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An Experimental study in Fibre reinforced concrete by using glass and steel fibre for sustainable construction

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Abstract: Steel fibre for reinforcing concrete is defined as short, discrete lengths of steel fibres with an aspect ratio (ratio of length to diameter) from about 20 to 100, with different cross-sections, and that are sufficiently small to be randomly dispersed in an unhardened concrete mixture using the usual mixing procedures. Glass fibres reinforced polymer composites have been prepared by various manufacturing technology and are widely used for various applications. Glass fibres are having excellent properties like high strength, flexibility, stiffness and resistance to chemical harm. Objective of this to compare the check performance of glass and steel fibres, different percentages of 0.25%, 0.5%, 0.75%, 1%, and 1.25% were used. 1.5% 1.75% And 2% for concrete of M30 grade. To compare the fresh properties of fibre-reinforced concrete to those of conventional concrete. To compare fibre-reinforced concrete with ordinary concrete in terms of compressive strength and split tensile strength. Studying the behaviour of reinforced concrete blocks fortified with steel and glass fibres is the main goal and the methodology of this to research if steel and glass reinforcement for concrete is appropriate. The study used a comprehensive approach that included selecting materials, preparing concrete mixes, testing physical and mechanical properties, and evaluating environmental sustainability. The results were analysed using statistical methods to determine the significance of the differences observed between the various concrete mixes. The rigorous experimental approach and statistical analysis provided reliable data to support the study's findings.

Keywords: steel and glass fibre, compressive strength, split tensile strength.

[1] Steel fibre

[2] Glass fibre

I. INTRODUCTION

Concrete is a mixture of cement, fine aggregate and coarse aggregate, which is mainly derived from natural resources. Increasing population, expanding urbanization, climbing way of life due to technological innovations has demanded a huge number of natural resources in the construction industry, which has resulted in scarcity of resources. This scarcity motivates to use, solid wastes generated by domestic and agricultural activities. Cement, usually in powder form, acts as a binding agent when mixed with water and aggregates.

Cement

Ordinary Portland cement (OPC) of 43 grade (Brand: JK Super Cement) was used throughout the course of the Experimental investigation. A binder is a substance used in construction that sets, hardens, and binds to other materials to form a bond. Cement is typically used to bind sand and gravel together rather than on its own. Masonry mortar is made from cement combined with fine aggregate, while concrete is made from sand and gravel.

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Coarse Aggregate

Coarse aggregates of 20mm size are used During our Experimental investigation. Coarse aggregates are materials with particles that are large enough to be retained on the I.S. Sieve No. (20 mm). To make concrete sturdy and weather-resistant, coarse aggregates, like fine aggregates, must be made up of sound, durable inert particles. It must be devoid of any chemicals, coatings, clay, or other fine material that might influence the cement paste's bonding.

Fine Aggregate

Fine aggregates are materials that have passed through I.S. Sieve No. (4.75mm). Fine aggregates make concrete dense by filling spaces in coarse aggregates, reducing cement shrinkage and resulting in a cost- effective mix. Fine aggregate in concrete is either natural sand or crushed stone dust. Sand can be collected from the sea, river, lake, or pit, but it must be thoroughly cleansed and tested before being used in a concrete mix to ensure that the total percentage of clay, silt, salts, and other organic matter does not exceed the necessary limit.

Steel fiber

Steel fiber-reinforced concrete (SFRS) is concrete (spray concrete) with steel fibers added. It has higher tensile strength than unreinforced shotcrete and is quicker to apply than weld mesh reinforcement. It has often been used for tunnels. Steel fibers are the most commonly used inorganic reinforcing fiber for most structural and non-structural purposes. They can be used with different shapes, geometries and surface textures, but usually they are used in two ways: as long continuous bars (in structural concrete composites structures) and as short discrete fibers with an aspect ratio from about 20–100 (and many times they are combined with other synthetic fibers.

Glass fiber

Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fiber reinforced composites are used in marine industry and piping industries because of good environmental resistance, better damage tolerance for impact loading, high specific strength and stiffness**.**

II. LITERATURE REVIEW

Genbao Zhanget (2022):
Self-compacting concrete (SCC) mixtures requires a large amount of Portland cement and thus resulting in high CO2 emissions, expanding its application has been in question to environment sustainability. By this study the flowability of jute fiber reinforced SCC mixtures with mineral powders can meet the requirement for most applications. The modification methods for jute fibers can effectively improve the fresh property of SCC mixtures in terms of the slump flow, especially the ultrasonic vibration coating treatment (UVCT) method.The cost-effectiveness would be significantly improved with the addition of natural material and waste disposals instead of Portland cement. The introduction of jute fiber and mineral powders in SCC mixtures enhanced the mechanical performance.

