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Impact of Polypropylene Fiber and Steel Fiber on Mechanical Properties of Concrete

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ABSTRACT

This experimental work portrays the mechanical properties of Hybrid Fiber Reinforced Concrete (HFRC).Concrete is exceptionally strong and versatile mould able construction material. It comprises of bond, sand, total blended with water and with or without including admixtures. As regular there are few disadvantages in concrete in concrete.

They are of brittle in nature and less ductile in nature and are weak in tensile strength. Because of its underlying cracks the durability of cement is questioned. To overcome this drawback the short discrete fibers that are consistently distributed are added to concrete which will decreases the underlying cracks and furthermore to increase the strength of concrete another type of fibers added to concrete. Adding of fibers to the concrete makes the ordinary cement to make it a composite blend and that gets benefits by each of the fiber and shows exhibits significant response.

For present work Steel Fibers and Polypropylene Fibers are utilized. Along these lines, adding of two fibers to concrete is known as Hybrid Fiber Reinforced Concrete. In the present work the two fibers which are utilized are steel fibers and polypropylene fibers. Here one fiber that is Polypropylene Fiber will reduce the underlying cracks and another fiber that is Steel Fiber will increase the strength and durability of cement. The fibers that are added to concrete are in equal proportions of 0.1%, 0.6%, 1%, and 1.6%. A grade of concrete M25is prepared as per the IS 10262:2009 reference code and then cube, cylinders are prepared and tested for Compressive strength, Tensile strength, Flexural strength. From the present work the strength parameters increments with the level of increment of fiber. The hybridization ratio of 1.6% gives better outcomes when compared with ordinary cement.

Key words: Steel Fibers Hybrid Fiber Reinforced Concrete, Fibers, , Polypropylene Fibers, Shrinkage, Compressive Strength, , Flexural Strength.

1. INTRODUCTION

Concrete is largely used material in all the sectors now days. Concrete require From the small construction to large structures like multi story buildings, irrigation structures, pavements, reservoirs, foundations, dams etc. for construction of all these structure its require huge amount of concrete material. Concrete is exposed to different environmental condition to with stand the environmental effects the properties of concrete have to increases with introducing any admixtures or fibers to concrete to increases the strength of concrete.

Concrete is prepared by jointly mixing Cement, Fine aggregate, Coarse aggregate, water and with or without adding admixture. By mixing all these materials the concrete will become composite and is also quite brittle because of less strength of materials. As we know this type of

concrete is very good in Compressive strength and very poor in Tensile strength and as well as Flexural strength. Therefore, for increase of Tension and Flexural strength, the concrete is additionally mixed by innovative materials such as fibers and materials having good pozzolona properties, construction chemicals etc. Nowadays cement mortar and concrete made with Portland cement is widely using construction material in the world .This materials are brittle in nature and also have dramatic disadvantages of poor deformability and fragile crack resistance in the daily usage and also their Tension and Flexural strength is relatively small when compared to Compressive strength. This disadvantage of tension and fragile crack resistance can overcome of adding of satisfactory volume fraction of certain fibers like Steel fibers, Polypropylene fibers, Glass fibers, Nylon fibers etc .Thus adding these fibers there is also increase in the strength of concrete.

2. LITERATURE REVIEW

Salina ruby g., gethanjali c., et.al entitled on "impact of hybrid fiber on reinforced concrete" in January 2014. For this study they used two types of fibers i.e. steel fiber with having length of 40mm, diameter is 0.5mm, Aspect Ratio 80 and another fiber is polypropylene with having a cut length of 38mm, diameter is 0.1mm with Aspect Ratio 380. For this investigation they used three different proportion such as S0.25+P0.75, S0.5+P0.5, S0.75+P0.25,(p-polypropylene, S-steel fibers) for M40 grade of concrete with water-cement Ratio 0.40 with addition of super plasticizer. Compressive strength, tensile strength, flexural strength test are carried out to perform and analyze the different mix proportion with fibers variation. Specimens are tested for 28 days curing. The conclusion of these paper is compressive strength is maximum for the proportion of S0.75+P0.25 it is because of high elastic modules of steel fiber & low elastic modules of polypropylene fiber and tensile strength, flexural strength also increase for the proportion S0.75+P0.25.

