

REVIEW OF BAHAVIOUR OF STEEL FIBRE REINFORCED FLY ASH CONCRET

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ABSTRACT

Concrete is one of the most common materials used in the construction industry. In the past few years, many research and modification has been done to produce concrete which has the desired characteristics. Cementitious materials known as pozzolans are used as concrete constituents, in addition to Portland cement. There is always a search for concrete with higher strength and durability. In this matter, blended cement concrete with the incorporation of fibers has been introduced to suit the current requirements. Plain concrete has good compressive strength but has low tensile strength, low ductility and low fire resistance. To circumvent these shortcomings, extensive research by concrete technologist has led them to find a very promising concrete material called as fiber reinforced concrete.

A lot of research work has been done and is going on the use of steel fibers and also fly ash as cement replacement in enhancing different properties of concrete. Research work done by different researchers is discussed here in brief.

Keyword: - Concrete, Cementitious

1. INTRODUCTION

1. **Bayramov, C. Tasdemir and M. Tasdemir**, conducted this research to optimize the fracture parameters of steel fiber reinforced concretes to obtain a more ductile behavior than that of plain concrete. The effects of the aspect ratio (L/d) and volume fraction of steel fiber (V_f) on fracture properties of concrete in bending were investigated by measuring the fracture energy (G_F) and characteristic length (l_{ch}). For optimization, three-level full SFRC trial experimental design and response surface method were used. The results show that the effects of fiber volume fraction and aspect ratio on fracture energy and characteristic length are very significant.
2. **Koksal, Altun, Yigit and Sahin**, the trio investigated the changes on some mechanical properties of concrete specimens produced by using silica fume and steel fiber. The main objective of the

work was to obtain a more ductile high strength concrete produced by using both silica fume and steel fiber. Two types of steel fibers with aspect ratios (fiber length/fiber diameter) of 65 and 80 were used in the experiments and volume fractions of steel fiber were 0.5% and 1%. Addition of silica fume into the concrete was 0%, 5%, 10% and 15% by weight of cement content. Water/cement ratio was 0.38 and the reference slump was 120 ± 20 mm. Slump test for workability, air content and unit weight tests were performed on fresh concretes. Compressive strength, splitting tensile strength and flexural strength tests were made on hardened concrete specimens. Load–deflection curves and toughness of the specimens were obtained by flexural test performed according to ASTM C1018 standards. Flexural test on beam specimens were achieved using a closed loop deflection-controlled testing machine. The use of silica fume increased both the mechanical strength and the modulus of elasticity of concrete. On the other hand, the addition of steel fiber into concrete improved toughness of high strength concrete significantly. As the steel fiber volume fraction increased, the toughness increased, and high values of aspect ratios gave higher toughness. Thus, the toughness of high strength steel fiber concrete depends on silica fume content, the fiber volume fraction and the fiber aspect ratio.

2. LITRATURE SURVEY

Singh and Kaushik studied the fatigue strength of steel fiber reinforced concrete (SFRC). An experimental programme was conducted to obtain the fatigue-lives of SFRC at various stress levels and stress ratios. Sixty seven SFRC beam specimens of size $500 \times 100 \times 100$ mm were tested under four-point flexural fatigue loading. Fifty four static flexural tests were also conducted to determine the static flexural strength of SFRC prior to fatigue testing. The specimens were incorporated with 1.5% volume fraction of corrugated steel fibers. The results indicated that the statistical distribution of equivalent fatigue-life of SFRC was in agreement with the two-parameter Weibull distribution. They determined coefficients of the fatigue equation corresponding to different survival probabilities to predict the flexural fatigue strength of SFRC for the desired level of survival probability.

Banthia and Sappakittipakorn, in the opinion of these two researchers, crimped steel fibers with large diameters are often used in concrete as reinforcement. Such large diameter fibers are inexpensive, disperse easily and do not unduly reduce the workability of concrete. However, due to their large diameters, such fibers also tend to be inefficient and the toughness of the resulting fiber reinforced concrete (FRC) tends to be low. Hence, an experimental program was carried out to investigate if the toughness of FRC with large diameter crimped fibers can be enhanced by hybridization with smaller diameter crimped fibers while maintaining workability, fiber dispersability and low cost. The results showed that such hybridization, replacing a portion of the large diameter crimped fibers with smaller

diameter crimped fibers can significantly enhance toughness. The results also suggested that such hybrid FRC, fail to reach the toughness levels demonstrated by the smaller diameter fibers alone.

Mohammadi, Singh and Kaushik, studied properties of plain concrete and steel fiber reinforced concrete (SFRC) containing fibers of mixed aspect ratio. An experimental programme was planned in which various tests such as inverted cone time; Vee bee time and compaction Factor were conducted to investigate the properties of plain concrete and fiber reinforced concrete in the fresh state. Compressive strength, split tensile and static flexural strength tests were conducted to investigate the properties of concrete in the hardened state. The specimen incorporated three different volume fractions, i.e., 1.0%, 1.5% and 2.0% of corrugated steel fibers and each volume fraction incorporated mixed steel fibers of size $0.6 \cdot 2.0 \cdot 25$ mm and $0.6 \cdot 2.0 \cdot 50$ mm in different proportions by weight. Complete load deflection curves under static flexural loads were obtained and the flexural toughness indices were obtained by ASTM C-1018 as well as JCI method. A fiber combination of 65% 50 mm + 35% 25 mm long fibers can be adjudged as the most appropriate combination to be employed in SFRC for compressive strength, split tensile strength and flexural strength. They found better workability as the percentage of shorter fibers increased in the concrete mix.

