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UTILIZATION OF DEMOLISHED CONCRETE AGGREGATE AS REPLACEMENT OF NATURAL AGGREGATE IN CONCRETE

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*Abstract:*In present day Demolished Concrete waste handling and management is challenging one in all over the countries in the world. Recycle the Demolished Concrete has reduced the environmental pollution and protect the natural resources. This research is focused on utilizing the Demolished Concrete waste and reduces the generation of construction waste. This research included a collecting a Demolished Concrete from the demolition of building at site, Crushing Demolished Concrete waste and is separated with different sizes using sieve analysis. The Demolished Concrete Aggregate (DCA) is replaced by various percentages of 0 %, 25 %, 50%, 75 % & 100% adding with steel fiber, silica fume and test can be conduct and compared with nominal Concrete. Treated DCA with cement mortar and Super plasticizer (SP) admixture added to (1%) of total cementations materials (TCM). The concrete properties exams performed such as; density, compressive strength, splitting tensile strength, and Flexural strength test. The tests concluded that the compressive strength, splitting tensile strength and Flexural strength values of DCA concretes are reduced with an increased DCA ratio relative to normal concrete. DCA in the concrete mix as a partial substitute of gravel decreases the compressive strength about 26 %, 34 % at DCA 75%, DCA 100%, respectively, compared with the normal concrete. However, at (DCA50-Si-SP-SF1) (Mixing additives together), the compressive strength is increase up to 50 %. Adding SP on mix separately, it decreases the strength. But combine effect of SP & Si, SP & SF increases the strength up to 12- 14 %. The mix DCA 50 % Si 10% SF 1% SP 1% gives better Flexural strength on both 7 and 28 days as 3.92N/mm2 and 7.37N/mm2. The Flexural Strength was increased up to 34% at (DCA50-Si-SP-SF1) when mixing additives together.

***Key Words* - Demolished Concrete Aggregate, Silica Fume, Density, Compression, Flexural, Splitting Tensile, Super plasticizer, Steel Fiber.**

I. INTRODUCTION

A. General

During the earlier stages of the Roman Empire around 300 BC, the Romans discovered that mixing a sandy volcanic ash with lime mortar created a hard water resistance substance which we know as concrete. A huge amount of solid waste is generated annually from construction and demolition activities. This has led 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. Among this waste, concrete apportions more than half of the total. The construction industry conspicuous consumer of raw material of many types and thus large material inventories are required to sustain the growth. Among the various raw materials used in construction, aggregates are important components for all the construction activities and the demand in 2007 has seen increase by 5%, to over 21 billion tones the largest being in developing countries like China, India etc. it is very important that the construction wastes are accounted properly. One of the best solutions to both the problems would be to recycle and reuse the demolished concrete as aggregates in new concrete. This will ensure sustainability in construction. This will not only provide for protecting the environment from depletion of natural aggregates but also will account for the problem of dealing with construction waste.

B. Introduction to Demolishing

Demolition is defined as destroying old buildings in a controlled manner when the design life of the building completed**.** India is presently generating construction and demolition (C & D) waste to the tune of 23.75 million tons annually and these figures are likely to double fold in the next 7 years. C & D waste and specifically concrete has been seen as a resource in developed countries. 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. The need for demolition, repairs and renewal of concrete and masonry structures is rising all over the world, more so in the developing countries.

C. Sources of Demolition and Construction Wastes

The main reasons for increase of volume of demolition concrete / masonry waste are as follows: -

- Many old buildings, concrete pavements, bridges and other structures have overcome their age and limit of use due to structural deterioration beyond repairs and need to be demolished.
- The structures, even adequate to use are under demolition because they are not serving the needs in present scenario.
- New construction for better economic growth and job opportunities;
- Structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc.Creation of building waste resulting from manmade disaster/war

D. 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.

II. LITERATURE REVIEW

A. Literature Review

J. Kalyana Chandrasekhar Reddy, P. S. S. Anjaneya Babu (2016): The various studies related to sustainable concrete construction have encouraged recycled aggregate which is a partial replacement of natural aggregate in concrete mixes. The significance of silica fume (SF) in concrete mix will improve the quality of recycled aggregates in concrete. The Portland cement was replaced with Silica Fume at 0%, 5% and 10%. The coarse aggregate in concrete mix is replaced by 0%, 25%, 50%, 75%, and 100% of recycled coarse aggregates (RCA). The compressive strength and split tensile strength of concrete made with recycled aggregates are evaluated.