S.c. Patodi, c.v. Kulkarani et.alentitled on "**Performance and Evaluation Of Hybrid Fiber Reinforced Concrete Matrix" in October 2012**. In their examination they utilized two fibers for hybridization, i.e. crimped steel fiber with having length of 25mm and breadth is 0.46mm with Aspect Ratio of 55.5 and another fiber is polyester fiber with having length of 12.5mm and distance across of fiber is 30Micron [Eq.Dia]. For making of HFRC they arranged six types of mix proportions, 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 review of cement with expansion of concoction admixture by dosage of 0.8% by weight of bond. Quality parameters of cement such Compression strength, Tensile strength, Impact strength, Flexural strength, shear strength test are researched with various blend extent. This paper presumed that all the quality parameters like compressive, elastic, Flexure, Shear quality is increments for blend extent of S0.7+P0.3. Effect quality may likewise increment for a similar extent.

Ahsana Fatima k m, shisi varghese et.al entitled on **"**Behavioral Study Of Steel Fiber and Polypropylene Fiber Reinforced Concrete" in October 2014. For their studies three type of fibers are used such as

hook end, steel crimped fiber with length of 30mm and equivalent diameter 0.6mm with Aspect Ratio 50 and crimped steel fiber is used with the length of 25mm and diameter is 0.5mm and having an Aspect Ratio 50. And another fiber is ENDURO-600 Macro synthetic polypropylene fibers with Aspect Ratio 50, having length 50mm and thickness is 1mm. The main intrest of this study is to study the ultimate strength parameters of hybrid fiber reinforced concrete with different mix proportion. In their study six different mix proportion of steel fiber and polypropylene fibers are added separately with mix proportion of 0%, 0.25%, 0.5% 0.75% by volume of concrete and hybridization Ratio of 0.5% of polypropylene fiber and 0.75% of steel fiber by volume of concrete for M30 grade of concrete with addition of super plasticizer with 7 and 28 days curing period. From this paper they conclude that compressive strength is increased with addition 0.75% steel fiber and crimped steel fiber have better compressive strength that hook end steel fiber. Split tensile strength also increases for 0.75% steel fiber and addition of polypropylene fibers by 0.5% of volume of concrete increases the split tensile strength. Flexural strength may increases with addition of 0.75% steel fiber by volume of concrete.

Prof.B.Pravin , Shinde et.alentitled on "Flexural Behavior of Hybrid Fiber Reinforced Concrete profound pillar and impact of steel and polypropylene fiber on mechanical properties of cement" in February 2015. In their investigation they utilized Flat creased steel fibers with having length of 25mm to 50mm and distance across is 0.55mm with Aspect Ratio 40 to 90. Also, another fiber is polypropylene fiber with having cut length of 12mm. In their investigation they utilized distinctive hybridization Ratio, for example, S0+P0%, S0+P100%, S25+P75%, S50+P50%, S75+P25%, and S100 + P0%. (P-polypropylene s-steel fibers) For M30 review of cement with water-concrete Ratio 0.45 at 28 days curing period. From this Journal they concluded that compressive quality of HFRC is gives most extreme for the Ratio 75-25% (steel-polypropylene). Split tensile strength of HFRC solid builds the quality with 100% steel fiber i. e. Proportion 100 to 0%. Flexural quality of HFRC of 50-half and SFRC 100 to 0% both proportion comes about is same.

3. MATERIALS AND MIXDESIGN

MATERIALS

This chapter deals with the materials that are used in the present investigation. Here we discussed about the properties of the materials that are used in the projects and also their permissible limits that are mentioned according to the bureau of Indian standards. Below materials are used in the present investigation.

1. Cement
2. Coarse aggregate
3. Fine aggregate
4. Water
5. Steel fibers
6. Polypropylene fibers

Percentage variation of fibers in mix

The proportions of fibers used in concrete mix are at percentage of 0.5%, 1%, 1.5% and for each proportion equal quantity (50% of each) of fibers are added in the mix. Hybridization of fibers are tabulated in below table.1.

