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EFFECTIVE MINIMIZATION OF CONSTRUCTION WASTE IN MAHARASHTRA

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ABSTRACT

The project is based on the recycling of the rapidly increasing construction and demolition waste. Through this process we want to take a step ahead, the idea of stopping illegal sand mining, earth excavation and ultimately save our mother Earth from destruction. The cost of recycled sand and aggregates is lower than conventional aggregates and sand, resulting in reduction of overall construction cost. Our primary aim is to study in depth about the different properties of construction and demolition waste, perform various tests, so that the recycling processes can be designed accordingly for optimum efficiency. On the basis of these test results and projections we will get a rough estimation about the total quantity of recycled aggregate and recycled sand that can be obtained. Further with the help of the obtained recycled material we intend to make various products such as concrete, paver blocks, hollow blocks, kerbstone etc which will in turn be less costly as well. These recycled materials and products made from it are economical without any considerable change in the strength and durability aspect. Not only the cost effectiveness but it will also be aesthetically pleasing.

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INTRODUCTION

Construction waste is bulky and heavy and is mostly unsuitable for disposal by incineration or composting. The growing population in the country and requirement of land for other uses has reduced the availability of land for waste disposal. Re-utilization or recycling is an important strategy for management of such waste. Waste is generated at different stages of construction process. Waste during construction activity relates to excessive cement mix or concrete left after work is over, rejection/ demolition caused due to change in design or wrong workmanship etc. Estimated waste generation during construction is 40 to 60 Kg. per sq. m. Similarly, waste generation during renovation/ repair work is estimated to be 40 to 50 kg/sq.m. The highest contribution to waste generation is due to demolition of buildings. Demolition of Pucca and Semi-Puce buildings, on an average generates 500 & 300 kg/ sq.m. Of waste respectively. Concrete appears in two forms in the waste. Structural elements of building have reinforced concrete, while foundations have mass non-reinforced concrete.

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Excavations produce topsoil, clay, sand, and gravel. This may be either re- used as filler at the same site after completion of excavation work or moved to another site.

A. Large quantum of bricks and masonry arise as waste during demolition. These are generally mixed with cement, mortar or lime. Stone arises during excavations or by demolition of old buildings. According to findings of survey, the most dominant reason for not adopting recycling of waste from Construction Industry is "Not aware of the recycling techniques". While 70% of the respondents have cited this as one of the reasons, 30% of the respondent has indicated that they are not even aware of recycling possibilities.

B. Types of Construction and Demolition waste:

Major Components	Minor Components
Bricks	Pipes (GI, iron, plastic)
Cement plaster	Electrical fixtures (copper/ aluminum wring, wooden baton
Rubble	Bakelite/plastic switches, wire insulation)
Stone \/time/wood (marble, granite, sand stone)	Panels (wooden, laminated)
Steel	Other (glazed tiles, glass panes)

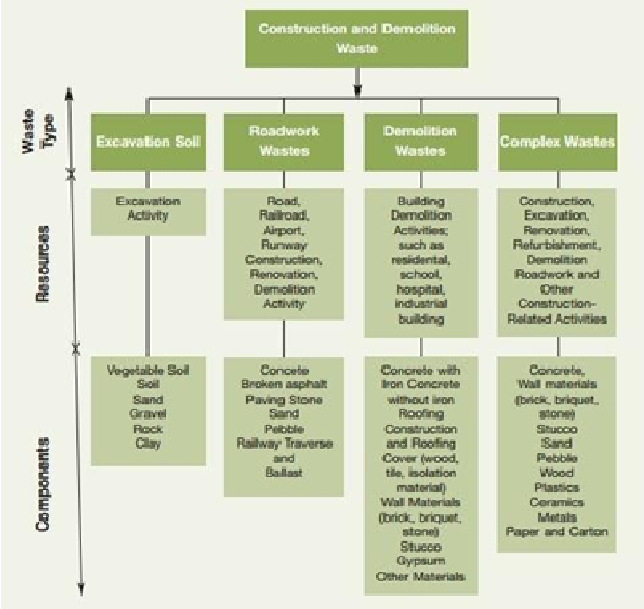
C. Classification of waste

- Residential
- Industrial
- Commercial
- Institutional
- Agricultural
- C&D

D. C&D waste as per types:

- Based on structure type(Residential, Commercial, Industrial, Institutional)
- Based on structure size(Heavy, Med,Light)
- Activity being performed

