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Waste Management Practices in Infrastructure Projects in India

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Waste Management Practices in Infrastructure Projects in India

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Abstract

Construction and demolition (C&D) creates waste that poses a great threat to the environment adding to the rising pollution levels across India. India generates 100-150 million tonnes/year an underestimate figure by roughly 35 times. C&D waste constitutes of Dredging Materials, Asbestos Materials, Concrete, Bricks, Tiles, Ceramics, Wood, Glass, Plastic, Metallic Waste, Drywall, Cement, Paints, Varnishes, Adhesives & Sealants. Proper management of this waste is a crucial aspect in achieving sustainable development and a circular economy. Currently this waste gets dumped in landfills without receiving any proper treatment catering to more pollution problems. With extensive exploratory research and literature reviews, Information has been gathered and compiled in this paper to highlight the status quo of C&D waste management systems in India with examples of PPP model of Delhi and Ahmedabad. It also elucidates on the govt policies like C&D waste rules 2016 and national resource efficiency policy, 2019 as well as Insights from best global practices to benchmark the existing systems.

C&D waste is recyclable with products of approved quality and standards to be used in construction activity. Some of these products are RMC bricks, blocks tiles, pavers and aggregates and soil to be reused for construction.These products face problems in their market uptake, solutions for which have been mentioned in this paper. Lastly the paper provides recommendations to improve overall C&D waste management infrastructure so as to develop a cleaner and greener India.

Keywords: circular economy, waste management, construction and demolition waste

Introduction

India being a developing nation is perpetually in a phase of building new infrastructure projects. “It is expected that India will become the third largest construction market in the world by 2022”. The industry had attracted ever increasing investments of 14.7 billion USD in 2019 alone. According to draft national resource efficieny policy 2019, material consumption has risen from 1.18 billion tonnes in 1970 to 7 billion tonnes in 2015. “Construction of these projects requires proper planning and execution but most often ignore the residual waste that is produced by undertaking these construction activities”. Waste produced from construction is called “construction and demolition waste”. In India this waste was defined on 29th March, 2016 by the Ministry of Environment, Forest and Climate Change (MoEF&CC) as “Any waste comprising building materials, debris and rubble resulting from construction, remodeling, repair and demolition of any civil structure’ is to be classified as C&D waste” [1]. Construction and infrastructure waste such as concrete, bricks, and metal is strangling our waterways, green spaces, and public spaces both inside and outside of cities. The debris pollutes the air with massive amounts of harmful dust particles. This waste needs to be reduced, re-used and recycled for curbing the environmental and habitation problems caused by it. This waste has a direct affect on the livelihoods of people. As migration from rural to urban India takes place with growing aspirations of the population of our developing nation, the need for housing and construction is only predicted to grow over the next decade.

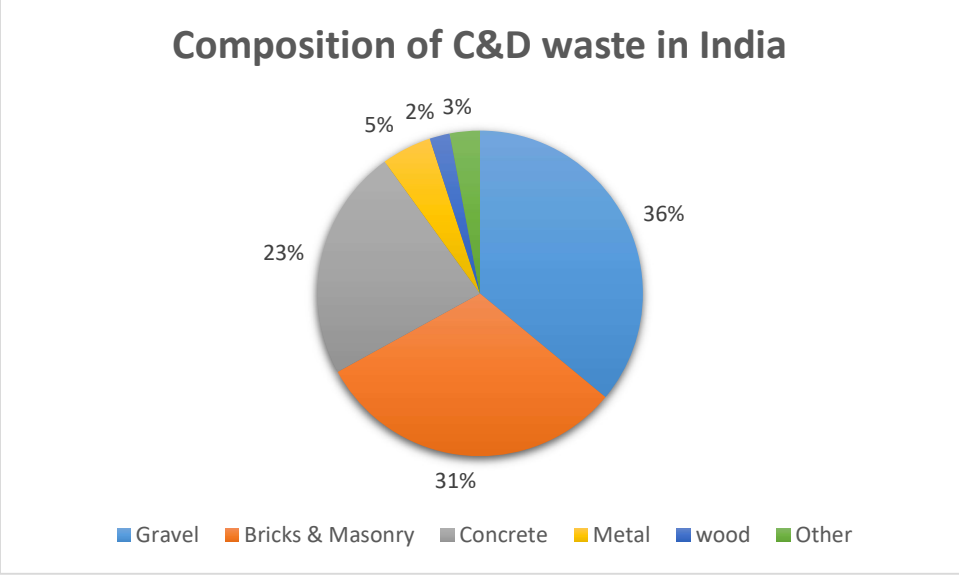
This growing need is only going to cater to more waste being untreated or inadequately treated and dumped in landfills unless proper C&D waste management principles are indoctrinated along with the 3Rs strategy of reducing, re-using and recycling. A lot of the material waste can be brought back to use in the construction sector such as manufactured sand

