Industrial Engineering Journal

ISSN: 0970-2555

Volume : 54, Issue 5, No.2, May : 2025

A STUDY ON CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT IN DEFENCE WORKS

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ABSTRACT

Construction and Demolition (C&D) waste is increasing in defense projects, where strict rules and sensitive areas make waste management harder. Indian defense projects have been slow to adopt sustainable waste practices, leading to inefficiencies and environmental damage. This study examines C&D waste management strategies, focusing on their effects on the environment, economy, and regulations. It analyzes ongoing work in stations to find better management methods that could save costs, time, materials, and labor. Recommendations for improving waste reduction, recycling, and reuse strategies are provided. These adjustments are expected to enhance waste management capabilities and support Sustainable Development Goals (SDGs).

Keywords: **Construction & Demolition (C&D) Waste, Recycled Aggregate (RA), Recycled concrete Aggregates, Sustainable Development Goals (SDGs).**

I. Introduction

1. Managing construction and demolition (C&D) waste in large infrastructure projects is vital for sustainability. Good practices, like recycling, can save money, reduce environmental harm, and advance project efficiency. Effective waste management is necessary to meet environmental laws and sustainability aims, especially as disposal options decrease. Improper waste disposal can worsen environmental issues and greenhouse gas emissions. Thus, managing C&D waste is key to achieving wider sustainability goals.

Table 1 Major and Minor Components of C&D Waste Source: TOOLKIT ON C & D WASTE MANAGEMENT RULES-2016 GOVT OF INDIA MOFEFCC

1. Major components includes • Cement concrete • Bricks • Cement plaster • Steel from RCC • Doors & windows • Roofing support systems • Rubble • Stones & Clay (Soil from excavation) • Timber etc.	2. Minor components includes • Conduits • GI pipes/Iron pipes/Plastic pipes • Electrical fixtures • Panels • Asbestos and contaminated soil • Glass • Plastic carry bags, sachets of tobacco and other plastics, Clothes, Cement bags, gunny bags, Thermocol, etc.

2. **Relevance to Defence Works in India:** India is focusing on improving its defence infrastructure, which is important for national security and development. The country is starting many large projects to modernize facilities like airfields and training centers, often in challenging locations. To address environmental and logistical issues, it is vital to use strong construction and demolition waste management strategies. This will help build defence infrastructure in a sustainable and cost-effective way and contribute to India's overall sustainability goals.

3. Problem Statement: The research aims to address the lack of efficient waste management in defence projects, despite regulations like the C&D Waste Management Rules (2016). The research explores challenges such as security concerns, remote locations, and limited recycling infrastructure. It aims to explore how sustainable waste management practices can be effectively integrated into defence mega-projects in India, aligning with national environmental and strategic goals. The research highlights the need for integrated C&D waste management policies in defence works.

4. Aim:

(a) To explore and evaluate the methods and practices exsisting at present and evolve them properly including construction and demolition waste management into defence infrastructure projects in India.
(b) To develop a framework that enhances the sustainability of these projects in defence works by understanding the requirements based on the study and recommend certain changes to existing policies and tendering procedures, that are aligned with national best practices to get defence works at par with India's Sustainability Goals.

5. Objectives:

(a) To evaluate the present state of Construction and Demolition (C&D) Waste Management framework and its applicability to Defence Infrastructure Projects in India.
(b) To identify and assess the unique challenges and barriers in incorporating sustainable C&D Waste Management practices in Defence-related mega Projects.
(c) To analyse ways to improve C&D Waste Management through analysis of data collected by site visits of ongoing Defence Projects.
(d) To provide policy recommendations for improving C&D Waste Management for furtherance of SDGs of India.

6. Scope: This study looks at construction and demolition (C&D) waste management in the defence sector of Western India. It assesses present practices and regulations related to waste management in defence projects. It identifies specific challenges faced by large-scale defence projects and explores sustainable waste management models suitable for these projects. Non-defence projects that do not produce significant C&D waste are not included in this study.

7. Hindrances / Limitations and Challenges Specific to Defence Projects:

(a) Construction and demolition (C&D) waste management for defence projects faces unique challenges. Security and confidentiality concerns complicate waste management due to restricted access and the need for careful handling of specialized materials, limiting outsourcing and recycling. Remote locations where many defence projects occur create logistical hurdles for transporting waste, making on-site recycling difficult.

(b) Defence projects have stricter material specifications, leading to higher wastage compared to civilian projects. Tight timelines pressure project completion, resulting in inefficient demolition and increased material wastage. There is also limited use of sustainable technologies, as initial costs and security concerns hinder their adoption.

(c) Moreover, defence projects are often in ecologically sensitive areas. Poor waste management poses risks to local ecosystems, including soil erosion and water contamination. Effective management of C&D waste in these fragile environments is essential but challenging. Strategies must balance national security needs with environmental sustainability.

(d) Organisational Limitations:

(i) **Lack of Awareness**: Within defence contractors and personnel, awareness of C&D waste management practices is low, especially in remote and high-priority defence projects where the focus is on speed and security.
(ii) **Limited Resources and Training**: Defence construction projects often lack the trained workforce and resources required to implement waste management strategies.

(iii) **Weak Enforcement of Regulations**: While India has laws such as the C&D Waste Management Rules, 2016, their enforcement is weak in defence-related projects due to the prioritization of national security over environmental concerns.
(iv) **Insufficient Incentives**: There are few policy incentives for defence contractors to implement sustainable waste management practices, and limited penalties for non-compliance in defence works.
(v) **Lack of Project-Specific Guidelines:** The regulatory framework does not provide detailed, sector-specific guidelines tailored to the unique requirements of defence infrastructure projects.
(vi) These limitations suggest that for C&D waste management to be fully integrated into defence projects, there must be a greater emphasis on raising awareness, enhancing on-site technological capacity and refining policies to address the unique challenges of defence infrastructure.

