

Utilisation of Recycled Produce of Construction & Demolition Waste

A READY RECKONER



bmtpc

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Affairs
Government of India

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ABOUT READY RECKONER

The urban population of India has grown from 109 million in 1971 to 377 million in 2011 & 419 million in 2014. It is expected to grow to almost 600 million by 2030. Actual Housing shortage as per the demand survey by states for urban areas is 10 million. Housing for All Mission launched in June, 2015 envisages construction of these dwelling units by 2022. The re-development of housing and infrastructure as well as new construction to meet the increasing demand is generating large volume of C&D wastes. Indiscriminate dumping and non-utilization of generated debris results in fugitive air pollution and other hazards of solid waste dumping in nallas, water bodies, empty plots and mixing up with municipal solid waste. The Swachh Bharat Mission (SBM) of Govt. of India under MoHUA has targeted processing of 100% solid waste including C&D waste in major cities/towns.

This would not only provide the clean environment but would also make available valuable construction materials that are in short supply and would in turn facilitate and expedite construction of mass housing under PMAY. The demand of building materials for 2021-22 has been reckoned by Building Materials and Technology Promotion Council (BMTPC) as cement 380 million tonne, steel 50 million tonne, bricks 600 billion numbers, aggregate 400 million cubic meters and timber 40 million cubic meters. Data shows that there is a considerable amount of shortage of conventional and traditional building materials in India. Of late fine aggregate has been imported. Zero-based estimate with existing housing stock of 110,139,853 urban and 220,695,914 rural (Census 2011), its rate of renovation and new construction of 5.75 billion sq. m area during 2005-2012, the average annual generation of C&D waste works out to 100 million tonne that appears to be near reality.

Erstwhile MoUD vide its circular dated 28th June, 2012 has desired all states to set up C&D waste recycling facilities in all the cities/towns with population over 1 million. It would also reduce the pressure on natural resources that are being otherwise exploited for building and road construction materials resulting in adverse impact on the environment. Proper management, processing and reuse of C&D waste has been the focus of various bodies of Govt. of India. C&D Waste Management Rules, 2016 have been issued by MoEF&CC vide notification no. GSR 317(E) dated 29th March, 2016.

BMTPC also brought out "Guidelines for Utilization of Construction & Demolition Waste in Construction of Dwelling Units and Related Infrastructure in Housing Schemes of the Government". Central Pollution Control Board issued "Guidelines on Environment Management of Construction & Demolition Waste" during March, 2017. "Guidelines for Sustainable Habitat" issued by Central Public Works Department (CPWD) in March, 2014 have a dedicated chapter "Guidelines on re-use of recycled of C&D waste". Bureau of Indian Standards (BIS) has issued 3rd amendment to IS-383:2016 "Coarse and fine aggregate for concrete" to include fine and coarse aggregate produced by processing of C&D waste. India Road Congress (IRC) has issued IRC-121: 2017 Guidelines for use of C&D waste in road sector.

The need has been felt by Ministry of Housing and Urban Affairs, Government of India to bring out a "Ready Reckoner for Utilization of Recycled Produce of C&D Waste" to guide and facilitate the stakeholders for easy understanding and implementation of "C&D Waste Management Rules, 2016" towards 100% utilization of this waste material as envisaged under SBM.

The READY RECKONER presented here would guide and facilitate all stakeholder agencies to implement the C&D Waste Management Rules, 2016 with ease and better understanding. In-situ processing of C&D Waste for large size redevelopment projects has been focused to minimize the impact on the environment as well as on the cost of produce. DECONSTRUCTION of buildings and structures has been recommended to be practiced instead of DEMOLITION to minimize the generation of debris and maximize salvage of components and materials that can be for re-used. Application of new technologies of DECONSTRUCTION has been advised.

It is believed that the READY RECKONER providing the salient features of all the prevailing related documents/ notifications in simple language including duties of all & monitoring & marketing plan would be handy and helpful for all the stakeholders.

Dr. Vimal Kumar
Secretary General
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Executive Director
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PREFACE

In the backdrop of Sustainable Development Goals & Climate Change Mitigation strategies, it is of paramount importance to bring into focus Construction and Demolition (C&D) waste generation and its handling issues. With housing for all and other infrastructural schemes in progress, construction is taking place at unprecedented rate and so is C&D waste and therefore, technology interventions not only to minimize and handle the C&D waste but also to convert this waste into useful resource is call of the day for sustainable development construction sector.

C&D waste is nothing but a waste materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often contain materials that inter alia include concrete, asphalt, wood, metals, gypsum, plastics and salvaged building components. It is a challenging task to handle C&D waste because it is bulky, heavy and inert and also mixture of various materials of different characteristics. It is also difficult to choose any suitable disposal method, for example, it cannot be incinerated due to its high density and inertness. With the advent of sustainable practices in the construction industry, C&D waste generation and handling issues have been in focus to achieve the sustainable goals for our common future. Reduce, Reuse, Recycle (3Rs) philosophy is highly useful in handling of C&D waste. Though recycling had already been taken place at the time of Second World War when Germany reused most of the demolished concrete for construction purposes, yet many countries, especially developing countries are not fully aware of potential of 3Rs and hence still find land filling as the only method for C&D waste handling. The better practice to handle C&D waste is to minimize generation of C&D waste, but sometimes it is unavoidable due to various issues.

C&D waste issues are more important for the developing countries, which are entering or already entered in construction boom era. Many countries do not have specific regulations designed for C&D wastes, although some countries include some sections in their solid waste management regulations & related policies. It was also pertinent to mention here that very small % of waste from construction industry is reused or recycled, the majority being deposited or used as landfill. Like other developing countries, India is also enjoying construction boom. With the rapid growth in construction activities of India it is appropriate to link the generation of C&D waste with the growth of construction industry and related issues. It is also essential to study C&D waste generation and establish sustainable methods to manage construction waste.

In terms of magnitude construction industry is second only to agriculture in India. Based on an analysis of the forward and backward linkages of construction, the multiplier effect for construction on the economy is estimated to be significant as it contributes significantly to the GDP. The importance of materials cost in construction industry can be seen from the fact that the component of materials cost comprises nearly 40%–60% of the project cost. In India C&D waste has two components (a) Major components comprising of Cement concrete, Bricks, Cement plaster, Steel from RCC, door/window frames, roofing support, railings of staircase etc., Rubble, Stone e.g. marble, granite, sand stone), Timber/wood (b) Minor components include Conduits of iron, plastic, Pipes of GI, iron, plastic, Electrical fixtures of copper/ aluminum wiring, wooden batons, switches, wire insulation, Panels i.e. wooden, laminated and others such as glazed tiles, glass panes etc.

In India, contractors play an important role in waste management. Contractual arrangements require that demolition wastes have to be disposed off by the contractor at his cost. Other than new construction, renovation or repair of buildings, demolition of an existing building/structure is the main cause of waste generation from the construction industry. In India, services of demolition contractors are taken when an old building is to be demolished due to deterioration of the building or to make way for construction of a new building. At present, the status as regards C&D waste in India is (a) items recovered during demolition are sold in the market at a discount with respect to price of new material (b) items, that cannot be re-used, are disposed to landfill site (c) Some municipal corporations allow C&D waste in their landfills, while others want to minimize it to prolong useful life of landfill sites (d) Different constituents of waste are not segregated prior to disposal.

C&D waste minimization and management are indispensable in view of limited landfill space and increasing quantum of demolition waste otherwise there may be issues related to handling the waste and finding space for landfilling. This is already causing an extra burden on solid waste management plans, which are struggling for new ways to combat the growth in municipal solid waste due to increase in urban population and economic development of the country. Government policies and laws are already in place to motivate and make C&D waste management mandatory for all types of construction activities. Reduce, Reuse & Recycle policy and use of waste minimizing technologies e.g. design for deconstruction and reuse of materials ought to be adopted to minimize C&D waste. Recycling of C&D waste by converting it to useful products such as fine and coarse aggregates, bricks, blocks, concrete etc. may offer dual benefit of saving landfill space and reduction in extraction of natural raw material for new construction activities, leading towards sustainable development.

BMTPC has made a sincere attempt to bring this ready reckoner which puts all information related with C & D waste at one place based on the available resources nationally & globally. During 2016-17, Govt. of India has put in place a techno-legal framework for efficient management of C&D waste and now it is the turn of State Govts., ULBs, public and private construction agencies including citizens of India to take a call and minimize C&D waste, dispose it safely and reuse and recycle it for its gainful utilization in construction sector. BMTPC mandated to promote clean housing technologies has firm belief that this publication will go a long way in establishing C&D waste as useful resource. This reckoner can be referred by all stakeholders involved into construction including individuals who want to know about various facets of construction and demolition of structures and its efficient handling, reuse & recycling.

C&D waste is a useful resource and can't be termed no longer as C&D waste but to be redefined as C&D material.

Dr. Shailesh Kr. Agrawal
Executive Director, BMTPC

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1 INTRODUCTION

1.1 PREAMBLE

Rapid urbanization, industrialization and spurt in the economic activity are putting tremendous pressure on building and infrastructure in urban areas. The urban population of India has grown from 109 million in 1971 to 377 million in 2011 and estimated to be 419 million in 2014. It is expected to grow to almost 600 million by 2030. The technical committee constituted by erstwhile Ministry of Housing & Urban Poverty Alleviation (MHUPA), Government of India has estimated housing shortage for urban areas at 18.78 million during the 12th FYP period of which over 95% is estimated in the Economically Weaker Sections (EWS) and Low Income Group (LIG) categories. The actual housing shortage as per the demand survey conducted under PMAY(U) by State Govts./UTs, stands at 10 million for EWS/LIG in urban agglomeration of the country. The demand of building materials for 2021-22 as reckoned by Building Materials and Technology Promotion Council (BMTPC) is cement: 380 million tonne, steel: 50 million tonne, bricks: 600 billion numbers, aggregate: 400 million cubic meters and timber: 40 million cubic meters. Data show that there is a considerable amount of shortage of conventional and traditional building materials in India. Of late fine aggregate are being imported and manufactured sand/stone dust is being used as replacement.

On the other hand, the re-development of housing and infrastructure as well as new construction to meet the increasing demand generates large volume of C&D wastes. Indiscriminate dumping and non-utilization of generated debris results in fugitive air pollution and other hazards of solid waste dumping in nallas, water bodies, empty plots and mixing up with municipal solid waste. The Swachh Bharat Mission (SBM) of Govt. of India under Ministry of Housing & Urban Affairs (MoHUA) has targeted processing of 100% solid waste including C&D waste in major cities/towns. Erstwhile Ministry of Urban Development (MouD) vide its circular dated 28th June, 2012 has desired all states to set up C&D waste recycling facilities in all the cities/towns having population over 1 million.

The proper management and processing of C&D waste would be win-win situation for all stakeholders. It would avoid indiscriminate dumping, land & air pollution and would make available the building construction materials that are in short supply. It would also reduce the pressure on natural resources that are being otherwise exploited for building and road construction materials resulting in adverse impact on the environment.

Proper management, processing and re use of C&D waste has been the focus of various agencies of Govt. of India since 2010. The Working Committee (2010) on Municipal Solid Waste Management recommended that this issue may be addressed specifically with due focus and attention. The Draft

Solid Waste Management Rules, 2015 published by MoEF&CC vide GSR 452(E) dated 3rd June, 2015 had a separate chapter on C&D waste. Subsequently, the draft rules culminated into C&D Waste Management Rules, 2016 issued by MoEF&CC vide notification no. GSR 317(E) dated 29th March, 2016.