E. Various components of Construction and Demolition waste:



F. Collection of C&D Waste:

- Collection of the C&DW can be done by the trucks having container of different sizes.
- Size of the container depends upon the demolition area/part.
- 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.
- For small generators of construction debris, e.g., petty repair/maintenance job, there may be two options –
  (i) Specific places for such dumping by the local body.
  (ii)Removal on payment basis.
- In case of small towns where skips and tipping trailers are not available, manual loading and unloading should be permitted.
- In case of large towns where C&D waste generates in large amount, Zoning of the towns is necessary. By multiple pickup points of C&D waste we can easily do collection of C&D waste in large cities.
- Close co-ordination between the Sanitary Department, Municipal Engineering Department and Town Planning Department is essential if there is no consolidated Solid Waste Management Department to take care of the construction and demolition waste in addition to other municipal garbage.

G. Segregation of waste:

- Segregation of C&D waste can be done by following methods:
  (1) On Site (2) Off Site

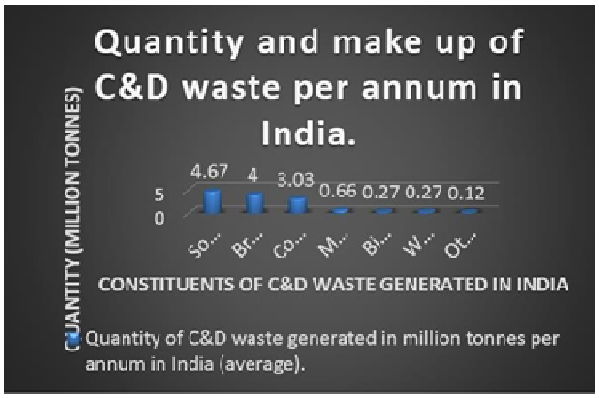
1) **ON SITE:** Man-made Sorting, by use of JCB, By use of Cranes.
   VEHICLE USED: JCD, Cranes, Tractors, Trucks etc.
2) **OFF SITE:** By use of Air Nozzle, By use of Sorting method.

Vehicle Used: Air nozzle, sorting machine, trucks, tractors etc.

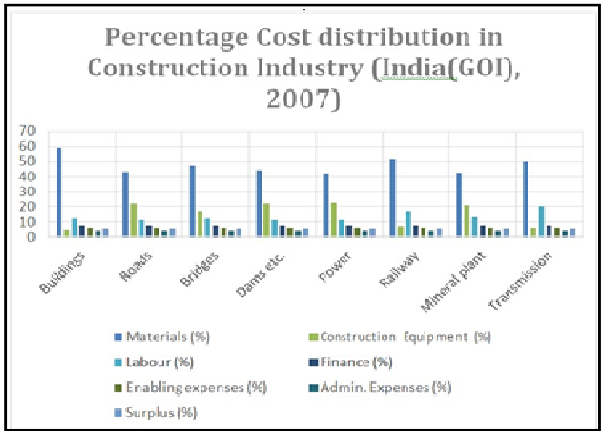
- Segregation of the C&D waste can be done by Chemical Mineralogical Appraisal and Mechanical Sorting.
- This both methods are Off site methods

Table 1. The Quantity and Make Up of Construction and Demolition Waste Per Annum In India

Constituent	Quantity generated in Million tonnes per annum
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	025 to 0.30MT
Wood	0.25 to 0.30MT
Others	0.10 to 0.15MT



Graph 1. The Quantity and Make Up of Construction and Demolition Waste per Annum In India



Graph 2. The distribution of cost among various modes of expenses in Indian construction industry

Literature Review

The concept of this project especially for India in new. There is a lot of scope for research in this field. The research work and implementation of recycling C&D waste has not been done on a larger scale in India. The literature review is an important portion for any project. From the many literature reviewed by us, both of national and international level, few research works and papers which we came through are listed here:

On-Site Grinding of Residential Construction Debris: The Indiana Grinder Pilot

Abstract: The objective of the pilot project documented in this report was to determine the feasibility of on-site grinding of clean wood, drywall, and cardboard waste from new residential construction as an alternative to conventional land filling. The evaluation included the identification and assessment of the major technological, economic, and environmental factors associated with the grinding technique. The pilot project was established near Indianapolis, Indiana and involved several organizations, including residential builders and a waste management firm. Although it is not possible for a single case study to comprehensively address all of the issues involved in on-site grinding, key results are presented below.

