Experimental Investigation on Mechanical Properties of M25 Grdae Concrete Containing DCA, Silica Fume and Steel Fiber

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Abstract— 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 purpose of this research is to investigate the mechanical properties of Demolished Concrete Aggregate (DCA) concrete. Five DCA concrete ratios are prepared experimentally by substituting, 0%, 25%, 50%, 75% and 100% of the gravel weight with DCA. While, the 10% of cement is substituted by silica fume (Si). Steel fibers acts as a bridge to retard their cracks propagation, and improve several characteristics and properties of the concrete. Fibers are known to significantly affect the workability of concrete. The aspect ratio and variable in this study were percentage of volume fraction (0, 0.5, 1.0 and 1.5) of steel fibers. Compressive strength, splitting tensile strength and flexural strength of the concrete were determined for the hardened properties. Their main purpose is to increase the energy absorption capacity and toughness of the material. But also, the increase in tensile and flexural strength is often the primary objective. A marginal improvement in the ultimate strength was observed. Adding steel fibers (SF) (0.5 %, 1.0 % and 1.5 %). The water absorption of recycled aggregates is higher than the natural aggregates. The range may vary based on the type of aggregates and in this case, it is 9% higher. This is also because of the attached mortar present on the aggregate surface which has a tendency to absorb more water. Concretemix DCA 50 % Si 10% SF 1% shows good strength at 7days (2.89N/mm2) and Mix DCA 50 % SF 1.5% shows good strength at 28 days (7.91 N/mm2).

***Index Terms*— Demolished Concrete Aggregate, Silica Fume, Density, Compression, Flexural, Splitting Tensile, Steel Fiber.**

1. Introduction

A. 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. 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.

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. As urbanization is increasing over time, the demand for new buildings and infrastructure has sharply risen. The existing old buildings are demolished to make way for new modern ones based on the need. With the steep increase in new construction the demand on natural aggregates has also risen. This leads to increased quarrying and subsequent depletion of natural aggregates.

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.

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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. *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.

2. Literature Review

Dr.R.Umamaheswari, Ajai.C (2021): The experimental investigations will carried to evaluate the effect of partial replacement of coarse aggregate by demolished waste on compressive strength and workability of demolished concrete. In this project, I will replace fine aggregates and coarse aggregates with the demolished concrete in the range 0%, 05%, 10%, 15% using M20, M25, and M30 grade of concrete. The prepared concrete mix will compare and test in terms of compressive strength and split tensile strength to conventional concrete.

Gandhi, et al., (2011): This paper evaluated the use of recycled aggregate in concrete. In this study recycled coarse aggregate have been used to replace virgin coarse aggregate. Natural aggregate had been replaced with demolished waste in varying percentages of 20%, 40%, and 60% 80% and 100%. Then the tests were carried out which include compression strength test to evaluate the strength of concrete.On comparing it was observed that the compressive strength first increased with the increase in percentage of recycled aggregate up to 60%.

Adarsh Krishna Ankit Kumar Tiwari, A K L Srivastava(2023) : aims at reuse of demolished concrete. Coarse aggregates were replaced by demolished waste in various proportions of 10, 20, 30 40, 50 and 100. Cubes, cylinder, beams were casted for different mix proportions and were kept under curing for 7, 14 and 28 days. Up to 30% replacement of fresh coarse aggregate, the compressive strength was found above 30 N/mm2.

Beenish Gowhar Naqaty1, Er. Neeraj Kumar2 (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.

3. 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 Fiber 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.

Fig.2. Silica Fume

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.

4. Methodology

To study the partial replacement of demolished waste in fresh (new) concrete, effect of demolished waste has been observed on the strength of concrete, by casting 84 specimens of cube, beam and cylindrical specimen in the laboratory of mix design of M25. The cement was used is OPC 43 cement. The physical tests conducted on cement to obtain properties of cement agreeing to the IS code1489-2015 & IS 4031 1988. A locally available river sand as fine aggregate confirming to IS-383-1970 and coarse aggregates (20mm) were used in the present investigation. The experiments result of the grading, physical properties, accomplished agreeing to specifications IS code 383-1970 The mix design is done as per IS 10262-2019. Coarse DCA was sourced from a building demolition and replaced natural aggregate at five weight ratios: 0 %, 25 %, 50 %, 75 % and 100 %. The used course DCA pass on through several stages before using are collecting, crashing and grading, then the material and sand separation and sieve analysis of particle size (20 mm). Silica fume (Si) utilized as replacement for further cement material. The Si was supplementary into the mix (substituting 10% of the weight of cement) to rise the attachment between DCA and the cement paste that improved the concrete strength.Steel fibers with two bent ends were used, the steel fibers (SF) added to the concrete composition at three weight contents 0.5 %, 1 % and 1.5 % with a diameter 0.55 mm and length 35 mm.

