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STEEL FIBER REINFORCED CONCRETE

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Abstract

Recently, considerable interest has been generated in the use of Steel Fiber Reinforced Concrete(SFRC). The most significant influence of the incorporation of steel fibres in concrete is to delay and control the tensile cracking of the composite material. This positively influences mechanical properties of concrete. These improved properties result SFRC being a feasible material for concrete pavements. The aim of this paper is to evaluate the use of SFRC for road pavements and compare its performance to plain concrete under traffic loading. influence of SFRC properties on performance design aspects of concrete roads discussed. Results from road trial sections, tested under in-service traffic, are used to validate the use of the material in roads. the Performance and behaviour of SFRC test section compared to plain concrete section. The performance of thinner SFRC ground slabs is found comparable to thicker plain concrete slabs. A design approach for SFRC is recommended in which an existing method for the design of plain concrete slabs is extended by incorporating the post-cracking strength of SFRC. Fibers generally used as a resistance of cracking and strengthening concrete. In this project, I am going to carry out test on steel fiber reinforced concrete to check the influence of fibres on flexural strength of concrete. According to various research papers, it has been found that steel fibres give the maximum strength in comparison to glass and polypropylene fibres. Hence, this project I was interested in finding out the optimum quantity of steel fibres required to achieve the maximum flexural strength for different grades of concrete

Key words:-*SFRC, Fibers, Reinforcement, Steel, Concrete, Shotcrete.*

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1. Introduction

These fibers are generally used for providing concrete with enhanced toughness and post-crack load carrying capacity. Typically loose or bundled, these fibers are generally made from carbon or stainless steel and are shaped into varying geometries such as crimped, hooked-end or with other mechanical deformations for anchorage in the concrete. Fiber types are classified within ACI 544 as Types I through V and have maximum lengths ranging from 1.5 "to 3" (30 - 80mm) and can be dosed at 10 to 100 Ibs / yd (6 to 67 kg / m3)

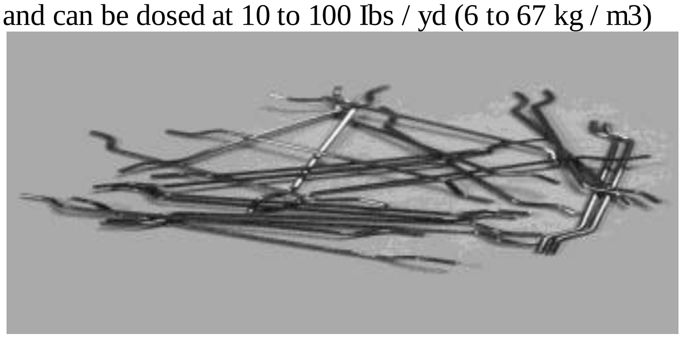

Fig 1.Steel Fiber

It is concrete containing fibrous material which increases its structural integrity. an contains short discrete fibers that are uniformly distribute and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers - each of which lends varying properties to the concrete. addition, the character of anfiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities. Steel Fiber reinforced concrete(SFRC) is Portland cement concrete reinforced with more or less randomly distributed steel fibers. In SFRC, thousands of small steel fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. SFRC is cement-based composite material that has been developed in recent years. It has been successfully used in construction with its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent p permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. The aspect ratio of the fiber is the ratio of its length to its diameter The principle reason for incorporating steel fibers into a cement matrix is to Increase the toughness and tensile strength and improve the racking deformation characteristics of the resultant composite containing steel fiber have been shown to have substantially improved resistance to impact and greater ductility of failure in compression, flexure and torsion. Similarly, its reported that elastic modulus in compression and modulus of rigidity in torsion are no different before cracking when compared with plain concrete tested under similar conditions. It has been reported that steel-fiber-reinforced concrete, due to improved ductility, could find applications where impact resistance is important. Fatigue resistance of the concrete is reported to be increased by up to 70%. It is thought that the inclusion of steel fiber as supplementary reinforcement in concrete could assist in the reduction of spilling due to thermal shock and thermal gradients. The lack of Corrosion resistance of normal steel fibers could be a disadvantage in exposed concrete situations where spilling and surface staining are likely to occur.

Steel fiber types

The types of steel fibers are defined by ASTM A820:

3.1. Type I: cold-drawn wire
3.2. Type II: cut sheet
3.3. Type III: melt-extracted
3.4. Type IV: mill cut
3.5. Type V: modified cold-drawn wire

Fig 2:- Steel fiber type

Type I fibers have tensile strength from 145,000 to 45,000 psi, whileTypes II, III, IV, and V have tensile strength as low as 50,000 psi. Fiber shapes range from round wires with deformed ends in different diameters (Type I), rectangular or square rod shapes with dimples (Type II) triangular cross-section and twisted (Type V), or crescent cros-section and corrugated (Type V), as well as other shapes. They also come in different lengths, ranging from 1/4 inch to more than

2 inches. Michael Carter, manager of key accounts for Propex (Fiber mesh), Chattanooga, Tenn., says there is a tradeoff with length.the longer fibers tend perform better but they can be more difficult to blend and mix into concrete. To solve this problem, manufacturers often bundle fibers using water-soluble glue to achieve better dispersion in concrete during mixing. Diameter or perimeter dimensions between products differ and fiber manufacturers sell different shapes. Jimm Milligan, says the challenge is to deform fiber ends in such a way as a achieve maximum anchorage with concrete and good cement paste bond along the length with the fiber.

