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EXPERIMENTAL STUDY ON STRENGTH CHARACTERISTICS OF CONCRETE BY USING DIFFERENT FIBERS AT VARIOUS REPLACEMENT LEVELS

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Abstract

Concrete is the most widely used building material in the world. Fiber-reinforced concrete (FRC) is a concrete in which small and discontinuous fibers are uniformly dispersed. The fibers used in FRC can be of different materials such as steel, stainless steel, carbon, glass, aramid, asbestos, polypropylene, jute,etc.

Adding these fibers to the concrete mass can greatly increase the compressive strength, tensile strength, bending strength and impact strength of the concrete. The results of the strength properties of steel, glass and cement reinforced with polypropylene fiber were presented in this study. The compressive strength of concrete samples made with different fiber amounts between 0%, 0.25%, 0.5% and 1% was studied. Samples with added different fibers showed better results with increasing fiber content.

1. INTRODUCTION

Deterioration of concrete systems is one of the major issues of the construction enterprise these days. Because replacing poor centers takes quite a few money and time, strengthening has turn out to be the suitable manner to increase wearing capability and lifespan. Concrete is the most broadly used artificial building material inside the international, it is an monetary cloth and the maximum used substance within the construction area. It is acquired by using blending cementitious substances, water and aggregates and on occasion adding additives, within the required proportions. The combination, as soon as placed in forms and left to treatment, is fashioned right into a mass much like a rock known as cement. The strength, sturdiness and other traits of concrete depend on the homes of its ingredients, the proportions of the elements, the compaction method and other controls at some point of positioning, compaction and hardening. Fiber-reinforced concrete (FRC) is a concrete that incorporates fibrous material that will increase its structural integrity. Fiber-bolstered concrete can be described as a composite fabric including combos of cement or cement mortar and discontinuous, discrete and uniformly dispersed fibers suitable. The normal fiber reinforced concrete is particularly used for floors and flooring, but can be considered for a wide variety of creation pieces (beams, pillars, foundations, etc.) by myself or with hand-tied armor. Fiber-reinforced cement (that is generally steel, glass or plastic fibers) is much less high priced than hand-tied reinforcement bars, growing tensile strength in many instances. The form, length and period of the fibers are critical.

Fiber-reinforced concrete substances had been new attractive materials for structural engineers in the subject of concrete buildings, especially for use as reinforcement materials for bolstered concrete beams. Steel, carbon, agamid and glass fibers are the fibers most normally used within the manufacturing of FRC reinforcement structures. Many systems are commercially to be had in bureaucracy consisting of slabs, fabric and pultruded sheets. However, most of these structures, if now not all, have a few drawbacks in terms of reinforcing the concrete beams.

They exhibit a stress reaction of the traces to the fault without showing any performance model. The final deformation values of these materials are very large compared to metallic deformation. As a end result, when bonded with epoxy to the tension face of a reinforced concrete beam If it reinforces it in bending, the metallic can yield even earlier than the reinforcing material starts off evolved to endure a huge load. Therefore, it's miles difficult to growth the pressure of the beam or its sliding load, until massive go-sections of these materials are used to contribute notably to the weight of the beam earlier than offering the steel reinforcement. Large move- sections of FRC won't be reasonably-priced and can bring about a fragile beam response because of the surprising boning of the reinforcement cloth of the concrete floor.

***Table 1:* properties of various fibers**

Fiber material	Tensile strength(N/mm^2)	Young's modulus (10^3 N/mm^2)	Specific Gravity
Steel	275-2758	200	7.86
Glass	1034-3792	69	2.5
Carbon	600-3690	120-580	1.65
Armed	1720-2540	41-125	1.44
Polypropylene	2800	255	0.97

2. Experimental Work

The experimental work accomplished to take a look at the impact of concrete energy is typically described and decided with the aid of the crushing resistance of a hundred and fifty mm x a hundred and fifty mm x one hundred fifty mm, on the age of 7, 14 and 28 days. It is the most common take a look at achieved on hardened concrete because it's far an easy take a look at to carry out and maximum of the acceptable concrete properties are qualitatively associated with its compressive electricity. Cast metallic mold one hundred fifty mm x 150 mm x 150 mm used to solid cement cubes full of steel glass, 0%, zero.25%, zero.5% polypropylene fibers, 1% by way of volume of concrete. The mold and its base are rigidly cushioned to lessen losses in the course of the casting. The aspects of the mildew and the bottom plates have been greased before casting to keep away from the union among the mildew and the concrete. The dice changed into saved for 24 hours without worrying at room temperature.

