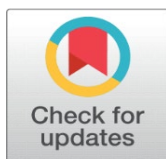


A COMPREHENSIVE STUDY PROPOSING THE GUIDELINES FOR REDUCING THE C&D WASTE IN THE CITY OF NAGPUR

Shrirang Tushar Kulkarni ¹✉, Kranti Kumar Myneni ²✉

^{1,2} School of Planning and Architecture Vijayawada, India



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Corresponding Author

Kranti Kumar Myneni,
kranti.myneni@spav.ac.in

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ABSTRACT

"Construction and demolition waste" "means building materials, debris, and rubble resulting from the construction, remodeling, repair, and demolition of any civil structure (CPCB, Ministry of Environment, Forests & Climate Change, 2016)." The data about various categories of cities was approximated based on insights derived from the secondary literature. In 2016, the metropolitan areas in India generated an excess of 150 million metric tons of Construction and Demolition (C&D) waste. (CPCB, Ministry of Environment, Forests & Climate Change, 2016), with small and medium-sized cities accounting for about half of the total. This research examines the current evolution of standards in Nagpur city, analyzes the current situation, and proposes guidelines to improve the situation. With a focus on developing comprehensive and effective strategies, this study seeks to address the unique challenges posed by C&D waste in the urban context of Nagpur. By analyzing existing practices, understanding the specific waste generation dynamics, and proposing standardized guidelines, this research aims to contribute to sustainable and streamlined C&D waste management, enhancing environmental responsibility and urban well-being in Nagpur. A questionnaire survey conducted among practicing and reputable builders in the Nagpur region has provided valuable insights and analysis to guide specialized recommendations for reducing C&D waste production. Ultimately, this study seeks to educate decision-makers in the industry, key players, and environmental activists to promote C&D waste management and enhance urban life in Nagpur.

Keywords: Construction & Demolition Waste, Demolition Waste Management, Standardization, Recycle

1. INTRODUCTION

India's population experienced an unforeseen surge, escalating from 286 million individuals in 2001 to 377 million individuals in 2011, as indicated by the Census of India 2011. Moreover, projections anticipate a notable growth of over two-thirds, from 400 million people in 2018 to a staggering 800 million people by the year 2050 (United Nations Department of Economic and Social Affairs – 2018). Over the past few years, India's urban built environment has likewise been quickly growing. The volume of MSW produced by such a large population is enormous, hence it is crucial to deal with the garbage to avoid the repercussions further.

Numerous reconstruction projects are already being carried out in several cities under various urban development programs in addition to new construction (MoUD 2015b, 2015a). Due to the significant and extensive transformations occurring in the construction domain, numerous implications regarding resources and the environment will ensue. These activities generate a significant amount of construction and demolition debris, which is not recycled, leading to a rise in landfills. "Accurate C&D waste quantification is crucial for building an efficient management system, both at the project and regional level (Bergsdal, 2007; Li and Zhang, 2013; Yost and Halstead, 1996). Growing population and urbanization are increasing building and demolition activities, increasing C&D waste creation CPCB (2017), Regulations on Environmental Management of Construction and Demolition, C&D Wastes."

Nagpur is a two-tier developing city a lot of infrastructure construction is going around the city which leads to the generation of a lot of C&D waste. This waste needs to be channelized to reduce the urban environmental impact as well as the amount of waste going into the landfill. Through a literature review, data on C&D waste from various cities is collected. The data is analyzed to see how it affects the environment and to identify measures to make the situation better. The data is compared to Nagpur city data for the study, and responses are found by conducting a questionnaire survey with Nagpur's practicing builders. Through an analysis of the literature and a questionnaire survey of practicing builders, the gap where we can genuinely comprehend the ground condition was found. The survey results showed a multitude of issues, with severe neglect serving as the root reason.

2. MATERIALS AND METHODS

2.1. MATERIAL FLOW ANALYSIS

Due to a lack of information on several factors, including building activity, it is difficult to estimate the existing and future volumes of C&D waste in Indian cities, according to the research conducted by Ram and Kalidindi in 2017, as well as H. Wu et al. in 2016, the ensuing rates of waste production were subsequently multiplied by the activities of construction, refurbishment, and dismantlement to ascertain the aggregate quantity "of construction and demolition waste that was produced."

