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Steel Fibre Reinforced Concrete Pavements for Roads

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ABSTRACT:

Road transportation is undoubtedly the lifeline of the nation and its development is a essential issue. The traditional bituminous pavements and their wishes for non-stop preservation and rehabilitation operations factors towards the scope for cement concrete pavements. There are numerous blessings of FRCP over CC and bituminous pavements like low upkeep fee, availability of cement is extra in comparison to bitumen. Fibre Reinforced Concrete Pavements, which is a latest development in the area of reinforced concrete pavement layout. FRC pavements show to be more efficient than conventional RC pavements. Main function of fibres is to bridge the cracks that increase in concrete and growth the ductility of concrete factors. Improvement on Post-cracking behaviour of concrete and imparts greater resistance to effect masses.

Water logging is a main cause for potholes in roads. WBM and Asphalt roads are permeable to water which damages the street and sub grade. But FRC roads are especially impermeable to water so they will not permit water logging and water being popping out on surface from sub grade. Implementation of sensors in roads might be less difficult even as using fibres for concrete. Maintenance activities associated with metal corrosion will be decreased whilst the use of FRC. Fibres reduce plastic shrinkage and substance cracking. Fibres additionally provide residual electricity after cracking occurred. The use of fibres in concrete can bring about cement saving up to ten% and inside the presence of fly ash; savings can be up to 35%.

There is a developing cognizance of the benefits of fibre reinforcement techniques of production all around the international. Steel Fibre Reinforced Concrete has turn out to be very famous due to its tremendous mechanical overall performance compared to the conferential concrete. Experimental investigations and evaluation of results were conducted to observe the compressive & tensile behaviour of composite concrete with various percentage of such fibres delivered to it. The concrete mix adopted have been M30 with varying percentage of fibres starting from 0.5, 1.0, 1.5 & 3%.

1. INTRODUCTION

1.1 GENERAL

In a creating nation, for example, India, street systems shape the veins of the country. Asphalt is the layered structure on which vehicles travel. It fills two needs, to be specific, to give an agreeable and strong surface for vehicles, and to diminish weights on basic soils. In India, the conventional arrangement of bituminous asphalts is generally utilized [1].

Locally accessible bond concrete is a superior substitute to bitumen which is the side-effect in refining of imported oil unrefined. Petroleum and its results are damning step by step. At whatever point we think about a street development in India it is underestimated that it would be bituminous asphalt and there are extremely uncommon possibilities for thinking about an option like solid asphalts [2].

Inside a few decades bituminous asphalt would be a history and hence the requirement for an option is exceptionally basic. The ideal arrangement would be Fiber Reinforced Concrete Pavements, as it fulfills two of the much requested prerequisites of asphalt material

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in India, economy and lessened contamination [3-4]. It likewise has a few different preferences like longer life, low support cost, fuel proficiency, and great riding quality, expanded load conveying limit and impermeability to water over adaptable asphalts.

Fiber reinforced concrete pavements are more proficient than conventional bond solid asphalt. "FRC is characterized as composite material comprising of cement strengthened with discrete arbitrarily however consistently scattered short length filaments." The strands might be of steel, polymer or regular materials. FRC is thought to be a material of enhanced properties and not as fortified bond concrete while fortification is accommodated nearby fortifying of cement in pressure locale [5-6]. Strands for the most part utilized as a part of bond solid asphalts are steel filaments and natural polymer filaments, for example, polyester or polypropylene.

1.1 ROLE OF STEEL FIBRES IN PAVMENTS

Plain concrete pavements have low tensile strength and strain capacity, however these structural features are improved by fibre summation, allowing simplification of the pavement layer thickness. This performance can be more and depends on fibre feature and dosage. The most substantial act of fibre reinforcement is to retard and control the tensile cracking of concrete. Therefore it is found to have more affect on the pavement cost due to decresed thickness essentials, low maintenance costs and longer useful life. Comparing with the life cycle of an asphalt road, SFRC pavements have been described to last twice as long.

1.1.1 Social Development

The modern conception of the project is the use of reused steel wire as concrete fibre reinforcement, which provides extra environmental profits for tyre reprocessing over land filling. In order to measure the economic and environmental picture of the manifestation pavement, life cycle cost analysis (LCCA) and life cycle assessment (LCA) studies.

1.1.1.2 Economic development

Utilization of steel filaments influences critical changes in flexure, to effect and weariness quality of cement. It has been utilized as a part of different sorts of structures. Development of recycled steel tyre cord (RTC) fibre reinforcement as an economical alternative to industrially produced steel fibres, used normally in SFRC construction.

