

TECHNICAL NOTE 003

New Construction Technology: Hybrid Bonding of FRP to Reinforced Concrete Structures



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Version 02, Jul 2013

Keywords

Fibre reinforced polymer (FRP), hybrid-bonded FRP (HB-FRP), structural rehabilitation

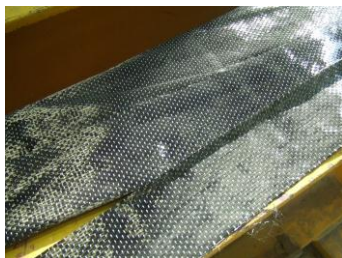
Synopsis

A new mechanical fastening technique for FRP to reinforced concrete, namely the hybrid-bonded FRP (HB-FRP), has been developed by researchers in the academia in Hong Kong. This simple method provides resistance to the separation of FRP laminate from the concrete substrate. The bond strength with this new hybrid bonding technology is approximately 7 times that of conventional adhesive bonding. A document entitled "**Hong Kong Guideline for the Strengthening of Concrete Structures using FRP Composites**" is being prepared, and this document makes provisions for the first time in the world to allow the use of HB-FRP for enhancement of bond strength.

1.0 Introduction

FRP is very strong in itself and has emerged as one of the popular materials for use in structural rehabilitation. However, the effectiveness of this method is limited by the relatively weak adhesive interface between the FRP and the concrete substrate (see figures below).

As a result, the tensile strength of FRP could never be fully utilised. Apart from the waste of FRP materials, the low bond strength also excludes the use of this strengthening method in major structural rehabilitation where higher member flexural and/or shear strength is required.



Fibre Reinforced Polymer (FRP)



Debonding failure between FRP and concrete substrate

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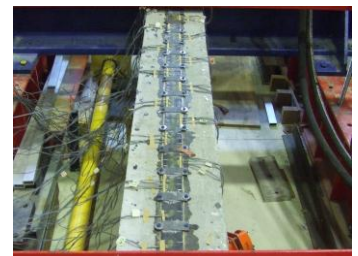
- i) The cost of FRP material has been reduced a lot recently, making the use of this material commercially viable.
- ii) FRP can be applied to strengthening of columns effectively using conventional adhesive bonding between FRP layers.

2.0 Hybrid-Bonded FRP

The hybrid fastening method developed by Dr Y F Wu of City University of Hong Kong is simple, entailing the use of a series of clamps and concrete fixing screws (see figures below).

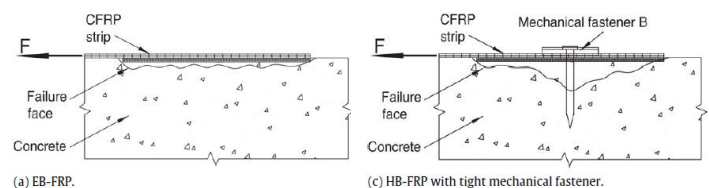


Clamps and concrete fixing screws



FRP fixed to concrete substrate using hybrid method

The exertion of normal pressure on the FRP by these clamps enables the friction mechanism at the interface to be mobilized; this enhances the bond strength substantially. The failure mechanisms of externally- and hybrid-bonded FRP are shown in the figures below.



(a) EB-FRP.
Failure mechanism of externally-bonded FRP

(c) HB-FRP with tight mechanical fastener.
Failure mechanism of hybrid-bonded FRP

HB-FRP is mainly applicable to the rehabilitation of highways structures where fire resistance is not a key design consideration. The visual appearance of HB-FRP could be improved by the use of metal cladding of some description.

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