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COMPARATIVE STUDY ON STRENGTH BETWEEN POLYESTER FIBER AND GLASS FIBER IN CONCRETE MIX

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Abstract: This paper deals with an experimental investigation on the influence of polyester and glass fibers on strength parameters of the M30 concrete used in Construction. In this study two types of concrete mixes were prepared individually. Polyester fiber of 0.1% to 0.4% and Glass fiber of 0.1% to 0.3% by weight of cement were added to the mixes. A comparative analysis has been carried out for conventional concrete with respect to the fiber reinforced in relation to their Compressive, Spilt tensile and Flexural Strength properties. As the Fiber content increases Compressive, Spilt tensile and Flexural Strengths are proportionally increasing. It is observed that fibers increased beyond 0.3% polyester fiber and 0.2% glass fiber content results in decrease in strengths. Economic analysis is indicating that with the addition of polyester and glass fibers increases in economy leads to higher initial cost by 8 to 11% is counterbalanced by the reduction in maintenance and rehabilitation operations by using Fiber Reinforced Concrete as compared to that of Conventional Concrete.
Key Words: F.R.C (Fiber Reinforced Concrete), P.R.C (Polyester fiber Reinforced concrete), G.R.C (Glass Fiber Reinforced concrete), C.C (convectional concrete), Mix design, Compressive Strength, Spilt tensile Strength and Flexural Strength. SSR (Standard Schedule of Rates).

I. INTRODUCTION

In modern times a wide range of engineering materials(including ceramics, plastics, cement and gypsum products) incorporate fibers to enhance composite properties. The enhanced properties include tensile strength, compressive strength, elastic modulus crack resistance, crack control, durability, fatigue life, resistance to impact and abrasion, shrinkage, expansion, thermal characteristics, and fire resistance. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cement material, aggregate and water and by adding some special ingredients. Hence concrete is very well suited for a wide range of applications. However concrete has some deficiencies as low tensile strength, low post cracking capacity, brittleness and low ductility, limited fatigue life, not capable of accommodating large deformations, low impact strength. Fiber Reinforced Concrete (FRC) is a cementing concrete reinforced mixture with more or less randomly distributed small fibers. In the FRC, a number of small fibers are dispersed and distributed randomly in the concrete at the time of mixing and thus improve concrete properties in all directions. The fibers help to transfer load to the internal micro cracks. FRC is cement based material that has been developed in recent year's. It has been successfully used in construction with its excellent flexural – tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. These fiber's have many benefit's.

1.1 Fiber Reinforced Concrete (F.R.C)

Fiber Reinforced Concrete is the type of concrete which contains Fibrous materials which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, polypropylene fibers, glass fibers, natural fibers. With in these different fibers, that character of fiber reinforced concrete changes with varying concretes, fiber materials, geometrics, distribution, orientation and densities. In Fiber Reinforced Concrete, fibers can be effective in arresting cracks at both macro and micro levels.

1.2 Polyester Fiber Reinforced Concrete (P.R.C)

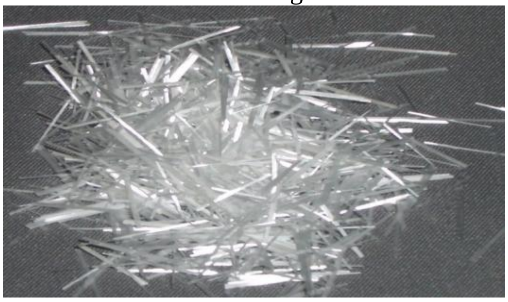
Polyester fibers are available in monofilament form and belong to the thermoplastic polyester group. They are temperature sensitive and above normal service temperature their properties may be altered. Polyester fibers are somewhat hydrophobic. Polyester fibers have been used at low contents (0.1%) to control plastic shrinkage cracking in concrete.