Construction and Demolition Waste recycling for sustainable growth and development

Abstract: Construction and demolition (C and D) waste is defined as the solid waste generated by the construction, remodeling, renovation, repair, alteration or demolition of residential, commercial, government or institutional buildings, industrial, commercial facilities and infrastructures such as roads, bridges, dams, tunnels, railways and airports. Construction and demolition waste is considered as high volume, low risk. It is commonly understood that this waste can be considered a resource, either for reuse in its original form or for recycling or energy recovery. Because of increasing waste production and public concerns about the environment, it is desirable to recycle materials from building demolition. If suitably selected, ground, cleaned and sieved in appropriate industrial crushing plants, these materials can be profitably used in concrete. Despite this, most Construction and Demolition waste ends up in landfills. This paper highlights the composition of Construction and Demolition waste, the need for its recycling and options that can be implemented for its efficient use in the field of concrete technology in general. (Journal of Environmental Research and Development Vol. 2 No. 4, April-June 2008).

Construction and Demolition waste – An Overview of Construction Industry in India

Abstract: India has established itself as one of the world's fastest growing economies and this growth has brought with it a significant boost in construction activities. With the rapid growth in construction activities, it is important to assess the amount of construction and demolition waste being generated and analyze the practices needed to handle waste in order to propose a sustainable construction approach. It has become essential to study C & D waste generation and handling to develop accurate data and establish sustainable methods to manage construction waste. Reduce, Reuse and Recycle [3R's] is highly useful in handling of construction and demolition waste. It is estimated that the total solid waste generated in India is about 960 million tonnes of which the construction waste alone is 14.5 million tonnes. Construction and Demolition waste in India during 2010 is estimated as 24 million tonnes. If measures to minimize and handle the construction and demolition wastes are not developed and efficiently adopted, it may have an impact on the environment. The paper provides an overview and statistics of construction and demolition waste of the construction industry in India. The paper gives an overview of the current status as well as the future potential for waste minimization, explores how waste management practices can be effectively implemented in construction projects.(International Journal of Chemical, Environmental & Biological Sciences (IJCEBS) Volume 1, Issue 4 (2013) ISSN 2320-4079; EISSN 2320–4087).

Construction waste management in India

Abstract: The management of construction waste is important today. The scarcity in the availability of aggregate for the production of concrete is one of the important problems facing by the construction industry. Appropriate use of the construction waste is a solution to the fast degradation of virgin raw materials in the construction industry. This paper enlightens the importance of reduce, reuse and recycle (3R) concept for managing the construction waste in India. (American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-2 pp-06-09).

Recycling and Reuse of Construction and Demolition Waste for Sustainable Development

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, economic 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 nonresidential 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. (OIDA International Journal of Sustainable Development, Vol. 6, No. 7, pp. 83-92, 2013).

Economic Aspects of Construction Waste Materials in terms of cost savings: A case of Indian construction Industry

Abstract: The excessive wastage of materials, improper management on site and low awareness of the need for waste reduction are common in the local construction sites in India. Today, in most European countries, it is economically feasible to recycle up to 80–90% of the total amount of construction waste and most demolition and recycling technologies are generally easy to implement and control (Lauritzen, 1998). Considering enormous increase in amount of waste generation owing to the growth in construction industry can lead to wastage of materials which has its economic value. Currently, existence of regional and national policies, laws and regulations governing reuse and recycle principles for C & D waste is minimal in India. Thus the paper aims to focus on the economic feasibility of waste minimization of construction waste materials in terms of cost savings in India. (International Journal of Scientific and Research Publications, Volume 2, Issue 10, October 2012 1 ISSN 2250-3153).

