Construction Materials and C&D Waste in India

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Abstract
Construction and demolition (C&D) waste generation and handling issues have been in focus to achieve sustainable goals. Owing to growth in construction in India, it is appropriate to link generation of C&D waste with the growth. If measures to minimize and handle the C&D waste are not developed and efficiently adopted it may threat the environment as well as sustainable movement of Indian construction industry. C&D waste in India in 2010 may be estimated as 24 million tonnes. This paper provides an overview of the construction industry in India and gives some statistics about the volume of C&D waste.

Keywords:
Construction and Demolition Waste, Recycling, Sustainable Construction, Demolition

1 INTRODUCTION

U.S. Environmental Protection Agency (EPA) defines construction and demolition (C&D) waste as 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 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 such as change-orders or demolition requirements for redevelopment.

Globally, building waste production of 2 to 3 billion tonnes per year is estimated, of which 30-40 % is concrete [1]. C&D waste issues are more important for the developing countries, which are entering or already entered in construction boom era. According to the annual report of Dubai municipality's Waste Management Department, a total of 27.7 million tonnes of construction waste were removed from various construction sites in the city in 2007, recording growth of 163 % in comparison to the waste generated in 2006, just 10.5 million tonnes [2]. In their study, Vilas and Guilberto [1] found that many countries in Asia do not have specific regulations designed for C&D wastes, although some countries include some sections in their solid waste management regulations and/or related policies. According to the study, developed countries generate 500 to 1000 kg per capita per year building & construction waste and waste in European Countries is estimated to be 175 million tonnes/year. It was also mentioned that very small percentage 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 handling to develop accurate data and establish sustainable methods to manage construction waste.

2 INDIAN CONSTRUCTION INDUSTRY

According to 11th five year plan [3], in terms of magnitude construction industry is second only to agriculture. 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. With around 27,770 enterprises involved directly in the activity of construction in 2005, the industry is one of the largest employers in the country and is characterized by a mix of both organized and unorganized entities. The employment figures have shown a steady rise from 14.6 million in 1995 to more than double in 2005 that is 31.46 million personnel comprising engineers, technicians, foremen, clerical staff, and skilled and unskilled workers. With several ambitious projects anticipated during the 11th Plan, the demand for construction manpower is going to grow at a consistent pace of at least 8%–9%, thereby resulting in an annual accretion of around 2.5 million persons to the existing stock [3].

The construction industry sets in motion the process of economical growth in the country. Over US$ 100 billion has been invested in this sector during 2004-2005, with the private sector contributing to 32.7 per cent of this investment. This sector is likely to continue to record higher growth in the coming years due to the Government of India's (GOI) recent initiative to allow 100 per cent foreign direct investment in real estate development projects [4]. As shown in Figure 1, construction share in total GDP has grown from 6.4% in 2000-01 to 7.2% in 2004-05 [5]. Technology Information, Forecasting and Assessment Council (TIFAC) study mentions that total construction work for five years during 2006-2011 is equivalent to $847 billion [5].

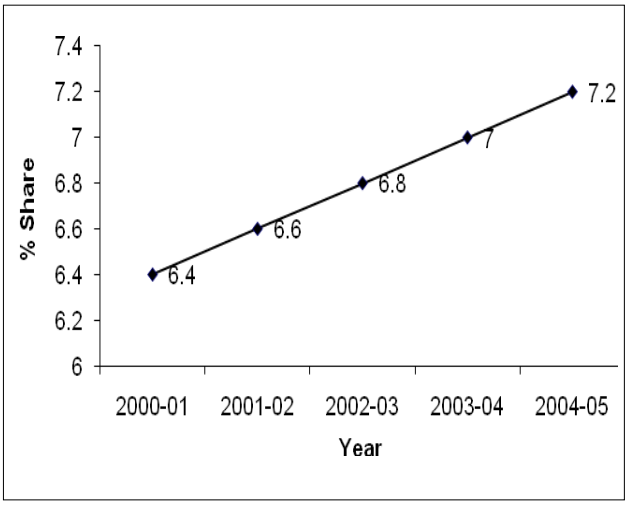

Figure 1: Percentage share of construction in total GDP.

Table 1 shows investment (in US billion Dollars) in the construction industry from 1998 to 2002, presented by Laskar and Murty [6].

