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Experimental Study on Behavior of Steel Fiber and Glass Fiber for M30 Grade Concrete

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Abstract

The cementations ingredients are one of the most important and often used materials in the building sector. These cement-based materials may be easily processed and prepared at an early stage, that is, before the curing process, into the necessary specified forms and structural configurations. However, these cement-based materials' main weakness is their brittleness, which is linked to their stiff characteristics and causes cracks to develop and spread when under stress. Due to this weakness, the mechanical qualities of the material deteriorate, necessitating expensive maintenance or even rebuilding over a very short period of time. Therefore, the construction industry needs new cement-based materials with improved durability features, such as those that offer increased fracture resistance. Since ancient times, ordinary concrete, a fragile substance, has taken the place of fiber-reinforced concrete. Although adding a single type of fibre to concrete may increase its mechanical strength, hybridising two fibre types can offset the drawbacks of each and combine their benefits. This thesis investigates the effects of utilising glass fibre and polypropylene fibre for concrete reinforcement on the mechanical characteristics of the concrete matrix.

In the current study, steel, fibres, and glass fibres were used in an experimental inquiry on M30 grade concrete. 0%+0%, 0.25%+0.25%, 0.5%+0.5%, 0.75%+0.75%, 1%+1%, 1.25%+1.25%, and 1.5%+1.5% are the doses at which steel and glass fibres are utilised. At the 7-day,

14-day, and 28-day curing periods, the compressive strength, split tensile strength, and flexural strength values are measured.

1. Introduction

ACI Committee 544 defines fibre reinforced concrete (FRC) as a type of hydraulic cement with discrete, discontinuous fibers and fine or coarse aggregates. When it is subjected to tensile stress, concrete is naturally fragile. By preventing or controlling fracture initiation, propagation, or coalescence, reinforcement with small discrete fibers that are oriented randomly could improve the mechanical properties of the concrete. Even when deflections surpass the plain concrete's fracture deflections, FRC may continue to support significant loads. FRC's characteristics and performance vary dependent on the matrix's characteristics as well as the fibre type, concentration, shape, orientation, and distribution.

FRC may be thought of as a composite material having two phases, with the fibre acting as the inclusion phase and the concrete acting as the matrix phase. The parameter most frequently used to describe the characteristics of FRC is the volume percentage of fibre inclusion. Other characteristics that might be employed for this include fibre count, fibre specific surface area, and fibre spacing. Another useful numerical measure for defining fibers is the aspect ratio, which is calculated by dividing the fiber's length by its equivalent diameter.

High strength, soluble base safe glass strands are integrated into a substantial grid to make glass fiber-built up concrete. The fiber and matrix deliver a synergistic solution of attributes that none of the parts functioning independently can provide in this configuration while maintaining their own physical and chemical properties. In most cases, the main load-bearing components are the fibers, while the surrounding matrix keeps the fibers in the right positions and directions, transfers the load, and protects them from the elements.

Steel fiber fortified concrete is a composite material with additional fixings made of fibers. The fibers are spread out randomly at small rates, like between 0.3 and 2.5 percent by volume in regular concrete. Deliveries of SFRC items involve blending steel fibres with the concrete's component parts and pouring the resulting green concrete into moulds. The regular processes are then used to condense and alleviate the item.

1.1 Effects of steel fiber in concrete

Concrete is frequently reinforced with fibres to prevent breakage due to shrinkage caused by drying and shrinking caused by plastic. Additionally, they lessen concrete's permeability, which prevents water leaks. A few different types of strands caused concrete to scrape, crumble, and show more obvious impact. Generally speaking, fibres cannot replace minor contrasting or enhance steel support since they do not increase the flexural nature of concrete. Unquestionably, a few fibres seriously damage the character of concrete. The volume component (Vf) of the composite (concrete and strands) is designated as the proportion of fibres added to the strong mix. The usual range of Vf is 0.1 to 3%. The point of view extent (l/d) is calculated by dividing the fibre length (l) by the distance between each fibre (d). For the calculation of perspective extent, fibres with a non-round cross territory utilise an equal width.

If the fiber's adaptation modulus is greater than that of the system (concrete or mortar folio), they aid in the transfer of load by increasing the material's rigidity. The durability and flexural quality of the lattice are often divided by an increase in the fiber's edge length. However, extremely long fibres will often ball up in the mixture and cause problems with usability. Utilising strands in concrete has a limited influence on the impact security of the materials, according to certain flow studies. This discovery is important since most people believe that adding strands to cement makes it more flexible. The usage of scaled-down scale fibres delivers superior impact insurance than differentiated and longer strands, according to the results of the study.