Pant Avinash S, Parekar Suresh R. The results of six bending, shear and torsion tests on steel fiber reinforced rectangular concrete beams without web reinforcement are presented and discussed. The variable parameter is longitudinal steel at bottom only. The top reinforcement, aspect ratio and volume fraction of steel fibers kept constant for all the beams. From the tests conducted, it was found that the torsional strength is independent of longitudinal reinforcement. The experimental results were compared with the modes of failure proposed by Mansur and Mansur and Paramasivam under combined bending, shear and torsion for SFRC beams and Dr. V. Ramakrishna and Vijayarangan for beams without web reinforcement under combined torsion and bending. It is shown that experimental results compare favorably with the theoretical predictions.

Mansur and Mansur and Paramasivam, Based on the test results some of the researchers proposed empirical equations and also developed analytical models for the torsional strength of fiber reinforced concrete beams in pure torsion. Very little research work was reported on plain concrete rectangular beams and rectangular beams without web reinforcement under bending, shear and torsion. Many researchers carried out tests on reinforced concrete beams with longitudinal reinforcement and web reinforcement under bending, shear and torsion and proposed modes of failure and some empirical formulae. Comparatively fewer attempts were carried out on fiber reinforced concrete beams in bending, shear and torsion. Mansur [11] and Mansur and Paramasivam [12] carried out the tests on steel fiber reinforced concrete beams (without longitudinal and web reinforcement) in combined bending and torsion and in combined bending, shear and torsion respectively. They proposed two modes of failure as Mode 1 and Mode 2. They proposed two equations to predict the torsional strength of steel fiber reinforced concrete beams.

3. SELECTION OF INGREDIENTS AND MIX DESIGN

3.2.1 Cement:

Among the chemical constituents of cement, the most important ones are C_3A , C_3S and C_2S . The C_3A portion of cement hydrates more rapidly, thereby reducing the workability of fresh concrete. It also adsorbs the chemical admixtures quickly which leads to reduction in availability of those admixtures for comparatively slower setting components of cement viz., C_2S and C_3S . This further affects the workability of fresh concrete and also its rate of retention of workability.

Regarding particle size distribution, it may be noted that finer particles hydrate faster than coarser particles and hence contribute more to early age strength concrete; however, at the same time, the faster the rate of hydration may lead to quicker loss of workability due to rapid and large release of heat of hydration. However, with reference to, the standard FAC test methods for properties of cement such as standard consistency, setting times, heat of hydration, etc., have to be modified as FAC mix contains mineral and chemical admixtures, which affect these properties significantly.

3.2.2 Fine Aggregate (Sand):

River sand is used as a fine aggregate. Among various characteristics the most important one for FAC is its grading. Coarser sand may be preferred as finer sand increases the water demand of concrete and very fine sand may not be essential in FAC as it usually has larger content of fine particles in the form of cement and mineral admixtures such as fly ash, silica fume etc. Also the water demand because of addition of fiber. The sand particles should also pack to give minimum void ratio, as the test result show that higher void content leads to requirement of more mixing water.

Properties such as void ratio, gradation, specific gravity and bulk density have to be assessed to design a dense FAC mix with optimum cement content and reduced mixing water.

4. EXPERIMENTAL PROGRAM

4.1 Aim of Experimental Work: The primary aim of this experimental program is to study the effect of silica fumes and fly ash content on the mechanical properties and non-mechanical properties of Steel fiber reinforced Concrete. Fly ash is used as mineral admixture and effect of different amount of Fly ash on the strength and durability related properties are studied. Also the effect of Fly ash on the workability characteristic of Steel fiber reinforced Concrete and its suitability for the construction industry is studied.

In this experimental program the strength parameters of concrete with varied doses of silica fumes, fly ash and steel fibers are studied. The concrete mix selected for this is M30.

4.2 Investigation of Concrete Properties:

Comparative study of effect of silica fumes and fly ash on Steel fiber reinforced concrete is done as far as following stated tests are concerned.

- 1) Workability (slump test).
- 2) Compressive strength test.
- 3) Flexural strength test.
- 4) Split tensile strength test.
- 5) Effective porosity test
- 6) Saturated water absorption test
- 7) Combine Effect of Shear and Torsion test on beam.

After performing all above test on FAC, following points are discussed.

- Effect of fly ash on the above mentioned properties
- Effect of silica fumes on the behavior of concrete.
- Optimum dose of fly ash and silica fumes in concrete.
- For the optimum dose of fly ash and silica fumes finding out the optimum dose of steel fiber
- For the optimum dose of fly ash, silica fumes and steel fiber study the behavior of FAC beam under shear and torsion.

5. CONCLUSION

This chapter presents a summary of present study, the major conclusions and future scope of the investigation with the applications of SFRC.

Following conclusion are drawn based on the result discussed in the previous chapter:

1. The wet and dry density at 7 and 28 days has increased marginally for fly ash concrete over normal PCC. This may be due to partial cement replacement by fly ash, which dandifies the concrete because of its micro filler effect due to the relatively finer particle size.
2. The mechanical properties of concrete are enhanced with the addition of fly ash. All the properties of concrete like compressive strength, split tensile strength and flexural strength is increased. Also there is reduction in porosity as well as reduction in absorption capacity of the concrete as compared with normal concrete.

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