Table.1: **Hybridization of fibers in concrete mix**

Percentage of fiber added in overall concrete mix (%)	Steel Fibers by Volume of Concrete (%)	Polypropylene Fibers by Weight of Cement (%)
0	0	0
0.5	0.25	0.25
1	0.50	0.50
1.5	0.75	0.75

Concrete mix design for M25 concrete (IS-10262:2009)

Stipulation for mix proportioning

1. Grade designation : M_{25}
2. Cement type : OPC 53 grade
3. Maximum supposed size of aggregate : 20mm
4. Minimum cement content :320 kg/m^3
5. Workability :75mm
6. Exposure condition : severe
7. Manner of concrete placing : normal
8. scale of supervision : good
9. Aggregate type : crushed angular aggregate
10. Maximum cement substance :450 kg/m^3

Test data for materials

1. Cement used : grade OPC 53
2. Cement specific gravity : 3.15
3. Specific gravity of
   a. Fine aggregate : 2.46
   b. Coarse aggregate : 2.62
4. Water absorption
   a. Fine aggregate: 1%
   b. Coarse aggregate : 1.5 %
5. Surface moisture :
   a. Fine aggregate : nil
   b. Coarse aggregate : nil

TARGET STRENGTH FOR MIX PROPORTIONING

$f^1_{ck} = f_{ck}+1.65s$

Where

f^1_{ck} =target average compressive strength at 28 days.

F_{ck} = compressive strength at 28 days, and

S= Standard deviation.

As of IS 10262: 2009, table 1, standard deviation s=4

Therefore, target strength (f^1_{ck}) =25+1.65×4

= 31.6 N/mm^2

SELECTION OF WATER –CEMENT RATIO

From IS 456-2000, table 5, maximum water cement ratio=0.50

SELECTION OF WATER CONTENT

From IS 10262:2009, table 2, maximum water content for 20mm aggregate= 186 liter

Estimated water content for 75mm slump=186+ (3/100)×186

=191.5 lit

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CEMENT CONTENT CALCULATION

Water cement ratio=0.45

Cement content =191.5/0.50=383 kg/m^3 <450 kg/m^3

VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE PROPORTION CONTENT

As of IS 10262:2009,table 3,volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate (zone 2) for water-cement ratio 0 .50

MIX CALCULATION

1. Volume of concrete=1m^3
2. volume of coarse aggregate=0.62
3. volume of fine aggregate=1-0.62=0.38
4. volume of cement = mass of cement / specific gravity of cement ×1/1000

   = 383/3.101×1/1000

   = 0.1215m^3

   Volume of water = water mass /water specific gravity×1/1000

   = 191.5/1×1/1000

   = 0.1915 m^3
5. volume of all in aggregate= (1-(0.1215+.1915)) =0.686 m^3
6. mass of coarse aggregate=volume of all in aggregate × volume of coarse aggregate × specific gravity of coarse aggregate×1000

   = 0.686×0.62×2.6×1000

   = 1105.83 kg
7. mass of fine aggregate=volume of all in aggregate × volume of fine aggregate×specific gravity×100

   = 0.686×0.38×2.46×1000

   = 641.66kg.

MIXING CASTING AND CURING

Mixing of concrete is done by machine and hand. All the ingredients that are added to the concrete is properly weighed and batched according to the mix proportions. Mixing of concrete is done accordingly by placing ingredients accordingly firstly fine aggregate followed by cement, coarse aggregate, water, steel fibers and polypropylene fibers respectively.

After mixing the concrete is placed for casting of cubes. For preparing of cubes, the moulds are used. These moulds are cleaned and fixed with bolts tightly without losing much of water. These moulds are greased at the inner surface for getting the cubes easily. The concrete is then poured in to the mould by three layers. Each layer is to be tampered by tamping rod for 25 times for getting the concrete compact.

After casting the cubes, they should be kept aside for 24 hours. After 24 hours cubes are removed from the moulds and are kept for cubes immediately in a water tub.

Fig.1: **Mixing and Casting of Cubes**

4. EXPERIMENTAL PROGRAM

To study the strength parameters of concrete it's necessary to conduct the certain tests on concrete. Concrete can be tested in fresh state as well as in hardened state with different mix proportion of fibers.

