Experimental Investigation of Shear Behavior of Reinforced Concrete Beam Repaired with DFRCC at Cover Thickness

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ABSTRACT

Recently, DFRCCs (Ductile Fiber Reinforced Cementitious Composites), materials with remarkable ductility when compared to ordinary fiber-reinforced concrete (FRC), have been developed and studied actively in the US, Japan, and many European countries. The transformation of failure behavior from brittle to ductile is achieved by incorporating with fracture mechanics concept especially micro-mechanical models approach of cementitious composite materials in manufacturing ordinary fiber-reinforced composites. The purpose of this study is to accurately understand the shear behavior of DFRCC repaired RC beams. Using a four-point bending test, the shear strengths and shear stress-deflection relations of DFRCC repaired RC specimens are obtained. The results show that DFRCC can be effectively used for repairing materials for concrete structures.

1. Introduction

Recently, the construction materials used in civil engineering field are rapidly undergoing technological advances. For instance, to complement the disadvantages of cement-based construction materials such as brittleness of failure, Ductile Fiber Reinforce Cementitious Composite (DFRCC), a high performance cementitious composite with superior ductility or strain capacity is currently being studied actively in many technologically advanced countries. Unlike existing materials, DFRCC can delay its failure due to localizing of cracks by forming multiple micro-cracks with crack widths ranging 50"`80 micro-meters.Many different types of DFRCC have

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been developed and tried to find real applications. One of the most visible applications is repair of an old infrastructure because the materials can be used in an appropriate part in a structure.The purpose of this study is to accurately understand the shear behavior of DFRCC repaired RC beams. In this study, reinforced concrete (RC) beams without stirrups are repaired using the DFRCC for the cover thickness and two times the cover thickness at the bottom tension section to understand the repairing effect of DFRCC on RC beam under shear loading. Moreover, a control beam specimen which is not repaired with DFRCC is tested for comparison. Using a four-point bending test, the shear strengths and shear stress-deflection relations of DFRCC repaired RC specimens are obtained.

2.Experimental program

2.1 Outline of experiments

Reinforced concrete beams are repaired using the manufactured DFRCC for the cover thickness and 2 times the cover thickness at the bottom tension section of the specimens. Moreover, a control beam specimen which is not repaired with DFRCC is tested for comparison. A displacement-controlled load is applied to the specimens at a rate of 0.005 mm/sec. The data obtained from the experiment are then analyzed to determine the effectiveness of DFRCC in repairing RC beams. Table 1 shows the mixture proportion of DFRCC used in the experiment.

Table 1. Mixture proportion of DFRCC

DFRCC (W/C=0.45)	Material	Cement	Water	Fly Ash	Silica Sand	SP	MC	Fiber (Volume %)	Coarse Aggregate
	(%)	1	0.45	0.15	0.7	0.01	0.0018	2	-

2.2 Shear test setup and experimental results

Figures 1 and 2 show the schematic figure and photo of test setup, respectively. The specimen is considered to have reached failure if the applied load reached below 30% of the maximum load, at which point the loading is stopped. Figures 3 and 4 show the Shear stress versus averaged center deflection of unrepaired and DFRCC repaired specimen and Crack patter of unrepaired specimen and the DFRCC repaired specimen obtained from the experiments respectively.

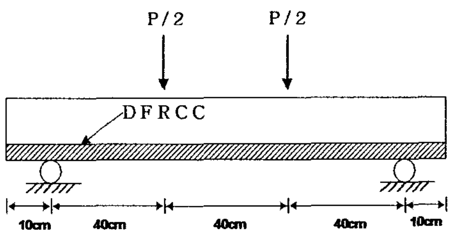

Figure 1. Schematic description of test setup

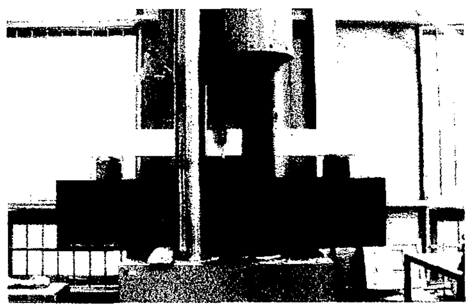

Figure 2. Photo of 4-point bending test setup

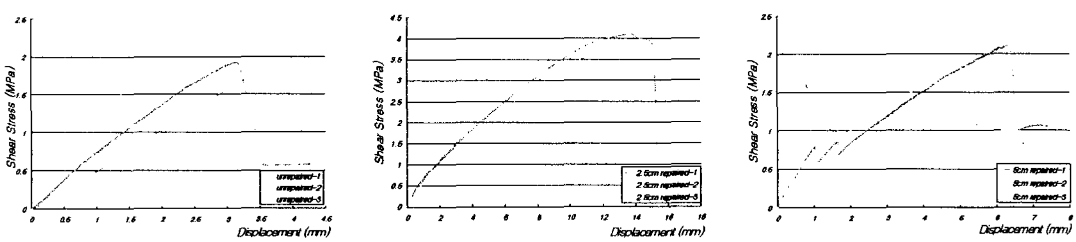

Figure 3. Shear stress versus averaged center deflection of unrepaired and DFRCC repaired specimen

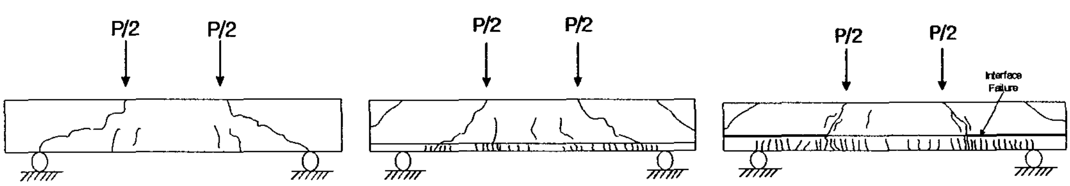

Figure 4. Crack patter of unrepaired specimen and the DFRCC repaired specimen

3.Conclusions

(1) The DFRCC repaired concrete specimen for its cover thickness showed higher shear strength and a more stable shear failure behavior than the unrepaired specimens.
(2) The DFRCC repaired specimen for two times its cover thickness showed similar shear behavior as the plain concrete beam due to the bond failure between the repaired DFRCC and original concrete interface.
(3) The shear strength and shear failure behavior in the DFRCC repaired specimen for two times cover thickness is lower and unstable than the DFRCC repaired specimen for the cover thickness, respectively.

Acknowledgement

Thisresearch was supported by a cooperative educational technology and development research program, "Hybrid FPR Rod Self-Monitoring System Analysis and Design Technology Development" (Grant No.: C103A1000009-03A0200-00940) from the Ministry of Construction and Transportation in Korea. The financial support is gratefully acknowledged.

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