3. MIX DESIGN

In this bankruptcy the layout of the concrete blend is offered. The following blending task for the M35 grade is based totally on the recommended Indian method of designing concrete combinations IS: 10262-2009. In this, the concrete blend layout methods had been brought, the elements that must be carried out inside the layout of the combination and the combination layout scheme system.

3.1 METHOD OF CONCRETE MIXDESIGN

The mix design methods being followed in different countries are mostly based on Empherical relationships, charts and graphs developed from extensive experimental investigations.

Following methods are in practice

1. ACI mixdesign method
2. USBR mixdesign method
3. British mixdesign method
4. Mix design method as perIndian standard

3.2 OUTLINE OF MIX DESIGN PROCEDURE:

1. Arrive the target mean strength from the characteristicstrength required.
2. Choose the W/C ratio for targetmean strength.
3. Arrive at the water content for theworkability required.
4. Calculate thecement content.
5. Choose relative properties of fine andcoarse aggregates.
6. Arrive at the concrete mixproportion.

3.3 **Mix Design for M35Grade:**

- **STIPULATIONS FORPROPORTIONING**

a)	Grade designation	:M35
b)	Type ofcement	: OPC53Grade
c)	Maximumnominalsize of aggregate	: 2OMM,10MM
d)	Minimum cement content	: 340kg/m³
e)	Maximum water-cement ratio	:0.42
f)	Workability (slump value)	:100mm
g)	Exposure condition	: severe
h)	Methodof concrete placing	:pumping
i)	Degree ofsupervision	:good
j)	Type ofaggregate	: crushedangular
k)	Maximum cement content	:470kg/m³

- **Test data for materials:**
  - a) Cement used : OPC53grade
  - b) Specific gravity of cement : 3.15
  - c) Specific gravity of:
    - i) Coarse aggregate : 2.74
    - ii) Fine aggregate : 2.55
  - d) Water absorption:
    - i) Coarse aggregate : 0.5 %
    - ii) Fine aggregates : 1.0 %
  - e) Free (surface)moisture
    - i) Coarse aggregate : Nil
    - j) Fine aggregate : Nil

- **TARGET STRENGTH FOR MIX PROPORTIONING**

Fck = fck + 1.65 s (From table 1, IS 10262:2009 standard deviation,

S=5N/mm²) Target strength = 35+1.65*5 = 43.25 N/mm²

- **SELECTION OF WATER-CEMENT RATIO**

From table 5, of IS 456, maximum water- cement ratio = 0.45

Based on experience adopt water-cement ratio = 0.35, 0.35< 0.42, Hence ok.

- **SELECTION OF WATER CONTENT**

From table 2, maximum water content for 20mmaggregates =186litre

10mm aggregates =208liter

Estimated water content for 100 mm slump = (60/100)186+ (40/100)208

= 195litres

- **CALCULATION OF CEMENT CONTENT**
  - Water – cement ratio = 0.42
  - Cement content = 195/0.42
    = 470 kg/m³
  - From table 5 of IS 456, minimum cement content for severe exposure condition
    = 340 kg/m³

470kg/m³> 340 kg/m³. Hence, ok.

- **PROPERTIES OF VOLUME OF COARSE AND FINE AGGREGATE CONTENT**

Volume of coarse aggregate = (60/100)0.64+ (40/100)0.48

= 0.576

Volume of fine aggregate = 1-0.576

= 0.424

- **MIX CALCULATIONS**
  - **a) Volume of concrete=1m³**
  - **b) Volume of cement = mass of cement/specific gravity ofcement*1/1000**

= 470/3.1*1/1000

= 0.1516 m³.