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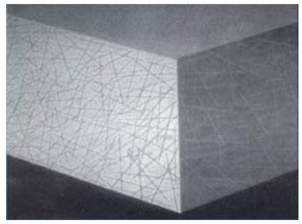


Figure 1: Steel fibers used in concrete graphical view

2. Materials used

2.1 Cement

Ordinary Portland cement of grade 53 was used, tested, and evaluated for physical and chemical qualities in accordance with IS: 4031 - 1988, and laboratory experimental research was conducted in accordance with IS: 12269-1987.

Figure 2: OPC 53 Grade cement

2.2 Fine aggregates

The continuing analysis uses fine totals made of sand from a nearby store. According to IS:2386, the physical characteristics of fine aggregate, including explicit gravity, mass thickness, degree, and fineness modulus, are assessed.

Figure 3: Fine aggregates

2.3 Coarse aggregates

In this experiment, coarse material that has been crushed and has a maximum adjusted size of 12.5 mm is employed. According to IS 2386, the physical characteristics of coarse total, such as explicit gravity, mass thickness, degree, and fineness modulus, are assessed.

Figure 4: Coarse aggregates

2.4 Steel fibers

As part of the SFRC strategy, tempered steel wire with a 0.5 mm across spacing has been utilised. In this study, a steel fibre with a diameter of 80 mm and a length of 40 mm was employed. The steel fibres are completely enclosed, restricted, and uninjured.

Figure 5: Steel fibers

2.5 Glass fiber

The mechanical properties of glass fiber are comparable to those of polymers and carbon fiber, among other fibers. When used in composites, it is significantly less brittle than carbon fiber and costs less, despite its lower stiffness. Glass-reinforced plastic (GRP), more commonly referred to as "fibreglass," is a fiber-reinforced polymer (FRP) composite material that is extremely strong and relatively light due to the use of glass fibers as a reinforcing agent in a variety of polymer products. This material is much denser than glass wool, contains very little air or gas, and is much worse at insulating heat than glass wool.

Figure 6: Glass fibers

2.6 Superplasticizer

The potent plasticizer in the solid blend makes it extremely beneficial for longer periods of time with significantly less water. SP430 is used as a water-decreasing additive in the current study because it is obvious that using a lot of superior material (fine total, bond, and fly fiery debris) makes the solid much firmer and requires more water for essential functioning.

2.7 Mix design of Concrete

Mix design is the process of selecting suitable concrete materials and figuring out how to produce concrete with a specific minimum of strength and durability at a reasonable cost.

1. 394 kg/m3 of cement
2. 197 kg/m3 = water
3. 732 kg/m3 for fine aggregates
4. A rough aggregate weighs 1139 kg/m3.
5. 0.5 is the water-to-cement ratio.

Final trial mix is 1:1.86:2.89 at w/c of 0.50 for M30 grade concrete.

2.8 Mix trials used in this study

The following are the mix trails used in this experimental investigation

1. M0 -0% glass fibers and 0% steel fibers
2. M1-0.25% glass fibers and 0.25% steel fibers
3. M2-0.5% glass fibers and 0.5% steel fibers
4. M3-0.75% glass fibers and 0.75% steel fibers
5. M4-1% glass fibers and 1% steel fibers
6. M5-1.25% glass fibers and 1.25% steel fibers
7. M6-1.5% glass fibers and 1.5% steel fibers

3. Experimental investigation

3.1 Mixing of concrete

Cement, coarse aggregate, and fine aggregate were distributed in measured amounts across an impermeable solid floor. Steel fibers are added at random as the solid is mixed. Repeated mixing took between 10 and 15 minutes to achieve the desired shade uniformity.

Figure 7: Concrete mixing

3.2 Casting and curing of test specimens

Standard cube specimens measuring 150 mm x 150 mm x 150 mm, standard prism specimens measuring 100 mm x 100 mm x 500 mm, and standard cylinder specimens measuring 150 mm in diameter x 300 mm in height were used for casting.

3.3 Placing and compacting

To stop water from escaping during filling, form oil was applied to the specimens. A comparable coating of form oil was also applied to the contact surfaces of the moulds' bases and the base plate. The solid is appropriately compacted at that point to fill the mold layer. The molds are leveled after they have been completely filled. On the final solid surface, slurry is used to fill in the gaps and make it flat. One thing to remember is that concrete ought to be compacted preceding the initiation of the strong beginning settling time.

3.4 Curing

After the season of water expansion to the dry fastening, the test samples of cubes, prisms, and cylinders were stored in a location free of vibration for 24 and a half hours at a temperature of 27 and a half degrees Celsius. After that, the solid 3D shapes, crystals, and chambers were taken out of the moulds and placed for 3, 7, and 28 days, respectively, of reconditioning.

