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Construction and Demolition Waste and Its Impact on Environment

Sukriti Suman

Research Scholar, Department of Zoology
Patna University, Patna

ABSTRACT

The construction Industry in India is flourishing. The urbanization, industrialization, modernization and rising population is impelling the construction industry to grow at a phenomenal rate. Demolition activities are also being carried out to replace old civil structures with newer, bigger and better one. These activities generate waste, termed as construction and demolition (C&D) waste, which contains various materials of varying properties. C&D waste has deleterious impact on the environment. It is giving rise to various types of pollution. This study analyses various data and survey on the C&D waste generation, constituents, management and its effect on the environment of India. The present study focuses on the detrimental impact of C&D waste on the environment. This paper also discusses the ways to generate less C&D waste and its proper handling.

Keywords: Construction, Demolition, C&D waste, Environmental impacts

INTRODUCTION

The construction industry in India is booming, attributed to the increase in the population, urbanization, industrialization and construction of various new infrastructures. It contributes considerably to the GDP. The construction industry plays a vital role in meeting the needs of society and making the quality of life better (Shen & Tam, 2002). The construction industry involves different processes and utilizes huge quantities of resources. These processes have severe impacts on the environment. Construction and demolition waste is generated at the time of construction and demolition activities. It results from construction, renovation, repair and demolition of any civil structure. U.S. Environmental Protection Agency (EPA) characterises construction and demolition waste as waste materials consisting debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. According to the Solid Waste Management Rules¹. C&D waste is the waste consisting of building materials, debris and rubble resulting from construction, re-modeling, restoration and destruction of any civil construction. Wastes also include surplus and damaged materials and products from construction work. Handling C&D waste is a challenging task because it is bulky, heavy, non-biodegradable and inert. C&D waste is a mixture of various materials having different properties and characteristics. According to reports from around the world, C&D waste constitutes nearly 20 to 30% of total solid waste and about 70 to 80 % of C&D waste is concrete and masonry. Construction and demolition activities generate huge amount of waste. Accumulation of C&D waste is creating harmful effects on the environment, ecological resources and human life. It is contributing to various types of pollution like air pollution, water pollution, soil pollution and noise pollution. It is affecting the entire living world as along with human beings, plants and animals are also not unscathed. In developed countries, recycling of construction and demolition waste is regulated by law and policy such that the recycling rates have far surpassed 90% (Mah, Fujiwara, & Ho, 2018). . Recycling of concrete and masonry waste is properly done in developed countries like

¹ MoEF & CC (2015) Draft Solid Waste Management Rules, 2015. New Delhi: Ministry of Environment, Forest and Climate Change, Government of India.

U.K., USA, France, Denmark, Germany and Japan. There is good amount of retrievable and reusable materials and products in the C&D waste. In India, items like bricks, tiles, wood and metals are recycled whereas concrete and masonry waste, contributing to more than 50% of the C&D waste are not currently being recycled in India and finally get dumped in landfills.

Table 1: Construction and demolition waste materials and sources²

Waste Material	Demolition Source	Construction Source
Asphalt	Roads, bridges, parking lots, roofing materials, flooring materials	Same
Brick	Masonry building equipment white goods, appliances installed equipment	Same
Ceramics/clay	Plumbing fixtures, tile	Same
Concrete	Foundation, reinforced concrete frame, sidewalks, parking lots, driveways	Same
Contaminants	Lead-based paint, asbestos insulation, fibreglass, fuel tanks	Paints, finishes
Fibre –based	Ceiling systems materials, Insulation	Same
Glass	Windows, doors	N/A
Gypsum/Plaster	Wall board, interior partition	Same
Metals, ferrous	Structural steel, pipes roofing, flashing, iron, stainless steel	Same
Metals, nonferrous	Aluminium, copper, brass, lead	Same lead
Paper, cardboard	N/A	Corrugated cardboard, Packaging
Plastics	Vinyl siding, doors, windows, signage, plumbing	Same
Soil	Site clearance	Same, packaging
Wood treated	Plywood: pressure- or creosote treated, Laminate	Same
Wood untreated	Framing, scraps, stumps, tops, Limbs	Same