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c) **Volume of water = mass of water/specific gravityof water*1/1000**

= 195/1*1/1000

= $0.195m^3$

d) **Volume of all in aggregates=(a-(b+c+d))**

= 1-(0.1516+0.195)

= 0.6534 m^3

e) **Mass of coarse aggregate = e*volume of coarse aggregate*specific gravityof coarse aggregate*1000**

=0.6534*0.57*2.74*1000

= 1025 kg

f) **Mass of fine aggregate = e*volume of fine aggregate * specific gravity of fine aggregate*1000**

= 0.6534*0.42*2.55*1000

= 700 kg.

- **MIX PROPORTIONS REQUIRED FOR COMBINED MIX**

Cement: 470kg/m^3

Water: 195kg/m^3

Fine aggregate: 760kg/m^3

Coarse aggregate: 1170 kg/m^3

Water-cement ratio: 0.42

Table 2: Mix design

Grade	Proportions	Cement (Kg/m³)	F.A (Kg/m³)	C.A (Kg/m³)	Water (LT)
M35	1:1.61:2.48	470	760	1170	195

Table 3: Quantitiesof materials

Grade	Type of Fiber	Proportions	Cement (Kg/m³)	F.A (Kg/m³)	C.A (Kg/m³)		%Water	%fiber (kg)
					20mm	10mm		
M35	Normal	0%	14.32	23.04	21.33	14.22	5.92	0
M35	Steel	0.25%	14.32	23.04	21.33	14.22	5.92	0.595
		0.5%	14.32	23.04	21.33	14.22	5.92	1.191
		1%	14.32	23.04	21.33	14.22	5.92	2.384
M35	Glass	0.25%	14.32	23.04	21.33	14.22	5.92	0.140
		0.5%	14.32	23.04	21.33	14.22	5.92	0.280
		1%	14.32	23.04	21.33	14.22	5.92	0.561
M35	Polypropylene	0.25%	14.32	23.04	21.33	14.22	5.92	0.073
		0.5%	14.32	23.04	21.33	14.22	5.92	0.147
		1%	14.32	23.04	21.33	14.22	5.92	0.294

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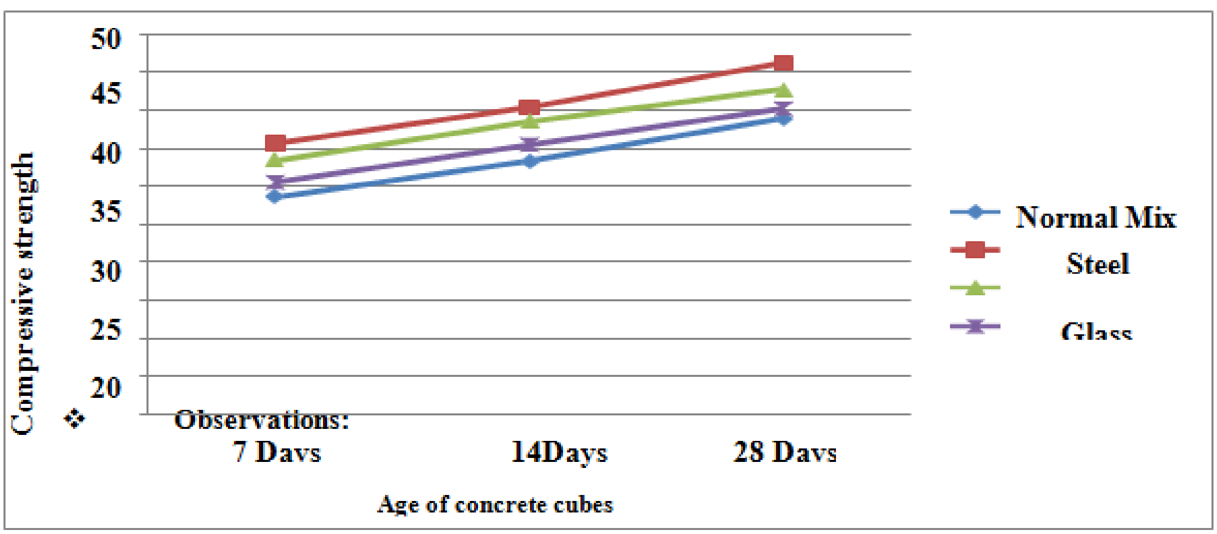
4. RESULTS AND DISCUSSIONS