and concrete aggregates that are extensively used, providing a basis for a circular economy. This research paper looks at various aspects via literature reviews of existing literature on the topic. It provides a collation of information on status quo of C&D waste generated and its management, existing government policies in place as well as benchmarks best practices and policies across the globe to provide a suitable strategy for managing this waste effectively in India.

Literature Review

Characteristics of construction and demolition waste

Construction & demolition produces an inert waste that can be reused or recycled in large quantities. According to a 2001 research by the Technology Information, Forecasting and Assessment Council (TIFAC), C&D waste in India typically contains soil, sand and gravel (36%), bricks and masonry (31%), concrete (23%), metal (5%), wood (2%), and other materials (3 per cent) [refer chart below]. However, the composition of C&D waste varies from region to region, depending on prevalent construction style and building material usage.



Environmental impacts of C&D waste

The C&D waste generated in the construction, preservation, and discarding segments of a structure, including waste from demolished structures, renovations and construction, as well as repair of roads, flyovers, bridges, and other structures, is a composite waste stream that contains a diverse range of constituents such as debris from the structures, bricks, concrete, soil, steel, timber (wood), and a mixture of siting materials. It also includes the incidence of surplus labour and energy consumption in various construction tasks. Large C&D projects in India regularly amass rubbish on the roadside, causing traffic congestion. Separate household garbage is thrown into nearby municipal bins or containers, as well as waste storage yards, resulting in bulky municipal waste and limiting its value for activities such as energy recovery and composting. The construction industry makes a significant contribution to the advancement of society. While this is acknowledged, it is also cited as a major contributor to environmental degradation. Land depletion, energy demand and consumption, solid waste creation, dust and gas emissions, noise pollution, and the use of natural resources, especially non-renewable resources, are some of its negative repercussions on society. Dust, noise, smoke, and stink are the most prevalent environmental consequences of diverse activities. The primary variables affecting the environment in the case of C&D waste management are dust and noise. Earth movements, destruction, and other construction operations frequently result in the spread of dirt clouds, which have a negative influence on the rising number of individuals suffering from respiratory disorders, as well as a negative impact on the degradation of surfaces. Various restoration tasks and façade dusting are also included in the dust producing activities. According to a 2017 IIT Kanpur study, road dust from C&D waste is the primary source of urban pollution, accounting for 56 percent of all PM10 particles and 38 percent of the harmful and respirable PM2.5.

particles. Paints, solvents, oils, and washing water are some of the polluting fluids used in the construction sector, and they can harm the ground and neighboring pavements.

Waste generation in India

India's construction sector is expected to develop at a rate of 7-8 percent over the next ten years, making it the world's third largest by the middle of the decade, thanks to growing urbanization [1]. Nearly 70% of the buildings that should exist by 2030 have yet to be constructed, according to estimates. Such vast construction will rely substantially on raw materials like sand (for concrete and mortar), soil (for clay bricks), stone (for aggregates), and limestone (for cement), all of which have significant environmental implications during their extraction and manufacturing. Some of these minerals, particularly sand, are already in short supply (due to environmental bans and limitations), putting the business at risk. According to draft national resource efficiency policy, 2019estimated annual consumption of these five categories of materials are- Sand: 750 million tonnes, Soil: 350 million meter cube, Stone (aggregate): 2 billion tonnes, Limestone: 242 million tonnes & Cement: 297 million tonnes [1].

It is very difficult to have a comprehensive estimate of C&D waste generation in India due to lack of data collection via a proper estimation method and lack of knowledge regarding C&D waste management amongst the collectors, generators, operators, and the general public. Thereby, making a quantification of the same is not possible. However, MoHUA (Ministry of Housing and Urban Affairs), in their annual report 20200-21 estimates that roughly **100 million tonnes/year** is the closest approximation for nationwide generation. Official estimates by the Building Material and Promotion Council estimates annual generation are estimated to be around **150 million tonnes/year**. It is believed to be an underestimated figure by the Centre for Science and Environment, who believe the actual figure to be 35 times of the estimated value. Despite

having such enormous amount of C&D waste generation, India recycles only 1% of it's C&D waste.