Polyester fiber

1.3 Glass Fiber Reinforced Concrete (G.R.C)

Glass fiber is available in continuous or chopped lengths. Fiber lengths of up to 35-mm are used in spray applications and 25-mm lengths are used in premix applications. Glass fiber has high tensile strength (2-4Gpa) and elastic modulus

(70-80Gpa) but has brittle stress-strain characteristics and low creep at room temperature. Claims have been made that up to 5% glass fiber by volume has been used successfully in sand-cement mortar without balling.



Glass fiber

II. TESTS ON MATERIALS

Laboratory tests were conducted to know the properties of cement, fine aggregate and coarse aggregate and those are discussed below:

2.1Tests on Cement

- Cement used in the present project is of 53grade Ordinary Portland Cement. Various physical tests like specific gravity, fineness, normal consistency, initial & final setting time, soundness on cement as per IS 4031.

Specific Gravity

- Specific gravity of cement used is 3.15.
- The specific gravity of cement as per IS requirements is in between 3-3.5.

Fineness of Cement

- Fineness of cement is tested by sieving of cement.
- Fineness of cement is 93.5%.
- The residue of cement should not exceed 10% by mass as per IS 4031: 1968.

Normal Consistency(As Per IS 4031 part 4)

- The standard consistency of a cement paste is defined as that consistency which will permit a Vicat's plunger to penetrate a depth of 5-7 mm from bottom of the mould.
- The percentage of water required to produce a cement paste of standard consistency is 27%.
- As per IS recommendations the standard consistency of cement should be in the range of 26% -33%.

Initial Setting Time (As Per IS 4031 part 5)

- The time elapsed between the moment water is added to cement to the time that paste starts losing its plasticity is called initial setting time.
- The initial setting time of the cement used is 40 minutes.
- As per IS recommendations initial setting time is greater than 30 minutes.

Final Setting Time (As Per IS 4031 part 5)

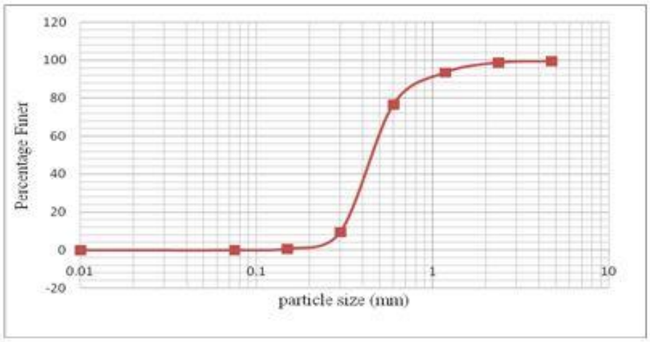
- The time elapsed between the moment of adding water to the cement, and the time when the paste has completely lost its plasticity is called final setting time.
- The final setting time of cement is 6hours 32minutes.
- As per IS recommendations final setting time should be within 10 hours.

Soundness Test (As Per IS 4031 part 3)

- Soundness test of cement was done by using lechatlier apparatus.
- Soundness test of cement: 3mm (not greater than 10mm).

2.2 Tests on Fine Aggregate

- Specific gravity of fine aggregate is 2.74 and sieve analysis was conducted to the fine aggregate which shows the sand belong to zone III as per IS: 383-1917.



Grain size analysis of sand

2.3 Tests on Coarse Aggregate

Aggregates used in the mix were 20 mm and 10mm respectively.

Size	Specfic gravity
20mm	2.71
10mm	2.51

Specific Gravity of aggregates.

Aggregate Impact value

- Average impact value of aggregate sample = 19.49%

Aggregate crushing value

- Average crushing value of aggregate sample = 26.20%

2.4 Mix Design

All the mixes prepared are corresponds to M-30 grade. For the design of mix IS: 10262-2009 recommendations are adopted. Design mix proportions of M-30 grade are given in the following.

