as the literature taken into consideration. Section 4 consists of a global scenario for C&D waste generation and its recycling guidelines, also their success. Section 5 consists of Smart City Mission and infrastructure projects in India. Section 6 consists of a discussion of the statistics from various sources. And lastly, section 7 gives the conclusion of the paper.

II. METHODOLOGY

The study used the following procedures for conducting a thorough search of the pertinent papers that is protocol development; screening of research publications on the basis of title, keyword, and abstract; and data extraction from the chosen papers. Around 50 research papers were initially chosen, they were then thoroughly reviewed and around 25 - 30 were taken into consideration. Also, data from government websites, international articles, national newspapers and various other sources were taken. The research paper consists of the findings and conclusion of an interview with the owner of the C&D waste recycling plant in Indore, India. At last, the main areas of action for improving circumstances and overall environmental sustainability are discussed.

III. LITERATURE REVIEW

The problem of construction and demolition waste is getting worse right now and will only get worse in the future, thus it must be effectively utilized in order to be organized and minimized. *(R. Rema, R. Remya and R. Rathiya, 2022). Sandeep and Abdol (2009)* also stated that it will further create issues related to handling the waste and finding space for landfilling. This will cause an extra burden on solid waste management plans, which are already looking for new ways to fight the growth in municipal solid waste due to the increase in urban population and developments in the country. For instance, Fédération Internationale du Recyclage (F.I.R) indicated that each ton of waste going to landfill occupies approximately 0.6 m^3 space of land. In addition to water pollution and soil fertility ruination, landfilling also causes vegetable deterioration and nitrate augmentation which affects human health. *(Kamyar Kabirifar, Mohammad Mojtahedi, Cynthia Changxin Wang, Vivian WY Tam,* **2020).** In 2007, the construction sector was the second largest sector in India in terms of material consumption. With the increase in absolute material consumption by more than a billion tons, the construction sector was the fastest growing sector between 1997 and 2007 *(TERI et al., 2016).*

IV. C&D WASTE RECYCLING- GLOBAL SCENARIO

Construction and demolition (C&D) waste is a concern to a lot of countries around the world. The main reason is that it is difficult to dispose of the waste. The common disposal ways are either dumping the waste in landfills or water bodies. C&D waste disposal in landfills may potentially affect groundwater and surface water. This polluted water can enter homes and harm people's health. Dumped C&D waste in water bodies has a variety of negative environmental consequences. It has an impact on aquatic plants and wildlife since it disrupts their natural environment. Dumping C&D trash into bodies of water raises the water level, potentially causing flooding in neighboring communities. C&D trash also contributes to air pollution since it contains dust, particulate matter such as PM10, asbestos, and other contaminants that can mix with the air [10].

As the above-mentioned reasons are proving to be hazardous to the environment, many countries started to use the concept of 3R for the proper management of waste. Many countries started the process of recycling the C&DW in the early 2000s. The data contains the amount of C&DW generated and the amount being recycled in different parts of the world are

shown in Table 1.

Table.1. Amount of C&DW generated and the amount being recycled in different parts of the world

Source	UBA 2009			ETC/RWM 2009		
Country	Year	Arising (million tonnes)	% re-used or recycled	Year	Arising (million tonnes)	% re-used or recycled
Austria	2004	6,6	76%	2006	6,7	60%
Belgium		12,3	86%	2004	11	68%
Belgium - Brussels	2000	1,2	59%	-	-	-
Belgium - Flanders	2006	9	92%	-	-	-
Belgium - Wallonia	1995	2,1	74%	-	-	-
Bulgaria	-	-	-	2004	3	-
Cyprus	-	-	-	2004	0,4	1%
Czech Republic	2006	8,4	30%	2006	11,8	23%
Denmark	2003	3,8	93%	2004	21,7	94%
Estonia	2006	2,4	73%	2006	0,7	92%
Finland	2004	1,6	54%	2004	20,8	26%
France	2004	47,9	25%	2004	342,6	62%
Germany	2002	73	91%	2006	192,3	86%
Greece	1999	2	5%	2004	4,1	-
Hungary	-	-	-	2006	5,4	16%
Ireland	2005	2,3	43%	2006	16,6	80%
Italy	2004	46,5	-	2004	46,3	-
Latvia	-	-	-	2006	0,1	46%
Lithuania	2006	0,6	-	2006	0,6	60%
Luxembourg	2005	7,8	46%	2004	2,7	-
Malta	-	-	-	2004	0,8	-
Netherlands	2005	25,8	95%	2005	25,8	98%
Poland	2000	2,2	75%	2006	16,8	28%
Portugal	1999	3	5%	2004	11,4	-
Romania	-	-	-	2005	0,4	-
Slovak Republic	-	-	-	2004	1,4	-
Slovenia	2005	1,1	53%	-	-	-
Spain	2005	35	-	2006	38,5	14%
Sweden	2006	11	-	2004	10,2	
UK		100,4	82%	2006	114,2	65%
UK - England	2005	89,6	80%	-	-	-
UK - Scotland	2003	10,8	96%	-	-	-
Average for x countries with available data			86%			66%
Total amount of C&D waste on which the estimation is based			252,7			820,2

(Source: Publication Office European Union, 2008) [11]

4.1 Recycling C&DW In Italy

The European Union's Waste Framework Directive 2008/98/EC seeks to recycle 70% of construction and demolition waste by 2020. With the exception of a few EU nations, however, only approximately half of C&D waste generated is now recycled. The good news is that several EU nations have already established and implemented a system that leads up to a 90% recycling rate [12].

