Experimental Investigation on Energy Dispersive Analysis of Fibre Reinforced Concrete

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Abstract- *Concrete structures are usually subjected to both static as a long term and dynamic as a short term loads. The impact resistance of plain concrete is low and that's mainly due to a fairly low energy dissipating features and inadequate tensile strength. To compensate for the weak tensile properties of the concrete the reinforced concrete is used and it has a better potential as a practicable structural material for such application under extreme loads such as impact. However, concrete is a developing material and the relevant studies towards the change and development of concrete which researchers have carried out to date reveals that the developed concrete improves the behaviour of structural member more when compared to conventional concrete. Fibre Reinforced Concrete (FRC) material is a developed concrete that has been proposed to improve the tensile behaviour of the concrete using fibres in the concrete mix. Steel Fibre Reinforced Concrete (SFRC) is popular FRC material that is being studied to improve the structural behaviour of members under different load conditions. This study aims to investigate and examine the structural behaviour of steel fibre reinforced concrete material at different volume fraction of the fibers. Experimental work is conducted for this research to obtain results on the behaviour of SFRC. The experimental work consists of testing concrete under tension, compression and flexure*

I. INTRODUCTION

Concrete is a very strong and versatile moldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years.

Concrete is the second most widely used substance after water and over six milliard tons of concrete is produced each year. Concrete is specified to different applications like a new construction, repair, rehabilitation and retrofitting. Concrete building components in different sizes and shapes include wall panels, doorsills, beams, pillars and more. Post tensioned slabs are a preferred method for industrial, commercial and residential floor slab construction. It makes sense to classify the uses of concrete on the basis of where and how it is produced, together with its method of application, since these have different requirements and properties.

The fiber Reinforced concrete is the concrete made with the hydraulic cement, containing fine, coarse aggregate and discontinuous fiber or concrete incorporating relatively short, discrete and discontinuous fibers Among characteristic of fibers that has influence on the response of the composite are type of fiber, length of fiber, the volume fraction of fiber and the bond of the fiber with the matrix.

Fiber Reinforced Concrete

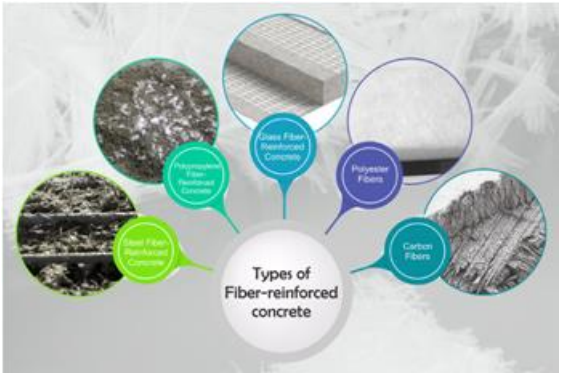
Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion, and shatter resistance in concrete. Larger steel or synthetic fibers can replace rebar or steel completely in certain situations. Fiber reinforced concrete has all but completely replaced bar in underground construction industry such as tunnel segments where almost all tunnel linings are fiber reinforced in lieu of using rebar. Indeed, some fibers actually reduce the compressive strength of concrete.

The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (Vf). Vf typically ranges from 0.1 to 3%. The aspect ratio (l/d) is calculated by dividing fiber length (l) by its diameter (d). Fibers with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the fiber's modulus of elasticity is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increasing the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. Longer length results in better matrix inside the concrete and finer diameter increases the count of fibers. To

ensure that each fiber strand is effective, it is recommended to use fibers longer than maximum size of aggregate. Normal concrete contains 19 mm equivalent diameter aggregate which is 35-45% of concrete, fibers longer than 20mm are more effective. However, fibers that are too long and not properly treated at time of processing tend to "ball" in the mix and create work-ability problems.

Advantages of Fiber-reinforced concrete

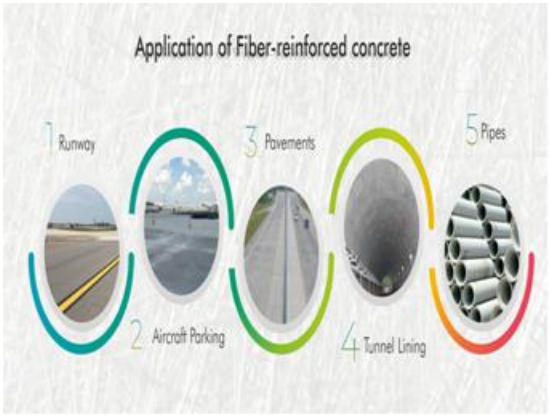
- The use of Flyash decreases landfill disposal. Coal – Fired Power Fibers reinforced concrete may be useful where high tensile strength and reduced cracking are desirable or when conventional reinforcement cannot be placed
- It improves the impact strength of concrete, limits the crack growth and leads to a greater strain capacity of the composite material
- For industrial projects, macro-synthetic fibers are used to improve concrete's durability. Made from synthetic materials, these fibers are long and thick in size and may be used as a replacement for bar or fabric reinforcement
- Adding fibers to the concrete will improve its freeze-thaw resistance and help keep the concrete strong and attractive for extended periods.
- Improve mix cohesion, improving pumpability over long distances
- Increase resistance to plastic shrinkage during curing
- Minimizes steel reinforcement requirements
- Controls the crack widths tightly, thus improving durability
- Reduces segregation and bleed-water
- FRC, toughness is about 10 to 40 times that of plain concrete
- The addition of fibers increases fatigue strength
- Fibers increase the shear capacity of reinforced concrete beams



