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Experimental Investigation on Strength and Durability properties of Steel and Glass fibre reinforced concrete composite

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ABSTRACT: The present paper deals with the study of Experimental investigation on strength and durability properties of steel and glass fibre reinforced concrete composite. In present project work M 35 grade (1: 1.7: 2.4) concrete with constant w/c ratio of 0.45 is designed mixed, cubes and cylinders are casted. The strength and durability properties are carried out for various mix designations and compared with normal conventional concrete. The physical tests on materials are carried out on cement, fine aggregate, coarse aggregate. Specific gravity, water absorption, fineness modulus, normal consistency setting time tests are carried out. Cube compressive strength and split tensile strength for 7 and 28 days are obtained. The various mix designation set for fibre reinforced concrete are tested for 7 and 28 days and compared with normal conventional concrete.

Water absorption, porosity, fire resistance tests are also carried out to check durability properties. Average compressive strength v/s various mix designations for cubes and cylinders are plotted graphically. The optimum dosage of fibre (steel and glass) reinforced concrete for various mix designation is plotted graphically. Water absorption, porosity and fire resistance are also shown graphically.

KEYWORDS: Concrete, Compressive, durability, fibre, strength

I. INTRODUCTION

Concrete is most widely used construction material. It is a major part of development in all countries especially in developing country like India. Concrete plays very important role in the infrastructural development of nation. Composed of cement (commonly ordinary Portland cement) along with cementitious materials such as fly ash, silica fume and aggregates (generally coarse aggregate of gravels or crushed rocks such as limestone or granite plus a fine aggregate such as sand), water and chemical admixtures.

Concrete is called as artificial stone consisting of cement paste as binder, sand and inert material called coarse aggregate. Concrete is an affordable, reliable, mouldable, solidifies and hardens after mixing with water and placement due to a chemical process known as hydration, the water reacts with the cement which bonds the other components together, eventually creating a robust stone like pavement, pipes, architectural structures, foundations, motor ways /roads /bridges /over passes, parking structures, block wall and footing for gates, fences and poles. In India alone about 170 million cubic meters of concrete is produced every year.

Concrete has technically very much advanced and has undergone so many changes from normal to high strength concrete, high performance to ultra high performance concrete, fiber reinforced concrete, prestressed concrete, reinforced cement concrete, self compacting concrete, high volume fly ash concrete, light weight concrete, ready mixed concrete etc.

A. Statement of Problem

1. To Study the strength properties of concrete using steel and glass fibre in order to study the effect of fibre composite on strength properties and comparing with normal conventional concrete.
2. To Study durability properties of steel and glass fibre reinforced concrete composite.
3. To Study the cube strength, split tensile strength of cylinders using steel and glass fibre.

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4. To Study Water Absorption, Porosity and Fire Resistance properties of fibre composite concrete.

B. **Objectives of Present Study**

1. To Study the Compressive strength of Cubes and Split Tensile strength of cylinders of M 35 grade of fibre reinforced concrete composite for various mix proportions (M 0, M 1, M 2, M 3, M 4, M 5) with constant water-cement ratio of 0.45.
2. To Study the compressive strength of fibre reinforced concrete composite (Steel and Glass Fibre) and comparing with conventional concrete.
3. To Study the Split tensile strength of fibre reinforced concrete (Steel and Glass Fibre) and comparing with conventional concrete.
4. To Study the optimum dosage of fibre used in concrete composite.
5. To Study the Workability requirement of fibre reinforced concrete composite for various mix designation.
6. To Study the Water Absorption property of fibre reinforced concrete composite.
7. To Study the porosity property of FRC composite.
8. To Study the Fire Resistance property of FRC composite.

C. **Methodology**

Based on above objectives of present study, following methodology has been set for present project work

1) Mix design as per IS 10262:2009 – Concrete Mix Proportioning-Guidelines
2) IS 456:2000 Plain and Reinforced concrete code of practice.

