Experimental Study of Shear Behavior in RC Members Based on Repair Thickness of DFRCC

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Background

- New Material that Overcomes the Brittle Failure Mechanism of Concrete
- DFRCC : Tougher and Stronger Cementititous Composite than Concrete
- Bridging Effect of Ductile Fibers produce Distributed Micro-Cracks with Width of 50～80㎛
- Study on Strengthening Effect of DFRCC

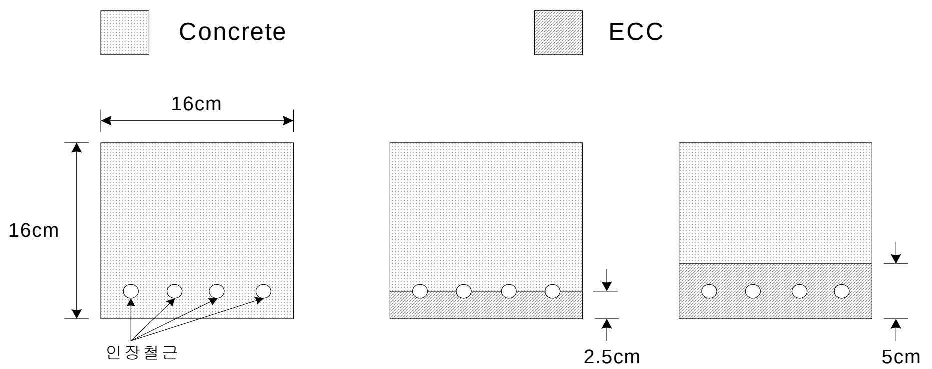
Experiment Details

Goal

- Shear Behavior of DFRCC Repaired RC Beam
- Repair Thickness Effect of DFRCC on RC Beam

Test Specimens

- Dimensions: Width 16cm, Height 16cm, Length 140cm
- Unrepaired RC Beam (Control Specimen)
- Cover Thickness Repaired w/ DFRCC RC Beam
- Twice Cover Thickness Repaired w/ DFRCC RC Beam



Material

- Cement : Domestic L Co. Type I Portland Cement
- Fiber : Japanese K Co. Ductile PVA(Polyvinyl-Alcohol) Fiber
- Domestic Silica Sand, Fly Ash, Superplasticizer, Metal Cellulose

Fiber Properties

Diameter (㎛)	Tensile St. (MPa)	Elongation (%)	E Modulus (GPa)	Vol. Percentage
39	1620	6	42.8	1.3

SP Properties

	Specific Wt.	Freezing Temp.
ADVA100	1.06kg/m^3	0°C

Mixture Content

DFRCC

- W/C=0.45
- Best Ductility and Strength from Trial Tests

Concrete

- Expected strength 300 kgf/cm^2
- Large Aggregate Size 19mm

ECC (W/C=0.45)	
Material	(%)
Cement	1
Water	0.45
Fly Ash	0.15
Silica Sand	0.7
SP	0.01
MC	0.0018
Fiber (Vol %)	2
Large Agg.	-

Concrete (W/C=0.54)	
Material	(%)
Cement	1
Water	0.54
Fly Ash	-
Sm. Agg.	1.75
SP	-
MC	-
Fiber (Vol %)	-
Large Agg.	2.13

Material Properties

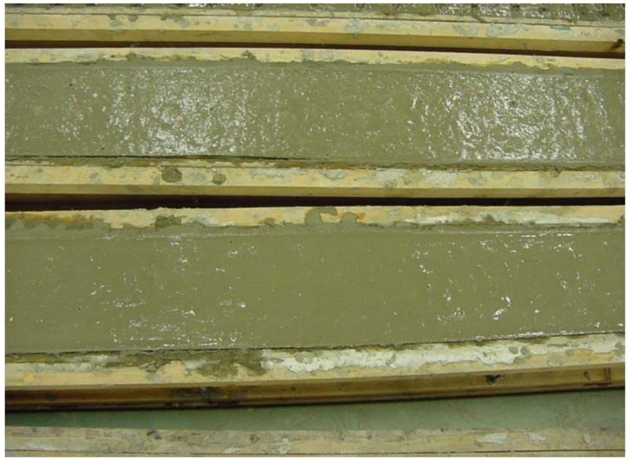
DFRCC and Concrete Properties

	DFRCC	Concrete
Comp. Strength (kgf/cm^2)	410	330
Tens. Strength (MPa)	5.95	2.50
Elastic Modulus (kgf/cm^2)	2.21×10^5	2.04×10^5