2.2. CONCERN REGARDING THE RATE OF C&D WASTE GENERATION

- 1) According to MOUD (2000), 10 to 15 million tonnes (MT) are produced annually.
- 2) 25 to 30 "million tonnes of Construction and Demolition (C&D) waste are generated annually in India, with only 5% undergoing proper treatment."
- 3) It has been approximated that India generates an annual output of 10-12 "million tonnes of construction and demolition waste."
- 4) Excessive C&D waste generation leads to inefficient use of natural resources.
- 5) Landfills release harmful chemicals and greenhouse gasses during decomposition.

Figure 1

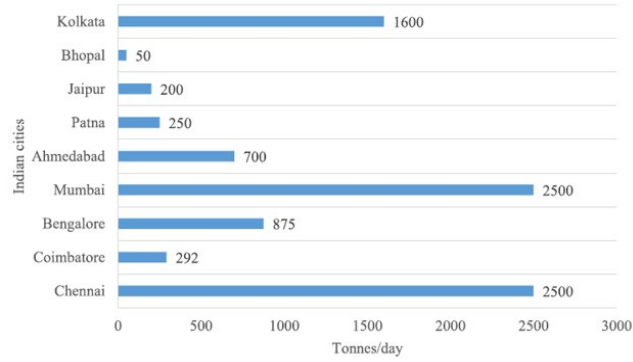


Figure 1 Source C & D Waste Generation (Tonnes Per Day) in Various Indian Cities (BMTPC, 2018; CPCB (2017))

2.3. ASSESSMENT OF C & D DEBRIS GENERATION IN INDIA

TIFAC has provided estimations for project-specific generation figures of C&D waste in the following manner:

- For new construction projects, the expected waste generation rate is between 40 to 60 kilograms per square meter.
- In the case of building repair activities, it has been determined that the waste generation rate ranges from 40 to 50 kilograms per square meter.
- However, when it comes to building demolition, it is evident that this activity yields the highest amount of waste generation, with a rate of 300 to 500 kilograms per square meter.

According to a review published in Elsevier Ltd., there are five main categories of approaches for measuring C&D waste. The aforementioned methods encompass “the site visit approach, the method of waste generation rate determination, the method of lifetime analysis, the method of classification system accumulation, and the method of variables modelling.”

C & D waste	Residential	Non residential	Total
New Construction	11%	6%	8%
Renovation	55%	36%	44%
Demolition	34%	58%	48%
Total	100%	100%	100%

Figure 2

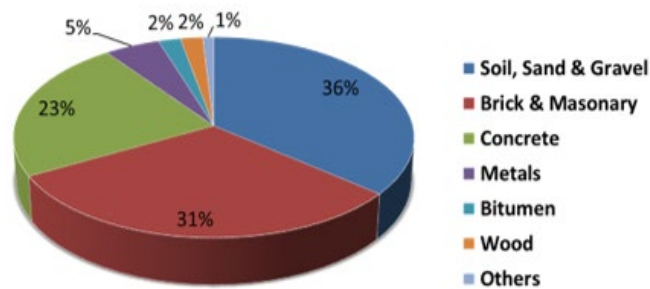


Figure 2 Typical Composition of C&D Waste

3. METHODOLOGY

Standardization in C&D waste refers to the process of creating and implementing uniform guidelines and procedures for managing waste generated “during construction and demolition activities.” A general approach to standardizing the management of C&DW is as follows:

- 1) Identify the key stakeholders: Identifying the key players is the first stage in standardizing waste management in building and demolition. This could involve regulators, waste management firms, construction firms, developers, and other interested parties.
- 2) Assess current practices: Analyze the waste management practices currently used in the sector. This might require gathering data on the amounts of waste produced, disposed of, and recycled, as well as examining present laws and practices.
- 3) Develop a standardized approach: Utilizing the evaluation as a guide, develop a standard procedure for handling construction and demolition waste. This may include recommendations for waste minimization, segregation, storage, transportation, and disposal. The strategy needs to consider how environmental factors influence waste management methods, in addition to addressing health and safety concerns.
- 4) Establish performance metrics: Create performance metrics once the standardized technique has been created to track advancement and guarantee compliance. This might entail establishing goals for trash reduction and recycling rates as well as putting in place procedures for reporting and monitoring.
- 5) Provide education and training: Educate and teach stakeholders to guarantee that the standardized strategy is executed successfully. This could involve training on techniques for waste reduction and segregation as well as the use of innovative waste management technology.
- 6) Monitor and evaluate: Finally, track and assess the standard approach's efficacy over time. This may entail monitoring performance indicators, conducting routine audits of waste management procedures, and adapting the strategy as necessary.

4. AREA OF STUDY

Nagpur city is located in Maharashtra. It is the 5th largest growing/developing city of India, but it is observed through the studies that due to the lot of construction activities going on a lot of waste is generated which is not being taken care off or disposed of properly which ultimately leads to the addition of large volumes to the landfills. Nagpur's waste generation is growing annually as a result of the expanding building infrastructure. In Nagpur, the method of landfilling is mostly employed for building and demolition debris. Natural resources and expensive commodities like sand, aggregate, and cement make up the majority of waste material. Recycling C&D waste will save money and natural resources if it is combined with natural materials to some degree.

Lack of waste separation at the source, lack of transfer stations, and lack of infrastructure for scientific landfills are the main issues facing the solid waste management industry. In 2012, NMC created a municipal sanitation plan (CSP) that outlines the problems and murky regions that coincide with CRIS findings.

Segregation at the source is related to the recovery mechanism's effectiveness. Construction of a composting and waste-processing plant, an RDF and biogas plant, and a 63-acre landfill facility for Nagpur City is among the projects that have been highlighted.

The construction industry has grown quickly as a result of the city's development and redevelopment projects, as well as the city's increased urbanization, but the environmental effects of C&D waste are also quickly emerging as a significant problem in the city's C&D waste material management. For management C&D waste was removed from the list of MSW wastes in 2016 and now C&D waste is altogether a different sector that needs to be looked upon on an urgent basis. The Ministry of Environment, Forest and Climate Change has established guidelines and regulations that outline the fundamental definitions of various terminologies associated with C&D waste. These guidelines also specify the responsibilities and duties of different departments involved in managing C&D waste. As defined in CPCB guidelines "Construction and demolition waste" means building materials, debris, and rubble resulting from the construction, refurbishing, repair and demolition of any civil structure. It consists of various types of materials such as Excavated materials, Concrete blocks, Bricks, Dry Mortar, Tiles, Steel, Plastics, Wood, and Concrete rubbles, etc. The guidelines specified by the Ministry of Environment, Forest and Climate Change deal at macro level." For Nagpur, we need to study the aspects at the micro level to tackle the issues. In Nagpur, most of the waste generated from a site is being dumped into landfills. This can be treated in a way so we can reutilize the waste generated, and it will eventually lead to the generation of a circular economy as well as it will have "a positive impact on the environment."

The below images shows the identified location, i.e. Nagpur, Maharashtra, where the experimentation will be held.

Figure 3



Figure 3 Location of Nagpur District

Figure 4



Figure 4 Nagpur City Plan

4.1. SITE FOR DUMPING OR A LANDFILL

According to the city development plan, the Bhandewadi compost depot would be used for the “disposal of municipal solid waste.” The 54-acre property is located roughly 10 km from the city's downtown. The area is enclosed by an 8-foot-tall wall. The dumping field also has concrete roads, lamps, and the supply of basic amenities. Currently, 800 tonnes of municipal solid trash are delivered to the disposal site every day. NMC has built a scientific landfill site for the secure disposal of rejected and unusable MSW. For the disposal of various types of trash, NMC established three landfill sites.