The European Union Framework, aimed at recycling 70% of C&DW generated. Before 2010, Italy was able to recycle around 68% of C&DW generated. But after 2011, it crossed the benchmark and since then has maintained to recycle C&DW more than the given aim. By 2015, Italy had managed to recycle 75.1% of C&DW generated.

Fig.1.Recycling of C&DW in Italy from 2010 to 2017

(Source: ISPRA data) [13]

4.2 Recycling of CDW in Riyadh City, Saudi Arabia

Large cities in the Gulf area generate a significant amount of CDW each year. Riyadh, Saudi Arabia's capital and one of the major cities, now produces more than 8 MTPA from 15 municipalities encompassing all of the city's key sectors. To satisfy the KSA Vision 2030 sustainable development targets, the entire city is undergoing massive building and demolition activity [14].

According to the International Trade Administration's (ITA) Country Commercial Guide for Saudi Arabia, the Kingdom of Saudi Arabia (KSA) expects to divert 60% (12 percent recycling, 35% reuse, and 13% treatment) of CDW from landfills [15]. However, the Saudi Investment Recycling Company (SIRC) can recycle 45 percent of the CDW collected in Riyadh. Further, SIRC aims to achieve a Zero waste scenario by 2030 [16].

4.3. Recycling C&DW- European Perspective

Construction and demolition waste receives a considerable lot of attention in Europe since it accounts for 25-30% of total municipal garbage created, as well as its high potential for recycling and reutilization. The amount of construction and demolition waste created in the EU each year surpasses 700 million tons. The countries with the greatest populations create the most stated garbage, with France and Germany being noteworthy examples. Furthermore, the amount of garbage created by any of the two listed countries is greater than the entire amount generated by all other EU countries combined, excluding the UK [17].

Countries with special laws for building and demolition waste have higher recycling rates, surpassing 80% of the generated quantity. These countries' main measures include imposing higher landfill taxes, which for mixed waste can be up to ten

times higher than for sorted waste, imposing taxes on the use of natural aggregates, and providing financial and fiscal incentives for sorting and recycling construction and demolition waste, or producing and using recycled aggregates [17].

4.4. Recycling C&DW in Indore, India

Till 2014 Indore was ranked 149th on the list of cleanest cities in India according to Swachh Survekshan's result. But, when Prime Minister of India, Mr. Narendra Modi launched the Swachh Bharat Mission on 2nd October 2015, Indore started its journey of becoming India's cleanest city. Since 2017 Indore has been ranked as India's Cleanest city and has been in its position for consecutive five years.

Fig.2. C&D Waste recycling plant in Indore, India.

Being the cleanest city in the country, Indore launched its first C&D debris waste processing plant in 2018 worth Rs 2.5 crore, a first in Madhya Pradesh.

Fig.3. C&D Waste recycling raw material

The facility was built with the intention of recycling building debris into paver blocks and bricks. It can crush 100 tons of garbage in a single day.

Fig.4, 5 & 6. C&D Waste recycling machinery

The machine comprises three primary units: a crusher unit, a screening unit, and a sand and brick dust washing unit. Following segregation, the trash will be crushed and classified into three sizes: 20mm, 10mm, and fine dust.

Fig.7 & 8. C&D Waste recycling finished products

They will then be cleaned before being used to produce ready-mix concrete, bricks or paver blocks, and manufactured sand. The new recycled products are produced by mixing contents in a ratio of 40% recycled C&DW and 60% fresh materials.

The plant receives CDW from Indore district as well as from Dewas district. To make working smooth, IMC (Indore Municipal Corporation) established 4 dumping stations around the city. The collection of CDW is around 50-60 tons per day. The recycled products like concrete bricks, pavers, blocks, etc. are now sold to government and private individuals which include IMC colonizers, IMC projects and private players.

V. SMART CITY MISSION INDIA INFRASTRUCTURE

On June 25, 2015, the Hon' Prime Minister launched the Smart Cities Mission. The Mission's major goal is to support communities that offer basic infrastructure, a clean and sustainable environment, and a reasonable quality of life for their residents by implementing "smart solutions." Through comprehensive work on the city's social, economic, physical, and institutional foundations, the Mission aspires to generate economic growth and improve quality of life. The emphasis is on sustainable and equitable growth through the establishment of repeatable models that serve as beacons for other aspiring cities.[9]

“The purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes.”- Vision of Smart City Mission.[9]

The idea is to make cities smarter, accomplish more with less, make better use of existing resources, and expand on them. Cities, according to the SCM, should provide inhabitants with needed infrastructure, good quality of life, environmental conservation, and innovative solutions [19]. In 2020-2021, when Finance minister Nirmala Sitharaman presented her first union budget, she proposed the setting up of 5 more smart cities in order to attract investment, drive economic growth, and improve the quality of life for people.[20]

5.1. Current Status of Infrastructure

For any economy, infrastructure is the foundation. The quantity and caliber of the country's infrastructure impact its capacity to capitalize on its comparative advantage and makes it possible for it to have cost competitive. Infrastructure can be a catalyst for social and economic change because of its strong backward and forward links and advantageous externalities [21].