II Research Methodology: The research methodology is structured around a combination of survey of site, interviews of stakeholders and C&D data of ongoing projects. The key steps include:
1. Literature Review : A comprehensive review of global and Indian literature on C&D waste management, with a focus on defence projects, identifying best practices and challenges.
2. Data Collection : Primary data from at least a regionsof defence infrastructure projects will be collected. This includes site visits, interviews with stakeholders, and a detailed analysis of waste management practices.
3. Primary Data Collection:
(i) Review of reports and data from relevant government bodies, such as the Military Engineer Services (MES), Border Roads Organisation (BRO) and Defence Research and Development Organisation (DRDO)etc.
(ii) Analysis of prior research and regulatory documentation on C&D waste management from various scholarly paper, libraries and Departments of various institutions.
4. Secondary Data Collection:
(i) Survey/Interviews with contract managers, planning staff, executive engineers, and contractors involved in defence infrastructure projects.
(ii) On-site visits at stations having C&D type of works and study with respect to observation of waste management practices at defence project sites.
5. Data Analysis : A combination of qualitative and quantitative analysis will be used to assess the effectiveness of waste management strategies, recycling rates, and material reuse. It will also include
(i) Comparison of the volume and type of C&D waste generated in a typical project.
(ii) Analysis of the C&D waste generated to highlight the process of 3Rs and also to show its effectiveness for the work.
(iii) Identification of key challenges and success factors.
(iv) Identification of policy/ procedural issues and recommendation thereof.
6. Findings, recommendations and Policy Suggestions : Synthesizing the findings from the literature, this study and data analysis, policy suggestions will be developed to support sustainable C&D waste management in defence projects.

III Literature Review:

1. **Mr. Sandeep Shrivastava et al (2010**) and his associates highlighted issues with waste production and management in India's construction industry, particularly in the construction and demolition (C&D) subsector. C&D waste was estimated to be 24 million tonnes in 2010, and the environmental and sustainability risks posed by the ineffectual management of this waste are concerning.**Mr. Suresh Soni et al (2018)** highlighted the problem of construction and demolition (C&D) waste, which makes up a significant portion of the world's solid waste and is frequently disposed of in landfills, in 2018. Mainly in lower-grade mixes, researchers are investigating

methods to repurpose this waste in innovative concrete. The paper explored how recycled aggregates (RA) from construction and demolition (C&D) waste can retain excellent cement qualities while using less water. Recycled concrete was found to be similar to normal cement because different sizes of recycled aggregates may have an impact on permeability and compressive strength. **Sakshi Gupta et al (2018)** looked at how construction projects in India contribute to environmental degradation. Their research highlighted the importance of taking preventive measures in waste management and proposed enhancements for sustainability. **Dr Neeraj Jain et al (2019)**, conducted research aimed at reducing municipal solid waste by gathering data through questionnaires to tackle important problems in waste management.

2. In a similar vein, **Dr. P. S. Sutar et al (2019)** research emphasized that environmental considerations and financial savings were driving an upward trend in concrete recycling. The recycling process includes cleaning and crushing concrete to produce recycled aggregates, which are subsequently evaluated for their suitability in road construction. These qualities were demonstrated to promote the use of recycled aggregates in road construction.

3. **Dr. K. P Ramaswamy et al (2020)** in his research at IIT Chennai showed issues in India's construction sector, such as a lack of skilled workers and low productivity. It looked at various ongoing construction projects and measured waste in monetary terms to understand how it is produced on construction sites. **Mr. Yash Lohan et al (2021),** emphasized the importance of construction waste management (CWM) for reducing waste and converting it into usable materials. For financial efficiency in construction projects, it's crucial to comprehend waste management techniques and their magnitude. Dr. Prashant Kumar Sreram et al (2021) conducted a study on material waste in the Construction Industry in India. The research revealed that there were significantly more concrete wastage than it was anticipated, which indicated potential for additional waste reduction in the Construction Industry.

4. **Dr. Mayuri Chandak et al (2022)** conducted a literature review to investigate the causes of waste production and the current waste management systems in place, with the goal of improving sustainability. It is more required as with more than 65% of all infrastructure investment, India's construction sector is expanding quickly. **Dr. Mayur Jain et al (2022)** conducted a research and emphasized that C&D waste produces around 615 million tons yearly, with widespread illegal dumping. It analyzed global recycling rates and discovered that India had the lowest rate, while nations like China and Australia recycled more than 60%. To enhance waste management, it advised implementing regulations from industrialized nations.

5. **Dr. P. N. Ojha et al (2023),** examined the management and classification of C&D waste in 2023. The findings showed that concrete mixes utilizing recycled coarse aggregates had distinct characteristics from non-recycled mixtures. In India, greater attention is being paid to C&D waste management due to the growing need for sustainable materials and the expansion of housing under the PMAY Yojna.

6. **Smt. Ritu Gulati et al (2023)**in their study emphasized the importance of source segregation of C&D waste for successful recycling and minimizing environmental impact. A strong regional strategy and for establishing the recycling facilities at the city level are prerequisites for sustainable waste management.

