Potential Utilization of Steel and Polypropylene Fibre on Ternary Blended Concrete

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***Abstract*—The present paper focuses on investigating the characteristics of M30 concrete with addition of Steel and Polypropylene fiber on a ternary blended concrete made out of Ground Granulated Blast Furnace slag (GGBS) and Sugar cane Bagasse ash. Here specimens are cast by adding Steel fiber at (0.5,1.0,1.5,2.0)% by volume of concrete and Polypropylene Fiber at (0.1,0.2,0.3,0.4)% by volume of concrete to the ternary blended concrete(TBC). It was found that the optimum dosage for Steel Fiber was 1.5% and that for Polypropylene was 0.3%.**

Keywords*—GGBS, Sugarcane Bagasse ash, Ternary Blended concrete, Fibre reinforced concrete(FRC).

I INTRODUCTION

Concrete is a versatile engineering material and its popularity as a basic building material is because of its good durability, ease with which it can be manufactured, the ability to mould it into any shape and size and its high compressive strength. But it has the demerits that plain concrete possess a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of the micro cracks, eventually leading to the brittle fracture of the concrete. Fiber reinforced concrete (FRC) is defined as the concrete made with hydraulic cement, containing fine or fine and coarse aggregate with discontinuous discrete fibers. FRC could play an important role to reduce the above mentioned problems.

Another important aspect is that since cement being inevitable in the production of concrete cement production is a significant source of global carbon dioxide (CO_2) emissions, making up approximately 2.4 percent of global CO_2 emissions from industrial and energy sources. The solution for this is to make binary or ternary blended concrete having Supplementary Cementitious Materials (SCM) which could have reduce the cement usage and also reduce the cost of concrete.

As a solution to the stated problems this study examines the effect of addition of fiber such as steel and polypropylene to a Ternary Blended Concrete (TBC), a concrete made with ordinary Portland cement with two other Supplementary Cementitious Materials. In this study the selected composition is 30% cement replacement by Ground Granulated Blast Furnace Slag (GGBS) and 10% cement replacement by Sugar cane Bagasse ash (BA).

I. OBJECTIVE

- To form a control mix with optimum cement replacement of
- GGBS by 30% by weight of cement and BAGASSEASH by 10% weight of cement.
- To add fiber to this control mix with Polypropylene fiber 0.1,0.2,0.3,0.4% by volume of concrete and Steel Fiber 0.5,1,1.5,2.0 % by volume of concrete.
- To find the optimum dosage of steel and polypropylene fiber.
- To perform regression analysis.

II METHODOLGY

- Material Testing
- Casting of Specimens
- Testing for Compressive strength, Flexural strength, Impact resistance, Modulus of elasticity, Split tensile strength.

The properties of the tested material are shown below.

1) Cement:

Ordinary Portland cement, 53 Grade conforming to IS: 8112-1989. The specific gravity of cement was 3.14.

2) Fine aggregate

M.Sand conforming to Grading zone II of IS: 383 1970. Its specific gravity was 2.61

3) Coarse aggregate

Locally available crushed granite stones conforming to graded aggregate of nominal size 20 mm as per IS: 383 – 1970.

4) Ground Granulated Blast Slag (GGBS)

Ground granulated blast furnace slag obtained from Bangalore. Ground granulated blast-furnace slag is the granular material formed when molten iron blast furnace slag is rapidly chilled (quenched) by immersion in water. It is a granular product with very limited crystal formation, is highly Cementitious in nature and, ground to

cement fineness, and hydrates like Portland cement. Specific gravity – 2.87

5) Bagasse ash (BA)

The sugar cane bagasse ash was obtained from Erode sugar factory. Specific gravity- 1.95

6) Super Plasticizer

A commercially available sulphonated naphthalene formaldehyde based super plasticizer (CERAPLAST 300) was used as chemical admixture to enhance the workability of the concrete.

7) Steel fiber (SF)

Corrugated steel fibers of aspect ratio 55 are used.

8) Polypropylene fiber

The commercially manufactured Recron-3S by Reliance Petro Chemicals is used.

