

Recycling of C&D Waste to reduce the impact on Environment in Delhi

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Abstract— The Construction and demolition waste generation is between the 2000-4000TPD as per the last four-year available annual report on DPCC. The generation of the C&D waste through the construction (building, flyover, roadwork, airport work etc.), demolition and repairing of the intended infrastructure but this activity gradually impacting the environment and depletion of the natural raw resources. The C&D waste consist of non-biodegradable material like concrete waste, metal scrap, therefore it is necessarily to recycle the C&D waste to minimize the impact on the environment and to sustain the existing raw resources.

Demolition and Construction (C&D) Debris produced during building and demolition processes is categorized as waste. A significant amount of construction and demolition debris is produced each time a building or other civil engineering structure is constructed, refurbished, or demolished. Depending on how and where it was formed, this trash frequently consists of a variety of materials, such as concrete, metals, bricks, glass, plastics, organics, etc.

Construction and demolition waste (C&DW) is generally separated into two categories: Non-inert materials (such as plastic, glass, paper, wood, flora, and other organic materials) and inert materials (such as sand, bricks, and concrete).

C&DW recycling is the most popular substitute. It can serve as a supplement to the current mineral supplies and lessen the strain on natural resources, environment and priceless urban land.

Index Terms— Construction and demolition waste, Debris, Recycling.

I. INTRODUCTION

The Construction and demolitions waste waste" means waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair and demolition of any civil structure. Wastes also include surplus and damaged products and materials arising in the course of construction work or used temporarily during the course of on-site activities. Under Rule 3, the following definitions have been provided:

- a) Sub rule (b) "construction" means the process of erecting of building or built facility or other structure, or building of infrastructure including alteration in these entities;
- b) Sub rule (d) "de-construction" means a planned selective demolition in which salvage, re-use and recycling of the demolished structure is maximized;
- c) Sub rule (e) "demolition" means breaking down or tearing down buildings and other structures either manually or using mechanical force (by various equipment) or by implosion using explosives.

Demolition waste characteristics: In India, when old structures are demolished, the primary waste products are soil, sand, and gravel, which account for bricks (26%) and masonry (32%), concrete (28%), metal (6%), wood (3%), and other materials (5%).

The main ingredients include metal, wood, asphalt, earth, bricks, and concrete. Soil, sand, gravel, and brick and masonry make up more than 60% of all garbage. (Source: Burari facility, Municipal Corporation of Delhi)

Numerous techniques have been used in the literature to estimate the production of C&D waste at the regional and project levels. The Technology Information, Forecasting and Assessment Council (TIFAC), which acknowledges that the generation is project-specific, have developed the following estimates on C&D waste generation:

- a. Range 40-60 kg per sq.m of new construction,
- b. Range 40-50 kg per sq.m of building repair,
- c. Range 300-500 kg per sq.m for demolition of buildings

II. RESEARCH PROBLEM

A. Review Stage

A significant portion of waste in these cities is illegally landfilled or discarded carelessly throughout the urban

areas, which contributes to material waste and ineffective land use practices. In the upcoming decades, as these cities' economies, populations, and physical areas grow, land-use conflicts and related environmental problems would only worsen in the absence of appropriate C&DW management approaches.

III. OBJECTIVE

The objective is to analyze to determine the following aspects of the C&D waste management process:

- To understand construction and demolition waste recycling with the latest technology, the right process
- To find out the segregated material as aggregate, sand etc. percentage based upon the feeding the C&D waste received from different sources.
- To determine the tentative quantity used to reuse the C&D waste material to make the different products and tolerances in the laws
- Generation of comparative assessment of the recycled C&D Waste with the DPCC report

IV. METHODOLOGY

The Detailed methodology include following steps:-

- Analysis existing C & D waste quantification by Site visit method
- By the use of load sensing device and monitor used for the monitoring of the C&D waste process facility.
- By analyzing the record of incoming C&D waste through weighting process.
- With the discussion of the C&D waste processing facility management team and their existing process.

V. AREA STUDY

Delhi, India's capital territory, is a massive metropolitan area in the country's north. The study area falls under the study of the recycling of C&D waste to reduce the impact on the environment in Delhi. The C&D waste generation varies from 2000 to 4000 TPD as per Delhi Pollution Control Board data. Such a huge amount of C&D waste generation affects the environment and human health.

