Study on Utilization of Demolished Concrete Waste as Coarse Aggregate in New Construction

Swapnil Tiwari[1], Dr. Vaishali Pendese[2], Dr. Debabrata mukhopadhyay[3]

M.Tech Scholer[1], Assistant Professor[2], Dean[3]

Department of Chemical Engineering

Chhattisgarh Swami Vivekanand University, Bhilai (C.G.)

Abstract: In present day scenario Demolished Concrete waste handling and management is challenging job for all civil engineers all over the world. Construction and demolition wastes constitute one of the major components of wastes generated worldwide. Very large quantities of aggregates are used in concrete production and in construction. When the useful life of the structure is over it will be demolished and all the demolished wastes just find their way to landfills. Finding large areas for landfills is becoming very difficult. On the other hand, continuous extraction and quarrying of natural aggregates for construction is causing depletion of natural resources. The recycling of demolished construction waste in to aggregates to be used in new engineering application provides a promising solution to both the problems. Recycling the Demolished Concrete will reduce the environmental pollution and protects the natural resources. In this work the usability of demolished waste as coarse aggregates in new concrete is attempted. This research is focused on utilizing the Demolished Concrete waste and reducing the generation of construction waste, and collecting Demolished Concrete from the demolition of building at site, Crushing Demolished Concrete waste and separating different sizes using sieve analysis, by collecting various sizes of Aggregate. This experimental investigation involves evaluating the properties of the constituents of concrete including the demolished concrete wastes which shall be used as coarse aggregates in new concrete with the aim of producing high strength concrete. The results of this experimental study are aimed at examining the properties and strength of recycled aggregate concrete made from different replacement ratios of recycled aggregates from natural aggregates and to evaluate the strength of recycled aggregate concrete to check its usability as structural concrete. In recent years demolished concrete waste handling and management is the new primary challenging issue faced by all the countries. It is very challenging and hectic problem that has to be tackled in an indigenous manner, it is desirable to completely recycle demolished concrete waste in order to protect natural resources and reduce environmental pollution. In my research paper an experimental study is carried out to investigate the feasibility and recycling.

Keywords: **Demolished Concrete, Construction Waste, Natural Aggregate, Recycled Coarse Aggregate, Compressive Strength, Flexural Strength**

1. INTRODUCTION

1.1. General

Concrete has been around for many centuries the first known use of a material resembling concrete was found by the Minoan civilization around 2000 BC. A huge amount of solid waste is generated annually from construction and demolition activities. This has lead to the promotion of waste recycling as a major measure to reduce waste and to mitigate the harmful effects of construction activities on the environment. This study presents an initial understanding of the current strengths and weaknesses of the practices intended to support construction industry in developing effect policies regarding uses of waste and recycled materials as construction materials.

1.2. INTRODUCTION TO DEMOLISHING

Works on recycling have emphasized that if old concrete has to be used in second generation concrete, the product should adhere to the required compressive strength. This paper deals with the review of the existing literature work for the use of recycled concrete as aggregates in concrete in respect of mainly the compressive strength and proposes and approach for use of recycled concrete aggregate without compromising the strength.

1.3. THE INDIAN SCENARIO

Indian construction industry is highly employment intensive and accounts for approximately 50% of the capital out lay in successive 5-year plans of our country. The projected investment in this industrial sector continues to show a growing trend. Central Pollution Control Board has estimated current quantum of solid waste generation in India to the tune of 48 million tons/annum of which waste from construction industry accounts for 25%. The total quantum of waste from construction industry is estimated to be 12 to 14.7 million tons per annum.

1.4. OBJECTIVES

The objectives of this study are following as-

- To use of the demolished and construction waste aggregate in the new concrete as the recycled concrete aggregate reduces the environmental pollution.
- To study the utilization of demolished and construction waste as a replacement of natural coarse aggregate.
- To study the mechanical and physical properties of demolished and construction waste aggregate by conducting experimental work.

2. LITERATURE REVIEW

1. Patel, and Patel, (2016) investigated effect of demolished waste and carried out comparative study of its mechanical properties. Recycled concrete aggregates were used in concrete in replacement of nominal concrete aggregates in different percentages 25%, 50%, 75%, and 100%. It was observed that the compressive strength was optimum with 50% replacement of recycled coarse aggregate.

