International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 08 | Nov-2015 www.irjet.net p-ISSN: 2395-0072

# "Strength aspects of hybrid fiber reinforced concrete"

**VINAYADEEP G M[1], BRIJBHUSHAN S[2],**

[1] *M.Tech. Student, Department of Construction technology, VTU regional office, PG center, Kalaburagi, Karnataka, India, email- vinayadeep@gmail.com*

[2] *Assistant Professor, Department of Construction technology, VTU regional office, PG center, Kalaburagi, Karnataka, India, email- brijbhushanpgct@gmail.com*

---

## Abstract:

***Concrete is one of the most common building materials used for constructive civil engineering structures and is essential in the infrastructure development of any nation. Concrete is used tremendously in a huge quantity after water by human. Concrete is used in the construction of various types of structures which include buildings, bridges, piers, chimneys, pavements, dams etc. Concrete have ability to with stand the water or impermeable material after hardening. It is having more strength in compression and weak in tensile strength. To overcome these tasks a no of experiments and researches are going in that one is HFRC. HFRC is one from which we can increase the tensile strength of the concrete within itself. . In fiber reinforced concrete the fibers are added to the concrete mix so that those are discontinuous fibers will be uniformly distributed in the mix. They will improve the concrete in all directions. But to get more improvement in the mechanical properties work has been done by combining two different types of fibers knows as hybridization. The experimental work has been carried out for $M_{20}$ mix proportion and the mechanical properties are tested by hybridizing the concrete with Glue hooked end steel and Polypropylene fibers .fibers are hybridized and added in the percentages of 0.5%, 1%, 1.5% and the results are compared with controlled concrete. Steel fibers having aspect ratio 80 are added by volume of the mix and Polypropylene fibers having cut length 12mm are added by weight of cement equally. The test results have shown improvement in the strength properties as the fibers are added in the mix with maximum values at 1.5% in comparison with controlled concrete. The variations are discussed below.***

***Key words:*** *hybrid concrete, Glue hooked end steel fiber, Polypropylene, compressive strength, tensile strength, flexural strength, impact strength, Sorptivity.*

## INTRODUCTION:

As we know that concrete is widely usable material at present days. It is calculated that the present consumption of concrete in the world is nearly 10 billion tones (12 billion tonnes) every year. But concrete is used tremendously a huge quantity after water by human. It is cheap and locally available material. The concrete is made by no. of materials such cement, sand, coarse aggregate and water. Concrete have ability to with stand the water or impermeable material after hardening and having more strength in compression and weak in tensile strength. To overcome these tasks a no of experiments or researches are going in that one is HFRC. HFRC is one from which we can increase the tensile strength of the concrete within itself.

**Kangiri et.al [1]** has done experiments on strength of concrete The hybridization is done in two different proportions such as 0.5% fiber volume ratio in these two combinations S0.4+P0.1, S0.35+P0.15, & in second mix of 1% fiber volume ratio three combinations S0.8+P0.2, S0.1+P0.3, S0.5+P0.5 for M25 grade of concrete for 7,14,28 days of curing. They concludes that hybrid fiber ratio such as S0.4+P0.1, & S0.8+P0.2 gives maximum strength compared to other proportion and gives high compressive and tensile strength. **Kavita S Kene et al (2012)[2]** has studied on cubes and cylinders of sfrc having 0% and 0.5%volume fraction. Steel fibers of hook end and having different aspect ratios and glass fibers having 12mm were used. They concluded that due to the fiber addition workability will be decreased and improvement in compressive and tensile strength is found. Compressive strength of cylinders and compressive strength of cubes are found nearly in the ratio of 3:4. **Geetahanjali et.al [3].** They studied the strength characteristics with hybridization of two types of fibers i.e. crimped steel fiber and polypropylene fiber for M20 grade. They used different proportions such as S0.25+P0.75, S0.5+P0.5, S0.75+P0.25, (p-polypropylene, S-steel fibers) and added super plasticizer They decides for the proportions of S0.75+P0.25 compressive strength, tensile strength and flexure strength is achieved maximum strength as compare to other combinatioins. **Kulkarani et.al[4]** Two types of fibers used those are crimped steel fiber For M20 of HFRC they prepared six different mix proportions such as P0+S0, P1+S0, P0+S1, P0.5+S0.5, P0.3+S0.7,

