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Fracture Mechanism of Medium and High Strength Concretes

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ABSTRACT

The project aims to review tensile softening behavior of M-30 and M-70 grade ferroconcrete .Concrete is extremely much weak in tension but by addition of randomly oriented steel fibers will change the behavior from brittle to ductile. Within the present work ,the steel fibers were added at the quantity fraction, being 0%,1%&,2%,3% to the traditional strength concrete and high strength concrete. the consequences of steel fibers on the tensile behavior of high and normal strength are investigated.Within the project work the tensile behavior of concrete reinforced with steel fiber contents was assessed performing direct tensile tests .The fracture energy of conventional SFRC was independent of the specimen size. The fracture energy of SFRC with high strength matrix and normal strength matrix was hooked in to the lastingness of the steel fibers. From the results found that with a rise differently of fibers the tensile softening behavior increases and fracture energy also increases.

Keywords: Concrete, Fracture Mechanism, M-30 and M-70 grade ferroconcrete

1. Introduction

Concrete may be a material containing Portland cement ,water, coarse aggregate and fine aggregate. The resulting material may be a stone like structure which is made by the reaction of the cement and water. This stone like material may be a brittle material which is robust in compression but very weak in tension. This weakness within the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and eventually , the member breaks. The formation of cracks within the concrete can also occur thanks to the drying shrinkage. These cracks are basically micro cracks. These cracks increase in size and magnitude because the time elapses and therefore the finally makes the concrete to fail.With most natural aggregates, it's possible to form concretes upto120 MPa compressive strength by improving the strength of the cement paste, which may be controlled through the selection of water-content ratio and sort and dosage of admixtures.

However, with the recent advancement in concrete technology and therefore the availability of varied sorts of mineral and chemical admixtures, and special super plasticizer, concrete with a compressive strength of up to 100 MPa can now be produced commercially with a suitable level of variability using ordinary aggregates These developments have led to increased applications of high-strength concrete (HSC) all round the globe.

HSC offers many advantages over conventional concrete. The high compressive strength are often advantageously utilized in compression members like columns and piles. Higher Compressive strength of concrete results reduction in column size and increases available floor space. HSC also can be effectively utilized in structures like domes, folded plates, shells and arches where large in-plane compressive stresses exist. The relatively higher compressive strength per unit volume, per unit weight also will reduce the general load on foundation of a structure with HSC. Also, the inherent techniques of manufacturing HSC generate a dense microstructure making ingress of deleterious chemicals from the environment into the concrete core difficult, thus enhancing the long-term durability and performance of the structure. Since the introduction of concrete with a compressive strength of 62 MPa in columns, shear walls and transfer girders of the reservoir Place in Chicago in 1975.

2. Uniaxial Tensile Test

The tension test is one of the most commonly used tests for evaluating materials. In its simplest form, the tension test is accomplished by gripping opposite ends of a test item within the load frame of a test machine. A tensile force is applied by the machine, resulting in the gradual elongation and eventual fracture of the test item. During this process, force-extension Data a quantitative measure of how the test item deforms under the applied tensile force, usually are monitored and recorded. When properly conducted, the tension test provides force- extension data that can quantify several important mechanical properties of a material.

These mechanical properties determined from tension tests include, but are not limited to, the following:

- Elastic deformation properties, such as the modulus of elasticity (Young's modulus) and Poisons ratio.
- Yield strength and ultimate tensile strength.
- Ductility properties, such as elongation and reduction in area
- Strain-hardening characteristics.

These material characteristics from tension tests are used for quality control in production, for ranking performance of structural materials, for evaluation of newly developed alloys, and for dealing with the static-strength requirement of design.

The basic principle of the tension test is quite simple, but numerous variables affect results. General sources of variation in mechanical-test results include several factors involving materials, namely, methodology, human factors, equipment, and ambient. methodology of the tension test and the effect of some of the variables on the tensile properties determined.

The following methodology and variables are discussed:

- Shape of the item being tested.
- Method of gripping the item.
- Method of applying the force.

Determination of strength properties other than the maximum force required to fracture the test item.

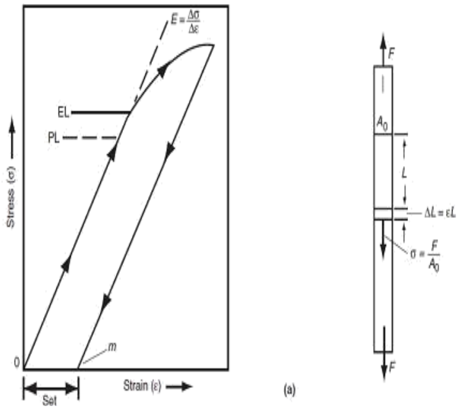

Fig 1.0 Stress-strain behavior in the region of the elastic limit. (a) Definition of σ and ε in terms of initial test piece length, L, and cross-sectional area, A0, before application of a tensile force, F. (b) Stress-strain curve for small strains near the elastic limit (EL)

Crack Formation

Fracture mechanics is an energy based method, in which the formation of cracks requires that the material must absorb some amount energy (Bazant and Planas 1998) associated with the resistance of that material (Anderson 2005). This energy requirement is important, because it implies that if it is not met the material will not fracture even after the design strength is met (Bazant and Planas 1998).