BMTPC, MoHUA brought out “Guidelines for Utilization of Construction & Demolition Waste in Construction of Dwelling Units and Related Infrastructure in Housing Schemes of the Government. Central Pollution Control Board issued “Guidelines on Environment Management of Construction & Demolition Waste” during March, 2017. “Guidelines for Sustainable Habitat” issued by Central Public Works Department (CPWD) in March, 2014 have a dedicated chapter “Guidelines on re-use of recycled of C&D waste”. Bureau of Indian Standards (BIS) has issued 3rd amendment to IS-383:2016 “Coarse and fine aggregate for concrete” to include fine and coarse aggregate produced by processing of C&D waste. India Road Congress (IRC) has issued IRC-121: 2017 Guidelines for use of C&D waste roads sector.

1.2 NEED FOR READY RECKONER

The need has been felt by Ministry of Housing and Urban Affairs, Government of India to bring out a “Ready Reckoner for Utilization of Recycled Produce of C&D Waste” to guide and facilitate the stakeholders for easy understanding and implementation of “C&D Waste Management Rules, 2016” towards 100% utilization of this waste material as envisaged under Swachh Bharat Mission.

1.3 C&D WASTE GENERATION AND UTILISATION SCENARIO

1.3.1 Indian Scenario

Large construction projects of housing, industry as well as infrastructure development are very common sites across the country. Development of economic zones, industrial corridors, reconstruction of old building structures adds to the magnitude of C&D waste.

Stringent laws are being formulated by the municipalities but enforcement has its limitations. Private contractors remove this waste to privately owned lands, low-lying areas for a price, or more commonly, dump it in an unauthorized manner along roads or other public areas. C&D waste from individual households finds its way into nearby municipal bins making the municipal waste heavy and degrading its quality for treatments such as composting or energy recovery. The activities regarding C&D waste management, processing and re-use have got energized after issuance of C&D Waste Management Rules, 2016 by MoEF&CC.

No authenticated C&D waste data is available with any of the agencies. Efforts are on to put in place the appropriate systems(s) to generate this data now onwards. Figures being quoted by different Government and private agencies vary from 10 MnT -15 MnT to 625 MnT per year. Zero-based estimate with existing housing stock of 110,139,853 urban and 220,695,914 rural (Census 2011), its rate of renovation and new construction of 5.75 billion sq. m area during 2005-2012, the average annual generation of C&D waste works out to 100 MnT that appears to be near reality.

The constituents of C&D waste generated and their respective quantum varies on regional basis and

also within the region. The representative C&D waste in urban areas of Northern plains would generally consist of soil, sand and gravel (26%), bricks & masonry (32%), Concrete (28%), metal (6%), wood (3%) others (5%). Bricks, tiles, woods and iron metal are sold for reuse / recycling. The balance materials generally go for landfill.

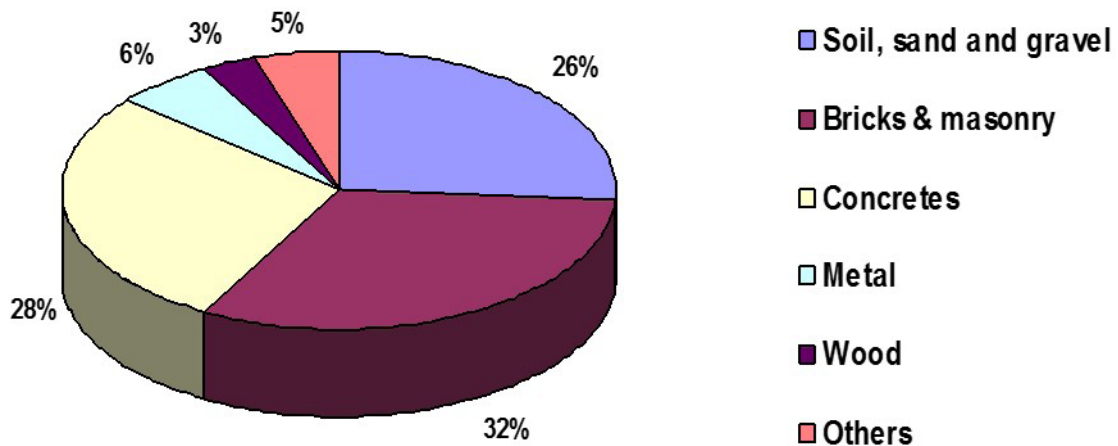


Figure-1. C&D Waste Composition: Indian Urban Areas

The Government, civic bodies and the industry are now very alert and active on the front of C&D waste management. More than ten Municipal Corporations have initiated the process to set up C&D waste processing facilities. In addition, Delhi is planning to set up four more plants for processing of C&D waste, including one by Delhi Metro Corporation. **Four plants, summarized below are operational for recycling of C&D waste:**

- **BURARI, NEW DELHI**

India's first plant for recycling of C&D waste has been commissioned during 2009 at 10 acre site at Burari, Jahangirpuri in North Delhi by Infrastructure Leasing & Financial Services (IL&FS) under an agreement with North Delhi Municipal Corporation. The plant was initially set up to process 500 tpd (tonnes per day) C&D waste. Processing of 1200 tpd was achieved during 2014 and Delhi Pollution Control Committee has awarded the permission to expand the capacity to 2000 tpd.

The products being manufactured at this facility are sand, coarse aggregate, Ready Mixed Concrete (RMC), bricks, blocks, curb stones, pavement blocks, hollow bricks etc.

- **SHASTRI PARK, NEW DELHI**

Second plant in Delhi for recycling of C&D waste has been commissioned at Shastri Park in East Delhi at 2.5 acre site to process 500 tpd C&D waste. The plant has been built in partnership with IL & FS, which would run it for 15 years before transferring it to EDMC.

- **AHMEDABAD, GUJARAT**

Ahmedabad Enviro Projects Pvt. Ltd. (AEPL) has commenced a 100 tonne per hour capacity plant for recycling of C&D waste in phase wise manner from December, 2013. The plant is fully operational since June, 2014 and is located at Pirana, Ahmedabad.

- **VIKHHOLI, MUMBAI**

Godrej Construction have commissioned a C&D waste processing plant at Vikhroli during early 2017 to manufacture 36000 blocks and 54000 pavers per day by using the produce of processed C&D waste.

Earlier Experiences:

- **KHARGHAR, MUMBAI**

Youth for Unity and Voluntary Action (YUVA), a non profit, non Govt. organization recycled 1500 tonne of C&D waste during 2002-06 at CIDCO-YUVA Building Centre (CYBC), Kharghar. CYBC is a joint venture of City and Industrial Development Corporation of Maharashtra Ltd. (CIDCO) and YUVA. The C&D recycling demonstration plant manufactured building materials like bricks, blocks, paving blocks, concrete, sand substitute and coarse aggregates. The laboratory test results proved the quality of end products. The products were used by private builders. However, Govt. projects could not accept the products for want of standards, specifications and departmental approvals.

- **EAST KIDWAI NAGAR, NEW DELHI**

M/S Enzyme India Pvt. Ltd. has set up C&D waste recycling plant in 2014 on PPP model with 100% buyback by NBCC with a capacity of 150 tpd at the project site of “Re-development of East Kidwai Nagar, New Delhi”. The construction project involved demolition of 2444 existing houses and allied structures, construction of 4747 houses covering 60 lakh sq. ft. area and commercial area of 12 lakh sq. ft. on a plot area of 86 acres with 12.7 lakh sq. ft. green area.

The recycled produce of C&D waste like fine aggregate, course aggregate and manufactured soil are being used directly for construction as a fill material and also in manufacture of downstream products like RMC, bricks, blocks, tiles, pavers, etc. These products are generally of good quality and are available at a economical price.

1.3.2 International Scenario

The study of C&D waste management scenario abroad reveals that there also it is driven by the factor of “compulsion”. Until recently, it has been cheapest and most convenient to put C&D waste in landfills. Of late, the operative landfills have got exhausted, lands are not available to create new landfill areas, and the increased costs of landfills, stringent environmental regulations, public resistance to landfills etc. have forced major city municipalities / administrators to adopt reuse and recycling of C&D waste.

If we go back in history, after Second World War large quantities of aggregates required for rebuilding the cities were not available. Recycled aggregates produced from the debris of destruction were used to the extent of 20 to 50% in concrete, blocks, pavers, etc. and compressive strength of 30 to 50 MPa was achieved.

Countries like Netherlands, Sweden, Denmark, Austria, France and Switzerland are now recycling 80 to 90% of their C&D waste. European Demolition Association was established as early as in 1992 to promote scientific management of demolition and C&D waste. Singapore is reusing / recycling 100% C&D waste.

The representative C&D waste composition in the cold climate countries is given in Figure-2, wood accounts for maximum percentage of 31%, followed by roofing – 11%, walling material – 10%, concrete and rubbles – 9%, metals – 5% and plastics - 2%.

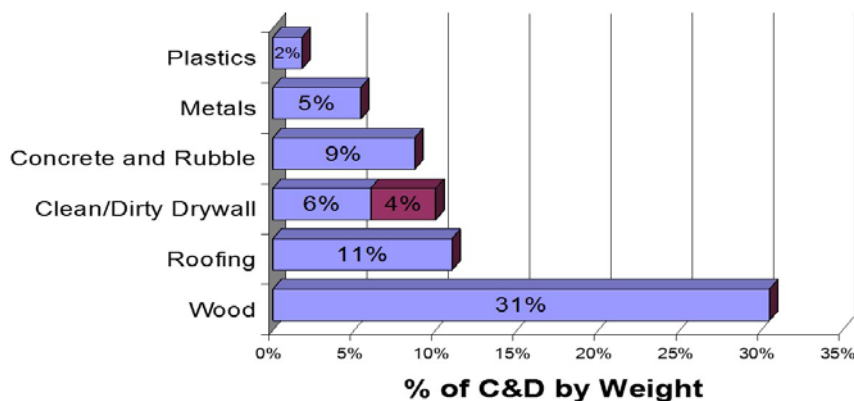


Figure-2: Average of C&D Waste characterization (percent by weight)

Tokyo enforced the construction waste recycling law. All construction projects must have a recycling programme for C&D waste. A simplified form indicate how the recyclable and fine materials will be dealt with and they track the reuse/ recycling of C&D waste. The current rate of recycling of C&D waste is more than 99%. In Australia Nalawala Hall, Fairfield City Council’s sustainability hub, incorporates the world’s first concrete load-bearing foundation slab which is 95% recycled aggregates.

Annual C&D waste generation in various countries is given in Figure-3.

