

Recycled C&D waste- An energy efficient and sustainable construction material

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Abstract

Construction and demolition (C&D) wastes are generated with construction or demolition activities and consists of non biodegradable materials such as cement concrete, bricks, plaster, steel, rubble, woods, plastics etc. Large use of natural resources for the production of construction materials such as concrete is a prime concern for sustainability. In order to minimize the environmental impacts in terms of energy consumption, pollution, waste disposal and global warming construction industries has started to look for new alternative sources which are capable of substituting the use of natural materials, also some attempts were taken to utilize the waste generated from the demolition of structures and construction activity. The main benefits from the recycling of C&D waste are conservation of natural resources, reduction in energy consumption, solution for waste disposal crisis, environment preservation. Its use reduces reliance on primary aggregates and lowers the environmental impact of construction.

Keywords: Construction and demolition, Environment, Energy, Sustainability.

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1. Introduction

Due to rapid urbanization, the extraction and production of raw materials such as sand (for concrete and mortar), soil (for clay bricks), stone (for aggregates) and limestone (for cement) will have significant ecological impact. India's construction industry is expected to grow at a rate of 7-8% over the next decade (NitiAyog, 2018). The generation of enormous quantity of C&D waste is especially expected in older cities, due to demolition of existing old buildings. Management of such huge waste is a challenge for every country; however, some countries such as Hong Kong, Taiwan, United States of America, Belgium, Denmark, Germany, Netherlands, Germany, France, Japan have started to reuse their C&D waste up to some extent. Lack of demolition experience and knowledge of their use makes them waste material. In Indian scenario, out of these wastes some items such as metal rods, pipe and fixtures, wooden frames were sold leaving behind the rubble composed of bulky materials such as concrete, stones, bricks, mortars etc. Sometimes these rubbles were utilized for back-filling in construction projects but most portions is disposed either in

designated landfills or often in unauthorized places such as road sides, river beds, low lying areas that causes environmental and safety problems to inhabitants.

Use of recycled C&D wastes has reduced the environmental concerns by the aggregate consumption of construction industry. Many successful applications (Akbulut and Gurer, 2007; Arulrajah et al. 2013; Asprone et al. 2015; Bennert et al., 2000; Disfani et al., 2012; Rahmann et al., 2014) were reported around the world. Materials recovered from the C&D sector accounts significant percentage and in few cases (Sustainability Victoria, 2013) it reached to almost half of the recovered material out of which half alone was concrete, which is approximately 25% of total reprocessing. For the wide application of C&D waste a sound framework is needed to be established. Several researchers (Elhakam et al. 2012; Kou et al. 2008; Kwan et al., 2011; Zhuang et al., 2012) have attempted more detailed studies on C&D wastes.

2. Typical Composition of C & D Waste

Population growth, industrial development, construction growth creates huge amount of C&D waste. Among these, construction industry is a major consumer of natural resources and the global production of aggregates almost doubled in 7 seven years from 21 billion to 40 billion tons in 2014. Production of 40 billion tons of global aggregates shows the ongoing vast development projects all around the world.

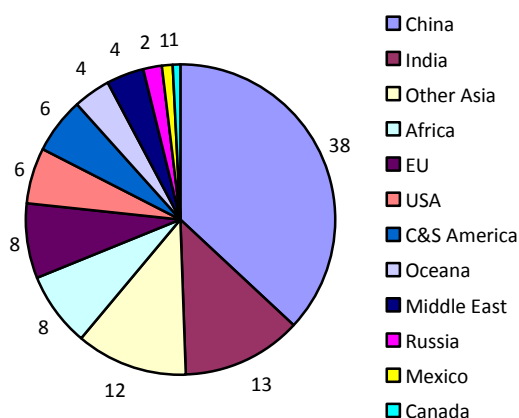


Fig. 1. Global aggregate production (Slattery, 2016).

Due to scarcity of natural material and land both, an alternative to use the enormous available C&D waste is gaining importance. However, research and development is highly required for its sustainable utilization as a construction material. Some developing nations such as Australia, Western Europe, America has shown considerable progress in adopting C&D waste management system, however major C&D waste producing countries such as China, India, Indonesia, Malaysia, Thailand, Gulf States, Brazil, Mexico are way behind to above developing nations in adopting the C&D waste management system. India also produces a significant amount of waste, which is not being utilized very well. Significant amount of waste could be used with the development of proper management system. Lack of technical expertise and awareness among the people leads this useful material to go in vain. Proper knowledge and management system could solve of scarcity of construction materials, which is totally dependent upon the natural materials in current scenario.

