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Study of the factor governing Characterization of Self Compacting Engineered Cementitious Composites under Tension

KEYWORDS: Self compacting ECC, Recron Fiber, Preparation of Specimens – Material Used - Test Results – Derived Properties - Conclusion.

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ABSTRACT The Fiber Reinforced concrete(FRC) can be categorized into conventional Fiber Reinforced Cementitious Composite(FRCC) and High Performance Fiber Reinforced Cementitious Composite(HPFRCC). FRCC shows a tension softening behavior after first cracking, whereas HPFRCC develops multiple cracking and a strain hardening behavior. Compared to plain concrete and conventional FRCC, HPFRCC shows improvement in ductility. By tailoring some of the properties in cementitious composites a new type of HPFRCC known as Engineered Cementitious Composites (ECC) has been developed.

I. NTRODUCTION

Tensile strain determined from a standard beam test has questionable validity. Also when material used is subjected to shear, direct tensile behaviour of SCECC is needed for structural design. The basic difference between ordinary concrete, FRC and SCECC can be seen by their uniaxial stress-strain curve. Uniaxial tension test is also needed for proper material characterization of SCECC.

Although uniaxial tension test is very simple in concept, it requires attention toward many test details like specimen alignment and post-crack stability. The use of uniaxial tension test for characterizing the properties of SCECC is much easier, since these specimens do not unload after first cracking. As a result, no sudden release of energy and no loss of stability occur during the strain-hardening stage up to peak load. The purpose of characterizing the tensile stress-strain behavior of SCECC is to obtain constitutive relations of the material that can be utilized by structural engineers for structural design. For truly strain-hardening ECC, the proper characterization of the post-cracking behavior is in terms of stress-strain relationship at least during the strain-hardening stage as the microcracks appear as inelastic damage spread over a volume of material. So the strain gauge should be long enough compared with the spacing between adjacent microcracks. For uniaxial stress-strain curve to be valid and useful for structural design, it is recommended that at least following information be included in a test report:

(a) Complete stress-strain curve
(b) Crack pattern & spacing at or beyond peak load and gauge length
(c) Crack opening (averaged over several crack) during strain-hardening.

II.PREPARATION OF SPECIMENS

Considering the fiber orientation effect, it is decided to prepare Briquette specimens. As in the original Briqutte specimen there was a sudden change in cross sectional area, it is modified here such that the cross section changes gradually. In addition to the direct tension specimens, cylindrical specimens are also can prepare to measure indirect tensile strength.

1) Constitute Materials

Cement and Fine Aggregates:

- To prepare the samples, J.K.Lakshmi 53 grade ordinary Portland cement is used. As particle size of aggregate affects fiber orientation and hence resulting properties of composite, fine silica sand passing through 300 sieve obtained from local river is also used in proper proportion with cement

Water:
As a constituent of matrix, simple tap water available in laboratory is used. Water quantity is taken with reference to cement content.

Super Plasticizer:
For preparing mix with a higher w/c ratio, super plasticizer is needed for good workability of matrix in SCECC. For this study purpose, super plasticizer is used. Glenium sky 777 brand of BASF Company is used in study of w: c ratio variation used for the study of s/c ratio variation.

Fiber:
As mentioned earlier the scope of the study is limited to use of Recron 3S fibers only. Recron 3S fibers are manufactured by Reliance Industries. It is polyester type synthetic fiber. Its technical data is given in Table 5.2.

TABLE I
PROPERTIES OF RECRON 3S FIBERS

Length (mm)	Equivalent Diameter (μ mm)	Tensile Strength (kg / cm2)	Modulus of Elasticity(N/mm2)
12	30-36	4000-6000	17250

Fig.1

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III. TEST RESULTS OF SPECIMENS

To have 1D effect of fiber orientation, extended briquette type specimens are prepared. The cross section of briquette in gauge length is kept as 25 x 25 mm with overall length of 180 mm. As only one of specimen dimensions is more than 3 times a fiber length (12.5 mm), it is called 1D fiber orientation. Specimens are prepared using the Iron mould as shown in Fig. 1. The gauge length is kept as 100 mm. Upper and lower portion are kept of such a shape so that it can easily fit into the fixture as shown in Fig. 2.