The drastic urbanization in rural areas and re-novation, repair, and construction in urban areas enhance the quantity and larger amount of C&D waste occupying areas for dumping. Therefore, C&D waste recycling is

the best substitute for reducing the usage of natural resources, which consequently reduces the impact on the environment.

The study covers the analysis of C&D waste generation every year and the process used to recycle the usable products.

VI. C&D PROCESSING FACILITY

This 2.5-acre C&D waste processing facility at shastri Park is run by M/s Indo Enviro Integrated Solutions Limited and has a 1000 TPD capacity. Irrespective of the plant processing capacity, the sequence of Unit operations is as follows:

- a) Receipt & Inspection of C&D Waste at the plant
- b) Weighment
- c) Manual Segregation & Resizing
- d) Wet Processing
- e) Manufacturing of Brick, Tiles, Kerb Stone etc.
(a) Receipt & Inspection of C&D Waste at the plant
 - Inspection of waste at entrance.
 - After acceptance of material, the truck proceeds for weighment.

b) Weighment

The C&D waste that was brought into the facility was first weighed using a computerized system that was erected close to the gate where vehicles enter. Following this, the arriving material was inspected. Records of the various products (concrete aggregates, soil, concrete blocks, GSB, and cement bricks, etc.) and incoming C&D waste were kept.

c) Manual Segregation & Re-sizing

After weighment, trucks are brought to Waste Dumping area. The C&D waste is dumped at the tipping floor. JCB is used to level the collected waste. Wood, steel, plastic and bituminous etc. are manually segregated which are sent either to Waste to Energy plant or dump site.



Figure:-1, Resizing the C&D waste into different size aggregate.



Figure:-2, Crushing the larger Processing the C&D waste into different size aggregate.

The remaining waste is segregated into 3 parts:

- i) Whole bricks segregated manually
- ii) Big concrete pieces
- iii) Mixed C&D

All large sized (ii) & (iii) are resized to 200mm-400mm size by mechanical and manual means.

(d) *Processing*

Mixed C&D: The dumping platform contains the grizzly feeder, which further segregates into small fractions. -60 mm material passes through grizzly and materials +60 mm is directly fed to the Jaw Crusher for crushing into smaller size. The smaller size is once again crushed and collected at surge hopper, then Small Size Granulator & then the Granulator product is screened for sizing. Over size material goes to Roll Crusher for crushing the oversize in -5 mm. material.

- The -60 mm material falls into the static conveyor shall discharge at elevated level of about 6.0 Meters. From the slow moving inspection conveyor, all the unwanted objects shall be hand-picked at the manual separation station. Picked material like clothes, wood, plastic etc. are collected in separate bins. The output will be fed into the input of the screening section for wet processing.



Figure:-3, Processing the C&D waste into different size aggregate.

(e) *Wet Processing*

The wet processing of the C&D waste with the CDE C&D System will be as under:-

- i.-60 mm material feed to the rinsing prescreen for washing where -3 mm material with silt goes to the Evowash system for washing. In addition, oversize material with contaminants feed to the Log washer.
- ii. In Log washer all contaminants like poly bags, clothes removes from the feed material.
- iii. The material from Log washer then feed to the Prograde screen for sizing in different grade and stockpiled with the help of Conveyor.

The following lists the construction and demolition waste that this facility collected, processed, and recycled in the years 2022–2023

Sr.no.	Component	Qty.(in MT)
1	Plastic	198.19
2	Concrete & Aggregate	5747.76
3	Mortar	1585.58
4	Boi Soil	11891.92
5	Wood	396.39

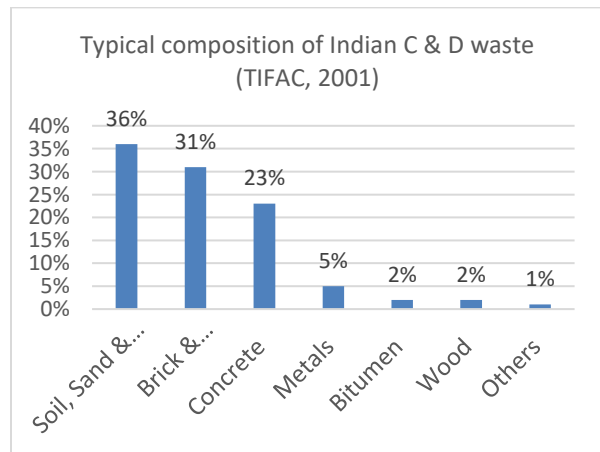


Table 2: -Demolition Waste received and processed at this facility in the Year 2022-2023
(Source-DPCC Annual report in Form IV FY 22-23)