Current status of C&D waste disposal in India

Only two cities Delhi and Ahmedabad have adopted PPP model for C&D waste management plan successfully whereas mostly everywhere else bids are given out to local contractors to dispose of demolition waste. Local contractors dump C&D garbage at designated landfills or in unapproved locations such as road sides, river beds, and low-lying regions, resulting in a slew of annoyance, safety, and environmental issues.

Government policies for C&D waste handling

The "C&D Waste Rules 2016" has given out detailed information regarding the duties and responsibilities of all stakeholders. The rules are applicable to all those who generate C&D waste. The rules specify the duties of waste generators, service providers and contractors, state government and local authorities, Central pollution control board, state pollution control board or pollution committee and Central ministries and details of Facility for processing/recycling facility. Details of Duties and responsibilities of all stakeholders are mentioned below.

Waste Generator –

- Collection and storage of "waste within their premises" and "ensuring no spill over or mixing" with municipal solid waste (MSW) [1]
- Depositing "waste in designated locations as notified by local authority"
- Submission of a "waste management plan" and getting an "approval before starting construction/demolition work". [1]
- "Payment of mandated charges by the authority for collection and disposal" [1]

Utility service providers and their contractors -

- Preparation of a waste management plan
- Collection and storage of waste by avoiding local disruption or pollution [1]
- Arranging disposal with urban local bodies and paying relevant charges [1]

Local Authority -

- Take responsibility for waste management. They may contact third party for oversight and outcome and are required to carry out a feasibility study before finalizing a management plan [1]
- They are authorized to pass by-laws mandating C&D waste management and fix charges and penalties for the same [1]
- They should designate intermediate collection points and site for facility. If required they can collaborate with state agencies. [1]
- Responsible for authorizing and approving waste management plan of generators and collecting relevant fees. [1]
- Arranging for collection,transportation and processing in contract with private parties [1]
- They are to establish a C&D waste generation database by linking waste management permits and monitoring compliances. [1]
- Have to create incentives for use of recycled products including through preferential purchase agreements in municipal contracts. [1]

State pollution control board/committee -

- To monitor implementation of the rule by local authority [1]
- Authorize C&D waste processing facilities as per criteria and monitoring environmental compliances [1]

- Preparation of annual report for Central public commissions board [1]

State Government -

- To prepare policy for C&D waste management [1]
- Aid in identifying land for waste management to the cities of the state
- Facilitate preferential procurement of recycled materials by all state agencies. [1]

Central public commission board -

- To provide guidelines for C&D waste management [1]
- To prepare annual compliance report for central government by analyzing data collected by state public commissions board [1]

Bureau of Indian Standards/Indian Roads congress -

- To standardize recycled products from C&D waste so as to enable proper utilization of these products

Central Government -

- To facilitate compliance by Ministry of home and urban affairs and Ministry of rural development
- Implementation review to be carried out by Ministry of Environment, Forest and Climate Change

The C&D waste rules 2016 have not received proper implementation due to various reasons which have been identified by the national think-tank Niti Aayog. The identification of these reasons have led a pathway for Niti Aayog to come up with a strategy, details of which are mentioned in the section “Niti aayog strategy for C&D waste management”.

Apart from C&D waste rules 2016, various guidelines and advisories have also been circulated. In a circular dated June 28, 2012, the Ministry of Urban Development (MoUD) requested that all states establish environmentally friendly C&D waste recycling facilities in all cities/towns with populations of over one million. The Ministry of Urban Development's paper, titled "Technical Aspects of Processing and Treatment of Municipal Solid Waste," acknowledged the necessity for CDW management as part of the Swachh Bharat Mission. The 2014 ‘Guidelines for Sustainable Habitats' published by the Central Public Works Department (CPWD) featured a set of ‘Guidelines on re-use of recovered C&D waste.' The guidelines cover how to recycle CDW and precautions to take, as well as the importance of having a deconstruction plan in place to recover usable items that can be reused without much processing. To address the significant shortage of conventional and traditional building materials in India based on high demand for building materials by 2021-2022, BMTPC released the ‘Guidelines for Utilization of Construction & Demolition Waste in Construction of Dwelling Units and Related Infrastructure in Government Housing Schemes' in 2016. The Ministry of Housing and Urban Affairs (MoHUA) circulated a notification by CPWD on the mandatory use of recycled portions of C&D trash in construction activities, if the same is available within 100 kilometres of the construction site, in a letter dated March 23, 2016. It further stated that Recycled Concrete Aggregate (RCA) obtained from C&D Waste should be used in the construction of Lean Concrete, Plain Concrete Cement (PCC), and Reinforced Concrete Cement (RCC). In 2015, the Delhi Public Works Department issued an advice to all Delhi Government Departments mandating the use of recycled C&D waste products in building construction and road works at a rate of 2- 10%. The Delhi PWD reissued the advice in 2018. This new guideline also demands the use of C&D waste products and recommends the installation of more small-capacity C&D waste recycling plants,