1.1.1.3 Strategic Need

Steel fibers have been needed for a large time in construction of roads and also in floorings, especially where more wear and tear is come into picture. Specifications and nomenclature are crucial for a material to be utilized as the tenders are invited based on specifications and nomenclature of the items. In a place where steel fiber reinforced concrete was applied for overlays like flooring, adopting nomenclature can be taking up for concreting of small thickness.

1.2 SIGNIFICANCE OF THE STUDY

The purpose of Steel Fiber Reinforced Concrete (SFRC) as complex matrix is potentially reward from the point of opinion of its capacity to carry much larger stresses.

- SFRC pavement guarantees an perfect higher life anticipation, decreased crack growth refer good serviceability and less corrosion.
- Analyze the mechanical characteristics of the SFRC
- Regulate the fibre proportions
- To ascertain the toughness resistance of the SFRC
- To assure the abrasive resistance of the SFRC
- To discover the cost of the pavement

1.3 OBJECTIVE OF THE STUDY

Main aim of this study is to come out essence of change of percentage of fibres in concrete mix and getting out thickness simplification of concrete slab with regarding to loads coming on to the pavement.

- To generate suitable mix designs
- To generate characterization tests for the fibres

- Harmonize fibre characteristics with specific applications
- Test presentation of concrete products

LITERATURE REVIEW

Later in 1939 the introduction steel swapping asbestos was put aside a couple of minutes. Regardless, at that period it was not productive. From 1960, there was a tremendous change in the FRC, generally by the introduction of steel fibers. Starting now and into the foreseeable future use of different sorts of fibers in concrete was made. In 1970's guidelines were made on the working of the fiber rein-compelled bond. Later in 1980's ensured technique was delivered for the use of FRC. In the latest decades, codes concerning the FRC are being made.

Steel Fiber Reinforced Concrete (SFRC) is concrete containing scattered steel strands. The most basic effect of the joining of steel strands in concrete is to delay and control the pliable part of the composite material. Concrete is a feeble material that won't pass on stacks under unadulterated bowing when part. By combining steel strands the mechanical properties of the strong is changed realizing enormous load passing on restrict after the strong has part (Chen, 2004). Research focus examinations on SFRC cases suggest that scattering of steel strands in solid gains ground.

The mechanical characteristics of the composite, strikingly impenetrability to dynamic load (Banthia et al., 1995) shear quality (Khaloo and Kim, 1997), shortcoming resistance (Johnston and Zemp, 1991) and post-breaking quality (Elsaigh and Kearsley, 2002).

All things considered, concrete is strong in weight and weak in strain. Insinuating Johan Magnusson 2004, Plain bond is depicted by a by and large low flexibility and brittle pliant disillusionment. In helper application, the strong will give the bracing bars to pass on the moldable powers once the strong has part with the objective that it stays, as it were, in compression under load. Additionallythe flexible disillusionment strain of the reinforced concrete is by and large lower than the yield strain of the steel braced and the strong split before any significant stack is traded to the steel.

In industry application, the steel reinforced are required to pass on the weight controls in the strong. As to that, to develop the new utilization of invigorated solid, additional fiber in the strong are required for improvement the mechanical properties of assistant concrete. As demonstrated by M.Behloul 2008, fiber fortified concrete is one of these new materials opening new courses for strong structure. By adding fiber to strong, it is improve the mechanical resistance and flexibility. Other than that, it's also reduced the plastic shrinkage; upgrade the impenetrability to scratched spot, fire, influence, et cetera.

Furthermore, the effect of the filaments lays more in the possibility of essentialness maintenance and split control than in an extended the store trade confine (Zollo 1997). There are numerous kind of fibers used as a piece of the strong, for instance, glass, wood, carbon, normal, steel, et cetera

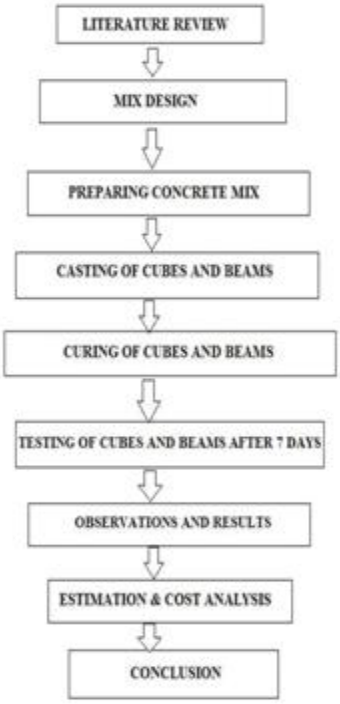
METHODOLOGY

3.1 GENERAL

This chapter explains the experimental program, which consisted of various laboratory experiments to quantify the plastic properties, mechanical properties and cracking performance of FRC concrete consisting of ten concrete mixtures. Additionally, the mixing procedure, concrete mixture proportions, and the preparation and storage of specimens are also described in this section. The plastic properties were determined by the unit weight and the time of flow test. Visual observation was also carried out to inspect for any clumps and balls caused by the fiber clinging together. The compressive strength, modulus of rupture, flexural toughness, and residual strength tests were used to evaluate the concrete mechanical properties, while the restrained shrinkage test was used to evaluate the cracking performance in concrete.