5. Result And Discussion

A. *Workability Test*

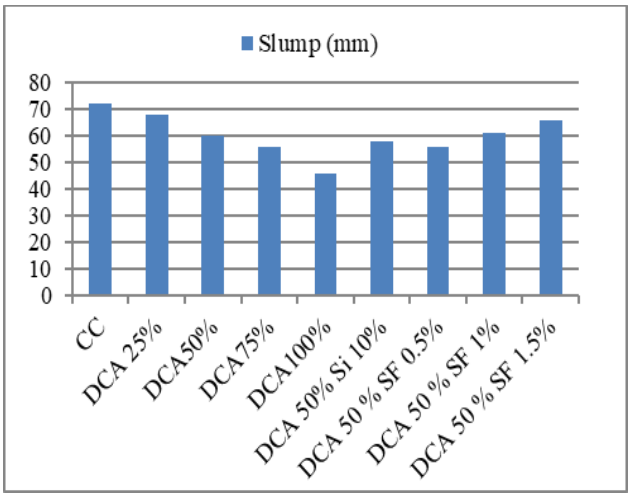

Fig.4. Bar Chart showing Slump cone test result

B. *Density of Hardened Concrete*

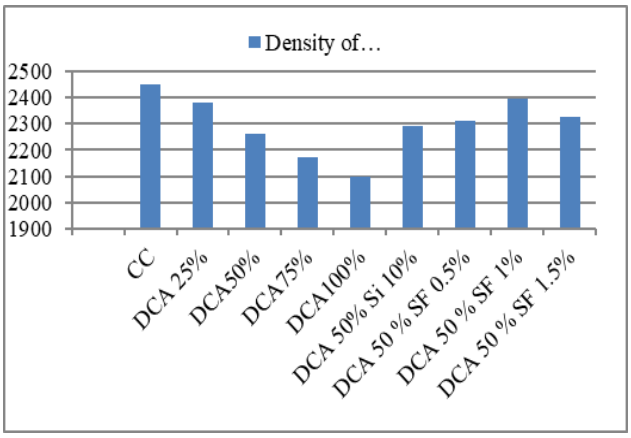

Fig.5. Bar Chart showing Density of concrete

C. *Compressive Strength*

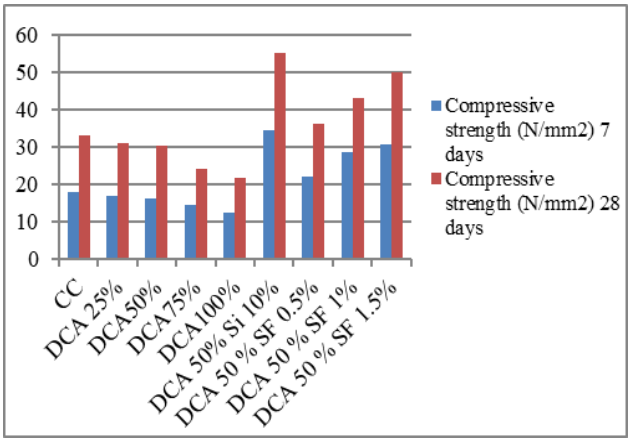

Fig.6. Bar Chart showing Compressive Strength test result of concrete

D. *Flexural Strength*

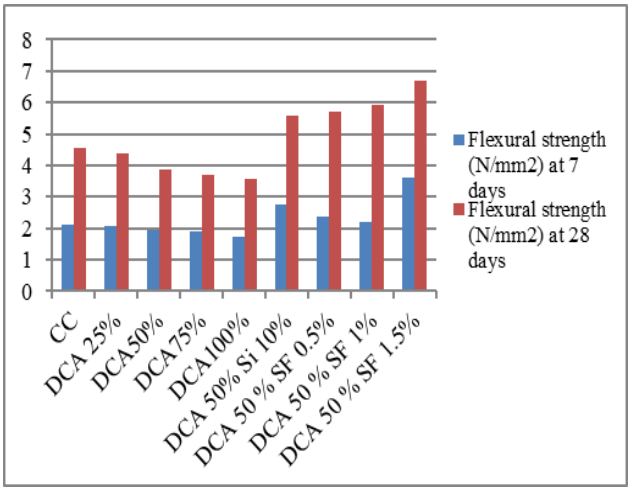

Fig.7. Bar Chart showing Flexural strength test result of concrete

E. Split Tensile Strength

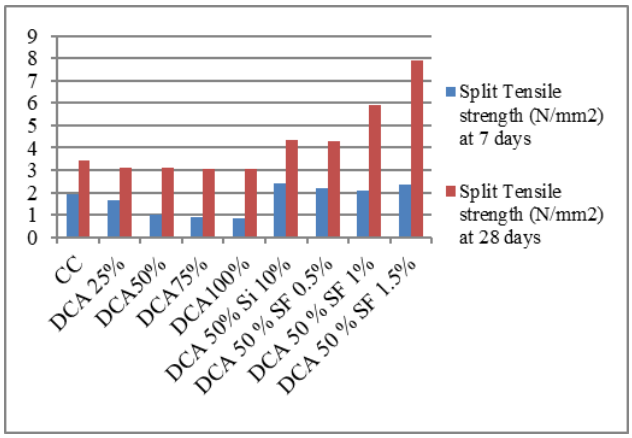

Fig.8. Bar Chart showing Split Tensile strength test result of concrete

6. 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.

- An increase in the DCA replacement ratio allows the effects of the slump to decrease.
- The density as reduced due to higher porosity of the DCA particles more than natural aggregate. Up to a 9%, concrete density reduction of the control mixture density can be accomplished by deducting considered quantities of coarse aggregate and substituting it with the DCA in the highest percentage used (DCA100).
- Compressive strength of control concrete at 7 and 28 is 17.95 N/mm2& 33 N/mm2 respectively, which decreases on replacing natural aggregates with DCA.
- DCA content has a little influence on the concrete tensile strength, displaying a reduction about 11 % at DCA 100%.
- Split tensile strength of control concrete at 7 and 28 is 1.92 N/mm2& 3.42 N/mm2respectively, value decreases on replacing NA with DCA @ 25-100%.
- Flexural strength of control concrete at 7 and 28 is 2.12 N/mm2& 4.56 N/mm2 respectively, Value decreases on replacing NA with DCA @ 25-100%. The 28 days strength increases when adding SF & Si.

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