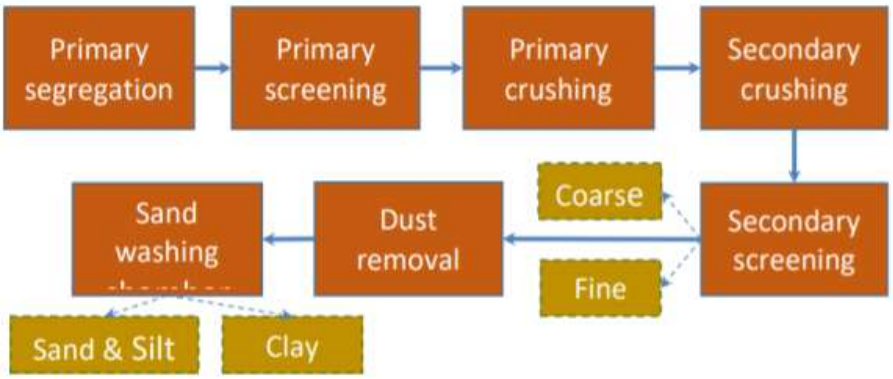
i.e., 500 TPD, at various places across the city, with at least one for each significant government stakeholder. The North Delhi Municipal Corporation has set aside seven dumping sites for C&D trash generated by individual households, according to the advice. [1]

Existing C&D waste handling practices

For Majority of brownfield construction projects across India, demolition contractors play a crucial role for servicing the demolition waste. These demolition contractors are part of the unorganized sector. They are neither registered with the government authorities nor have expertise in waste handling. They are in a contractual agreement with the builder/owner who bear the cost of transportation of waste materials to be disposed off at a designated landfill area. They mainly carry out their job by transporting the waste from project site to a designated landfill. The constituents of the waste are not segregated prior to disposal. This leads to unnecessary wastage of resources which could be otherwise treated and utilized again for construction. Segregating these materials from landfills becomes an even heftier task as no accountability is taken by government authorities. Thereby a lack of data collection mounts the challenge to efficiently treat this waste.

C&D waste management process

Before being brought to the designated landfill, the waste management process would comprise of primary segregation; screening; crushing; secondary crushing; secondary screening; dividing the materials between coarse and fine aggregates; followed by dust removal; Sand Washing; ultimately leading to output of Sand& Silt or Clay.



The coarse and fine aggregates are of various sizes which may be used as recycled aggregates in construction or used to manufacture a range of pre-cast products like bricks.

From the outset of any infrastructure project, the construction waste management plan needs to be adopted as an integral part of the project. It may by recognized as a part of the materials management. There also needs to be the realization that one project's wastes are a source of material for another project. Understanding such a premise facilitates efficient and effective C&D waste management approach. The need for waste management should be taken into account early in the design process. As it becomes a topic for discussion both at pre-construction and ongoing regular job meetings, it will ensure that the contractors and appropriate sub-contractors are fully informed of the requirements and implications on their work prior to the construction phase.

Public private partnership as a model for waste management

IL&FS Environmental Infrastructure & Services Ltd (IEISL) created a pilot project in partnership with MCD to illustrate the possibilities of a scientifically managed process in regard to the collection and recycling of C&D trash in Delhi. The pilot project envisioned a proper collection mechanism for C&D waste generated in the city, transportation of the garbage to a designated processing location, waste processing, and land reclamation through filling, levelling, and compaction. It was established to set an example for other cities in India, as it was the first

such initiative of structured management of C&D garbage in the country. Hence the learning from this pilot project is of great importance.

The project was launched with the public-private partnership (PPP) basis at Burari on roughly seven acres of land supplied by the MCD for a ten-year period. The PPP approach for collecting, processing, and disposing of C&D trash is successful because it accomplishes two goals: conserving landfill space on the one hand, and generating a market for C&D waste recyclables on the other. Collection and delivery of C&D trash began on July 24, 2009, and processing at the plant began on December 29, 2009. IEISL is collecting 500 tonne per day (TPD) of C&D garbage at the processing facility from three designated zones in Delhi: Karolbagh, Sadar - Paharganj, and City. At the waste management plant, the C&D waste is recycled into aggregates, which are then processed into Ready Mix Concrete (RMC), pavement blocks, kerb stones, and concrete bricks. The products have undergone extensive testing in various laboratories and have been found to be appropriate for the intended use. These items are available for purchase on the market.

