V-121 NUMERICAL ANALYSIS OF FLEXURAL BEHAVIOR OF SIFCON

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1. INTRODUCTION

Plain concrete is the inherently brittle failure which occures under tensile stress system. Main purpose of using fibers in cement based materials is to increase the toughness or tensile strength. However, the mixing turns out to be difficult when the volume of fraction of fibers reaches 2 % or more. SIFCON (slurry infiltrated fiber concrete) is a new material which overcomes this difficulty by pre-placing fibers in the mold instead of mixing. Compared to the SFRM (steel fiber reinforced concrete), SIFCON exhibits outstanding strength and toughness. Yet, as it is a relatively new material, little is reported about the mechanical properties. The object of this research is to evaluate the experimental flexural response of SIFCON specimens using the numerical method.

2. PROCEDURE OF THE NUMERICAL ANALYSIS

Fig.1 shows theoretical model for the numerical analysis. Fig.2 shows the flow chart for the numerical analysis.

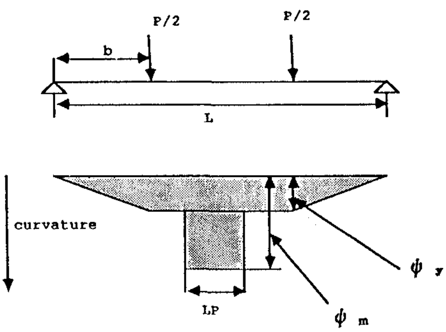

Fig.1 Theoretical model for the analysis

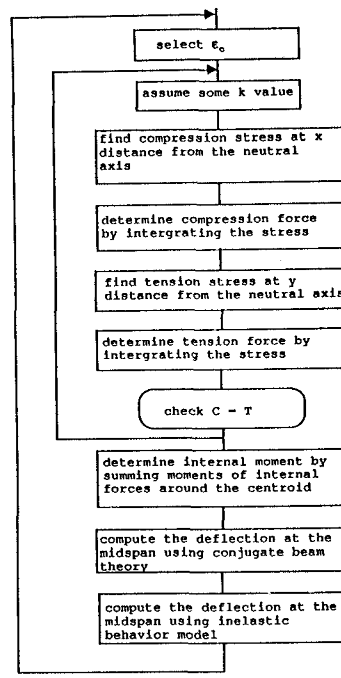

Fig.2 Flow chart

The numerical analysis consists of two steps.
1) The first step is to determine the neutral axis at which the compression force is in balanced with the tension force. The compression (or tension) force is calculated by integrating the stress from the neutral axis to the extreme compression fiber (or the extreme tension fiber).
The compression test was performed on SIFCON cylinder specimens with dimensions of 3 x 6 in. (7.6 x 15.2 cm), to plot the stress-strain relationship in the compression zone. The tensile test was performed on specimens with dimensions of 2 x 3/8 x 12 in. (5.1 x 0.95 x 30.5 cm), to plot the stress-strain relationship in the tension zone.
2) The second step is to find the moment and compute the midspan deflection. Following conjugate beam theory and inelastic behavior model were employed to calculate the deflection.

$$DF1 = \Phi_{mid} \times (3L^2 - 4b^2)/24 \quad (1)$$

$$DF2 = \phi_y (3L^2 - 4b^2)/24 + (\phi_m - \phi_y) Lp (L - Lp/2)/4 \quad (2)$$

Where DF1 : deflection at the midspan by conjugate beam theory
Φ_{mid} : cuvature at the midspan L : span length
b : distance from the support to the loading point
DF2 : deflection at the midspan by inelastic behavior model
Lp : inelastic behavior region ϕ_m :the maximum curvature
ϕ_y : the curvature at the yield point

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3. The COMPARISON OF EXPERIMENTAL AND ANALYTICAL LOAD DEFLECTION RESPONSE

Fig.3 shows the typical compressive stress-strain curve obtained from SIFCON specimens. Fig.4 also shows the typical tensile stress-strain curve obtained from SIFCON specimens. Fig.5 graphs the theoretical and experimental load-deflection curves with 7.6 x 3.8 x 45.7 cm dimensions. The experimental curve is based on the average properties obtained from the load tests.

