

Tensioned CFRP Strip Method (Outplate Method™)

1. Introduction

In recent years, the continuous fiber reinforcement method has been widely applied to repair and reinforcement on civil engineering structures. For example, it may be used to increase the earthquake resistance of an RC bridge pier or reinforce the superstructure of a bridge so that it can bear larger vehicle loads. Carbon fiber and other continuous fiber reinforcing materials are especially useful in reinforcing civil engineering structures since these materials are extremely strong, lightweight and corrosion resistant. A tensioned CFRP strip method (Outplate Method™) that utilizes carbon fiber as a tensioning material has been developed to make effective use of carbon fiber's strength. This method permits efficient reinforcement of existing structures.

2. Characteristics

The Outplate Method employs a prefabricated tensioning material (Outplate™) which consists of a CFRP strip and two steel anchoring devices. The CFRP strip is made up of high strength carbon fibers and thermo-setting resin, fabricated using a Pultrusion Method (see **Photo 1**). Both ends of the CFRP strip are embedded in steel anchoring devices and fixed by expansive cement paste so that the strip can be used to reinforce an existing structure. First, the Outplate is bolted to a steel plate fixed to the concrete structure necessary to be reinforced (see **Photo 2**). Then, it is tensioned by using a special hydraulic jack to pre-stress the concrete, and at the same time, it is bonded to the concrete surface by epoxy resin (see **Fig.1**).

The salient features of the Outplate Method are shown below.

- (1) Excellent reinforcing effect: Reduction of stress of existing reinforcement, improvement of ultimate flexural capacity, prevention of cracking, restoration of deflection.
- (2) Ease of application: Use of lightweight prefabricated tensioning material, no heavy-duty machines required, reduction of work hours.
- (3) Slim finish: Thin CFRP strip, compact anchorage.
- (4) High durability: Use of corrosion-resistant CFRP strip.
- (5) Low reinforcement cost: Reduced use of CFRP, shortened period of work.

3. R&D Activity

In cooperation with Ritsumeikan University, Nippon Steel Composite Co., Ltd., DPS Bridge Works Co., Ltd. and Kokusai Structural Engineering Corp. jointly developed the CFRP strip anchoring method, tensioning system, bonding method, etc. for the Outplate Method. After conducting a series of practical tests and experiments on reinforcement of concrete members, the Outplate Method was first put into practice in 2002.

In 2003, a research association for the Outplate Method was founded through the initiative of certain construction companies. The research association is now managed by 20 member companies. The Outplate Method has already been applied to ten structures and registered in the New Technology Information System (NETIS) of the

Ministry of Land, Infrastructure and Transport. Thus, it is getting recognized as a useful reinforcement method.

At present, efforts are being made to tackle the development of a new tensioning system, lightweight anchoring device, and a large-capacity tensioning material in order to widen the scope of application for the Outplate Method.

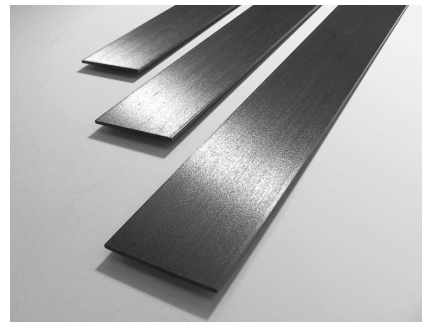


Photo 1 CFRP strip

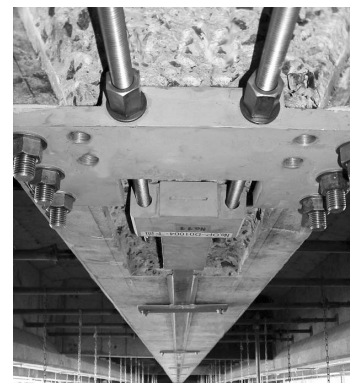


Photo 2 Anchorage device

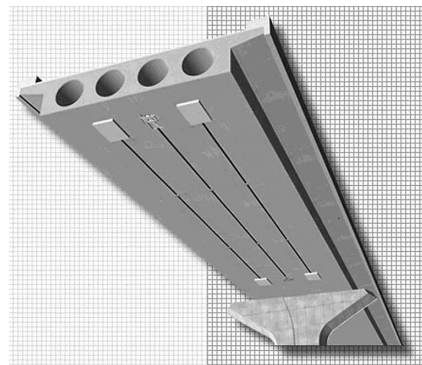


Fig. 1 Strengthening of bridge with Outplate

For further information, contact
Nippon Steel Composite Co., Ltd.