

Experimental Investigation on Hybrid Fiber Reinforced Concrete

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Abstract- Plain cement concrete is good at providing reasonable compressive strength but it tends to be brittle in nature and is weak in tensile strength, and minimum resistant to cracking, poor toughness. To overcome the consists of two different types of fiber combination i.e. steel and polypropylene fibers are used with conventional concrete. The fiber proportions of 0%, 0.25%, 0.5%, 0.75%, and 1% for M40 grade of concrete. Compressive strength test on cubes and flexural strength test on beams were carried out to study the properties of hardened concrete for 7 and 28days of curing period.

Keywords- HYBRID FIBERS i.e STEEL and POLYPROPLENE FIBERS, COMPRESSIVE STRENGTH, FLEXURAL STRENGTH

I. INTRODUCTION

Concrete is a relatively brittle material and develops micro cracks even during curing and initial stages of strength development where as reinforcement of concrete with randomly distributed short fibers improves the initiation and propagation of cracks by improving overall properties of conventional concrete. Fiber reinforcement is a commonly used to provide enhanced toughness and ductility to brittle cementitious matrix. The reinforcement of concrete with a single type of fiber may improve the desired properties to a limited level, where as combination of two or more types of fibers if used in optimal way in concrete achieves better engineering properties due to positive synergetic effect. This includes the combination of different kinds of fibers with different shapes, dimensions, strength and modulus to concrete matrices.

A composite can be started as a hybrid when two or more types of fibers is used in a combined matrix to produce a composite that will reflect the benefit of each of the individual fiber used. This will finally provide a synergetic response to whole structure. Such a composite of concrete is termed as the hybrid fiber reinforced concrete (HFRC).The Hybrid fiber reinforced concrete, is effective in arresting cracks both it macro and micro levels. In plain concrete structural cracks develop even before loading, due to drying shrinkage or other causes volume change. The width of these initial cracks is few

microns, but their other dimensions may be of higher magnitude.

When concrete is loaded, the micro cracks propagate and open up, and additional cracks form in places of minor defects. The development of such micro cracks is the main cause of inelastic deformations in concrete. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and uniformly dispersed fibers to concrete would act as crack stop and would substantially improve its static and dynamic properties.

Different Types of Fibers:

Following are the different types of fibers generally used in the construction industries.

1. Steel Fiber Reinforced Concrete
2. Polypropylene Fiber Reinforced (PFR) cement mortar & concrete
3. Glass-Fiber Reinforced Concrete
4. Asbestos Fibers
5. Carbon Fibers
6. Organic Fibers

R. H. Mohakaret et.,al (2016)-To determine the Compressive strength and flexural strength of hardened concrete. All of them deliberated that the Hybrid Fiber Reinforced Concrete. In the study we are used in steel fibers and polypropylene fibers. They are used in different proportions as 0.25%, 0.5%, 0.75% and 1% of M20 grade of concrete. All the specimens were cured for the period of 7days, 14days, and 28days.They concluded that reduction of secondary reinforcement at some level and make structure economical. It prevents the spalling of concrete which results in better protection of reinforcement cover, and also conclude that HFRC can be used to resist seismic effects in structure, the floors additionally act as a foundation slab that is bracing and carrying the entire building load. The final result of maximum compressive strength and flexural strength areobtained by adding 1% fibers to the concrete and they cured for 28days.

Flat end Fibers

FE (Flat End) fibers are straight fibers with flattened, enlarged ends for improved anchorage. FE fibers can be applied with minimum rebound loss. The typical tensile strength of the wire is 1200MPa. Shown in fig 1.1.



Fig 1.1 Flat End Fibers

Tabix Fibers

Tabix is an undulated steel fiber (1100 M pa) used in slope and wall applications without overhead projection. Shown in fig 1.2.



Fig 1.2 Tabix Fibers

Hooked end Fibers

Hooked end fibers are straight fibers with additional hooked ends. The hooked end shotcrete fiber can be used in all shotcrete applications. Commonly used with dosage of 25 to 50 kg/m³, depending on ground conditions. The hooker end fiber is shot with low rebound losses. The typical tensile strength of the wire is 1200 Mpa. Shown in fig 1.3.



Fig 1.3 Hooked End Fibers

Advantages

- Reinforcing concrete with steel fibers results in durable concrete with a high flexural and fatigue flexural strength.
- It improves abrasion and impact resistance.
- The elimination of conventional reinforcement and in some cases the reduction in section thickness can contribute to some significant productivity improvements.
- Steel fibers can deliver significant cost savings, together with reduced material volume, more rapid construction and reduced labor costs.
- Steel fiber reinforced concrete distributes localized stresses.
- Increase tensile strength and toughness.
- Reduces surface permeability, dusting and wear.
- They act as a crack resistor.
- The random distribution of steel fibers in concrete ensures that cracks free stress accommodation occurs through out the concrete.
- The micro cracks are intercepted before they develop and impair the performance of the concrete.
- Steel fibers are a far more economical design alternative.