Ahmedabad launched their C&D waste management facility in 2014 on a PPP basis in partnership with Amdavad Enviro Projects Private Ltd. This facility has 1 plant and has a capacity of 1000 tonnes per day. The waste being recycled here has been used to manufacture products like “Paver blocks, tiles, hollow blocks/bricks, pre-fabricated structures like frames, manhole covers, benches etc”.

Both Delhi and Ahmedabad, followed a Design Build Operate and Transfer (DBOT) model where “the municipal corporation is responsible for both transportation and processing of C&D waste”. They have authorized agencies to transport this waste to the facility and have designated collection points.

Global policies for C&D waste management

Landfills are not an option for Hong Kong, which has severe land limits. Because of which, C&D waste is subject to very strict restrictions. It charges developers a fee for construction waste. The technique has reduced the amount of C&D trash that must be disposed of in landfills by 60%. Furthermore, charges have been established to encourage on-site recycling and reuse: 100% trash utilisation is taxed at HKD $27 per tonne, whereas garbage that requires landfill disposal is charged at HKD $125 per tonne. The money raised goes toward maintaining and subsidising C&D waste recycling centres. This has produced incentives for reuse as well as particularly efficient construction procedures that take use of construction debris generation. Hong Kong dismantles structures in a systematic manner rather than demolishing them. It also provides tax breaks to C&D recycling centres. Singapore, yet another land constrained country, recycles 98 per cent of its C&D waste.

South Korea has one of the most comprehensive and long-standing C&D waste recycling policies in the world. Its low-carbon green growth approach includes C&D waste management. A statute enacted in 2005 called the Acceleration of C&D Waste Reuse/Recycling Act, which calls for step-by-step demolition and the usage of recycled aggregates. For recycled asphalt concrete aggregates, recycled concrete aggregates, and road pavements, it has implemented distinct building codes. The Standard Building Construction Specifications of the Architectural Institute of Korea urge that recycled C&D material be used more frequently. Korea had a 36 percent effective recycling rate, with a goal of reaching 45 percent by 2016.Today their Recycling rate is over 80 percent.

There are specific standards in the European Union addressing the use of recycled materials in construction. Aggregates made from natural, recyclable, and manufactured materials

are specifically mentioned in the EU 2004 legislation in the form of European Standards for Aggregates. They are concerned with the suitability of use and make no distinction between resources. Although C&D waste is not utilised in structural or foundation frames in the EU, it is widely used in non-structural frames. Over 20% of some member countries' national consumption is made up of recycled materials, according to reports.

Over 90% of C&D waste produced in Germany is used for a variety of applications. Thanks to rigorous waste disposal legislation and disposal fees that encourage recycling. In Germany, the vast majority of recycling and reuse applications use fairly basic technologies and procedures (such as crushing and sorting) that are either currently in use or straightforward to install in India. In Germany, only a tiny percentage of recycled C&D waste is employed in advanced structural applications (such as load bearing concrete), for which detailed standards and protocols have been devised. [1]

Circular economy of C&D waste to products

The major applications of C&D waste processed products are listed below:

- Granular Sub-Base (GSB)—Regardless of the kind of construction, crushed C&D waste can be employed as a GSB layer for road building. The granular sub-base layer is created by piling and compacting different-sized C&D aggregates one on top of the other directly beneath the pavement surface. This serves as the pavement structure's load-bearing and strengthening component, as well as providing drainage and frost protection. The Indian Roads Congress (IRC) has produced ‘IRC-121:2017 Guidelines for Use of C&D Waste in the Road Sector,' which outlines which materials and in what proportions recycled C&D waste can be safely utilised for certain road construction/repair applications.

- Recycled Concrete Aggregates (RCA)—Pure concrete waste can be recycled to produce aggregates of various standard sizes that can be used to substitute natural aggregates in construction.
- Recycled Aggregates (RA)— Crushed aggregates of standard size created from a mix of C&D waste materials are referred to as Recycled Aggregates (RA). In the construction of non-load bearing structures, RA can be utilised to partially replace natural aggregates.
- Manufactured Sand (M-Sand)— Manufactured sand is made from C&D waste, and the finer particle fraction can be utilised to substitute natural sand in non-load bearing constructions.
- Smelting—Scrap metal recovered from C&D waste is melted through smelting process and recycled to make new products.