P0.7+S0.3(P-polypropylene S-steel fibers) and in these concrete they add of chemical admixture by dose of 0.8% by weight of concrete. They decided that the strength parameter increases for mix proportions of S0.7+P0.3. Impact strength may also increase for the same proportion

## MATERIALS AND METHODS:

**Cement:** This experimental study has been carried by using of ordinary Portland cement (OPC) 53 Grade of ultra tech company. The different properties of cement are given below in table 1,

**Table 1: cement properties**

| Sl.no | Properties | Opc 53(g) |
|---|---|---|
| 1 | Specific Gravity | 3.14 |
| 2 | Normal consistency | 36% |
| 3 | Soundness | 6mm |
| 4 | Initial setting time | 42 min |
| 5 | Final setting time | 4hr 25min |

**Coarse Aggregates:**

The coarse aggregates which are locally available and passing through 20mm sieve and retained on 4.75mm sieve were used for this study. The aggregates were brought from vishwadeep crushers Pvt Ltd sedam road kalaburagi Preliminary tests were conducted on coarse aggregate and its results are formulated in the following table 2.

**Table 2: coarse aggregates properties**

| Sl.no | Properties | Results |
|---|---|---|
| 1 | Shape of aggregate | Angular |
| 2 | Specific gravity | 2.78 |
| 3 | Water absorption | 17% |
| 4 | Fineness modulus | 4.3 |

**Fine aggregate:**
The river sand with Zone II specification passing through 4.75mm sieve as per IS 383-1978.Sand is brought from Bheema river bed near Shahapur, its physical properties are irregular in size.The preliminary tests are conducted and the results are tabulated as below table 3

**Table 3: Fine aggregate properties**

| Sl no | Different properties | Results |
|---|---|---|
| 1 | Specific gravity | 2.60 |
| 2 | Water absorption | 1.5% |
| 3 | Fineness modulus | 2.5 |
| 4 | Type and zone | River sand and Zone II |

**Water:** Portable water is used for investigating this project during both for casting as well as for curing.

**Steel fibers**: In this present study the Glue hooked end steel fibers which are having a length of 40 mm, 0.5 mm dia, 500-750 Mpa tensile strength are used.

**Polypropylene:** In this study were used.

**Concrete mix design:**

The mechanical properties of hardened concrete are studied by casting cube, cylinder, and prism specimens. For impact test L/4 of cylinder specimens were casted. For $M_{20}$ concrete mix proportion specimens were cast and tested after 28 days of curing. Materials for the mix proportion were calculated as per IS 456-2000 using Indian Standard Mix Design (IS: 10262, 2009) for grade like $M_{20}$.The fibers are added in mix with different proportions such as steel fibers are added by volume and Polypropylene fibers are added by weight of cement in concrete mix. The percentage addition is shown below.

**Table: 4 Different variations of fibers in the mix**

| Fiber added in concrete mix (%) | Steel Fibers by Volume of Concrete (%) | Polypropylene by Weight of Cement (%) |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 0.25 | 0.25 |
| 1 | 0.50 | 0.50 |
| 1.5 | 0.75 | 0.75 |

## RESULTS AND DISCUSSIONS:

**Fresh concrete:** compaction factor test and slump cone test are done on fresh concrete for knowing the workability of HFRC concrete and the values are tabulated below in table 5.

**Table 5: Slump and compaction factor test results**

| Sl.no | % of fibers | Slump values in mm | Compaction factor |
|---|---|---|---|
| 1 | 0 | 96 | 0.95 |
| 2 | 0.5 | 92 | 0.92 |
| 3 | 1.0 | 87 | 0.90 |
| 4 | 1.5 | 84 | 0.89 |

In the fig.1 as addition of fibers is increasing there is a decrease in the slump values. It is so because as the fibers are added the bleeding will be reduced and the mix will become harsh. From this we can conclude that as the percentage of fiber content is increased the workability will be decreased.

It can be observed from graph in fig.2 that as the fiber content in the mix increase compaction factor values decreases. From this we can conclude that the workability of the mix decreases as the content of the fiber in the concrete increases.