Mix Design

TABLE-1: CONCRETE MIX DESIGN

Cement (kg/m^3)	GGBS (kg/m^3)	Bagasse ash (kg/m^3)	M. Sand (kg/m^3)	Coarse Aggregate (kg/m^3)	w/c ratio
228	114	38	672.78	1192.2	0.43

Mix Designation

TABLE -2: MIX DESIGNATION

Mix Designation	Steel (% by volume of concrete)	Mix Designation	Poly propylene (% by volume of Concrete)
C	0	C	0
S1	0.5	P1	0.1
S2	1	P2	0.3
S3	1.5	P3	0.5
S4	2.0	P4	0.4

IV. RESULTS AND DISCUSSIONS

A. Tests on Hardened property

The various tests for hardened concrete has been performed and tabulated.

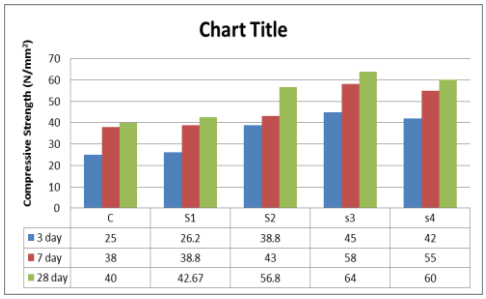


Fig 1: Compressive strength of Steel Fibre added concrete

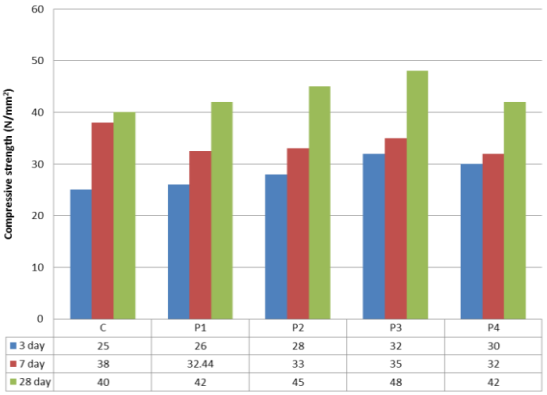


Fig2: Compressive strength of Polypropylene Fibre added concrete

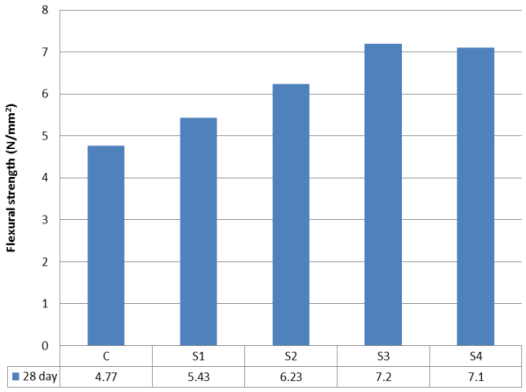