Patil, Suhas Vijay Rao, K. Balakrishna Nayak, Gopinatha (2021): Several countries have started using recycled aggregate as a partial replacement to natural aggregate in concrete. Recycled aggregate contains adhered mortar, which distinguishes it from the natural aggregate. It is recommended to use ball mill processed recycled coarse aggregates as a complete replacement to natural coarse aggregates along with a 5 % addition of silica fume for better performance.

Beenish GowharNaqaty, Er. Neeraj Kumar (2021): This research paper assessed the use of demolished waste for partial replacement of coarse aggregates in varying percentages. The specimens were casted with 10%, 15% and 20% replacement of recycled coarse aggregate and tested after 7 & 28 days in Laboratory. Demolished concrete found to have lower bulk density, higher workability, crushing strength, impact value and water absorption value as compared to normal concrete.

Adarsh Krishna, Ankit Kumar Tiwari, A K L Srivastava(2023): aims at reuse of demolished concrete. The demolished waste had been collected from some college work site. Coarse aggregates were replaced by demolished waste in various proportions of 10, 20, 30 40, 50 and 100. When replaced by 50%, the compressive strength was observed 27.11 N/mm2 which is higher than target strength of 26.6 N/mm2. Hence, the concrete up to 50% replacement is more suitable for the regular construction works.

B. Objective

The aim of this study is to find out utilization of waste materials on concrete in order to investigate the feasibility of using materials from deconstructed buildings as the recycled concrete aggregate reduces the environmental pollution and to evaluate suitable percent of DCA as replacement of NA.

III. MATERIALS

A. Demolished Concrete Aggregate

Demolished concrete aggregate (DCA) 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 concrete aggregate is called Demolished concrete aggregate (DCA)

B. Steel Fibre Reinforced Concrete

Steel fibers are made of shredded steel wire having low percentage of carbon © or also known a stainless-steel mesh. The fibers can be flat, hooked or undulated. Undulated steel fibers are effective in a way that the concrete holds a better grip over the surface of the fibers. Steel fibers are short, discrete lengths of steel with an aspect ratio from about 30 to 150, and with any of several cross sections. Some steel fibers have hooked ends to improve resistance to pullout from a cement-based matrix. These are Most commonly used fiber. Their shape will be Round of diameter 0.25 to 0.75mm. they Enhances flexural, impact and fatigue strength of concrete and used for-overlays of roads, airfield pavements, bridge decks.

Fig.1. Steel Fiber Reinforced Concrete

C. Silica Fume

Silica Fume in Concrete Silica (also known as silicon dioxide, small) is one of the side effects of quartz and silicon reduce coal, iron and silicon composite material, when the peak electric heater flawlessly. Given the extraordinary precision and a high proportion of silica is a material viable unusual ash. Silicon is used as part of the gray concrete to improve its performance, such as compressive strength, adhesive strength and scratch resistance area, and the reduction of the porosity, along these lines, and also helps to protect the rebar consumption.

Fig.2. Silica Fume

D. Super plasticizer

Super plasticizer constitutes a relatively new category and improved version of plasticizer, use of which was developed in Japan and Germany during 1960 and 1970 respectively. Use of super-plasticizers permits the reduction of water to the extent up to 30% without reducing workability in contrast to the possible reduction up to 25% in case of plasticizers. The use of super plasticizer is practiced for production of flowing, self-leveling, self-compacting and for the production of high strength and high-performance concrete. It is the use of super plasticizer which has made it possible to use fly ash, slag and particularly silica fume to make high performance concrete.

IV. METHODOLOGY

A. 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. A steel mould in the form of frustum of cone is used in slump test which has the top diameter of 100 mm, bottom diameter of 200 mm and the height is 300 mm. According to Indian standard specification, the maximum size of the aggregate in concrete that can be used to perform slump test is restricted to 38 mm.

B. 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. For most of the works cubical molds of size 15cm x 15cm x 15cm are commonly used.

C. Tensile Strength Test

The split tensile test is an indirect way of evaluating the tensile test of concrete. In this test, a standard cylindrical specimen is laid horizontally, and the force is applied on the cylinder radially on the surface which causes the formation of a vertical crack in the specimen along its diameter. Split tensile strength test was conducted by using the method prescribed by IS5816-1999.The specimens were tested for 7 & 28 days the cylinder specimen was placed in horizontal direction on the testing machine.

