RECYCLING AND REUSE OF CONSTRUCTION AND DEMOLITION WASTE FOR SUSTAINABLE DEVELOPMENT

Snehal Anilkumar Kumbhar [a], Anilkumar Gupta [b], Dadaso Balaku Desai [c]
[a, b, c] Civil Department, Dr. J. J. Magdum College of Engineering, Jaysingpur, Kolhapur, Maharashtra, India.
[a] Corresponding author: kumbharsnehala@gmail.com

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Abstract: As we are living in 21st century, new technologies are being invented in almost every sector to make human life fast and easier. Beside this we are still finding the solutions to problems related to our environment, energy and natural resources.

Construction industry produces large amount of waste throughout the year. Most of the time construction and demolition waste ends up in landfills disturbing environmental, economical and social life cycle. Construction and demolition waste is the waste materials that are produced in the process of construction, renovation or demolition of residential or non-residential structures. Components of construction and demolition waste typically include concrete, asphalt, wood, metals, gypsum wallboard, roofing, paper, plastic, drywall and glass.

Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs; and can be considered as one of the solution to solve construction and demolition waste problem. Sustainable development in construction will help a lot to reduce the problems related to environment and natural resources as construction industry is a major user of world's resources. Sustainable design, proper use and reuse of the resources/construction materials will make construction industry more economical and green.

Concrete is the second most consumed material after water, so recycling of concrete can save construction costs also it will help to keep environment healthy. Concrete collected from sites is put through crushing machine, usually uncontaminated concrete i.e. free from wood, plastic, paper and other unwanted materials. Metals such as rebar are removed with the help of magnets and other sorting devices.

In many countries like Japan, United States, United Kingdom various recycling techniques are being used and returning good results. Process of recycling construction and demolition waste includes storage, sorting, collection, transportation, recycling and disposing. Recycling methods used in japan are heating and rubbing methods, eccentric-shaft rotor method and Mechanical grinding method.

Recycling of Construction and demolition waste has many benefits such as reduction in transportation cost, it keeps environment clean and reduces natural resource exploitation. To promote recycling and reuse of waste, awareness about its effects and benefits should be communicated with people, contractors, engineers and architects. More numbers of recycling plants should be installed and allowing the use of recycled aggregate instead of natural aggregate for some purpose.

In this paper I am going to focus on different recycling techniques and reuse of construction and demolition waste.

Keywords: Construction & Demolition waste; Recycling; Reuse; Recycling techniques; Sustainable development.

INTRODUCTION

The promotion of environmental management and the mission of sustainable development have exerted the pressure demanding for the adoption of proper methods to protect the environment across all industries including construction.

Construction by nature is not an eco-friendly activity. Construction, renovation and demolition activities lead to the formation of waste. Construction and demolition waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, flyover, subway, remodeling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. A part of this waste comes to the municipal stream. These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or communal waste

bin/container. It is not uncommon to see huge piles of such waste, which is heavy as well, stacked on roads especially in large projects, resulting in traffic congestion and disruption.

Waste from small generators like individual house construction or demolition, find its way into the nearby municipal bin/vat/waste storage depots, making the municipal waste heavy and degrading its quality for further treatment like composting or energy recovery. Often it finds its way into surface drains, choking them. It constitutes about 10-20 % of the municipal solid waste (excluding large construction projects).

Preservation of the environment and conservation of the rapidly diminishing natural resources should be the essence of sustainable development. So recycling of Construction Waste is the need of the day.

CONSTRUCTION AND DEMOLITION WASTE MATERIAL CATEGORIES AND SOURCES (REF TABLE 1)

Effects of construction and demolition waste

Environment effects

(a) The disposal of C&D waste in landfills has led to contamination of groundwater & Surface water. (b) Damage of ecological resources. (c) As in the production of cement emission of CO2 is more it leads to air pollution and many other problems.

Economic effects

(a) As there is loss of primary resources it will affect the economic. (b) It will affect the nations GDP. (c) It takes more consumption of fuel, so transportation cost also increases. (d) It also affects on tourism and international reputation.

Social effects

Due to contamination of water it affects on the health of people.