IV Present Indian Scenario of C&D Waste Processing: In India, C&D waste makes up about 30% of the country's total municipal solid waste. The Technology Information, Forecasting and Assessment Council (TIFAC) reported that the construction industry generates 12 to 15 million tons of waste each year, with 7-8 million tons consisting of concrete and brick. The Indian Real Estate Industry faces a shortage of aggregates, needing 55,000 million cubic meters, while the road construction sector requires 750 million cubic meters, straining natural resources. Although some materials like bricks and metal are recycled, more than half of the concrete and masonry waste is not

recycled properly. This waste is often sent to landfills or dumped illegally in water bodies. With rising environmental concerns and limited landfill space, cities such as Ahmedabad, Delhi, Mumbai, and Pune are now prioritizing the recycling of C&D waste materials.

1. **Need for C&D wastes Processing :** Construction activities, including building and renovating, result in demolition tasks that create construction and demolition (C&D) waste. This waste is a major issue for builders and owners, especially due to the lack of natural materials needed. Reusing or recycling this waste can help reduce demand for new materials. However, construction and demolition projects lead to environmental and economic problems, like resource depletion and pollution from poor waste disposal.

Despite some recycling due to rising material costs, many materials are still thrown away, and some waste contains harmful substances. Demolition is usually done by specialized contractors who provide equipment and personnel and take away the leftover waste. Property owners pay these contractors based on the value of recyclable materials like steel and wood..

2. Regulations on C&D Waste Managements and its histrory: To address the problems of resource depletion, increasing demand for building materials, societal awareness on pollution effects (dust, pollution due to traffic conges on owing to roadside disposal) of C&D waste, rules were framed. The rules that were framed to address the issue of C&D waste management are :

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 5, No.2, May : 2025

Table no. 1 Regulations on C&D waste management in India

Year	Authority	Regulation / Guideline	Key Provisions / Directions
2000	MoEFCC	**Municipal Solid Wastes (Management and Handling) Rules, 2000**	First formal rule, included limited provisions for handling C&D waste under solid waste category.
2016	MoEFCC	**Construction and Demolition Waste Management Rules, 2016**	Landmark rules **dedicated to C&D waste**; mandates waste generators to segregate, store, and dispose; Local bodies to establish recycling facilities.
2017	CPCB	**Guidelines on Environmental Management of C&D Waste**	Detailed **technical guidance** on segregation, transportation, processing, and use of recycled products.
2018	BIS	**IS 383: Specification for Coarse and Fine Aggregates**	Revised to allow use of **recycled concrete aggregates** in construction work.
2019	NGT (National Green Tribunal)	**Directions in O.A. No. 199/2014**	Strong directions to **urban local bodies** to comply with 2016 Rules; Imposed fines for non-compliance.
2020	CPWD	**Guidelines for Sustainable Habitats**	Advocated **reuse of C&D materials**, on-site waste management, and green procurement in government works.
2021	MoHUA	**Model Building Bye-laws** (Amended)	Mandated **C&D waste management plans** for buildings >5000 sq.m.; Encouraged decentralized processing.
2022	CPCB	**Revised Guidelines for C&D Waste Management**	Stressed on use of **mobile waste processing units**, **geo-tagging**, and **inventory preparation**.
2023	NGT / CPCB	**Periodic Compliance Orders**	Regular monitoring reports from states/UTs; stricter timelines for setting up recycling plants and compliance.
2024	MoEFCC	**Construction and Demolition Waste Management Rules, 2016 Amended and called as Act on C&D Waste Management vide Gazette Notificaiton by GOI 24 Jul 2024 enforced from 01 Apr 25**	Landmark Act **dedicated to C&D waste Management which** mandates waste generators to segregate, store, and dispose; Local bodies to establish recycling facilities and also directs all stakeholders to follow reduction, recycling and reusing with laid down norms for all to achieve target till 2029.

3. A typical C&D waste processing cycle along with processed waste products is as under in the figure below:

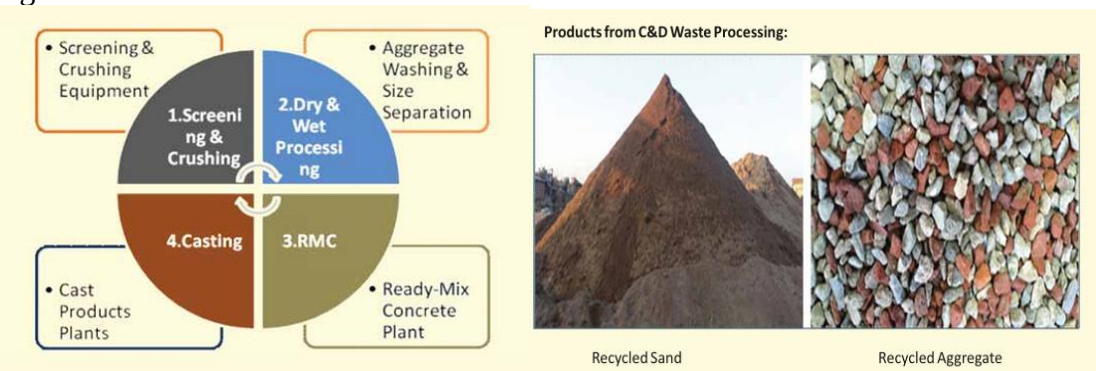


Figure no. 1 A typical C&D Waste Cycle and processed C&D waste products

Source: L&T magazine DigitAlly and Concord Sep 23

4. Key highlights of the recent developments on C&D Waste Management in India:

(i) Mandatory for large cities to setup recycling plant within 18 months and smaller cities within 2-3 years.

(ii) Generators of waste are required to pay notified collection and processing fees.

(iii) Imposition of heavy penalties on illegal dumping of C&D Waste.

(iv) Use of Construction & Demolition waste (20% to 100%) is allowed in construction. IS 383 standard code revised.