Specimens

- Casting

DFRCC Mixing



DFRCC Repaired Specimens

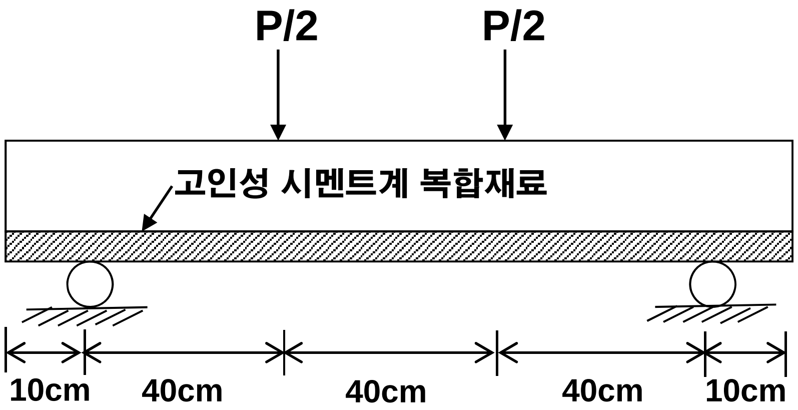
No. of Specimens

- Total 9 specimens (28 days dry cured)

Experiment

◆ 4 Point Bending Test

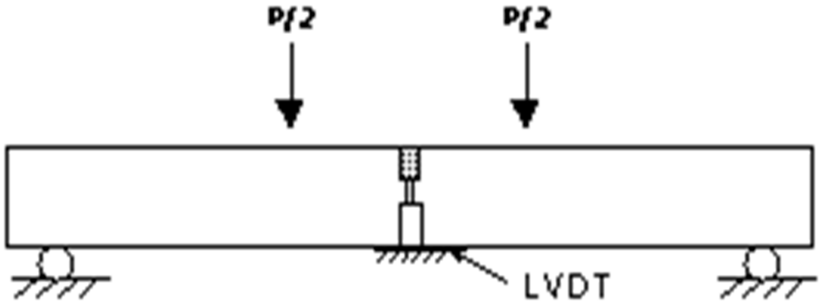
- 300 ton UTM
- Displacement Controlled 0.005 mm/sec