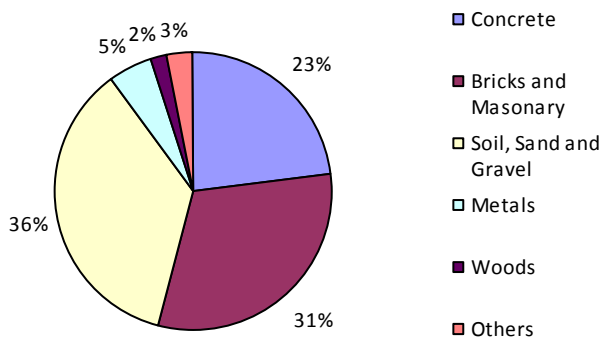


Fig. 2. C&D Waste in India (TIFAC, 2001)

The data in Table 1 shows the C&D waste generation in some selected cities of India, however the amount will be significantly high if taken collectively for the whole country. Our country has huge potential to utilize this waste. Regulations and legislation by the government authority in our country could be helpful in structuring and constituting a market for building material and products derived from the C&D waste.

Table 1. C & D waste generation in selected Indian cities (GIZ and DIA, 2015).

City	Population (Census 2011, in millions)	Daily C&D waste generation (tonnes/day)	Annual C&D waste generation (million tonnes/annum)
Mumbai	12.44	2500	0.75
Delhi	16.78	4600	1.38
Bengaluru	8.44	875	0.26
Chennai	6.50	2500	0.75
Kolkata	4.49	1600	0.48
Jaipur	3.47	200	0.06
Patna	2.51	250	0.08
Ahmedabad	6.06	700	0.21
Bhopal	1.91	50	0.02
Coimbatore	2.61	92	0.03

3. Recycling C & D Waste

Recycling C&D waste has huge potential to create a separate sustainable market for the construction industry. The life of a building could be categorized generally into three phases such as construction, renovation and demolition. Among all the phases demolition phase produces the maximum waste aggregates, which could be utilized for variety of application, if managed properly with utmost care. Recycled aggregates could be obtained from these wastes after allowing them to the crushing plants. Flow chart in Fig. 3 shows the steps involved in crushing plant to obtain reusable aggregates from the C&D wastes. Waste material is allowed for primary crushing initially, followed by primary, magnetic and secondary screening. After these screening, the residual were removed and secondary crushing is allowed.

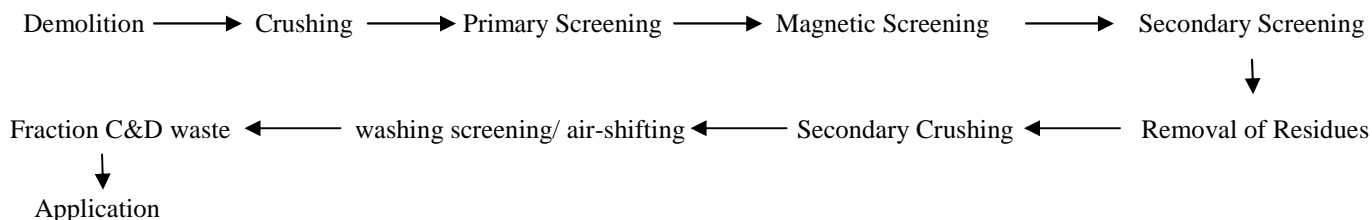


Fig. 3. Typical crushing plant process for recycled aggregate production (Ng and Engelsen, 2018).



Fig. 4. Typical C&D waste recycling site (<http://ogara.co.uk/recycled-soils-aggregates.php>).

The crushed material is allowed for washing screening, air shifting and the obtained fraction of C&D waste at this stage is utilized for various applications. Most of the processing plants were operating on the similar pattern with small modifications as per the requirement of the waste materials at the site. Initially the sorting of the waste materials were performed manually, the mechanical operation were performed only with recyclable materials. The non-recyclable materials obtained in C&D waste were not allowed in this process and disposed.

4. Benefits of Recycling C & D Waste

Recycling C&D waste could solve some of our potential problems which the world is facing nowadays. It is well known that production of construction materials effects adversely to the environment by generation toxic gases and harmful chemicals as by product. Also, their manufacturing utilizes good amount of money which again affects the economy. Recycling not only minimizes the production of the materials but also protect environment by reducing the CO₂ footprints. Less production leads to less harnessing of natural resources which helps in their conservation, also the proper utilization could be helpful in improving the health conditions of the locality. Since most of these waste materials are hazardous, they disposal in open space should be avoided. Reducing carbon footprints would be helpful in maintaining balance in the environment.