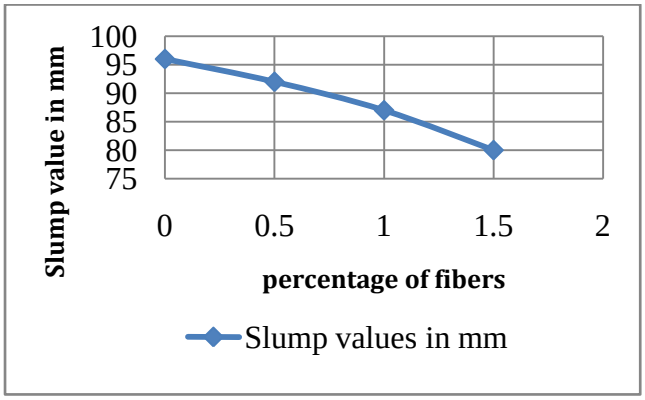


**Fig 1: graph of slump cone test**

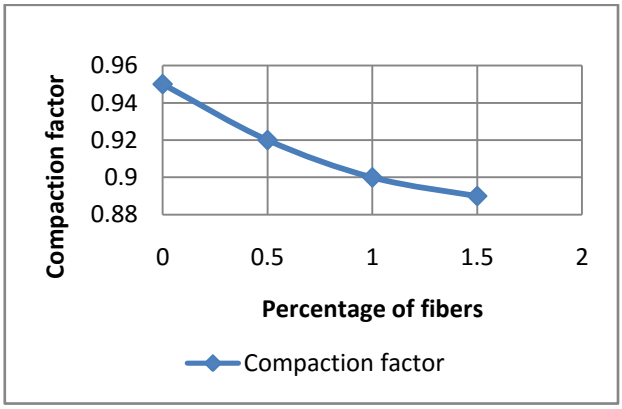


**Fig 2: graph of compaction factor values**

**Hardened concrete:** Compressive strength, Split tensile strength, Flexural Strength, Impact strength and Sorptivity of concrete were tested on Cubes, Cylinders and Prisms with different percentages of steel and glass for M20 mix are tabulated. The strength of concrete has been tested after 28 days of normal curing.

**Compressive strength test**

**Table 6: Compressive strength results**

| sl. no | Fibers (%) | Compressive strength of HFRC in n/mm² | % variation compressive strength of HFRC over controlled concrete |
|---|---|---|---|
| 1 | 0 | 28.24 | 0 |
| 2 | 0.5 | 38.72 | 15.10 |
| 3 | 1 | 42.55 | 26.48 |
| 4 | 1.5 | 47.26 | 40.48 |

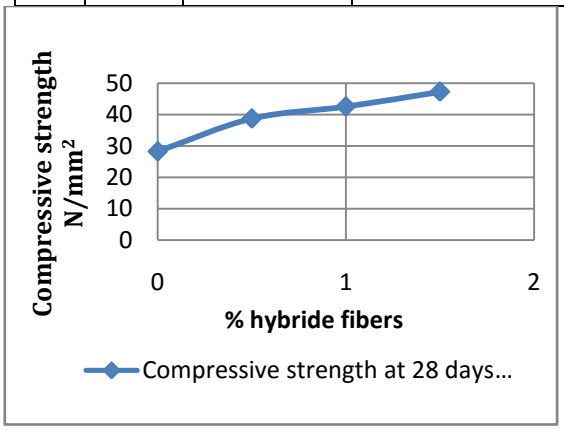


**Fig 3: graph of compressive strength results**

From the above fig.3 it is clear that at 0.5% addition of fibers the compressive strength is 38.72 N/mm2.As the percentage of fibers is increased to 1 % and to 1.5 % the compressive strength is 42.55 N/mm2, 47.26 N/mm2 respectively. When compared with controlled concrete the increase in the compressive strength with fiber addition in percentages of 0.5%, 1%, 1.5% is 15.10%, 26.48%, 40.48% respectively.

## Tensile strength test

**Table 7: Tensile strength test results**

| Sl .no | fibers (%) | Tensile strength of hfrc in n/mm² | % variation tensile strength with controlled concrete |
|---|---|---|---|
| 1 | 0 | 2.60 | 0 |
| 2 | 0.5 | 2.46 | 5.69 |
| 3 | 1 | 3.39 | 23.30 |
| 4 | 1.5 | 3.96 | 34.34 |

