FLEXURAL BEHAVIOR OF FIBER-REINFORCED EXPANSIVE MORTAR

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1. INTRODUCTION

Fiber-reinforced and expansive concretes are two special types of concrete. Usually various types of fiber are added to concrete to enhance the toughness after cracking while expansive agent is usually utilized to chemically prestress the reinforced concrete members.

There has been the interest on the combination of fiber and expansive agent. To date, there is some research regarding this combination [1-4]. It has been reported that fiber can reduce the rate of expansion and shrinkage [1]. Effects of the amount of fibers and the content of expansive agent on tensile and compressive strengths have been reported by some researchers [1-4]. However, these reported results are still not enough to gain the concrete conclusion on the interactive effect. In this study, an attempt is put to more observation on the flexural behaviors of expansive fiber-reinforced concrete.

2. EXPERIMENTAL PROGRAM

Flexural behavior of fiber-reinforced expansive mortar with different dosages of expansive agent and contents of fiber were investigated. Water-binder ratio of 0.35 was selected to avoid effect of bleeding on the interface between mortar and fibers. The expansive agent to powder ratios were 0.05 and 0.1 in this experiment. 26mm-length steel fiber with indent shape was applied. Fiber contents were varied from 1% to 2.5% in replacement of a portion of sand in mortar so that paste content was same.

Cement, sand, and 85% of water were mixed together in first 120 seconds. Then, superplasticizer and the remaining water were added and mixing was continued for 120 seconds. Then fibers were gradually put into mortar while the mixing was continuing in order to prevent balling effect. All fibers were inserted to mortar within 60 seconds and the mixing continued for 60 seconds to make sure the uniformity of fiber-reinforced mortar.

The fiber-reinforced expansive mortars were then cast into the steel frameworks with size of 100mm×100mm×400mm. At 24 hours after casting, frameworks were removed and the specimens were kept in wet condition (wrapped by wet clothes) for 7 days, and then were subsequently kept in air-dry condition.

The bending test was conducted at the age of 28 days by four-point loading with 10-cm shear span. The load-deflection relationship of each specimen was recorded.

3. EXPERIMENTAL RESULT

3.1 Load Capacity

The load capacities of all the specimens are shown in Fig.1. The contrast effect of expansive agent on peak load can be observed. With 1% fiber content, the increase of expansive agent content from five to ten percent could improve the load capacity. In contrast, for 2.5% fiber content, the increase of expansive agent to powder ratio from five to ten percent resulted in notable reduction in peak load. Meanwhile, effect of the increase of the amount of expansive agent was not remarkable in case of 2% fiber content.

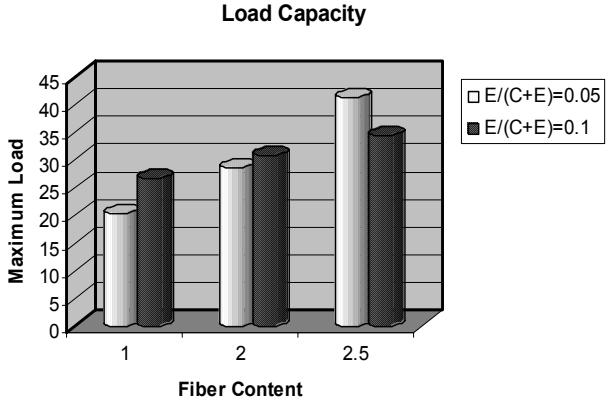

Fig.1: Effect of expansive agent content and fiber content on maximum load capacity

3.2 Load-Deflection Relationship

The load-deflection relationships are shown in Fig.2 and Fig.3. In both figures, comparison between the specimens with same amount of expansive agent is given. The stiffness increases with amount of fiber and is approximately same for those with same amount of

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fiber regardless of the amount of expansive agent. The displacement corresponding to maximum load of specimens with five percent expansive agent content increases with fiber content whereas the opposite trend can be observed in case of specimen with ten percent

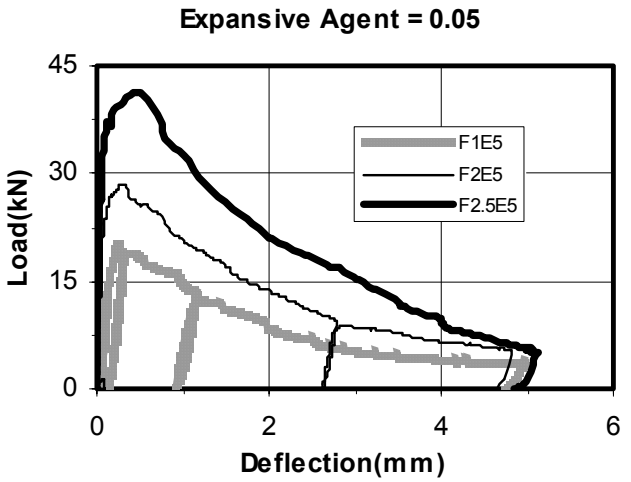

Fig.2: Load-deflection relationship of specimens with expansive agent to powder ratio of 0.05

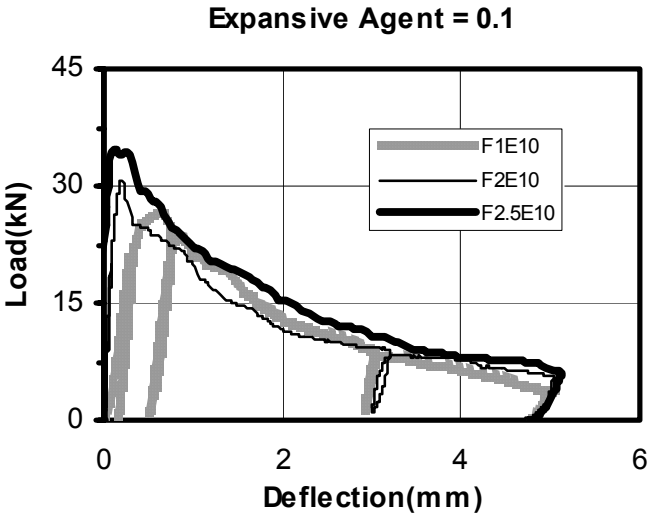

Fig.3: Load-deflection relationship of specimens with expansive agent to powder ratio of 0.1

expansive agent content [Fig.2-3].

Most interestingly, the peak load and toughness of specimen are almost same regardless of the amount of fibers in case of ten percent expansive agent. While those of specimen with expansive agent to powder ratio of 0.05 is greatly affected by amount of fiber. This suggests that efficiency of fibers on flexural behavior might be downgraded by too large expansion.

4. DISCUSSION

From above experimental results, the expansion of matrix seems to result in two main subsequences; prestress of fibers and degradation of bonding. These two mechanisms take place interactively. The prestress of fiber might increase load capacity in flexure. This prestress effect seems to increase with the amount of fibers. However, prestress would cause earlier slip of fiber and this prestress could be meaningless if the bonding between fiber and matrix is too much degraded by too large expansion.

As a result, the balance of these two effects should be carefully controlled and it might be expected that, for one type of fiber, there should be most suitable combination between amount of fiber and the expansive agent content.

5. CONCLUSION

- Prestress of fibers by expansive agent could increase load capacity of fiber-reinforced mortar; however, there is a limitation of maximum prestress level.
- The expansion downgrades bonding capacity of fibers and limits the allowable prestress in fibers.
- There should be the optimum combination of expansive agent and amount of fibers on the flexural behaviors.

6. REFERENCE

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