Research about

“Self Healing in Concrete Pavement with Fiber” (FRC)

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1-History :-

* The use of fibres to strengthen materials which are much weaker in tension than in compression goes back at least 3500 years, when straw was used to reinforce sun-baked bricks in Mesopotamia.

* Horsehair was used in mortar and straw in mud bricks.

* Asbestos fibers were used in concrete in the early 1900.

* In the 1950s, the concept of composite materials came into picture.

* Steel , Glass and synthetic fibers have been used to improve the properties of concrete for the past 30 or 40 years.

*Research into new fiber-reinforced concretes continues even today.

2-Introduction:-

* Concrete containing cement, water , aggregate, and discontinuous, uniformly dispersed or discrete fibers is called fiber reinforced concrete.

* It is a composite obtained by adding a single type or a blend of fibers to the conventional concrete mix.

3-Why Fibers are used?

* The fibers are not added to improve the strength , their main role is to control the cracking of FRC and increase the ductility of concrete elements.
* There is considerable improvement in the post-cracking behavior of concrete containing fibers due to both plastic shrinkage and drying shrinkage.
* They also reduce the permeability of concrete and thus reduce bleeding of water.
* Some types of fibers produce greater abrasion and shatter resistance in concrete.

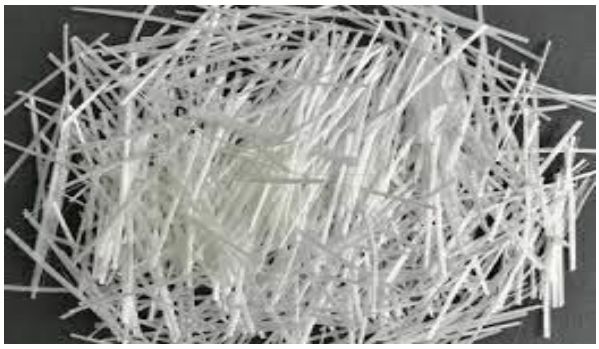
4-Types of Fibers:-

A- Steel fibers (SFRC)

* Aspect ratios of 30 to 250.
* Diameters vary from 0.25 mm to 0.75 mm.
* High structural strength.
* Reduced crack widths and control the crack widths tightly, thus improving durability. * Improve impact and abrasion resistance.
* Used in precast and structural applications, highway and airport pavements, refractory and canal linings, industrial flooring, bridge decks, etc.

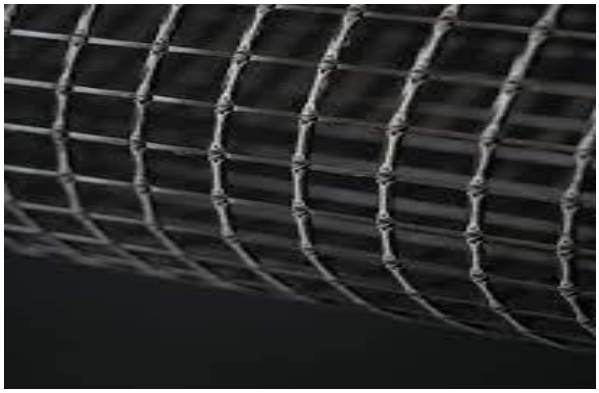
B- Glass fibers (GFRC)

*High tensile strength, 1020 to 4080 N/mm2 .
* Generally, fibers of length 25mm are used.
* Improvement in impact strength.
* Increased flexural strength, ductility and resistance to thermal shock.
* Used in formwork, swimming pools, ducts and roofs, sewer lining etc.

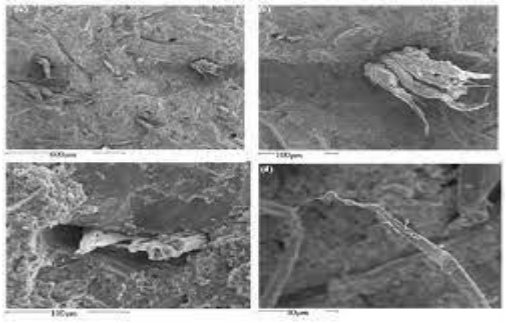



C-Carbon Fibers

* Posses very high tensile strength 2110 to 2815 N/mm2 and Young's modulus.
* Cement composite consisting of carbon fibers show very high modulus of elasticity and flexural strength.




D-Cellulose Fibers



E-Asbestos Fibers

* Mineral fiber, most successful of all as it can be mixed with Portland cement. *Tensile strength of asbestos varies between 560 to 980 N/mm2. *Asbestos cement paste has considerably higher flexural strength than Portland cement paste.

*For unimportant concrete work, organic fibers like coir, jute and canesplits are also used.

F-Synthetic Fibers: Polypropylene Nylon Fibers (SFRC)

*Man- made fibers from petrochemical and textile industries.

*Cheap, abundantly available.

*High chemical resistance.

* High melting point.

* Low modulus of elasticity.