Ingredient	Cement	Water	Fine aggregate	Coarse aggregate	Chemical admixture	Water cement Ratio
Weight	310 kg/m^3	155 liters	74.562 kg/m^3	1305.88 kg/m^3	2.17 kg/m^3	0.5

M30 Ratio: 1: 2.307: 4.285

Concrete mix Proportion :

Mix designation	Description of Mix
Conventional concrete	C.C
PRC 0.1%	C.C+0.1%P.F
PRC 0.2%	C.C+0.2%P.F
PRC 0.3%	C.C+0.3%P.F
PRC 0.4%	C.C+0.4%P.F
GRC 0.1%	C.C + 0.1%G.F
GRC 0.2%	C.C + 0.2%G.F
GRC 0.3%	C.C + 0.3%G.F

III. RESULTS

3.1 Workability of Concrete:

Slump cone test was performed to determine the slump of the concrete mixes. The slump values for various mixes as shown in below table.

Percentage of Fiber	Polyester fibers Slump(mm)	Glass fibers Slump(mm)
0	113	113
0.1	105	102
0.2	97	91
0.3	85	78
0.4	76	-

Slump values for different % of fibers

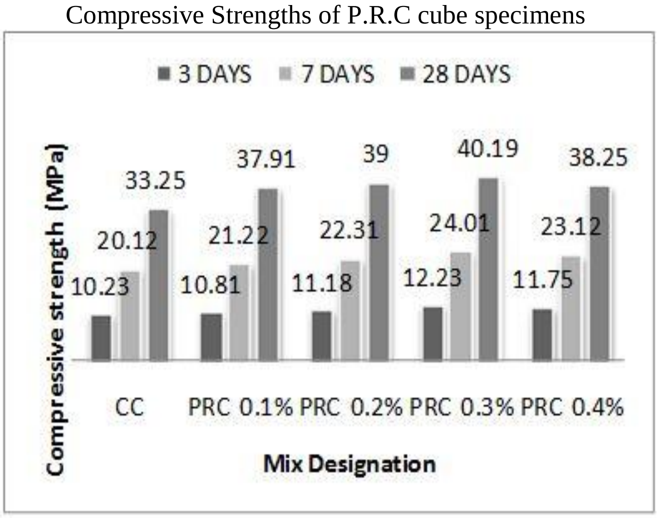
It is observed that from the above results as the percentage of fibers increases the slump of the concrete is decreasing. This may be due to the fibers, as the percentage of fiber increases they obstructing the flow of the concrete.

3.2 Mechanical Characteristics of P.R.C (Polyester fiber Reinforced concrete)

3.2.1 Compressive Strength of P.R.C cube specimens

Concrete Mix	3 days (MPa)	7 days (MPa)	28 days (MPa)
C.C	10.23	20.12	33.25
PRC (0.1%)	10.81	21.22	37.91
PRC (0.2%)	11.18	22.31	39.00
PRC (0.3%)	12.23	24.01	40.19
PRC (0.4%)	11.75	23.12	38.25

Compressive Strengths of P.R.C cube specimens

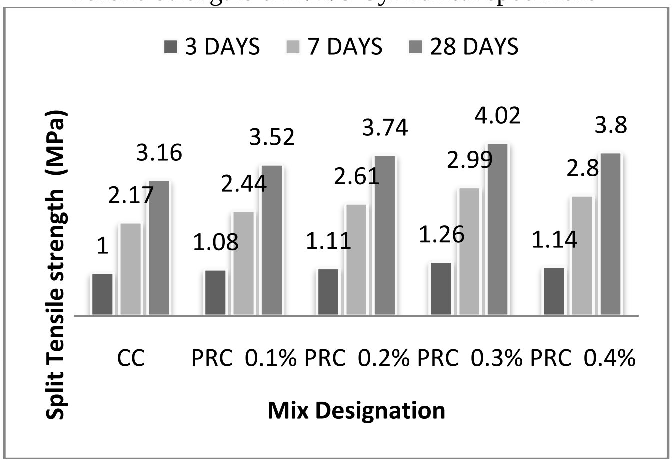


Compressive strength values of C.C and P.R.C at 3, 7 and 28 Days

3.2.2 Split Tensile strength P.R.C cylinder specimens :

Concrete Mix	3 days (MPa)	7 days (MPa)	28 days (MPa)
C.C	1.00	2.17	3.16
PRC (0.1%)	1.08	2.44	3.52
PRC (0.2%)	1.11	2.61	3.74
PRC (0.3%)	1.26	2.99	4.02
PRC (0.4%)	1.14	2.80	3.80