D. 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. So that the load shall be applied without shock and increasing continuously at a stress increase at approximately 7 kg/sq mm that is at a rate of loading 400 kg/min for the 150 mm specimens

V. RESULT AND DISCUSSION

A. Workability Test

For the 50% replacement DCA with 0% silica fume, Steel fiber, Super plasticizer concrete, the slump value is 60 mm. The addition of silica fume reduced the water content, so workability of the concrete gradually reduced.

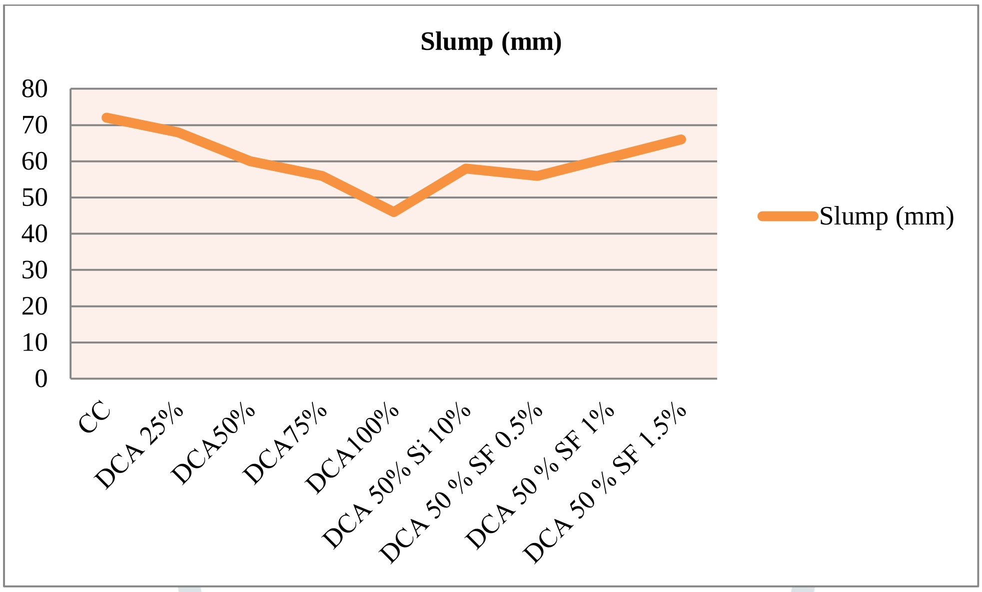

Fig.3. Bar Chart showing Slump cone test result

B. Density of Hardened Concrete

Density of control concrete is 2450 Kg/m^3 for the 50% replacement DCA with 0% silica fume, Steel fiber, Superplasticizer concrete, density is 2260 Kg/m^3. The addition of only silica fume or Steel fiber increases the density. The mix DCA 50 % Si 10% SF 1% SP 1% has density 2368 Kg/m^3.

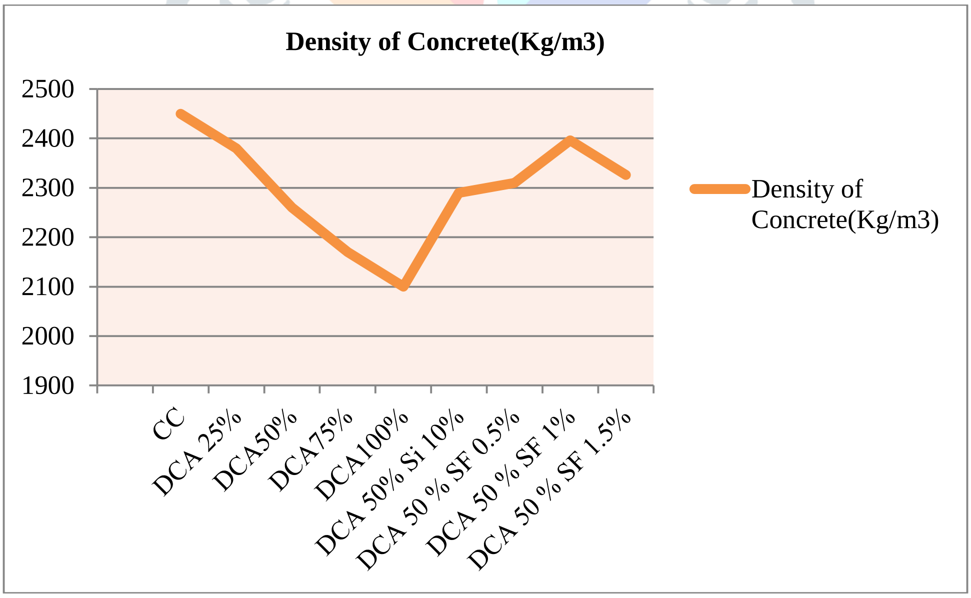

Fig.4. Bar Chart showing Density of concrete

C. Compressive Strength

Compressive strength of control concrete at 7 and 28 is 17.95 N/mm^2 & 33 N/mm^2 respectively, which decreases on replacing NA with DCA. The mix DCA 50 % Si 10% SF 1% SP 1% gives better compressive result as 40.61 N/mm^2 and 66.58 N/mm^2.

