

CHAPTER 1 GENERAL PROVISIONS

1.1 Scope

- (1) These (draft) guidelines for retrofit cover the fundamentals of the retrofitting of existing concrete structures.
- (2) These (draft) guidelines for retrofit cover the retrofitting of structures using the external cable method, the bonding and jacketing method, and the overlaying and jacketing methods, based on existing technologies.

[Commentary]

(1) The fundamentals of ordinary design and construction of concrete structures are covered in the Standard Specification for Design and Construction of Concrete Structures (Design)[1] and (Construction)[2], published by the Japan Society of Civil Engineers (hereafter "Standard Specification"), while matters pertaining to seismic design are covered in the Standard Specification (Seismic Design)[3]. Standards relating to the maintenance of concrete structures are covered in the Guidelines for Maintenance of Concrete Structures (Draft)[4] published by the Japan Society of Civil Engineers (hereafter "Maintenance Guidelines"). These (draft) guidelines are designed to complement these documents and indicate standards for the retrofitting of existing concrete structures, which in recent years has been applied in an increasingly number of cases. These guidelines concentrate on design and construction considerations for ensuring that the retrofitting members bond to the existing structure and methods for verifying the performance of retrofitted structures, matters that are unique to and critical for retrofitting. Matters that are common to the Standard Specification and Maintenance Guidelines have been omitted.

These (draft) guidelines are applicable when the mechanical characteristics of structures are changed to improve their performance, and when performing the "Retrofit" "Restoration of Functions" and "Improvement of Functions" processes described in the Maintenance Guidelines.

This publication is made up of the (draft) Guidelines for retrofit and supplementary materials. The (draft) guidelines cover the flow of the retrofitting process and general matters. The supplementary materials include manuals of retrofitting methods, sample designs and other reference materials. The manuals of retrofitting methods contain practical considerations relating to retrofitting design and construction based on existing technologies. The sample designs show actual application of the matters covered in the (draft) guidelines and manuals.

(2) Many different retrofitting methods are currently being implemented. In the (draft) Maintenance Guidelines, the retrofitting methods are classified as shown in **Figure C1.1.1**.

Structural retrofitting technologies are currently at the stage of general research, and the performance results and organization of technologies used for the different methods are not uniform. In the future, it is expected that new methods will be developed and new views will be proposed for existing methods as well. These (draft) guidelines cover the fundamental approach to retrofit as well as specific design and construction methods for those methods that are currently applied most often, based on existing technologies.

Of the many retrofitting methods, these (draft) guidelines provide detailed design and construction methods for the external cable construction method, the bonding and jacketing construction method and the overlaying and jacketing construction method.

The external cable construction method is included under (9) Prestressing introduction method in the retrofitting methods shown in **Figure C1.1.1**.

The bonding and jacketing construction method is classified as a method that involves increasing the number of retrofitting members and includes the (6) Steel plate bonding method (7) Fiber-reinforced plastic bonding method and (8) Steel plate jacketing construction method, as well as the fiber-reinforced plastic jacketing construction method (not shown in the figure). However, this includes only the fiber-reinforced plastic bonding and fiber-reinforced plastic jacketing construction methods that use continuous fiber sheets and does not cover cases in which continuous fiber reinforced plates fabricated at the factory are used.

The overlaying and jacketing construction method is a retrofitting method in which concrete sections are added and corresponds to (2) Overlaying construction method and (3) Jacketing construction method in the figure.

