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STUDY ON STRENGTH AND DURABILITY OF FIBRE REINFORCED CONCRETEBY USING STEEL FIBRES

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ABSTRACT

Critical investigation for M-40 grade of concrete having mix proportion 1:1.5:2.9 with water cement ratio 0.36 to study the compressive strength of steel fibre reinforced concrete (SFRC) containing fibers of 0%, 0.5%, 1%, 1.5% volume fraction of hook Steel fibers. The reinforcement effects of mechanical properties were analyzed by comparing the conventional concrete. In this paper, different steel fiber incorporation volume concrete test specimens of various mix proportions were prepared, mechanical properties of steel fiber concrete made by vibratory mixing and the normal mixing technologies respectively, were compared and analyzed.

Keywords: *Fibres, Fibrereinforced concrete, hook steel fibres.*

1. INTRODUCTION

Concrete is by far the most widely-used man-made construction material and studies indicating that it will continue to be so in the years and decades to come. Such versatility of concrete is due to the fact that from the common ingredients, namely, cement, aggregate and water (and sometimes admixtures), it is possible to tailor the properties of concrete so as to meet thedemands of any particular situation.

In the true sense, concrete is thus the realbuilding material rather than the ingredients like cement and aggregates, which are only intermediate products. This concept of treating concrete as an entity is symbolized with the progress of ready-mixed concrete industry, where the consumer can specify the concrete of his needs without bothering about the ingredients; and further in pre-cast concrete industry where the consumer obtains the finished structural components satisfying the performance requirements. Therefore, treating concrete in its entity as a building material. In this context a concrete mix forms a 'system'. Concrete mixes are also characterized by the fact that, unlike the other common structural materials like steel, these are mostly manufactured at site; the inherent variability of their properties and need for proper quality control, therefore, become important considerations.

1.1 Cement

Cement is a well-known building material and has occupied an indispensable place in construction work. The function of cement is, first to bind the sand and coarse aggregate together and second to fill the voids in between sand and coarse aggregate particles. Thus, it acts as the binding medium. Ordinary Portland Cement (OPC) of 53 grade is used for the entire investigation. The specific gravity of Ordinary Portland Cement was found tobe 3.15.

.1.2 Steel fibre

In 1910, Porter first suggested the use of SFs in concrete (Naaman,1985). However, the first scientific research on fiber reinforced concrete(FRC) in the United States was done in 1963 (Romualdi and Baston, 1963). SFRC is produced using the conventional hydraulic cements, fineand coarse aggregates, water, and SFs. To enhance the workability and stability of SFRC, superplasticizers (chemical admixtures) may also be added into theconcrete mix. The behavior of SFRC can be classified into three groups according to its application, fiber volume percentage and fibereffectiveness; for instance SFRC is classified based on its fiber volumepercentage as follows: 1-Very low volume fraction of SF (less than 1% per volume of concrete), which has been used for many years to control plastic shrinkage and as pavement reinforcement. 2- Moderate volume fraction of SFs (l% to 2% per volume of concrete) which can improve modulus of rupture (MOR), flexural toughness, impact resistance and other desirable mechanical properties of concrete. 3-High volume fraction of SFs (more than 2% per volume of concrete) used for special applications such as impact and blast resistance structure; these include SIFCON

(Slurry Infiltrated Fiber Concrete), SIMCON (Slurry Infiltrated Mat Concrete). The fibers were bought from Chennai.

2. LITERATURE REVIEW

Srinivasalu. et al (1987) examined that the dynamic behaviour of reinforced concrete beams with equal tension and compression reinforcedand varying percentages of steel fibers was studied at SFRC. The test beams were subjected to particular static loads those simulated different levels of cracking before they were subjected successively to steady stateforced vibration tests. Dynamic flexural rigidity and damping were fromthe data collected from the test. Tests show that that the dynamic stiffnessof SFRC beams in the uncracked state was only marginally high (15% for a fiber volume content of 1%) than for reinforced concrete beams. However large increase in stiffness in the post cracking stage was observed: but this was nearly the same for all the fiber volumes studies (0.5% to 1%). The damping values exhibited by SFRC beams showed significant scatter. Researchers concluded that the average in the uncracked state, applicable to design of machine foundation is 1% critical.

Equation are also formulated from the test results to estimate thedynamic stiffness of beams in post cracking stage for use in the designs involving SFRC elements in blast and earthquake resistant structures.