Indian Scenario

Construction industry is one of the largest industries in India. India is one among the fastest developing countries and with newer technologies and equipments, rapid urbanization is taking place. Construction industry is considerably contributing to the Gross Domestic Product. Also, due to increasing population of this country, more and more buildings and infrastructure are needed. Lot of new civil structures are being constructed. Demolition of old or small buildings to replace with newer and bigger ones is also taking place. These activities are contributing towards generation of huge amount of C&D waste. A study conducted by Centre for Science and Environment of India states that a new construction generates 40-60 kg of C&D waste per square meter and the waste produced by demolition is 10 times than that of generated during construction. The C&D Waste Management Rules, 2016, announced by the Ministry of Environment, Forest and Climate Change (MoEF & CC) on 29th March 2016 is a step in managing the C&D waste generated in the country in a better and efficient way. C&D waste recycling plants like in Delhi and Ahmedabad are helping in recycling and then reusing the materials. This effort is surely reducing the

² Kumbhar, S., Gupta, A., & Desai, D. (2013). Recycling and reuse of construction and demolition waste for sustainable development. *OIDA International Journal of Sustainable Development*, 6(7), 83-92.

amount of C&D waste that gets dumped in landfills. Table No.2 shows the amount of certain constituents of C&D waste generated in India in million tons per annum.

Table 2: Tons of C&D Waste Generated in India

Constituents	Generated in Million Tons p.a. (Range)
Soil, Sand & gravel	4.20 to 5.14
Bricks & Masonry	3.60 to 4.40
Concrete	2.40 to 3.67
Metals	0.60 to 0.73
Bitumen	0.25 to 0.30
Wood	0.25 to 0.30
Others	0.10 to 0.15

Source-TIFAC, 2000

In India, C&D waste has been grouped in two types of components which are major components and minor components.³

Major components

- Cement concrete
- Bricks
- Cement plaster
- Steel (from RCC, door/window frames, roofing support, railings of staircase etc.)
- Rubble
- Stone (marble, granite, sand stone)
- Timber/wood (especially demolition of old buildings)

Minor components

- Conduits (iron, plastic)
- Pipes (GI, iron, plastic)
- Electrical fixtures (copper/ aluminium wiring, wooden baton, switches, wire insulation)
- Panels (wooden, laminated)
- Others (glazed tiles, glass panes)

In India, around 50% of C&D waste is reutilized and recycled while the remaining is generally sent to landfills. C&D waste is generally combined with municipal solid waste (MSW). Proper segregation of materials and products are not done in India for most of the times. The conventional constitution of C&D waste in India according to three different surveys conducted by TIFAC, MCD and IL&FS is presented in Table No. 3 as reported by Gayakwad & Sasane in the year 2015.

Table 3: Composition of Construction and Demolition Waste in India.⁴

MATERIALS	TIFAC, 2001	MCD Survey, 2004	IL&FS Survey, 2005
	Composition in (%)		
1. Soil, Sand & Gravel	36	43	31.5
2. Brick & Masonry	31	15	59
3. Concrete	23	35	-
4. Metals	5	-	0.4
5. Bitumen	2	-	-
6. Wood	2	2	1.5
7. Others	1	1	7.6

³ TIFAC, Ed. (2000). "Utilization of Waste from Construction Industry." Department of Science & Technology, New Delhi

⁴ Gayakwad HP, Sasane NB (2015) Construction and Demolition Waste Management in India. International Research Journal of Engineering and Technology (IRJET) 2(3): 712-715.

With the increasing population, construction of new buildings and infrastructure are done hastily. In search of livelihood people are migrating from countryside to the cities. People are also moving to cities in hope of better quality of life. These activities are putting burden on cities and hence, resulting to more and more construction of civil structures. As, construction and demolition process is increasing tremendously in Indian cities, generation of C&D waste is also incrementally increasing. Table No. 4 shows the amount of waste generated in selected Indian cities.