Sr.No.	Description	Quantum (year 2022-2023) in MT
1	C&D Waste Received (As per plant Operator)	369056 MT (1011.1TPD) (101.1% of Capacity)
2	Total Quantity of C&D waste Proceesed and Recycled	349454 MT (957.4 TPD) 95.7% of Capacity
3	Manufactured Sand	16320
4	GSB	51159
5	Screen Soil	215975.6
6	CC Bricks	6106 m3 (763260 pieces)

C&D waste is processed using only wet methods, with a 150 TPD capacity. On-site weighbridge equipped with automated technology. Tata Power provides the power connection, with a 300 KW authorized power load. Among the equipment are the Aqua Cycle, JAW, Prograte, and Evo wash.

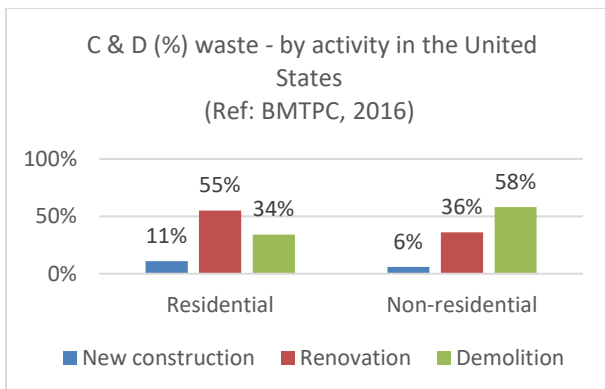
The plant uses raw materials like building and demolition waste (also known as waste debris or Malba) to make final products like fine and coarse aggregates.



Figure:-4, Processing the C&D waste into sand.

Table 3 :-Details of C&D waste Received & proceeds and C&D Waste Recycled Products in the financial Year 2022-2023
(Source-DPCC Annual report in Form IV FY 22-23)

Sr.No.	Location of C&D Waste Processing facility	Name of operator	Local body/ authority	Year of commissioning	Plot area (acre)	Capacity (in TPD)	C&D waste received in 2022-2023(MT)	C&D waste processed in 2022-2023 (MT)	Off take of C&D Recycled products by Govt. Deptt.(MT)
1	Shastri Park	M/s Indo Enviro Integrated Solutions Limited	MCD	2016	2.5	1000	369056	349454	298297



VII. IMPACTS OF CONSTRUCTION & DEMOLITION WASTE

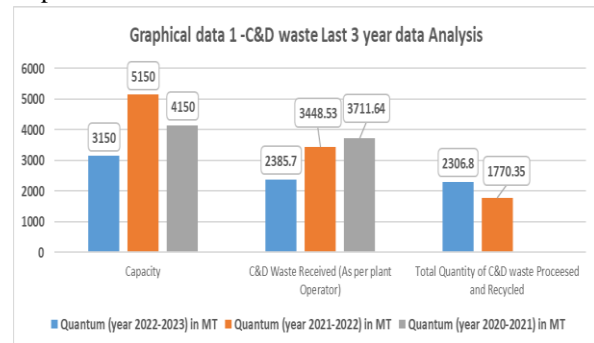
Over & above waste, Construction, renovation, and demolition projects create environmental and economic problems. Proper management of C&D waste provides the following benefits:

Economic Advantages:

- Creates Economic Impulses in following ways:
- Improvement in the economic situation of recycling industry.
- More jobs for workers with both high and low qualifications.
- Recovery of costs associated with transportation and tipping fees.
- Good quality of waste material stimulated by better prices.
- Reduces Disposal Costs.
- Less waste end up in landfill, increasing lifetime and reducing costs.
- Conserves Natural Resources.
- Return of waste material into material cycle.
- Reduction of dependency on primary material.
- Reduces costs of new constructions.
- Lower prices than new material.

Environmental Advantages:

- It reduces the environmental impacts of waste in dumps and landfills. Land, water and air pollution impacts are reduced thereby resulting in less pollution from manufacturing and transportation related emissions and lower greenhouse gas emissions, reduction in extraction of virgin natural resources.
- Social and Health Advantages
- It ensures that the ill effects of pollution arising out of such wastes are minimized including health impacts.