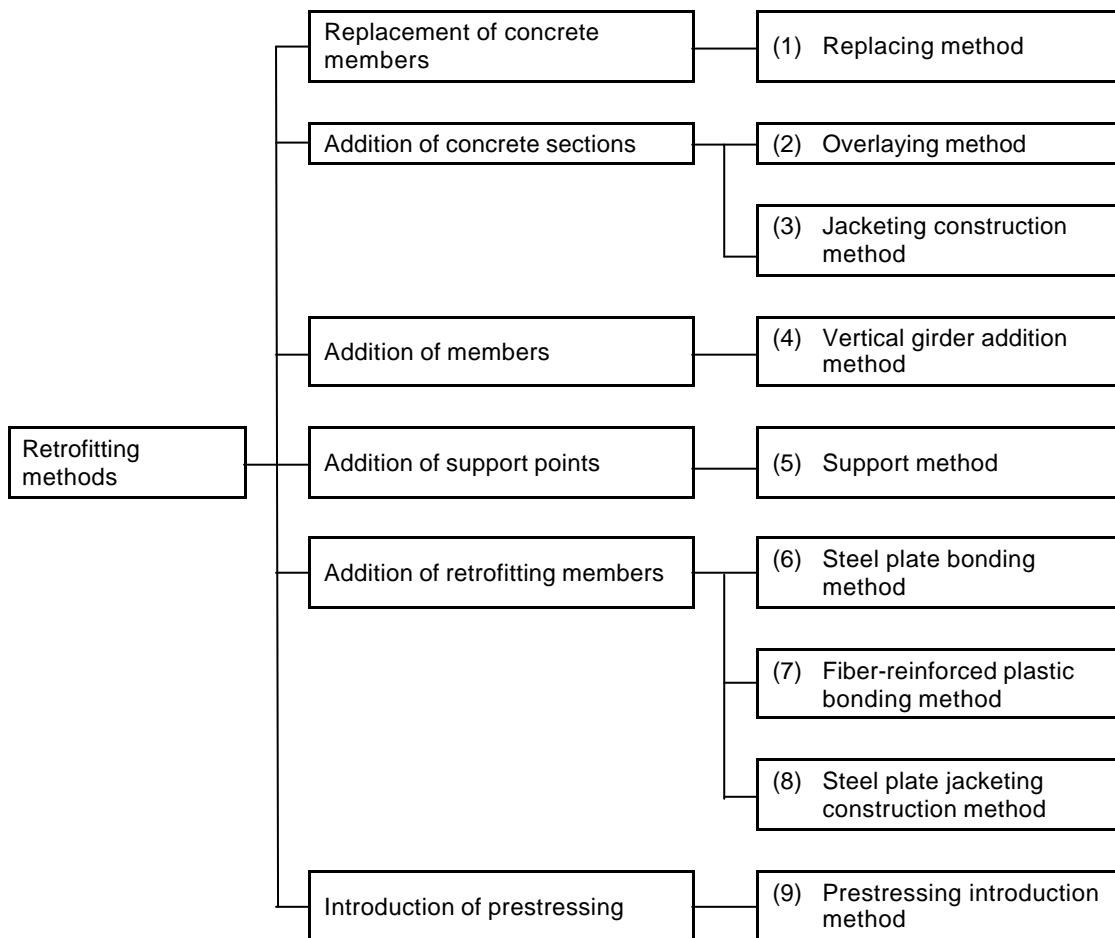


Figure C1.1.1 Sample retrofitting methods [5]

Of the retrofitting methods shown in **Figure C1.1.1**, the (1) Replacing method (4) Vertical girder addition method and (5) Support method are not specifically covered in these (draft) guidelines. In future revisions, methods other than those shown in these (draft) guidelines will be included, and those currently included will be revised to reflect technological progress.

The items in these (draft) guidelines alone may not be adequate for the design and construction of every structure. Moreover, design and construction of retrofitted structures with even more advanced construction methods is expected to become possible with technological progress. In such cases, it is not necessary to adhere to the methods shown in these (draft) guidelines. However, the fundamentals of and approach to retrofit will no doubt be the same, so the gist of these (draft) guidelines should be observed and they should be applied appropriately in accordance with the situation.

It should be noted that, in general, retrofitting technologies for structures are at the research stage, and many matters have not been finalized. Also, when conducting retrofitting in accordance with these (draft) guidelines, it is important to perform suitable maintenance after retrofitting.

1.2 Definitions

The following terms are defined for use in these (draft) guidelines:

Continuous fiber prestressing materials:

Of the continuous fiber retrofitting members, the general term for those that can be used as prestressing materials. "Continuous fiber reinforcing materials" is the general term for unidirectional reinforcing

materials formed by impregnating continuous fibers with fiber adhesive which is allowed to harden, for the purpose of using them to reinforce concrete, or for bundled or woven continuous fibers only.