- Mix Design of concrete as per IRC 44: 2008

- Mix Design of SFRC as per IRC SP: 46-1997
- Analyze compressive strength of mixes with compression test carried out on cubes
- Analyze Flexural Strength of beams with flexural testing machine.
- Analyze Modulus of Elasticity of Cubes with modulus of elasticity testing machine
- Analyze thickness reduction of concrete slab with IRC 58: 2002 guidelines.



3.2 MATERIAL SELECTION

3.2.1 Materials required for rigid pavements

- Cement
- Coarse Aggregates
- Fine Aggregates
- Water
- Fibres

Figure 3.1.1 Materials required for Rigid Pavements

3.3 SAMPLE PREPARATION

Concrete containing hydraulic cement, water, best mixture, coarse combination and discontinuous discrete Steel fibres is called Steel Fibre Reinforced Concrete. It may also contain pozzolans and different admixtures generally used with conventional concrete. For maximum structural and non-structural functions, steel fibre is generally used of all the fibres. Steel fibres are added in conjunction with dry blend of all components on the way to put together the SFRC.

EXPERIMENTAL TESTS

4.1 TESTS ON AGGREGATES

4.1.1 SIEVE ANALYSIS TEST (For Coarse Aggregate)

To distribute the given aggregates according to their sizes. The check is carried out in accordance to IS: 2386 (Part I)–1963.And widespread take a look at approach is also given in ASTM 138-06. Sieve evaluation the most essential belongings of sediment debris, affecting their entrainment, shipping and deposition, and so on. From the particle length distribution we discover whether or not pattern is well graded or poorly graded.

OBSERVATIONS & RESULTS

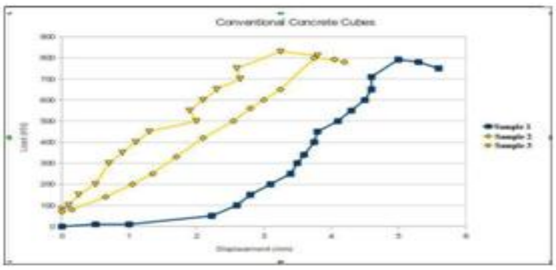


Figure 5.1 Graph between load v/s Displacement for Conventional Concrete cubes

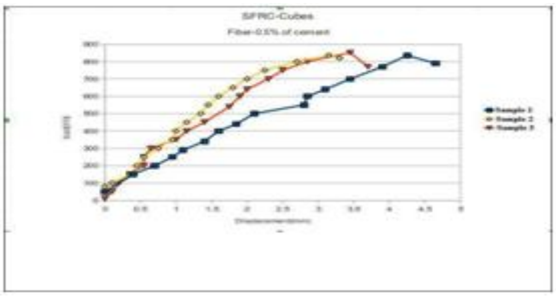


Figure 5.2 Graph between load v/s Displacement for Fibre 0.5% wt. of Cement

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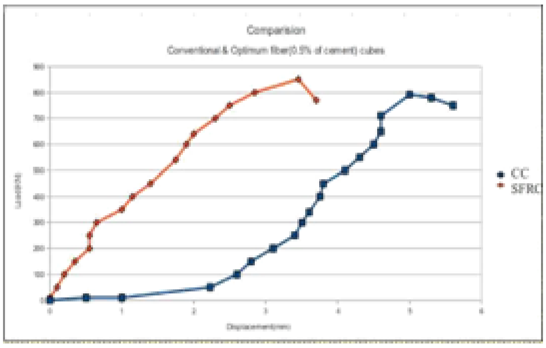

