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A Study On the Hardened Properties of M25 Grade Concrete Using Carbon Fibers and Its Evaluation by NDT

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ABSTRACT

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. concrete plays a vital role in the development of infrastructure buildings, industrial structures, bridges and highways etc. Leading to utilization of large quantity of concrete.The present project focuses on investigating characteristics of M25 grade concrete is choosen and aggregate mean size of 20mm is adopted Carbon fibers are added by 1% to the weight of cement.. It leads to examine the admixtures to improve the performance of concrete. The cubes, beams and cylinders are tested for both compressive, flexural, Concrete Core test, youngs-modulus strength tests were conducted for 7, 28, 56, 90 days and the results are compared to the conventional concrete. ND-Tests like rebound hammer and ultra-sonic pulse velocity were conducted. Cube specimens of size 150 mm, cylinder specimens of diameter 150,100 mm and height 300,150 mm respectively, beam specimens of size 100 mm and length 500 mm were casted.

Keywords: Fiber Reinforced Concrete, Type of Fiber, Admixture, Concrete Mix Design M25.

I. INTRODUCTION

Concrete is the most widely used man-made building material in the world, owing to its versatility and relatively low cost, concrete has also become the material of choice for the construction of structures exposed to extreme condition (Lomborg (2001)). Concrete plays a vital role in the development of infrastructure Viz.., buildings, industrial structures, bridges and highways etc, leading to utilization to large quantity of concrete. Fiber Reinforced Concrete (FRC) is a concrete meeting combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituents and normal mixing. This leads to examine the admixtures to improve the performance of the concrete.

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Within these different fibers that character of fiber-reinforced concrete changes with varying concretes, fiber materials , geo materials, distribution, orientation, and densities. Concrete has enormous resistance against compressive loads but weak in resisting tensile loads which causes cracks.

Carbon fibers were mostly used as a substitute for secondary reinforcement industrial floor slabs and prefabricated concrete products. In the recent years, the use of Carbon fiber-reinforced concrete (CFRC) has significantly increased in industrial pavements, roads, foundation slabs, tunnel segments, concrete cellars as an effective alternative to conventional reinforcement. Carbon fibers with cement produces a strong composite with superior crack resistance to improve structure durability, improved ductility and strength behavior prior to failure. The addition of Carbon fiber controls tensile cracks, and brittleness property increases compressive strength, Conventional concrete loses its tensile resistance after the formation of multiple cracks. However, fiber reinforced concrete can sustain a portion of its resistance following cracking to resist more cycles of loading. Plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of randomly distributes discontinuous fibers is to bridge across the cracks that develop provides some post cracking “ductility”.

They are typically short fibers that are chopped to a specific length from a few millimetres to several centimeters. The fibers are black in colour, and their surface may have a textured or rough appearance. They commonly used as a reinforcement material incomposite materials, where they help improve the strength and stiffness of the composite. Some properties of black chopped carbon fibers may include high strength, low weight, high modulus of elasticity and good thermal conductivity.

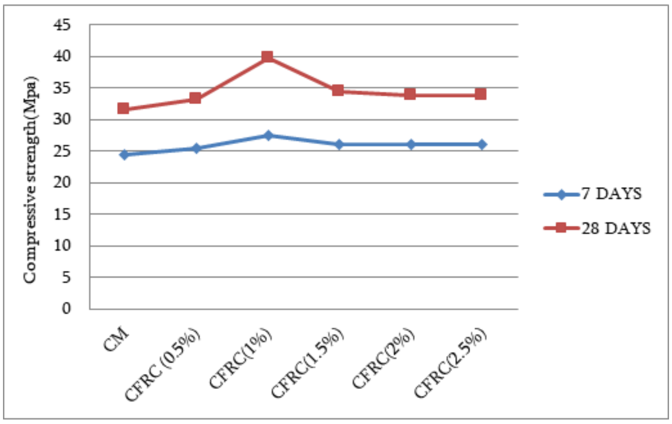
II. RESULTS AND DISCUSSION

Initially we conducted a series of compressive strength tests on different percentages of varying fibers to obtain the optimum percentage of carbon fibers. The cubes were casted for 0.5%, 1%,1.5%,2% and 2.5% of carbon fibers by weight of cement for 7 and 28 days.