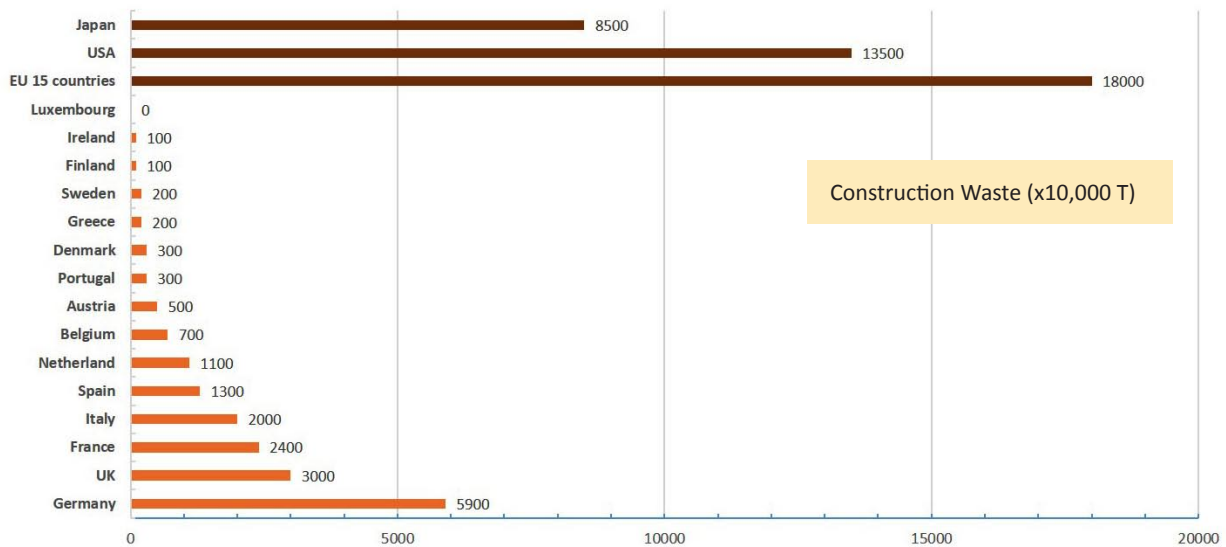


Figure-3: Construction waste generated in different countries

Number of C&D waste recycling plants in operation as reported by European Demolition Association for some of the countries are given in Table-1.

Table-1: Number of C&D waste recycling plants

Sl. No.	Country	No. of plants
1.	Belgium	60
2.	France	50
3.	Netherland	70
4.	UK	120
5.	Germany	220
6.	Denmark	20
7.	Italy	43

1.4 DECONSTRUCTION

Demolition of buildings and structures converts all the materials into debris, a mix of all types of material. It takes away the opportunity to re-use some of the components, materials, even the structural elements. Deconstruction, which is also known as engineered demolition can salvage to a great extent the components and materials for re-use and thus also reduce the volume of debris generated. In India the deconstruction contractors generally follow a practice of removing windows, doors, metallic items and to some extent sanitary and plumbing fittings for re-use as shown in Photo 1 & 2.

Latest technologies and equipments available can be employed to salvage concrete slabs, wall panels, flyover parapets as well as slabs, and many more items for re-use (Photo 3, 4, 5, & 6). These technologies are already being used in some of the projects in Metros and also in deconstruction of MG Setu Patna, Bihar (Photo 7). Development of residential towers of more than 50 floors is becoming a common scenario (Photos 8 & 9). City of Mumbai has already constructed a few residential towers of more than 100 floors. All such constructions are generally with precast concrete elements or in-situ casted concrete. The decommissioning/ deconstruction plan of these buildings need to be developed along with the structural design of construction. Appropriate space provisions may also be kept at appropriate levels as per the deconstruction plan for its implementation whenever required.



Photo 1: Salvaging doors and windows



Photo 2: Salvaging materials with economical value



Photo 3: Robot for eating concrete



Photo 4: Salvaging of Parapet



Photo 5: Sawing of wall



Photo 6: Salvaging of fly over structure

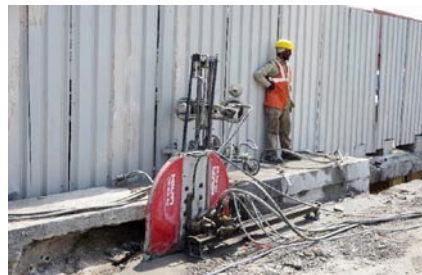


Photo 7: India's largest on going demolition project MG Setu Bridge Patna



Photo 8: Precast elements



Photo 9: High rise residential towers

2 C&D WASTE MANAGEMENT RULES AND GUIDELINES

2.1 C&D WASTE, GENERATOR AND MANAGEMENT OF GENERATION SITE

This part presents the salient features of C&D Waste Management Rules, 2016 issued by MoEF&CC, Guidelines on Environment Management of C&D Waste issued by CPCB, Guidelines for Utilization of C&D Waste in Construction of Dwelling Units and related Infrastructure published by BMTPC, Guidelines issued by CPWD regarding use of C&D Waste and Standards/ Guidelines issued by BIS/ IRC. This is to facilitate understanding, comprehension and appropriate action by all stakeholders. Important aspects are described hereunder:

2.1.1 What is included in C&D waste?

Construction and demolition waste includes all the materials that are generated as a waste either during the construction or repair or re-modelling or demolition (including de-construction and decommissioning) of any civil structure. Civil structure includes all the civil engineering constructions that generally consist of beams, columns, piers, walls, cables, slabs, foundations etc. Civil structure also include roads, runways, taxiways, dams, water reservoirs, canals, man made river fronts and civil engineering systems/ arrangements for providing civil services like water supply, sewerage, telephone/ broadband and electricity supply, etc. It includes the debris generated even at a level of smallest dwelling unit to a mega project. It also includes all civil structures even if they are used for non-civilian purposes.

2.1.2 What is not included in C&D waste?

All debris/malba/waste generated at any of the civil structures during construction, repair, re-modelling, demolition, de-construction, decommissioning, etc. is included in C&D waste irrespective of its location or quantum. Nothing is excluded.

2.1.3 Who is generator of C&D waste?

The owner of the civil structure, may be a person or association of person or institution that leads to generation of C&D waste/ malba/ debris during its construction, repair, re-modelling or demolition (including de-construction and decommissioning) is the waste generator. However, if the above said activity/ activities is/are contracted to any person or association of person or institution and the contract states very clearly that the handling and management of the malba/debris i.e. C&D waste generated would be the responsibility of the contractor in that case the contractor would be treated as

the generator for the purposes of management of C&D waste.

Regarding repair/ cutting of roads/ lanes/ runways, etc. or otherwise for the C&D waste generated at such places, the contractor/ executor shall be the C&D waste generator. In case the contractor/ executor do not fulfil his due responsibilities regarding management of C&D waste at the generation site, the work awarding officer shall be responsible and considered as the C&D waste generator.

2.1.4 Who is responsible for management of C&D waste and the waste generation site?

The C&D waste generator is responsible for proper management of C&D waste and the waste generation site.

2.1.5 What is proper management of C&D waste and the waste generation site?

Proper management of C&D waste and its site includes the following but not limited to these aspects only:

- (i) The C&D waste generation site shall not allow littering of malba/debris or create any type of pollution i.e. fugitive dust [$PM_{2.5}$ ($\mu\text{g}/\text{m}^3$) max.: 40 annual average and 60 daily average for domestic areas, 60 annual average and 100 daily average for industrial areas] and noise [max. 65 dB during day time & 35 dB during night for residential areas and 75 dB during day time & 70 dB during night for industrial areas].
- (ii) The reusable items such as bricks, doors, windows, cupboards, kitchen & bathroom fittings, other fittings, wooden items, glass, wall panels, roof slabs, other structural elements, etc. may be removed first without damaging these items and be stored separately and supplied to re-users/ second hand markets.
- (iii) The recyclable items like electrical wires, metals, glass, plastics, paper boards, gypsum boards, etc. be collected separately and supplied to re-meltors.
- (iv) Concrete debris be kept separately and be processed/ supplied to processing plant without mixing with masonry, soil and other debris.
- (v) MSW, toxic waste, electronic waste, hazardous waste etc. are not to be mixed with the C&D waste and are to be disposed off separately in a safe manner as prescribed in SWM rules.
- (vi) C&D waste is to be segregated in different streams such as concrete, soil, bricks and mortar and other streams stated above for supply to second raw materials market/ re-meltors/re-users/ processors.
- (vii) The C&D waste generated at the site is to be evacuated at the required frequency to avoid mix up and spilling over to neighbouring areas.
- (viii) Safety of equipment and manpower is to be ensured.

- (ix) Rules and regulations of local agencies regarding permissions required and other aspects be followed.
- (x) Details of C&D waste generated and its disposal/ re-use/ processing, etc. as may be reported to the local authority as may be required.

2.2 WHERE TO DEPOSIT THE C&D WASTE AND CHARGES TO BE PAID?

- (i) Generator of small quantity of C&D waste for one time and generator of C&D waste of less than 2 tonne shall deliver the C&D waste material duly segregated to the designated C&D waste collection points/ bins notified by the local authority at their cost or they can register the requisition with the local authority for collection of the C&D waste and in such case collection charges as may be fixed by the local authority would be payable by the C&D waste generator.
- (ii) Generator of more than 2 tonne but not exceeding 20 tonne may register the requisition with the local authority for collection of the C&D waste and in such case collection charges as may be fixed by the local authority would be payable by the C&D waste generator or may deliver the C&D waste to the C&D waste processing plant site at its cost. Processing charges as may be fixed by the local authority would also be paid by the generator.
- (iii) Generator of more than 20 tonne but not exceeding total 1 lac tonne for the duration of the project shall deliver the C&D waste to the C&D waste processing plant site at its cost. Processing charges as may be fixed by the local authority would also be paid by the generator.
- (iv) Generator of 1 lac tonne or more for the duration of the project shall process the C&D waste material in-situ at the C&D waste generation site and use the produce/ downstream products in the same project or supply it to the near by projects at mutually agreed terms & conditions.
- (v) The C&D waste generated by service providers and their contractors for laying or maintenance or repair of sewer line, water supply line, electrical cables, telephone/ data communication lines or any other services shall manage the site and dispose off the C&D waste generated in a manner as detailed above under Para 2.2 (i) to (iv) as applicable.

2.3 WHO IS LOCAL AUTHORITY?

For cities/ towns the local authority is Municipal Corporation, municipality or municipal council as the case may be. For notified areas the local authority is the notified area committee.

2.4 DUTIES OF LOCAL AUTHORITY AND OTHER STAKEHOLDERS

2.4.1 Duties of local authority

- (i) The local authority is responsible to establish/ get established the C&D waste processing plant functional within 18 months from the date of notification of C&D Waste Management Rules, 2016 for 1 million and above population cities, 24 months for cities with population of 0.5 -1 million

and 36 months for the cities with population less than 0.5 million.

The stipulated time schedule has already been over for cities of population more than 0.50 million. Expeditious actions are required to be taken to accomplish the assigned works at the earliest. The criteria for site selection for storage and processing or recycling facilities for C&D wastes given in Schedule-I and the time frame for planning and implementation is given in Schedule-III.

- (ii) Within the time frame given above the local body to prepare and issue detailed direction regarding proper management of C&D waste including identification and notification of deposition points for small quantity generator of C&D waste, the arrangements and frequency for clearing the bins at deposition points, arrangements for collection of C&D waste from the points of generation by themselves or through the contractor wherever requisitioned by the generator. The C&D waste is to be collected, transported and delivered to the central processing facility in the segregated form. C&D waste collection charges and the processing fee is to be decided and notified.
- (iii) Shall mandate the C&D waste generators to submit the C&D waste management plan well in advance including quantum to be generated, mix of the waste, plan of separation, supply to collection points/ re-processing site and use of produce from C&D waste processing and the expected completion date.
- (iv) To accord the approval with or without modifications for C&D waste management plan submitted by the generator within a month.
- (v) Shall implement IT-based system to record, generate information and monitor generation of C&D waste, its movement, processing and utilisation of produce of C&D waste processing.
- (vi) Shall mandate use of produce of C&D waste at least to the extent of specified percentage of total construction materials, say 10-20%.
- (vii) Shall give incentive for use of produce of processed C&D waste material by ensuring its quality and competitive price as compared to virgin construction materials through the concessionaire/ contractor by devising appropriately the total system of collection and transportation charges and processing fees.
- (viii) Shall motivate the C&D waste generators of 1 lac tonne and above for in-situ processing of C&D waste.
- (ix) Shall undertake education and capacity building activities for the demolition contractors as well as builders to adopt modern technologies/ techniques for de-construction of structures and maximize recovery of reusable items than demolition.
- (x) Shall advise and guide the C&D waste processors to apply to the State Pollution Control Board/ Committee for obtaining authorisation for C&D waste processing facility in FORM-I.
- (xi) Shall guide and facilitate the C&D waste processors for utilization of produce & downstream products in various construction projects including road construction and also at land fill sites

(for land fill sites, refer Schedule-II)

- (xii) Shall ensure reporting of accident at the C&D waste processing facility by contractor/ concessionaire in FORM-V to the local authority and shall review and issue instructions, if any, to the in-charge of the facility.
- (xiii) Shall submit annual report to State Pollution Control Board/ Committee in FORM-III.