TESTS ON CONCRETE

FRESH CONCRETE:

The test conduct for fresh concrete is

1. Slump cone test.
2. Compaction factor.

TESTS ON CONCRETE AFTER 28 DAYS

The test conduct for hardened concrete is

1. Compression test
2. Split tensile test
3. Flexural test

Slump Cone Test:

The concrete slump test measures the workability or fluidity of the concrete. Slump test performed to check the indirectly measurement of consistency or stiffness of freshly made concrete. Consistency of concrete can measure the quantity of water added during the mixing of concrete and Concrete stiffness is the property of finish product quality. The test is carried out using a mould known as a slump cone with having 300mm height and base is 200mm in diameter and top cone having a 100mm diameter. The base is placed on a hard non-absorbent surface and This cone is filled with fresh concrete in three layers and each layer have tamped 25 times using a 16mm diameter steel rod. At the end of the third layer, concrete is struck off flush to the top of the cone. After complete filling of cone the cone is carefully lifted vertically upwards, a unsupported concrete is slump of that concrete.

Fig.2: Slump Cone Apparatus

RESULTS AND DISCUSSION

From the present work of experimentation results of all the parameters are calculated and tabulated below.

In the below fig 4 as addition of fibers is increasing there is a decrease in the slump values. It is because of as the fibers are added to the concrete bleeding will be reduced and the mix will become more homogenous. From this it can concluded that as the percentage of fiber content is increased in the concrete workability will be decreased.

Table.2: **Results of slump cone test results**

SL.NO	% OF FIBERS	SLUMP CONE VALUES (mm)
1	0	95
2	0.5	90
3	1	85
4	1.5	78

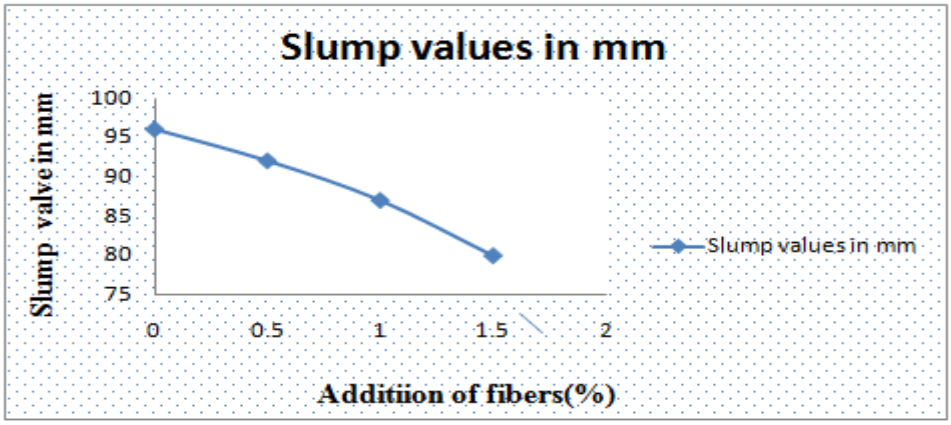

Fig.3: Graph showing the slump cone valves of HFRC.

CONCLUSION

From my experimental investigation I concluded the following points.

1. There is increase in Compressive strength of HFRC contrast with ordinary cement as a result of addition of fibers. The most extreme increment in compressive quality saw at having half and half proportion 1.6 % i.e. 0.75 % steel fiber and 0.75 % polypropylene fiber and When contrasted and traditional cement the expansion in the compressive strength with fiber expansion in rates of 0.6%, 1%, 1.6% is 11.58%, 27.33% and 38.83% separately.
2. Tensile strength marginally increment for the proportion 0.6 % of fibers contrast with conventional cement, from there on it might increment in tensile strength and hybrid ratio having 1.5% gives most extreme strength contrast with other extent. Thus flexural strength increases with the increase of addition of fibers in the mix. When compared with controlled concrete the increase in the flexural strength with fiber addition in percentages of 0.5%, 1%, 1.5% is 9.33%,23.44%,33.19% respectively.
3. Slump cone valves is decrease with Addition of fibers is increases. It is why because when the fibers are added to concrete the bleeding will be reduced and the mix will become homogenous. From

this it can be concluded that as the percentage of fiber content is increased the workability will be decreased. As the percentage increase in fibers the compaction factor values decreases. From this it can be concluded that the workability of the mix decreases as the fiber content in the concrete increases.

4. The optimum percentage of fibers addition is 1.5%. Addition of fibers up to 1.5% gives best results in all strength parameters compare to other mix propor

FUTURE WORK

The same investigation can be carried out for different types of fibers with hybridization ratios and also for different grades of concrete. Which is further more helpful in the increasingly development of technology in the construction technology.

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