Mugahed Amran et.al (2022):
The aim of the paper is to development of basalt fiber-reinforced high-strength eco-friendly concrete with modified composite binder for sustainable construction. Cement composites based on a modified polymineral binder with the use of enriched aluminosilicates obtained from coal ash have been developed. A technology has been developed for extracting aluminosilicates from coal ash, which includes five stages. The choice of grinding technology of modified composite binder in a vario-planetary mill up to 550 m2 /kg has been made, where the combined action of high impact energy.

Shaoce Dong (2022):
Glass fiber reinforced polypropylene (GFPP) composite materials have high potentials for civil engineering applications because of their abilities to be reshaped at construction sites and to be recycled and efficiently produced. In the present paper, the durability properties of glass fiber reinforced polypropylene (GFPP) sheet with thickness of 0.3 mm exposed to four aging environments were explored. SWSC solution immersion caused more obvious reduction in terms of GFPP sheet's longitudinal tensile strength compared with immersion in water, especially under 60 C SWSC solution. After immersion in 60 C SWSC solution up to six months, GFPP sheet lost almost all its longitudinal tensile strength and integrity shown by scanning electron microscope results.

Gianni Blasi, Marianovella Leone (2022):
The use of recycled steel fibres, to complement or possibly replace traditional steel reinforcement. Nevertheless, the contribution of the fibres on the mechanical performance of concrete is still uncertain and requires further investigation.

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This study is aimed at providing an analytical model for the tensile response of concrete reinforced with manufactured steel fibres and recycled steel fibres recovered from waste tyres. T The test results evidenced that a higher fibres' amount generally reduces the peak strength and increases the energy dissipation capacity.

- The peak strength reduction was more evident in case of recycled fibres, since their high variability in shape led to non-uniform distribution in the mixture and, consequently, generated weak regions. - In case of manufactured fibres, an optimized fibres amount (0.4%) was found to significantly increase the cumulative energy dissipated, with respect to all other specimens considered, while similar results were obtained comparing recycled and manufactured fibres for the remaining cases.

Nikola Tosica et. Al (2021):

The main objective of the study presented in this paper is to evaluate the feasibility of multi-recycling (recycling over multiple "generations") of polypropylene fibre reinforced concrete (PPFRC). The specific objectives are the determination of the recyclability of PPFRC relative to plain concrete; the determination of properties of the recycled concrete aggregates (RCA) obtained by PPFRC recycling and their effect on recycled aggregate concrete (RAC) production; as well as the assessment of the potential recovery of polypropylene (PP) fibre during the recycling process. Considering the used recycling process in a jaw crusher, the recovery rate of fibres from PPFRC was between40% and 65%. Maintaining a constant effective w/c ratio and cement content, leads to significant of the compressive strength loss over of generations of RAC with this loss being.

III. EXPERIMENTAL INVESTIGATION

COMPRESSIVE STRENGTH (IS 516:1959)

SL.NO	**% Steel And Glass fibre (Adding)**	**Average compression Strength In Mpa**	
		7 Days	**28 Days**
1.	0.25	**19.79**	**32.17**
2.	0.5	**20.61**	**32.73**
3.	0.75	**21.21**	**32.88**
4.	1	**22.4**	**33.13**
5.	1.25	**22.9**	**33.97**
6.	1.5	**23.2**	**35.1**
7.	1.75	**20.1**	**32.5**
8.	2	**19.7**	**31.7**