2.4.2 Duties of SPCBs/ Committees

- (i) The SPCBs/ Committees shall examine the proposal for C&D waste processing facility to be set up and shall issue authorisation to the operator in FORM-II.
- (ii) State Pollution Control Boards/ Committees shall monitor the implementation of C&D Waste Management Rules, 2016 and submit annual report to CPCB and State Government/ UT administrator by 31st July each year in FORM-IV. The report shall also contain the comment and suggestions.

2.4.3 Duties of State Governments/ UT administrator

State Government and UT administrator shall prepare policy document for management of C&D waste within one year from the issuance of notification of “C&D Waste Management Rules, 2016”. The State department dealing with land shall provide suitable site(s) for storage, processing and recycling facilities for C&D waste at least for 20-25 years. The allotted site shall be incorporated in the approved land use plan by the Town and Country Planning Department so that there is no disturbances to the C&D processing facility on long term basis. State Government shall also mandate use of certain percentage (say 10-20%) of materials made from processing of C&D waste in municipal and government contracts and shall also strictly monitor and ensure the quality of produce made from processing of C&D waste.

2.4.4 Duties of Central Pollution Control Board

CPCB shall prepare operational guidelines for environmental management of C&D waste management. Shall analyse and collate the data/ reports received from SPCBS/ Committees to review “C&D Waste Management Rules, 2016”, for matters related to development of environmental standards and shall forward annual compliance report to MoEF&CC before 30th August of each year.

2.4.5 Duties of Bureau of Indian Standard (BIS)

The BIS shall prepare and update on regular basis the codes of practices and standards for use of recycled materials and products of C&D waste in respect of construction activities.

2.4.6 Duties of Indian Road Congress (IRC)

IRC shall prepare and update on regular basis the codes of practices, manuals and standards for use of recycled materials and products of C&D waste in construction of roads and allied structures.

2.4.7 Duties of Central Government

Ministry of Housing & Urban Affairs (erstwhile MoUD) and Ministry of Rural Development and Ministry of Panchayati Raj shall facilitate local bodies in compliance of C&D Waste Management Rules, 2016 and MoEF&CC shall review implementation of these rules as and when required on regular basis.

2.4.8 Duties of C&D Waste Processing Contractor/ Concessionaire

The C&D waste processing contractor/ concessionaire shall maintain and operate the C&D waste storage and recycling facility site with accordance with C&D Waste Management Rules, 2016 and the directives of local authority including the following:

- (i) Shall obtain authorization from State Pollution Control Boards/ Committee for establishing C&D waste storage and processing/ recycling facilities for construction and demolition waste through FORM-I.
- (ii) Shall arrange to collect the C&D waste from the collection point as well as from the site of C&D waste generators in segregated mode as per the terms and conditions/ notification of local authority.
- (iii) Shall process/ dispose off in environment friendly manner the segregated C&D waste collected/ received.
- (iv) Shall process separately the concretes to generate recycled concrete aggregates (RCA) without mixing with any other waste.
- (v) Shall maintain and operate system(s) to receive the C&D waste, store it in a segregated mode, process it and get the produce utilized by marketing it or by producing the down stream products and marketing thereof.
- (vi) Shall maintain the C&D waste storage and processing facilities in an environment friendly manner without littering/ spill over of C&D waste material, maintaining the internal roads and areas duly paved/ covered with appropriate material like morum/ coarse sand like material or grass to avoid fugitive dust, stagnation of water, etc. Levels of fugitive dust shall not increase more than $60 \mu\text{g}/\text{m}^3$ on annual basis and $100 \mu\text{g}/\text{m}^3$ on 24 hour basis. Noise level shall not increase 75 dB during the day hours and 70 dB during the night hours (10 PM - 6 AM). To ensure adherence to noise and fugitive dust standards, setting up of the processing facility in a covered area or in underground area with appropriate air quality control mechanism may be considered.
- (vii) Shall maintain systems for weighing of incoming C&D waste material in segregated categories, maintaining record thereof and similar details of utilization/ supply of process materials including downstream products agency / customer wise in computer based user friendly system.
- (viii) Shall ensure quality of produce of C&D waste material and downstream products as per the requirements of the customers and/ or as per the standard specifications.

- (ix) Shall maintain on its website real time information about availability of produce of C&D waste and downstream products as well as their quality report and price along with the system for placing online order and payment.
- (x) Shall report accidents, if any, to the local authority in FORM-V.
- (xi) Shall ensure safety and welfare of workers, officers and visitors to the C&D waste storage and processing facility.
- (xii) Shall utilize to the extent available and possible the processed water for processing of C&D waste and production of downstream products and shall operate the wet system with zero discharge

3 C&D WASTE PROCESSING TECHNOLOGIES

The C&D waste generators are advised to segregate the C&D waste in difference streams as well as local authority and its contractors/transporters are advised to collect and transport the C&D waste in segregated mode. However, it may happen that C&D waste is received at the central processing facility in a mixed condition. It is essential and advisable to recover the maximum of reusable/remeltable items before processing the supplied C&D waste. This activity shall be the first and prime activity at the C&D storage and processing facility.

The processing of C&D waste can be done either at a central common facility wherein all C&D waste materials can be brought for processing. For bulk generators say projects generating more than one lac tonne C&D waste, it is advisable to process the material at the project site itself i.e. in-situ processing. This would save the transportation cost of waste material as well as that of processed material, would reduce road congestion as well as vehicular pollution. It would also save the foreign exchange used to import the gasoline fuel. For smaller quantity C&D waste generating projects, the mobile plants can be more suitable. The technologies and plants and equipment for these options are briefed hereunder:

3.1 CENTRALIZED COMMON PROCESSING FACILITY

The processing of C&D waste at Centralized Common Processing Facility would generally have the broad stages as described below:

- (i) Segregation of incoming materials by man and machine broadly in three groups, namely: (a) the big size unwanted materials such as plastics, wood, electrical, metals and other wastes are removed manually for dispatch to recycling / reuse units (for metals, plastics and wood, etc.) and the wastes to MSW dump yards, (b) very big concrete blocks of size about 425 mm and above are identified/ segregated and broken into smaller pieces manually or by use of mobile rock breakers or hydraulic rock breakers, etc. and (c) mixed C&D debris of smaller size.
- (ii) The broken down concrete pieces and other available pieces of about 65 mm and above are fed to dump hopper for feeding to impact crusher through grizzly feeder. The impact crusher with a close setting of 65 mm would crush the input material to about -65 mm size.
Impact crusher technology is energy efficient, more versatile and accommodating for shape variety of input material. Its easy to operate and maintain with quick access to parts.
- (iii) The output of impact crusher is segregated through a set of vibratory screens / grizzly set filter. The material of size +40 mm is fed to cone crusher for production of coarse aggregate and the

smaller pieces (-40 mm) are screened by second stage vibrating screens into four groups, namely, -40 mm + 20 mm, -20 mm + 10 mm, -10 mm + 5 mm and -5 mm. The output of cone crusher is also segregated through vibratory screen stage-2. Aggregates of size -80 mm + 40 mm, if required can be screened before feeding to cone crusher.

Cone crusher technology has advantages over other options. The cone crusher breaks the input material by squeezing force created by an eccentrically spindle. The crushing chamber has less steepness for better results. The process continues until the pieces are sized to the requirement and discharged. It is highly productive, reliable for product quality, easy to maintain and with low operational costs.

- (iv) The mixed C&D waste remaining after the removal of big pieces of concrete and unwanted materials is conveyed to grizzly set with filters of 65 mm. During this transit the unwanted materials like illustrated earlier are removed and sent to rejects. Full bricks and near to full bricks are also segregated for re-use. The grizzly set filters would segregate the material in four streams: (a) – 5 mm material that would be collected for landscaping/ low lying area fill, etc., (b) -40 mm + 5 mm, this would be fed to vertical shaft impact crusher (VSI) after magnetic separator for manufacture of sand, (c) The materials of size - 65 mm + 40 mm is fed to cone crusher after magnetic separator and (d) the materials of sizes + 65 mm is fed to impact crusher.

The VSI sand manufacturing technology is recommended over other sand manufacturing equipments as VSI technology can achieve accurate classification of the manufactured sand. Further, it also controls the shape, sharp edges and flakiness of the final product. The feed material is not crushed but breaks itself at natural fault/ weak lines and joint surfaces under the impact of kinetic energy imparted to it.

- (v) Washing and stacking of produced coarse aggregates and the fine aggregates.

The output of the process would be:

- (a) Coarse aggregate of size -40 mm + 20 mm, -20 mm + 10mm, and -10 mm + 5 mm
- (b) Sand -4.75 mm/ +0.150 mm
- (c) Fine waste for landscaping and filling of low lying areas.
- (d) Rejects

- (vi) Manufacture of down stream products

The fine and coarse aggregates can to be converted into following building products at the C&D waste recycling plant:

- (a) Ready mix concrete
- (b) Bricks, blocks, tiles, kerb stones
- (c) Paver blocks
- (d) Pre-fab concrete slabs, etc.

Balance of fine and coarse aggregates is supplied to the market/ building construction project sites.

The flow chart of the process and list of major equipments with broad specifications for 2000 TPD and 750 TPD capacities are given in Figure 4/Table 2 and Figure 5/Table 3 respectively. The illustrative photographs of important equipments are placed at Figures 6 to 12.