4.1 Compressive Strength:

Compressive Strengths of Different fiber Concrete Cubes

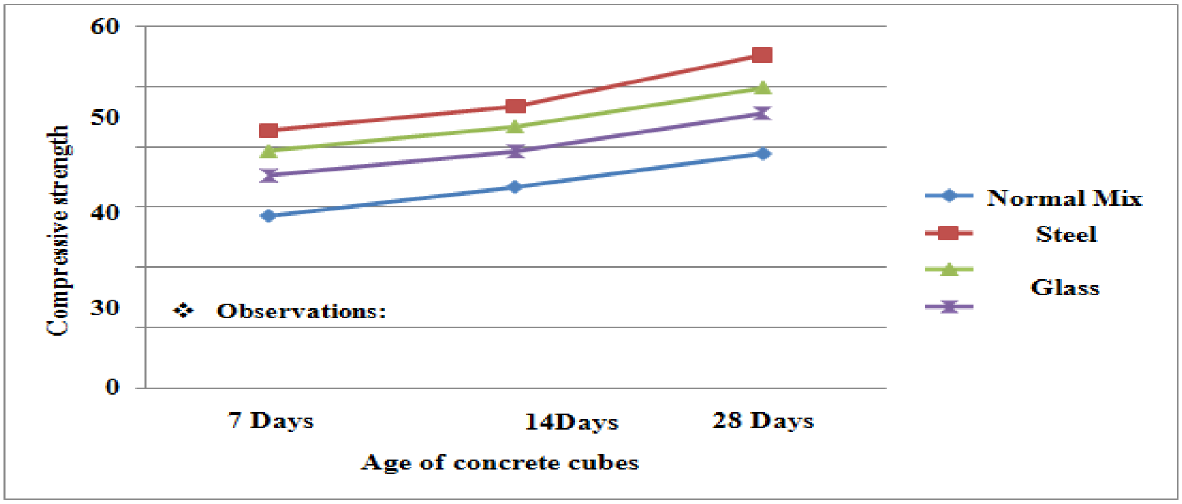
S.no	Mix	% of fibers added	7 days	14 days	28 days
1	Normal mix	0%	28.56 N/mm^2	33.35 N/mm^2	38.96 N/mm^2
2	Steel fiber	0.25%	35.65 N/mm^2	40.43 N/mm^2	46.26 N/mm^2
		0.5%	38.5 N/mm^2	43.60 N/mm^2	50.25 N/mm
		1%	42.85 N/mm^2	46.87 N/mm^2	55.36 N/mm^2
3	Glass fiber	0.25%	33.35 N/mm^2	38.52 N/mm^2	42.80 N/mm^2
		0.5%	36.53 N/mm^2	40.85 N/mm^2	45.65 N/mm^2
		1%	39.46 N/mm^2	43.45 N/mm^2	49.83 N/mm^2
4	Polypropylene Fiber	0.25%	30.55N/mm^2	35.45 N/mm^2	40.23 N/mm^2
		0.5%	32.65 N/mm^2	38.21 N/mm^2	42.85 N/mm^2
		1%	35.34 N/mm^2	39.35 N/mm^2	45.65 N/mm^2