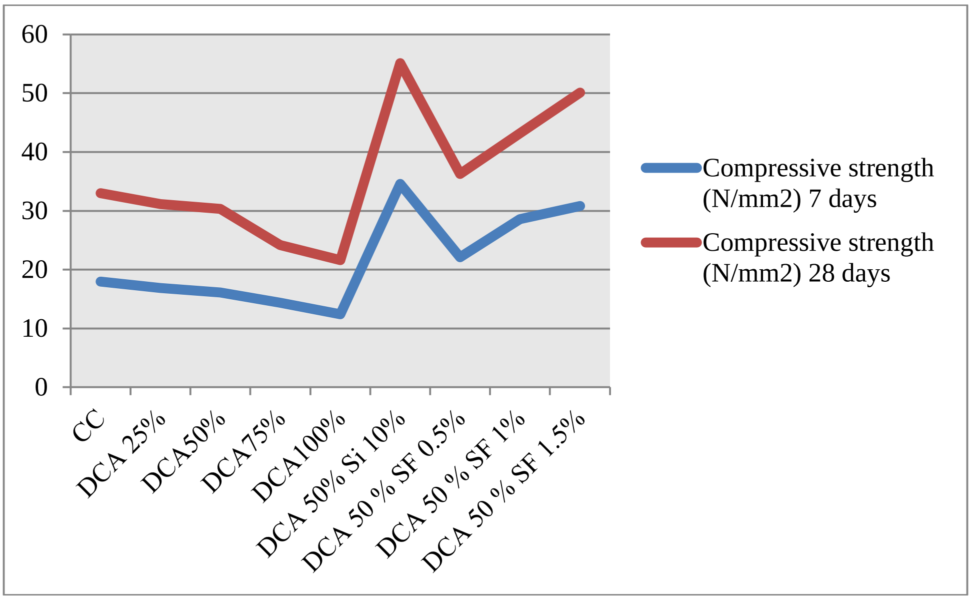

Fig.5. Bar Chart showing Compressive Strength test result of concrete

D. Split Tensile Strength

Split tensile strength of control concrete at 7 and 28 is 1.92 N/mm^2 & 3.42 N/mm^2 respectively, value decreases on replacing NA with DCA @ 25-100%. Concrete mix DCA 50 % Si 10% SF 1% shows good strength at 7days (2.89 N/mm^2) and Mix DCA 50 % SF 1.5% shows good strength at 28 days (7.91 N/mm2.But The mix DCA 50 % Si 10% SF 1% SP 1% gives better tensile strength on both 7 and 28 days as 2.93 N/mm^2 and 7.8 N/mm^2.