Why to recycle Construction and Demolition waste

Recycling Construction and Demolition debris is one of the most important aspects of this movement. Construction and demolition recycling is among the most visible commitments a developer can make to sustainable building, visible to every worker on the site and to every passerby.

Reduce costs

Recycling, reusing salvaged building materials and minimizing materials and packaging reduces waste disposal costs and material expenses.

Marketing opportunity

Company's experience in waste prevention and recycling can be an essential marketing tool to the growing number of potential clients interested in participating in the LEED™ and BUILT GREEN™ green building programs.

Employment

Ecocycle.org estimates that for each job in a landfill, 10 other people are employed elsewhere in processing recycled products and another 25 are employed in manufacturing products from recycled materials.

Reduce the environmental impact

Preventing and recycling wastes: (a) Reduces depletion of natural resources such as trees, oil and minerals. (b) Creates less pollution by reducing manufacturing and transportation-related emissions. (c) Uses less energy and water compared to many virgin material product manufacturing processes. (d) Reduces greenhouse gasses by using less energy for manufacturing and transportation.

Recycling of Construction and Demolition waste

Construction and Demolition waste management may be defined as the discipline associated with the proper storage, collection and transportation, recovery and recycling, processing, reusing and disposal of C and D wastes in a manner that is in accord with the best principles of human health, economic, engineering, aesthetics and other environmental considerations. The management approaches are different from one country to another, as are the levels of environmental protection. Most of the Construction and Demolition waste management systems reviewed on the following basis: Construction and Demolition waste management includes following steps. (a) Storage and segregation. (b) Collection and transportation. (c) Recycling and reuse. (d) Disposal.

Storage and segregation

Construction and Demolition wastes are best stored at source i.e. at the point of generation. If they are scattered around or thrown on the road, they not only cause obstruction to traffic but also add to the workload of the local body. A proper screen should be provided so that the waste does not get scattered and does not become an eyesore.

Table 1: Construction and demolition waste material categories and sources

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, fiberglass, fuel tanks	Paints, finishes
Fiber -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	Aluminum, 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

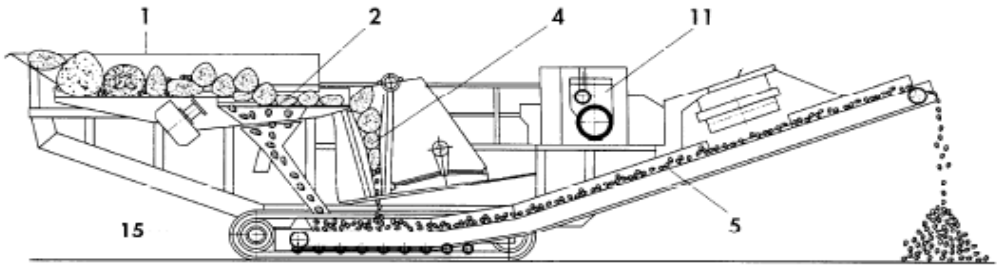

Figure 1: Main components of a mobile crusher

1-Feeding hopper
2-Oscillating conveyor
4-Jaw crusher
5-Discharging transport belt
11-Diesel engine as power unit
15-Mobile by wheels, crawlers or skids

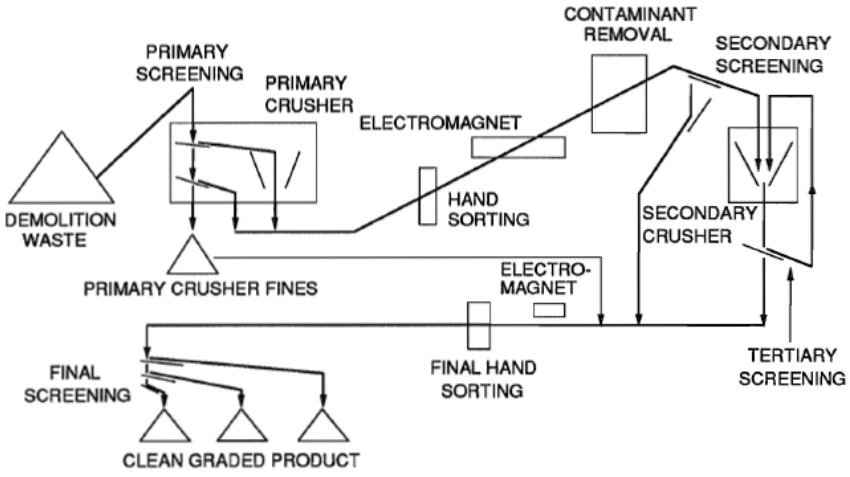

Figure 2: Layout of stationary recycling plant.