(v) Introduction of Centralized Helpline number including Mobile App in and toll free numbers for all ULBs mandatory.

5. The potential uses of C&D waste processed item is as given in the table below:

Table no. 2 Potential uses of C&D Waste

Source: TOOLKIT ON C & D WASTE MANAGEMENT RULES-2016 GOVT OF INDIA MOFEFCC

Material	Potential use
Asphalt	Road sub-base fill
Concrete	Crushed and mixed to make new asphalt cement blocks, crushed and screened aggregate can be used in asphalt concrete
Dirt	Landscaping landfill cover
Metal	Scrap metal dealers
Wood	Timber/wood pulp shredded for fuel, animal, bedding, landscaping, manufactured building products and compost
Brick	Masonry crushed for ornamental store
Glass	Fiberglass insulation sandblast, aggregate in asphalt reflective beads
Gypsum	Soil amendment, gypsum board, absorbent media
Plastic	ABS, plastic lumber, PVC, Highway barriers
Polystyrene	Insulation
Porcelain	Crushed for aggregate
Corrugated Cardboards	Paper mills, Fuel pellets
Carpet	Landfill cover
Roofing Shingles	Asphalt paving

6. **Current Practices in Defence Sector on C&D Waste Management**:

(a) **Segregation & Storage**: Most defence construction sites follow basic waste segregation. However, formalized mechanisms for on-site waste handling are still evolving.

(b) **Recycling & Reuse**: Limited to ad-hoc reuse of bricks, concrete chunks, and steel within project sites. Large-scale recycling infrastructure is mostly absent within defence zones.

(c) **Disposal Practices**: Waste is often disposed of in nearby lowlying areas in landfill sites in the station or is at the disposal of the Contractor, with limited compliance to CPCB norms.

(d) **Guideline for C&D Waste Management**: It is still in its evolving stage and there are no clearcut guidelines available in to be followed on subject. Hence, there is a gap which needs to be plugged by making policy/ guideline changes.

(e) **Lack of Dedicated Policies:** Defence-specific guidelines for C&D waste are not yet comprehensive.

(f) **Logistical Constraints:** Many defence projects are located in remote or sensitive border areas, where waste transportation and recycling facilities are minimal.

(g) **Security Restrictions:** Limitations on third-party entry restrict private sector participation in waste collection and processing.

(h) **Awareness & Training Gaps:** On-ground personnel are often unaware of updated waste handling protocols.

(i) **Recent Developments**

(i) Pilot initiatives for **on-site crushing** and **reuse of aggregates** in road construction (BRO projects).
(ii) Inclusion of **green building codes** and **GRIHA/IGBC ratings** in defence infrastructure planning, which indirectly promote better waste management.
(iii) Collaboration with MES, DRDO and CPWD for **eco-friendly construction practices**.
(j) A detailed summary of the C&D waste management in Defence Works is as given in table below:

Table no. 3 Summary Table for current status of C&D in Defence Work

Aspect	**Status in Defence Works**
Policy Framework	Based on MoEFCC 2016 Rules; Defence-specific guidelines lacking also changes required in tendering procedures
Segregation	Partially implemented at local unit level
Recycling	Minimal, mostly ad-hoc reuse as lack of awareness prevalent
Disposal	Often informal or landfill-based and responsibility of Contractor
Security/Access Constraints	High – limits private/ third party involvement

V **Data Collection**: Data was collected from various construction and demolition (C&D) waste recycling units in urban local bodies (ULBs) for a study related to the Defence sector. A survey was conducted within the Defence community as part of the study's goals. Initially, efforts were made to obtain the necessary data. The data came from Defence installations in Western India, where C&D work was ongoing. It was determined that a specific station would be chosen for data collection, and this was then requested for the study.

1. **Data from Installation**: For the sake of secrecy of information, data and locations as they were taken from Defence works in an installation it were named as Station A Work A1.

2. **Survey of Environment**: A detailed questionnaire was created for interviews and general surveys. The goal is to gather information about awareness, application, and policies related to Defence Works. It also aims to assess knowledge of C&D Waste management among different levels of the Defence Works community. The following was followed as below:

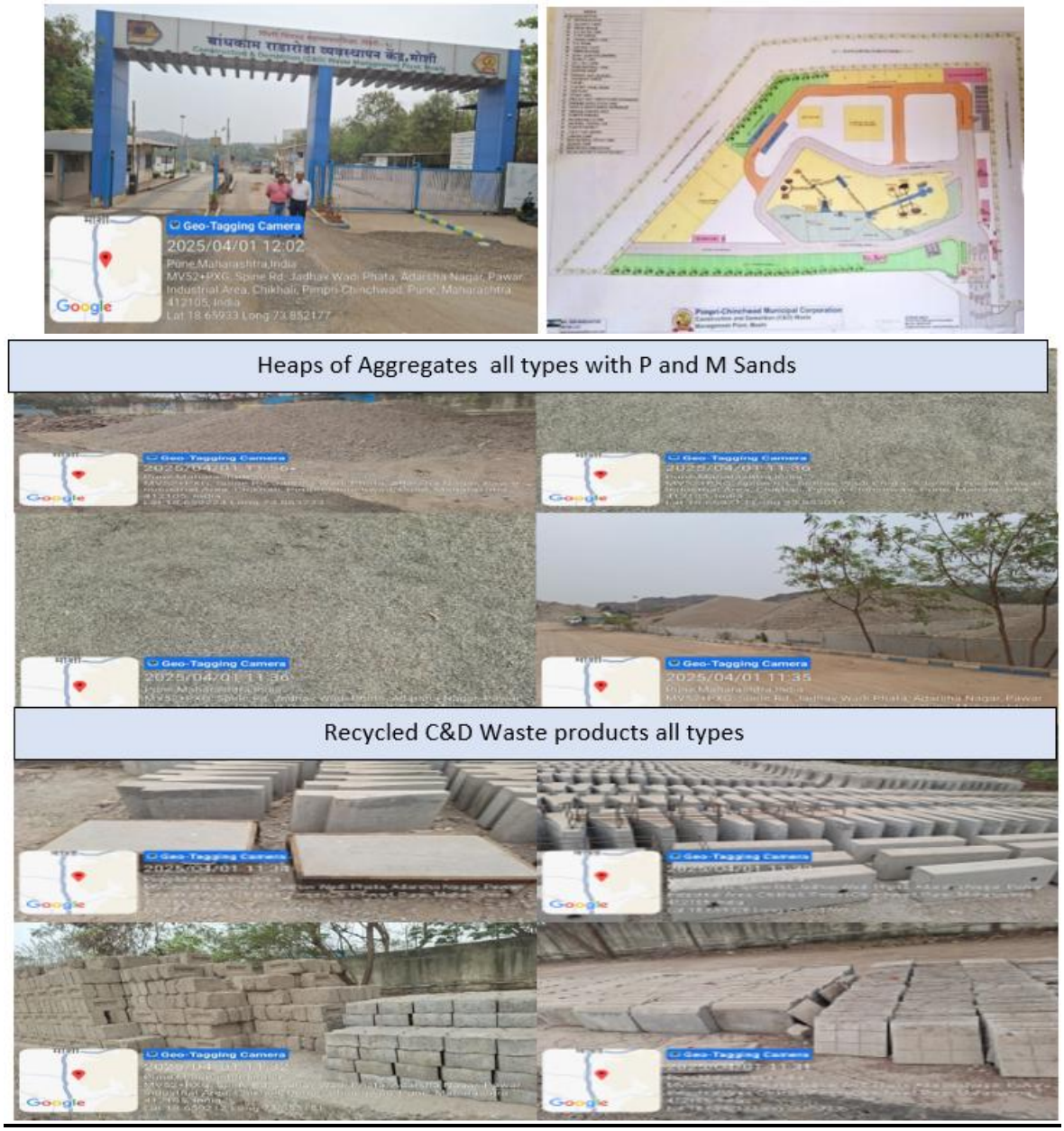
(i) Survey forms were divided into three main categories viz, Planning Managers at all levels in Defence Works, Contracting Mangers at all levels in Defence Works and Executive Managers at all levels in Defence Works.
(ii) These were then circulated in the environment by use of information media and also physical interviews and a detailed data was obtained in over a period of 21 days.
(iii) The process of collection of data as well as the work of survey and interview of the stakeholders in the Defence works fraternity was done almost simultaneously as against it was planned during the first phase of the project as lot of liaison and meeting with various government entities were to be carried out initially, that included meeting concerned Urban Local Body (ULB) officials as well as the civilian contractors running the show on behalf of these ULBs.

3. Visit to C& D Recycling Facilities.

(a) During the interveing period between receipt of data from various stations a visit to various C&D waste recycling facilities was carried out to ascertain the process of recycling of C&D Waste and the types of recycled products that are obtained from them. The first visit was carried out at Pimpri Chinchwad Mucipal Corporation C&D Waste Recycling facility at Moshi. The various aspects as seen in the facilites are depicted in Geotag photos as depicted below:

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 5, No.2, May : 2025

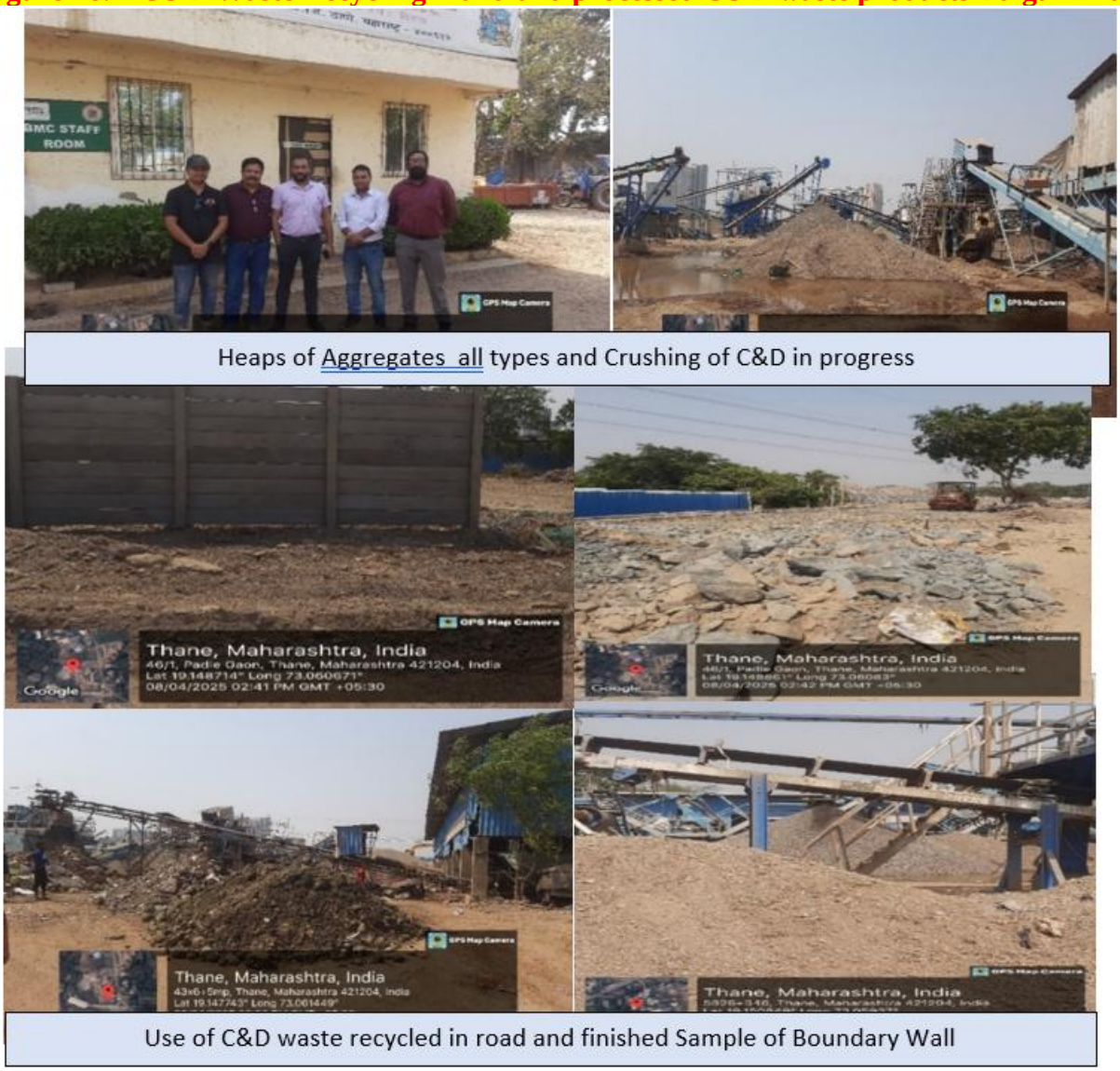
Figure no. 3 C&D Waste Recycling Plant PCMC and processed C&D waste products Moshi Pune