- **Compressive strength vs. age of concrete (0.25%):**



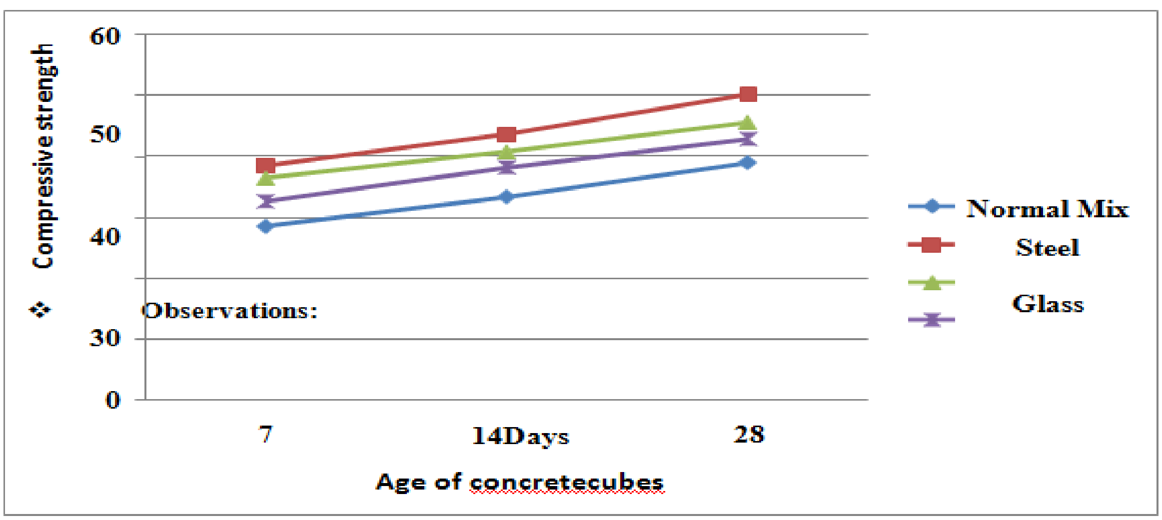
Graph 1: Compressive strength vs. age of concrete (0.25%)

◆ **Compressive strength Vs age of concrete (0.5%)**



Graph 2 : Compressive strength -Age of concrete for cubes of 0.5% of fiber content

◆ **Compressive strength vs. age of concrete (1%)**



Graph 3 : Compressive strength -Age of concrete for cubes of 1% of fiber content

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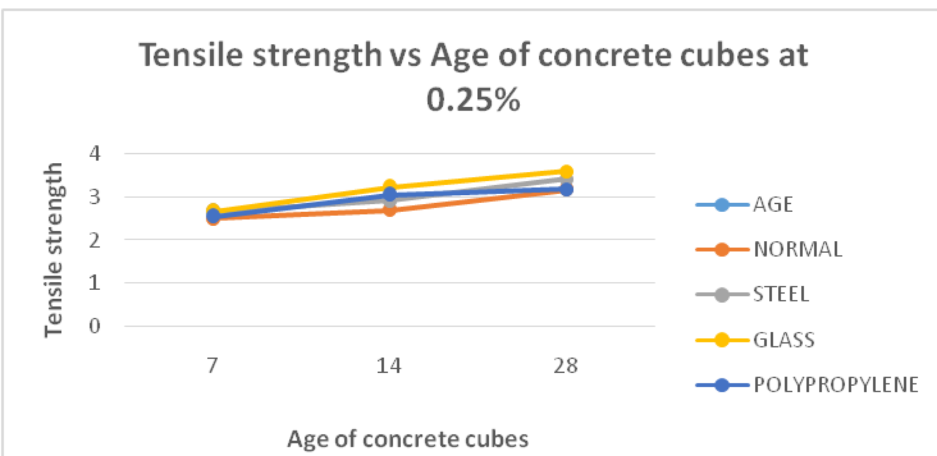
4.2 Tensile Strength:

Tensile Strength of Different Fiber Concrete Cubes

S.no	Mix	% of fibers added	7 days	14 days	28 days
1	Normal mix	0%	2.5N/mm^2	2.7 N/mm^2	3.17N/mm^2
2	Steel fiber	0.25%	2.66 N/mm^2	2.92 N/mm^2	3.42 N/mm^2
		0.5%	2.84 N/mm^2	3.16 N/mm^2	3.82 N/mm^2
		1%	3.35 N/mm^2	3.91 N/mm^2	4.48 N/mm^2
3	Glass fiber	0.25%	2.67 N/mm^2	3.52 N/mm^2	3.17 N/mm^2
		0.5%	2.78 N/mm^2	3.85 N/mm^2	3.44 N/mm^2
		1%	2.82 N/mm^2	3.92 N/mm^2	3.68N/mm^2
4	Polypropylene fiber	0.25%	2.55N/mm^2	3.05 N/mm^2	3.19 N/mm^2
		0.5%	2.65 N/mm^2	3.35 N/mm^2	3.55 N/mm^2
		1%	2.98 N/mm^2	3.67 N/mm^2	3.85 N/mm^2



