Experimental Investigation on Mechanical Properties Effect of Nano Materials as Cement Replacement in Concrete Incorporating Crumbed Rubber as Coarse Aggregate Replacement

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ABSTRACT:
In modern years Fibre reinforced concrete is cement based composite material has been developed. It has been successfully used in construction with its outstanding flexural tensile strength, resistance to splitting, impact resistance and outstanding permeability and frost resistance. It is a successful way to raise toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. Fibre is added as a reinforcing material possessing certain characteristic properties.
Concrete is the most extensively used structural material in the world with an yearly production of over seven billion tons. For a multiplicity of reasons, much of this concrete is cracked. The reason for concrete to undergo cracking may be endorsed to structural, ecological or economic factors, but most of the cracks are formed due to the natural weakness of the material to resist tensile forces. Concrete normally shrinks and force crack when it is controlled. It is now well-known that steel fibre reinforcement offers a solution to the problem of cracking by making concrete tougher and more yielding. It has also been proved by wide investigation and field tests carried out over the past three decades. The present investigation focuses on introduction of steel, glass, carbon fibres, Polyvinyalcohol (PVA) fibres, of polypropylene fibres at the time of mixing and production improves a number of properties of concrete, particularly those related to strength, performance and durability. This review paper is an evaluative report of studies established in the recent years. It describes and gives an Experimental basis for the research.

I. INTRODUCTION
Fiber reinforced concrete (FRC) is concrete obtained by the addition of fibers to concrete (short discrete fibers that are uniformly distributed). Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Adding fibers to concrete greatly increases the toughness of the material. The use of fibers also alters the behavior of the fiber matrix composite after it has cracked, thereby improving its toughness.
Concrete will give better durability and also its costs during construction as well as maintenance are very low when compared to other construction materials. As we know that concrete is strong in construction and weak in tension and tends to fail because of its deficiencies such as low tensile strength, low strain at fracture. The weakness of concrete is due to the presence of micro cracks at mortar aggregate interface. In present experimental work forM25 grade of concrete can be designed according to IS 10262:2009 with four different proportions of hybrid fibers are added with concrete ingredients.

FIBRE REINFORCED CONCRETE (FRC)
Fibre reinforced concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinues, discrete, uniformly dispersed suitable Fibres. And Fibre is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat the Fibre is often described by the parameter aspect ratio which is ratio of Fibre length to its diameter.

OBJECTIVES
Following are the aims and objectives of project work:
1. To determine the optimum percentage combination of HFRC.
2. To compare the strength of concrete cube containing hybrid Fibres with fixed 0%, 1%, 2%, 3% and 4% proportions with steel, glass, carbon fibres, Polyvinyalcohol (pva) fibres, of polypropylene fibres and combined with Steel Fibres and Glass fibres, carbon Fibre and Glass fibres and polyvinyalcohol Fibre and polypropylene fibres composition respectively of volume of the concrete.
3. Mechanical properties were calculated.

II LITERATURE REVIEW
Selina ruby g., geetthanjali c., et.al entitled on "impact of half breed Fibre on strengthened cement" in January 2014. In this study they utilized two sorts of strands i.e. pleated steel Fibre with having length of 40mm and breadth is 0.5mm with Aspect Ratio 80 and another Fibre is polypropylene with having a cut length of 38mm and distance across is 0.1mm with Aspect Ratio 380. In their studies they utilized three diverse extent, for example, S0.25+P0.75, S0.5+P0.5, S0.75+P0.25,(p-polypropylene, S-steel filaments) for M40 evaluation of cement with water-bond Ratio 0.40 with expansion of super plasticizer. Compressive, elastic, flexural qualities test can be completed to perform and dissect the diverse blend extent with strands variety. Examples are tried for 28 days curing. The finish of these paper is compressive quality is greatest for the extent of S0.75+P0.25 this is a result of high versatile modules of steel Fibre and low flexible modules of polypropylene Fibre and elasticity, flexural quality additionally increment for the extent S0.75+P0.25.