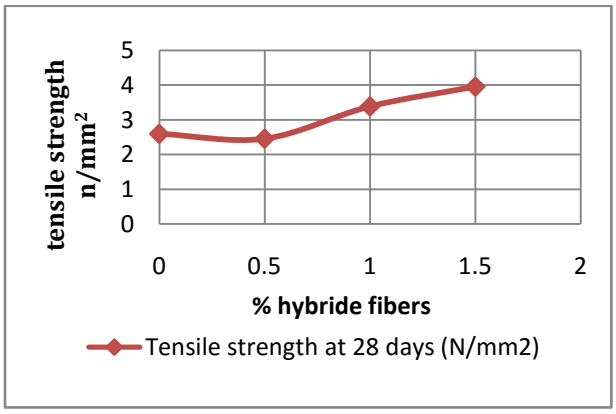


**Fig 4: graph of tensile strength results**

From the above fig.4 it is clear that at 0.5% addition of fibers the split tensile strength is 2.46 N/mm2.As the percentage of fibers is increased to 1 % and to 1.5 % the compressive strength is 3.39 N/mm2, 3.96 N/mm2 respectively. When compared with controlled concrete the increase in the split tensile strength with fiber addition in percentages of 0.5%, 1%, 1.5% is 5.69 %, 23.30 %, 34.34 % respectively

## Flexural strength test

**Table 8: Flexural strength results**

| sl .no | Fibers (%) | flexural strength of hfrc in n/mm² | % variation flexural strength over controlled concrete |
|---|---|---|---|
| 1 | 0 | 4.00 | 0 |
| 2 | 0.5 | 5.25 | 31.25 |
| 3 | 1 | 6.00 | 50.00 |
| 4 | 1.5 | 6.15 | 53.75 |

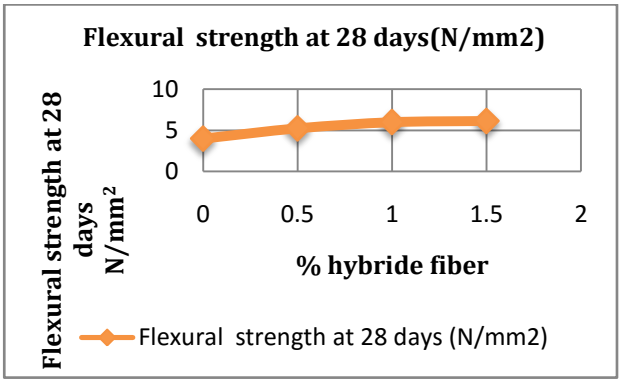


**Fig 5: graph of flexural strength results**

From the above fig.5 it is clear that at 0.5% addition of fibers the flexural strength is 5.25N/mm².As the percentage of fibers is increased to 1 % and to 1.5 % the flexural strength is 6 N/mm², 6.15N/mm² respectively. When compared with controlled concrete the increase in the flexural strength with fiber addition in percentages of 0.5%, 1%, 1.5% is 31.25 %, 50.00 %, 53.75 % respectively.

## Impact strength test

**Table 9: Impact strength test results**

| sl .no | Fibers fraction (%) | first visible crack in no. of blows | Final failure in no. of blows |
|---|---|---|---|
| 1 | 0 | 7 | 40 |
| 2 | 0.5 | 12 | 55 |
| 3 | 1 | 15 | 97 |
| 4 | 1.5 | 25 | 145 |

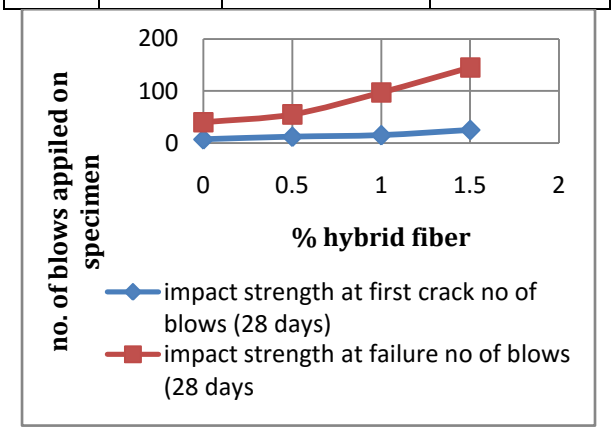


**Fig 6: graph of impact strength results**

From the above figure 6.6, it is clear that the number of blows required for the failure of impact specimen had been increasing when the percentage of fibers in concrete mix is increased. The number of blows required for visible crack for 0.5% is 12 and for failure is 55.As the fiber percentage is increased to 1% and1.5% the number of blows required to initial crack and also final failure are noted as 15,97 and also 25,145 respectively. Thus from the above results it resembles that as fiber percentage in concrete mix increases the impact resistance of concrete increases.