Market uptake of C&D waste processed products

One of the main challenges faced by C&D waste processing units in India is market uptake of products made with processed waste due to lack of knowledge and awareness in the construction industry regarding these products. These products are also perceived to be of inferior quality. Some challenges face by recycled C&D products include:

- Lack of confidence in recycled products: The experience in Delhi and Ahmedabad has shown that the market for recycled products made from C&D waste is still quite weak in India. Engagement with the construction industry repeatedly demonstrates that potential buyers are hesitant about such recycled products that they perceive to be inferior in quality. Even when informed about the updated IS 383 that allows recycled aggregates in many applications, potential buyers appear risk averse, pointing to their clients who seem to prefer ‘conventional’ products.

- Poor economic viability of recycled products: Currently aggregates are taxed at 5 per cent and manufactured products are taxed at 18 per cent making the use of recycled products economically unviable for customers. GST relaxation for C&D waste recycled products including manufactured products such as tiles, paver blocks, bricks, sand and aggregates may be considered. To ensure enhanced market uptake of C&D waste-based products, two approaches that can be adopted:

1. Preferential buy back by government and private entities

2. Eco-labelling and green certification of products

The first stage, according to Niti Aaayog, is to create industry-specific awareness and capacity development materials and share them via a web portal. To shift preconceptions and entrenched business practises in the building sector, including the use of recycled products, sustained communication and participation is essential. The construction sector is diverse and made up of a variety of actors - builders/developers, demolition contractors, architects, building material manufacturers, and so on – thus capacity development must address all of them. To do this, industry and professional associations may be enlisted. These capacity-building activities can be implemented by such organisations through workshops, trade exhibits, and their own publications. Industry associations are likely to take over this task once they are convinced that a) the industry needs to meet this regulatory mandate (2016 Rules) and b) valuable economic prospects can be realised. In order to persuade stakeholders regarding successful waste management techniques and processes, as well as the reliability of recycled products created from C&D trash, scientific experts from government and industry must be enlisted. The potential for new profitable investments in recycling C&D waste must be emphasised, with a particular focus on selling such "green" products through eco-labelling or other kinds of market recognition

such as certification from organisations such as GRIHA, IGBC, and others. BMTPC can play a key role in this endeavour as well.

Professional and industrial organisations such as CII, FICCI, Builders Association of India (BAI), Indian Institute of Architects (IIA), CREDAI, and others can be approached by MoHUA. With limited government engagement, these organisations can then take over the job of outreach to the larger construction industry. These groups and their partners should hold frequent capacity building events in each city (say, once every quarter) to ensure that a large share of the industry in that region has been reached. It's possible that the bigger players will be targeted first, followed by the smaller players. This high frequency of events is only required for the first couple of years to generate a minimal level of industry awareness; after that, such events may be cut back to a lower frequency as considered suitable.

Niti Aayog strategy for C&D waste management

The European Union Resource Efficiency Initiative for India (EU-REI), a consortium led by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, The Energy and Resources Institute (TERI), Confederation of Indian Industry (CII), and adelphi proposed to develop a compass as part of the ongoing support to the Resource Efficiency Strategy of NITI Aayog and the European Delegation to India. The strategy's purpose is to create a framework for implementing the 2016 C&D Waste Management Rules.

To develop a standard technique for inventorizing and characterisation of C&D waste, an ad hoc expert task team should be formed. As part of the existing Swachh Bharat Mission site, an online webportal might be utilised for data aggregation, correct inventorisation, and dissemination of best practises, toolkits on technology, management, and business models,

among other things. Simultaneously, state-level facilitation (such as Urban Development) must be accelerated to enable widespread implementation across all states, not only in a few pioneer cities. Smaller towns' needs should be prioritised, as their generation may not be sufficient to warrant a large central processing facility.

The task force will: a) select a quantity estimation method best suited for the Indian context from among many approaches in use worldwide, b) use this method to estimate the total amount of C&D waste generated per year in the country, c) prepare a simple model for cities to estimate C&D waste generation within their own boundaries without having to conduct long and detailed studies, and d) prepare a report for the Indian government. The Swachh Bharat Mission (SBM) web portal, which is already being used by ULBs to report on MSW generation, might be expanded to collect data on C&D waste generation across the country. MoHUA might think of creating a centralised web-platform that can be used as an online marketplace. The platform might include data on the amount of C&D waste generated and where it was generated in order to offer users with up-to-date information that they can utilise right away.