You also can gage fiber effectiveness by aspect ratio-the length divided by the diameter. The higher the aspect ratio the better the performance. Longer fibers have higher aspect ratios. Use aspect ratios to compare fibers of equal length.

Some manufacturer blend steel fibers with the polymer plastic macro and micro fibers in order to get synergistic effect.

Crack control

The cracks and control joints represents future maintenance problems, so fewer joints is a mark of quality. The joints in floors, as necessary whichare, typically deteriorate , costing owners money for repairs as a floor ages. the owners often are willing to pay for higher dosages of steel fibers in exchange for increasing the joint spacing and joint life. If they could afford it, owners would construct floors with no joints at all. Just adding steel fibers to a load of concrete doesn't ensure success. A steel fiber in concrete represents only one part of the system.There are other important elements to consider, including sub-grade preparation, concrete mix design, and the total water in a mix.The condition of the sub-base is critical. The sub-grade under a slab must have adequate drainage, be properly compacted, and have a flat, smooth surface. The installation of a good vapor barrier system also is recommended. Concrete places over the mud and water puddles should not be allowed.These areas should be removed, replaced with suitable material, and compacted before concrete is placed. The goal is to create a smooth surface for the underside of a concrete slab to freely move on when shrinking slabs that get caught by irregularly shaped sub-grade can become stressed enough to crack.

Mixing

Most fibers today are added at the ready-mix plant. The most popular method is to use a conveyor concrete ingredients are loaded. if they are mixed into concrete on a jobsite, either conveyors or machines that can blow them into the mixer are used. Either way, mixing is easily accomplished.

2. Properties of concrete improved by steel fibers

1. Flexural Strength: Flexural bending strength can be increased of up to 3 times more compared to conventional concrete.

2. Fatigue Resistance: Almost 1 1/2 times increase in fatigue strength.

3. Impact Resistance: Greater resistance to damage in case of a heavy impact.

4. Permeability: The material is less porous.
5. Abrasion Resistance: More effective composition against abrasion and spalling.
6. Shrinkage: Shrinkage cracks can be eliminated.

2.1 Advantages of steel fiber concrete

1. The Clean layer may be omitted.
2. The concrete can be made directly from the truck.
3. The construction period is shorter, since reinforcement installation and acceptance accounted.
4. No problems with wrong horizontal reinforcement.
5. Higher wear resistance, because the steel fibers to the surface rich.
6. Reinforcement of the cut joints increases their durability.
7. Always a cost savings compared to conventional reinforcement.
8. The power in the crack is usually higher than for mild steel.
9. Reduce crack widths and control the crack widths tightly, thus improving durability
10. Improve impact- and abrasion-r –resistance
11. Improve freeze-thaw resistance and crack resistance.
12. Steel fibers reduce the permeability and water migratio in concrete, which ensures protection of concrete due to the ill effects of moisture.

2.2 Disadvantages of steel fiber concrete

1. Steel fibers on the surface can affect the optics.
2. When cutting the slip joints are isolated fibers torn.
3. In open areas or in wet rust is (purely optical problem).

2.3 Applications

1.Residential: including driveways, sidewalks, pool construction with shoterete, basements, colored concrete, foundations, drainage, etc.
2. Commercial: exterior and interior floors, slabs and parking areas, roadways and
3. Warehouse / Industrial: light to heavy duty loaded floors and roadways
4. Highways / Roadways / Bridges: conventional concrete paving, SCC, white-toppings, barrier rails, curb and gutter work, pervious concrete, sound attenuation barriers, etc.
5. Ports and Airports: runways, taxiways, aprons, seawalls, dock areas, parking and loading ramps.
6. Waterways: Dams lock structures, channel linings, ditches, storm-water structures, etc.
7. Mining and Tunneling Precast segments and shotcrete, which may include tunnel lining,shafts, slope stabilization, sewer work, etc.
8. Elevated Decks: including commercial and industrial composite metal deck construction and elevated formwork at airports, commercial buildings, shopping centers, etc.
9. Agriculture: farm and animal storage structures, walls, silos, paving, etc.
10. Precast Concrete and Products: architectural panels, tilt-up constructions walls, fencing, septic tanks, burial vaults, grease trap structures, bank vaults and sculptures

3. STEELCRETE

3.1 Introduction

Steel-Crete is a light weight high compression strength all-purpose repair compound with excellent bonding properties when applied correctly. Steel-Crete can be applied smooth or can be stiffened for texture and vertical applications. Steel Crete can dries to a firm and durable surface in many cases morestronger than the other original substrate.