DESIGNATION OF MIX TYPE AND TOTAL NUMBER OF CUBES AND CYLINDERS

MIX DESIGNATION	MIX TYPE		CUBES		CYLINDERS	
	STEEL FIBRE DOSAGE	GLASS FIBRE DOSAGE	7 DAYS	28 DAYS	7 DAYS	28 DAYS
M 0 (Conventional Concrete)	(0% & 0%)		3	3	2	2
M 1	(0.5% & 1%)		3	3	2	2
M 2	(1% & 1.5%)		3	3	2	2
M 3	(1.5% & 2%)		3	3	2	2
M 4	(2.0% & 2.5%)		3	3	2	2
M 5	(2.5% & 3%)		3	3	2	2
TOTAL =			**18**	**18**	**12**	**12**

Table no-1 (Mix Designation of Steel Fibre and Glass fibre Percentages)

Durability test= 18 Cubes and 12 Cylinders. Steel fibre is added in 0.5%, 1%, 1.5%, 2.0%, 2.5% dosages with Glass fibre increments of 1%, 1.5%, 2.0%, 2.5%, 3.0%

II. STEEL AND GLASS FIBRE REINFORCED COMPOSITE CONCRETE

Fibre reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibres. Now, why would we wish to add such fibres to concrete plain unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of randomly distributed

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discontinuous fibres is to bridge across the cracks that develop provides some post- cracking "ductility". If the fibres are sufficiently strong, sufficiently bonded to material, and permit the FRC to carry significant stresses over a relatively large strain capacity in the post cracking stage. In the present project steel and glass fibre composites has been used to get the benefits of both glass and steel fibres. The composite is used to get better strength and durability properties. Both the fibres have their own different contributions when used in concrete and incorporating them together will result in enhanced attributes of the concrete.

Fig-1 Steel fibres

Fig-2 Glass Fibres

A. TESTS ON MATERIALS

BRAND NAME: OPC ULTRATECH CEMENT (43 GRADE)

Sl. No.	Physical properties.	Readings achieved.	Requirement as per is-8112 1989
1	**Specific Gravity**	3.08	3.12 to 3.19
2	**Normal consistency**	32 %	26 % to 33 %
3	**Initial setting time**	35	minimum: 30 min
4	**Final setting time**	320	maximum:600 min
5	**Fineness of cement**	4.0mm	maximum:10%

Table no-2 Cement test results

- Specific Gravity of Coarse aggregate-2.80.
- Specific Gravity of Fine aggregate-2.60.
- Water Absorption of Coarse aggregate-0.6%
- Water Absorption of Fine aggregate- 1%
- Fineness modulus of Fine aggregate- 2.42.
- Coarse aggregate used with sizes -20mm- 40% 12.5mm-60%
- Fine aggregate: Conforming to Zone II.
- Aspect ratio of Steel fibre- 60.

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III.RESULTS AND DISCUSSIONS

A. STRENGTH AND DURABILITY TEST RESULTS

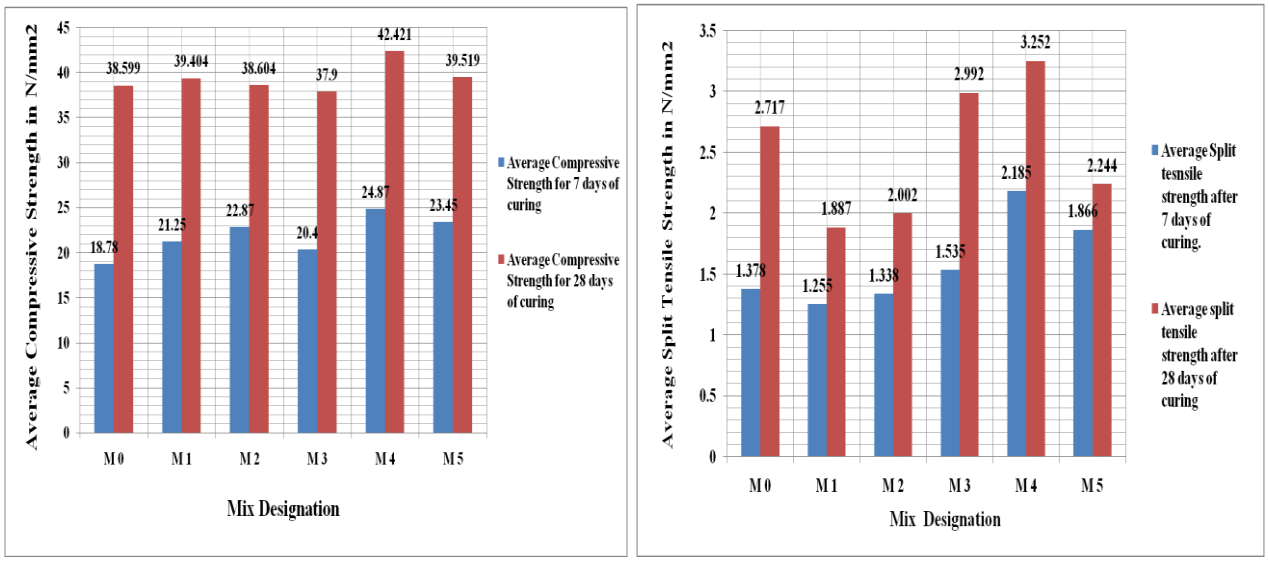
The present study mainly concentrates on steel and glass fibre reinforced concrete composite and strength properties are compared with conventional concrete of mix design of grade M 35. In our project, a detailed study of physical properties is carried out for the following ingredients of concrete.