Compressive Strength of Percentage of steel and glass fibre

SL.NO	**Average Compression Strength In Mpa**	
	7 Days	**28 Days**
1.	19.58	31.6

Compressive Strength of Conventional Concrete

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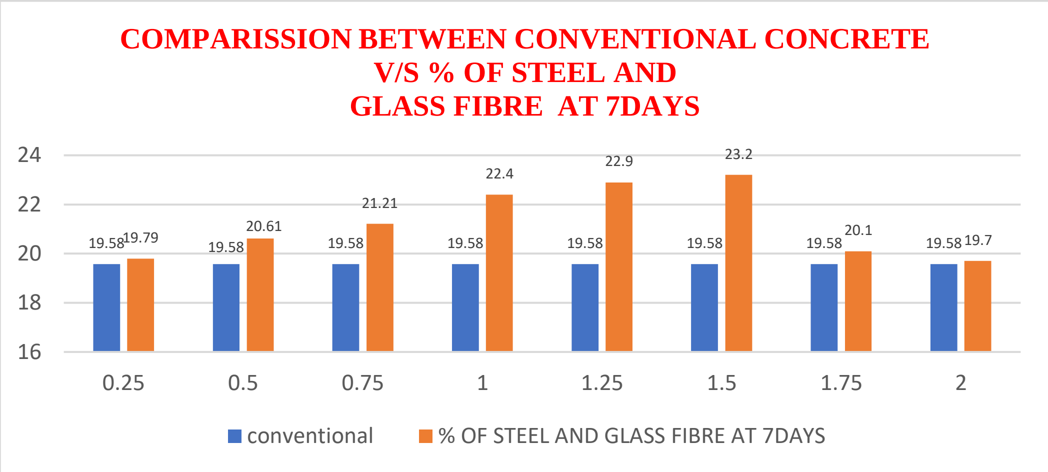
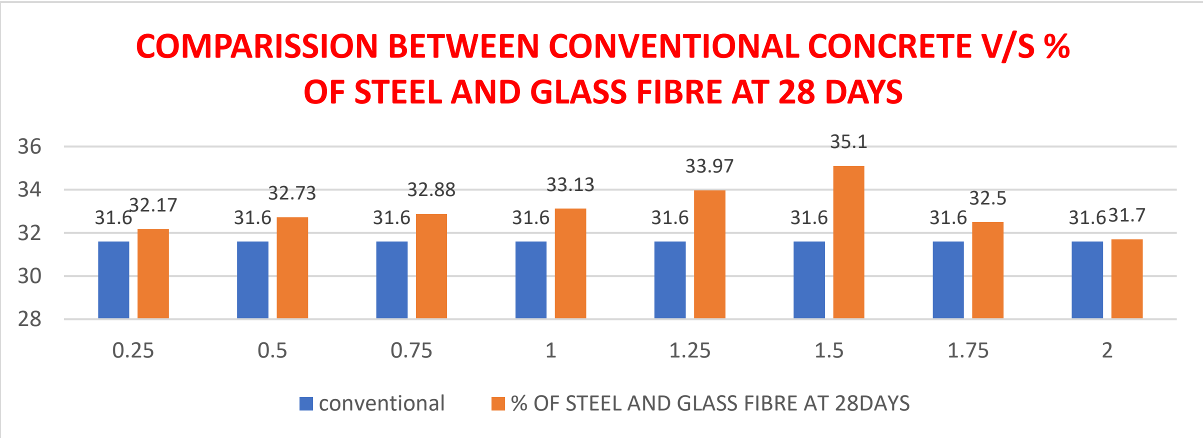


Conventional Concrete v/s % of steel and glass fibre at 7 days



Conventional Concrete v/s % of steel and glass fibre replacement at 28 days

SPLIT TENSILE STRENGTH (IS 5816:2004)

SL No.	% Of steel and glass fibre	Avg. Tensile Strength (Mpa)	
		7 days	28 days
1.	0.25	**1.98**	**3.2**
2.	0.5	**2.1**	**3.39**
3.	0.75	**2.24**	**3.4**
4.	1	**2.31**	**3.48**
5.	1.25	**2.38**	**3.51**
6.	1.5	**2.45**	**3.58**
7.	1.75	**2.01**	**3.02**
8.	2	**2.00**	**3.11**