Year	1998	1999	2000	2001	2002
Residential Construction					
	2.14	2.26	3.57	4.16	4.28
Non Residential Construction					
	3.80	3.92	3.57	4.04	4.40
Civil Eng. Construction					
	44	47.86	55.47	63.21	72.2
Total					
	49.94	54.04	62.61	71.41	80.9

Table 1: Investment in the construction industry, amount in USD billion.

Based on the above data, values for year 2008 to 2011 were estimated assuming the same rate of growth. Table 2 presents the estimated values, which were read from the graph shown in Figure 2.

Year	2008	2009	2010	2011
Residential Construction				
	8.00	8.62	9.24	9.86
Non Residential Construction				
	5.19	5.33	5.45	5.58
Civil Eng. Construction				
	115.24	122.38	129.52	136.55
Total				
	128.43	136.33	144.21	151.99

Table 2: Estimated investment in Indian construction industry, amount *in USD* billion.

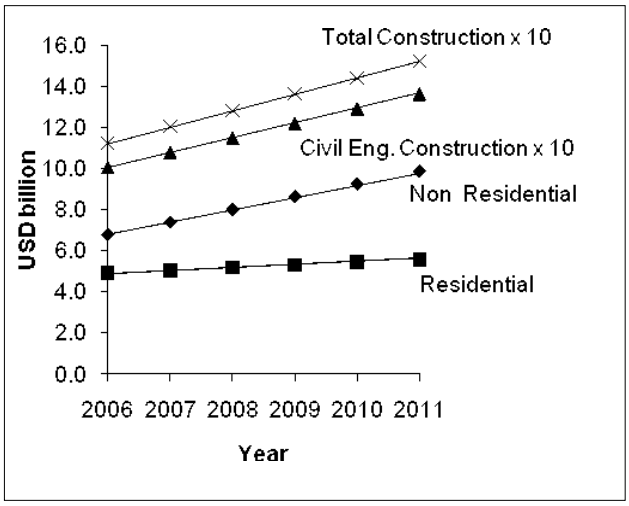

Figure 2: Estimated investment in Indian construction industry.

Table 3 shows the distribution of cost among various modes of expense in Indian construction industry [7].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. This percentage is higher for projects such as building, railway, and transmission, and lower but still a critical part of other projects such as power and mineral plant. In addition, the Indian construction industry is the largest consumer of material resources of both natural such as stone, clay, lime and the processed and synthetic resources [4].

According to "India – A building Industry in Transition" [8] many positive and negative points are associated with Indian construction industry. Continuing strong economic growth, foreign investment, cheap & plentiful labor, strong engineering education systems are some of the positive points. On the other hand, inflationary pressures, relatively low skilled and uneducated labors, government bureaucracy, and lack of infrastructure are some of the negative points that make the construction activity more challenging. It also suggests that there is an urgent requirement for a government sponsored 40–50 year holistic infrastructure plan for India to continue on its high growth path towards economic maturity.

	Materials %	Construction equipment %	Labor %	Finance %	Enabling Expenses %	Admin. Expenses %	Surplus %
Building	58-60	4-5	11-13	7-8	5.5-6.5	3.5-4.5	5-6
Roads	42-45	21-23	10-12	7-8	5.5-6.5	3.5-4.5	5-6
Bridges	46-48	16-18	11-13	7-8	5.5-6.5	3.5-4.5	5-6
Dams, etc	42-46	21-23	10-12	7-8	5.5-6.5	3.5-4.5	5-6
Power	41-43	21-24	10-12	7-8	5.5-6.5	3.5-4.5	5-6
Railway	51-53	6-8	16-18	7-8	5.5-6.5	3.5-4.5	5-6
Mineral plant	41-44	20-22	12-14	7-8	5.5-6.5	3.5-4.5	5-6
Transmission	49-51	5-7	19-21	7-8	5.5-6.5	3.5-4.5	5-6

Table 3: Percentage cost distribution in construction industry.