Disadvantages

- Steel fibers well out float on the surface of a properly finished slab.
- The rain damaged slab allows both aggregate and fibers to be exposed and will present as aesthetically poor whilst maintaining structural soundness.
- Fibers are capable of substituting reinforcement in all structural elements.
- The fibers alternatives cost saving and design economics are diminished.
- Strict control of concrete wastage must be monitored in order to keep it at a minimum.

- Wasted concrete means wasted fibers.
- Greater reduction of workability.
- High cost of materials.
- Generally fibers do not increase the flexural strength of concrete, and so cannot.
- Replace moment resisting or structural steel reinforcement.

Polypropylene

Polypropylene fiber is mainly used in cement concrete to reduce the excessive wide cracks can also result in leakage in structures. Improving the surface quality, like roof of building and wall and floor, becomes a crucial task to the construction field. So on the basis of successfully developing polypropylene fiber develops cracking resistance and improve quality of buildings wall and floor. By adding polypropylene fibers into the concrete, the plastic shrinkage cracks of concrete at the early age reduced and it can also reduce the surface bleeding and settlement of aggregate of fresh concrete, which can prevent the formation of settling cracks. Polypropylene fibers are cheap and abundantly available. Polypropylene is used in many structures such as dams, tanks, and other construction works.



Fig 1.4 Polypropylene Fiber

Advantages

- Avoid the shrinkage of concrete.
- To improve the deformation characteristics of concrete.
- Enhance resistance and control the crack
- To improve the impact strength of concrete, increase the stripping resistance.
- Prevent dryness and prevent crack propagation of concrete.
- Increase impact and abrasion resistance.
- Improves the finishing characteristics.
- Improve durability of concrete.

- Prevents intrinsic cracking in concrete.

Disadvantages

- Low melting temperature.
- Hard to dyed after manufacturing, except after substantial treatment and modification.
- Degraded to UV (Ultraviolet).
- Poor resilience.
- Polypropylene undergoes creep.

S.no	Weight of cement (W ₁) Gm	Weight of residue (W ₂) gm	Fineness of cement (W ₂ /W ₁) *100
1	100	9	9%
2	100	8	8%

Result: Fineness of cement = 9%

Normal Consistency of Cement Procedure

1. The Standard Consistency of Cement Paste Which Permits. The vicat’s apparatus to a point 5 to 7mm from the bottom of the vicat’s mould
2. Take 500 gm of cement and prepare a paste with weighed quantity of water taking care to see that the time of gauging in between 3 to 5 min.
3. Take 500 gm of cement and prepare a paste with weighed quantity of water taking care to see that the time of gauging in between 3 to 5 min.
4. Fill the vicat’s mould resting on non-porous plate with this paste, and level off its top.
5. Place the test-block in the mould with non-porous resting place under the plunger, lower the plunger gently to touch the surface of the test block and release quickly.
6. The amount of water required is expressed as a percentage by weight of the dry cement. The test is performed at a temperature of 25°C

S.no	% Of Water Added	Quality of Water added (ml)	Vicat’s plunger in reading (mm)
1	26	78	37
2	28	84	30
3	30	90	27
4	32	96	12
5	34	102	5

Wt. of cement taken = 300 grams

Result: Normal consistency of cement = 34%

Trail no	1	2	3	4	5	6
Initial reading mm	0	0	0	0	0	0
Final reading mm	0	0	1	2	3	5
Penetration mm	0	0	1	2	3	5
Time collapsed (Initial setting time)	0	10	15	20	26	29

Table 3.3: Initial Consistency of Cement

Wt. of cement taken = 300 grams

Wt. of water to be added = $0.85 \times 300g / 100$

APPENDIX

This is to certify that the dissertation entitled “**EXPERIMENTAL INVESTIGATION ON HYBRID FIBRE REINFORCED CONCRETE**” being submitted by **DONALA PRAVEEN KUMAR** with Regd.No. **423232913007** in partial fulfillment of the requirements for the award of **MASTER OF TECHNOLOGY in civil engineering with the specialization of TRANSPORTATION ENGINEERING** is an authentic work carried out by **Mr.HEMANTH KUMAR M.Tech** under their supervision and guidance. To the best of my knowledge, the matter embodied in this seminar report has not been submitted to any other University/institute for award of any degree of engineering

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