Segregation can be carried out at source during Construction and Demolition activities or can be achieved by processing the mixed material to remove the foreign materials. Segregation at source is most efficient in terms of energy utilization, economics and time. Gross segregation of C and D wastes into road work materials, structural building materials, salvaged building parts and site clearance waste is necessary. Additional segregation is required to facilitate

Reuse/recycling of materials like wood, glass, cabling, plastic, plaster board and so on before demolition in order to produce recycled aggregate that will meet the specification.

Collection and transportation

If the Construction and Demolition debris is stored in skips, then skip lifters fitted with hydraulic hoist system should be used for efficient and prompt removal. In case, trailers are used, then tractors may remove these. For handling very large volumes, front-end loaders in combination with sturdy tipper trucks may be used so that the time taken for loading and unloading is kept to the minimum.

Recycling and reuse

Construction and Demolition waste is bulky and heavy and is mostly unsuitable for the disposal by incineration/ composting. The growing population and requirement of land for other uses has reduced the availability of land for waste disposal. Reutilization or recycling is an important strategy for management of such waste. Apart from mounting problems of waste management, other reasons which support adoption of reuse/recycling strategy are reduced extraction of raw materials, reduced transportation cost, improved profits and reduced environmental impact. Above all, the fast depleting reserves of conventional natural aggregate has necessitated the use of recycling/ reuse technology, in order to be able to conserve the conventional natural aggregate for other important works. In the present context of increasing waste production and growing public awareness of environmental problems, recycled materials from demolished concrete or masonry can be profitably used in different ways within the building industry. The study survey indicates the major components of the Construction and Demolition waste stream are excavation material, concrete, bricks and tiles, wood and metal.

Disposal

Being predominantly inert in nature, Construction and Demolition waste does not create chemical or Bio-chemical pollution. Hence maximum effort should make to reuse and recycle them as explained above. The material can be used for filling/leveling of low-lying areas. In the industrialized countries, special landfills are sometimes created for inert waste, which are normally located in abandoned mines and quarries.

Recycling Process of Construction and Demolition Waste

A recycling plant is quite similar to a plant producing crushed natural aggregate. Basic method of recycling of concrete and masonry waste is to crush the debris to produce a granular product of given particle size. Plants for processing of demolition waste are differentiated based on mobility, type of crusher and process of separation. There are two types of recycling plants viz. Mobile, and Stationary plant.

Mobile plant

A mobile plant consists of one crusher and some sorting devices. The removal of contaminants and steel is mainly conducted by hand sorting and self-cleaning electromagnets. In some cases mobile plants can consist of two crushers.

In the mobile plant, the material is crushed and screened and ferrous impurities are separated through magnetic separation. The plant is transported to the demolition site itself.

Advantages of Mobile Plant

(a) Suitable for demolition sites with a large amount of CDW, i.e. re-build of expressways, large industrial complexes. (b) Economic feasible from an amount of 5000 to 6000 t per site. (c) Transport in the vicinity of the site is reduced particularly if the rubble is produced, recycled and reused on the same site. (d) Disposal costs are reduced because of less dumping. (e) The local supply of aggregates is increased and therefore less aggregate needs to be imported into the area. (f) The recycling plant can be moved relatively easily to another site.

Disadvantages of Mobile Plant

(a) There are limited cleaning facilities in this type of installation and therefore the recycled product is normally of low quality. (b) The recycling plant can cause high levels of dust and noise which would be unacceptable close to residential area. (c) This type of plant can only be used if there is sufficient quantity of rubble on the site to justify the expense of setting up the recycling plant.