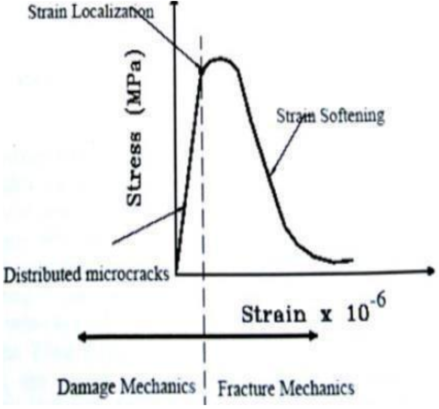

Fig 2.Tensile softening curve

MODES OF FRACTURE FAILURE:

A crack front in a structural component is a line usually of varying curvature.

Thus, the state of stress in the vicinity of the crack front varies from one point to another.

MODE I – it is the opening mode and the displacement is normal to the crack surface.

MODE II – it is the sliding mode and the displacement is in plane of the plate (the separation is antisymmetric and the relative displacement is normal to the crack front).

MODE III – it is the tearing mode and the displacement is parallel to the crack Front.

EXPERIMENTAL PROGRAM:

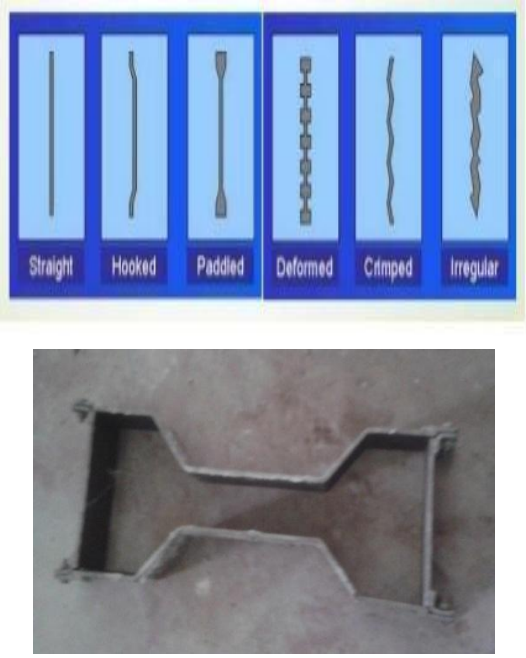

Fig-3 Types of Steel fibers & Specimen mould shape

3. Test Setup and Specimen

The dimensions of the test specimen were chosen to be representative of actual structural Element and to provide a cross section large enough to place various types and amounts of Fiber .The load introduction system was designed to prevent the development of eccentricities or unexpected end rotations. Rigid end conditions were chosen as the best solution from a constructive point of view.

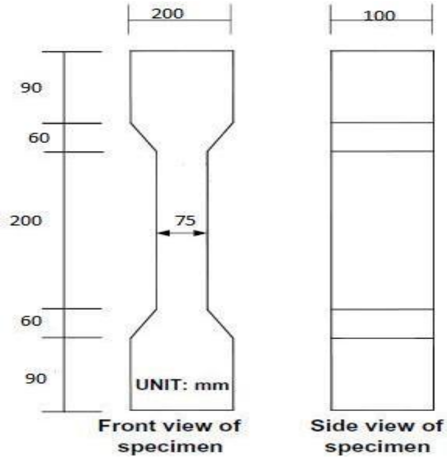

Fig-4 dimensions of specimen

Table 1:Failure loads of M30 and M70 with variation in% of fibers

Appendix A. GRADE **Appendix E. CONCRETE**	**Appendix C. % OF FIBER**	**Appendix D. FAILURE LOAD(KN)**
Appendix G. M30	**Appendix H.** 0	**Appendix I.** 12
	Appendix J. 0.5	**Appendix K.** 24.5
	Appendix L. 1	**Appendix M.** 26.06
	Appendix N. 1.5	**Appendix O.** 27.4
Appendix P. M70	**Appendix Q.** 0	**Appendix R.** 24.304
	Appendix S. 0.5	**Appendix T.** 24.5
	Appendix U. 1	**Appendix V.** 26.45
	Appendix W. 1.5	**Appendix X.** 35.28

