INVESTIGATION OF REINFORCED CONCRETE BEAM WITH PARTIAL REPLACEMENT OF FINE AGGREGATE BY USING FOUNDRY SAND AND BY ADDING GLASS FIBER

S. Sujitha

PG Scholar, Department of Civil Engineering, Pandian Saraswathi Yadav Engineering College, Sivagangai, India

Abstract

Used-Foundry sand is a by-product of ferrous and nonferrous metal casting industries. Foundries successfully recycle and reuse the sand many times in a foundry. In an effort to utilize used-foundry sand in large volumes, research is being carried out for its possible large-scale utilization in making concrete as partial replacement of fine aggregate. Glass fiber is a recent introduction in making fibre concrete. It has very high tensile strength and reducing the overall cost of construction there by bringing economy in construction. This paper presents the results of an experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate (regular sand) was partially replaced with used-foundry sand (UFS). Fine aggregate was replaced with four percentages (10%, 20%, 30% and 40%) of UFS by weight for M-20 grade concrete, and as supplementary addition of glass fiber at 0.5% to the concrete.. Tests were performed for the properties of fresh concrete. Compressive strength, splitting- tensile strength, flexural strength, and modulus of elasticity were determined for 28 days. Test results indicated a marginal increase in the strength properties of plain concrete by the inclusion of UFS as partial replacement of fine aggregate (sand) with Glass fibres and that can be effectively used in making good quality concrete and construction materials. Applications of foundry sand, which is technically, sound, environmentally safe for sustainable development. . Use of foundry sand in various engineering applications can solve the problem of disposal of foundry sand and other purposes

Introduction

Concrete is economical, strong, and durable. Although concrete technology across the industry continues to rise to the demands of a changing marketplace, the industry recognizes that considerable improvements are essential in productivity, product performance, energy efficiency, and environmental performance. The industry will need to face and overcome a number of institutional, competitive, and technical challenges. One of the major challenges, with the environmental awareness and scarcity of space for land filling, is the wastes/byproduct utilization as an alternative to disposal.

Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and nonferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. Foundries successfully recycle and reuse the sand many times in a foundry. When the sand can no longer be reused in the foundry, it is re-moved from the foundry and is termed foundry sand. The physical and chemical characteristics of foundry sand depend on the type of casting process and the industry sector from which it originates. In modern foundry practice, sand is typically recycled and reused through many production cycles.

The introduction of fibres in concrete has brought a solution to develop a concrete having enhanced flexural and tensile strength, which are a new form of composite material. At the micro-level, fibres inhibit the initiation and growth of cracks, and after the micro-cracks coalesce into

macro-cracks, fibres provide mechanisms that abate their unstable propagation, provide effective bridging and impart sources of strength gain, toughness and ductility. In the view of the global sustainable developments, it is imperative that fibers like glass, carbon, polypropylene and aramid fibres provide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitation, erosion resistance and serviceability of concrete.

Glass fibre is a material consisting of numerous extremely fine fibres of glass. Glass fibre is commonly used as an insulating material. It is also used as a reinforcing agent for many polymer products. Glass fibres are useful thermal insulators because of their high ratio of surface area to weight. It act as a good chemical resistance.

Design Mix Materials

Cement

The cement used is OPC 43 grade cement. The Ordinary Portland Cement of 43 Grades conforming to IS: 8112-1989 is be used. Tests were conducted on the cement like Specific gravity, consistency tests, setting tests, Compressive strength N/mm^2 at 28 days.

Table 1 Physical Properties of Cement

S. No.	Properties	Values
1	Specific gravity of cement	3.15
2	Standard consistency of cement	30%
3	Initial setting time	30 min
4	Final setting time	600 min
5	Compressive strength	43 Mpa

Fine Aggregate

The sand used for the experimental works was locally procured and conformed to grading zone II. Sieve Analysis of the Fine Aggregate was carried out in the laboratory as per IS383-1970. The following tests are carried out on fine aggregate as per IS: 2386 (Part3)- 1963 to find out its physical properties.

Table 2 Properties of Sand

S. No.	Properties	Values
1	Specific gravity of sand	2.55
2	Fineness Modulus	2.9
3	Bulk density	1722 m^3

Foundry Sand

Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder and dust.

Figure 1 Foundry Sand

Table 1 Properties of Foundry Sand

S. No.	Properties	Values
1	Specific gravity	2.15
2	Unit weight (kg/m^3)	1526
3	Fineness modulus	1.3

Glass Fibre

Glass-fibre reinforced concrete (GRC) is a material made of a cementations matrix composed of cement, sand, water and admixtures, in which short length glass fibres are dispersed. Glass fibre is consists of A-glass, C-glass, E-glass, and AE-glass fibre. It has been widely used in the construction industry for non-structural elements, like façade panels, piping and channels.