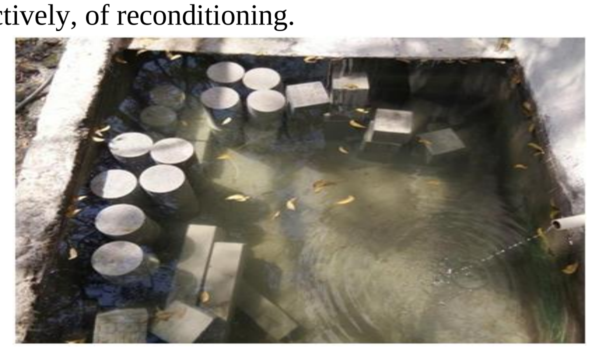


Figure 8: Test specimens kept for curing

4 Tests to be conducted on concrete

4.1 Workability

4.1.1 Slump cone test

The "slump test" is a method for determining concrete's consistency. The firmness or consistency of the blend uncovers how much water has been added. The solidness of the substantial blend ought to relate to the principles for the type of the finished item.

Figure 9: Slump cone test

4.1.2 Compaction factor test

The compaction factor test is the cement functionality test performed at a research facility. The proportion of generally compacted to altogether compacted concrete burdens is known as the compaction factor. The Road Research Laboratory in the UK developed it, and it is used to evaluate cement's value.

4.2 Compressive strength of concrete

This test's instructions were derived from [9] IS516-1959. Standard 3D forms measuring 150 x 150 x 150 mm were used to determine the cement's compressive strength. On the CTM bearing surface, examples of limits of 200T with no frills and a constant rate of stacking connected until the 3D shape failed. The compressive quality was established and the most severe burden was identified ([21] AS Alnuaimi).

Figure 10: Compressive strength test machine and sample after testing

4.3 Tensile strength of concrete

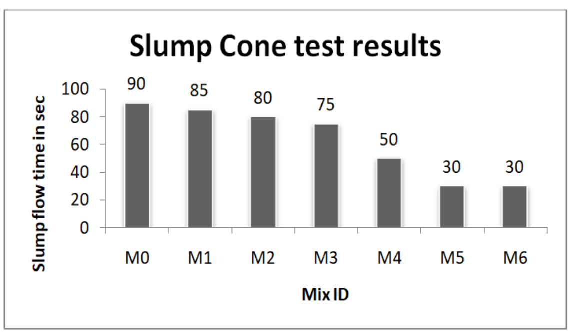
This test was guided by IS516-1959. The standard 150mm x 300mm cylinders were utilized for the cement's quality evaluation. Tests are put on the CTM's bearing surface, which has a limit of 200T, without giving indications of instability, and a steady pace of stacking is kept up with until the chamber exhausts. The level of excellence was established after the highest load was observed. From IS5816 to 1999, the Split Rigidity Testing Procedure

4.4 Flexural strength of concrete

This test was guided by IS516-1959. The cement's quality was evaluated with the usual 150mm x 300mm prisms. A constant rate of stacking is maintained until chamber dissatisfaction, and examples with a maximum weight of 200T are positioned on the CTM bearing surface without exhibiting any signs of flimsiness. The level of excellence was established after the highest load was observed. From IS5816 to 1999, the Split Rigidity Testing Procedure.

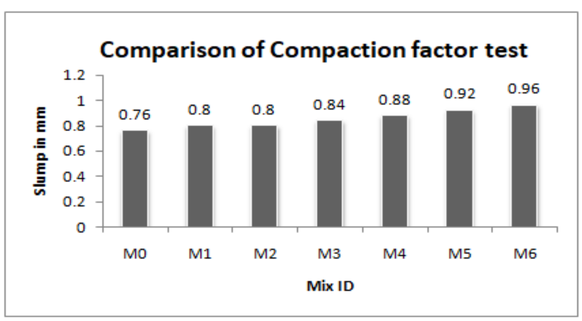
5. Results and analysis

5.1 Slump cone test



Graph 1: Comparison of slump cone test values

5.2 Compaction factor test



Graph 2: Comparison of compaction factor test values

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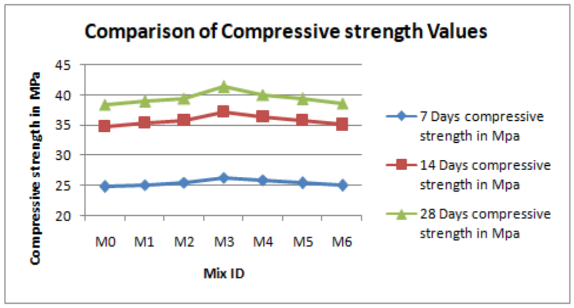
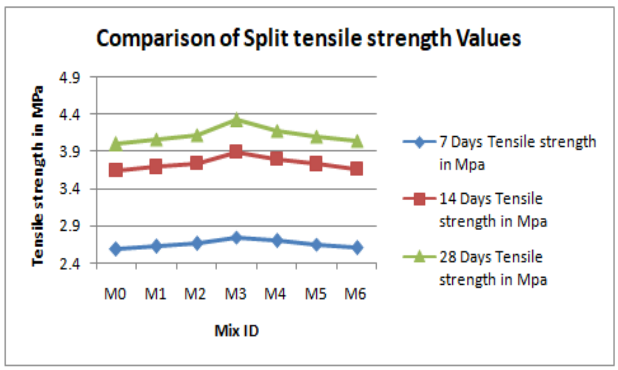
5.3 Compressive strength