Steel Fiber Reinforced Concrete

Steel fiber is a metal reinforcement. A certain amount of steel fiber in concrete can cause qualitative changes in concrete's physical property. It can greatly increase resistance to cracking, impact, fatigue, and bending, tenacity, durability, and others. For improving long-term behavior, enhancing strength, toughness, and stress resistance, SFRC is being used in structures such as flooring, housing, precast, bridges, tunneling, heavy-duty pavement, and mining. The types of steel fibers are defined by ASTM A820 are, Type I: cold-drawn wire, Type II; cut sheet, Type III: melt-extracted, Type IV: mill cut and Type V: modified cold-drawn wir

Applications Of Fiber-Reinforced Concrete



The applications of fiber reinforced concrete depend on the applicator and builder in taking advantage of the static and dynamic characteristics of the material. Some of its area of application is,

1.Runway
2.Aircraft parking
3.Pavement
4.Tunnal Lining
5.Wall
6.Pipes
7.Dams

II. STUDY OF MATERIALS

Material testing is essential for the mix design of concrete. It gives the optimum amount of materials required for a given strength and workability of concrete. Hence the properties of the following materials were found.

Materials Used

Cement
Fine Aggregates
Coarse Aggregates

Water
Synthetic Fibre

MATERIAL TESTS

Fineness of Cement

The fineness of cement can be defined as the measure of size of particles of cement or in simple form "Specific surface of Cement". The fineness test on cement conducted as per IS4301- Part I: 1996

Procedure

Correctly 100gms of cement was weighed and taken in a standard IS sieve 90micron.
The lumps were broken down and the material was sieved continuously for 15 minutes using sieve shaker.
The residue left on the sieve was weighed. This weight shall not exceed the specified limit as given in the table.

S.No	DESCRIPTION	VALUE
1	Weight of sample (gm)	100
2	Weight of material retained after sieving(gm)	3.46
3	% of residue left on the sieve on 90µ	3.46

Observation

Fineness of cement = (weight retained/ weight taken) x 100

= (3.46/100) x 100 = 3.46%

Limitation: up to 5% (OPC)
Result
Fineness of cement = 3.46%

SPECIFIC GRAVITY TEST OF CEMENT (As per IS 2270 Part III)

The specific gravity of the cement is the ratio of the specific weight of cement to the specific weight of kerosene. It is an important property for the design of a concrete mix. It is found with the help of Le Chatelier's apparatus.

Procedure

Weigh the specific gravity bottle dry (W_1)
Fill the bottle with cement sample at least half of the bottle and weight the bottle (W_2)
Fill the bottle containing cement with kerosene and weigh (W_3)

Pour some of kerosene out and introduce a weighted quantity of cement (say about 60 grams) into the bottle. Roll the bottle gently in the inclined position until no further air bubble rise to the surface. Fill the bottle to the top with kerosene and weigh it (W_4)

Table 5.2 specific gravity of cement

S.NO	PARTICULARS	VALUE (grams)
1	Empty weight of flask (W_1)	122
2	Weight of flask+ cement (W_2)	222
3	Flask + cement + kerosene(W_3)	444
4	Weight of flask+ kerosene(W_4)	384

Specific gravity, $g = \frac{w_2 - w_1}{[(w_2 - w_1) - (w_3 - w_4)] \times \text{sp.gravity of kerosene}}$

= (222-122)/ {[(222-122) – (444-384)] x0.79}
= 3.15

Result: Specific gravity of cement = 3.15

SPECIFIC GRAVITY OF FINE AGGREGATE (As per IS 2386:1963 Part III):

The specific gravity of aggregates is determined using a Pycnometer. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature. The specific gravity of a soil is used in the phase

relationship of air, water, and solids in a given volume of the soil.

Procedure

Determine and record the weight of the empty clean and dry pycnometer, W_1.
Place 10g of a dry soil sample in the pycnometer. Determine and record the weight of the pycnometer containing the dry soil, W_2.
Add water to fill the pycnometer. Soak the sample for 10 minutes and weigh it. Let it be W_3.
Empty the pycnometer and clean it. Then fill it with water only .Clean the exterior surface of the pycnometer with a clean, dry cloth. Determine the weight of the pycnometer and water, W_4.

SI. NO	DESCRIPTION	VALUE (grams)
1	Empty weight of the pycnometer (W_1)	665
2	Pycnometer + sand (W_2)	969
3	Pycnometer + sand + water(W_3)	1720
4	Pycnometer+ water(W_4)	1527

Specific gravity $= \frac{w_2 - w_1}{(w_2 - w_1) - (w_3 - w_4)}$

= (969 – 665)/((969 – 665) –(1720 – 1527))

g = 2.73

MIXDESIGN

Mix design of synthetic fiber reinforced concrete is concerned with achieving a workability, homogeneity, durability and strength suitable for its use. Variables defining any mix design of SFRC are commented below, as well as their influence on some properties of fresh and hardened SFRC.

Overall result:

Cement = 350 kg/m3
Synthetic Fibre = 3.5 kg/m3
Chemical Admixture = 7 kg/m3
Fine aggregates = 830.56 kg/m3
Coarse aggregate = 1215.43 kg/m3
Water = 140 lit

III. CONCLUSION

The Synthetic Fibre Reinforced Concrete of M30 were designed manually and the fresh properties of concrete such as slump flow, J-ring, V-funnel and L-box has determined. Strength parameters such as compressive strength and split tensile test has tested. The properties of required materials for concrete is tested as per standards. The mix design is prepared as per Indian Standards and the strength and durability also check in this experiment. This experiment was done by using venous materials in various testing process with different time periods

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