Fig.2

Fig.3

For curing of samples, they are placed into water for 28 days. After 28 days, samples are tested on Material Testing System (MTS) under displacement control at a rate of 0.005 mm/second. Results are evaluated from automatically generated data sheet as shown in Table 1.

TABLE II
TEST RESULTS OF BRIQUETTE SPECIMENS

Type	No	Failure Load	Direct Tensile Strength	Strain (%)	Strain Hardening
SCECC	1	3381.5	5.41	0.54	NO
	2	3105.9	4.96	0.41	
	3	2516.2	4.03	1.76	
ECC	1	1565.5	2.51	1.90	YES
	2	1774.4	2.84	2.26	
	3	1397.5	2.24	0.46	

From the above result we can conclude that SCECC first crack strength is much higher than ECC, while the multiple crack and crack width control cannot be seen in SCECC results compare to the ECC result.

To have an idea of mode of failure, photographs of failure pattern comparison between ECC and SCECC are shown in Fig. 3.(a) SCECC Samples does not show multiple cracking and strain-hardening behavior Fig. 3(b).

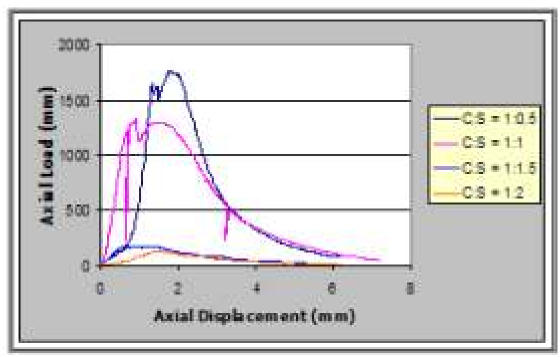
(a) ECC Specimen **(b) SCECC Specimen**

Fig. 8.3 Failure Patterns Comparison in Specimens

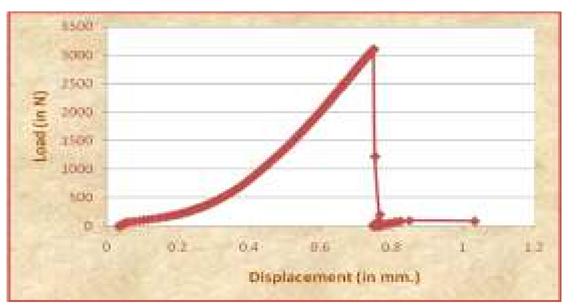
IV. DISCUSSION OF TEST RESULTS

To develop SCECC, there were many compromises can be done in material proportion and quality. The Briquette specimen Being small in size, and easy to handle during the testing and consume less material in casting. Results of direct tension test performed on briquette specimens are presented in Table 8.1. The SCECC gives more strength then ECC. And from Fig. 8.3 one can say that ECC matrix is very poor, so it can not gives strain hardening phenomenon. Very small initial displacement of actuator without increase in load was observed due to setting of grips into specimen ends firmly but that was cancelled and adjusted to zero to get actual displacement of specimen. Load-Displacement curves comparison between SCECC and ECC are shown in Fig. 8.10. Strain hardening can not be seen in these graphs for the matrix with ECC matrix. Briquette specimens are truly one dimensional as most of the fibers are aligned towards loading direction and are fully effective in load resisting mechanism and pull out action. The microscopic defects trigger the formation of matrix crack at so-called first crack stress. As the first crack forms, the fibers bridge it, transmitting tensile stresses across the crack surface. But in this matrix proportion no strain hardening developed in SCECC specimens.

V .LOAD-DISPLACEMENT RESPONSE OF BRIQUETTE SPECIMENS



RESULTS OF ECC



RESULTS OF SCECC

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