4.2. PRECIS OF C&D WASTE MATERIAL MANAGEMENT

The amount of waste produced in Nagpur is allegedly not accessible through suitable or satisfactory statistics. Even after the guidelines given by “the Ministry of Environment, Forest and Climate Change and CPCB, this is because MSW management,” which includes building and demolition waste management, is not handled under a distinct regulatory framework in the city. As a result, acquiring information and managing construction and demolition debris are becoming more challenging. According to a report issued “by the MOEF (Ministry of Environment and Forest) in 2008,” the nation produces 5.3 lakh tonnes of garbage each day. Accordingly, 210 million tons of MSW is generated annually and it has been taken lightly to date. Depending on the type of structure, construction debris has a different composition. For instance, concrete and steel will be obtained from flyovers and bridges. Residential buildings will have diverse compositions, as would other types of constructions. Concrete, steel, wood, tiles, gypsum, bricks, polymers, etc. are all used in its construction.

Table 1

Table 1 Composition of Construction and Demolition Waste Material

Sr. No	Components of C&D waste	TIFAC (%)
01	Soil/ sand/ aggregate	36
02	Bitumen	2
03	Steel	5

04	Concrete	23
05	Wood	2
06	Others	1

The features of Demolition Trash: In the nation of India, during the process of dismantling ancient edifices, the predominant composition of debris consists of earth, sand, and crushed stone. Furthermore, this assemblage of demolition waste includes approximately 26% bricks and 32% masonry, in addition to 28% concrete, 6% metallic substances, and 3% wood. For repurposing or recycling, bricks, tiles, wood, and iron metal are commercially traded (BMTPC).

The information about the composition of construction and demolition waste material is shown in [Table 1](#). About 60% of the entire waste material is made up of soil, sand, aggregate, and concrete. Therefore, it is a serious issue that cement, which is expensive, is going into landfilling. For the management of garbage in the city of Nagpur, recycling is not being used.

Figure 5



Figure 5 Site Images Showing the Construction & and Demolition Waste

Figure 6



Figure 6 C&D Wastes Being Dumped Carelessly Alongside Roadsides

Upon visiting various construction sites in Nagpur, it was observed that the waste material mainly consisted of sand, soil, aggregates, and concrete.

4.3. NAGPUR C&D WASTE DATA

Table 2

Table 2 Showing the C&D Waste Data for Nagpur City									
Sr. SO.	Name of ULB	Class	population	Total Qty of C & D waste Generated during whole year in MT	Total Qty of C & D waste processed/recycled in MT	Total Qty of C & D waste Disposed by landfilling without processing (last option) or filling low lying area	Number of Storage Facilities for C&D Waste Storage	Transportation (Truck, Tractor, Dumper placer, other)	Transportation Municipal magistrates appointed for taking penal action for non-compliance with these rules.
1	Nagpur Municipal Corporation	MC-CLASS A	2750000	17136	0	17136	1	20	No

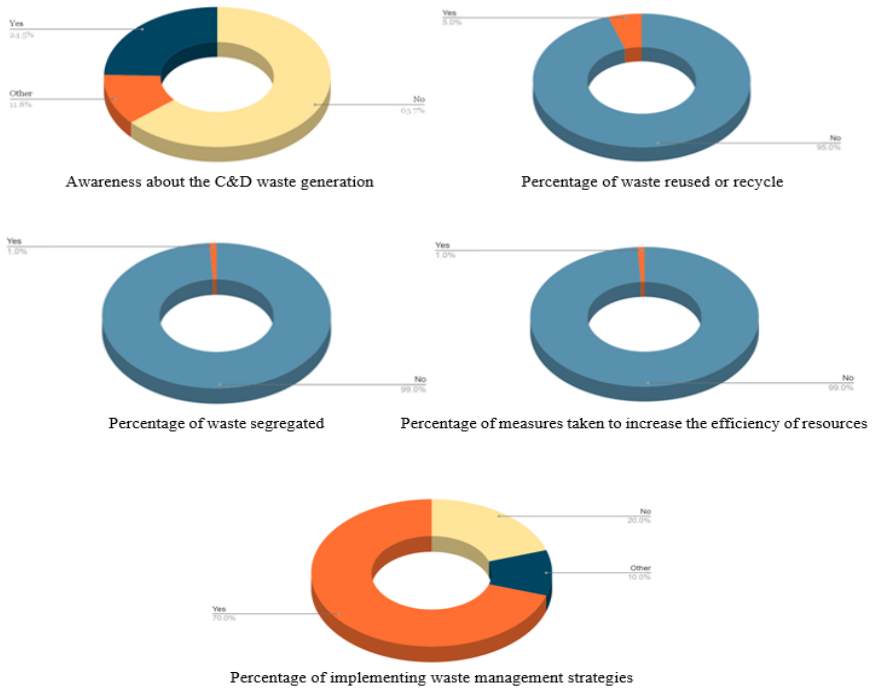
According to the 2011 census, Nagpur City's population was 27.5 lakh, and by 2030, it is anticipated to reach 40 lakhs. Total Quantity of C & D waste generated during the whole year is 17136 MT and we can observe from the data no C&D waste is reused/ recycled and almost the total amount is being disposed of to landfill without processing which causes a very adverse impact on the environment. Storage facilities are also very less in Nagpur and currently only one is present near Kalmana market as per the area dedicated to it. Implementation of new storage spaces is required. There is now no authority looking into this subject, which is leading to several issues around the city.