1) Steel Fibres and Glass Fibre.
2) Coarse Aggregates and Fine Aggregates.

The tests carried out to know the strength or mechanical properties are as under

3) Cube Compressive strength for 7, 28 days.
4) Split Tensile strength of cylinders for 7, 28 days.
5) Specific Gravity test.
6) Durability test.
   a) Water Absorption test.
   b) Porosity test.
   c) Fire Resistance test.

B. GRAPHICAL REPRESENTATIONS



Graph 1- Graphical Representation of Average Compressive Strength and split tensile strength v/s Mix designation for 7, 28 days of curing.

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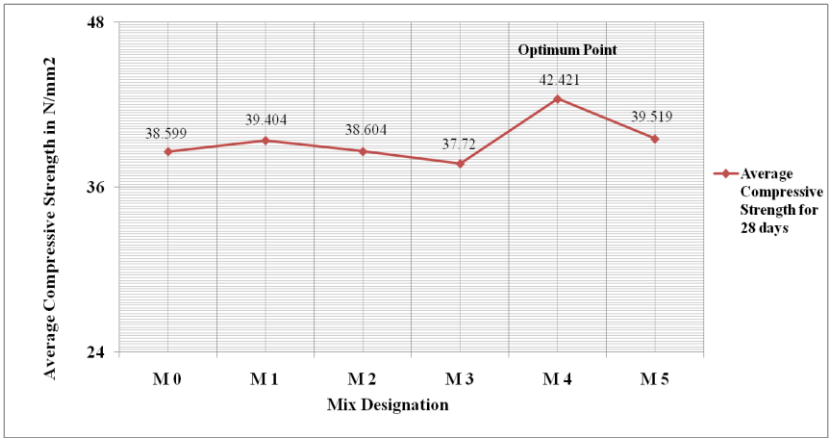


Graph 2- Graphical Representation of Compressive Strength v/s Mix designation for 28 days of curing (Optimum dosage graph).

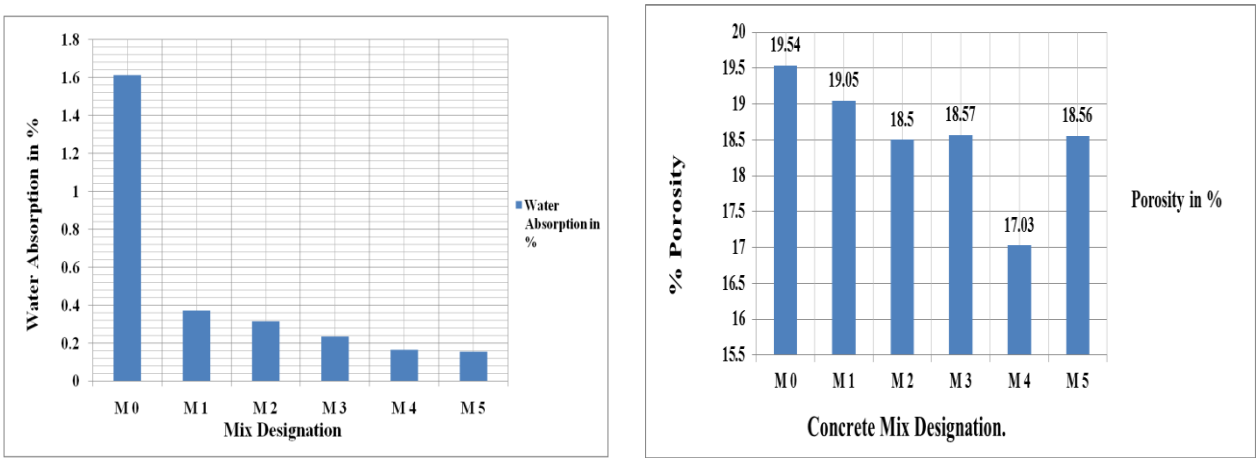
C. DURABILITY TEST RESULTS

Durability of concrete can be defined as its ability to resist weathering action, chemical attack, abrasion or any other process of deterioration. Durable concrete will retain its origin form, quality and serviceability when exposed to its environment.