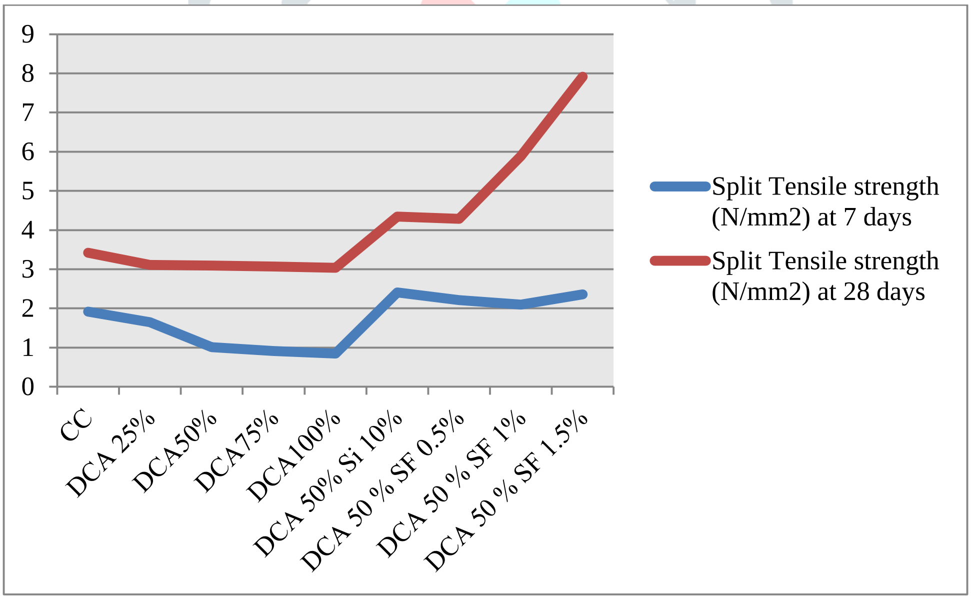

Fig.6. Bar Chart showing Split Tensile strength test result of concrete

E. Flexural Strength

Flexural strength of control concrete at 7 and 28 is 2.12 N/mm^2 & 4.56 N/mm^2 respectively, Value decreases on replacing NA with DCA @ 25-100%. The 28 days strength increases when adding SF & Si, but adding SP on mix separately, it decreases the strength. But combine effect of SP & Si, SP & SF increases the strength up to 12- 14 %. The mix DCA 50 % Si 10% SF 1% SP 1% gives better Flexural strength on both 7 and 28 days as 3.92 N/mm^{2}and 7.37 N/mm^2.

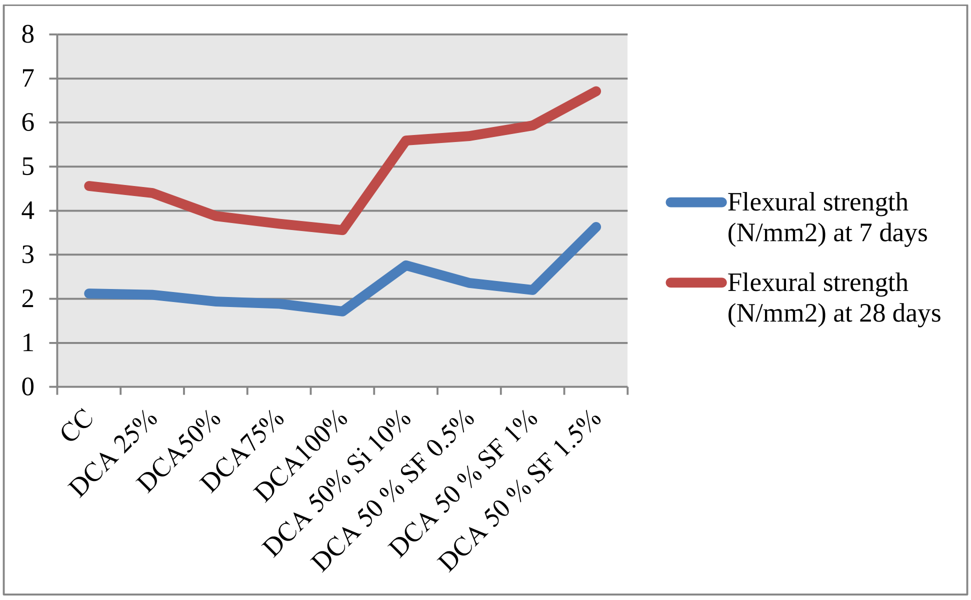

Fig.7. Bar Chart showing Flexural strength test result of concrete

VI. Conclusion

The experimental work has offered a test of the mechanical properties of concrete comprising DCA. This represents a recent trend of experiments using discarded waste and rubbish as substitute materials for the concrete's normal gravels. The following findings were discovered:

1. An increase in the DCA replacement ratio allows the effects of the slump to decrease. However, the results increased particularly the super-plasticizer effect when using additives, if mix time addition seven to eight minutes.
2. The mix DCA 50 % Si 10% SF 1% SP 1% gives better compressive result as 66.58 N/mm^2.
3. The mix DCA 50 % Si 10% SF 1% SP 1% gives better tensile strength on both 7 and 28 days as 2.93 N/ mm^2 and 7.8N/ mm^2. Mixing additives together (DCA50-Si-SP-SF1) displaying an increase of up to 50%.
4. Adding SP on mix separately, it decreases the strength. But combine effect of SP & Si, SP & SF increases the strength up to 12- 14 %. The mix DCA 50 % Si 10% SF 1% SP 1% gives better Flexural strength on both 7 and 28 days as 3.92N/ mm^2 and 7.37N/mm^2.
5. The Flexural Strength was increased up to 34% at (DCA50-Si-SP-SF1) when mixing additives together

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