

CHAPTER 1 GENERAL

1.1 Scope

- (1) These recommendations provide design and construction standards for the upgrading of existing concrete structures through bonding or jacketing with continuous fiber sheets.
- (2) These recommendations may also be applicable to the upgrading of structures by wrapping with continuous fiber strands.

[Commentary]

- (1) These recommendations consist of design and construction standards for the upgrading of existing concrete structures using continuous fiber sheets with the aim of improving their strength and durability. The recommendations include standards not only for repair and strengthening as described in the Recommendations for Maintenance of Concrete Structures (Draft), but also for the recovery of structural functionality, such as by reducing deflection, and for measures to ameliorate adverse effects on third parties by preventing spalling of concrete.

The recommendations are predicated on a process that involves bonding fiber sheets onto the structure or jacketing the structure with such sheets at the site, then impregnating them with epoxy resin. The types of continuous fiber covered by these recommendations are carbon and aramid fibers, with which Japan has considerable experience. Both have a mass per unit area of less than 400 g/m². When applying these recommendations to cases where another material, such as glass fiber, is to be used, or where the unit mass of the fiber sheet is greater than stated above, or the prefabricated sheets are used, performance should be verified through experimental tests or by other means.

Continuous fiber sheets are light, very strong, durable, and resistant to corrosion. Upgrading of structures using such sheets offers the following advantages in design and construction:

Advantages in design

- Since the continuous fibers are arranged in a single orientation, the maximum reinforcing effect can be achieved by bonding or jacketing with the fibers aligned in the direction designated in the design.
- Any required volume for upgrading can be easily obtained by increasing/decreasing the unit mass and the number of plies.
- The dead weight added to an upgraded structure is minimized because of the light weight of fiber sheets.
- The fiber sheets protect the concrete from deterioration while also protecting reinforcing steel from corrosion because the matrix itself is highly resistant to corrosion and can block external influences.

Advantages in construction

- Upgrading manually is possible, because the work entails simply bonding fiber sheets to the structure or jacketing the structure with sheets using cold-setting resins
 - Because the materials are light in weight, upgrading can be carried out by a small number of workers over a short period, and there is no need for heavy construction equipment or large preparation areas.
 - Since the fiber sheets are easily shaped on site, the method is suitable even when a structure has complicated shape.
- (2) Even when upgrading existing concrete structures by jacketing with continuous fiber strands, the same performance as with continuous fiber sheets can be anticipated. Therefore, these recommendations can be applied to continuous fiber strands as well. However, they are not applicable to flexural strengthening or to punching shear strengthening for planar members.

One of the advantages of upgrading by jacketing with continuous fiber strands is that it is possible to reduce manpower by using a winding equipment.

What are not covered in these recommendations shall conform to the following Standard Specifications and Recommendations.

Standard Specifications for Design and Construction of Concrete Structures (Design) (Seismic Design) (Construction) established 1996	1996
Standard Specifications for Design and Construction of Concrete Structures (Construction) "Durability Verification Standards" established 1999	1999
Recommendations for Design and Construction of Concrete Structures Using Continuous Fiber Reinforcing Materials	1996
Recommendations for Maintenance of Concrete Structures	1995
Recommendations for Retrofit of Concrete Structures	1999

1.2 Definitions

The following terms are defined in these recommendations:

Continuous fiber strand:

Several thousand to several tens of thousands of continuous fibers bound together, each fiber measuring from several micrometers to a dozen or more micrometers in thickness

Continuous fiber sheet:

Continuous fiber strands arranged in a sheet-like or textile-like form in one or two planar directions

Fiber mass per unit area:

The mass of fibers in a continuous fiber sheet per square meter. In the case of strands, this value is defined for the wound interval.

Impregnation resin:

The resin used to impregnate and bond the continuous fiber filaments and give them the functions of a composite material, and to attach the continuous fiber sheet to the surface of concrete

Interfacial fracture energy:

The amount of energy per unit bonding area needed to produce interfacial failure