Graph 4: Tensile Strength –Age of concrete cubes for 0.25%

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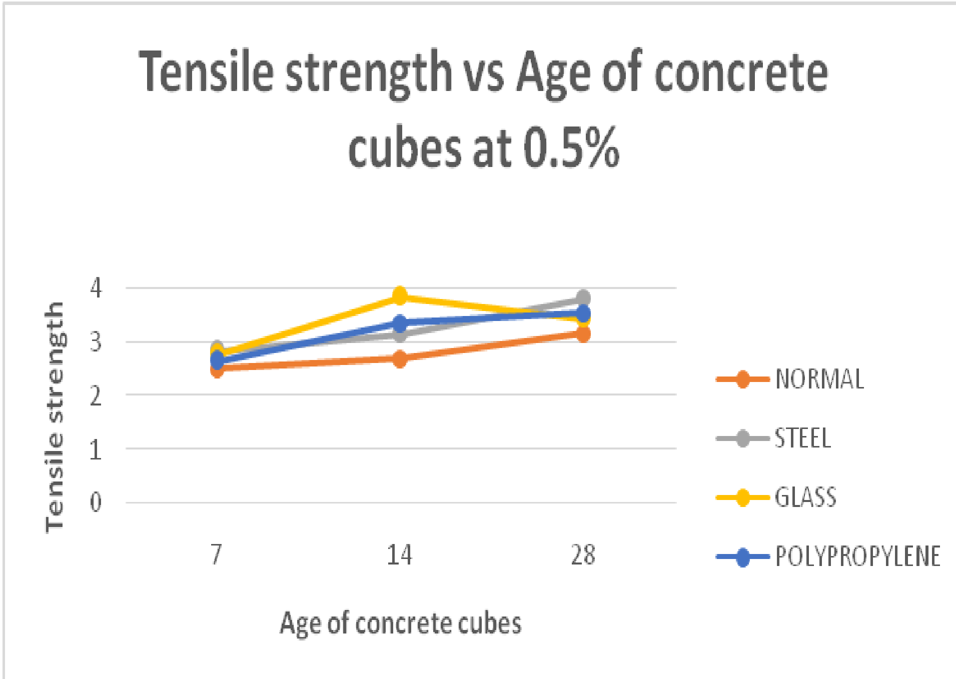
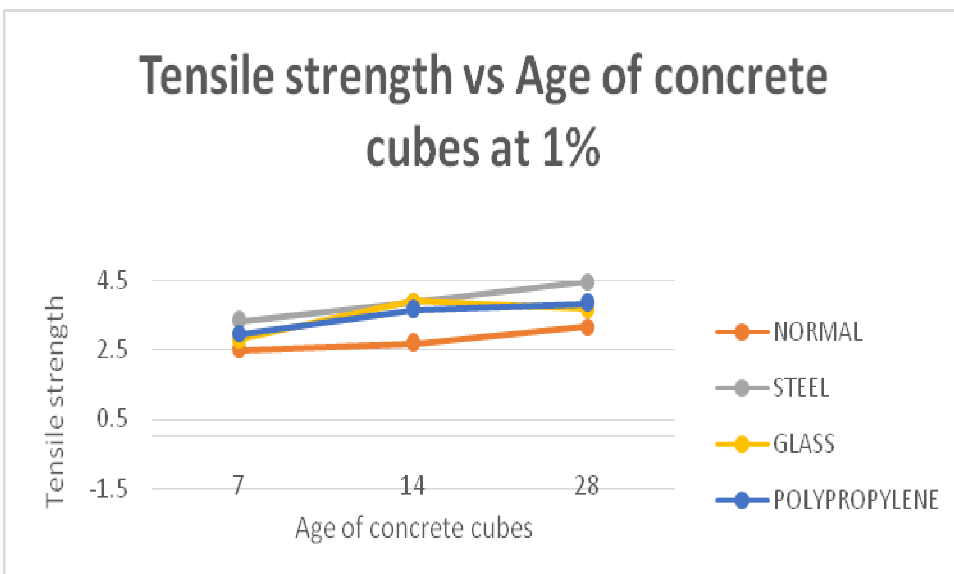