Challenges and Roadblocks in implementing government policies

Land shortage - Because Indian cities are highly inhabited and poorly designed in terms of infrastructure and essential civic facilities, land scarcity is a widespread issue. The problem is exacerbated in larger cities, which have satellite villages strewn over their borders. Any type of waste management/recycling facility requires a large quantity of land, and it must be located far enough away from residential areas. Many large cities are already having difficulty locating suitable site for MSW management, let alone CDW management, which is considered less critical. Outside the municipal boundaries is often the only viable choice for a large enough land parcel, which necessitates efficient collaboration with other entities, particularly state

government level departments/agencies. Even locating smaller property parcels that will serve as intermediate C&D garbage collection facilities across the city/town is difficult.

Lack of monitoring capacity/resources - Personnel and resource shortages are common among local governments and municipal agencies. They are struggling to appropriately monitor, collect, and dispose of MSW, an issue of increased public concern, and implementing a new C&D waste management system is an extra obligation for which they are unprepared. Because most localities lack demolition permits, demolition sites and techniques are rarely, if ever, regulated. As envisioned by the 2016 Rules, an ideal management plan would necessitate the construction of a new C&D waste monitoring system, which would necessitate effective collaboration between the ULB Building Department and the Waste Management Department.

Lack of capacity and experience in C&D waste management - Aside from the overall capacity/resource challenges, C&D waste management is a relatively new topic about which many local officials are unfamiliar. Even after attending capacity building workshops, local governments and municipal organisations are confused how to proceed with trash estimation, feasibility planning, tendering, and other tasks. In many circumstances, a lack of familiarity or a previous poor experience with PPPs can add to the hesitancy. Funding shortages limit the capacity to hire a consultant for a feasibility study, and even when consultants are retained, there is no guarantee that they will provide adequate advise.

Concern about finances and business case - Due to ongoing budgetary constraints, local governments and municipal bodies are naturally leery of any new commitments that appear to be a fresh source of spending. It's usually tough to persuade them of the effective business case used in the Delhi and Ahmedabad models during capacity building workshops. The tipping fee paid by the ULB to the contracted party is seen as an unjustified burden, but it may not be a net

expense because: a) the ULB saves money by not having to haul bulky C&D waste, and b) the 2016 Rules allow the ULB to impose charges on waste generators, with tipping fees paid from this revenue. In other circumstances, city officials have suggested that the contractual party pay the ULB instead of getting a tipping charge for each tonne of C&D garbage, and/or split earnings from the sale of recycled items with the ULB. This deters potential investors, which is understandable given that India's market for recycled C&D waste goods is still in its infancy.

Lack of urgency/priority - Even early discussion and planning on C&D waste management has not occurred in many cities/towns, while progress has stagnated in others after introductory discussions. In the context of a general shortage of manpower and resources, C&D waste management is regarded as a low priority. The public is more concerned about MSW disposal, and there have been MSW-related litigation in numerous localities. As a result, MSW collection and disposal are given more attention.

The construction industry also has an important role to play – both in ensuring that their generated waste is disposed properly and in gradually increasing the adoption of recycled products in construction practices. Larger players should ideally adopt significant in-situ utilization of C&D waste in their projects, wherever feasible, and could consider investing in processing facilities as a business option.

Lack of awareness and concern - The construction industry is set in its ways and has a long history of turning a blind eye to how C&D waste is disposed of; convincing them to change will be difficult and gradual. At the same time, few people are aware of C&D waste recycling and reuse options other than using rubble as a filler.

Dominance of the unorganized sector in demolition- The demolition industry is primarily controlled by tiny disorganised operators, with the exception of a few specialist enterprises that

specialise in high-tech destruction for huge infrastructure projects. This makes it difficult for city officials to oversee and supervise small demolition firms, who are often unregistered and have gotten away with dumping C&D debris in unapproved sites.

Lack of confidence in recycled products - The market for recycled products made from C&D garbage in India is still quite poor, as evidenced by experiences in Delhi and Ahmedabad. When working with the construction industry, it's clear that potential purchasers are wary of recycled materials that they believe to be of lower quality. Even after being told of the new BIS standard (383) that allows recycled aggregates to be used in a variety of applications, potential buyers look risk hesitant, citing their clients' preference for "traditional" products.

