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Influence of Elevated Temperature on the Fracture Parameters of Basalt Fiber High Strength Concrete

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Abstract- Fire accidents, sabotages or natural hazards are the situations where concrete is likely to get exposed to elevated temperatures. Exposure to elevated temperature causes Physical changes including large volume changes due to thermal dilations, thermal shrinkage and creep related to water loss. The volume changes can result in large internal stresses and leadto micro-cracking and fracture. Elevated temperatures also cause chemical and micro- structural changes such as water migration, increased dehydration, interfacial thermal incompatibility and the chemical decomposition of hardened cement past and aggregate. All these changes decrease the stiffness of concrete and increase the irrecoverable deformation. The mechanical properties must be accurately predicted after the fire as they are crucial for the further usage of concrete structures. In view of all above, the present project is taken up tostudy the effect of elevated temperatures studies on the strength parameters and fracture parameters of plain and basalt fiber high strength concrete. In the present project, influence of elevated temperature on the strength parameters and fracture parameters was studied on 90 plain concrete specimens (18 Cubes + 36 Prisms+ 36 Cylinders) and 90 Basalt fiber reinforced concrete specimens (18 Cubes + 36 Prisms+ 36 Cylinders) for Compressive strength, Flexural strength, Split Tensile strength, Modulus of elasticity, Fracture energy and Fracture toughness. Specimens were tested at the end of 28 days of conventional curing for 100^{0}C, 300^{0}C, 500^{0}c, 700^{0}C and 900^{0}C temperatures for 02 hours in a high temperature furnace of 1000^{0}C capacity. The percentage decrease in average residual compressive strength at 100^{0}C for plain and basalt fiber concrete cubes is 4.7% and 1.84% respectively. The percentage decrease in average residual compressive strength at 300^{0}C for plain and basalt fiber concrete cubes is 8.5% and 4.9% respectively.

Key Words- Basalt Fiber High strength Concrete, Fire accidents, Flexural strength, Split Tensile strength

I. INTRODUCTION

High Strength Concrete (HSC) can be developed through microstructure enhancement techniques with cementitious material s. For high-strength concrete, it is always essential to have a combination of mineral and chemical admixture to ensure achievement of required strength. HSC is characterized by high compressive strength. HSC is

- Use of nominal maximum size coarse aggregates between 9.5-12.5 mm
- Use of fine aggregate having fine Modulus between 2.8-3.2

II. EXPERIMENTAL PROGRAMME

Two trial castings have been done to find out the optimum percentage of super plasticizer at an interval of 0.5% and optimum percentage of basalt fiber at an interval of 0.25%. From the results it is found that optimum percentage of super plasticizer as 1.5% and optimum percentage of basalt fiber as 1.25%.

Table 1. Trial casting with Master Ease 3709.

S. No	Cube Designation	% of basalt fiber	Average Compressive strength(Mpa)
1	E-1	0.50	67
2	E-2	1.00	73
3	E-3	1.25	79
4	E-4	1.50	76

III. RESULTS AND DISCUSSIONS

The percentage decrease in average residual compressive strength at 3000C for plain and basalt fibre concrete cubes is 8.5% and 4.9% respectively. The percentage decrease in average residual compressive strength at 5000C for plain and basalt fibre concrete cubes is 9.7% and 5.5% respectively. The percentage decrease in average residual compressive strength at 7000C for plain and basalt fibre concrete cubes is 46.9% and 28.8% respectively.

The percentage decrease in average residual compressive strength at 9000C for plain and basalt fibre concrete cubes is 81.7% and 59.5% respectively. Between 1000C to 9000C, the percentage decrease in residual compressive strength was increased for both plain concrete cubes and basalt fiber concrete cubes.

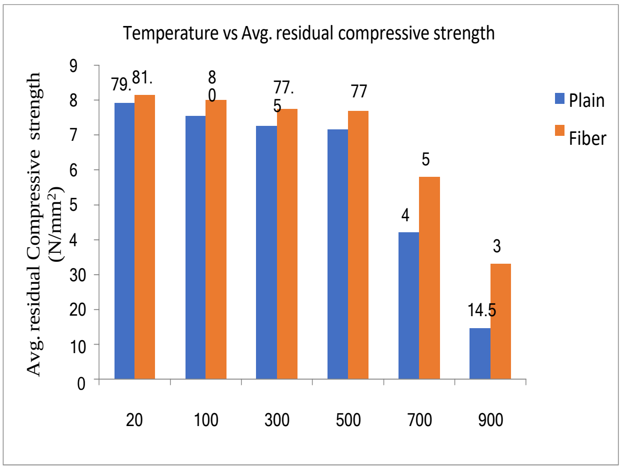

Fig 1. Average residual Compressive strength of Plain and Basalt fiber concrete cubes at different temperatures.