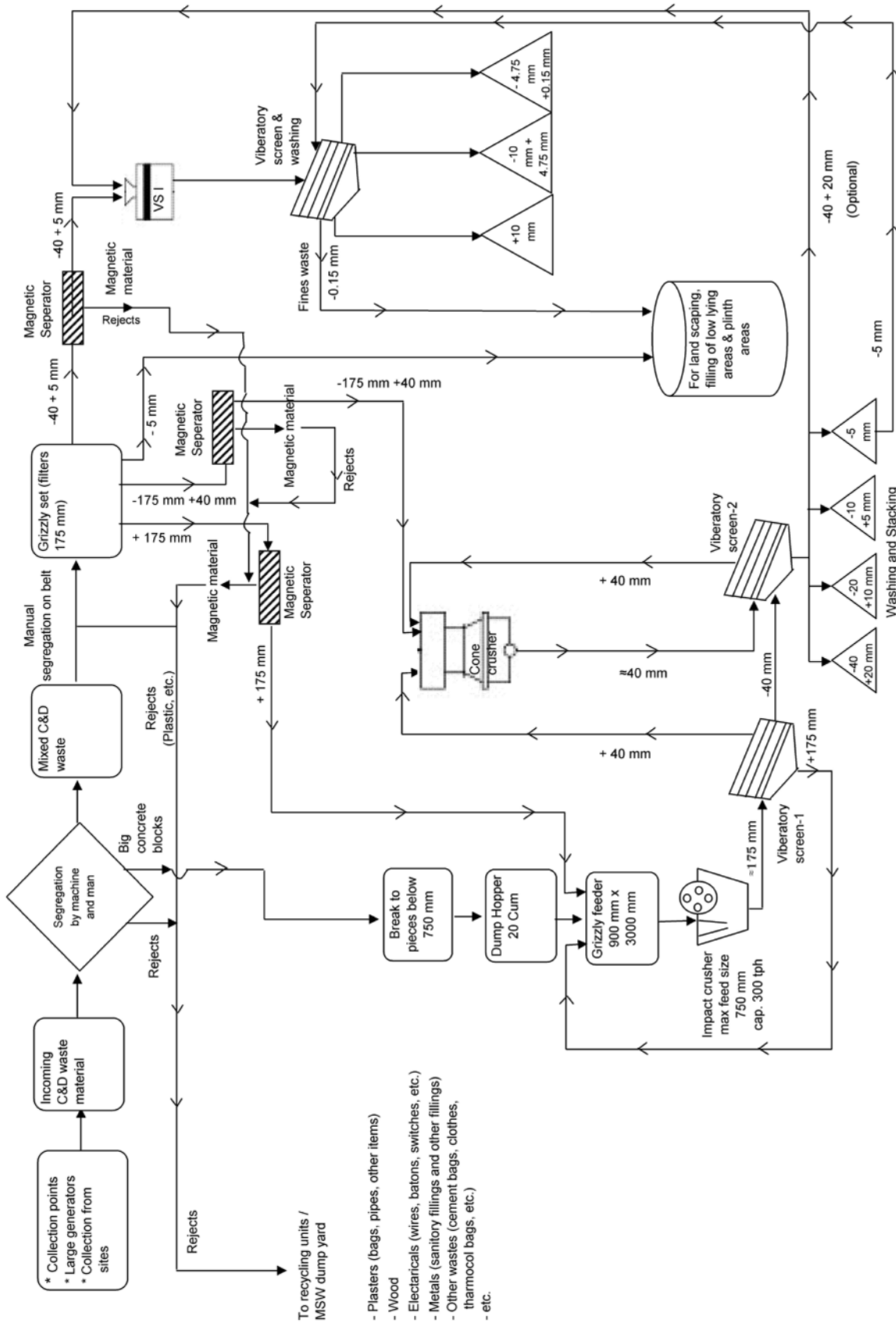


Figure 4 : C&D waste processing flow chart for 2000 TPD capacity

- Plasters (bags, pipes, other items)
- Wood
- Electricals (wires, batons, switches, etc.)
- Metals (sanitary fillings and other fillings)
- Other wastes (cement bags, clothes, thermocol bags, etc.)
- etc.

Table 2: Major equipments for processing of 2000 TPD of C&D waste

S. No.	Equipment	Broad Specifications
1.	Dump hopper	20 cum
2.	Grizzly feeder	900 mn x 3000 mm
3.	Impact crusher	maximum opening close size sitting capacity
		750 mm 175 mm 300 tpd
4.	Vibratory screen-1	300 tph
5.	Cone Crusher	200 tph
6.	Vibratory screen-2	200 tph
7.	Grizzly set filters	200 tph
8.	VSI crusher	60 tph
9.	Vibratory washing screen/ log washer	60 tph
10.	Hydraulic press for brick making	1,00,000/shift
11.	Egg lying block making machine	15,000/shift
12.	Paver block vibratory table/hydraulic press	20,000/shift
13.	Tile making vibratory tables/ hydraulic press	15,000/shift
14.	Kerb stone – Egg laying machine	5,000/shift
15.	Ready mix concrete plant	100m ³ /shift

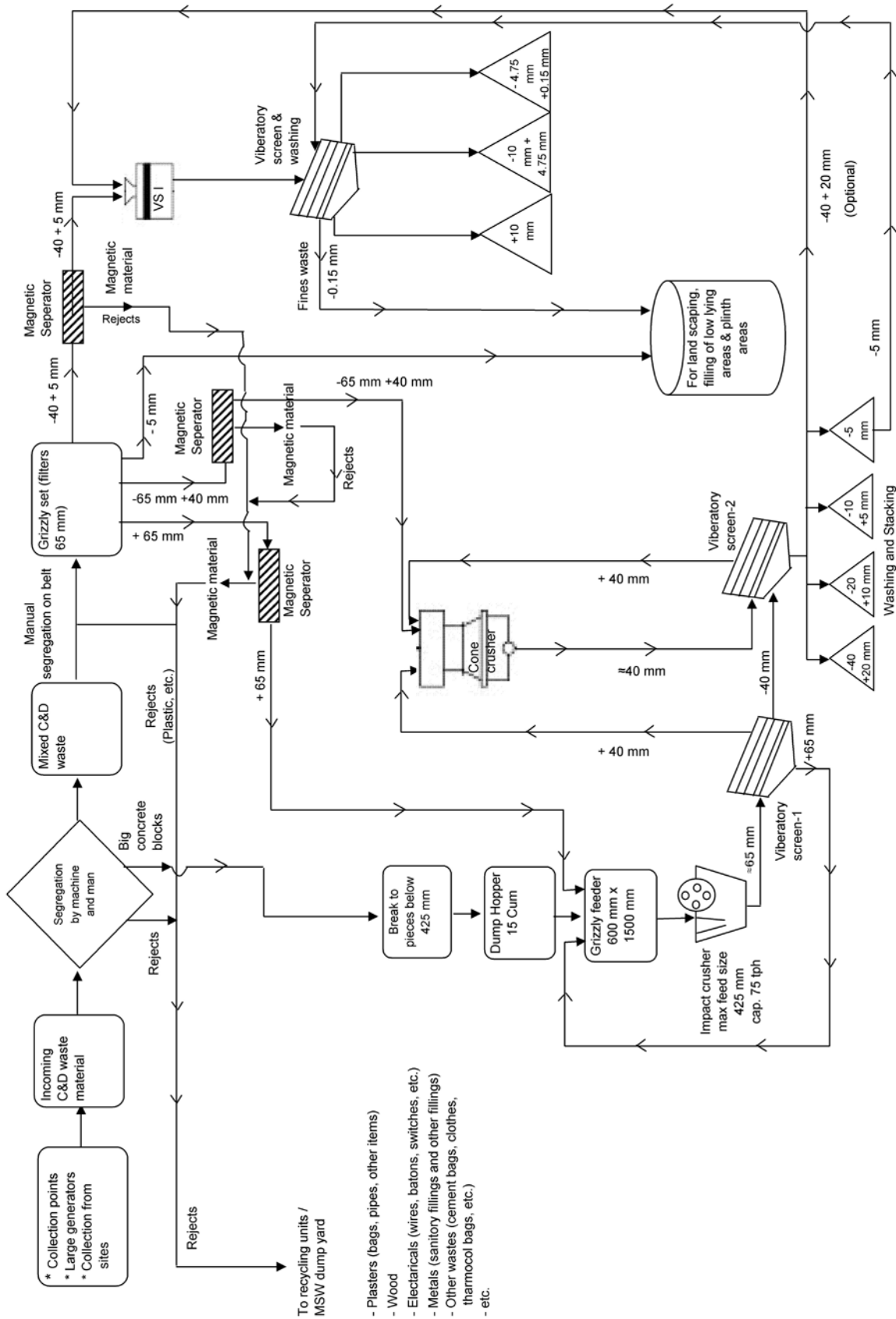


Figure 5: C&D waste processing flow chart for 750 TPD capacity

Table 3: Major equipments for processing of 750 TPD of C&D waste

S. No.	Equipment	Broad Specifications
1.	Dump hopper	20 cum
2.	Grizzly feeder	900 mm x 3000 mm
3.	Impact crusher	maximum opening close size sitting capacity
		750 mm 175 mm 300 tpd
4.	Vibratory screen-1	300 tph
5.	Cone Crusher	200 tph
6.	Vibratory screen-2	200 tph
7.	Grizzly set filters	200 tph
8.	VSI crusher	60 tph
9.	Vibratory washing screen/ log washer	60 tph
10.	Hydraulic press for brick making	1,00,000/shift
11.	Egg lying block making machine	15,000/shift
12.	Paver block vibratory table/hydraulic press	20,000/shift
13.	Tile making vibratory tables/ hydraulic press	15,000/shift
14.	Kerb stone – Egg laying machine	5,000/shift
15.	Ready mix concrete plant	100m ³ /shift