(b) The Second visit was carried out at Thane Muncipal Corporation C&D Waste Recycling facility at Daigar. The various aspects as seen in the facilites are depicted in Geotag photos as depicted below:

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 5, No.2, May : 2025

Figure no. 4 C&D Waste Recycling Plant and processed C&D waste products Daigar Thane



(c) The rates of the recycled products that were made from the deposited C&D waste was obtained from these locations. It was pertinent to note that the cost of these products vis-à-vis original and virgin materials varied and were lesser because they were devoid of any royalty as they are all recycled. Moreover, these were all conforming to the IS 383 2016 (with amdt of 2017) as per the norms specified for there inclusion in construction industry as Recycled Aggregates and Recycled Concrete Aggregates.A comparative table of rates of these recycled products versus original with price ranges as obtained from the sites are placed in the table below:

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ISSN: 0970-2555
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Table no. 4 Comparative rates of Original Vs Recycled Products at Thane Daigar

Rate Difference Between Recycled & Natural products at Thane				
Sr. No.	Description	Unit	Rate of Products in Rs	
			Recycled***	Natural*
1	M Sand	Tonne	1100-1250	1400-1600
2	P Sand	Tonne	1300-1350	1650-1800
3	Aggregate	Tonne	300-350	300-500
4	Aggregate	Tonne	270-300	400-600
5	Sludge/ Soil	Tonne	50-70	300-400
6	Paver block	Piece	13	14-18
7	GSB	Tonne	700	1000-1200

Table no. 5 Recycled Product rates of C&D Recycled Products at Moshi PCM

sr.no.	Description	basic rate	unit	Complete rate 2022-23 with GST	20% Discount
1	Tapering R.C.C. M-20 Barrier type Kerb with gutter	972	Rmt	1020.60	816.48
2	Tapering R.C.C. M-20 Semi Barrier type Kerb with gutter	858	Rmt	900.90	720.72
3	Tapering R.C.C. M-20 Mountable type Kerb with gutter	774	Rmt	812.70	650.16
4	C.C. hollow block 100x200x400 Superstructure cm 1:6	1231	Sqm	1299.45	1039.56
5	C.C. hollow block 200x200x400 Superstructure cm 1:6	1332	Sqm	1431.39	1145.11
6	Masonry in precast solid Concrete block of size (300mm x 200 mm x 150 mm) in c.m. 1:6 for superstructure	7638	Cum	8047.51	6438.01
7	Interlocking Praving Block 80 mm Gray	1032	Sqm	1095.68	876.54
8	Interlocking Praving Block 60 mm colour	919	Sqm	977.03	781.62
9	Interlocking Praving Block 80 mm colour	1166	Sqm	1236.38	989.10
10	Interlocking Praving Block 60 mm Rubber moulded glossy	1096	Sqm	1162.88	930.30
11	Interlocking Praving Block 80 mm Rubber moulded glossy	1401	Sqm	1483.13	1186.50
12	Interlocking Praving Block 40 mm colour	842	Sqm	896.18	716.94

(d) It can be seen from the above rates of the recyled C&D waste products and the original ones with GST that the recycled items are any time economical than Virgin materials. However, it should also be noted that the C&D Waste recycling facility at Daigar is also providing the aggregates and sands to UltraTech and L&T who are regularly testing and utilising these materials which is in fact conformation of workability, strength and use of recycled products as replacement of virgin ones to cut done costs and go green.