* It's types are acrylic, aramid, carbon, nylon, polyester, polyethylene, polypropylene, etc.

* Applications in cladding panels and shotcrete.

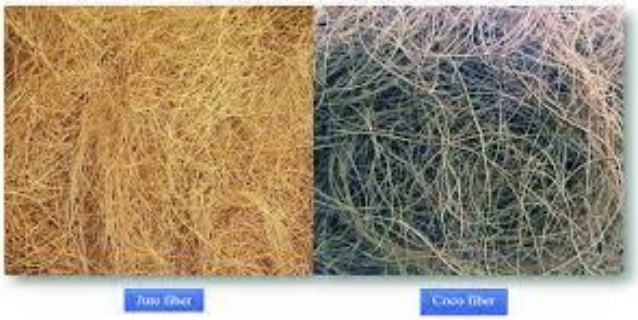
G-Natural Fibers (NFRC) : Coir Hay

*Obtained at low cost and low level of energy using local manpower and technology.

* Jute, coir and bamboo are examples.

* They may undergo organic decay.

* Low modulus of elasticity, high impact strength.



5-Structural behavior of FRC :-

*Flexure The use of fibers in reinforced concrete flexure members increases ductility, tensile strength, moment capacity, and stiffness. The fibers improve crack control and preserve post cracking structural integrity of members.

* Torsion The use of fibers eliminate the sudden failure characteristic of plain concrete beams. It increases stiffness, torsional strength, ductility, rotational capacity, and the number of cracks with less crack width.

* High Strength Concrete Fibers increases the ductility of high strength concrete. Fiber addition will help in controlling cracks and deflections.

*Shear Addition of fibers increases shear capacity of reinforced concrete beams up to 100 percent. Addition of randomly distributed fibers increases shear-friction strength and ultimate strength.

6-Factors affecting the Properties of FRC :-

6-1- Volume of fibers :-

* Low volume fraction(less than 1%) .

*Used in slab and pavement that have large exposed surface leading to high shrinkage cracking.

* Moderate volume fraction(between 1 and 2 percent) .

*Used in Construction method such as Shortcrete & in Structures which requires improved capacity against delaminating, spalling & fatigue.

*High volume fraction(greater than 2%) .

*Used in making high performance fiber reinforced composites.

6-2- Aspect ratio of fiber :-

*It is defined as ratio of length of fiber to it's diameter (L/d).

*Increase in the aspect ratio up to 75, there is increase in relative strength and toughness.

* Beyond 75 of aspect ratio, there is decrease in aspect ratio and toughness.

6-3- Orientation of fiber :-

*Load Direction *Parallel *Perpendicular *Random.

6-4- Relative fiber matrix stiffness.:-

*Modulus of elasticity of matrix must be less than of fibers for efficient stress transfer.

* Low modulus of fibers imparts more energy absorption while high modulus fibers imparts strength and stiffness.

* Low modulus fibers e.g. Nylons and Polypropylene fibers.

* High modulus fibers e.g. Steel, Glass, and Carbon fibers.

7- Advantages and Disadvantages of FRC:-

Advantages

* High modulus of elasticity for effective long-term reinforcement, even in the hardened concrete.
* Does not rust nor corrode and requires no minimum cover.
* Ideal aspect ratio (i.e. relationship between Fiber diameter and length) which makes them excellent for early-age performance.
* Easily placed, Cast, Sprayed and less labour intensive than placing rebar.
* Greater retained toughness in conventional concrete mixes.
* Higher flexural strength, depending on addition rate.
* Can be made into thin sheets or irregular shapes.
* FRC possesses enough plasticity to go under large deformation once the peak load has been reached.

Disadvantages

*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.

8-Applications of FRC :-

*Overlays of air-fields.
* Road pavements.
*Industrial flooring. Bridge decks.
*Canal lining.
*Explosive resistant structure.
*Refractory lining.
*Fabrications of precast products like pipes, boats, beams, staircase steps, wall panels, roof panels, manhole covers etc. *Manufacture of prefabricated formwork moulds of “U” shape for casting lintels and small beams.
*Road pavement Bridge decks Precast canal lining Manhole cover.

9-Difference between FRC and RC

Fiber Reinforced Concrete (FRC)

- High Durability .
- Protect steel from Corrosion .
- Lighter materials .
- More expensive .
- With the same volume, the strength is greater .
- Less workability .

Normal Reinforced concrete (RC)

- Lower Durability .
- Steel potential to corrosion .
- Heavier material .
- Economical .
- With the same volume, the strength is less .
- High workability as compared to FRC .

10- Conclusion :-

* very costly .
*normally apply on bridge constructions .
* the ability to sustain a load without excessive deformation or failure .
*used as external reinforcement in the rehabilitation of reinforced concrete (RC) beams and slabs .
*architects used it as siding/cladding, roofing, flooring and partitions .

How does FRC work?
https://www.youtube.com/watch?v=XYiRY5o99yQ

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