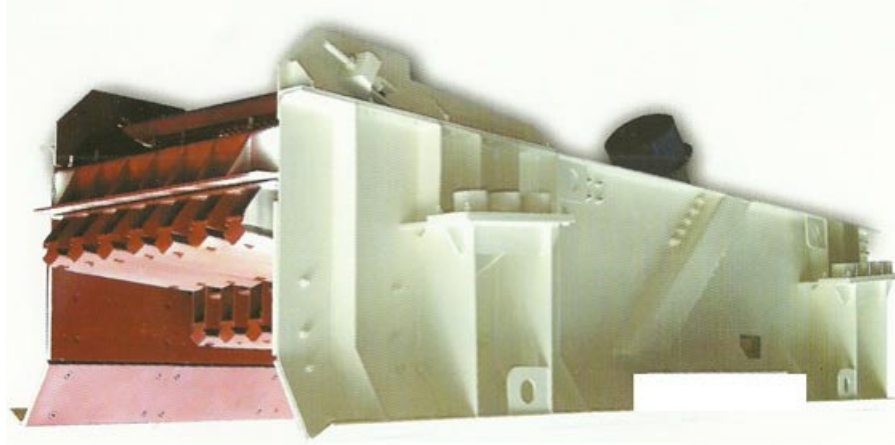


Figure-6: Grizzly Feeder

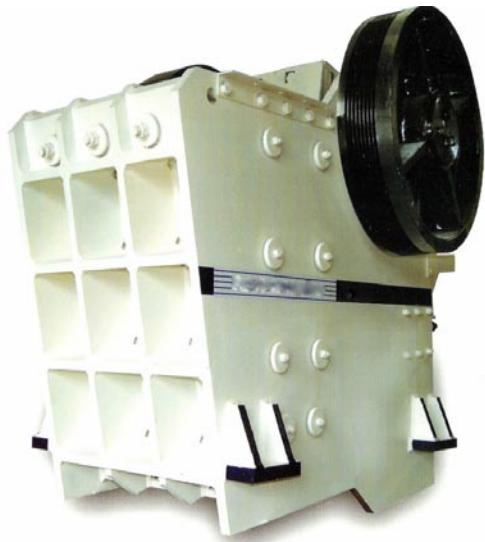


Figure-7: Jaw Crusher

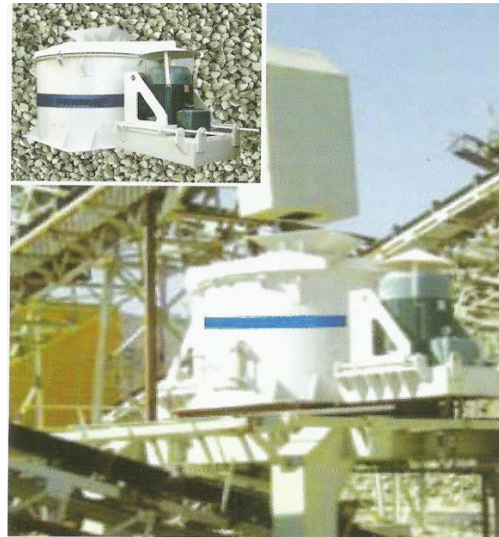


Figure-8: Vertical Shaft Impact Crusher

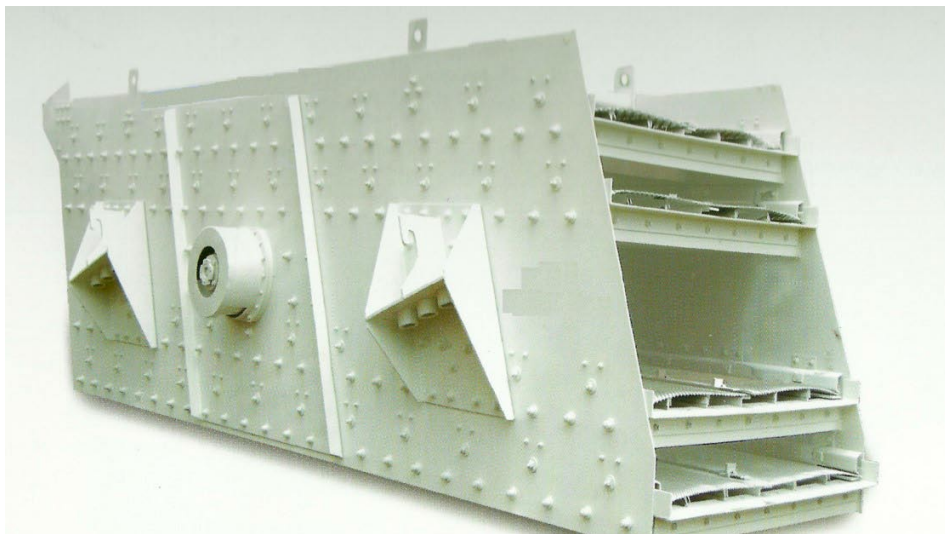


Figure-9: Vibrating Screens



Figure-10: Fly Ash Brick Making Machine



Figure-11: Fly Ash Block Machine



Figure-12: Tile and Paver Block Making Vibratory Table

3.2 IN-SITU PROCESSING

The projects generating 1 lac tonne or more C&D waste may set up in-situ processing plant for which multiple technological options are available as illustrated below in Photos.



CRUSHING BUCKET



ON SITE CRUSHER

Photo 10: Mobile/ in-situ crushers for C&D waste



Photo 11: Crawler cone crusher for mobile/ in-situ application



Photo 12: Crawler jaw crusher for mobile/ in-situ application

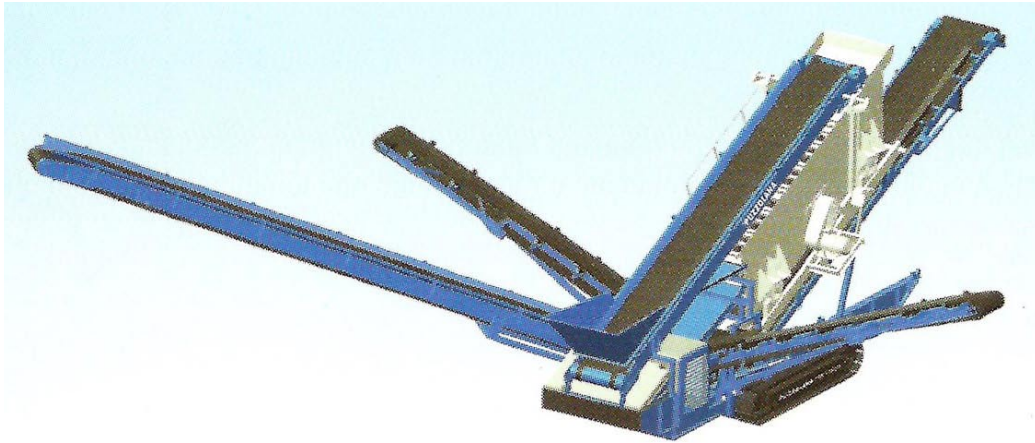


Photo 13: Crawler screen for mobile/ in-situ application



Photo 14: Combo plant for in-situ processing of C&D waste

3.3 MOBILE PLANTS

Vendors have come up with C&D waste crushing and segregation facilities mounted on wheels that can move in at the C&D waste generation site of low volumes. These equipments are generally available of a capacity to process up to 5 tonne debris per day. This equipment can be hired for the required number of days at required intervals as per the generation of C&D waste. The wheel mounted equipment are similar to those illustrated in Photo plates numbered 10 to 13 above.

4 THE PRODUCE OF RECYCLED C&D WASTE AND ITS UTILIZATION

4.1 PRODUCE & DOWNSTREAM PRODUCTS USAGES

The direct produce of recycling of C&D waste are:

- (i) Fine aggregate
- (ii) Recycled Concrete Aggregates (RCA) of different sizes (5-10 mm, 10-20 mm, 20-40 mm or as required)
- (iii) Recycled Aggregates (RA) of different sizes (5-10 mm, 10-20 mm, 20-40 mm or as required)
- (iv) Manufactured soil



Photo 15: Direct produce of C&D waste processing

The manufactured soil is quite suitable for landfill, landscaping as a substitute of excavated soil which leads to environment degrading low lying areas. Fine and coarse aggregates are ready raw materials for RMC plants and construction sites.

The various downstream products which can be manufactured using recycled C&D waste are:

- Bricks, blocks, tiles, hollow bricks, wall tiles;
- Pavers, kerb stones;
- Park benches, drain covers, planters, compound wall, fence post, tree guards, tree pit covers, manhole covers, underground cable covers, pre-cast boundary wall panels and poles, etc.



Photo 16: Recycled concrete blocks & pavers

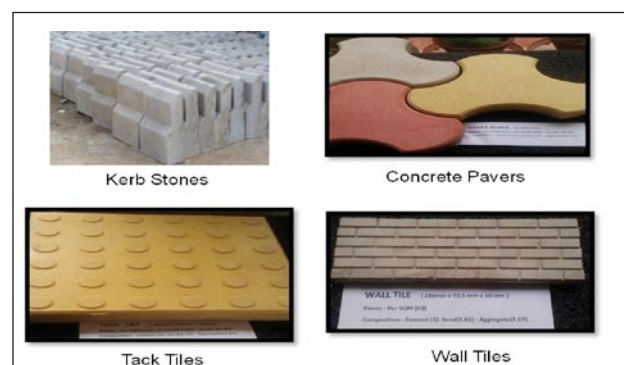


Photo 17: Recycled concrete products

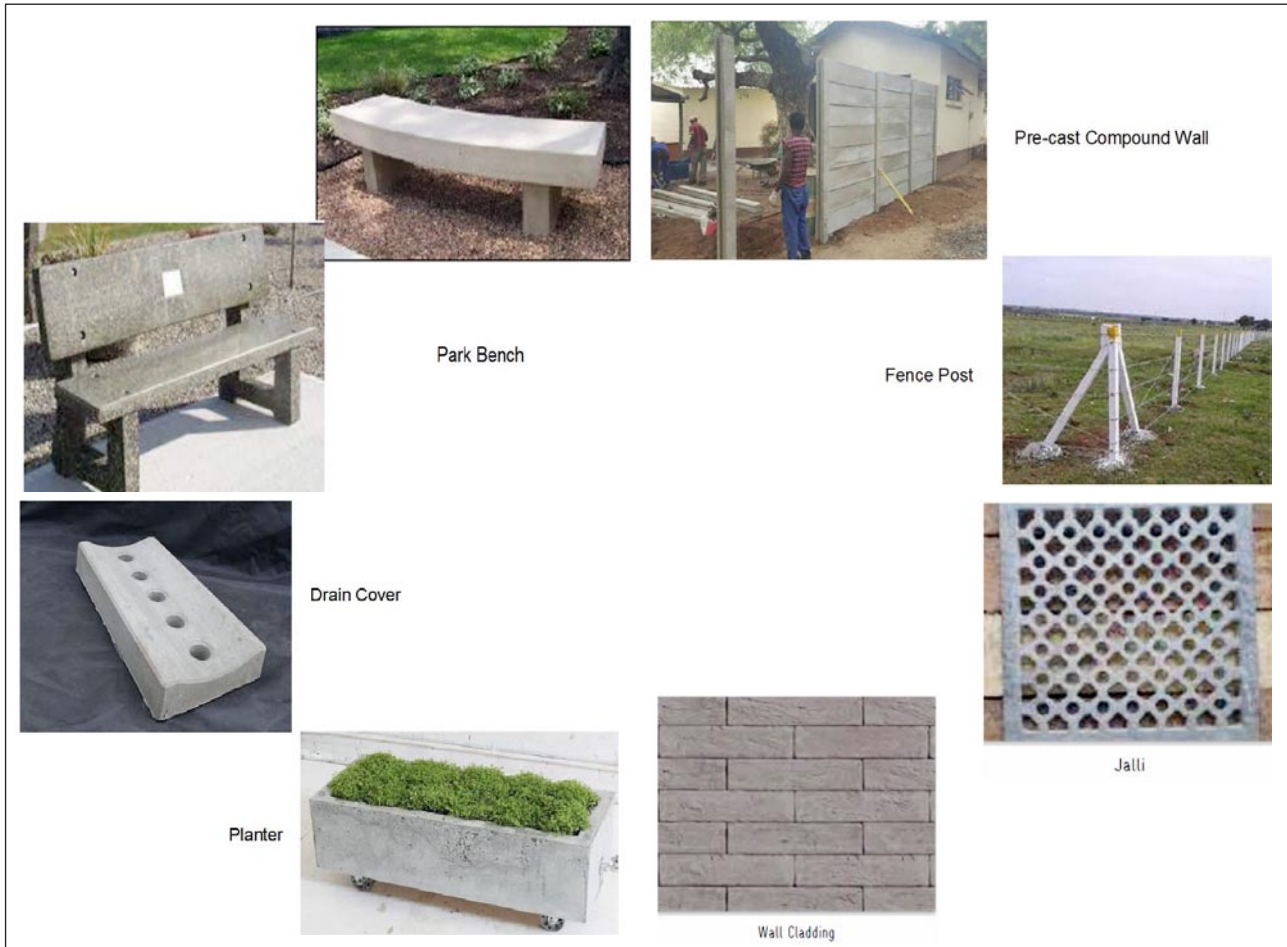


Photo 18: Concrete products of C&D waste produce

The produce of C&D waste processing i.e. fine and coarse aggregates are good materials for road construction. A few road stretches have been constructed using these materials.



Photo 19: Road constructed with C&D waste processed material at Delhi

The mix of produce i.e. fine aggregates and different sizes of coarse aggregates can be varied by the contractor/ concessionaire as per the demand from market.

4.2 QUALITY, SPECIFICATION AND STANDARDS FOR USE OF PRODUCE

(i) Concrete Applications:

The fine aggregates and coarse aggregates have been successfully used and certified for their suitability for use in concrete. Table 4 and Table 5 below give the results of validation done at NCCBM, Ballabgarh in addition to many more validations at other centres.