India is also taking many initiatives for the betterment of its infrastructure. India is spending around 1.4 trillion USD in order to achieve the bigger picture of a 5 trillion USD economy. According to Economic Survey 2021-22, India pumped in about 1.1 trillion USD on infrastructure, however, the challenge is to set up infrastructure investment substantially.

With this goal in mind, the National Infrastructure Pipeline (NIP) was established with a projected infrastructure investment of around Rs. 111 lakh crore (USD 1.5 trillion) between FY 2020–2025 to deliver top-tier infrastructure

throughout the nation and raise inhabitants' standards of living.

NIP started off with 6,835 projects, but it has now grown to nearly 9,000 projects spanning 34 different sub-sectors of infrastructure. Around 70% of India's estimated capital investment on infrastructure is expected to be spent in the fiscal years 2020–2025 on areas including energy (24%), roads (19%), urban (16%), and railroads (13%) projects.[21]

The development of upcoming industrial corridors, infrastructure projects, and programs like Bharatmala (50 new national corridors) and Sagarmala across the nation will receive 16 percent of the urban investment share of infrastructure attention as their influence on smart cities is essential. Additionally, INR 6,450 crore has been allotted for the Smart City Mission in 2019–20, which is 5% more than the updated projections for 2018–19 [20].

5.2. Redevelopment

The majority of Indian metropolises are older than a century and have experienced an unprecedented influx of migrants that has led to massive unplanned constructions in their most desirable areas. The cities are expanding haphazardly, resulting in unplanned, irreversible changes that have negative repercussions on all fronts and make future infrastructure integration virtually difficult. Unplanned developments are causing severe issues in Bengaluru, Delhi, and Mumbai. The old built-up environment will be replaced by redevelopment, which will also make it possible to co-create a new layout with improved infrastructure employing mixed land uses and higher densities [22]. And thus, it will generate a huge amount of C&DW which needs proper management. Also, the recycled output of C&DW can be used for building further infrastructure.

5.3 Discussion

Infrastructure is a key to improving an economy. It plays a crucial role in developing countries. But with increasing infrastructure for satisfying the never-ending demands of the growing population, brings construction waste to the picture. Infrastructure not only means building new amenities but also redeveloping the existing cities to meet the requirements of the population.

This process of redevelopment and increasing infrastructure brings in the need for proper management of Construction and Demolition Waste (C&DW). By reviewing around 30 research papers and articles from various sources including data from government websites and national newspapers, we can clearly see the rising need for infrastructure around India which also includes The Smart City Mission (SCM). Under SCM it is one of the main goals according to the Guideline, 2016 [23], that the city should have proper C&DW management. But only 1% of C&DW generated in India in a day is being recycled, which is nearly 6,500 tons per day. This shows that there is a huge requirement for recycling CDW plants in India. Along with proper management of CDW, the recycled output can be of great use to the rising demands of new infrastructure.

This recycled product of CDW is produced by mixing 40% of CDW and 60% of new material. This shows that it will save up to 40% of resources to make new infrastructure. It will also lead to the generation of employment and will provide a way towards sustainable development.

Hence, with the rising infrastructure project under Smart City Mission, rapid urbanization growth and growing population is booming the construction industry, which leads to greater amounts of construction and demolition waste. Thereby, using that waste, recycling it, and further taking the recycled products in use for the infrastructure projects. This will not only eliminate the waste but also provides us with recycled products that save new resources.

VI. CONCLUSION

The guidelines issued by the central government of India in 2016 [23] clearly stated the importance of proper Construction and Demolition waste Management. This paper analyses the current status, its need, and a way to sustainable development. European countries have been working on the policy of recycling CDW since the early 2000s and to date, it has been successfully converting almost 90% CDW collectively each year. The result is quite commendable in other countries as well. India is also a huge producer of CDW. It produces around 15 million tons of CDW each year. The statistics clearly show that only 1% is being recycled and the rest is being dumped either in oceans or landfills. Also, according to government statistics infrastructure projects undergoing and to be completed account for more than 9000. The government also started the Smart City Mission (SCM) in 2016 which considered infrastructure as one of its main pillars.

Analyzing the above data, it is seen that there is a high scope for the construction industry in India. And therefore, it will also generate CDW. The government needs to build more CDW recycling plants in order to recycle that waste instead of dumping it in the ocean or in landfills which may further lead

to other environmental problems. The positive aspect is that the recycled products can then be used for further infrastructure projects. A clear demand and supply relationship is seen and henceforth, opens the gate for private players as well to grab the opportunity. This will ultimately lead to sustainability and a zero-waste model in the construction industry.

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