Table 4: C&D waste generation in some cities of India.⁵

City	Population (Census 2011)	C&D Waste Generation (Million Tones/Annum)	C&D Waste Generation (Tones Per Day)
Mumbai	12,442,373	0.750	2,500
Delhi	16,787,941	1.380	4,600
Bengaluru	8,443,675	0.263	875
Chennai	6,500,000	0.750	2,500
Kolkata	4,496,694	0.480	1,600
Jaipur	3,471,847	0.060	200
Patna	2,514,590	0.075	250
Ahmedabad	6,063,047	0.210	700
Bhopal	1,917,051	0.015	50
Coimbatore	2,618,940	0.028	92

Impacts of construction and demolition waste on the environment

C&D waste is getting generated incrementally. With increasing population, rapid urbanisation and modernization, construction industry is growing at a phenomenal rate. Deconstruction and demolition work has also escalated in order to renovate old building or building new civil structures at the sites of pre-existing ones. This increases the demand of landfills as existing landfills are already drowning in C&D waste.

Although the C&D waste contains inert materials but some harmful materials could also be present which can be detrimental to its immediate surroundings. The disposal of C&D waste in landfills could also contaminate groundwater and surface water. This contaminated water can reach to households and affect people's health. Contaminated surface water may get its way to water bodies like ponds and rivers affecting aquatic life as well as animals consuming water directly from the ponds and rivers. C&D waste that is dumped in water bodies leads to various detrimental impacts on the environment. It affects aquatic flora and fauna by interfering with their natural habitat. Dumping of C&D waste in water bodies also results in increasing level of water which could lead to floods in the nearby areas. C&D waste also leads to air pollution as it may carry dust, particulate matter like PM10, asbestos and other pollutants that may get mixed with air.

C&D waste treatment plants also generates pollutants like CO, CO₂, SO₂, oxides of nitrogen (NO_x), volatile organic compounds, particulate matter and dust contributing to air pollution. Soil at and around the construction and demolition site as well as the site where C&D waste is either stored temporarily or dumped permanently, gets polluted. The runoff water from these areas may carry the pollutants to a distant place contaminating that area too. Some vegetation may accumulate those contaminants. These vegetations could get into the food chain and affect animals and human beings. Construction and demolition sites generate huge noise and hence lead to noise pollution. The chief causes of noise generation are the concrete mixers, earthmoving machinery, pile drivers, pneumatic devices, and various other operating various machinery at the site of construction and demolition. Noise is also produced at the site of C & D waste recycling and disposal. Noise pollution leads stress, irritability, sleep disturbances, high blood pressure, irregular heartbeats heart diseases and noise induced hearing loss. Noise pollution becomes more problematic when the construction and demolition sites are near schools, colleges, old age home and hospitals. Noises emerging from construction and demolition sites also adversely affect the animals, birds and pet animals of nearby areas.

⁵ GIZ and DA. (2015). Resource Efficiency in the Indian Construction Sector: Market Evaluation of the Use of Secondary Raw Materials from Construction and Demolition Waste. New Delhi, GIZ.

Construction and Demolition Waste Management.

The impacts of C&D waste on the environment have become a serious and pressing issue. It has hazardous impacts on environment, ecological resources, animals and human beings. Construction and demolition waste management is critical for sustainable development. Comprehensive waste management strategies should be practiced. Environment-friendly technologies are needed for C & D waste management. Focus should be on generation of less waste as far as possible. Recovery of reusable items can be achieved by sorting and segregation of C&D waste. Recyclable materials can be saved from getting dumped. The management of C&D waste can be done by applying the concept of 3R's - reduce, reuse and recycle followed by incineration, if it could be applicable, and then disposal to landfills. Table No. 5 shows the components of C&D waste and whether these are recyclable, reusable, biodegradable, incinerable and appropriate to be dumped in landfills.

Reduce

One of the effective methods is to generate less amount of C & D waste. This could be done by proper use of resources, use of salvaged materials, avoiding over-ordering of virgin materials. Storage of the materials should be done properly. Storage area should be safe, secure and moisture free. Proper and Efficient designing should be done before starting a construction process. Use of standard size and quantities of materials should be considered in order to generate less waste. At the site of demolition, care should be taken in order to recover more usable items and hence, reducing waste generation.