2. Subramani, and Kumaran, (2015) assessed a study on concrete which incorporate over burnt brick ballast and concrete waste partially due to their abundance. The main objective of this research project was to determine the properties of concrete by replacing natural coarse aggregate with over burnt brick ballast aggregate and concrete waste. 25%, 50% (M15, M25) incorporation was used as a partial replacement of natural coarse aggregate. The compressive strength was observed to be optimum when containing 50% of concrete waste. Also, it was found that as the percentage of concrete waste and crushed brick fine aggregate was increased it influences more hardened properties of concrete.

3. Topcu, and Sengel (2004) had studied the effect of waste aggregate on properties of concrete. Experimental investigations have been carried out to assess the effect of partial replacement of coarse aggregate by waste aggregate. Recycled aggregates were used in concrete in replacement of nominal concrete aggregates in varying percentages of 30%, 50%, 70% and 100%. Afterward, these mixtures underwent freeze –thaw cycles. As a result, it was found that C16-quality concrete could be produced using less than 30% C14-quality waste concrete aggregate. Moreover, it was observed that the unit weight,

workability, and durability of the concrete produced through WCA decreased in inverse proportion to their endurance for freeze thaw cycles.

3. MATERIALS & METHODOLOGY

3.1. MATERIALS

In making any type of concrete, selection and type of materials is very important as all the properties depends on them. The following materials are being used and are listed below.

- Cement
- Fine aggregate (sand)
- Coarse aggregate replaced with Recycled coarse aggregate (RCA)
- Water

3.1.1. Cement

Cement is very fine material having adhesive and cohesive properties which provide a binding medium to discrete ingredients. cement is a product obtained by pulverizing clinker formed by calcinating raw materials primarily consisting of lime (CaO), Silicate(SiO2),Alumina(Al2O3) and Iron Oxide(Fe2O3).

3.1.2. Aggregate

Aggregates are raw materials that are produced from natural sources and extracted from pits and quarries, including gravel, crushed stone, and sand. Aggregates are commonly obtained by crushing naturally occurring rock. Types of aggregates include Coarse aggregate and fine aggregate. The aggregate of each type is further sub-divided into many types and classification based on its size.

3.1.3. Water

Water is one of the most important elements in construction and is required for the preparation of mortar, mixing of cement concrete and for curing work etc. The quality of water used has a direct impact on the strength of the motor and cement concrete in the construction work.

3.1.4. Recycled concrete aggregate

Recycled concrete aggregate (RCA) is generally produced by the crushing of concrete rubble, screening then removal of contaminants such as reinforcement, paper, wood, plastics and gypsum. Concrete made with such recycled concrete aggregate is called recycled aggregate concrete (RAC)

3.2. METHODOLOGY

3.2.1. Tests on Cement:

Specific Gravity test

The specific gravity is normally defined as the ratio between the weight of a given volume of material and weight of an equal volume of water. The Portland cement have a specific gravity of value around 3.15.

Consistency test

The consistency of cement is the minimum water requirement to start the chemical reaction between water and cement. This test helps to identify the minimum water required to make the cement paste.

Setting Time

The initial setting time of concrete is the time when cement paste starts hardening while the final setting time is the time when cement paste has hardened sufficiently in such a way that a 1 mm needle makes an impression on the paste in the mould but 5 mm needle does not make any impression. Final setting time is that time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the mould but 5 mm attachment does not make any impression

Fineness test

The fineness of cement is a measure of the size of particles of cement and is expressed in terms of the specific surface area of cement. The fineness of cement is measured as the % weight retained on a 90μm IS sieve over the total weight of the sample.

3.2.2. Tests on Fine Aggregate

Fineness Modulus

Fineness modulus is an empirical value that describes the average size of particles in a sample of aggregate. This factor provides a basis to select estimated proportions for concrete mix design.

Specific Gravity

Specific Gravity is defined as the ratio of Weight of Aggregate to the Weight of equal Volume of water. The specific gravity of an aggregate is considered to be a measure of strength or quality of the material.

Absorption Test

Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition, when it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential.

3.2.3. Test on Coarse Aggregate & Recycled Concrete Aggregate

Fineness modulus

Fineness modulus of coarse aggregates represents the average size of the particles in the coarse aggregate by an index number. It is calculated by performing sieve analysis with standard sieves.

Impact Value Test

The impact test on aggregate is carried out to know the response of aggregates to different kinds of loads that the aggregates will be subjected to during their service life.

Crushing value test

Aggregate crushing value test on coarse aggregates gives a relative measure of the resistance of an aggregate crushing under gradually applied compressive load.

4. MIX DESIGN

4.1.1. Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully.

4.1.2. Mix Proportion

There are four terrain categories. The terrain in which a specific building stands is evaluated as one of the following terrain categories:

Category 1 – exposed open terrain with few or no objections in which the average height of any object surrounding the structure is less than 1.5m.