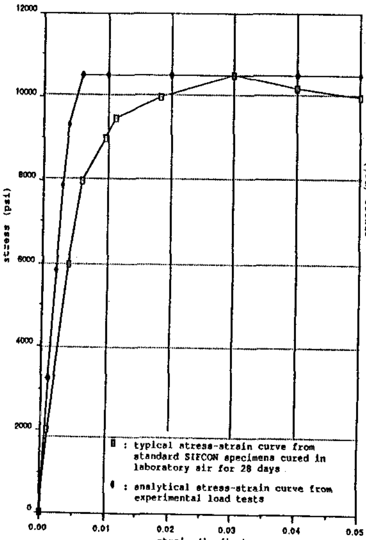

Fig.3 Compressive stress -strain curve

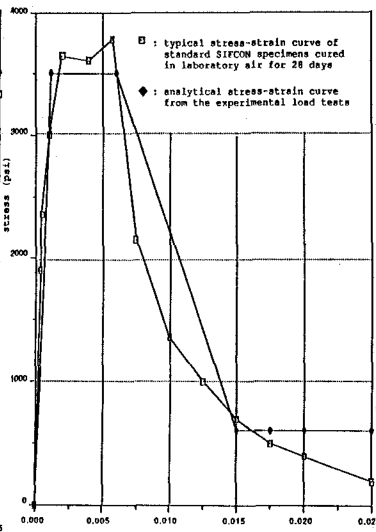

Fig.4 Tensile stress -strain curve

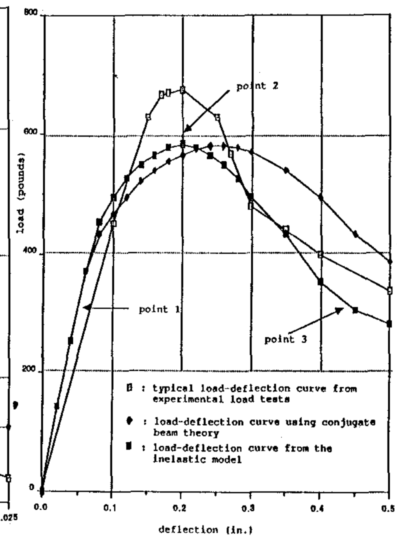

Fig.5 Theoretical and experimen -tal load-deflection curves

Fig.5 indicates that the analytical curve from the inelastic behavior model has approximately the same behavior as the experimental results. The difference in peak-load may be caused by the tensile stress being slightly smaller than the actual stress-strain response in the tension zone of flexural load test. Several points have identified on the curve that correspond to particular state of behavior (Fig.6). Point 2 represents the point of maximum load. At this point, the k value was 0.37, which expresses that 63 percent ofthe cross sectional area is in the tension zone. Point 3 represents the descending point, the k value was 0.21, which indicates 80 percent of the cross sectional area is in the tension zone. Compression strain at the top fiber was 0.006, just reached the peak-stress. Over 50 percent of the cross sectional area belongs to the descending branch of the tension zone. These results indicate that flexural failure of SIFCON specimens is generally controlled by the collapse of the tension zone.

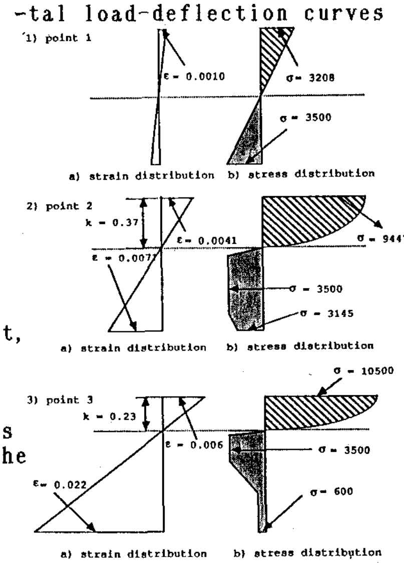

Fig.6 Stress-strain distribution representing particular states of behavior

3. CONCLUSION

Numerical analysis of SIFCON specimens leads to the following results.

1)The analytical load-deflection curve described by the inelastic behavior model ,is approximately identical to the experimental curve.

2) At the maximum point, compared to SFRM specimens, SIFCON specimens have a high k value due to the high bearing stress capacity of the tension zone. In the tension, SIFCON specimens have a load capacity about five times larger than SFRM specimens. This larger load capacity in the tension zone leads to a load capacity five times greater for flexural tests.