S.c.Patodi, c.v. Kulkarani et.al entitled on "Execution Evaluation Of Hybrid Fibre Reinforced Concrete Matrix" in October 2012. In their study they utilized two filaments for hybridization, i.e. creased steel Fibre with having length of 25mm and breadth is 0.45mm with Aspect Ratio of 55.5 and another Fibre is polyester Fibre with having length of 12.5mm and measurement of Fibre is 30Micron [Eq.Dia]. For making of HFRC they arranged six diverse blend extent, for example, P0+S0, P1+S0, P0+S1, P0.5+S0.5, P0.3+S0.7, P0.7+S0.3(P-polypropylene S-steel filaments) for M20 evaluation of cement with expansion of concoction admixture by dosage of 0.8% by weight of concrete. Quality parameters of cement such pressure quality, elasticity, Flexural quality, sway quality, shear quality test are examined with various blend extent. This paper inferred that all the quality parameters like compressive, tractable, Flexure, Shear quality is expansions for blend extent of S0.7+P0.3. Sway quality may likewise increment for the same extent.

Ahsanafathima k m, shisivarghese et.al entitled on "Behavioral Study Of Steel Fibre and Polypropylene Fibre Reinforced Concrete" in October 2014. For their studies three kind of filaments are utilized, for example, snare end, steel pleated Fibre with length of 30mm and identical measurement 0.6mm with Aspect Ratio 50 and creased steel Fibre is utilized with the length of 25mm and width is 0.5mm and having an Aspect Ratio 50. Also, another Fibre is ENDURO-600 Macro engineered polypropylene strands with Aspect Ratio 50, having length 50mm and thickness is 1mm. The principle goal of this study is to think about the quality parameters of cross breed Fibre strengthened cement with various blend extent. In their study six diverse blend extent of steel Fibre and polypropylene strands are included independently with blend extent of 0%, 0.25%, 0.5% 0.75% by volume of cement and hybridization Ratio of 0.5% of polypropylene Fibre and 0.75% of steel Fibre by volume of cement for M30 evaluation of cement with expansion of super plasticizer with 7 and 28 days curing period. From this paper they reason that compressive quality is expanded with expansion 0.75% steel Fibre and creased steel Fibre have better compressive quality that snare end steel Fibre. Part elasticity likewise increments for 0.75% steel Fibre and expansion of polypropylene strands by 0.5% of volume of solid builds the split rigidity. Flexural quality may increments with expansion of 0.75% steel Fibre by volume of cement.

III: MATERIALS AND METHODOLOGY

In making any type of concrete, selection and type of materials is very important as all the properties depends on them.

The following materials are being used and are listed below.

- Cement
- Coarse aggregate
- Fine Aggregate
- Fibres
- Steel, Glass, Carbon, PVF, PPF and
- Water

Cement

The most common cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 53 grade (OPC) conforming to IS: 8112-1989 is used. A cement is a binder, a substance used in construction that sets, hardens and adheres to other materials, binding them together.

Coarse Aggregate

Aggregates are primarily naturally occurring, inert granular materials such as sand, gravel, or crushed stone. But, technology is broadening to include the make use of recycled materials and man-made products. In this investigation used 12mm size aggregates are used for Concrete.

Fine Aggregate

Fine Aggregate can be natural or manufactured sand, but it have to be of uniform grading. The particle fineness than 150um sieve are considered as fines. To achieve a balance between deformability or fluidity and stability, the total content of fineness has to be high, usually about 520 to 560kg/m^3

Steel Fibres

Steel Fibres have been used in concrete since the early 1900s. Steel Fibres are widely used Applications of steel-Fibre-reinforced concrete include highway pavement, airport runways, refractory concrete and shotcrete tunnel lining by spraying Fibre- reinforced concrete. Its potential improvement to increase toughness, minimize cracking due to temperature, resistance to impact, abrasion, blasting and fatigue. Furthermore steel Fibre reinforced concrete greatly reduces the potential for fracture and spalling.

Glass Fibres

Glass Fibre has roughly comparable mechanical properties to other Fibres such as polymers and carbon Fibre. Although not as rigid as carbon Fibre, it is much cheaper and significantly less brittle when used in composites. Glass Fibres are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight Fibre-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "Fibreglass". This material contains little or no air or gas, is more dense, and is a much poorer thermal insulator than is glass wool.

Carbon Fibres.