Use of Recycled Aggregate Concrete

Abstract: Use of recycled aggregate in concrete can be useful for environmental protection. Recycled aggregates are the materials for the future. The application of recycled aggregate has been started in a large number of construction projects of many European, American, Russian and Asian countries. Many countries are giving infrastructural laws relaxation for increasing the use of recycled aggregate. This paper reports the basic properties of recycled fine aggregate and recycled coarse aggregate & also compares these properties with natural aggregates. Basic changes in all aggregate properties are determined and their effects on concreting work are discussed at length. Similarly the properties of recycled aggregate concrete are also determined. Basic concrete properties like compressive strength, flexural strength, workability etc. are explained here for different combinations of recycled aggregate with natural aggregate. Codal guidelines of recycled aggregates concrete in various countries are stated here with their effects, on concreting work. In general, present status of recycled aggregate in India along with its future need and its successful utilization are discussed here. (IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684,PP: 52-59).

Maximizing Reuse and Recycling of Construction Materials

Abstract: The demolition of building structures produces significant amounts of materials that are for the most part land filled. The total Construction and Demolition (C&D) waste in U.S. was estimated to be 154 Million Metric Ton (MMT) in 2003. As its primary purpose, deconstruction seeks to maintain the highest possible value for materials in existing buildings by dismantling buildings in a manner that will allow the reuse or efficient recycling of the salvaged materials. This paper intends to provide an overview of U.S. construction and demolition waste and includes sections on waste statistics, benchmark data, policies, and strategies to maximize reuse and recycling.

Construction & Demolition Waste in India

Abstract: With the advent of industrialization March there has been huge depletion of natural resources. The recycling of the construction material to serve the ever increasing need for more cities ought to be sustainable.

Waste quantification models for estimation of construction and demolition waste generation: A review

Abstract: Quantification is crucial for construction and demolition waste management. Accurate estimation can be satisfied by developing waste quantification model that is applicable for regional or nation-wide C&D waste generation. This paper presents a review on quantification models for C&D waste from literatures and how they correlate. Most studies combine the empirical waste assessment data or waste generation factor obtained in the field with area of activity level extracted from national statistical database from their respective countries, which provides annual data on sector activities. National or regional estimates provide general figures and forecasts for annual C&D waste generation. Studies found that waste generation factor will differs according to locations. Since volume and characteristic of waste are crucial for waste quantification, quantitative data record from waste audit findings could benefit the authorities for the annual estimates. National C&D waste reduction plan should start from well-established waste minimization plan at project sites. Copyright © 2012 Inder science Enterprises Ltd. (International Journal of Global Environmental Issues (10.1504/IJGENVI.2012.049378)).

METHODOLOGY

Methodology:

- The main aim of our project was regarding research and development (R&D) of construction and demolition(C&D) waste by further studying its properties in detail.
- The general scenario of construction waste and solid waste is explained in detail in Chapter1.
- As civil engineers it our duty to move towards constructive technology rather than destruction.

- During our primary survey of construction and demolition waste quantity we found that in Hadapsar itself 35000MT of waste is dumped at Handewadi and daily 300MT of construction waste is collected.
- So in line with our Pune Municipal Corporations policy of Reduce Reuse Recycle we derive our methodology for recycling of construction and demolition waste and making useful products out of it.
- So we carried out sampling of concrete, bricks, tiles, wood, metals, plastic etc. i.e. the different components of C&D waste.
- In-depth testing of these approximately 37kgs of C&D waste collected from 11 different sites. On the basis of various result of these testing we designed a process.

Data Collection

Sampling

The very next thing on focus, after the general study of various aspects of construction and demolition waste at national and local level was sampling. The basic meaning of sampling is to collect randomly the desired material from various points/location on which one has to make study. Thus for carrying out any research work practically on any material, sampling is necessary. In context to construction and demolition waste, in Pune city there are more than 15 sites solely assigned for dumping of C&D waste. Out of which 11 sites were selected for carrying out sampling. Within the limits of PMC the whole city is divided into 8 zones. Thus the site selection for sampling was done in such a way that all zones were covered. The sites which are on major locations of the city and the sites where good amount of C&D waste is dumped were selected. The below given list is about the sites from which samples of C&D waste were taken and further tests were conducted on it, which is explained in the next chapter.

Sampling Sites

Sheetal Distributors Wadki, Hadapsar, Pune. Commercial Site.

