OSCILLATION LOADING EFFECT ON SERVICEABILITY OF RC FIBROUS CONCRETE

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1. Introduction

Recently, there has been much attention on the rapidly deteriorating infrastructure. The main cause of the decay of infrastructure is the deterioration of the materials used in the construction and repair of the structures. In many types of infrastructure, such as bridges, cracking behavior is the most important factor for the determination of durability and serviceability of structures. The experimental program deals with the mechanical properties most important for such materials, namely, fatigue crack initiation, propagation, restrict the crack widths, and hence, improve the serviceability of concrete structures using short fiber composite materials under oscillation loading.

2. Experimental program

All concrete mixtures were prepared with ordinary Portland cement with 3.15 specific gravity. The fine aggregate used in concrete was Natural River sand with 2.55 specific gravity and 2.3 fineness modulus. The coarse aggregate was crushed sand stone with 20-mm maximum size and 2.73 specific gravity. Two types of fiber, either polypropylene fibers or steel fibers (30 mm long) have generally been used in the specimens with either 0.5 % or 1.0 % by volume. RC T-Beam tested in flexural fatigue was subjected to a non-reversed loading. The load fluctuated between 10 % and 60 % of the ultimate load obtained in static flexure test. Cracks width was measured using a crack microscope reading to 0.02 mm. Before the commencement of the cyclic loading tests, each beam was loaded up to the upper limit statically.

3. Results and Discussion

Several versions of the fiber concrete show very strong and ductile behavior for serviceability design concept of RC fibrous concrete. Figure 1 shows the load deflection curves for concrete with different types of fibers. A significant difference in performance between steel and polypropylene fibers is found in the static flexural test. The flexural toughness is defined as the potential to absorb the energy with cracking. The area enclosed by load-deflection curve shows the flexural toughness. Japan Society of Civil Engineers recommends using the flexural toughness factor σ_b obtained by Eqn.1.

$$\sigma_b = T_b . l / \delta_{tb} . bh^2 \qquad (1)$$

Where, δ_{tb}: l/150 of span length, T_b: the area enclosed by load-deflection curves within the deflection equal to δ_{tb}, l: length of span, b: width of beam, h: height of beam.

The flexural toughness factors σ_b of concrete with polypropylene and steel fibers are 1.95 N/mm2 and 4.36, respectively. When the flexural toughness factor is used, the flexural toughness of concrete with polypropylene fiber is estimated as half as that with steel fiber. By comparison, the load deflection curve of the beam reinforced with different type of fibers as shown in Figures 2, it found that the performance of fibers was very similar at various fiber volume fractions. The largest increase in toughness was obtained when the concrete beams were reinforced with steel fibers followed by those reinforced with polypropylene fibers. It is clear that the flexural toughness factors σ_b can follow the toughness of concrete beams at failure. In the same time, the fiber has played an important role in decreasing fatigue damage degree, and delaying the damage process of concrete. Typical crack growth (width and number of cracks) with the increase in number of load cycles is shown in Figures 3 and 4. Figures 5 and 6 show the relationship between crack width and load. The crack width was measured at center of specimen. The specimen was made 5 mm raid to introduce the cracking. The control specimen was suddenly broken when the crack width reached at 0.5 mm. However, the concrete with fibers sustained the load of the half of maximum load at 2.0-mm crack width.

4. CONCLUSIONS

In spite of the flexural toughness can describe the toughness of concrete structural members with fibers at failure, it is not easy to use it in order to explain the propagation of cracking under service load. It is necessary to express the sustaining ability of load after cracking by an adequate estimating method.

Keywords: Serviceability, Cracking, Flexural toughness, Polypropylene fibers, Steel fibers

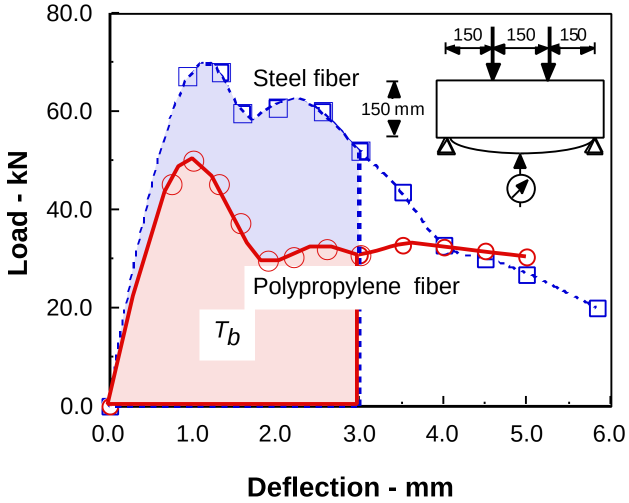

Figure 1: Load-Deflection curves for plain concrete reinforced with different type of fibers