3.2 Applications

Steel-Crete can be floated over badly damaged asphalt to greatly extend the life of the surface at a fraction of the cost of applying new asphalt. The Steel-Crete can also be used to patch cracks and holes in stucco, poured concrete, masonry block, tile pavers, cinder block, brick, mortar wash, and many other substrates. Steel-Crete makes an excellent light weight low spot repair on flat roofs prior to applying roof coatings and is very water resistant

1. Support of underground openings in tunnels, mines, drainage adits and exploratory adits.
2. Rock slope stabilization and support of excavated foundations, often in conjunction with rock and soil anchor systems.
3. Channel linings, protection of bridge abutments and stabilization of debris-flow pro creeks.
4. Rehabilitation of deteriorated marine structures such as bulkheads, piers, sea walls and dry
5. Rehabilitation of reinforced concrete structures such as bridges, chemical processing dock and handling plants.

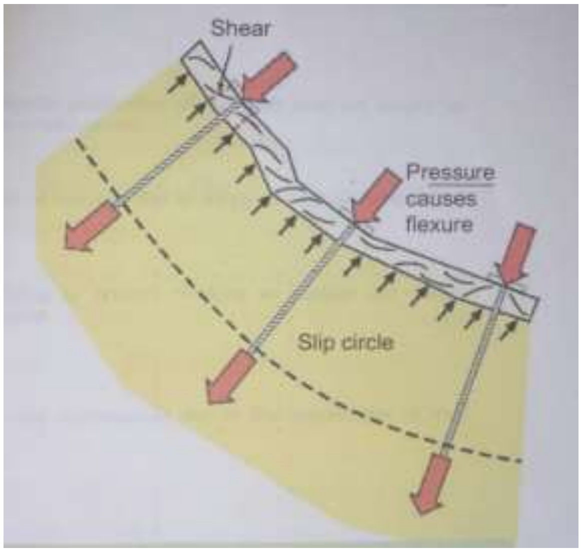

Fig 3:- For slope stabilization

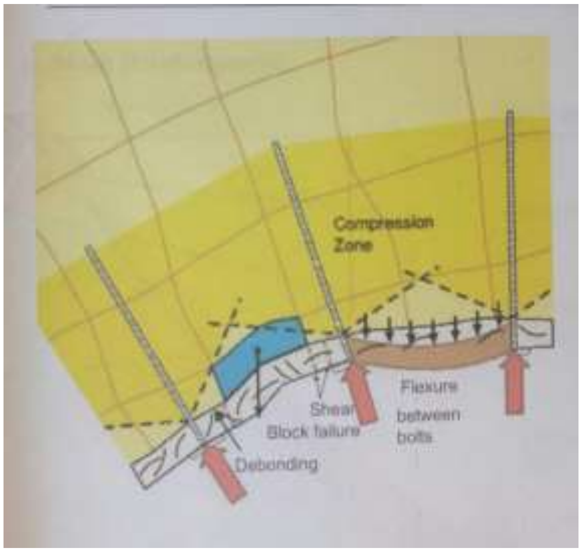

Fig 4:- Tunnel lining steel shotcrete spans

3.3 Benefits

3.3.1 Technical Benefits

1. The homogenous fiber reinforcement gives a resistance to tensile stresses at any point in the Shotcrete layer.
2. An increase of load bearing due to the redistribution of stresses.
3. The removal of mesh increases the bond of the Shotcrete to the surface.
4. Excellent corrosion resistance,
5. Excellent control of cracks.
6. Follows the ground contours to give constant thickness and reduced consumption.
7. Avoids "shadowing" or voids behind mesh.

3.3.2 Economic Benefits

1. Increases safety.
2. Reduced time.
3. Minimizes rebound losses, particularly in combination with Micropoz or Microsilica 60

3.4 Method of use

Steel-Crete is a single component material requiring only the addition of water and is available in 5 gallon pails or 35 and 50 pound bags. Using a clean pail or mixing container blend 5 parts Steel-Crete with 1 part clean water adding the water to the container first. Mix at low to moderate speed until creamy and reasonably stiff as if it were whipped butter. Using a trowel, putty knife, or straight edge, float Steel-Crete over the damaged surface or crack until depressions are filled completely. when repairing asphalt pavement several applications should be used to build surfaces up 1/4 to 3/8 inch. Remove any excess and clean up with water as soon as possible.

Conclusion

1. Flexural Strength: Flexural bending strength can be increased of up to 3 times more compared to conventional concrete.
2. Fatigue Resistance: Almost 1 1/2 times increase in fatigue strength.
3. Impact Resistance: Greater resistance to damage in case of a heavy impact.
4. Permeability: The material is less porous.
5. Abrasion Resistance: More effective composition against abrasion and spalling.
6. Shrinkage: Shrinkage cracks can be eliminated.
7. Corrosion: Corrosion may affect the material but it will be limited in certain areas.
8. Although different t t of steel fibershave been used, Hook-ended steel fibers were found to perform better performance than the other types.
9. The normal transporting, placing and finishing methods used for plain concrete can also used for SFRC.
10. The extended design approach resulted in SFRC slabs that are equivalent to the plain concrete slab under in-service traffic loading. This approach can be serve as a interim design approach for the SRFC roads while our understanding the behaviour of the SFRC roads evolves and more advanced methods are developed.

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