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Experimental Investigation on Hybrid Fiber Reinforced Green Cement Concrete

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Abstract: *In this experiment the beams and cubes were cast by adding fibre in green cement concrete and ordinary conventional concrete. Green cement from bagasse ash is used to reduce the CO₂ emission in the concrete. The project work deals with the comparative study on compressive strength and flexural strength of hybrid fibres reinforced green cement concrete and hybrid fibres reinforced opc concrete. Plain concrete possess a very low tensile strength, limited ductility and little resistance to cracking. So, the development of such micro cracks is the main cause of inelastic deformation in concrete. It has been recognized the addition of small, closely spaced and uniformly dispersed fiber to concrete would act as crack arrester and would substantially improve static and dynamic properties. Hybrid fibers such as coir and steel wires are used to increase the tensile strength in OPC and green cement concrete in this project. Two different percentages 0.5% and 1% are taken as volume based such as coir fibres and steel fibres were added to the concrete M₂₅ grade. The compression test and flexural test were conducted on cubes and beams and their results were compared and reported.*

I. INTRODUCTION

Concrete is a homogeneous material of cement, fine aggregate, coarse aggregate and water. It is very strong in carrying compressive forces and hence in gaining importance as building materials throughout the world. By the judicious use of available materials for concrete making and their proportioning concrete mixes are produced to have the desired properties in the fresh and hardened stages as per situation demand. Due to the benefits the use of fibre reinforced concrete has steadily increased during the last two decades and its current field of application includes in all high cost building to attain more strength with low cost construction. Bagasse is a lateral product of cane sugar that despite its several uses in industry due to not being correctly used is known as an agricultural waste and causing pollution to the environment and consequently energy waste. The research into the use of bagasse ash in cement has been undertaken many years ago.

A. Green Cement

Eco-friendly cement is obtained by partial replacement of cement with certain low cost waste materials. Sugarcane bagasse ash is one such material which is residue resulting from the burning of sugarcane bagasse in boilers for power generation.

Sugarcane bagasse ash is a waste material and being disposed to open landfills causing serious environmental impacts. In this study an attempt has been made to use this ash as partial replacement in ordinary Portland cement by 10 weight%. Hence bagasse ash is a potential material for cement production.

B. Need For Green Cement

Manufacturing of Portland cement is a resource exhausting, energy intensive process that releases large amount of the greenhouse gas CO₂ into the atmosphere. Production of one ton of Portland cement requires about 2.8 tons of raw materials, including fuel and other materials. As a result of de-carbonation of lime, manufacturing of one ton of cement generates about one ton of CO₂.

The cement industry has been pointed out as one of the major contributors of anthropogenic CO₂ emissions with about 5% globally. Bagasse ash can be utilized to possible addition of bagasse ash as supplementary cementitious material.

C. Hybrid Fibres Reinforced Concrete

Hybrid fibres reinforced concrete (HFRC) is a concrete containing fibrous material which increases its structure integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibers, glass fibers, synthetic fibres and natural fibres. Within these different fibres character of fibres reinforced concrete changes with varying concrete, fibres, materials, geometries, distribution, orientation and densities.

II. MIXING

Mixing of fibres reinforced concrete needs careful conditions to avoid balling of fibres, segregation and the difficulty of mixing the materials uniformly. Increase in the aspect ratio, volume percentage, size and quantity of coarse aggregate intensity the difficulties and balling tendencies. Steel fibres content in excess of 2% by volume and an aspect ratio of more than 100 is difficult to mix. Mixing of concrete may be done by any one of the conventional method of hand mixing or machine mixing. But it's necessary to have a uniform dispersion of fibres and aggregate constituents to prevent segregation or balling of aggregate during mixing.



Fig 1. Mixing of Fibres with cement

III. CASTING

The test cube, beam and cylinder specimen were made after mixing and in such as to produce full compaction of the concrete with neither segregation nor excessive laitance. Since this of hybrid fibres reinforced concrete, the lower half of the moulds was filled with steel fibre reinforced concrete and the upper half of the moulds were filled with coir fibre reinforced concrete. In placing each scoopful of concrete, the scoop is required to be moved around the top edge of the mould as the concrete slides from it, in order to ensure a symmetrical distribution of the concrete within the mould. Each layer is compacted by hand using the standard tamping rod and the strokes of the rod are distributed in a uniform manner over the cross section of the mould. The number of strokes per layer required to produce the specified condition vary according to the type of concrete. For cubical specimen, in no case should the concrete be subjected to less than 35 strokes per layer for 15cm or 25 strokes per layer for 10cm cubes. For cylindrical specimen, the numbers of strokes are not less than thirty per layer.