Bayasi Z. et al (1989), Studied Optimum use of Pozzolanic materials in steel fiber reinforced concrete. They carried out the effects on fresh and hardened material properties for fly ash ca5used by substituting cement with fly ash and silica fume in steel fiber reinforced concrete were studied experimentally. The percentage substitution of cement ranged from 0 to 40% and from 0 to 20% for silica fume. The workability of fresh fibrous mixtures was characterized by measuring theinverted slump cone time. The hardened material was tested at 28 days under compression and flexural loads. The development of compressive strength with time was also assessed in steel fiber reinforced concrete incorporating fly ash. The generated test data were used todecide the optimum ranges of cement substitution with fly ash or silica fume in steelfiber reinforced concrete for achieving desirable fresh mix and hardenedmaterial characteristics.

Soroushian P. et al (1991), in their paper entitled 'Fiber-type effectson the performance of steel fiber reinforced concrete' have presented theresults of an experimental study on the relative effectiveness of differenttypes of steel fiber in concrete. A constant fiber volume fraction of 2% was used throughout this investigation. The fresh fibrous mixes were characterized by their slump, inverted slump-cone time and subjective workability, and the hardened materials by their compressive and flexuralload-deformation relationships. The authors have concluded that the overall workability of fresh fibrous mixes was found to be largelyindependent of the fiber type. The crimped fibers have produced only slightly higher slumps. Hooked fibers were found to be more effective than straight and crimped ones in enhancing the flexural and compressivebehavior of concrete. Under flexural loads, crimped fibers were slightly less effective than straight ones in improving the strength and energy absorption of concrete.

Lin Showmay Hsu. et al (1994), Studied Stress-Strain Behavior ofSteel-fiber High- Strength Concrete under Compression. They wereconducted a series of compression tests on 3 x 6-in. cylindrical specimensusing a modified test method that gave the complete stress-strain behavior for high-strength steel- fiber concrete with or without tie confinements. The volume fractions of steel fiber in the concrete were 0,0.5, 0.75, and 1 percent, respectively. Empirical equations are proposed herein to represent the complete stress-strain relationships of high- strength steel-fiber concrete with compressive strength exceeding 10,000psi. Various parameters were studied, and their relationships were experimentally determined. The proposed empirical stress- strain equations have been compared to actual cylinder tests under axial compression and were found to be in good agreement.

Nataraja. C. et al (1998 & 1999). Studied Steel fiber reinforced concrete under compression and Stress-strain curve for steel fiber reinforced concrete in compression. They have proposed an equation to quantify the effect of fiber on compressive strength of concrete in terms of fiber reinforcing parameter. In their model the compressive strength ranging from 30 to 50 MPa, with fiber volume fraction of 0%, 0.5%, 0.75% and 1% and aspect ratio of 55 and 82 were used. In all the modelsonly a particular w/c ratio with varying fiber content was used. The absolute strength values have been dealt with in all the models and thus are valid for a particular w/c ratio and specimen parameter.

Banja. et al (2001) Studied Investigation on the compressive strength of silica fume concrete using statistical

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methods. They studied theeffect of silica fume on the tensile and compressive strength of high performance concrete (HPC). They developed mathematical model usingstatistical methods to predict the 28- day Compressive strength of silica fume concrete with water-to cementations material (w/cm) ratios rangingfrom 0.3 to 0.42 and silica fume replacement percentages from 5 to 30. They have developed relationship between compressive strength and fiberreinforcing index that predicts 28-day compressive strength at any fiber content in terms of fiber reinforcing parameter and at any water-to- cementations material ratios.

3. MATERIALS

3.1CEMENT TEST

1. Specific gravity of cement = 3.15
2. Fineness of cement = 6%

3.2FINE AGGREGATE (M-SAND) TEST

Specific Gravity of Fine Aggregate = 2.57

3.3COARSE AGGREGATE TEST

Specific gravity of coarse aggregate = 2.79

3.4TEST ON STEEL FIBRES

Grade	Dia mm	Length mm	Type
Carbon steel	0.6	6	Hooked (soft)

Aspect ratio = 0.5

4. MIX DESIGN FOR CONCRETE MIX

Concrete mix design is an art of selecting suitable ingredients of concrete and determining their relative proportions with the objective of producing concrete of certain minimum strength and durability as economically as possible. Design of concrete mix requires complete knowledge of the various properties of these constituent materials and the properties of concrete in plastic condition.

CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER
1	1.5	2.9	0.36

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5. Compressive Strength Test

For compressive strength test cube specimen of dimension 150 x150 x 150 mm were cast for M 40 grade of concrete. Superplasticized 0.5 % to 0.7 % by weight of cement added .

% of Fibre	0 % fibres	0.5 % fibres	1 % fibres	1.5 % fibres
Compressive strength (N/mm^2)	48.34	51.45	52.34	55.45

Table 2 – COMPRESSIVE STRENGTH OF SFRC 0, 0.5, 1, 1.5 %

CONCLUSION

Concluded that compared to conventional concrete the 1.5 % of the steel fibre concrete have achieved more compressive strength compared to other 1.5% of steel fibre.

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