From the results we conclude that the CFRC (1%) showed the optimum percentages of mixing carbon fibers into the concrete. Initially due to the addition of 0.5% ofcarbon fibers by weight of cement, the compressive strength was nearby as that of conventional concrete of M25 grade for 7 and 28 days then on addition of 1% of carbon fibers by weight of cement in concrete it increased suddenly by 24.4% by the conventional concrete of M25 grade concrete. The compressive strength decreased by some what when addition of 1.5% of carbon fibers.

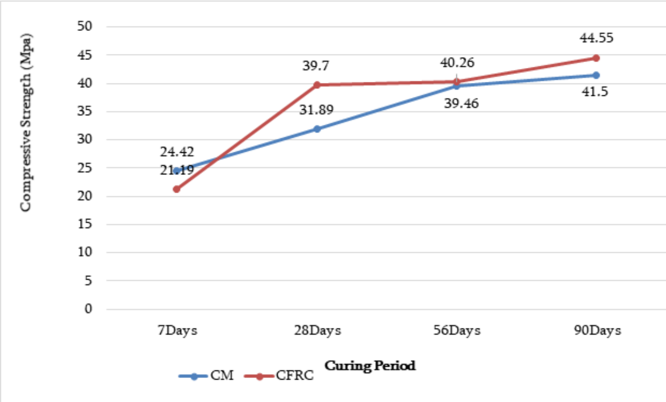
On comparision of compressive strength of 0%, 0.5%, 1%, 1.5%, 2%, and 2.5% of carbon fibers in the M25 grade concrete, we arrive at a point where 1% is choosen as optimum fiber content in concrete. A graph has been plotted between the different fiber contents showing the trend of increase.

A graph on comparision of varying percentages of fibers with CM.



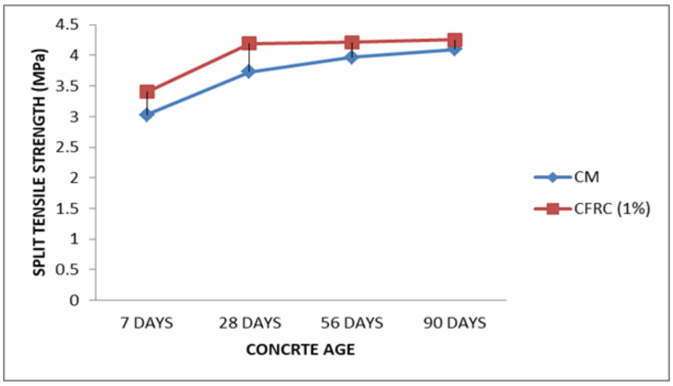
The results of the compressive strength of M25 grade concrete and Carbon fiber reinforced concrete for 7, 28, 56 and 90 days conducted are presented in graphical forms. A comparison on the strengths of control concrete and Carbon fiber reinforced concrete is done in a graphical representation.

A graph on Compressive Strength for different mixes at varying curing period.



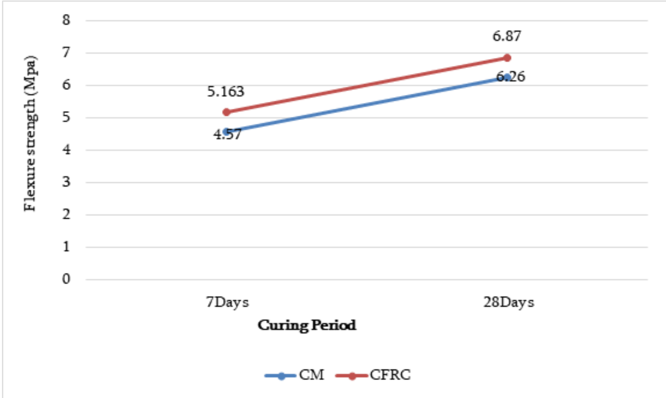
Compressive strength for the control mix M25 increases gradually from 7 to 90 days as well as the Carbon fiber reinforced concrete. In comparison, the CFRC (Carbon Fiber reinforced concrete) has a slight increase in the compressive strength than the conventional M25 grade concrete as observed in the presented chart above.

A graph on Split Tensile Strength for different mixes at varying concrete ages.