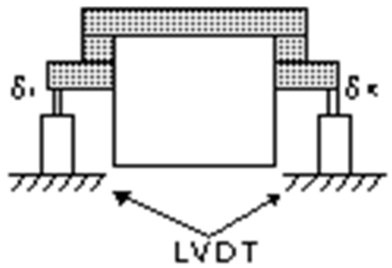


Experiment

◆ Displacement Data

- 2 LVDTs used





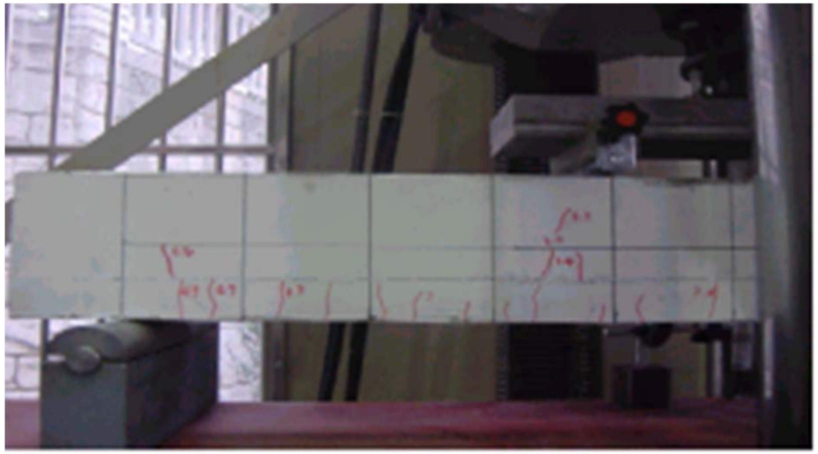
- Average Center Displacement

$$\delta_T = \frac{\delta_L + \delta_R}{2}$$

Experiment

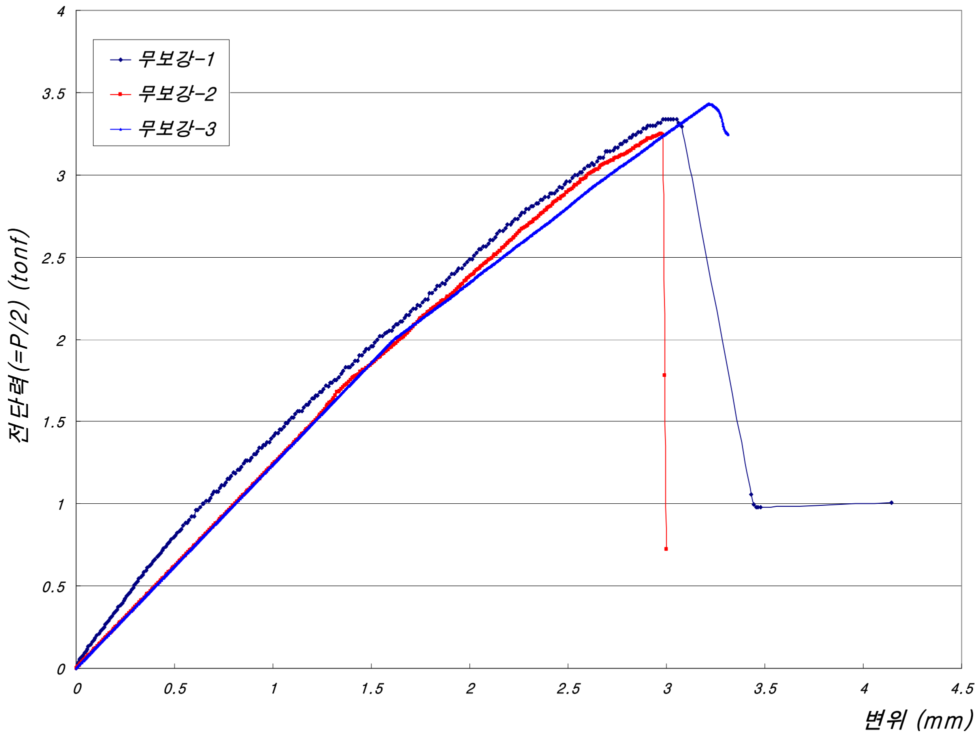
◈ Photographs of Experiment