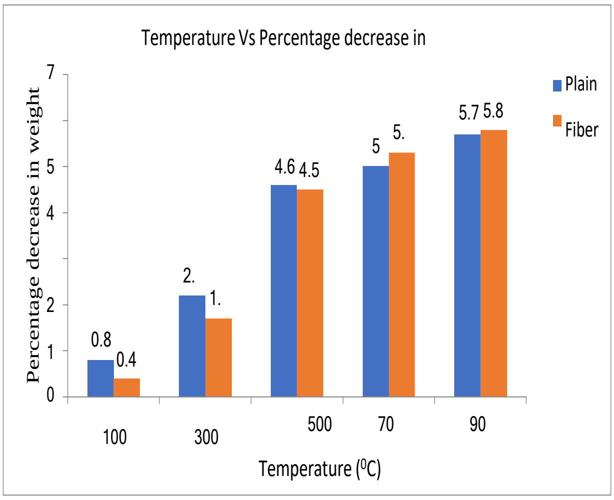

Fig 2. Percentage decrease in weights of plain concrete cubes and fiber concrete cubes at different temperature.

The decrease in residual compressive strength between 5000C and 7000C may be attributed to de-composition of the cementing compound C-S-H with its different phases, de-hydration of calcium hydroxide (CH) into free lime.

These changes would have affected the volume occupied by these cementitious products and when combined with the weakened cohesion between the mixture constituents due to the different expansions experienced by each of them.

At 9000C the residual compressive strength was attributed to the de-composition of calcium carbonate through the loss of CO2 and the free water might have lost.

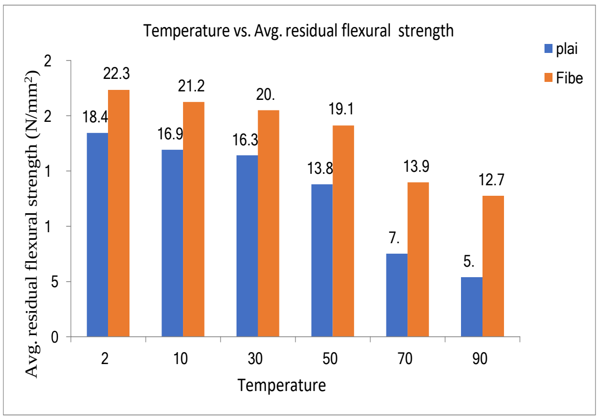

Fig 3. Residual Flexural strength of plain concrete prisms and fiber concrete prisms at different.

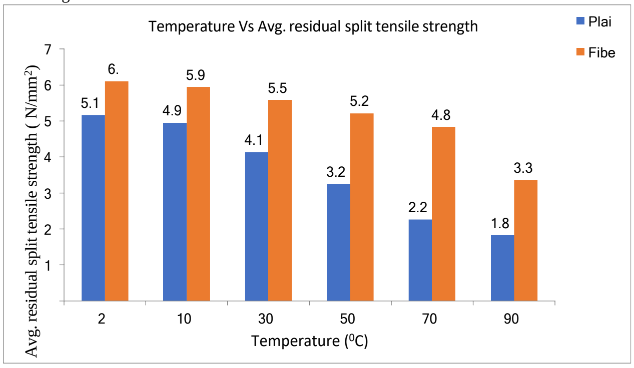

Fig 4. Average residual split tensile strengths of plain concrete cylinders and fiber concrete cylinders at different Temperatures.

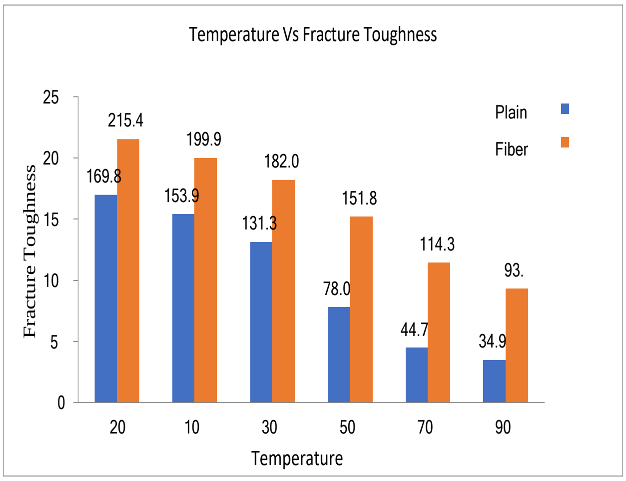

Fig 5. Fracture Toughness of Plain and basalt Fiber concrete prisms at different temperatures.