Table 3

Table 3 Showing the 'A' Class Corporations Data	
"A" Class Municipal Councils Generation v/s treatment (MT/Year)	
Generation	11933.8
Processing/ Recycle	2745.7
Landfill without processing	5363.3

5. RESULTS AND DISCUSSION

A questionnaire survey was conducted among active builders in Nagpur city. Through these interactions, valuable insights were gathered, painting a vivid picture of the challenges faced and the necessary solutions required to drive improvement. The survey data revealed that the majority of the participants lacked awareness regarding the significance "of C&D waste" and its management.



The questionnaire survey conducted with practicing builders in Nagpur revealed a lack of proper waste management practices and highlighted the need for guidelines to minimize C&D waste generation. However, around (70%) of the respondents were interested to learn more about sustainable construction practices and waste management strategies. To implement the strategies till micro level (site level), the formulation of strategies shall be explained and the authorities should train the contractors and site personnel. Around (65%) of the respondents were having neglectful demeanor towards waste generation on-site, only (25%) of respondents were aware about the waste generation but were unaware about its management. Majority (i.e. 95%) of the respondents are those who do not reuse/recycle the C&D waste. This is a very significant percentage which reveals the lack of knowledge and awareness regarding the reuse/recycle of waste. Furthermore, (0%) none of the respondents separate the waste during the demolition process. From the questionnaire survey it is observed that the builders in the Nagpur city are very careless considering the C&D waste generated on sites. However, they were very keen to know, curious about the methods to improve the situation. They are not qualified enough to understand the implications caused, therefore, it is significant to form the guidelines about Nagpur city.

The creation of specific guidelines aimed at addressing the issue of construction and demolition (C&D) waste holds the promise of enhancing the overall condition of the city and, by extension, benefiting the environment. Consequently, the implementation of effective waste management strategies assumes critical importance in mitigating the environmental repercussions and curbing the volume of waste directed to landfills. The insights gleaned from this study possess substantial potential for the development of robust waste management policies and guidelines tailored to the unique needs of Indian cities. "These measures are vital in the ongoing effort to ameliorate the adverse impact of C&D waste on the environment."

Through a literature analysis, data on "C&D waste" from various cities is collected. The data is analyzed to see how it affects the environment and to identify measures to make the situation better. The data is compared to Nagpur city data for

the study, and responses are found by conducting a questionnaire survey with Nagpur's practicing builders. Through an analysis of the literature and a questionnaire survey of practicing builders, the gap where we can genuinely comprehend the ground condition was found. The survey results showed a multitude of issues, with severe neglect serving, as the root reason.

We will be proposing guidelines based on all the data collected, analyzed and obtained through the questionnaire survey.