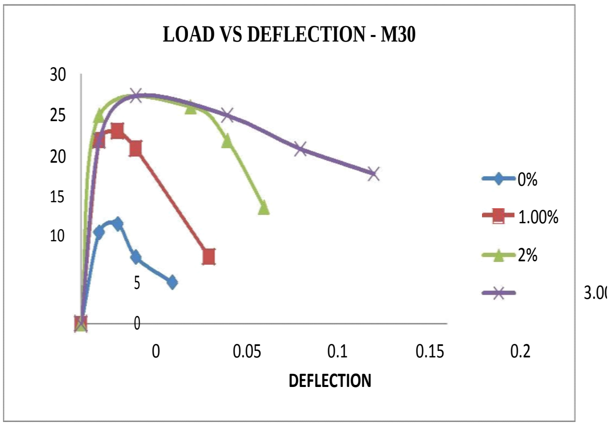

Fig :5.1:Load vs Deflection for M30(0%,1.0%,2.0%,3.0%)

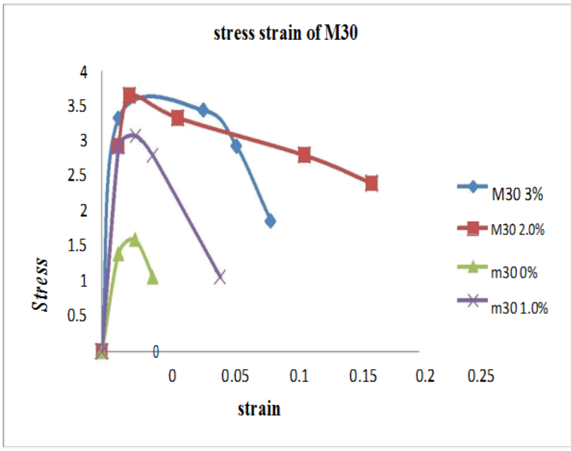

Fig-5.2: Stress vs Strain of M30 (0%, 1%,2%,3%)

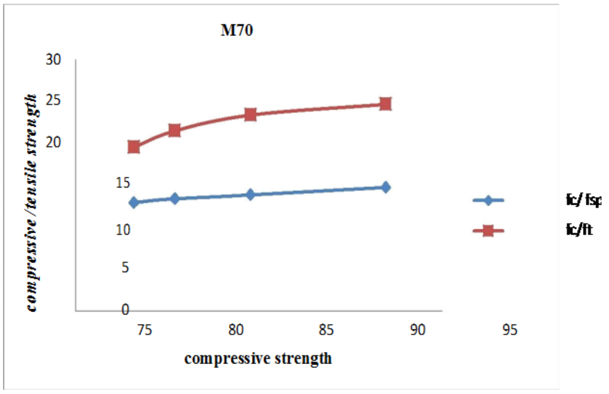

Fig-5.3: Variation of compressive /tensile strength ratio with compressive StrengthM70.

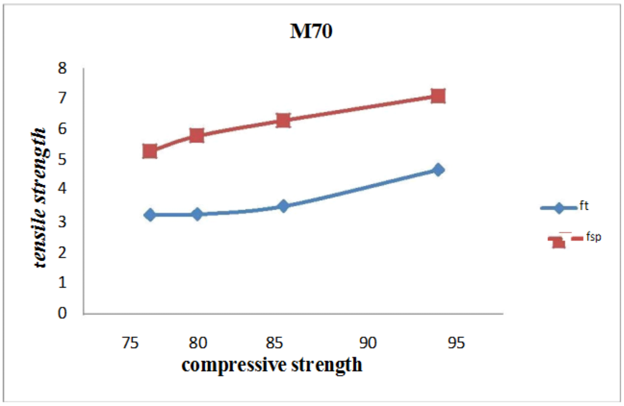

Fig 5.4: Relation between compressive strength and tensile strengths(ft)M70

4. Conclusions

- The proposed test method for measuring direct lastingness minimized the eccentricity during loading.
- The first crack strength and whole post cracking behavior were mainly influenced by the quantity of fibers Fracture energy increases with a rise differently of steel fiber both in high strength concrete and normal strength concrete.
- higher the quantity fraction of fibers, the upper the utmost post-cracking Stress. It decided that the uni-axial lastingness was 62.1% smaller than split lastingness for 0% replacement and 55.95% smaller for 1.0%replacement and 59.4% smaller for two replacement and 64.2% smaller for 3.0% replacement these for top strength concrete.
- It decided that the uniaxial lastingness was 68.25% smaller than split lastingness for 0% replacement and 61.32% smaller for 1.0 %replacement and 63.2% smaller for two replacement and 68.84% smaller for 3.0% replacement these for normal strength concrete .
- The ratios of split lastingness to compressive strength and uniaxial lastingness to compressive strength increased as compressive strength increased.
- Form the results it had been proved both in high strength concrete and normal strength the post cracking increase.

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