Carbon fiber is composed of carbon atoms bonded together to form a long chain. The fibers are extremely stiff, strong, and light, and are used in many processes to create excellent building materials. Carbon fiber material comes in a variety of "raw" building-blocks, including yarns, uni-directional, weaves, braids, and several others, which are in turn used to create carbon fiber composite parts.

Poly Vinyalcohol (PVA) Fibres.

PVA Fibers (polyvinyl alcohol) are high-performance reinforcement fibers for concrete and mortar. PVA fibers are well-suited for a wide variety of applications because of their superior crack-fighting properties, high modulus of elasticity, excellent tensile and molecular bond strength, and high resistance to alkali, UV, chemicals, fatigue and abrasion. PVA fibers are unique in their ability to create a molecular bond with mortar and concrete that is 300% greater than other fibers.

Polypropylene Fibres

Polypropylene fiber, also known as polypropene or PP, is a synthetic fiber, transformed from 85% propylene, and used in a variety of applications. The fiber is thermoplastic, resilient, light weight and resistant to mildew and many different chemicals

Concrete Mix Proportions for Trial Mix

Cement = 384.8 kg/m^3

Water = 197.4 kg/m^3

Fine aggregate =790.3 kg/m^3

Coarse aggregate = 1073.33 kg/m^3

IV. EXPERIMENTAL INESTIGATION

- COMPRESSIVE STRENGTH TEST
- ACID ATTACK TEST
- SULPHATE ATTACK TEST
- PERMEABILITY TEST

DISCUSSION ON RESULTS

Compressive strength

Table 1 Compressive Strength of Steel Fibres

Mix Percentage	7days Strength (N/mm²)	28 days strength (N/mm²)
0%	4.8	12
1%	8.9	20
2%	9.5	29
3%	9	22.5
4%	7.5	21.5

Table 2 Compressive Strength of Carbon Fibres

Mix Percentage	7days Strength (N/mm²)	28 days strength (N/mm²)
0%	4.8	12
1%	8.5	19.5
2%	10	28.5
3%	9.5	23
4%	8	22

Table 3 Compressive strength of Glass fibres

Mix Percentage	7days Strength (N/mm²)	28 days strength (N/mm²)
0%	4.8	12
1%	6.5	12.5
2%	7.5	19.5
3%	6.5	14
4%	5.8	12.5

Table 4 Compressive strength of Polyvinyalcohol (PVA) fibres

Mix Percentage	7days Strength (N/mm²)	28 days strength (N/mm²)
0%	4.8	12
1%	7	13
2%	8.2	17
3%	7	15
4%	6	12

Table 5 Compressive strength of Polypropylene Fibres

Mix Percentage	7days Strength (N/mm²)	28 days strength (N/mm²)
0%	4.8	12
1%	8	14
2%	9	20
3%	7.5	16
4%	6	14