Table 4: Results for Replacement of Natural Fine Aggregate by Recycled Fine Aggregate in Concrete

Sr. No.	Replacement %	Compressive Strength as per IS-516 (MPa)			
		07 days	28 days	56 days	90 days
1.	0	25.93	38.98	46.14	52.00
2.	25	31.84	42.90	51.16	58.80
3.	50	34.27	46.14	53.87	61.82
4.	75	30.55	39.87	47.15	53.62
5.	100	24.77	37.97	44.42	51.30

Source: Nikhil Kaushik, V.V. Arora and P.N. Ojha, National Council for Cement and Building Materials, India

Table 5: Results for Replacement of Natural Coarse Aggregate with Recycled Coarse Aggregate in Concrete

Sr. No.	Replacement %	Compressive Strength as per IS-516 (MPa)			
		07 days	28 days	56 days	90 days
1.	0	25.93	38.98	46.14	52.00
2.	25	26.28	44.48	51.59	55.29
3.	50	25.36	38.56	45.05	51.31
4.	75	22.80	36.42	41.54	45.50
5.	100	21.60	32.29	37.18	41.62

Source: Nikhil Kaushik, V.V. Arora and P.N. Ojha, National Council for Cement and Building Materials, India

Based on validations at other centres also, BIS has permitted use of these materials under IS-383, the standard for fine and coarse aggregates for use in concrete as given below in Table 6.

Table 6: C&D produce Utilisation Permitted by IS: 383(2016)

Sr. No.	Type of Aggregate	Maximum Utilization		
		Plain Concrete Percent	Reinforced Concrete Percent	Lean Concrete (Less than M-15 Grade) Percent
(i)	Coarse aggregate			
(a)	Recycled concrete aggregate (RCA)	25	20 (Only up to M-25 Grade)	100
(b)	Recycled aggregate (RA)	Nil	Nil	100
(ii)	Fine aggregate			
(a)	Recycled concrete aggregate (RCA) (See Note 1)	25	20 (Only up to M-25 Grade)	100

NOTES:

1. It is desirable to source the recycled concrete aggregates from sites being redeveloped for use in the same site.
2. In any given structure, only one type of manufactured coarse aggregate and one type of manufactured fine aggregate shall be used.
3. While using manufactured aggregate as part replacement for natural aggregate, it should be ensured that the final grading meets the requirements specified in tables 7,8,9 of this standard.

(ii) Road Construction:

The validation of fine and coarse aggregates produce of C&D waste processing for road construction has also been done. The results of work done at Central Road Research Institute for road applications are given at Table 7 and Table 8 below.

Table 7: Compressive Strength of DLC with C&D Waste Aggregates (RA)

Mix Designation	C&D Aggregate Percentage	Compressive Strength (MPa)	
		7 Days	28 Days
Conventional concrete	Nil	13.5	18.2
C&D 10	10	13.0	17.3
C&D 30	30	11.1	16.3
C&D 50	50	9.9	13.1

Table 8: Strength Properties of Concrete Using RCA and Fly Ash

Mix Designation	Percentage Replacement of NMA with RCA	Slump (mm)	28 Days Compressive strength in MPa	56 Days Compressive strength in MPa	56 Days Split Tensile strength in MPa
NAC*	Nil	65	46	53	3.96
NAF**	Nil	61	47	58	4.15
R50***	50	63	47	54	3.53
R75	75	62	47	54	3.63
R100	100	68	49	57	4.15

* M45 grade concrete using Natural Mineral Aggregates (NMA)- Cement used 410 kg/m³

** M45 grade concrete using NMA and fly ash (82 kg/m³ of fly ash was admixed in addition to 410 kg/m³ of cement)

*** In the NAF Concrete given above, 50 per cent of NMA was replaced using RCA

Based on the above findings along with tests and trials at other centres, Indian Road Congress has permitted the use of produce of C&D waste processing and has issued IRC: 121-2017 “Guidelines for use of construction and demolition waste in road sector”.

The manufactured soil is also a good substitute for soil for construction of road and fly over embankments. It saves precious top soil.

C&D waste processing produce are also widely used worldwide. As an illustration the provisions in some of the countries are given in Table 9.

Table 9: Provisions for Using C&D Waste in Concrete in Different Countries

Country	C&D Type	Maximum Substitution Allowed	Maximum Strength of Concrete that can be made using C&D	Other Restrictions
United Kingdom	RCA	20%	20 to 40MPa	No Chloride Exposure, No Freeze thaw
	RA	Not Specified	16 MPa	Only Mild Exposure
Australia	RCA	30%	40 MPa	
	RA	100%	20 MPa	
RILEM	RA	100%	16 MPa	Masonry Aggregate
	RCA	100%	50 MPa	
Korea	RCA	30%	27 MPa	
Germany	RCA	35%	25 MPa	In dry or low humidity environments
		25%	30 MPa	
Portugal	RCA	25%	35 MPa	
		20%	40 MPa	
Hong Kong	RCA	20%	35 MPa	
		100%	20 MPa (Non Structural Concrete)	

Source: IRC:121-2017

4.3 ECONOMICS AND ECO-FRIENDLY

The comparison of price of produce of C&D waste as well as some of the downstream products like kerb stones, paver blocks, paver tiles as validated by IRC are given in Table 10.

Table 10: Comparison of Price of Products (year 2015) made using C&D with DSR

DSR Code No	Item	Unit	DSR Rate in Rs.	Price of equivalent item made using C&D (Rs.)
983	Fine aggregate (sand)	m ³	700	665
1159	Stone dust	m ³	1100	950
287	Brick mix aggregate	m ³	600	465
295	Stone aggregate 20 mm	m ³	1175	900
297	Stone aggregate 10 mm	m ³	1175	900
1182	Surkhi	m ³	700	635
8686	Precast Kerb stone, M20 Grade	m ³	4100	3950
7070	Precast CC Paver block, M30 Grade	m ²	360	340
7237	Precast Paver tile (22 mm thick)	m ²	540	475

Source: IRC:121-2017

In addition, it is also been reported by C&D waste processing plant at Burari, Delhi; Ahmedabad and Vikhroli, Mumbai that the downstream products are cost effective than the comparable products otherwise available in the market.

The cost economics published by CYBC, Kharghar C&D waste processing plant is given in Table 11.

Table-11: Cost saving in recycled C&D waste products-CYBC

Building products	% saving
Solid block	25
Hollow block	30
Paving block (60 mm thick)	25
Paving block (80 mm thick)	20

Source: Project report CYBC-Mr. N. M. Shirgonkar

Eco-Friendly

The produce and downstream products of C&D waste processing are eco-friendly as they conserve the natural resources, resultant mining and environment degradation as well as the use of C&D waste eases out the demand on land for dumping.

4.4 MARKETING PLAN AND CUSTOMER REACH

In addition to the support of Government and local authority for use of C&D waste produce in various construction activities, the concessionaire may do the following:

- (i) Do not restrict marketing of produce only to building construction projects.
- (ii) Market the products also to road projects including flyovers and allied structures, railway over bridges, metro projects, infrastructure projects, reclamation of low lying areas and plinth filling etc.
- (iii) The waste fines (-0.150 mm) can be used for filling of low lying areas, plinth areas and for landscaping and termed are as manufactured sand.
- (iv) Details of products including, quality, environmental impact and supportive Govt. policies be put on the web site of the company as well as local civic body.
- (v) Track be kept of all the forthcoming construction projects of Government and it may be ensured that use of “recycled C&D produce” are included at DPR and Tender preparation stages itself.
- (vi) MoUs/ agreements be entered with major construction projects well in advance of start of construction. For other projects also, order booking be done well in advance. This would also facilitate in planning of product mix for production.
- (vii) Consumer awareness and technical seminars be held at regular intervals, including visibility at print and electronic media.
- (viii) Web marketing including uploading the details of available C&D waste produce item-wise, quality, quantity and price on a real time basis. Order & payment acceptance be online along with tracking of status of order.
- (ix) Construction project that do not use C&D waste produce as per the advisory of local authority be brought to the notice of local authority.

5 WAY FORWARD AND CONCLUSION

5.1 WAY FORWARD

1. Implementation and commissioning of C&D waste/ debris/ processing facilities be expedited in the cities/ town of population more than 1 million through sensitization of local authorities and sharing of experiences.
2. De-construction/ engineered demolition be advocated and practiced than demolition.
3. Concrete debris be stored, transported and processed separately to produce Recycled Concrete Aggregate (RCA), a high value product.
4. The concessionaire shall also manufacture end products like bricks, blocks, tiles, pavers blocks, kerb stones, RMC etc. and generate revenue through sale of these products plus aggregates (fine & coarse) and processed soil.
5. The overall financial management be such including the tipping fee payable by C&D waste generator, that the selling prices of end building construction products manufactured by recycling C&D waste are at least 20 per cent less than corresponding conventional materials.
6. All Government and redevelopment constructions be mandated to use recycled C&D waste products at least to the extent of 20 per cent of the total corresponding materials' use.
7. New private constructions be mandated to use recycled C&D waste products to the extent of at least 10 per cent of the total corresponding materials' use.
8. Large projects of re development, like the ones being implemented by CPWD and NBCC at New Delhi, may be mandated to :
 - a) Undertake deconstruction of old structures and not demolition
 - b) Minimise debris, maximise re-usables
 - c) Concrete debris be collected, stored, transported and processed separately to get RCAs
 - d) Process the C&D debris in situ at its project site and utilize all the produce directly or by converting into downstream products
 - e) Environment norms be strictly followed especially for air, water and noise.

9. Option of “Processing plant on the wheels” for small/ medium size projects be utilized and made a practice.
10. All construction plans approved by local civic bodies be monitored by the civic body and the concessionaire jointly through a computer based system for use of recycled C&D waste products by them.
11. Mechanism and guideline be formulated for quality assessment/ certification of salvaged items and their re-use.
12. Penalties for indiscriminate dumping of C&D waste be many fold of tipping fee.
13. Cities generating more than 2000 TPD of C&D waste may have more than one centralized processing plant.
14. Number of collection points and location there of should be such that small quantity debris generator/ citizen gets a collection point within a distance of 2-3 km.

5.2 CONCLUSION

The C&D debris is a source of construction material. Technologies for its processing are well developed and plant and equipments are available for processing of this material for smallest quantity to a large quantities. The quality of produce of processed C&D debris has been found to be acceptable for building construction, road construction and for manufacture of downstream products, not only in India but worldwide. Gainful utilization of this material provides eco friendly and economical constructions.

REFERENCES

1. C&D Waste Management Rules, 2016, MoEF&CC
2. Guidelines for utilization of C&D waste in construction of dwelling units and related infrastructure in housing schemes of the Government, 2016, BMTPC, MoHUA, Govt. of India
3. Guidelines on Environmental Management of Construction & Demolition (C&D) Wastes, March, 2017, CPCB
4. Swachh Bharat Mission Document
5. CPWD Guidelines for Sustainable Habitat, March, 2014
6. Ministry of Urban Development (MoUD) circular dated 28th June, 2012
7. National Ambient Air Quality Standards notified by CPCB on 18th November, 2009
8. The noise pollution (Regulation and Control) rules, 2000, CPCB
9. Website of Canadian Province of Nova Scotia
10. Website of Tokyo Metro Waste Management
11. Website of Environmental Protection Agency (EPA), USA
12. Website of European Demolition Association

(C&D Waste Management Rules, 2016)

SCHEDULE I

Criteria for Site Selection for Storage and Processing or Recycling Facilities for construction and demolition Waste

[See Rule 7(1)]

- (1) The concerned department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition and hand over the sites to the concerned local authority for development, operation and maintenance, which shall ultimately be given to the operators by Competent Authority and wherever above Authority is not available, shall lie with the concerned local authority.
- (2) The Local authority shall co-ordinate (in consultation with Department of Urban Development of the State or the Union territory) with the concerned organizations for giving necessary approvals and clearances to the operators.
- (3) Construction and demolition waste shall be utilized in sanitary landfill for municipal solid waste of the city or region as mentioned at Schedule I of these rules. Residues from construction and demolition waste processing or recycling industries shall be land filled in the sanitary landfill for solid waste.
- (4) The processing or recycling shall be large enough to last for 20-25 years (project based on-site recycling facilities).
- (5) The processing or recycling site shall be away from habitation clusters, forest areas, water bodies, monuments, National Parks, Wetlands and places of important cultural, historical or religious interest.
- (6) A buffer zone of no development shall be maintained around solid waste processing and disposal facility, exceeding five Tonnes per day of installed capacity. This will be maintained within the total area of the solid waste processing and disposal facility. The buffer zone shall be prescribed on case to case basis by the local authority in consultation with concerned State Pollution Control Board.
- (7) Processing or recycling site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.
- (8) The approach and or internal roads shall be concreted or paved so as to avoid generation of dust particles due to vehicular movement and shall be so designed to ensure free movement of vehicles and other machinery.