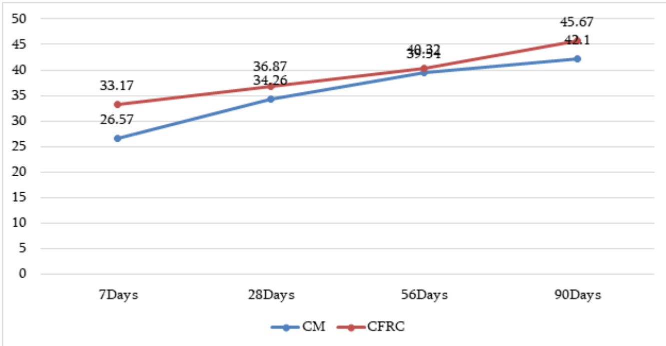
The Split tensile strength increases gradually with the amount of curing in both the mixes reaching up to 4.106 N/mm2 for conventional concrete and 4.25 N/mm2 for CFRC (Carbon Fiber Reinforced Concrete). As a result of addition of 1% carbon fibers to the M25 grade concrete we observe a significant increase of split tensile strength of about 12.33% than the conventional concrete.

A graph on Flexure Strength for different mixes at varying curing period.



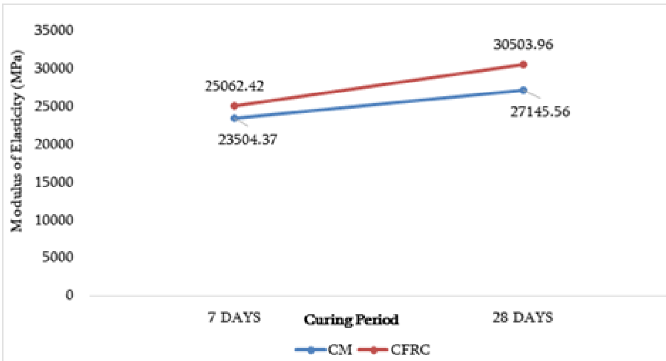
The Flexural strength for the control concrete of grade M25 reaches up to 6.26 Mpa for 28 days, but due to the addition of Carbon fibers in the control concrete the flexural strength increases to 6.87 Mpa that's about 9.7% than that of the control concrete.

A graph on Concrete Core Strength for different mixes at varying curing period.



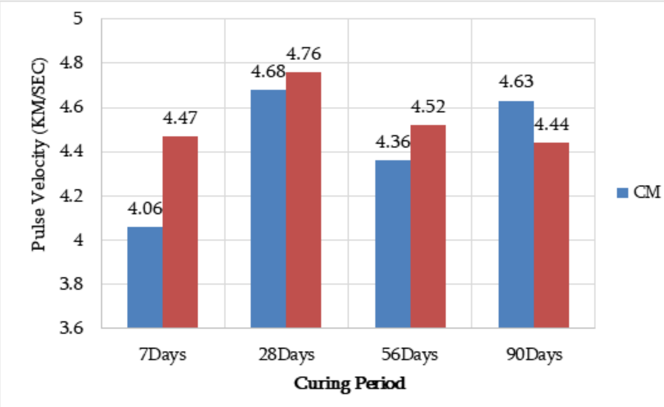
The Concrete Core strength for the control concrete of grade M25 reaches up to 34.26 Mpa for 28 days, but due to the addition of Carbon fibers in the control concrete the Concrete Core strength increases to 36.87 Mpa that's about 5.8% than that of the control concrete.

A graph on the comparision of mean modulus of elasticity.



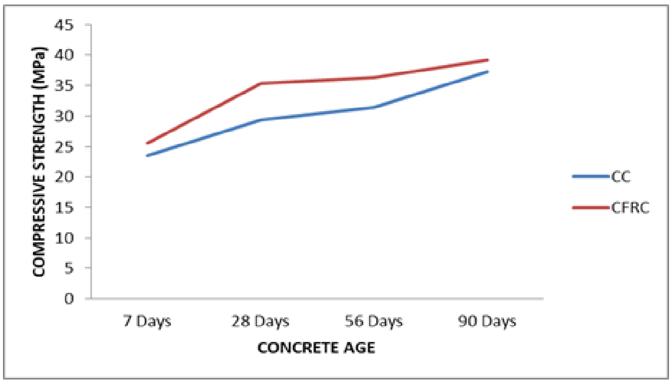
From observations on the graph shown above, there can be observed a significant increase in the Modulus of elasticity of the Carbon Fiber Reinforced Concrete (CFRC) specimen when compared to control concrete specimen at both 7 and 28 days.

Graph on comparison of pulse velocity of different mixes.