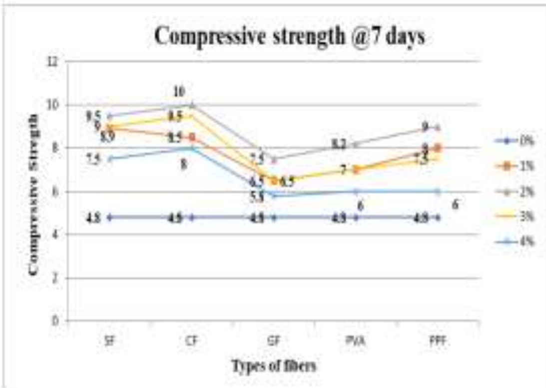

Fig. 1 Compressive Strength of fibers @7 days

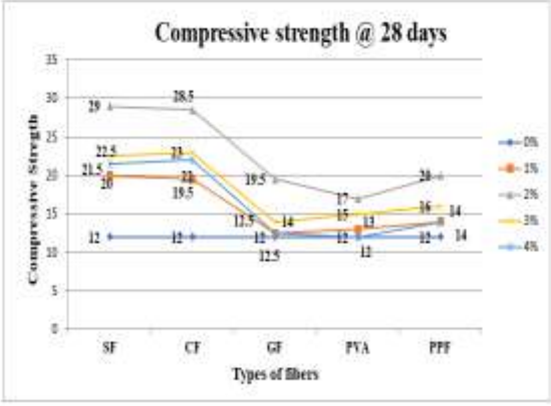

Fig. 2 Compressive Strength of fibers @7 days

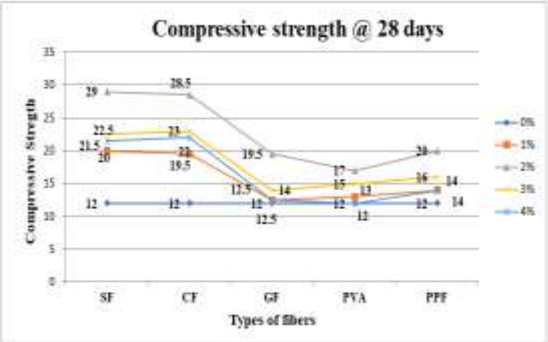

Fig. 3 Compressive Strength of fibers @7 days

Table 6 Compressive strength of Steel Fibres and Glass fibres

Mix Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	4.8	12
0.5%+0.5%	12	21
1%+1%	24	25
1.5%+1.5%	23.5	24
2%+2%	22	21

Table 7 Compressive strength of Carbon fiber and Glass fibres

Mix Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	4.8	12
0.5%+0.5%	14	24
1%+1%	24	27
1.5%+1.5%	23	23
2%+2%	21	21

Table 8 Compressive strength of Polyvinylalcohol fiber and Polypropylene fibres

Mix Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	4.8	12
0.5%+0.5%	13	25
1%+1%	24	29
1.5%+1.5%	20	24
2%+2%	19	22

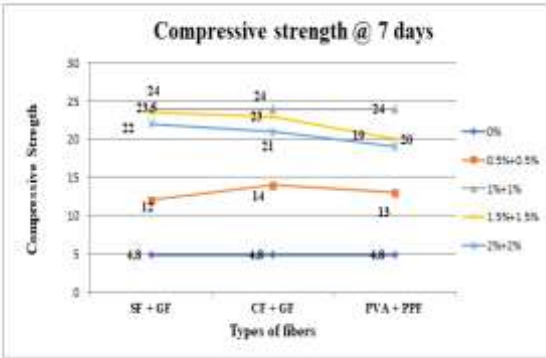

Fig.: 4 Compressive Strength of fibers with combined ratios @ 7 days

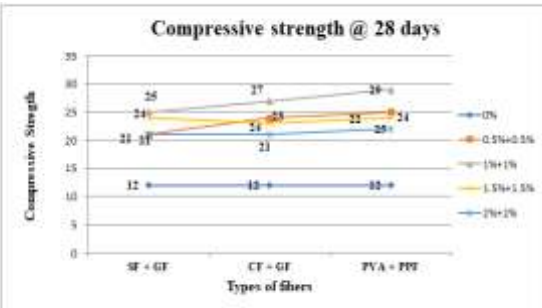

Fig.: 5 Compressive Strength of fibers with combined ratios @ 28 days

Table 9 Split Tensile Strength of Steel Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
1%	3.2	4
2%	3.5	4.8
3%	3.1	4.4
4%	3	3.9

Table 10 Split Tensile Strength of Carbon Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
1%	3.5	4.5
2%	4	5
3%	3.2	4.5
4%	2.9	3.8

Split Tensile Strength of Glass Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
1%	3.2	3.8
2%	3.5	4
3%	3	3.5
4%	2.9	3.2

Table 11 Split Tensile Strength of Polyvinylalcohol Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
1%	3.5	4.1
2%	3.7	4.5
3%	3	4.1
4%	2.8	3.8

Table 12 Split Tensile Strength of Polypropylene Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
1%	3.7	4
2%	4	4.2
3%	3.9	3.7
4%	3.2	3.4