Fig 3: Flexural Strength of Steel fibre added concrete

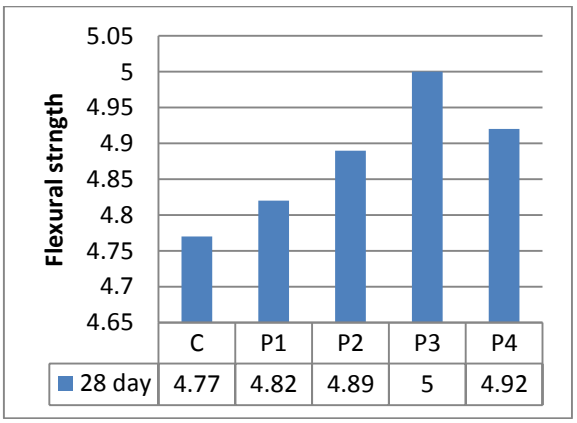
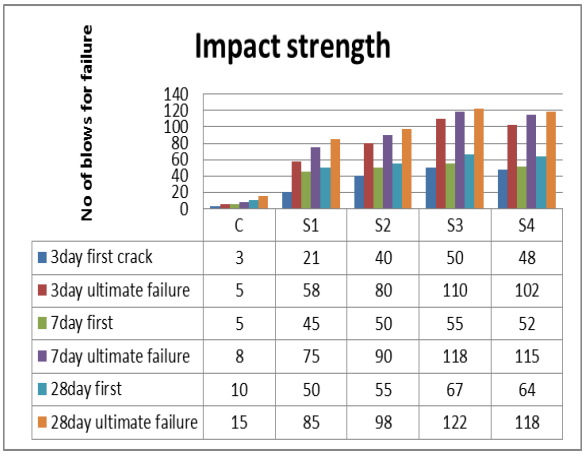
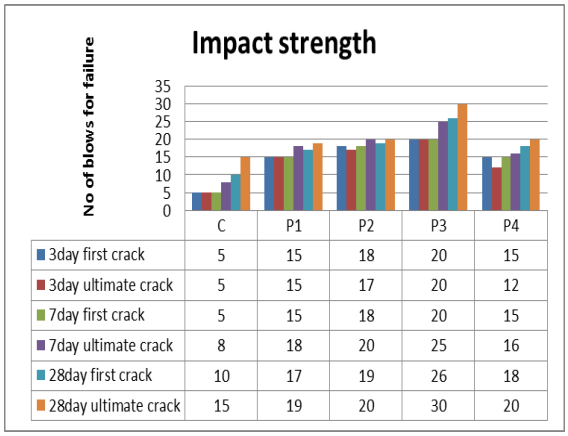


Fig 4: Flexural Strength of Polypropylene fibre added concrete



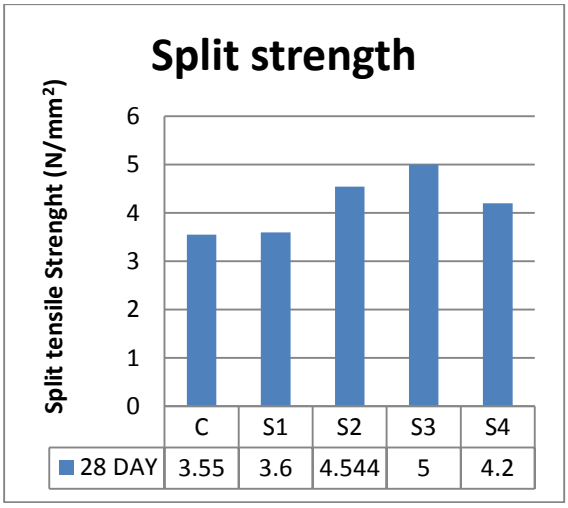
	C	S1	S2	S3	S4
3day first crack	3	21	40	50	48
3day ultimate failure	5	58	80	110	102
7day first	5	45	50	55	52
7day ultimate failure	8	75	90	118	115
28day first	10	50	55	67	64
28day ultimate failure	15	85	98	122	118

Fig 5: Impact strength of Steel fibre added concrete



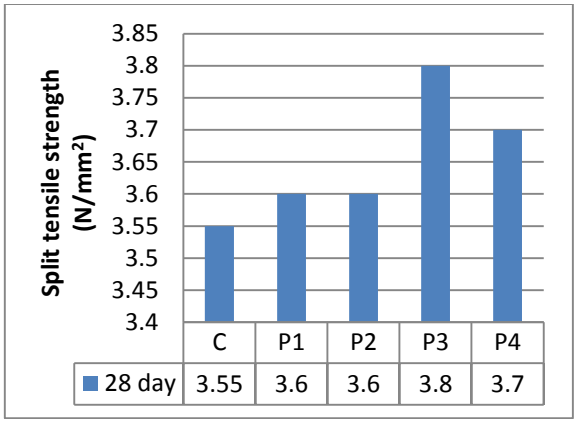
	C	P1	P2	P3	P4
3day first crack	5	15	18	20	15
3day ultimate crack	5	15	17	20	12
7day first crack	5	15	18	20	15
7day ultimate crack	8	18	20	25	16
28day first crack	10	17	19	26	18
28day ultimate crack	15	19	20	30	20