Tensile Strengths of P.R.C Cylindrical specimens

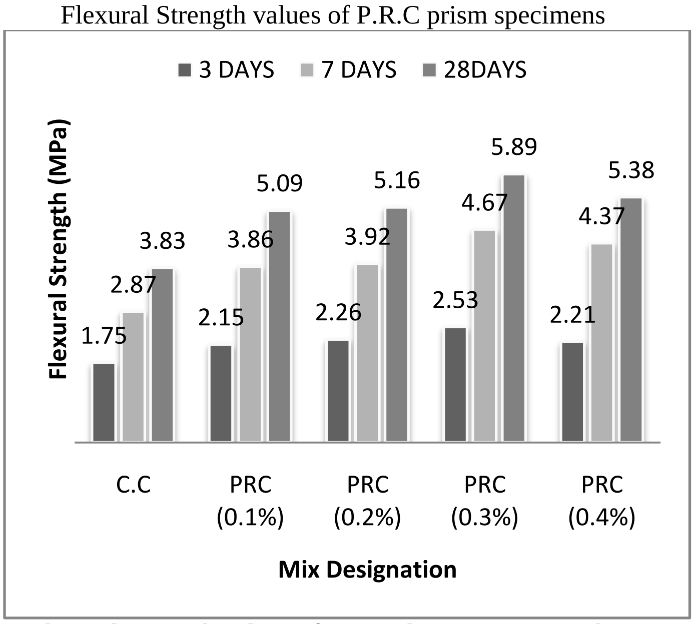


Split Tensile strength values of C.C and P.R.C at 3,7 and 28 Days

3.2.3 Flexural Strength of P.R.C Prism Specimens :

Concrete Mix	3 days (MPa)	7 days (MPa)	28 days (MPa)
C.C	1.75	2.87	3.83
PRC (0.1%)	2.15	3.86	5.09
PRC (0.2%)	2.26	3.92	5.16
PRC (0.3%)	2.53	4.67	5.89
PRC (0.4%)	2.21	4.37	5.38

Flexural Strength values of P.R.C prism specimens



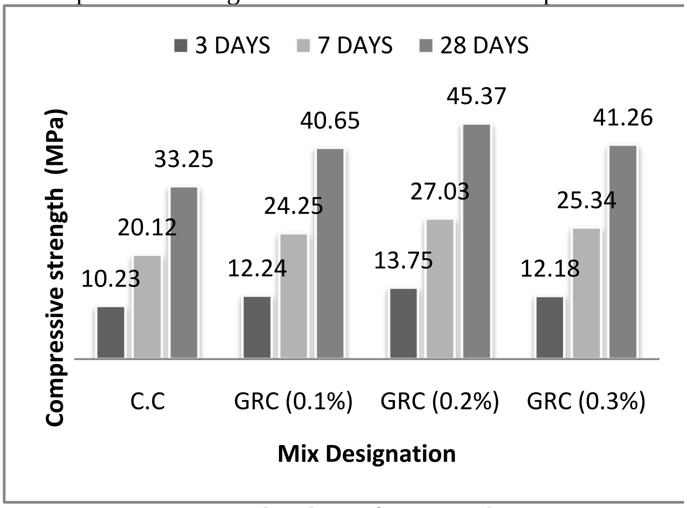
Flexural Strength values of C.C and P.R.C at 3, 7 and 28 Days