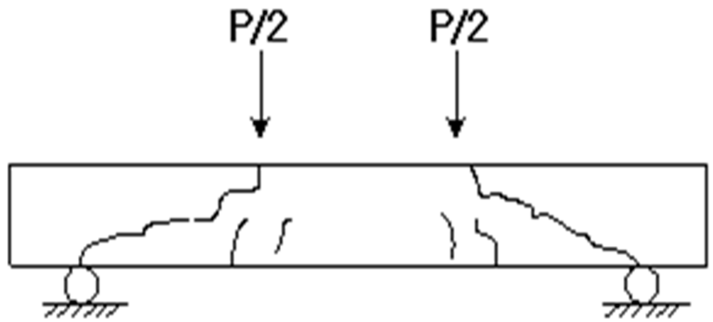
- Crack Formation and Propagation



Results

◆ Unrepaired Specimen

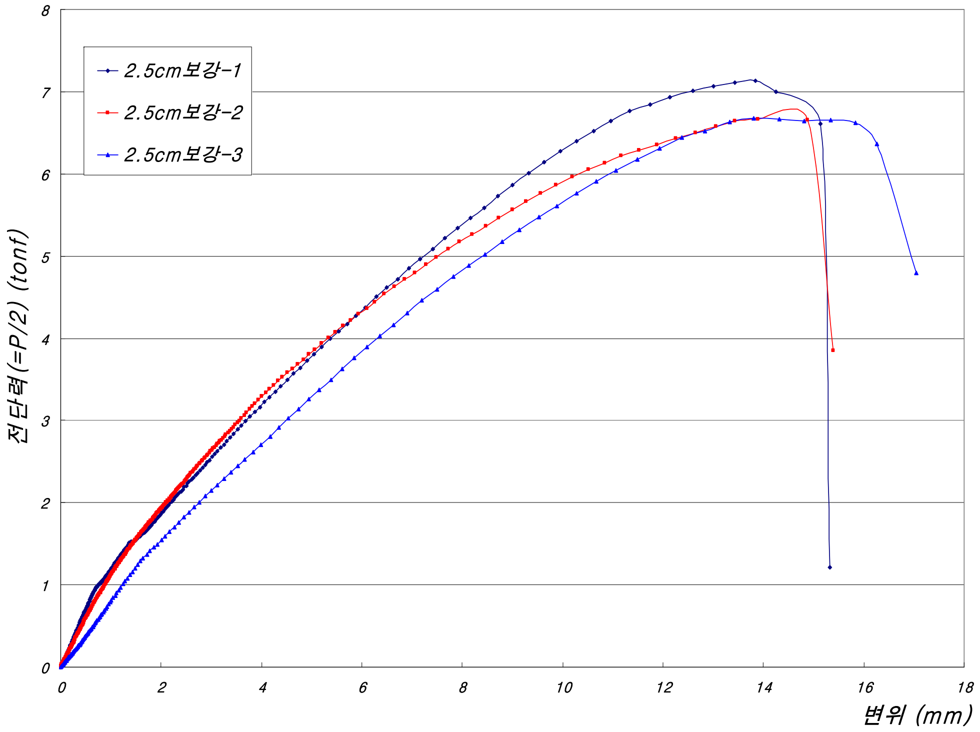


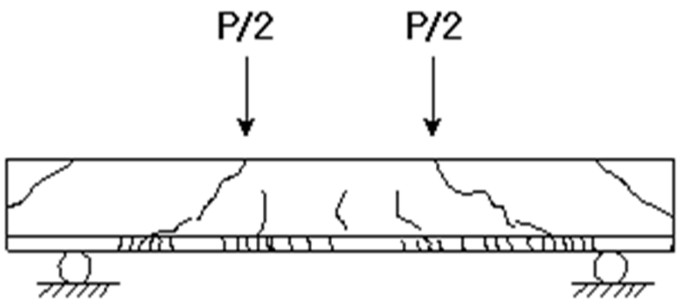


- Max Load of 6~7 tons
- Brittle Shear Failure
- Max. Center Deflection of 3~3.5 mm

Results

Cover Thickness Repaired w/ DFRCC (2.5cm)