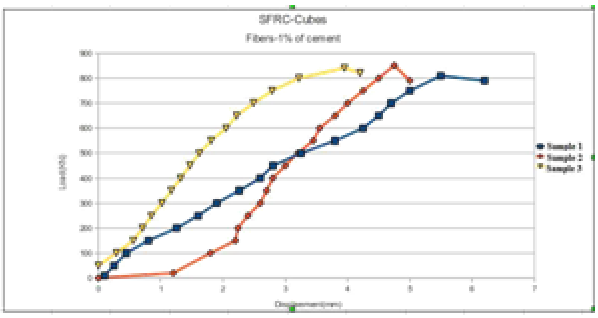

Figure 5.3 Graph between load v/s Displacement for Fibre 1.0% wt. of Cement

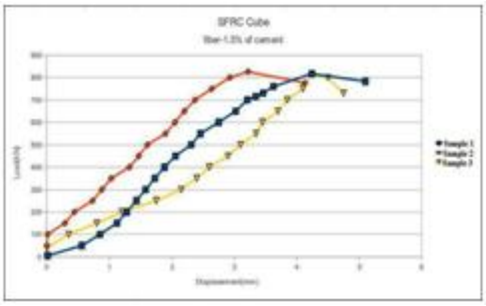

Figure 5.4 Graph between load v/s Displacement for Fibre 1.5% wt. of Cement

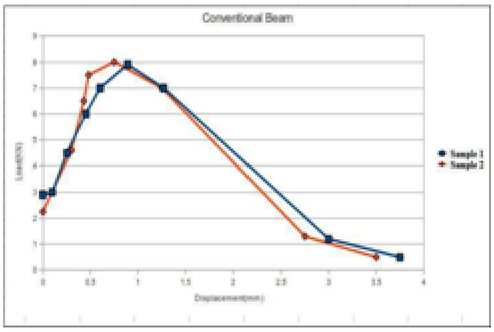

Figure 5.5 Graph between load v/s Displacement for Fibre 3.0% wt. of Cement

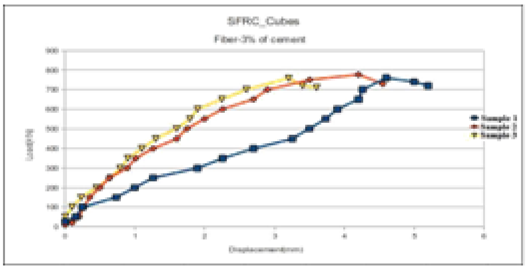

Figure 5.6 Graph between load v/s Displacement for Conventional Concrete Beams

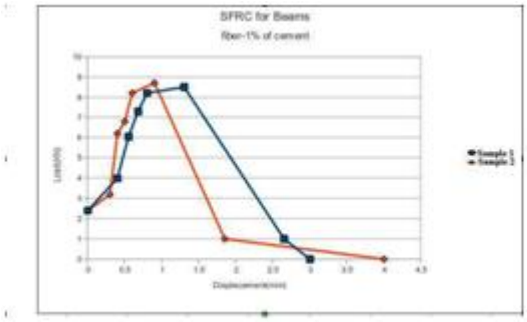

Figure 5.7 Graph between load v/s Displacement for Beams of fibre-0.5% wt. Cement

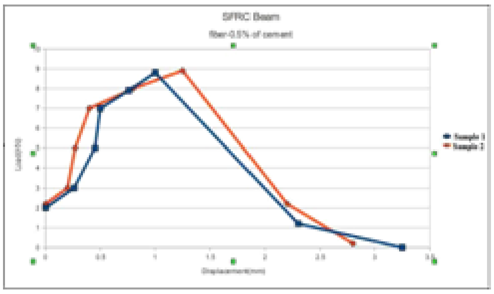

Figure 5.8 Graph between load v/s Displacement for Beams of fibre-1.0% wt. Cement

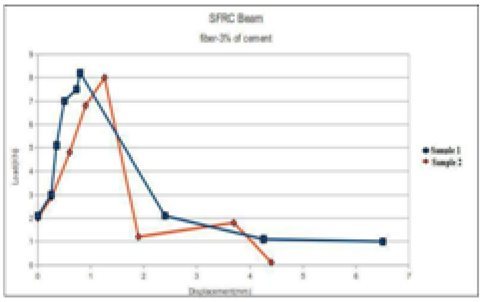

Figure 5.9 Graph between load v/s Displacement for Beams of fibre-1.5% wt. Cement

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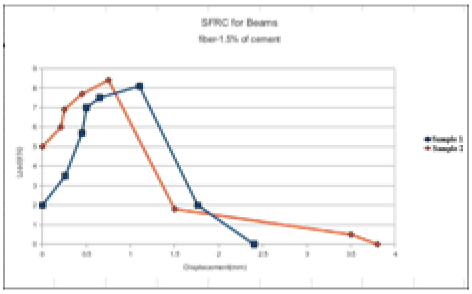