IV. CONCLUSIONS

The percentage decrease in average residual compressive strength at 1000C for plain and basalt fibre concrete cubes is 4.7% and 1.84% respectively. The percentage decrease in average residual compressive strength at 3000C for plain and basalt fibre concrete cubes is 8.5% and 4.9% respectively. The percentage decrease in average residual compressive strength at 5000C for plain and basalt fibre concrete cubes is 9.7% and 5.5% respectively.

The percentage decrease in average residual compressive strength at 7000C for plain and basalt fibre concrete cubes is 46.9% and 28.8% respectively. The percentage decrease in average residual compressive strength at 9000C for plain and basalt fibre concrete cubes is 81.7% and 59.5% respectively. Between 1000C to 9000C, the percentage decrease in residual compressive strength was increased for both plain concrete cubes and basalt fiber concrete cubes.

The decrease in residual compressive strength between 5000C and 7000C may be attributed to decomposition of the cementing compound C-S-H with its different phases, dehydration of calcium hydroxide (CH) into free lime. The decrease in compressive strength at 900C may be attributed to the decomposition of calcium carbonate through the loss of CO2 and the loss of all free water.

The percentage decrease in average residual flexural strength at 1000C for plain and basalt fibre concrete prisms is 8.4% and 4.9% respectively. The percentage decrease in average residual flexural strength at 3000C for plain and basalt fibre concrete prisms is 11.2% and 8.27% respectively. The percentage decrease in average residual flexural strength at 5000C for plain and basalt fibre concrete prisms is 25.2% and 14.36% respectively. The percentage decrease in average residual flexural strength at 7000C for plain and basalt fibre Concrete prisms is 59.35% and 37.5% respectively. The percentage decrease in average residual flexural strength at 9000C for plain and basalt fibre concrete prisms is 70.7% and 42.9% respectively.

The percentage decrease in average residual split tensile strength at 1000C for plain and basalt fibre concrete cylinders is 4% and 2.62% respectively. The percentage decrease in average residual split tensile strength at 3000C for plain and basalt fibre concrete cylinders is 19.9% and 8.52% respectively.

The percentage decrease in average residual split strength at 5000C for plain and basalt fibre concrete cylinders is 37% and 14.59% respectively. The percentage decrease in average residual split tensile strength at 7000C for plain and basalt fibre concrete cylinders is 56.2% and 20.81% respectively. The percentage decrease in average residual split tensile strength at 9000C for plain and basalt fibre concrete cylinders is 64.7% and 45.08% respectively.

The percentage decrease in average Fracture energy at 1000C for plain and basalt fibre concrete prisms is 15.52% and 9.48% respectively. The percentage decrease in average Fracture energy at 3000C for plain and basalt fibre concrete prisms is 38.48% and 20.37% respectively. The percentage decrease in average Fracture energy at 5000C for plain and basalt fibre concrete prisms is 71.9% and 42.66% respectively.

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The percentage decrease in average Fracture energy at 7000C for plain and basalt fibre concrete prisms is 87.7% and 61.75% respectively. The percentage decrease in average Fracture energy at 9000C for plain and basalt fibre concrete prisms is 91.1% and 68.1% respectively.

The percentage decrease in average Fracture toughness at 1000C for plain and basalt fibre concrete prisms is 9.34% and 7.2% respectively. The percentage decrease in average Fracture toughness at 3000C for plain and basalt fibre concrete prisms is 22.64% and 15.5% respectively.
The percentage decrease in average Fracture toughness at 5000C for plain and basalt fibre concrete prisms is 54.03% and 29.51% respectively. The percentage decrease in average Fracture toughness at 7000C for plain and basalt fibre concrete prisms is 73.6% and 46.93% respectively. The percentage decrease in average Fracture toughness at 9000C for plain and basalt fibre concrete prisms is 79.4% and 56.79% respectively.

The percentage decrease in fracture energy and Fracture toughness was increased for both plain concrete prisms and basalt fiber concrete prisms with the increase in the temperature due to the stiffness degradation of the specimens.

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