

**Zeitschrift:** IABSE reports = Rapports AIPC = IVBH Berichte  
**Band:** 999 (1997)  
  
**Artikel:** Shear reinforcement of RC beams using carbon fiber sheets  
**Autor:** Mitsui, Yoshiyuki / Takeda, Koji / Murakami, Kiyoshi  
**DOI:** <https://doi.org/10.5169/seals-1116>

### **Nutzungsbedingungen**

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

### **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

### **Terms of use**

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

**Download PDF:** 18.01.2026

**ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>**

## Shear Reinforcement of RC Beams Using Carbon Fiber Sheets

### Yoshiyuki MITSUI

Professor  
Kumamoto University  
Kumamoto, Japan

Yoshiyuki Mitsui, born in 1940, received his D.Eng. degree in structural engineering from Osaka University in 1974.

### Kiyoshi MURAKAMI

Associate Professor  
Kumamoto University  
Kumamoto, Japan

Kiyoshi Murakami, born in 1957, received his D.Eng. degree in building materials from the University of Tokyo in 1986.

### Koji TAKEDA

Graduate Student  
Kumamoto University  
Kumamoto, Japan

Koji Takeda, born in 1967, received his M.Eng. degree in building materials from Kumamoto University in 1994.

### Hiromichi SAKAI

Manager  
Mitsubishi chemical Corp.  
Kitakyushu, Japan

Hiromichi Sakai, born in 1952, received his D.Eng. degree in building materials from Kumamoto University in 1994.

### Summary

An experimental study was conducted on shear reinforcement of reinforced concrete beam using carbon fiber sheets. The results indicated that ultimate shear strength of the strengthened beam is about 1.3 to 1.8 times higher than that of the virgin beam and similar shear-reinforcing effects of the sheets are obtained for the crack-damaged and afterwards repaired beam.

### Introduction

External epoxy-bonding of thin carbon fiber reinforced plastics sheets (hereafter called the CF sheet) is a superior technique for strengthening of existing reinforced concrete (RC) structures or repair of deteriorated RC ones since the CF sheet is light in weight, high in stiffness and strength and superior in durability, and also the bonding work is easy and not skilled. Authors have already performed experimental studies on flexural and shear reinforcement of RC beams using the CF sheets and presented the results that ultimate flexural strength of the strengthened beam is increased by about two times that of the virgin one and any shear cracks can not be observed in the shear-strengthened area of the beam (1,2). This paper presents the results of a further experimental study on shear reinforcement of RC beams using the CF sheets.

### Experimental

The configuration and bar arrangement of the RC beam specimen is shown in Fig.1. The specimens had a same cross section and two different lengths and shear spans. The stirrups were not arranged in the central shear span. Some specimens were initially crack-damaged by pre-loading and subsequently repaired by injecting epoxy resin into the cracked parts. The arrangement of the CF sheet is shown in Fig.2. Double sheets were bonded crosswise each other over both sides of the beam by epoxy resin adhesive. One more sheet was intentionally arranged on the soffit of the beam to reinforce the tension side of the beam. The bonding work was performed according to the same procedures as presented in Ref.1 and 2. The test was conducted under antisymmetric loading system as shown in Fig.2.

### Results, Discussion and Conclusions

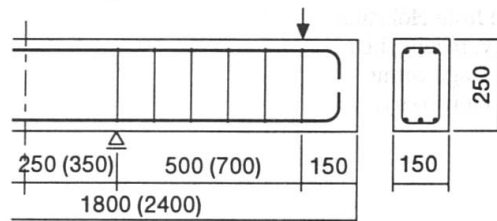
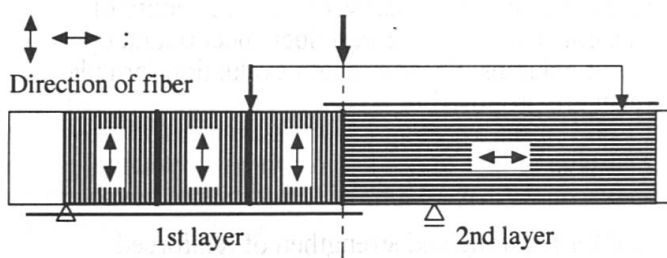
Photos 1 shows failure mode of the strengthened beam after the test. The bonded sheets were