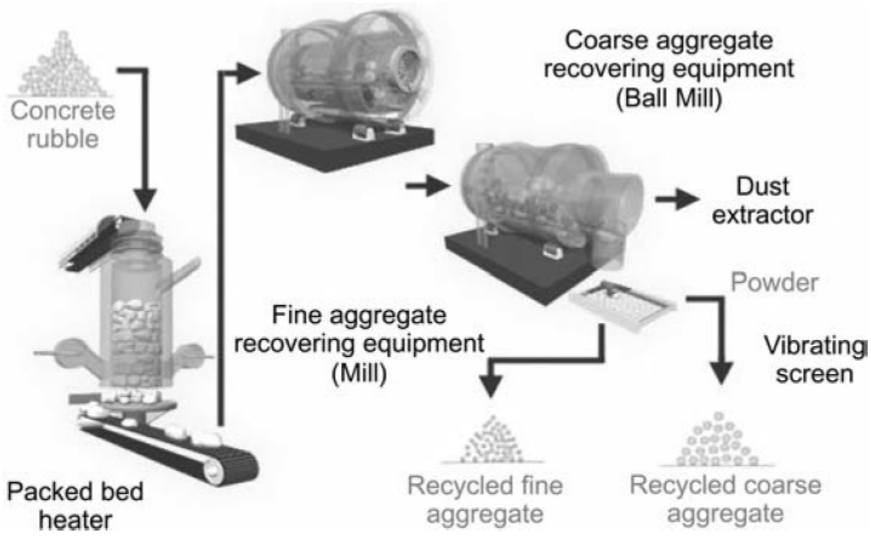

Figure 3: Heating and rubbing method

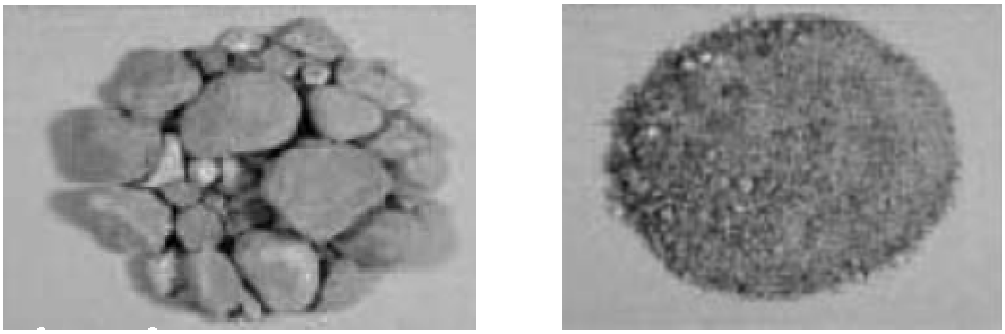

Figure 4: Recycled aggregates by heating and rubbing method

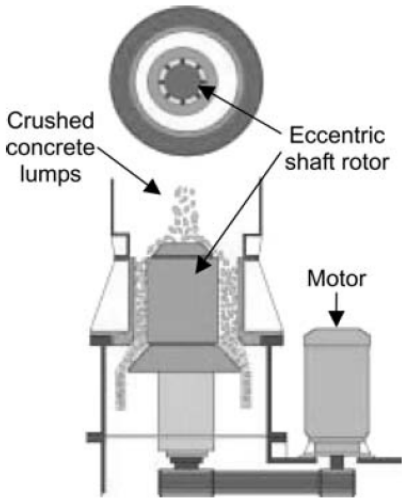

Figure 5: Eccentric shafts rotor method

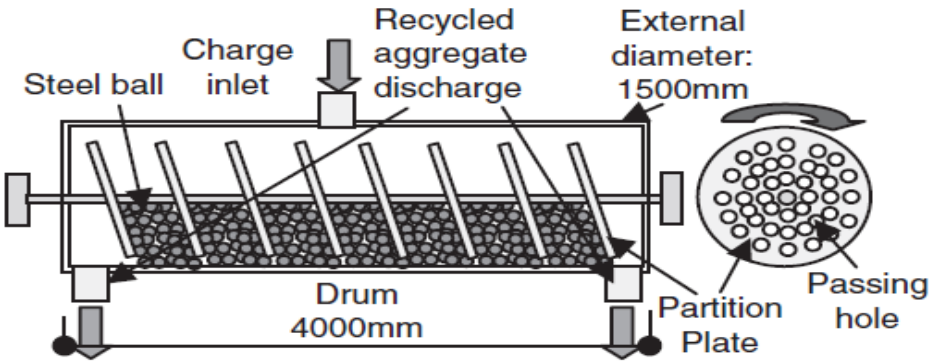

Figure 6: Mechanical grinding method

Stationary plant

A stationary recycling plant usually incorporates a large primary crusher working in conjunction with a secondary crusher and also includes various cleaning and sorting devices to produce high quality aggregate. Self -cleaning electromagnets, sieves and hand sorting are employed to produce a relatively clean recycled aggregate from a mixed and contaminated input material. In Britain, this type of plant normally combines two jaw crushers and is capable of yielding a range of graded products.

Advantages of Stationary Plant

(a) Suitable for recycling centers in high density areas (b) Disposal costs are reduced because of less dumping. (c) The recycling plant is capable of producing a high quality of product. (d) The local supply of aggregates is increased and therefore less aggregate needs to be imported into the area. (e) The efficiency of plant is better than that of mobile recycling plant because different recycled products of various grading can be produced.

Disadvantages of Stationary Plant

(a) The initial investment of setting of such a plant can be in excess. (b) There is an increase in transport in the vicinity of recycling plant. (c) The recycling plant can cause increase in noise levels. (d) The efficiency of production depends on the local supply of rubble.

Recycling Technologies of Demolished Concrete in Japan

Heating and rubbing method

In the heating and rubbing method, concrete masses are heated at 300°C and the cement paste content is weakened to remove mortar and cement paste from the aggregate. Figure 3 shows an overview of a recycled aggregate production system using this method. Figure 4 illustrates the recycled coarse and fine aggregate produced by the system. While the production of recycled aggregate generated a large amount of fine powder, it also indicated the possibility of using fine powder like this as a substitute solidification material for the deep mixing stabilization method (soil cement walls).

Eccentric-shaft rotor method

In the eccentric shaft rotor method, crushed concrete lumps are passed downward between an outer cylinder and an inner cylinder that eccentrically rotates at a high speed to separate it into coarse aggregate and mortar through a grinding effect. Figure 5 presents an overview of a recycled aggregate production system using this method.