Category 2 – open terrain with well-dispersed obstacles generally between 1.5 and 10 m high.

Category 3 – terrain with numerous closely spaced obstacles of structure size up to 10 m in height with few or no isolated tall structures.

Category 4 – terrain with numerous large high obstacles.

4.1.3. Workability test (Slump cone test)

Workability of concrete is defined as the ease and homogeneity with which a freshly mixed concrete or mortar can be mixed, placed, compacted and finished. Strictly, it is the amount of useful internal work necessary to produce 100% compaction. Slump cone test is the most common method for measuring the workability of freshly mixed concrete.

4.1.4. Compressive strength test

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied. For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used.

4.1.5. Tensile Strength Test

Tensile strength of concrete is much lower than its compressive strength (that's why steel is used to carry the tension forces). It has been estimated that tensile strength of concrete equals roughly about 10% of compressive strength. The split tensile test is an indirect way of evaluating the tensile test of concrete.

4.1.6. Flexural strength test

Flexural strength test on concrete beam to determine the strength of concrete. Flexural strength test is conducted by using the method prescribed by IS 516 – 1959. Beams of dimension 700mm×150mm×150mm were used for this test, the test specimen is placed in the machine at the bearing surfaces of the supporting and loading rollers.

5. EXPECTED OUTCOME

1. Based on literature reviews it has been observed that recycled aggregate concrete may be an alternative to the conventional concrete.

2. The reuse of dismantled concrete will help in improvement of overall environment of the region. Firstly, by reduction in mining and secondly reduction in air pollution resulting from production of aggregates (dust pollution) and transportation of aggregate from mining to consumption point

3. The idea of reusing the waste material is very exciting and encouraging specially when it will be helpful in minimizing destruction to earth's crust and green forest cover by virtue of reduced mining.

4. The use of dismantled aggregate in making fresh concrete will also help in reduction of solid waste dumping on existing landfill sites.

5. From the previous research work it is found that the flexural strength of RCA concrete is comparable to the natural aggregate concrete which is a positive point. So the RCA concrete can be used for flexural strength by adjusting W/C ratio

6. REFERENCES

1. R. Sri Ravindrarajah, and Y. H. Loo Beng, "Recycled concrete as fine and coarse aggregate in concrete", *Magzine of Concrete Research,* Volume No. 39, Issue No. 141, Page No. 241- 220, 1987.
2. Ilker Bekir Topcu, and Nedim Fuat Guncan, "Using waste concrete as aggregate", *Cement and Concrete Research,* Volume No. 25, Issue no. 7, Page no. 1385-1390, 1995.
3. Ilker Bekir Topcu, and Selim Sengel, "Properties of concretes produced with waste concrete aggregate", *Cement and Concrete Research,* Volume No. 34, Page No. 1307-1312, 2004.
4. Hardik Gandhi, Dr. Dharshana Bhatt, and Chetnaben Vyas, "Study on use of recycled coarse aggregate in concrete", *National Conference On Recent Trends in Engineering and Technology,* Page No. 13-14, 2011.
5. G. Murali, R. Saravanakumar, C. Balaji, R. Muthuraman, V. Sreekavitha, and S. Archana, "Experimental investigation on concrete with different waste stone as a aggregate", *International Journal Of Engineering Research and Application(IJERA),* Volume No. 2, Issue No. 3, Page No. 253-256, 2012.
6. Mohd Monish, Vikas Srivastava, V. C. Agarwal, P. K. Mehta, and Rakesh Kumar, "Demolished waste as coarse aggregate in concrete", *Journal Of Academia and Industrial Research (JAIR),* Volume No. 1, Issue no. 9, Page No. 540-542, 2013.
7. T. Subaramani, and S. Kumaran, "Experimental Investigation of using concrete waste and brick waste as a coarse aggregate", *International Journal of Application or Innovation in Engineering And Management (IJAIEM),* Volume No. 4, Issue No. 5, 2015.

8. Nikita Patel, and Dr. Piyush Patel, "Use of demolished concrete materials in concrete and comparative study of its mechanical properties", *International Journal of Innovative Research In Science, Engineering and Technology (IJIRSET),*

9. Hansen, T.C. and Marga, M. 1992. Strength of recycled concrete made from coarse and fine recycled concrete aggregate. *Ibid* .135: 605-612.

10. IS: 456-1978. Code of practice for plain and reinforced concrete. Indian Standard Institute, New Delhi.