Table 5: C&D waste type and it's Properties⁶

C&D waste	Recycle/reuse potential	Biodegradable potential	Potential landfilling	for	Potential for incineration
Concrete	Recycled aggregate for road base, and for concrete	No	Yes		No
Steel	Recyclable to steel	No	No		No
Brick and block	Backfill, recycled aggregate	No	Yes		No
Insulation	Insulate attic or as sound proofing on interior walls	No	No		Yes
Glass	Finer glass as pozzolans in cement	No	Yes		No
Ceramic	Possibly recyclable as filling material as a coarse aggregate for concrete	No	Yes		No
Aluminium	Recyclable to aluminium	No	No		No
Plastic	Recyclable to any form	Some can be biodegradable	No		Yes
Paint	Reusable as paint/concrete admixture	Some can be biodegradable	No		Yes
Wood	Recyclable to veneer board/paper pulp	Yes	Yes		Yes
Gypsum board	Recyclable to new board, crushed wall as clay and silt mixture and can be composed	Yes	No		No
Card board	Composting, fire kindling, paper production	Yes	Yes		Yes
Asbestos	No	No	If properly sealed		No

⁶ Yeheyis, M., Hewage, K., Alam, M. S., Eskicioglu, C., & Sadiq, R. (2012). An overview of construction and demolition waste management in Canada: A. *Clean Technologies and Environmental Policy* .

Reuse

A good strategy to manage C & D waste is to reuse some perfectly good materials rather than discarding them. Extra or left over materials should be safely stored for the future use. Intact materials from deconstruction or demolition site can be used again in new construction projects. Salvaged materials can be used in current or future projects. Reuse of materials helps in reducing waste and also is economical.

Recycle

Recycling is the process of separating, collecting, processing, marketing and ultimately using a material that would otherwise have been thrown away (USEPA, 1995). Recycling is an effort to prevent useable and valuable materials from being dumped into the landfill. Recycling aims to bring back the inert, nonhazardous and recyclable wastes back into new construction materials. Successful recycling needs the waste to be segregated properly according to their types, then storage should be done in different containers for different types waste materials. Recycling helps in the conservation of resources for future. Some common recyclable materials in the C & D waste are metals, plastics, wood, glass, cardboards, plasterboards, bricks, tiles, concrete, stones etc.

Incineration

Incineration is a process of waste management or waste treatment which involves the combustion of organic substances present in waste materials. This converts waste materials into ash, gas and heat. Incineration results in the emissions of carbon monoxide, carbon dioxide, hydrogen fluoride, sulphur dioxide, oxides of nitrogen (NO_x) and various other harmful gases. So, incineration is not very common and preferred way to deal with the C & D waste, it can only be permissible for the disposal of many hazardous wastes such as highly flammable compounds, volatile substances, toxic chemicals etc.

Landfilling

Landfilling is the final step in C & D waste disposal. All the construction and demolition debris are dumped in landfills. Landfills are made for the purpose of disposal of those C&D waste materials which can no longer be used or recycled but in India many of the items that are reusable or recyclable, end up in the landfills. Landfilling has serious impacts on environment. Due to escalation in construction industry, more and more waste is getting generated. This increases the demand of landfills.

CONCLUSION

India is one of the fastest developing countries. Construction industry in India is growing extensively owing to the urbanization, industrialization, modernization and various other development projects. Construction and demolition activities are also being done in order to meet the needs of the growing population. These activities are generating huge amount of C&D waste which has detrimental effects on the environment, ecological resources and various life forms including human beings. C&D waste are giving rise to air pollution, water pollution, soil pollution and noise pollution. These have deleterious impacts on human beings and other life forms as well. Proper management of C&D waste can reduce its negative impacts on the environment. Many items like wood, metals, bricks, tiles, concrete, masonry etc. can be recycled from the C&D waste. Many developed countries are recycling and reusing good amount of C&D waste but in India, steps are required be taken to encourage these activities. Only a few C&D waste recycling plants are there in India and not all are functional. The 3R's-reduce, reuse and recycle should be comprehensively applied in order to reduce the amount of C&D waste. A few materials can be subjected to incineration but great amount of gaseous pollutants are generated so, it not very acceptable method. Finally, the C&D waste are dumped in landfills.

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