Mechanical grinding method

Mechanical grinding is a method used to produce coarse and fine aggregate by separating a drum into small sections with partitions, loading the drum with iron balls for grinding and rotating the partitions. Figure 6 shows an overview of the recycled aggregate production system using this method. The coarse aggregate produced by these methods has been used for actual construction projects.

Applications

In general, applications without any processing include: (a) Many types of general bulk fills (b) Bank protection (c) Base or fill for drainage structures (d) Road construction (e) Noise barriers and embankments

Most of the unprocessed crushed concrete aggregate is sold as 37.5 mm (1½ in.) or 50 mm (2 in.) fraction for pavement subbases. After removal of contaminants through selective demolition, screening, and /or air separation and size reduction in a crusher to aggregate sizes, crushed concrete can be used as: (a) New concrete for pavements, shoulders, median barriers, sidewalks, curbs and gutters, and bridge foundations (b) Structural grade concrete (c) Soil-cement pavement bases (d) Lean-concrete or econo-crete bases (e) Bituminous concrete

CONCLUSION

This study has developed concepts for the reutilization of construction materials, including waste debris, by means of recycling into other components that are useful in construction. Primary opportunities identified in this study to divert Construction and Demolition debris from the solid waste stream exist in the form of demolition operations to salvage or recycle building materials and systems.

A successful construction waste management plan involves all the principal parties of a project: owner, architect, engineer, contractor, and subcontractor. By involving each of the parties early on in the design process it is easier to achieve established goals. The construction waste management plan should require the contractor to minimize waste, develop ways to reuse existing materials, which may be included in the new design or elsewhere. The architect should be familiar with the regional waste management infrastructure and establish a waste management goal for the contractor.

The reasonable regulations and design/green-rating systems should be established to promote concrete recycling. Concrete recycling will become one of the most important elements for construction sustainability.

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