Graph 5 : Tensile Strength –Age of concrete cubes for 0.5%

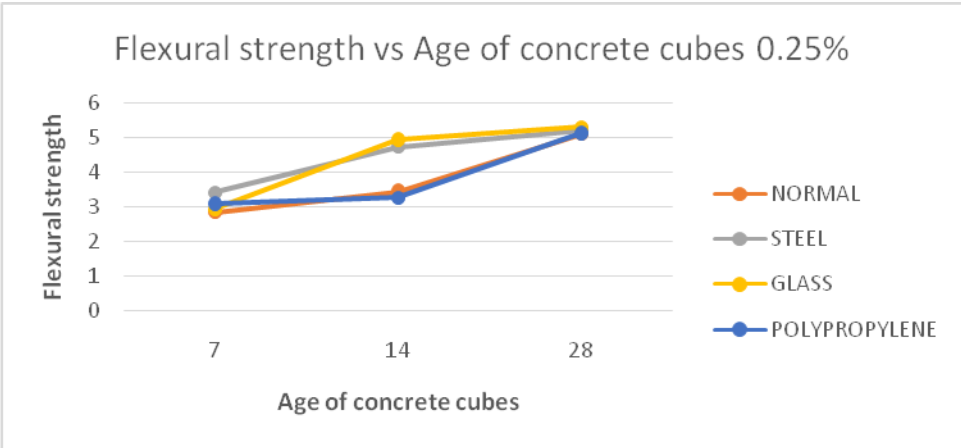


Graph 6 : Tensile Strength –Age of concrete cubes for 1%

4.2 FLEXURAL STRENGTH OF CONCRETE

Flexural Strength of Different Fiber Concrete Cubes

S.no	Mix	% of fibers added	7 days	14 days	28 days
1	Normal mix	0%	2.85 N/mm^2	3.45 N/mm^2	5.08N/mm^2
2	Steel fiber	0.25%	3.42 N/mm^2	4.73 N/mm^2	5.21 N/mm^2
		0.5%	3.95 N/mm^2	4.92 N/mm^2	5.4 N/mm^2
		1%	4.97 N/mm^2	5.45 N/mm^2	5.61 N/mm^2
3	Glass fiber	0.25%	2.95 N/mm^2	4.95 N/mm^2	5.1 N/mm^2
		0.5%	3.53 N/mm^2	4.85 N/mm^2	5.12 N/mm^2
		1%	3.5 N/mm^2	4.7 N/mm^2	4.8 N/mm^2
4	Polypropylene fiber	0.25%	3.1N/mm^2	3.28 N/mm^2	5.12 N/mm^2
		0.5%	3.65 N/mm^2	4.82 N/mm^2	5.28N/mm^2
		1%	4.58 N/mm^2	5.13 N/mm^2	5.34 N/mm^2