Table 2 Properties of Glass Fiber

S. No.	Properties	Values
1	Type	E glass fiber
2	Length	6mm
3	Tensile strength(Gpa)	3.5
4	Modulus (Gpa)	73.5
5	Elongation (%)	4.8
6	Density (kg/m^3)	2720

Design Mix Methodology

Mix Proportion

A cement concrete mix 1:1.5:2.61 was designed as per IS: 10262:2009 methods and the same were used to prepare the test samples.

Table 3 Mix Proportions of Concrete

Mix Design	Water	Cement	FA	CA
M20	208.5	417.15	629.8	1088.1

Results and Discussions

Compressive Strength Results

Compressive strength is the most important property of the hardened concrete. 150mmx150 mmx150mm concrete cubes were cast using 1:1.5:2.61 mix proportion with w/c ratio of 0.50.Specimens with OPC (control) and fine aggregate replaced by foundry sand at 10%, 20%, 30% and 40% and by adding 0.5% of glass fiber were cast. The concrete cubes were tested accordance with the IS standards at the 28 days. Compressive strength results are shown in fig2.The compressive strength was increased up to 13%, 25%, 44% and 66% when compared to control specimen.

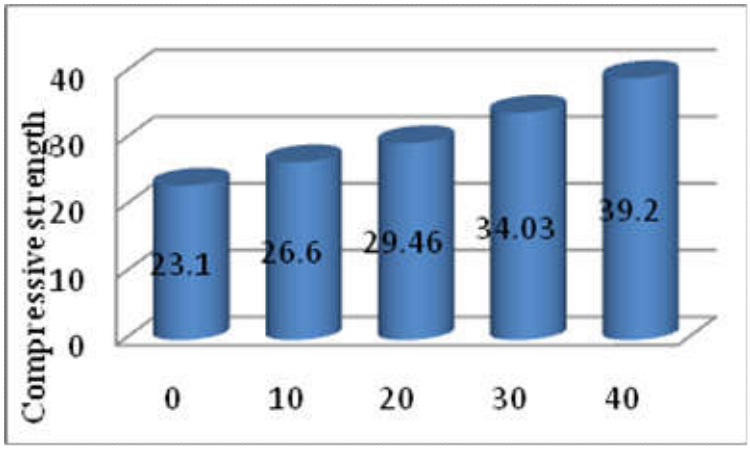

Figure 2 Average Compressive Strength of Concrete at 28 days

Spilt Tensile Strength

Cylinder specimens were tested for splitting tensile strength. Standard cylinder moulds (150mmx300mm) the 28days spilt tensile strength was increased up to 5.4%, 12.4%, 20.6%, and 28.5% when compared to control specimen.

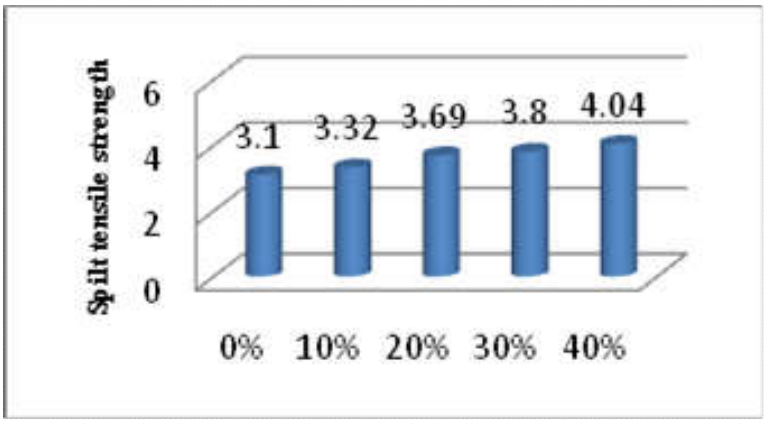

Figure 3 Spilt Tensile Strength of Concrete N/mm2 at 28 days

Flexural Strength

The specimens were tested under two point loading .Standard beam moulds (100 mm x 100 mm x 500 mm and) were cast for the preparation of concrete specimens for flexural strength. The 28days flexural strength was increased up to 7.4%, 25%, 37.1% and 52.4% when compared to control specimen.