## Sorptivity

**Table 8: Sorptivity test results**

| Sl. No | Fibers (%) | Dry weight (grams) | Wet weight (grams) | Sorptivity value in 10^-7mm/min^0.5 |
|---|---|---|---|---|
| 1 | 0 | 8257 | 8260 | 4.020 |
| 2 | 0.5 | 8897 | 8900 | 4.021 |
| 3 | 1.0 | 8990 | 8997 | 9.022 |
| 4 | 1.5 | 9120 | 9128 | 10.254 |

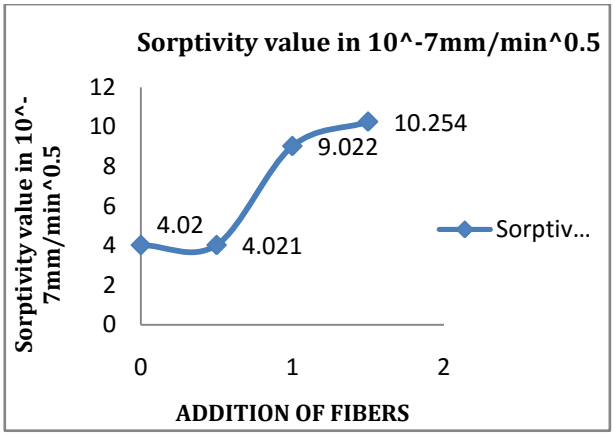


**Fig 7: graph of sorptivity test results**

## CONCLUSIONS:

1. From this we can conclude that the workability of the mix decreases as the fiber content in the concrete increases.
2. It is observed that when fibers added to the HFRC its compressive strength gradually increases compared to conventional concrete and also concluded that at 1.5% of ratio of fiber .compressive strength of HFRC is drastically high .0.5%, 1%, and 1.5% at these percentages of fiber additions to the concrete respective compression strength are increases as 15.10%, 26.48% and 40.48%.
3. It is observed that when fibers added to the HFRC its tensile strength decreased initial percentage of 0.5% as compared to conventional concrete and then as percentage of fibers 1% and 1.5% increases the tensile strength of HFRC respectively.
4. It is concluded that when fibers added to the HFRC its Flexural strength gradually increases compared to conventional and also observe that at 1.5% of hybrid ratio is most flexural strength.
5. Impact strength of the concrete is increased by increases of adding percentage of fibers in concrete as compared to conventional concrete HFRC impact strength is more.
6. Sorptivity will be more as the percentage of fibers addition is increase. From results we can conclude that 0.5% addition of hybrid fibers gives same Sorptivity value compare to conventional concrete.

**REFERENCES:**

1. Konapure C.G.and Kangiri S.D. "Evaluation of Performance of Hybrid Fiber Reinforced Concrete (HFRC) for M25 Grade" International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 516.
2. Vikrant S. Vairagade, Kavita S. Kene "Experimental Investigation on Hybrid Fiber Reinforced Concrete" International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 3, May-Jun 2012, pp.1037-104.
3. Sivakumar "Influence of hybrid fibers on the post crack performance of high strength concrete: Part I experimental investigations" Journal of Civil Engineering and Construction Technology Vol. 2(7), pp. 147-159, July 2011.
4. Selina ruby g., geethanjali c., jaison varghese, p. Muthu priya "Influence of Hybrid Fiber on Reinforced Concrete" International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014.
5. Ahsana fathima k m & shibi varghese "Behavioral study of steel fiber and polypropylene fiber" International Journal of Research in Engineering & Technology ISSN (E): 2321-8843; ISSN (P): 2347-4599Vol. 2, Issue 10, Oct 2014, 17-24.

**AUTHORS BIOGRAPHY**

**Mr.Vinayadeep G M** received B.E Civil engineering degree in BKIT Bhalki, Karnataka, India. He is presently pursuing M.Tech Degree in Construction Technology from VTU, Karnataka, India.

**Mr.Brijbhushan S** received the B.E Civil Degree and M.Tech Degree in Construction Technology from VTU, Karnataka, India. He is presently working as Assistant Professor in the department of construction technology in the centre for PG studies, regional office Kalaburagi. He has published many research papers. He has two years professional work experience in Construction industry.