Split Tensile Strength % of steel and glass fibre replacement

SL.NO	Avg. Tensile Strength in Mpa	
	7 Days	28 Days
1.	1.95	3.15

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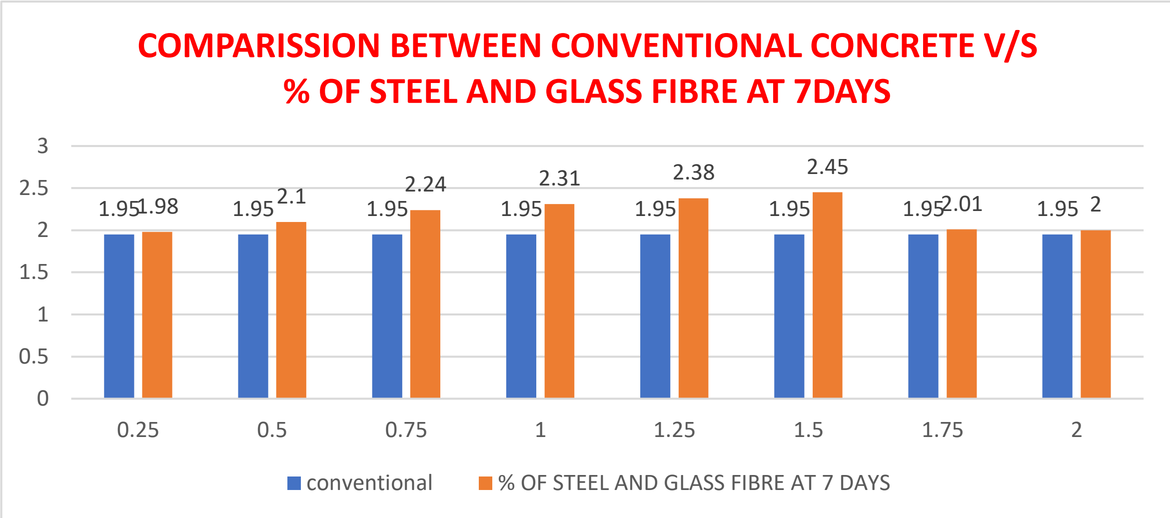
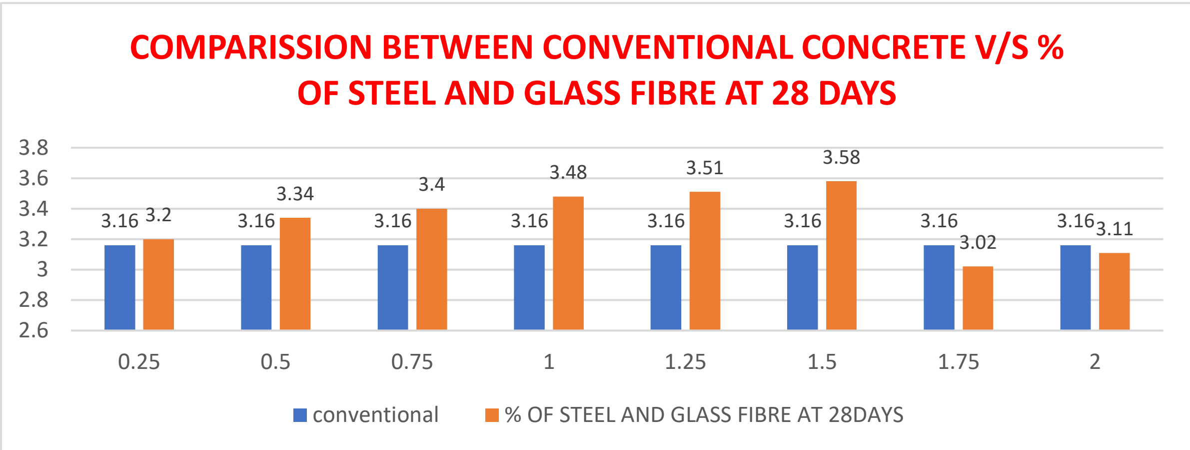
Split Tensile Strength of Conventional Concrete



Conventional Concrete v/s % of steel and glass fibre at 7 days



Conventional Concrete v/s % of steel and glass fibre at 28 Days

IV.CONCLUSION

- Optimum Compressive Strength is obtained by adding 1.5% of steel and glass fiber in concrete.
- Optimum split tensile strength is obtained by adding 1.5% of steel and glass fiber in concrete
- By adding fibers, such as glass or steel, to the concrete mix, the resulting FRC can exhibit higher tensile strength, compressive strength, and durability.
- Target compressive strength was 35.1 N/mm^2 for 28 days and split tensile strength was found to be 3.58 N/mm^2 has been achieved.
- Steel fiber showed consecutive increase up to 1.5% later the strength got decreased.

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- From experimental investigation results on fresh properties of concrete (Measurement of Slump) shows within the Permissible limits as per IS456:2000 for structural concrete work.
- Basic tests on Cement, Coarse Aggregates, Water, limits as per the IS Codal Provisional.

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