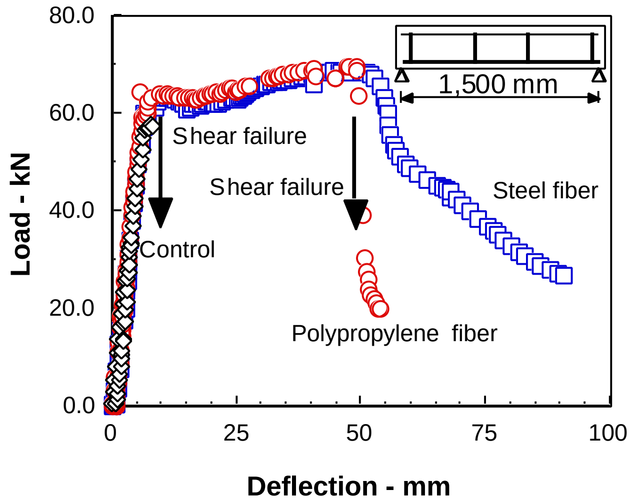

Figure 2: Load-Deflection curves for RC beams reinforced with different type of fibers

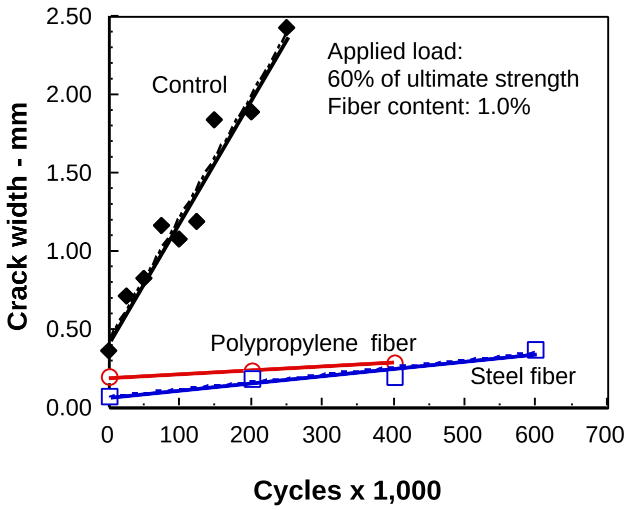

Figure 3: Effect of number of load cycles on crack width

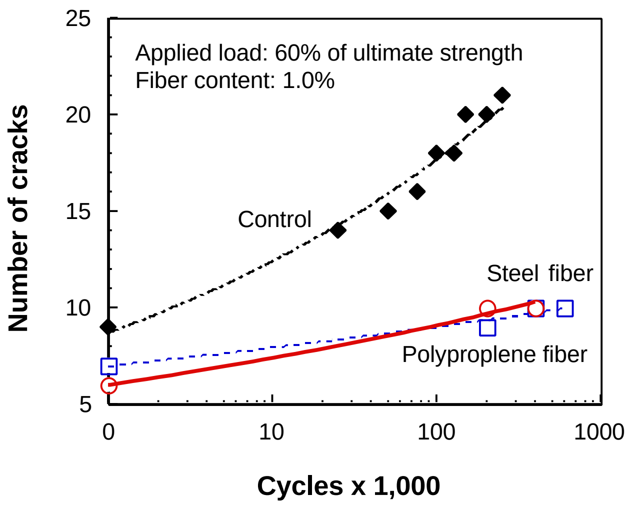

Figure 4: Effect of number of load cycles on number of cracks

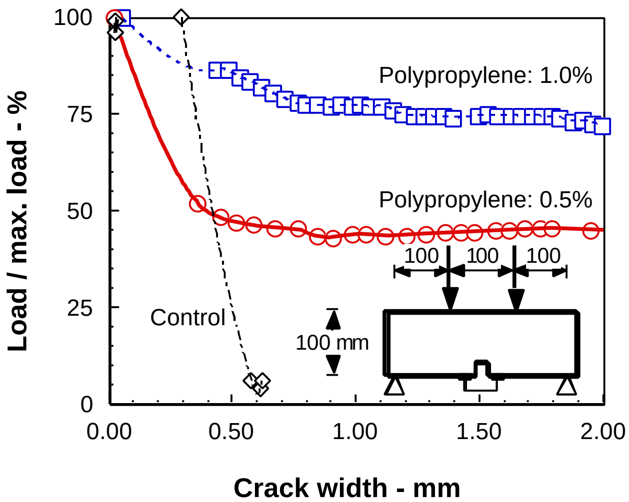

Figure 5: Effect of ratio of load / max. load on crack width

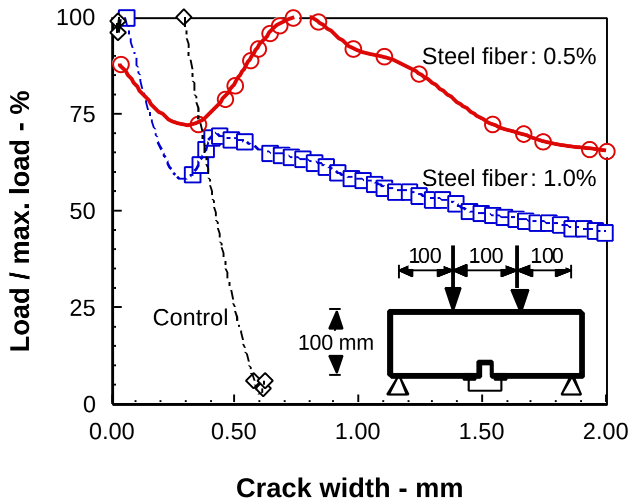

Figure 6: Effect of ratio of load / max. load on crack width