6. PROPOSING GUIDELINES FOR THE CITY OF NAGPUR

To “effectively tackle the generation of Construction and Demolition (C&D) waste, the following guidelines can be established about Nagpur city:”

- 1) **Incorporate waste minimization into the design phase:** Waste reduction methods should be incorporated into plans throughout the design phase of construction projects. This is something that architects and engineers should do. This can entail choosing materials with a smaller environmental effect, constructing structures to be easily disassembled and reused, and employing strong, long-lasting materials.
- 2) **Implement waste separation at the source:** Waste should be separated at the building site, and the separated items should be labeled, stored, and gathered for recycling or disposal. This has to have provisions for hazardous wastes like asbestos and lead that needs to be handled and disposed of specifically.
- 3) **Create a waste management strategy:** Construction and demolition projects need to create a thorough waste management plan that details the steps to take in handling garbage from collection to disposal. The plan should include who will be in charge of each task as well as the materials that will be recycled, utilized, or disposed of.
- 4) **Encourage recycling and reuse:** By recycling and reusing materials, construction and demolition operations may produce far less trash. Construction businesses should offer incentives for waste reduction, such as cash incentives for recycling and reuse, and penalties for non-compliance, to promote recycling and reuse.
- 5) **Establish a regulatory framework:** A regulatory framework should be established to ensure that construction and demolition projects comply with waste management guidelines. The regulatory framework should include penalties for non-compliance and incentives for waste reduction.
- 6) **Educate and train workers:** Workers should be educated and trained on waste management practices, including the proper “handling and disposal of waste materials. This should include training on the hazards associated with certain waste materials and the appropriate protective equipment that should be used. By implementing these guidelines in Nagpur city, we can effectively tackle “the generation of C&D waste” and promote sustainable construction practices.

7. CONCLUSIONS

The study highlights the necessity for effective administration of building and demolition waste in India. The rapid expansion of India's urban constructed surroundings “has brought about a notable increase in the” creation of C&D waste, which is not being appropriately recycled, resulting in negative environmental consequences. The study offers an intricate analysis of the generation of “C&D waste, strategies” for disposal, and the significance of precise quantification for the

efficient management of waste at both the regional and project domains. The research concentrates on the city of Nagpur, where a substantial amount of C&D waste is being generated due to the ongoing infrastructural development.

A survey was undertaken among active builders in Nagpur, shedding light on crucial issues concerning the management “of construction and demolition (C&D) waste in the” area. It reveals a significant lack of effective waste management practices on construction sites, emphasizing the need for enhanced waste management strategies to mitigate the environmental impact. Encouragingly, 70% of respondents show a keen interest in learning about sustainable construction practices and waste management, indicating a potential shift toward more eco-friendly approaches within the industry. However, the survey also exposes a significant awareness gap, with 65% of respondents being aware of waste generation but lacking the knowledge for proper management. This underscores the need for educational and training programs for construction professionals. A concerning finding is that 95% of respondents do not engage in waste reuse or recycling, indicating a lack of awareness about the economic and environmental benefits. This highlights the need for educational and incentive programs to promote responsible waste handling and recycling. Furthermore, none of the respondents separated waste during demolition, indicating a critical shortfall in waste management practices. Efficient waste separation at the source is vital for effective recycling and landfill reduction. In conclusion, the survey underscores the urgent need for comprehensive waste management reform in Nagpur's construction industry. Interest in sustainable practices is promising but must be complemented by educational programs and guidelines to bridge the awareness gap.

In conclusion, the survey indicates that builders in Nagpur city, while currently demonstrating a lack of waste management awareness and practices, are genuinely interested in improving the situation. The findings support the necessity for developing comprehensive guidelines specific to Nagpur to address C&D waste management. These guidelines should focus on providing not only the necessary strategies but also training and education for construction professionals to promote sustainable practices. By addressing these issues, Nagpur can work towards reducing the environmental impact and diverting waste from landfills, ultimately contributing to a more sustainable and environmentally responsible urban development in the region. This study emphasizes the significance of modifying waste management strategies to meet the unique requirements and difficulties of emerging cities like Nagpur.

CONFLICT OF INTERESTS

None.

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None.

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