3.3 Mechanical Characteristics of G.R.C (Glass Fiber Reinforced concrete)

3.3.1 Compressive Strength of G.R.C Cube specimens :

Concrete Mix	3 days (MPa)	7 days (MPa)	28 days (MPa)
C.C	10.23	20.12	33.25
GRC (0.1%)	12.24	24.25	40.65
GRC (0.2%)	13.75	27.03	45.37
GRC (0.3%)	12.18	25.34	41.26

Compressive Strengths of C.C and G.R.C cube specimens

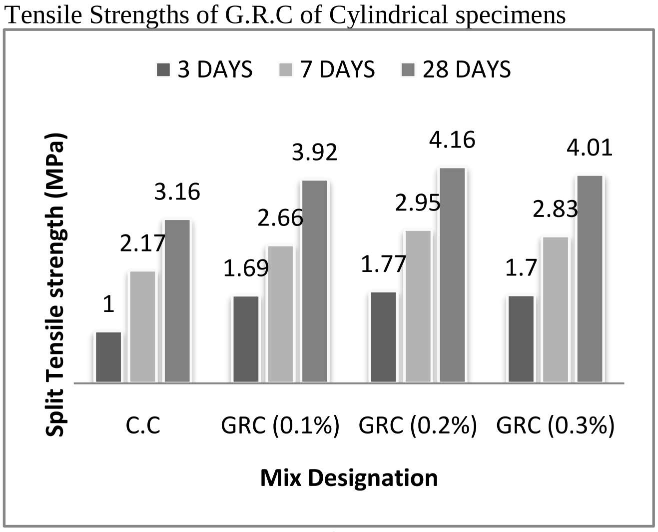


Compressive strength values of G.R.C cube specimens

3.3.2 Split Tensile strength G.R.C cylinder specimens:

Concrete Mix	3 days (MPa)	7 days (MPa)	28 days (MPa)
C.C	1.00	2.17	3.16
GRC (0.1%)	1.69	2.66	3.92
GRC (0.2%)	1.77	2.95	4.16
GRC (0.3%)	1.70	2.83	4.01

Tensile Strengths of G.R.C of Cylindrical specimens

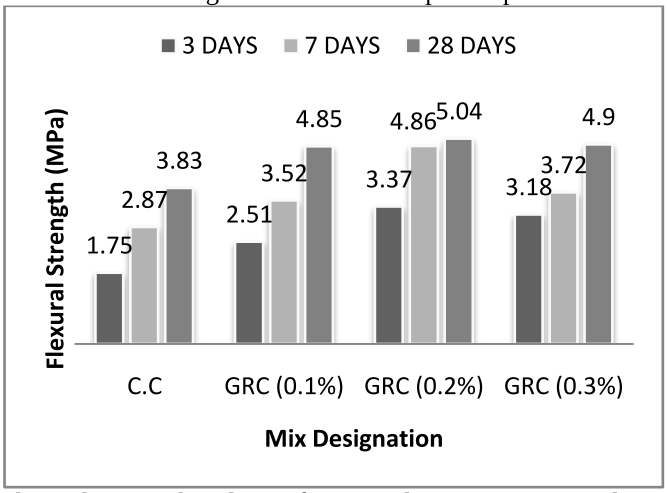


Split Tensile strength values of C.C and G.R.C at 3, 7 and 28 Days

3.3.3 Flexural Strength of G.R.C Prism Specimens :

Concrete Mix	3days (MPa)	7days (MPa)	28days (MPa)
C.C	1.75	2.87	3.83
GRC (0.1%)	2.51	3.52	4.85
GRC (0.2%)	3.37	4.86	5.04
GRC (0.3%)	3.18	3.72	4.90