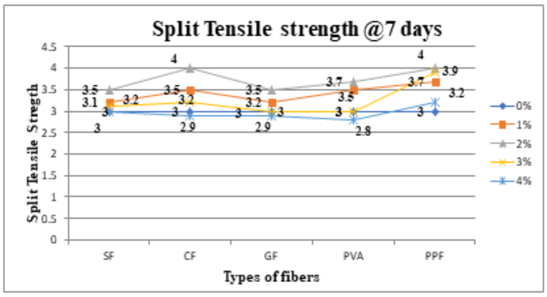

Fig.: 6 Split Tensile Strength of Fibres @7 days

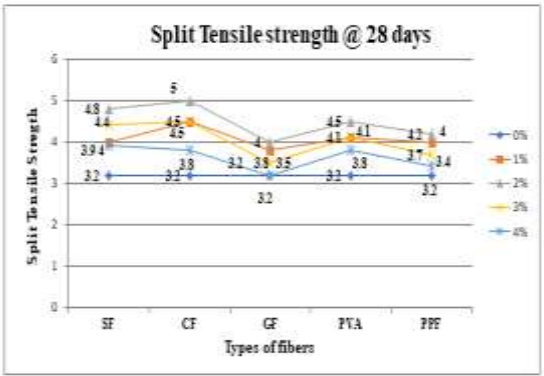

Fig.: 7 Split Tensile Strength of Fibres @ 28 days

Table 13 Split Tensile Strength of Steel Fibres and Glass Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
0.5%+0.5%	3.5	3.9
1%+1%	4	4.5
1.5%+1.5%	3.5	4.2
2%+2%	3	3.8

Table 14 Split Tensile Strength of Carbon and Glass Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
0.5%+0.5%	4.5	4.9
1%+1%	5.1	5.1
1.5%+1.5%	4.6	3.8
2%+2%	3.5	3.2

Table 14 Split Tensile Strength of PVA Fibre and Polypropylene Fibres

Percentage	7days Strength (N/mm^2)	28 days strength (N/mm^2)
0%	3	3.2
0.5%+0.5%	4.5	4.7
1%+1%	4.6	4.9
1.5%+1.5%	4	3.8
2%+2%	3	3.2

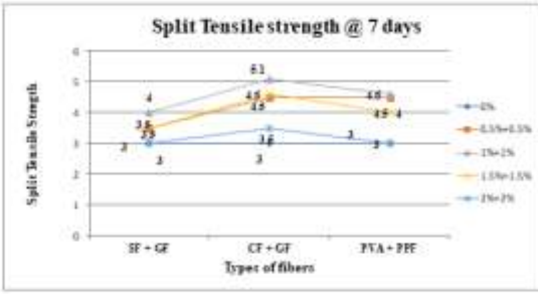

Fig.: 8 Split Tensile Strength of Fibres with combined ratios @ 7 days

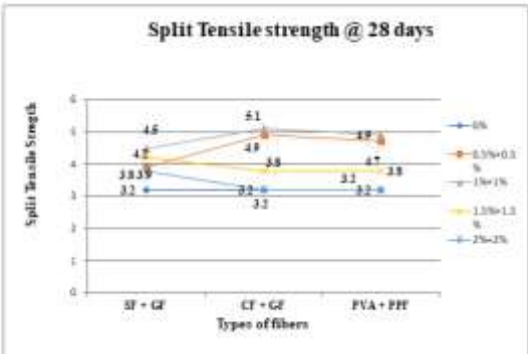

Fig.: 9 Split Tensile Strength of Fibres with combined ratios @ 28 days

DURABILITY TEST

Table:15 Durability test (BASE NaCl)

Percentage	Material	28 days strength (N/mm²)
2%	Glass fiber	17
2%	Steel fiber	24
2%	carbon fiber	25
2%	Polyvinyalcohol fiber	18
2%	Polypropylene fiber	23
1%+1%=2%	Glass+steel fibers	25
1%+1%=2%	Glass+Carbon fibers	29
1%+1%=2%	Polyvinayalcohol+Polypropylene	25

Fig.:10. Compressive Strength of fibers Durability (NaCl) @ 28 days

Table: 16 Durability test (sulphuric acid)

Percentage	Material	28 days strength (N/mm²)
2%	Glass fiber	17
2%	Steel fiber	19
2%	Carbon fiber	26
2%	Polyvinyalcohol fiber	18
2%	Polypropylene fiber	23
1%+1%=2%	Glass +steel fibers	24
1%+1%=2%	Glass+Carbon fibers	28
1%+1%=2%	Polyvinayalcohol+polypropylene	22