According to Eleventh Five Year Plan [3], the major challenge that the construction industry faces is to raise its delivery capabilities commensurate with the targets for sectors such as transportation, housing, and urban development. The planned development of infrastructure would face constraints, unless the construction industry improves the delivery potentials by addressing crucial issues and impediments by bringing in systemic changes. The major issues in the construction industry include productivity, construction cost, contract procedures, dispute resolution, safety issues, construction finance, and environmental issues. This plan also suggests that, aspects related to enhanced quality in construction products should be accorded attention at all levels. To achieve this, the Performance Appraisal Certificate Scheme is being implemented for the development and promotion of materials, products, and systems under the joint initiatives of Building Materials and Technology Promotion Council (BMTPC), Construction Industry Development Council (CIDC), Bureau of Indian Standards (BIS) and other agencies. BIS and Indian Bureau of Mines are the main authorities for issuing and maintaining the codes/standards pertaining to safety and other practices in the Indian construction industry.

GOI permits foreign investment up to 100 per cent for development of integrated townships, including housing, commercial premises, hotels, resorts, city and regional level urban infrastructure facilities such as roads and bridges, mass rapid transit systems and manufacture of building materials. The GOI permits imports of building materials and products under open general license system. Under the Government of India's new Export-Import Policy, the duty on building products is pegged at 15 percent. The GOI has announced its intention to reduce progressively the import duty rates [4].

Eleventh Five Year Plan suggests that following measures should be adopted by the construction industry to achieve the desired growth in construction sector and to align it with global trends in terms of growth, quality, and competitiveness [3]:

- Improve productivity through introduction of efficient technologies and modern management techniques.
- Reduce transactional costs by reviewing contract procedures and dispute resolution mechanisms.
- Enhance quality standards and provision of adequate institutional finance to the construction sector.
- Develop a National Plan for human resource development through training and certification of construction personnel.
- Accord greater importance to safety in construction activities by establishing trained and certified Safety Management Teams.

3 ENVIRONMENTAL REGULATIONS RELATED TO INDIAN CONSTRUCTION INDUSTRY

According to Eleventh Five Year Plan[3], sustainable development concepts applied to the design, construction, and operation of construction projects can enhance both the economic well being and the environmental health of communities. Ministry of Environment and Forest (MOEF) recognizes Environmental Impact Assessment an important tool for integrating these objectives and it should be a necessary pre-condition before construction projects beyond stipulated size are approved. Further, initiatives for ensuring adherence to international standards and regulations, such as the Environment Protection Act 2006 and the Energy Conservation Act 2001 are also required. Various interdisciplinary organizations such as CIDC and BMTPC have been set up to address the issues of environment-friendly technologies and energy efficiency in building materials. Central and State Pollution Control Board (CPCB) approves, monitors, and regulates projects from all sectors including construction, keeping in view their impact on environment. According to Municipal Solid Wastes (Management and Handling) Rules of 2000, C&D wastes or debris shall be separately collected and disposed of [9].

4 CONSTRUCTION & DEMOLITION WASTE IN INDIA

4.1 Components

In India C&D waste has two components [5]:

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/ aluminum wiring, wooden baton, switches, wire insulation)
- Panels (wooden, laminated)
- Others (glazed tiles, glass panes)

Figure 3 and Table 4 show the percentage distribution and tonnage of various constituents of C&D waste in India in 2000, respectively [5].

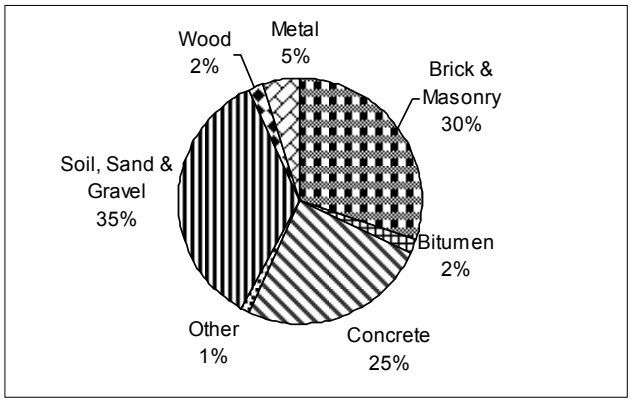

Figure 3: Different constituents of C&D waste.

Constituent	million tonnes/yr
Soil, Sand and gravel	4.20 to 5.14
Bricks and 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

Table 4: Quantity of various constituents generated per year.