Figure 5.10 Graph between load v/s Displacement for Beams of fibre-3.0% wt. Cement

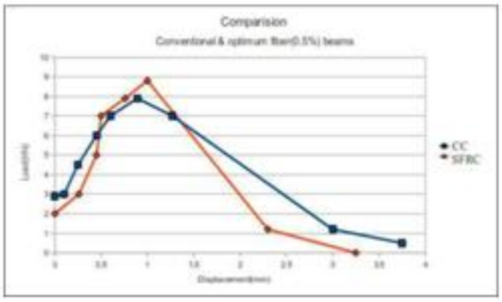

Figure 5.11 Graph between load v/s Displacement, Comparison Conventional & Optimum fibre (0.5% of cement) cubes.

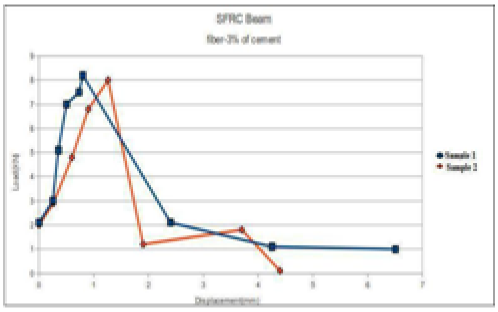

Figure 5.12 Graph between load v/s Displacement,Comparison Conventional & Optimum fibre (0.5% of cement) beams

ECONOMIC ANALYSIS

1. Cost of construction for 0% Fibres Mix i.e. Normal mix

- Length of road = 75 m
- Width of road = 7.5 m
- Pavement thickness = 37 cm
- Total = 208.13

As per the SOR rates cost of construction of 1 m3 of Cement Concrete road is Rs. 845

2. Cost of construction of 0.5% Fibres Mix i.e. Steel Fibres mix

- Length of road = 75 m
- Width of road = 7.5 m
- Pavement thickness = 33.5 cm

So total concreting work to be done in m3 75*7.5*0.35 = 188.13 m3

As per above mention rate from SOR for 1 m3 Cost of construction for this section = 188.13*845 = 1,58,969.85 Rs.

Now, Difference in cost of construction = 1,75,869.85-1,58,969.85 = 16,900 Rs.

So the saving in cost of construction by adding 0.5% steel fibres in concrete mix is 9.7%.

SUMMARYAND CONCLUSION

7.1 Summary

The concept express that fiber reinforcement in cement enclose road base has the capability to increase achievement by increasing fatigue life of the base and alter resistance to reflective cracking of the asphalt. The studies also create that the properties of hardened SFRCC, such as flexural strength, are remarkably better than those of conventional RCC. Thus, the influence of steel fiber for powerful pavement construction can be implying extremely. The proposed SFRC pavement design is come up productive other way to SFRC for influence in road construction industry both in economical and environmental part. Employ easy design methodology, present laying and material production equipment, SFRC pavement may be the ideal special way in road construction.

7.2 Conclusion

- Therefore, by going through different journals and studies papers we are able to finish that FRC might be economically and correctly solving the existing problems with RC pavements.
- FRC is a sustainable improvement inside the present technology.
- We did no longer carry out the bonding take a look at but by means of going thru journals and

the checks which we did, we've got observed that because of randomly distribution of discontinuous fibres they're used to bridge throughout the cracks that expand and provides a few publish cracking ductility.

- The research emphasizes that fibre reinforcement in a cement certain avenue base has the potential to enhance performance by using improving fatigue lifestyles of the base and improved resistance to reflective cracking of the asphalt.
- The studies additionally establish that the residences of hardened SFRC, consisting of flexural electricity, are remarkably higher than those of conventional RCC. Thus, the use of metal fibre for powerful pavement construction can be cautioned undoubtedly.
- Addition of metallic fibres reduces the workability of concrete; hence it becomes important to utilize top notch plasticizers. And those SFRC is used for foremost, high budget tasks only because Steel fibres are value effective.
- The use of fibres in concrete can bring about cement saving up to 10% and inside the presence of fly ash; savings may be as much as 35%.
- “TURN POLLUTION INTO SOLUTION”

7.3 Scope for the future work

- The performance of the thinner SFRC slabs on the ground is found comparable to thicker plain concrete slabs.
- Based on , a 25 percent thickness reduction is possible by incorporating 30 kg/m3 of hooked end steel fibres.
- The long design concept resulted in SFRC slabs that are equivalent to the plain concrete slab under in service traffic loading. This concept can serve as an interim design concept for SFRC roads while our understanding of the behavior of SFRC roads evolves and more advanced methods are came out.

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