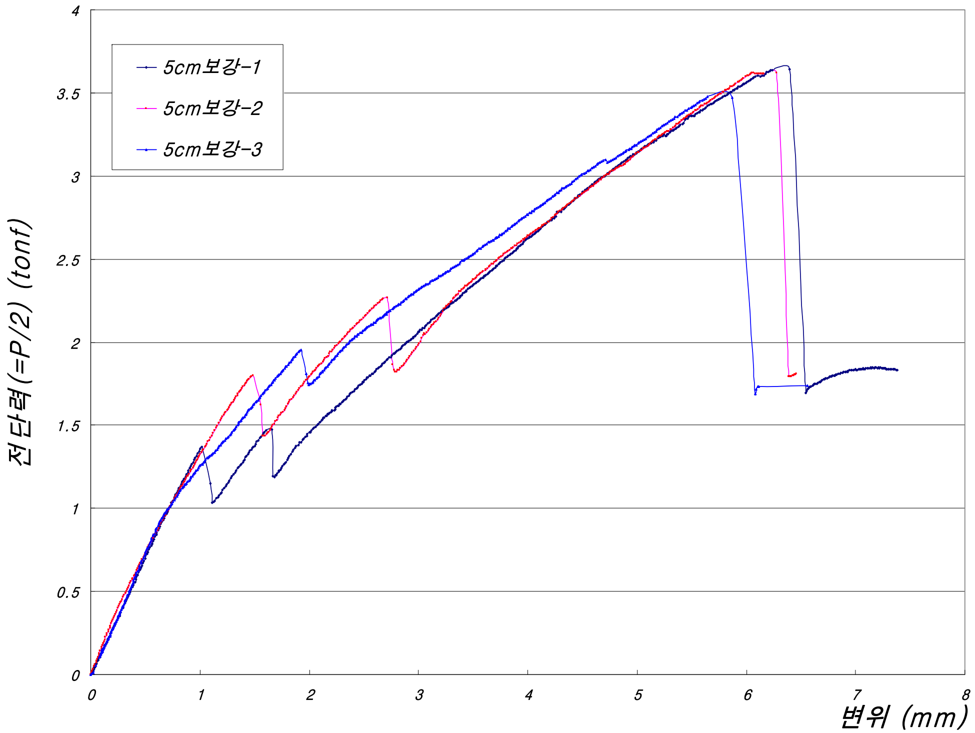


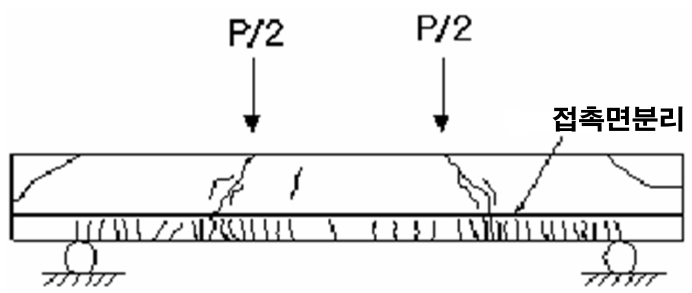


- **DFRCC Contributed Extended Failure**
- **Load of 12~14 tons**
- **Brittle Shear Failure**
- **Deflection of 14~15 mm**

Results

◆ Twice Cover Thickness Repaired w/ DFRCC (5cm)

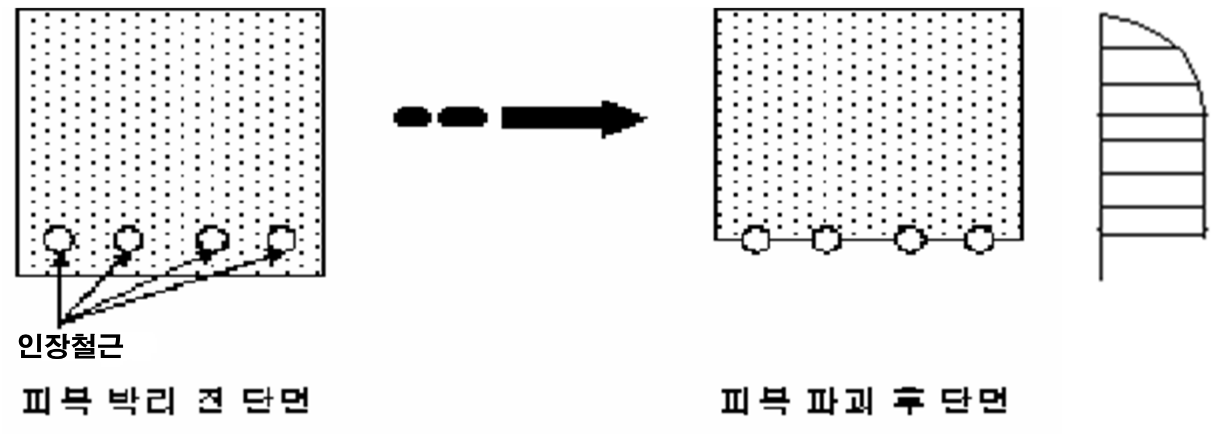




- Load of 6~7 tons
- Brittle Shear Failure
- Deflection of 6~7 mm
- Concrete & DFRCC Debonding Failure