Poor economic viability of recycled products - Customers cannot afford to use recycled items since aggregates are now taxed at 5% and manufactured products are taxed at 18%, making them economically unviable. GST exemptions for C&D waste recycled products, such as tiles, paver blocks, bricks, sand, and aggregates, may be considered.

Departments and agencies of the state government While local governments and municipalities bear the primary responsibility for C&D waste management planning and execution, state government organisations and departments can often help to ensure effective coordination and pave the way for successful implementation. State urban agencies have a low level of involvement. In addition to the 2016 Rules, state urban departments are expected to draught policies on C&D waste management to aid implementation while taking into account the local environment. Furthermore, state urban departments (often in conjunction with other related organisations) may be required to identify and dedicate suitable property for the establishment of waste processing plants. Their engagement has been inadequate in the majority of situations, and C&D waste management appears to be a low priority concern. Public construction agencies have

a low level of engagement. PWD, Housing Development Board/Authority, City Development Authority, public sector utility corporations, and other state government organisations are involved in large construction/demolition activity. According to the 2016 Rules, these entities are required to coordinate with local municipal bodies regarding proper disposal of their C&D waste, to implement in-situ utilisation of C&D waste in their own projects wherever possible, and to adopt policies to purchase recycled products. However, engagement has remained low, owing in part to coordination issues between state and local government entities.

Methodology

The methodology followed in preparation of this paper has been exploratory research by going through various government policies and documents as well as literature reviews of multiple research papers on the topic of Construction and demolition waste management. The paper provides a descriptive explanation of C&D waste management as well as follows up with expected future of the management of this waste in India.

Finding

Findings from this research are majorly descriptive of the state of affairs of construction and demolition waste management in India. Some major inference that can be drawn form this paper are the policies being implemented across the globe. For instance, policy like charging a fee to the developer for construction waste, like Hong Kong does. Other findings are the lack of protocols around waste management as defined in Germany. Some of these issues have been realized and Niti aayog, the think tank for government of India has come up with their strategy and plans to implement a system of C&D waste management in India but the results of these steps are yet to be observed. If the waste rules 2016 were followed aptly, all cities in India would have had an existing infrastructure to collect, transport and recycle waste by April 2019 as

envisaged during the announcement of the rules, which is not the ground reality today. The implementation has been facing problems due to problems such as finding proper land for disposal and recycling of C&D waste. Third party i.e transporters being responsible for disposal of this waste instead of the construction companies implementing a waste management plan in their project charters. Lack of accountability and framework on part of the state government agencies and departments on dealing with C&D waste. PPP models have shown to work positively as has been noticed by it's implementation in Delhi and Ahmedabad.

Discussion

Discussion around the products produced from C&D waste management require further inquiry. This paper highlights the by products of recycling various types of C&D waste and the products that are approved by Government of India. These products despite being of adequate quality do not receive the desired attention that is much needed for a growing economy in a sustainable manner. Industry awareness as well mandated use are some of the actionable guidelines given by the government. The major driver for these products still remain the private industry which needs to procure these materials at a cost that is feasible.

Conclusion

The state of affairs of C&D waste management implementation in India is next to non-existent compared to the amount of waste that is generated. Although policy framework is fluid and does not restrict from recycling and reusing recycled products in other infrastructure projects, The waste rules don't provide targets to be achieved in a specific time frame for proper implementation and assessment of progress. The policy doesn't mandate proper standard for the recycled material and tax levied is comparably more than manufactured products available in market. It converts to low market adoption of this material and creates a hinderance in spreading

the awareness regarding C&D waste management. There needs to be promotion towards adopting construction waste management in construction management, promotion of alternate use of materials in other infrastructure projects. There needs to be a database regarding C&D waste disposal for keeping track of progress in C&D waste management. Measures need to be taken toward developing a market for C&D waste recycled products. Indian companies have the technical expertise and capability to manufacture C&D waste handling machines and plants. One such example is of CDE Asia that exported their huge machine to Korea in July 2021. Their machines are capable of turning C&D waste into sand and stone chips and are among the world leaders in wet technology for processing and recycling of C&D waste. Despite being world leaders in this technology and having manufacturing in Kolkata, the machines have found their utility in only few major cities like Delhi, Hyderabad, Surat, Thane and Pune. CDE Asia claims that installation of their plants makes available construction material like and sand and aggregate as well as reduces air pollution, carbon footprint and land requirement for landfills. Utilization of such plants across India to setup waste treatment facilities in tandem with the waste rules 2016 and proposed strategy by Niti aayog has a good possibility to make a cleaner and greener India devoid of this waste.

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