IV. RESULTS AND DISCUSSION

A. Comparison of Compression Strength Test Results

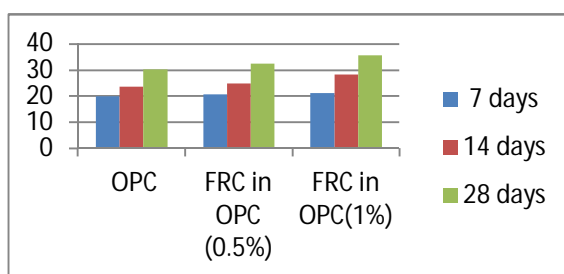


Fig 2. Bar chart for the compressive strength for OPC, FRC (0.5%) in OPC and FRC (1%) in OPC

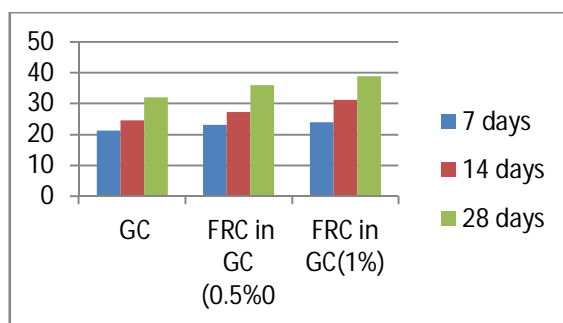


Fig 3. Bar chart for the compressive strength for GC, FRC (0.5%) in GC, FRC (1%) in GC

B. Comparison Of Flexural Strength Test Results

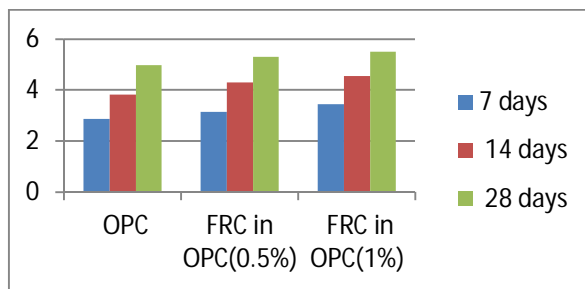


Fig 4.Bar chart for the Flexural strength for OPC, FRC(0.5%) in OPC, FRC (1%) in OPC

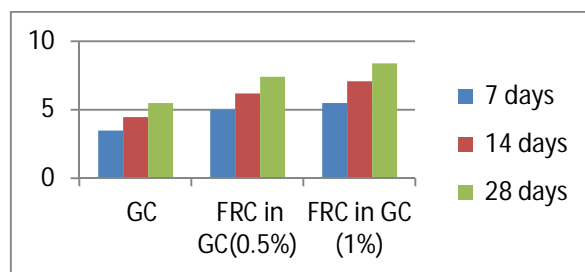


Fig 5.Bar chart for the Flexural strength for GC, FRC (0.5%) in GC, FRC (1%) in GC

The fabrication and casting of green cement cubes and beams are less expensive when compared to conventional concrete specimens. The usage of green cement will prevent the CO₂ emission in the concrete. The various mix percentages (0.5% and 1%) of the coir and steel fibres were added in the GC and OPC concrete. The cubes and beams were tested to find the compression and flexural strength and we have found that Fibres reinforced green cement concrete (1%) ratio gives the compressive strength as 38.87N/mm². Compressive strength is a measure of load at the instance of failure. The crushing or compressive strength of M25 grade concrete should not be less than 31.6 N/mm². The result shows that, GC and hybrid fibres are good in strength. The flexural strength results also same as the conventional concrete and provides satisfactory results.

V. CONCLUSION

After testing compressive strength of Green cement concrete and fibres reinforced green cement concrete (0.5% and 1%) strength it was found to be increased when comparing the ordinary Portland cement concrete and fibres reinforced concrete. A hybrid fibre volume fraction of fibres reinforced green cement concrete (1%) with 50-50% steel-coir combination significantly improves the compressive strength of concrete as well as the flexural strength. The hybrid fibre reinforced green cement concrete specimen exhibit enhanced strength in flexure. As per the result, we stated that the flexural strength and compressive strength of fibres reinforced in opc and green cement concrete are much more than plain OPC and GC concrete. Green cement reduces CO₂ emission in concrete and high compressive strength and flexural strength. To reduce crack widths and control the crack widths tightly, thus improve durability, To improve ductility To reduce steel reinforcements.

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