Analysis

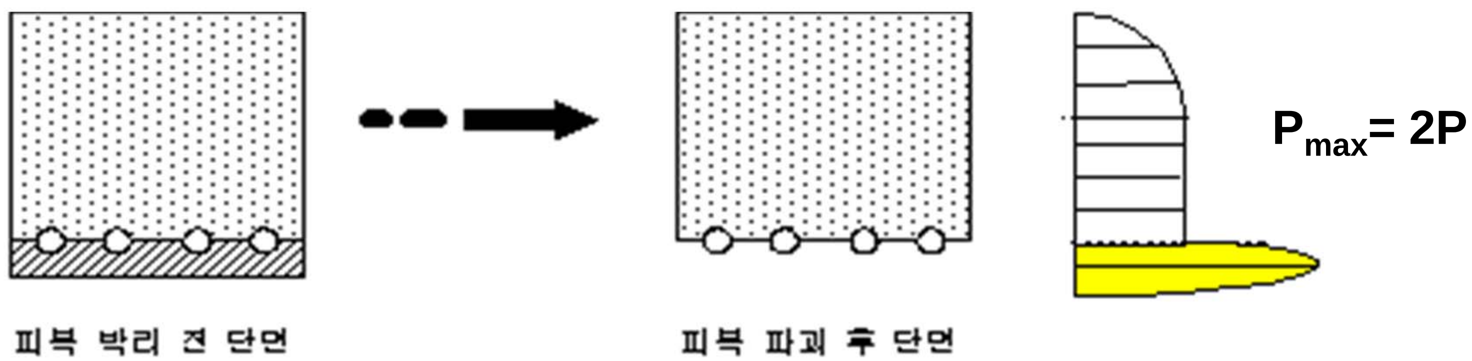
◈ Unrepaired Specimen



$P_{max} = P$

- Initial Crack Formation ➡ Propagation Toward Supports
- Brittle Shear Failure Mechanism

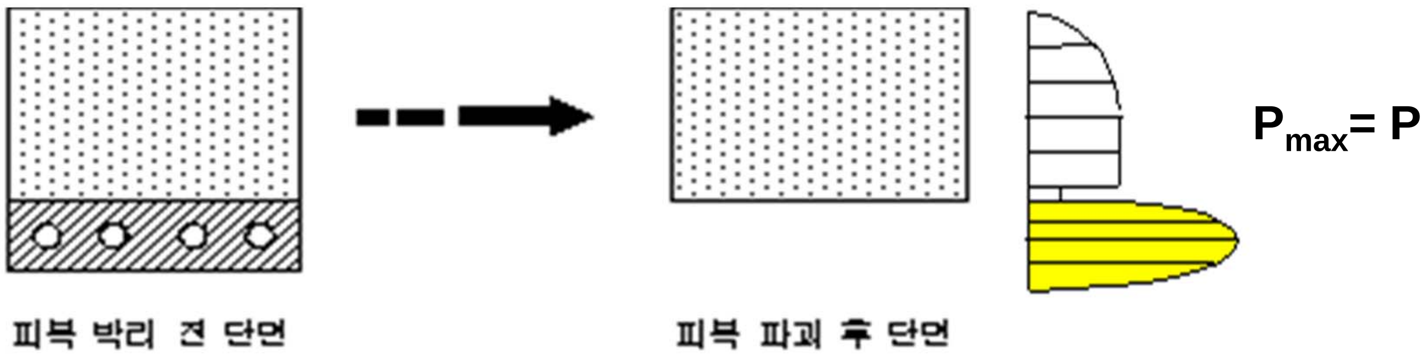
◈ Cover Thickness Repaired w/ DFRCC (2.5cm)



- Initial Crack Formation ➡ Transfer to DFRCC
  ➡ Formation of Distributed Micro-cracks
- Increased Shear Capacity due to DFRCC
- Stable Failure Mechanism

Analysis

◆ Twice Cover Thickness Repaired w/ DFRCC (5cm)



- Initial Crack Formation ➡ Transfer to DFRCC ➡ Debonding Failure
- Decreased Shear Capacity due to Weak Bonding Surface
- Plain Concrete Failure Mechanism

Conclusions

- **Unrepaired beam specimens showed brittle shear failure as expected in RC beam.**
- **Cover thickness repaired specimens showed higher shear strength and failed in more stable manner.**
- **Twice cover thickness repaired specimens had equal shear strength as unrepaired specimens due to debonding between DFRCC and concrete.**
- **DFRCC repaired specimens' shear capacity is controlled by the location of the bonding surface.**