VII. INITIATIVES TO PROMOTE RECYCLING OF C & D WASTE IN INDIA

Source:- Guidelines On Environmental Management Of Construction & Demolition (C & D) Wastes shared by the CPCB.

The constitution of India has rules pertaining to the conservation and enhancement of the environment.

- In 2007, the demand for aggregates increased by five percent to over 21 billion tonnes, with developing countries like India having the highest demand. (AIT, Thailand) conducted a study for a few Asian nations, including India; the report was published in May 2008.

- As a result, managing C&D waste with regard to reuse and recycling is more crucial.

(i). Ministry of Urban Development (MoUD):

- Ministry of Urban Development vide circular dated June 28, 2012, directed States to set-up such facilities in all cities with a population of over 10 lakhs (one million plus cities) to establish environment friendly C & D recycling facilities (reference base being the first C & D waste processing facility commissioned in Delhi in Burari model).

- The MoUD report ‘Technical Aspects of Processing and Treatment of Municipal Solid Waste’, Swach Bharat Mission (MoUD, 2016) also recognises the need for C & D waste management (Page 227).

(ii). Ministry of Environment, Forest & Climate Change (MoEF&CC):

- Environmental considerations have been integrated into all levels and in National Environment Policy of 2006, incorporation of the concept of 3Rs, is reflected in all the notified waste management rules (MSW, plastic, BMW, HW, e-wastes).

- A Report of the Committee to ‘Evolve Road Map on Management of Wastes in India (2010)’ highlights C & D problems; it recognized the utility of the waste and acknowledged lack of data on the waste generation.

- The C & D Waste Management Rules, 2016 were notified by MoEF & CC vide notification no. G.S.R. 317(E) dated 29th March 2016.

(iii). Bureau of Indian Standards (BIS):

- Under the Construction and Demolition (C & D) Waste Management Rules, 2016 Rule (11) under Duties of Bureau of Indian Standards (BIS) and Indian Roads Congress (IRC), ‘

- The Bureau of Indian Standards and Indian Roads Congress shall be responsible for preparation of code

of practices and standards for use of recycled materials and products of construction and demolition waste in respect of construction activities.

Role of Standards (BIS) in Utilization of C & D Wastes:

- It is the basis for acceptance
- Wider use by increasing confidence in users consumers
- Transfer of technology
- Scope for review / amendment / revision / withdrawal
- Techno-legal - Part of regulatory documents
- Techno-financial - Part of financing projects
- Basis for training / capacity building and R&D

IS 383: 2016 Indian Standard COARSE AND FINE AGGREGATE FOR CONCRETE – SPECIFICATION (3rd Rev)

This standard covers the requirements for aggregates, crushed or uncrushed, derived from natural sources, such as river terraces and riverbeds, glacial deposits, rocks, boulders and gravels, and manufactured aggregates produced from other than natural sources, for use in the production of concrete for normal structural purposes including mass concrete works.

These manufactured aggregates are of two types namely:

- Recycled Aggregate (RA) — It is made from C & D waste which may comprise concrete, brick, tiles, stone, etc.
- Recycled Concrete Aggregate (RCA) – It is derived from concrete after requisite processing.

BIS IS: 383 permitting

- Use of recycled aggregates up to 25% in plain concrete,
- 20% in reinforced concrete of M-25 or lower grade and
- up to 100% in lean concretes of grade less than M-15.

(iv). *Building Material & Technology Promoting Council (BMTPC):*

BMTPC in 2016 released “Guidelines for utilization of C & D waste in construction of dwelling units and related infrastructure in housing schemes of the Government”

(v). *Central Public Works Division (CPWD)*

- The “Guidelines for Sustainable Habitat (March 2014)” are based on reports of National Mission on ‘Sustainable Habitat’ by the Ministry of Urban Development (MoUD) and draft code on "Approach to Sustainability" as part of National Building Code (NBC 2005).

- The PART IV of the Guidelines for ‘Sustainable Habitat’ discusses ‘Guidelines on reuse and recycling of Construction and Demolition (C & D) waste’. The guidelines on Construction and Demolition (C & D) waste addressed the building industry activity.

(vi). CPWD & NBCC

- Approximately 25-30 million tonnes of C & D wastes is generated annually in India of which 5% is processed.