4.2 C&D waste handling

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 [5]. According to TIFAC study,

- Items recovered during demolition are sold in the market at a discount with respect to price of new material.
- Items, that cannot be re-used, are disposed to landfill site.
- Some municipal corporations allow C&D waste in their landfills, while others want to minimize it to prolong useful life of landfill sites.
- Different constituents of waste are not segregated prior to disposal.
- Builders/ owners bear the cost of transportation, which at present, ranges between US$ 6 to 13 per truckload depending on the distance of demolition site from landfill area.
- Municipal authorities incur cost of US$ 1.50 to 2 per tonnes of waste, but presently no charge is levied by them on the owner or builder
- Though directives exist for disposal of waste to landfill areas, presently penal action against violators is practically not taken.

4.3 C&D waste estimation

Various studies have been done to estimate the quantity of C&D waste in India. Pappu, Saxena et al [10] presented 14.5 million tonnes/year C&D waste in India. CPCB estimated quantum of solid waste generation in India to be to the tune of 48 million tonnes per annum for year 2000, out of which waste from construction industry accounted for about 12 to 14.7 million tonnes [5]. As shown in Figure 4, Singhal and Pandey [11] presented the growth in municipal solid waste in India. This graph can be used for rough estimation of C&D waste based on assumption that C&D waste is estimated to be 25-30% of municipal solid waste [5].

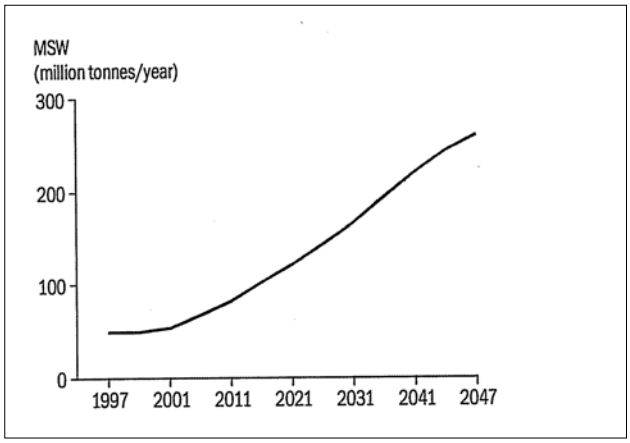

Figure 4: Municipal solid waste generation in India.

Therefore, from Figure 4 total C&D waste generated in year 2000 was approximately 13-15 million tonnes. Comprehensive study for C&D waste estimation was done by TIFAC [5]. This study presented following data related to C&D waste in India for the year 2000:

- C&D waste was estimated as 14.69 million tonnes.
- Waste generation during construction and renovation/ repair work was 40 to 60 and 40 to 50 kg/m^2 respectively.
- The highest contribution to waste generation was from demolition of buildings, which yielded on average 425 kg/m^2 of waste.

Table 5 represents the comparative study of C&D waste for India & USA for the year 2000. The data for USA were collected from CIB TG 39 reports [12].

	Description	India	USA
1.	Year	2000	2000
2.	C&D waste generation		
	a) New Construction	50 kg/m^2	41 kg/m^2
	b) Renovation /Repair	45 kg/m^2	118 kg/m^2
	c) Demolition	425 kg/m^2	515 kg/m^2

Table 5: C&D waste data for India and USA.

Figure 4, C&D-municipal solid waste ratio assumption, and TIFAC study could be used to estimate C&D waste for future years. For example, C&D waste in India for the year 2010 may be estimated as 22-26 million tonnes by using Figure 4. This range is in agreement with the 24 million tonnes C&D waste value for the year 2010, which is estimated by following the procedure used in TIFAC study [5].

5 SUMMARY

Owing to growth in construction, it is expected that C&D waste generation in India will increase. If measures to minimize and handle the C&D waste are not developed and efficiently adopted, it may threat environment as well as sustainable movement of the country. C&D waste minimization and handling are necessary 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 will cause an extra burden on solid waste management plans, which are already looking for new ways to fight with the growth in municipal solid waste due to increase in urban population and developments in the country. Government policies and laws should be reformed to motivate and make C&D waste management mandatory for all types of construction activities. It would be desirable to have more accurate and detailed data such as C&D waste generation and the way it is managed in India. 3Rs policy and use of waste minimizing technologies e.g. design for deconstruction and reuse of materials should be adopted to minimize C&D waste. Recycling of C&D waste by converting it to aggregate may offer dual benefit of saving landfill space and reduction in extraction of natural raw material for new construction activities, leading towards sustainable development.

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