External cable method:

Placement of prestressing materials on the outside of the concrete to apply tensile force to the members through the anchorage section or deviator in order to achieve the required performance improvement.

External cables:

Of the concrete prestressing steel or continuous fiber prestressing materials, those prestressing materials that can be used for the external cable construction method in which the prestressing materials are placed on the outside of the concrete.

Internal cables:

Of the concrete prestressing steel or continuous fiber prestressing materials, those prestressing materials that are placed on the inside of the concrete. These are categorized as bonded or unbonded depending on whether or not they are bonded to the concrete.

Anchorage section:

The section in which anchorage components are fastened to the concrete members to transmit the prestressing force. These are made up of the anchorage components and the members that are used to fasten them.

Deviator:

The section in which deflection components are fastened to the concrete members to transmit, to the concrete members, the partial force from the prestressing that is applied to the external cables. These are made up of the deflection components and the members that are used to fasten them.

Steel plate bonding method:

A method in which steel plates are attached to the outside of the concrete section to make up for insufficiencies in the primary or distribution reinforcement of the existing members; these bond to the existing members to form a composite configuration in order to achieve the required performance improvement. This method is used for bridge decks and almost all other concrete members.

Fiber-reinforced plastic bonding method:

A construction method in which glass fibers, carbon fibers, aramid fibers or other continuous fiber materials (continuous fiber sheets, etc.) are bonded to the outside of the concrete section, bonding to the existing members to form a composite configuration, after which an organic or other material coating is applied on top, both to prevent the entry of carbon dioxide, chloride ions, moisture etc. and to provide the necessary performance improvement. This method is used for bridge decks and almost all other concrete members.

Steel plate jacketing construction method:

A construction method in which steel plates are placed continuously around the entire periphery of the existing column members, etc. that have insufficient load-carrying capacity, bonding to the existing members to form a composite configuration in order to achieve the required performance improvement. This method is used for bridge piers, etc.

Fiber-reinforced plastic jacketing construction method:

A method in which continuous fiber sheets or other fiber materials are placed continuously around the entire periphery of existing column members, etc. with insufficient load-carrying capacity, bonding to the existing members to form a composite configuration in order to achieve the required performance improvement. This method is used for bridge piers, etc.

Continuous fiber sheet:

Reinforcing materials with continuous fibers arranged in one direction or both directions to form a sheet. Alternately, fiber-reinforced plastics formed by impregnating continuous fibers with impregnation adhesive which is then allowed to harden.

Upper surface overlaying construction method:

A method that does not use steel reinforcement but involves cutting and cleaning the upper surface of the deck and then laying steel fiber reinforced concrete to increase the thickness of the deck in order to achieve the required performance improvement.

Steel reinforced upper surface overlaying construction method:

A variation on the upper surface overlaying construction method, in which the deck is retrofitted by placing steel reinforcement on the overlaying layer and then laying steel fiber reinforced concrete to increase the thickness of the deck in order to achieve the required performance improvement.

Lower surface overlaying construction method:

A method in which steel reinforcement or other reinforcing material is placed mainly on the underside of the deck and then overlaying material, primarily highly adhesive mortar, is applied by troweling or spraying to add thickness and bond in order to achieve the required performance improvement.

Lower surface spray method:

A method in which steel reinforcement is placed on the underside of a deck and then overlaying material, primarily super-quick hardening steel fiber reinforced mortar, is sprayed on to ensure that the steel reinforcement is covered and bonded to the existing deck, in order to reduce the stress and deflection of the existing reinforcement and achieve the required performance improvement.

Reinforced concrete jacketing construction method:

A method in which steel reinforcement is placed around the existing members and concrete is added to increase the number of sections and achieve the required performance improvement.

Mortar spray method:

A method in which lateral ties, spiral reinforcement or the like are applied to the existing members and mortar is sprayed to bond them together in order to achieve the required performance improvement.

Precast panel jacketing construction method:

A method in which precast panels with lateral ties or the like inside are placed around the perimeter of the column and fastened with joint dowels or the like, and the gaps between the column and panels are filled with grout to bond them, in order to achieve the required performance improvement.

Cement-based reinforcing materials:

Cement-based composite materials (concrete/mortar) used as overlaying reinforcements.