- To address utilization of C & D wastes, the Central Public Works Department (CPWD) and National Building Construction Company (NBCC) have recommended use of recycled portions of C & D wastes in their construction activities or if the same is available within 100 km from construction site. Reference was made to the BIS 383: 2016 standards.

(vii). Indian Road Congress (IRC)

Under the Construction and Demolition (C & D) Waste Management Rules, 2016, Rule 11 indicates the role of Indian Roads Congress (IRC) w.r.t. preparation of code of practices / standards for use of recycled materials and products of construction and demolition waste in respect of road works.

VIII. ABBREVIATIONS AND ACRONYMS

C&D –Construction and Demolition

TPD-Ton Per Day

GSB- Granular subbase

DPCC-Delhi Pollution Control Committee

IX .COMPARISON WITH EXISTING RESEARCH

In keeping with the presumptions and system boundaries of other studies, this section compares the results with those of prior studies on C&DW recycling. Although the life cycle inventory and impact assessment numbers in our study are greater than those published elsewhere, the overall results of the literature review, indicate that C&DW recycling has less of an environmental impact.

The graphic data 1 in the reports reflects the capacity of Delhi to recycle the C&D waste, which remains greater than the generation and recycling percentage, which is continuously increasing with the advancement of technology and working on the previous data to make a more robust system to achieve a recycling rate of 100%.and the different recycling processing units recycled the C&D waste, as per the DPCC annual report Form IV comparison. The local government also enforced much to intensify the usage of recycled products; for the same, they set an objective every financial year to minimize the adverse effects on human health, and the environment. The number of recycled products like GSB, screen soil, blocks, etc. increased in the financial year 2022-2023 as compared to the last 3 years, which reflects the growth of a sustainable journey.

X. LIMITATIONS AND FUTURE WORK

Treatment of non-inert rejects from recycling, which include tiny amounts of plastics, wood, cloth, glass, and other inert materials combined with soil and other C&DW inert elements, could use some improvement. The recycling residual fraction was landfilled, but in order to close the material circle to attain a 100% recycled economy, this fraction needs to be valued. Fourth, the water-related consequences of recycling were overlooked because the facilities use cleaned water from a nearby wastewater treatment plant, which would have otherwise been dumped into the river. Potential impacts of this sort of channeling on river ecology might be included in future studies.

XI: CONCLUSION

Due to the varying pace of developmental activities in cities, the redevelopment of cities is due to rapid urbanization, where demolition activities become necessary. Growing development is intensifying several environmental-related issues. Delhi continuously consumes massive amounts of fine and coarse aggregates and generates the same amount of construction and demolition waste. Densification of cities raises the demand for raw materials from longer distances, impacting vehicle emissions from quarrying and other operations. Due to the larger demand, Delhi imports raw materials for construction from nearby cities. In view of the same, the Ministry of Urban Development, vide a circular dated June 28, 2012, directed States to set-up such facilities in all cities with

a population of over 10 lakhs (one million plus cities) to establish environment friendly C&D recycling facilities (the reference base being the first C&D waste processing facility commissioned in Delhi in the Burari model). C&D waste recycling facilities in cities could potentially mitigate these issues. A significant portion of the waste is now landfilled or deposited in an open manner, which causes conflicts with land usage and wastes important building materials. Integrated recycling provides an alternative source of materials and greatly reduces the environmental effects of the construction industry, promoting the circular economy.

The foremost advantages include the minimization of greenhouse gas emissions, energy consumption, land requirements, usage of natural resources, air pollution, health issues, and water use. It helps to reduce dependence on primary materials, which reduces the cost of new construction. Approx. 95.7% of C&W was processed and recycled in FY 22–23. The amount of C&W waste recycled is greater than in the in the last three years, which clearly reflects the process that has advanced to make the impact less to a greater extent. recycled GSB, screen soil, blocks, aggregate, and sand precast products. Soil, sand, and gravel are found to be the to be the highest in C&D waste composition. The study said that C&D waste generation is 3 times greater in demolition as compared to new construction. In addition, renovation work generates five times more C&D waste as compared to new construction. The quantum of generation of C&D waste for renovation and demolition is quite higher than that required by construction technology to minimize the generation rate at source only.

XII: ACKNOWLEDGMENT

The authors express their gratitude to the IL&FS staff of the C&DW recycling plants located in New Delhi's Shastri Park for their invaluable assistance in elucidating plant operations and providing crucial data. We would like to express our gratitude to the reviewers for their insightful feedback, which greatly enhanced the work.

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