Graph 7 :Flexural strength -Age of concrete for cubes of 0.25% of fiber content

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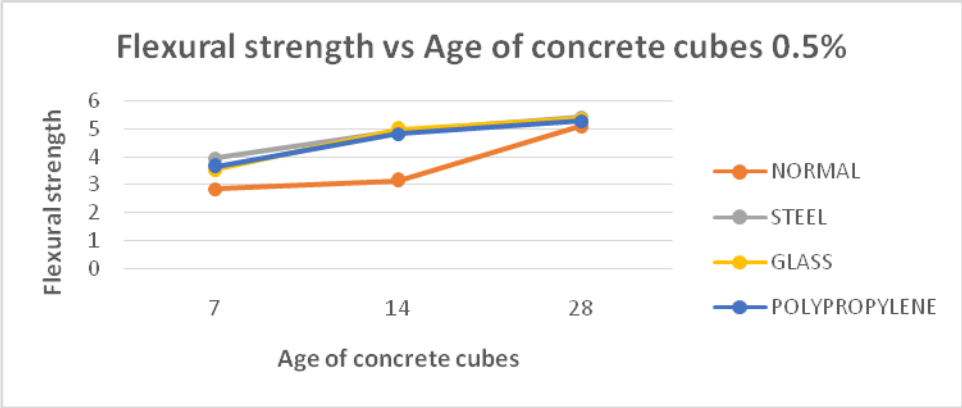
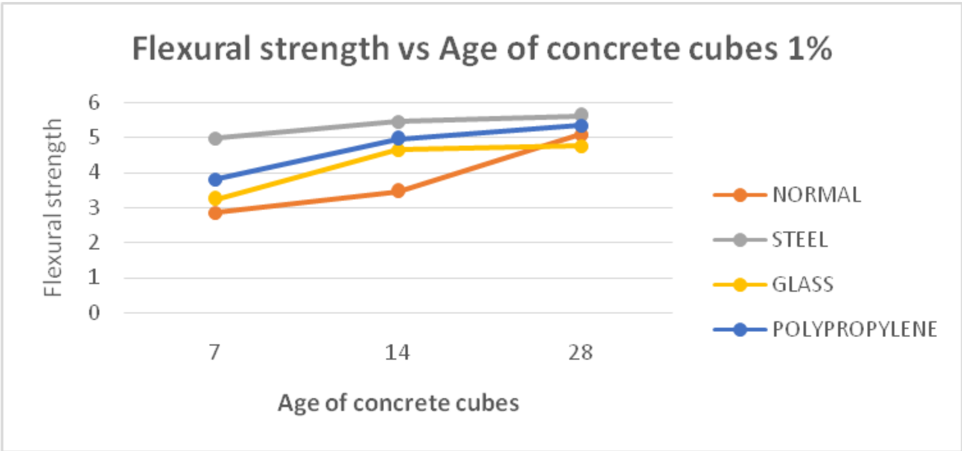


Graph 8 :Flexural strength -Age of concrete for cubes of 0.5% of fiber content



Graph 9 :Flexural strength -Age of concrete for cubes of 1% of fiber content

CONCLUSIONS

- With the increase of fiber content material, the strength characteristics increases.
- The remaining load behavior is likewise progressed because of the addition of fibers.
- Compressive, split tensile and flexural strengths increases while using different fibers at replacement levels of 0.25%,0.5%&1%
- Steel fibers supply greater strength while as compared to glass and polypropylene fibers. The steel fiber reinforced concrete offers 27.27% with addition of 1% glass fiber volume of concrete with as compared with normal mix.
- The steel fiber reinforced concrete offers 28.9% with addition of 0.5% steel fiber quantity of concrete with in comparison with regular blend.
- The polypropylene fiber strengthened concrete offers 17.17% with addition of 1% polypropylene fiber quantity of concrete with as compared with everyday mix.

- With addition of 0.5% polypropylene fiber gives 9.98% quantity of concrete with in comparison with normal mix.
- The polypropylene fiber reinforced concrete offers compressive strength of 3.25% increases at addition of 0.25% polypropylene fiber volume of concrete with compared with regular blend.
- With addition of 0.5% polypropylene fiber split tensile value increases 11.98% quantity of concrete when comparison with normal mix.
- With addition of 0.5% steel fiber split tensile value increases 20.5% quantity of concrete when comparison with normal mix.
- With addition of 0.5% glass fiber split tensile value increases 08.5% quantity of concrete when comparison with normal mix.
- The steel fiber reinforced concrete offers split tensile value at 21.45% with addition of 1% polypropylene fiber when comparison with regular blend.
- The flexural strength of the glass fiber reinforced concrete increases at 0.78% with addition of 0.5% glass fiber when compared with normal concrete.
- The flexural strength of glass fiber bolstered concrete decreases at 5.5% with addition of 1% glass fiber extent of concrete with compared with everyday mix.
- The polypropylene fiber strengthened concrete offers 0.78% of flexural strength increases with addition of 0.25% polypropylene fiber volume of concrete with in comparison with regular.
- The flexural strength value increases at 10.43% with addition of 1% of steel fiber when compared with normal concrete.

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