TEST RESULT

Overview

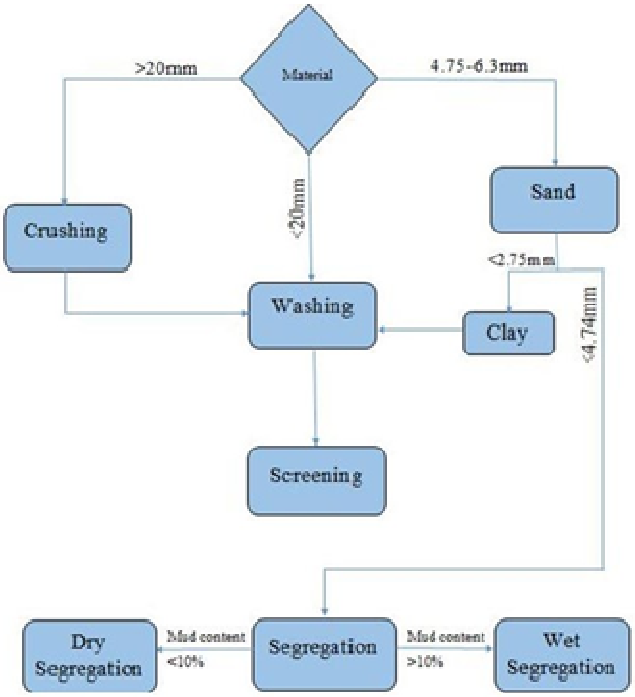
The samples which were collected from 11 sites across the city were further taken to laboratory for carrying out tests. The testing of this material is important because without checking its properties minutely, the process design for recycling plant is not possible. Though the sites from which sampling was done, were solely assigned for dumping of only construction and demolition waste, various others things were also being duped there. So first of all before carrying out tests on the samples the primary segregation was done. During this the unwanted waste was separated by simply hand picking. This unwanted waste consisted of plastic, metal wastes, bitumen wastes (road debris) etc

Tests conducted

- Sieve analysis (Particle size distribution)
- Impact value test
- Sieve Analysis Report [26]

Sieve analysis is the most primary and basic test of civil engineering. It is commonly known as the gradation test. It is a basic essential test for all aggregate technicians. The sieve analysis determines the gradation (the distribution of aggregate particles, by size, within a given sample) in order to determine compliance with design, production control requirements, and verification specifications. The gradation data may be used to calculate relationships between various aggregate or aggregate blends, to check compliance with such blends, and to predict trends during production by plotting gradation curves graphically, to name just a few uses. Used in conjunction with other tests, the sieve analysis is a very good quality control and quality acceptance tool.

Data Analysis



Flowchart 3. Process Analysis Based On Conclusion of Test Results

Theoretical explanation of Test Results

The total material left after testing is segregated as shown in above given flowchart into mainly three sections. The first section is of material which is crushable i.e. particles greater than 20mm. Second section is directly sent for screening i.e. whose particle size is between 6.3mm to 20mm.Now the process of washing is conducted for the remaining portion of the total material left. This is mainly called as sand. Further, the particles whose size is less than 2.75mm is directly sent to washer and the remaining part is again segregated by two methods namely: Wet segregation (mud content >10%) and Dry segregation (mud content <10%). Now the crushed material is washed before undergoing screening. At the end, after completion of each separate process, the screening and washing is done.

Theoretical explanation of detailed analysis

We carried out total sampling of 38.942 kg of C and D waste collected from 11 different sites of Pune. Various tests namely Crushing and screening were carried out on these samples. Out of the total collected sample 2.673 kg of unwanted waste was recovered. The sand and clay content was found to be 12.440 kg i.e. approx. 35 %. The unwanted waste comprised of

plastic, metals, ceramics, etc. This unwanted waste cannot be recycled and has to be dumped or incinerated depending on the properties of the waste. The sand and clay content can be recycled for washing and manufacturing of sand which can be further used in new construction. Sieve analysis was also carried out of the crushed materials to determine its properties.

Conclusions

Waste can only be reduced once all employees and contractors are fully aware of the extent of the problem in the company. Each construction employee must be trained on waste management. This training may include waste management induction training to reinforce the importance of waste minimization practices. Adequate communication strategies from the top to the bottom levels of organizations, the use of reliable practices (work studies) to establish waste allowances and the introduction of incentives for better waste management practices would help to develop and implement waste management applications in the construction industry and thereby improve their performance.

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