Fig 6: Impact strength of Polypropylene added concrete



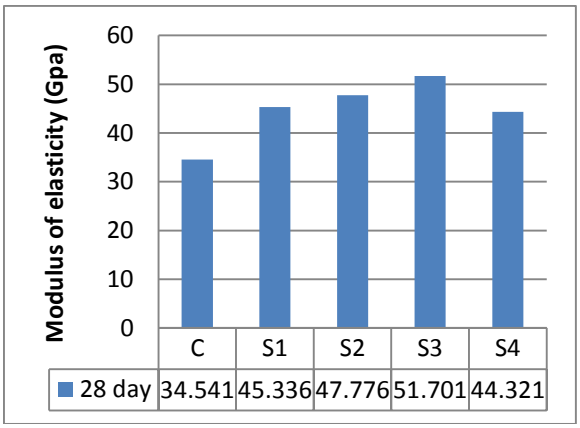
	C	S1	S2	S3	S4
28 DAY	3.55	3.6	4.544	5	4.2

Fig 7: Split strength of Steel fibre added concrete



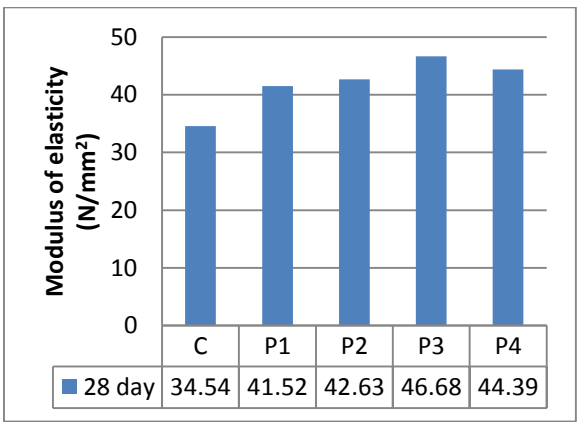
	C	P1	P2	P3	P4
28 day	3.55	3.6	3.6	3.8	3.7

Fig 8: Split strngth of Polypropylene added concrete



	C	S1	S2	S3	S4
28 day	34.541	45.336	47.776	51.701	44.321

Fig 9: Modulus of elasticity of steel added concret



	C	P1	P2	P3	P4
28 day	34.54	41.52	42.63	46.68	44.39

Fig 10: Modulus of elasticity of Polypropylene added concrete

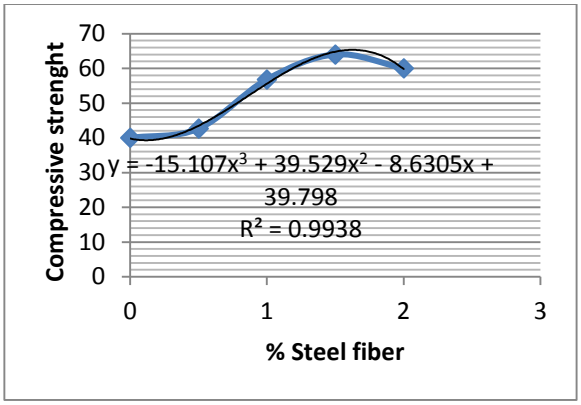


Fig 11: Regression curve fitting for Compressive strength with steel variation

V. CONCLUSION

1. From all the cases it was seen that the addition of fibre would result in increase of the Mechanical Properties of concrete.
2. The optimum dosage of Steel Fibre was found to be 1.5% by volume of concrete.
3. The optimum dosage of Polypropylene was found to be 0.3% by volume of concrete.
4. In the case of Polypropylene added concrete it was observed that beyond 0.3% , when it was added it resulted in the honey combing of the specimens. This could be the reason why it further showed the reduction in strength latter on.
5. Fibre could play an important role in arresting the crack in the concrete.
6. Crack arrestment would definitely improve durability of concrete.
7. Regression curve can further clarify the optimum dosage

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