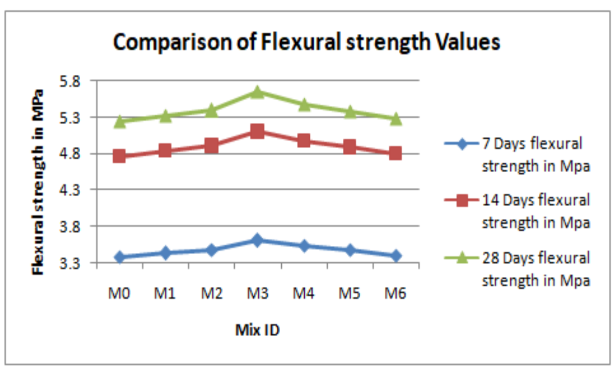
Graph 3: Comparison of compressive strength of concrete

5.4 Split tensile strength



Graph 4: Comparison of split tensile strength of concrete

5.5 Flexural strength



Graph 5: Comparison of flexural strength of concrete

6. Conclusions

The following conclusions were drawn from the previous experimental investigation:

1. Glass and steel fibers can, without a doubt, improve the fundamental properties of concrete by replacing cement with them, but only up to a certain point before the concrete begins to lose its strength.

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2. Fibers should be used sparingly because they make concrete less workable.
3. Surface integrity typically improves and bleeding decreases when fiber-reinforced concrete is utilized.
4. Adding more steel strands as opposed to glass filaments would expand the weakness of cement.
5. The seriousness of the rut cone esteem decreases as the extent of glass to steel strands in M30 grade substantial ascents.
6. As the ratio of steel to glass fibers in M30 grade concrete rises, so does the severity of the compaction factor value.
7. Subsequent to restoring for 7, 14, and 28 days, it was resolved that the M3 blend, which comprises of 0.75 percent steel filaments and 0.75 percent glass strands, had the best qualities for compressive strength, split elasticity, and flexural strength.
8. The M3 mix, which consists of 0.75% steel fibers and 0.75% glass fibers, was found to have the highest compressive, split, and flexural tensile strength values after curing for 7, 14, and 28 days, respectively.
9. The M3 mix, which consists of 0.75% steel fibers and 0.75% glass fibers, was found to have the highest flexural strength values for compressive strength, split tensile strength, and flexural strength after curing for 7, 14, and 28 days, respectively.

References

[1]. Pammar R. P. and Ramesh V. " Experimental study on combined effect of steel and glass fibers on compressive strength, flexural strength and durability of concrete and comparison with conventional concrete" International journal of civil and structural engineering research Vol. 3, Issue 1, pp: 146-150 2015

[2]. M.C. Guru Prasad, K.Tanuja and N.Vasu Deva Naidu, "Experimental study & strength of concrete by using steel & glass fibers" International Research Journal of Engineering and Technology (IRJET) Vol. 03, Issue 9, 2016

[3]. Tejas R Patil and Ajay N. Burile, "Comparative study of steel and glass fiber reinforced concrete composites" International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064, 2015

[4]. Kene S. K., Vairagade S. V. and Sathawane S. "Experimental study on behavior of steel and glass fiber reinforced concrete composites", "International research journal of engineering and technology (IRJET) Volume: 02 Issue 04 (2015) pp 129-133

[5]. Ragi S. "A comparative and experimental study on the mechanical properties of various steel and glass International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 02 | Feb-2018

[6]. Yasir Khan, M Anwar Ansari, Md. Saroj, Shahnewaj Haider, Sachin Kulkarni and Gunderao .V. Nandi, "Experimental Investigation on Strength and Durability properties of Steel and Glass fibre reinforced concrete composite" IJARSET Vol. 3, Issue 6, 2016

[7]. A. Upendra Varma and A.D. Kumar, ‘’ Glass Fibre Reinforced Concrete" ISSN : 2248-9622, Vol. 3, Issue 5, Sep-Oct 2013, pp.1914-1918

[8]. J.D.Chaitanya Kumar, G.V.S. Abhilash, P.Khasim Khan, G.Manikanta Sai and V.Taraka Ram, "Experimental Studies on Glass Fiber Concrete", American Journal of Engineering Research (AJER) Volume-5, Issue-5, pp-100-104, 2016.