When designing a concrete mix or designing a concrete structure the exposure condition at which the concrete is supposed to withstand is to be assessed in the beginning with good judgment. In the case of foundation the soil characteristics with respect to sulphate and chloride content in soil and ground water are also required to be investigated.

The following tests were conducted for the test of durability of concrete in this project

1) Water Absorption.
2) Porosity.
3) Fire Resistance.



Graph 3- Graphical Representation of Water Absorption and percentage porosity v/s Mix designation after 28 days of curing.

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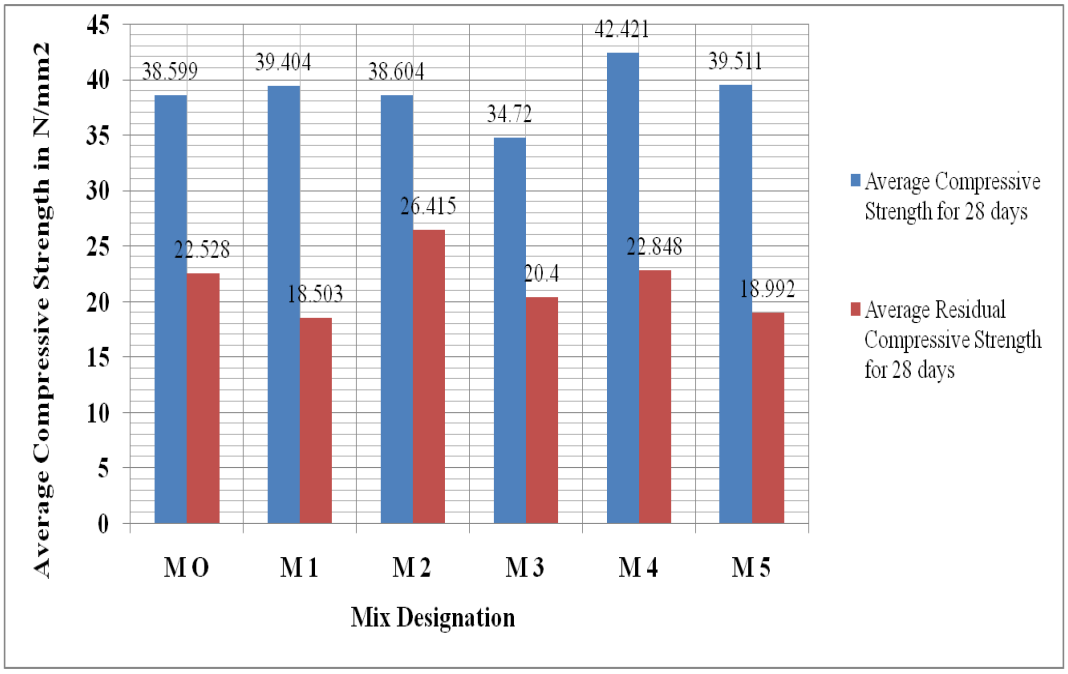

Graph 4- Graphical Representation of Fire Resistance v/s Mix designation for 28 days of curing.

IV. SUMMARY & CONCLUSIONS

The Study on effect of glass and steel fibre reinforced concrete composite can still be promising works as there is always a need to overcome the Brittleness of concrete. The Experimental study on strength and durability properties of concrete composite focuses on study of effect of glass and steel fibre. Following conclusions could be drawn from present study.

1) The Compressive strength of fibre reinforced concrete composite with various mix designation found higher as compared to normal conventional concrete for 7 and 28 days of curing (Refer Graph No-1).

2) The Split Tensile strength of fibre reinforced concrete composite with various mix designation showed higher strength as compared to normal conventional concrete (Refer Graph No. 1).

3) The Compressive strength of fibre reinforced concrete composite for mix designation M 4 (2% & 2.5%) showed higher strength compared to other mix designation and conventional concrete.

4) The optimum dose of M 4 (2% & 2.5%) steel and Glass Fibre showed better strength results compared to other dosages of fibres (Refer Graph No-2).

5) Slump will lose at the higher percentage of Steel and Glass Fibre. Density of concrete increases as percentage of fibre dosages of Steel and Glass.

6) The Water Absorption capacity of mix designation M 4 (2% & 2.5%) & M 5 (2.5 & 3%) fibre reinforced concrete composite showed least value as compared to other mix designation (Refer Graph No- 3).

7) The Percentage of porosity M 4 (2% & 2.5%) FRC composite showed least value among various mix designations (Refer Graph No-3).

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8) The capacity of Fire Resistance for M 2 (1% & 1.5%) & M 3 (1.5% & 2%) showed almost least value among various mix designations (Refer Graph No-4).

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