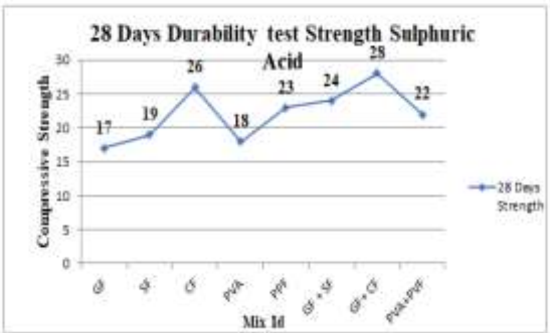

Fig.:11. Compressive Strength of fibers Durability Sulphuric Acid @ 28 days

Table: 17. Permeability test

Percentage	Material	28 days test(1000ml)
2%	Glass fiber	0.104 ft/min
2%	Steel fiber	0.162 ft/min
2%	Carbon fiber	0.041 ft/min
2%	Polyvinyalcohol fibers	0.158 ft/min
2%	Polypropylene fibers	0.125 ft/min
1%+1%=2%	Glass +steel fiber	0.43 ft/min
1%+1%=2%	Glass+Carbon fibers	0.031 ft/min
1%+1%=2%	Polyvinayalcohol+polypropylene	0.098 ft/min

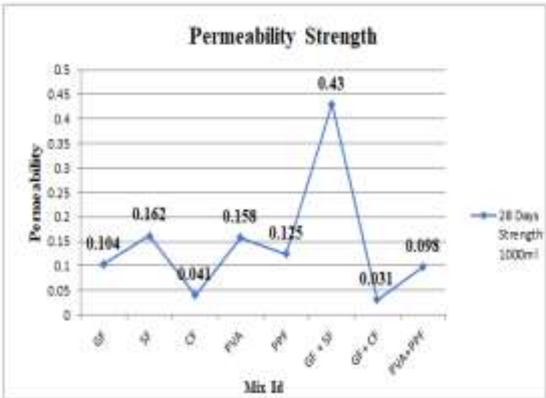

Fig.: 12 Permeability test values

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VI. CONCLUSION

CONCLUSION:

The optimum percentage combination of HFRC is determined.

2. The strength of concrete cube containing hybrid Fibres with fixed 0%, 1%, 2%, 3% and 4% proportions with steel, glass, carbon fibres, polypropylene fibres and polyvinyalcohol (pva) fibres, along with polypropylene fibres and combined with Steel Fibres and Glass fibres, carbon Fibre and Glass fibres and polyvinyalcohol Fibre and polypropylene fibres composition respectively of volume of the concrete were drawn.

3. Mechanical properties of the specimens with individual Fibres steel, glass, carbon fibres, polypropylene fibres and polyvinyalcohol (pva) fibres were noted, from the test results it is concluded that the compressive strength is optimum in carbon Fibre individual compare to all other Fibres

4. Mechanical properties of the specimens with individual Fibres steel, glass, carbon fibres, polypropylene fibres and polyvinyalcohol (pva) fibres were noted, from the test results it is concluded that the split tensile strength is optimum in carbon Fibre individual compare to all other Fibres.

5. Mechanical properties of the specimens with combined with Steel Fibres and Glass fibres, carbon Fibre and Glass fibres and polyvinyalcohol Fibre and polypropylene fibres were noted, from the test results it is concluded that the

compressive strength is optimum in carbon Fibre and glass Fibre combined compare to all other Fibres

6. Mechanical properties of the specimens with combined with Steel Fibres and Glass fibres, carbon Fibre and Glass fibres and polyvinyalcohol Fibre and polypropylene fibres were noted, from the test results it is concluded that the Split tensile strength is optimum in carbon Fibre and glass Fibre combined compare to all other Fibres.

7. Durability properties of the specimens with individual Fibres steel, glass, carbon fibres, polypropylene fibres and polyvinyalcohol (pva) fibres were noted, from the test results it is concluded that the compressive strength @ base NaCl is optimum in carbon Fibre individual compare to all other Fibres

8. Durability properties of the specimens with individual Fibres steel, glass, carbon fibres, polypropylene fibres and polyvinyalcohol (pva) fibres were noted, from the test results it is concluded that the compressive strength @Acid Sulphuric is optimum in carbon Fibre individual compare to all other Fibres.

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