4. Data of a Defence work of a Station A involving C&D waste generation: As a sample study to gauge amount of waste that is generated in a defence work involving both construction and demolition waste generation is done at a station A for the work A1 the details that are taken are as under:

Table no. 6 Project Overview Defence Work A1

Item	Description
Total Project Cost	₹1416 lakh approx
Main Structures to be Constructed	03 (1x G+7, 1x G+1 and 1x UG Sump)
Structures to be Demolished	7 (6× G+2, 1× Overhead Tank)
Demolition Cost (Estimated)	₹60 lakh
Excavation & Miscellaneous Costs	₹13.5 lakh
C&D Waste Processing Cost	₹0.45 Cr (assumed /taken from C&D Waste Recycling Facility updated)
Recovered Materials	Concrete, Steel, Bricks, GSB, Sand, Pavers, Earth **(C&D Waste can be recycled)**
Waste Disposal	Most may be reused or dumped inside station

Table no. 7 Data of C&D waste generation in Defence Work A1 of Station A

NAME OF THE PROJECT : DEMOLITION AND CONSTRUTION OF STATION MARRIED QUARTERS AT STATION -A WORK A1				
SNO.	**DETAILS REQUIRED**	**QTY IN AU**	**AMOUNT IN lakh Rs**	**REMARKS IF ANY**
1	**TOTAL MAIN STRUCTURES TO BE CONSTRUCTED AS IN SCHEDULE A**	**3**	**1416**	**03 (1x G+7, 1x G+1 and 1x UG Sump)**
2	**TOTAL STRUCTURES TO BE DEMOLISHED WITH ESTIMATED COST**	**7**	**60**	**07 (6 x G+2, 1x Overhead Tank)**
3	**TOTAL COST OF THE PROJECT**		1416	
4	TOTAL ESTIMATED COST OF THE PROJECT STRUCTURE TO BE DEMOLISHED		60	
5	TOTAL ESTIMATED VOLUME OF CONCRETE IN DEMOLITION STRUCTURE WITH COST	3514 Cum	33	
6	TOTAL ESTIMATED QTY OF STEEL IN DEMOLITION STRUCTURE (ESTIMATED)	60196 kg	16	
7	TOTAL ESTIMATED QTY OF BRICKS IN THE DEMOLITION STRUCTURE (ESTIMATED)	1641 Cum	13	
8	TOTAL ESTIMATED QTY OF STEEL REQUIRED IN NON STRUCTURAL STEEL IN THE PROJECT	575 kg	0.5	
9	TOTAL RECOVERED VOLUME OF CONCRETE IN DEMOLITION STRUCTURE (ESTIMATED)	2291		
10	TOTAL RECOVERED QTY OF STEEL IN DEMOLITION STRUCTURE (ESTIMATED)	60196 kg		

11	TOTAL AREA OF HARD STANDING REQUIRED IN PROJECT IF ANY (ESTIMATED)	7107 Sqm	24	
12	TOTAL PAVER BLOCKS REQUIRED IN PROJECT IF ANY (ESTIMATED)	435 Sqm		
13	TOTAL PAVEMENT TILES REQUIRED IN PROJECT IF ANY (ESTIMATED)	0		
14	TOTAL VOLUME/ QTY OF GSB REQUIRED FOR ROADS IN PROJECT IF ANY (ESTIMATED)	1250		
15	TOTAL VOLUME/QTY OF COARSE SAND REQUIRED IN PROJECT (ESTIMATED)	2550 Cum		
16	TOTAL VOLUME/QTY OF PLASTER SAND REQUIRED IN PROJECT (ESTIMATED)	1000 Cum		
17	COST AND DETAILS OF ANY OTHER ITEM IN THE PROJECT BEING REUSED B/R AND E/M	NA	0	
18	TOTAL COST OF ALL EXCAVATIONS AND COMMENT WHEHTER BEING UTILISED IN STATION OR OTHERWISE		13.5	
19	ANY OTHER ASPECT RELEVANT TO CONSTRUCTION AND DEMOLITION WASTE GENRATED/ CAN BE REUSED/RECYCLED	NA		Dumped inside station

Table no.8 Summary of Materials with Cost Savings Defence Work A1

Material	Original Material Cost (₹)	Recycled Material Cost (₹)	Savings (₹)
GSB (442 tons)	₹5,30,400	₹3,09,400	₹2,21,000
Plaster Sand (354 tons)	₹5,84,100	₹4,77,900	₹1,06,200
Coarse Sand (902 tons)	₹14,43,200	₹11,27,500	₹3,15,700
Hard Standing (7107 sqm)	₹85,28,400	₹53,30,250	₹31,98,150
Paver Blocks (435 sqm)	₹2,50,690	₹1,94,880	₹55,810
Other C&D Items	₹3,600	₹2,800	₹800
Earthwork Reuse	₹0	₹13,50,000 (reuse value)	₹13,50,000
Concrete (993 Cum recovered)	₹0	₹26,40,000 (processed recycled product)	₹26,40,000
Bricks (580 Cum)	₹0	₹13,00,000	₹13,00,000
Non-structural Steel (575 kg)	₹0	₹50,000	₹50,000
Total	₹1,64,90,390	₹1,14,92,230	₹49,98,160
Note:-Original Material has Royalty as well as transportation Costs while Recycling material have no royalty and only transportation cost.			

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 5, No.2, May : 2025

VI Observations and Findings:

1. The reuse of C&D waste materials may lead to **cost savings exceeding**, primarily due to avoidance of procurement, royalty and transport on virgin materials.
2. On-site **earth reuse** reduces hauling/disposal costs and supports landfilling and levelling. Also reuse of **excavated soil** internally further avoids waste handling/disposal cost.
3. Processing of **concrete, GSB, and sand from C&D Waste recycling units may** avoid significant purchase costs.
4. **Steel reuse** through reprocessing may add financial value and diverts material from landfills.

