IMPACT OF ELEVATED TEMPERATURES ON THE STRENGTH PROPERTIES AND MICROSTRUCTURE STUDY OF FIBRE (CARBON AND POLYPROPYLENE) REINFORCED CONCRETE

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Keywords

Fibre, compressive strength, elevated temperature, microstructure

Introduction

Fiber reinforced concrete (FRC) is a building material whose utilization in the concrete industry has been rapidly increasing. This development is motivated by its physical and mechanical properties which contribute to traditional concrete elements and structures various economic benefits such as structure stability, part or full elimination of conventional reinforcement, enhanced impact resistance, resistance to mechanical loads and environmental loads. Recently, many comprehensive studies have been undertaken with the aim to observe the mechanical behaviour of FRC exposed to elevated temperature.

Although concrete is well-known for a high degree of fire resistance, high temperature seriously damages microstructure and macrostructure which results in generalised mechanical decay of a concrete composite. As a consequence, the extensive knowledge of mechanical properties of FRC exposed to elevated temperature seems to be decisive for a wider utilization of the material. The fire response of concrete composites is closely associated with concrete composition, particularly with a type and content of concrete components used. Generally speaking, concrete made of siliceous aggregates, such as granite, shows unfavourable mechanical properties at high temperature compared to concrete composed of calcareous aggregates such as dolomite and limestone.

In the present study, experimental investigation is carried out on carbon and polypropylene fibre reinforced concrete and subjected to elevated temperatures. Microstructure imaging characterization of fibre solid particles is also examined.

Objectives

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. The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. The main objectives of the project are

1. To investigate the influence of fibers (Carbon and Polypropylene) on strength property of concrete under different temperatures (200°, 400°, 600° C).

2. To study the microstructure behaviour of Carbon and Polypropylene fibre reinforced concrete specimens subjected to different temperatures.
3. To examine the microstructure imaging characterization of fibre solid particles.

Methodology

In the present study, the experimental investigation is carried out on fibre reinforced concrete subjected to elevated temperatures.

1) Collection of materials required.
2) Characterization of materials.
3) Designing the mix of concrete grade M40 using IS 10262:2019 code.
4) Mixing of the materials and carrying out the workability tests.
5) Casting the specimens required for compressive strength test.
6) Curing the specimens for 7 and 28 days in water.
7) To conduct the thermal analysis at different temperatures.
8) To conduct the respective strength test.
9) To conduct Scanning Electron Microscope (SEM) test.

Materials and Mix Proportions

1. Grade of Concrete- M 40 [1: 1.42: 3.33: 0.36]
2. Specific gravity of cement- 2.95
3. Specific gravity of fine aggregate- 2.40
4. Specific gravity of coarse aggregate- 3.05

Material Quantities

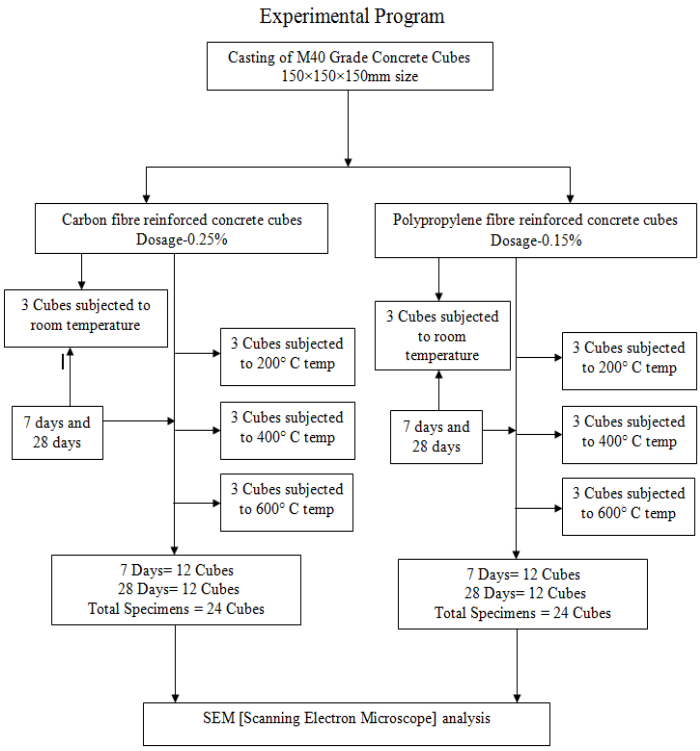
- Cement- 412 kg.
- Fine Aggregate- 589 kg.
- Coarse Aggregate- 1374 kg.
- Water-148 kg.
- w/c ratio- 0.36.
- Chemical Admixture- 4.12 kg.

From extensive literature review, Optimum dosages of carbon fibre and polypropylene fibre have been obtained.

Optimum Dosage of Carbon Fibre- 0.25%. [Mand Kamal Askar et al (2023), Xiuquan Ji et al (2023), Dejia Liu et al (2018), Safiuddin (2018), Biswajit, Jena M (2016)] & Optimum Dosage of Polypropylene- 0.15%. [Bhagwat Yamuna (2023), Anthony Nkem Ede (2014), Roohollah Bagherzadeh , Hamid Reza Pakravan (2012)].

Carbon fibre

Polypropylene fibre



Results and Conclusions

Based on above experimental program, cubes for 7 days and 28 days are casted for both carbon and polypropylene fibre reinforced concrete. Awaiting the strength results after subjecting it to elevated temperatures (200°, 400°, 600° C).

Workability Test

Slump readings

1. 100mm
2. 90mm
3. 120mm

Cubes casted for Carbon fibre reinforced concrete

Innovation in the Project

Considerable literature is available on Impact of elevated temperatures on the strength and mechanical properties of fibre (Carbon and polypropylene) reinforced concrete. Many researchers have carried out influence of fibre on strength and mechanical properties only. Very few literature papers are available on elevated temperatures. Present study incorporates the study of fibres influence on strength property and microstructure analysis for elevated temperatures. The behaviour of fibres under elevated temperatures and characterization of fibre solid particles will be studied.

Future Work Scope

The work can be extended to study the strength properties of concrete under elevated temperatures for different types of fibres, combination of fibres etc.

XRD analysis can also be studied to understand the crystallographic structure, chemical composition, and physical properties of a material.

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