peeled off by force. All of the specimens failed due to diagonal tension cracking in the central shear area. Table 1 shows the measured values of cracking load  $P_{cr}$  and ultimate load  $P_u$  of the beam with the central shear span  $L=250\text{mm}$ . The cracking load  $P_{cr}$  was estimated from shear deformation behaviors measured in the central shear span. Specimen A was initially crack-damaged nearby ultimate stage by pre-loading, and subsequently repaired and strengthened. Specimen B was lightly crack-damaged, and strengthened. The results obtained are as follows. The reinforcing effect of the sheet was small for crack initiation. The ultimate shear strength of the strengthened beam increased by about 1.4 times that of the virgin one. The increasing rate of strength was about 1.3 to 1.8 for the beam with  $L=350\text{mm}$ . Similar reinforcing effects of the sheet were obtained for the crack-damaged beam and the crack-damaged and afterwards repaired beam.

## References

1. K.Takeda et al.: Composites Part A 27A(1996) 981-987.
2. Y.Mitsui et al.: Textile Composites in Building Construction 96, 91-98.

Fig.1 Configuration and bar arrangement of specimen



Main reinforcement : upper ; 3-D10 (SD345)  
lower ; 3-D10 (SD345)

Stirrup :  $\phi 5$ , @100mm

Concrete : nominal strength = 21MPa

Carbon fiber sheet (CF sheet) :

T. S. = 3400 MPa, T. M. =  $2.3 \times 10^5$  MPa

Section area of CF = 167 mm<sup>2</sup>/m

Adhesive agent : epoxy resin

Crack repairing material : epoxy resin

Fig.2 Arrangement of CF sheets and loading method (antisymmetric load)

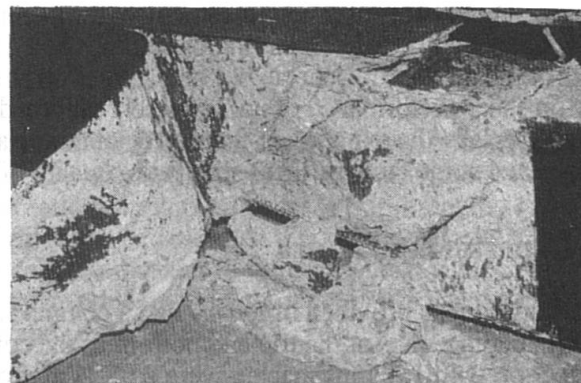
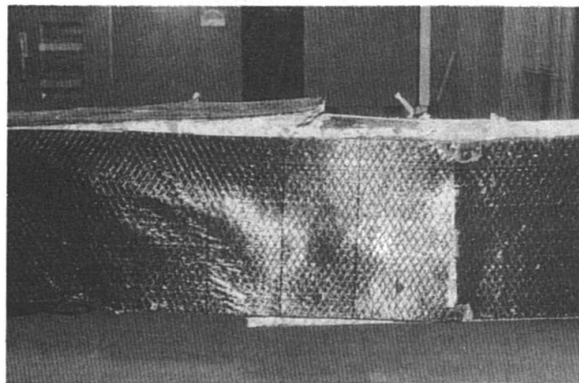


Photo 1 Failure mode of the strengthened beam after the test

Table 1 Test results (central shear span  $L = 250\text{mm}$ )

Specimen No.	State of Specimen	$P_{cr}$ (kN)	$P_u$ (kN)
A	virgin	125.5	188.3
	repaired and strengthened	58.8	268.7
B	virgin	103.0	-
	strengthened	73.5	274.6
C	strengthened	132.4	256.9

$P_{cr}$  : cracking load

$P_u$  : ultimate load