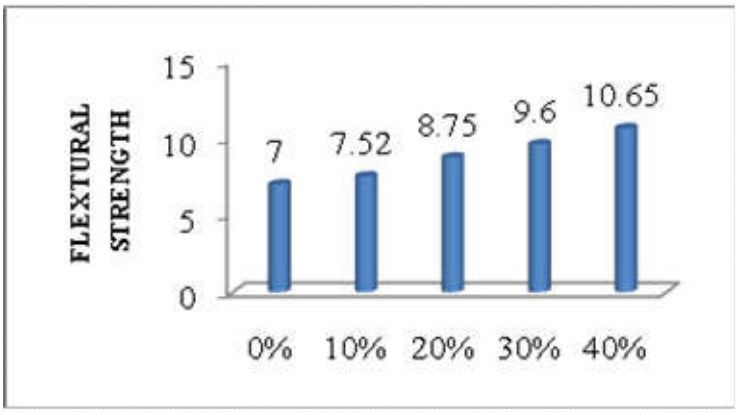

Figure 4 Flexural Strength of Concrete at 28 days

Load Vs. Deflection Curve

The load deflection curve for M20 grade of concrete and 10%, 20%, 30% and 40% substitution of foundry sand and glass fiber of R.C beams. It can be understand that the ultimate load was increased by replacing various percentages of foundry sand in R.C.C members.

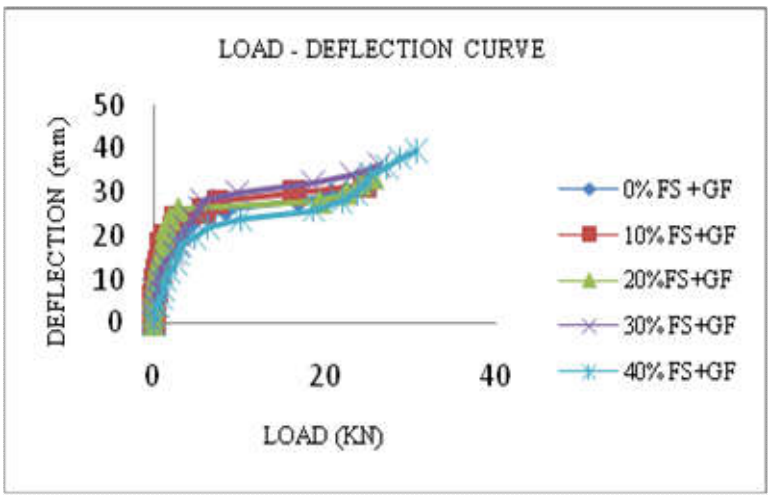

Figure 5 Comparative Load-Deflection Curve

Flexural Strength of R.C.C Beams

The ultimate load carrying capacity of the R.C.C beams under flexural loading is relatively increased with increasing the various percentages of R.C.C members.

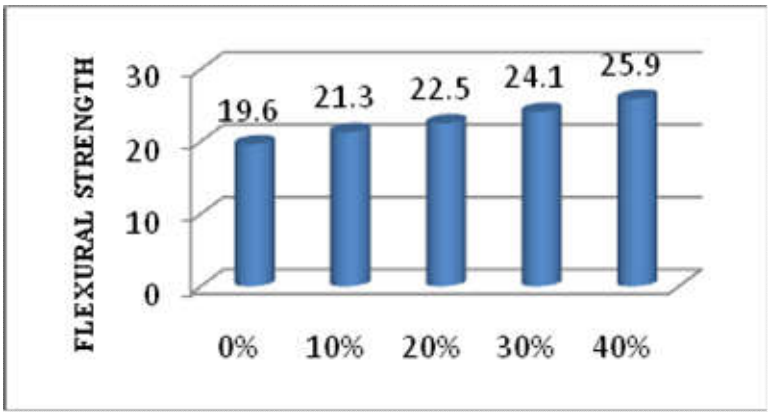

Figure 6 Flexural Strength for R.C.C Beams

Conclusion

The test result shows the foundry sand as partial replacement of cement increase the strength of concrete**.** For different mix proportion, the 1.5% of gives the high strength when compared to other mix proportion. Compressive strength, splitting-tensile strength and flexural strength test results of concrete mixtures increased with foundry sand and glass fiber mixes.

- For 10%FS+GF system, the compressive, spilt tensile, flexural strength was increased up to 13%, 5.4%, 7.42% and 8.7% with the control mix.
- For 20%FS+GF system, the compressive, spilt tensile, flexural strength was increased up to 25.1%, 12.4%, 25% and 14.8% with the control mix.
- For 30%FS+GF system, the compressive, spilt tensile, flexural strength was increased up to 44%, 20.6%, 37.1%, and 23% with the control mix.
- For 40%FS+GF system, the compressive, spilt tensile, flexural strength was increased up to 66%, 28.2%, 52.14% and 30.6% with the control mix.
- Environmental effects from wastes and disposal problems of waste can be reduced through this research. A better measure by an innovative Construction Material is formed through this research.

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