- (9) Provisions of weigh bridge to measure quantity of waste brought at landfill site, fire protection equipment and other facilities as may be required shall be provided.
- (10) Utilities such as drinking water and sanitary facilities (preferably washing/bathing facilities for workers) and lighting arrangements for easy landfill operations during night hours shall be provided and Safety provisions including health inspections of workers at landfill sites shall be carried out made.
- (11) In order to prevent pollution from processing or recycling operations, the following provisions shall be made, namely:
 - (a) Provision of storm water drains to prevent stagnation of surface water;
 - (b) Provision of paved or concreted surface in selected areas in the processing or recycling facility for minimizing dust and damage to the site.
 - (c) Prevention of noise pollution from processing and recycling plant:
 - (d) provision for treatment of effluent if any, to meet the discharge norms as per Environment (Protection) Rules, 1986.
- (12) Work Zone air quality at the Processing or Recycling site and ambient air quality at the vicinity shall be monitored.
- (13) The measurement of ambient noise shall be done at the interface of the facility with the surrounding area, i.e., at plant boundary.
- (14) The following projects shall be exempted from the norms of pollution from dust and noise as mentioned above:

For construction work, where at least 80 percent construction and demolition waste is recycled or reused in-situ and sufficient buffer area is available to protect the surrounding habitation from any adverse impact.
- (15) A vegetative boundary shall be made around Processing or Recycling plant or site to strengthen the buffer zone.

(C&D Waste Management Rules, 2016)

SCHEDULE II**Application of materials made from construction and demolition waste and its products
[See Rule 7(3)]**

Sl. No.	Parameters	Compliance Criteria
1	Drainage layer in leachate collection system at bottom of Sanitary Landfill Gas Collection Layer above the waste at top of Sanitary Landfill and Drainage Layer in top Cover System above Gas Collection Layer of Sanitary Landfill For capping of sanitary landfill or dumpsite, drainage layer at the top	Only crushed and graded hard material (stone, concrete etc.) shall be used having coarse sand size graded material (2mm – 4.75mm standard sieve size). Since the coarse sand particles will be angular in shape (and not rounded as for riverbed sand), protection layers of non-woven geo-textiles may be provided, wherever required, to prevent puncturing of adjacent layers or components.
2	Daily cover	Fines from construction and demolition processed waste having size up to 2 mm shall be used for daily cover over the fresh waste. Use of construction and demolition fines as landfill cover shall be mandatory where such material is available. Fresh soil (sweet earth) shall not be used for such places and borrow-pits shall not be allowed. Exception – soil excavated during construction of the same landfill. During hot windy days in summer months, some fugitive dust problems may arise. These can be minimised by mixing with local soil wherever available for limited period.
3	Civil construction in a sanitary landfill	Non-structural applications, such as kerb stones, drain covers, paving blocks in pedestrian areas.

(C&D Waste Management Rules, 2016)

SCHEDULE III**Timeframe for Planning and Implementation
[See Rule 13]**

Sl. No.	Compliance Criteria	Cities with population of 01 million and above	Cities with population of 0.5-01 million	Cities with population of less than 0.5 million
1	Formulation of policy by State Government	12 months	12 months	12 months
2	Identification of sites for collection and processing facility	18 months	18 months	18 months
3	Commissioning and implementation of the facility	18 months	24 months	36 months
4	Monitoring by SPCBs	3 times a year – once in 4 months	2 times a year – once in 6 months	2 times a year – once in 6 months
*The time Schedule is effective from the date of notification of these rules.				

(C&D Waste Management Rules, 2016)

FORM – I
See [Rule 7 (2)]
Application for obtaining authorisation

To,	
The Member Secretary	
Name of the local authority or Name of the agency appointed by the municipal authority	
Correspondence address	
Telephone No.	
Fax No.	
Nodal Officer and designation (Officer authorized by the competent authority or agency responsible for operation of processing or recycling or disposal facility)	
Authorisation applied for (Please tick mark)	Setting up of processing or recycling facility of construction and demolition waste
Detailed proposal of construction and demolition waste processing or recycling facility to include the following	
Location of site approved and allotted by the Competent Authority.	
Average quantity (in tons per day) and composition of construction and demolition waste to be handled at the specific site.	
Details of construction and demolition waste processing or recycling technology to be used.	
Quantity of construction and demolition waste to be processed per day.	
Site clearance from Prescribed Authority.	
Salient points of agreement between competent authority or local authority and operating agency (attach relevant document).	
Plan for utilization of recycled product.	
Expected amount of process rejects and plan for its disposal (e.g., sanitary landfill for solid waste).	
Measures to be taken for prevention and control of environmental pollution.	
Investment on project and expected returns.	
Measures to be taken for safety of workers working in the processing or recycling plant.	
Any preventive plan for accident during the collection, transportation and treatment including processing and recycling should be informed to the Competent Authority (Local Authority) or Prescribed Authority	
Date:	Signature of Nodal Officer

(C&D Waste Management Rules, 2016)

Form-II
See [Rule (7) (3)]
Format for Issue of Authorisation to the Operator

File No.: _____

Date : _____

To,

Ref : Your application number _____ Dt.

The _____ State Pollution Control Board or Pollution Control Committee after examining the proposal hereby authorizes _____ having their administrative office at

_____ to set up and operate construction and demolition waste processing facility at _____ on the terms and conditions (including the standards to comply) attached to this authorisation letter.

1. The validity of this authorisation is till _____. After expiry of the validity period, renewal of authorisation is to be sought.

2. The _____ State Pollution Control Board or Pollution Control Committee may, at any time, for justifiable reason, revoke any of the conditions applicable under the authorisation and shall communicate the same in writing.

3. Any violation of the provision of the construction and demolition Waste Management Rules, 2016 shall attract the penal provision of the Environment (Protection) Act, 1986 (29 of 1986).

Date:

Place:

(Member Secretary)

State Pollution Control Board/

Pollution Control Committee

(C&D Waste Management Rules, 2016)

Form –III
See [Rule 8(2)]
Format of Annual Report to be submitted by Local Authority
to the State Pollution Control Board

- (i) Name of the City or Town.....
- (ii) Population.....
- (iii) Name and address of local authority or competent authority

Telephone No :
Fax :
Email ID:
Website:
- (iv) Name of In-charge or Nodal Officer dealing with construction and demolition wastes management with designation
- 1. Quantity and composition of construction and demolition waste including any deconstruction waste
 - (a) Total quantity of construction and demolition waste generated during the whole year in metric ton
Any figures for lean period and peak period generation per day
Average generation of construction and demolition waste (TPD)
Total quantity of construction and demolition waste collected per day
Any Processing / Recycling Facility set up in the city
Status of the facility
 - (b) Total quantity of construction and demolition waste processed / recycled (in metric ton)
Non-structural concrete aggregate :
Manufactured sand :
Ready-mix concrete (RMC) :
Paving blocks :
GSB :
Others, if any, please specify :
 - (c) Total quantity of Construction & Demolition waste disposed by land filling without processing (last option) or filling low lying areas
No of landfill sites used :
Area used :
Whether weigh-bridge : Yes No
facility used for quantity estimation?

(d) Whether construction and demolition waste used in sanitary landfill (for solid waste) as per Schedule III

: Yes No

2. Storage facilities

(a) Area or location or plot or societies covered for collection of Construction and Demolition waste

(b) No. of large Projects (including roadways project) covered

(c) Whether Area or location or plot or societies collection is Practiced (if yes, whether done by Competent Authority or Local Authority or through Private Agency or Non-Governmental Organization) :

(d) Storage Bins : -----
 Specifications Existing Proposed
 (Shape & Size) Number for future

(i) Containers or receptacle (Capacity) :

(ii) Others, please specify :

(e) Whether all storage bins/collection spots are attended for daily lifting : Yes No

(e) Whether lifting of Construction & Demolition Waste from Storage bins is manual or mechanical (please tick mark) please specify mode : Manual Mechanical Others, and equipment used (specify equipment)

3. Transportation

		Existing	Actually Required / Proposed number
Truck	:		
Truck-Hydraulic	:		
Tractor-Trailer	:		
Dumper-placers	:		
Tricycle	:		
Refuse-collector	:		
Others (Please specify)	:		

4. Whether any proposal has been made to improve Construction and Demolition waste management practices

5. Have any efforts been made to involve PPP for processing of Construction & Demolition waste : If yes, what is (are) the technologies being used, such as:

Processing / recycling Technology	(Quantity to be processed)	Steps taken
Dry Process	:	
Wet Process	:	
Others, if any, Please specify	:	

6. What provisions are available to check unauthorized operations of:

Encroachment on river bank or wet bodies	:
Unauthorized filling of low line areas	:
Mixing with solid waste	:
Encroachment in Parks, Footpaths etc.	:

7. How many slums are provided with construction and demolition waste receptacles facilities:

8. Are municipal magistrates appointed for taking penal action for non-compliance with these rules: Yes No
 [If yes, how many cases registered & settled during last three years
 (give year wise details)]

Dated:

Signature of Municipal Commissioner

(C&D Waste Management Rules, 2016)

Form –IV
See [Rule (8)(3)]

Format of Annual Report to be submitted by the State Pollution Control Board / Committees to the Central Pollution Control Board

To,

The Chairman,
Central Pollution Control Board,
Parivesh Bhawan, East Arjun Nagar,
Delhi-110032

1. Name of the State/Union territory :
2. Name & address of the State Pollution Control Board/Pollution Control Committee :
3. Number of municipal authorities responsible for management of municipal solid wastes in the State/ Union territory under these rules :
4. A Summary Statement on progress made by municipal authorities in respect of implementation of Schedule III : Please attach as Annexure-I
5. A Summary Statement on progress made by municipal authorities in respect of implementation of Schedule IV : Please attach as Annexure-II

Date: Chairman or the Member Secretary
State Pollution Control Board/
Place: Pollution Control Committee

(C&D Waste Management Rules, 2016)

Form –V
See [Rule14]
Accident reporting

1. Date and time of accident :
2. Sequence of events leading to accident :
3. The type of construction and demolition waste involved in accident :
4. Assessment of the effects of the accidents
 - a. on traffic, drainage system and the environment :
5. Emergency measures taken :
6. Steps taken to alleviate the effects
 - a. of accidents :
7. Steps taken to prevent the recurrence
 - a. of such an accident :
8. Regular monthly health checkup of workers at
 - a. Processing / recycling site shall be made
9. Any accident during the collection,
 - a. transportation and treatment including
 - b. processing and recycling should be informed
 - c. to the Competent Authority (Local Authority) or
 - d. Prescribed Authority

Date :

Place:

Authorized Signatory

Designation

[18-6/2014-HSMD]

Bishwanath Sinha, Joint Secretary



Building Materials and Technology Promotion Council

Ministry of Housing & Urban Affairs, Government of India

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