5. Data Analysis of Respone of Survey Questionaire to the Defence Enviroment :

(a) After the closure of survey response time 21 days all the responses were downloaded in an excel sheet for further analysis. The common as well as important questions were then segregated and there responses of each category was taken down in tabular form as under:

Table no. 9 Summary of Responses from Planning, Contracting and Executive Managers

Category	Findings
1. Awareness about C&D Waste Rules (2016 & 2024)	• **Low awareness overall—majority** (especially senior staff) unaware of both the 2016 rules and 2024 amendments. Few junior officers (0–5 yrs exp.) and some mid-level (6–15 yrs) reported awareness. Only a few mentioned awareness or relevance of the updated Act or related IS codes (e.g., IS 383).
2. Willingness to Undertake C&D Waste Management	• Most respondents showed strong willingness to incorporate C&D waste plans at project commencement. Several support mandatory recycled material usage and believe in waste reutilization benefits.
3. Presence of Existing Policy Guidelines	• **Majority noted lack of clear guidelines or said existing contract manuals don't mention C&D management**. Some acknowledged general disposal norms (e.g., vendor-based disposal), but these are not specific or standardised. • Respondents mentioned limited or no formal guidelines issued by HQ. Some mentioned GRIHA, SSR updates, and Planning Circulars, but **most were unaware.**
4. Need for Modifications to Policy & Tendering	• **Strong consensus that tendering procedures need revision.** • Adding dedicated C&D clauses in contracts, • Financial consequences for violations. • Making recycling mandatory in project scope. • Waste reporting mandates for contractors • Pre-casting from recycled C&D materials as approved methodology
5. Knowledge of Penalties for C&D Waste Violations	• Most were unaware of local or national penalty structures. Penalties (if applied) are limited to monetary fines, profit deductions, or contract warnings—largely inconsistent.
6. Current Percentage of C&D Waste Management in Projects	• Vast majority reported 0–10% actual reuse/recycling.A few claimed up to 11–25%, but this was limited to specific pilot projects or individual initiatives.
7. Key Suggestions for Improving C&D Waste Management	• Increase number of C&D recycling plants • Provision of tax incentives & industry awards • Adopt modular & prefabricated construction techniques • Ensure mandatory segregation at source • Integrate monitoring and audit systems

8. Cost-Benefit Analysis & Innovation Insights	• Cost savings through use of recycled materials (e.g., concrete aggregates, tiles, steel), • Reduction in landfill dependency, • Improved environmental sustainability and Lower material extraction & transport costs. • Many support performance-linked incentives & innovation rewards for contractors.
9. Contractual Enforcement Issues	• Many faced difficulty in enforcement due to absence of clear contractual clauses.Only a few had incorporated cost-benefit analyses or specific penalty measures in contracts.
10. Collaboration & Incentive Systems	• Rewarding contractors for cost savings, • Clear penalty & incentive structure and finally • Training & workshops for field-level staff

(b) With increasing emphasis on sustainable development, resource optimization and mission readiness, integrating structured C&D waste management into defence projects is no longer optional but it is a strategic necessity.

VII Findings from Study on C&D Waste Management in Defence Works:

1. There is a visible lack of awareness of Laws in C&D waste management as given by GOI. Also local application of C&D waste management is not sufficient since there are no laid down policy or procedure to be followed is present in the Defence works environment on C&D Waste Management. It will align Defence Sector with national and global climate goals through circular economy principles.
2. From the analysis of the Defence Work A1 of station A we can see recycling can yield **up to 12% cost savings** in defence construction.
3. **IRC:121-2017** permits use of recycled aggregates in roads and base layers.
4. It is possible to reduce costs of construction materials and disposal logistics by use of recycled C&D products, it will promote local reuse of materials in remote/high-altitude defence zones
5. Enhance sustainability of defence infrastructure through waste minimization and reuse

VIII Recommendations for Defence Works Sector to Act upon, Future Scope and Conclusion:

1. Recommendation for Defence Works

(a) Policy Framework Development: Create a defence-specific C&D waste management policy aligned with MoEF&CC rules and issue strict guidelines to be followed.

(b) Use of C&D Recycling Plants: Establish liaison with C&D recycling units in major cantonments (e.g., Delhi, Pune, Secunderabad).

(c) Training & Capacity Building: Conduct workshops for MES and BRO staff on sustainable construction practices.

(d) Smart Cantonment Integration: Use GIS-based tracking and include waste KPIs in smart cantonment performance reviews.

(e) Modern Technologies and Design tools: Use latest available technology knowhow and design applications to reduce material wastages at initial stages.

(f) Achievement of C&D Management Targets: Defence forces will be also be flagbearers of green revolution with adoption of new C&D Waste management norm and policy upgradations

2. **Future Scope & Conclusion**:

(a) Way Ahead:

(i) The study highlights several key points regarding construction and demolition (C&D) waste management in defense projects. It suggests conducting a analysis for using recycled C&D waste in all defense works.

(ii) It emphasizes the importance of modern design, material management and C&D waste management for harbouring green technologies and sustainable development goals.
(iii) The study also calls for establishing Mobile C&D Management Units in remote areas, close to logistics.
(iv) Finally, it stresses the need for regular audits and implementing measures from the planning stage to maximize benefits.

(b) Conclusion: Defence has a strategic opportunity to convert construction and demolition waste into a national asset. With structured policy, pilot projects, and capacity building, Defence Sector can lead India's sustainable construction movement—achieving both **mission readiness** and **environmental responsibility**, also becoming the Nations Flagbearers.

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