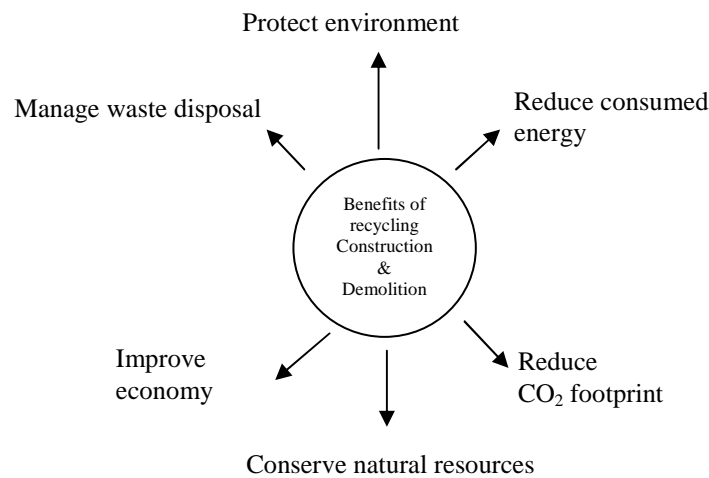


Fig. 5. Benefits from recycling C&D waste (Ng ad Engelsen, 2018).

Many developed countries in the Europe have good ratio in the production of total aggregates and production of recycled aggregates. The economic conditions of these nations are much better when compared with their counterparts. The utilization of recycled products should be implemented in the Asian countries as well. A huge C&D wastes are generated in this region, but proper management system is not adopted yet. A proper utilization could solve serious issues in this region.

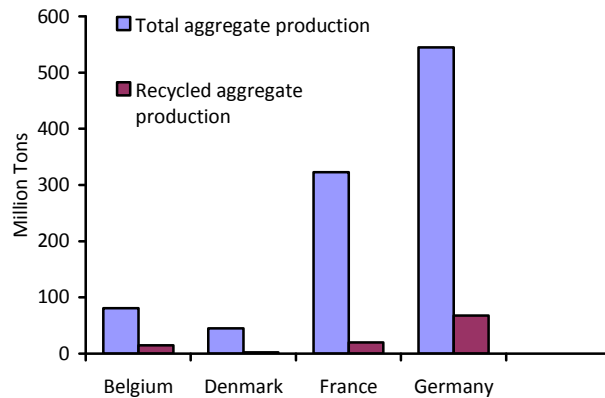


Fig. 6. Comparison of Total aggregates production and recycled aggregate production (UEPG, 2016).

5. Issues for Recycled Aggregate Usage

Various factors such as limiting standards and guidelines, low supply and demand, lack of recycling facility, perception of the customer etc. acts as a barrier for recycled aggregates to be used as an alternative to conventional construction materials.

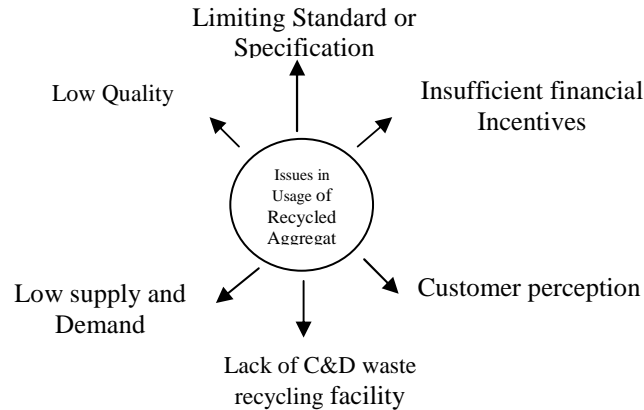


Fig. 7. Obstructions preventing the wider application of recycled aggregates in construction industry (Silva et al., 2017).

However, if proper care is taken by the policy makers in resolving these issues, the C&D wastes could be accepted for variety of applications. The quality of these recycled aggregates is still needed to be addressed.

6. Conclusion

Proper utilization of C&D wastes has potential to solve many serious issues which were faced all around the world. Rapid infrastructural demands have raised serious problem related to supply of the construction materials. Having limited natural resources, it is impossible to fulfill the demand of future constructions. Recycled aggregated could be a good alternative in such cases and solve serious problems of environmental impact due to production of new materials. More studies leading to specification and guidelines will be helpful for the common people to adopt these materials as sustainable construction materials.

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Biographical notes

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