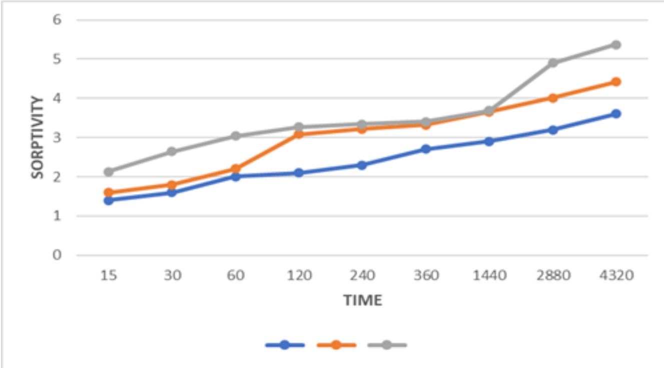
The pulse velocity for the control concrete reaches up to 4.68 Mpa for 28 days, but due to the addition of Carbon fibers in the control concrete the pulse velocity increases to 4.76 Mpa that's about 1.7% than that of the control concrete.

A graph showing the comparision of Approximate Compressive strength based on the rebound number.

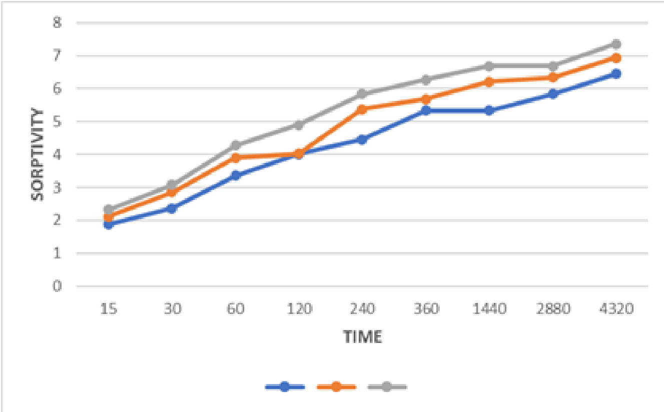


The Avg compressive strength of rebound for the control concrete reaches up to 28 Mpa for 28 days, but due to the addition of Carbon fibers in the control concrete the Avg compressive strength of rebound increases to 30 Mpa that's about 7.1% than that of the control concrete.

A graph on Sorptivity values for control mix M25 grade concrete.

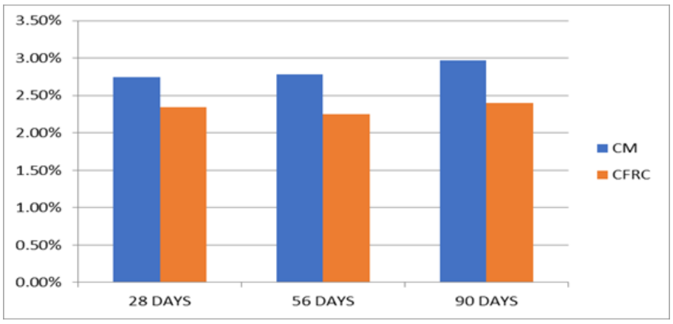


A graph on Sorptivity values for CFRC(1%).



The values obtained for CM of M25 grade and CFRC (1%), all the results are in the range of "Excellent to Good". The addition of fibers gives some good results in durability criteria. The CFRC (1%) shows the better results when compared to control concrete.

A graph on comparison of Water absorption for both the mixes.



The concrete specimens of both CM of grade M25 and CFRC(1%) have a water absorption range <3%, they fall under the category of "Very Good Concrete".

III. CONCLUSION

- The targent strength achevied for M25 grade concrete is 31.89 Mpa.
- The carbon fiber of 1% is obtained as optimum by conducting compressive strength tests for different ratios of fiber content.
- Compressive strength of M25 grade concrete by addition of carbon fiber gives 24.4% increased at 28 days w.r.t control mix.
- Split tensile strength of M25 grade concrete by addition of carbon fiber gives 12.33% increased at 28 days w.r.t control mix.
- Flexural strength of M25 grade concrete by addition of carbon fiber gives 9.7% increased at 28 days w.r.t control mix.
- Modulus of elasticity of M25 grade concrete by addition of carbon fiber gives 12.3% increased at 28 days w.r.t control mix.
- Concrete core test of M25 grade concrete by addition of carbon fiber gives 5.8% increased at 28 days w.r.t control mix.
- Destructive testing methods gives the better results compared to the nondestructive tests.
- With addition of fiber content to the normal conventional concrete durability studies shows the better results.

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