Flexural Strength values of G.R.C prism specimens



Flexural Strength values of C.C and G.R.C at 3, 7and 28 Days

IV. CONCLUSIONS

- It is observed that Slump values of the concrete are decreasing as the fiber percentage increasing. The reduction in slump with the increase in the fiber will be attributed to presence of fibers which causes obstruction to the free flow of concrete.
- Compressive Strength enhancement ranges from 14.01% to 20.00% when % of fiber increases from 0.1% to 0.3% for P.R.C when compared to the conventional concrete at 28 days. 0.3% is observed as the optimum value.
- Split tensile Strength enhancement ranges from 21.2% to 27.21% when % of fiber increases from 0.1% to 0.3% for P.R.C when compared to the conventional concrete at 28 days. 0.3% is observed as the optimum value
- Flexural Strength enhancement ranges from 32.89% to 53.78% when % of fibers increases from 0.1% to 0.3% for P.R.C when compared to the conventional concrete at 28 days. 0.3% is observed as the optimum value.
- Compressive Strength enhancement ranges from 22.25% to 36.45% when % of fiber increases from 0.1% to 0.2% for G.R.C when compared to the conventional concrete at 28 days.
- As the fiber content is increased from 0.1% to 0.2% in weight of cement there is an increase in the split tensile strength from 24.05% to 31.6% for G.R.C .when compared to the conventional concrete at 28 days.
- At the age of 28 days, there is a significant

improvement in the flexural strength with the addition of fibers. The increment in the flexural strength of G.R.C is from 26.78% to 31.59% when % of fibers varied from 0.1% to 0.2% respectively. 0.2% is observed as the optimum value.

- Construction cost per m3 is increased by 8.83% by using polyester fiber and an increase of 10.44% by using glass fiber. As the cost increases on addition of fibers in concrete increases in strength(compressive, split tensile and flexural strengths) of the concrete which leads to increase in crack resistance, elastic modulus, durability, fatigue, resistance to impact and abrasion. It decreases the maintenance cost and improves the long term serviceability of the structure.
- The higher initial cost by 8 to 11% is counterbalanced by the reduction in maintenance and rehabilitation operations by using Fiber Reinforced Concrete.T his study was to achieve the highest compressive, split tensile, flexural strength and to observe how these parameters changed with the variation of some factors like water to cement ratio will be decreased because of low permeability and shrinkage reduction in concrete. However, more economical approach could be achieved by improvement in strength (compressive, split tensile and flexural strengths) which leads to improvement in serviceability of structures.

REFERENCES

[1] Barbara G. Charalambidi1; Theodoros C. Rousakis2; and Athanasios I. Karabinis, “Fatigue Behavior of Large-Scale Reinforced Concrete Beams Strengthened in Flexure with Fiber-Reinforced Polymer Laminates” in American Society of Civil Engineers, 2016.
[2] Bilal S. Hamad, M.ASCE1 ; and Elias Y. Abou Haidar2, “Bond Studies of High-Strength Concrete Joints Confined with Stirrups, Steel Fibers, or Fiber-Reinforced Polymer Sheets “ in American Society of Civil Engineers, 2016.
[3] PadmanabhanIyer. “Mechanical Properties of Fiber-Reinforced Concrete Made with Basalt Filament Fibers” in American Society of Civil Engineers,2015.
[4] S.A kanalli, Ramupalankar, Bharat kumar, Praveen kumar, Prakash S.K “Comparitive study of polymer Fiber reinforced concrete with conventional concrete ” in IJRET, 2014.
[5] C. Selin Ravi kumar and T.S. Tandavamoorthy “Glass fiber concrete: investigation on strength and fire resistant properties” in IOSR-JMCE, 2013.
[6] Pshtiwan N shakor, S.S pimplikar“ Glass fiber reinforced concrete use in construction” International Journal of technology and Engineering System Volume 2, March 2011.
[7] M.S.Shetty, “Concrete Technology”, S.Chand & company Ltd, New Delhi. IS Codes:
[8] IS:4031,“methods of tests conducted on cement” Bureau of Indian standards, New Delhi.
[9] IS:383-1970,“Specification for coarse and fine aggregates”.
[10] IS:2386 (part-1)-1963, “Methods of testing for aggregate for concrete”.
[11] IS:10262-2009, “Recommended guidelines for concrete mix design, Bureau of Indian standards”, New Delhi, India.
[12] IS:516-1959, Indian standard methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi, India.

