
**Structural intervention of
existing concrete structures using
cementitious materials —**

**Part 2:
Top-surface overlaying**

*Intervention structurelle sur les structures en béton existantes
utilisant des matériaux cimentaires —
Partie 2: Recouvrement de la surface supérieure*

[ISO 5091-2:2023](https://standards.iteh.ai/catalog/standards/sist/2088bdae-5bcd-4f67-b383-75afeb789521/iso-5091-2-2023)

<https://standards.iteh.ai/catalog/standards/sist/2088bdae-5bcd-4f67-b383-75afeb789521/iso-5091-2-2023>



iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 5091-2:2023

<https://standards.iteh.ai/catalog/standards/sist/2088bdae-5bcd-4f67-b383-75afeb789521/iso-5091-2-2023>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	v
Introduction.....	vi
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Investigation of existing structure.....	2
4.1 General.....	2
4.2 Investigation.....	2
4.2.1 Investigation using documents, records.....	2
4.2.2 On-site investigation.....	3
5 Intervention design.....	3
5.1 General.....	3
5.2 Structural plan.....	3
5.3 Structural details.....	3
6 Materials.....	4
6.1 General.....	4
6.2 Materials in existing structure.....	4
6.3 Materials used in repairing or strengthening parts.....	5
6.3.1 Cementitious materials.....	5
6.3.2 Reinforcing materials.....	5
6.3.3 Bonding products.....	5
6.3.4 Waterproof materials.....	5
6.3.5 Pavement materials.....	5
6.4 Characteristic values and design values of materials for repaired or strengthened parts.....	6
6.4.1 General.....	6
6.4.2 Cementitious materials.....	6
6.4.3 Reinforcing materials.....	6
6.4.4 Bonding products.....	6
7 Actions.....	6
7.1 General.....	6
7.2 Actions for intervention design.....	6
8 Performance verification for repaired or strengthened structure.....	6
8.1 General.....	6
8.2 Calculation of response.....	7
8.2.1 General.....	7
8.2.2 Modelling of structure.....	7
8.2.3 Structural analysis.....	7
8.2.4 Calculation of response values.....	7
8.3 Durability verification.....	7
8.3.1 General.....	7
8.3.2 Verification related to steel corrosion.....	7
8.4 Safety verification.....	7
8.4.1 General.....	7
8.4.2 Verification related to failure.....	7
8.4.3 Verification related to fatigue failure.....	8
8.5 Serviceability verification.....	9
8.5.1 General.....	9
8.5.2 Stress level limit.....	9
8.5.3 Verification related to appearance.....	9
8.6 Restorability verification.....	9

8.6.1	General.....	9
8.7	Structural details.....	9
8.7.1	Thickness of top-surface overlaying parts.....	9
8.7.2	Cover.....	10
8.7.3	Placement of reinforcing materials.....	10
8.7.4	Joints for reinforcing materials.....	10
8.7.5	Structural details related to seismic performance.....	10
9	Construction.....	11
9.1	General.....	11
9.2	Prior investigation and construction plan.....	11
9.3	Mix proportion of cementitious materials.....	11
9.4	Preparation.....	12
9.5	Surface treatment.....	12
9.6	Assembly of reinforcing materials.....	13
9.7	Manufacture of cementitious materials.....	13
9.8	Transportation, placement, compaction and finish.....	13
9.9	Curing.....	13
9.10	Pavement.....	13
9.11	Quality control.....	14
9.12	Inspection.....	14
10	Records.....	14
11	Maintenance.....	14
Annex A (informative) Examples of design and execution.....		15
Bibliography.....		18

ITC STANDARD PREVIEW
 (standards.iteh.ai)

ISO 5091-2:2023

<https://standards.iteh.ai/catalog/standards/sist/2088bdae-5bcd-4f67-b383-75afeb789521/iso-5091-2-2023>

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 7, *Maintenance and repair of concrete structures*.

A list of all parts in the ISO 5091 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

As a repairing and strengthening method, attaching of cementitious material layer to surface of existing concrete structures has been widely accepted. Since the cementitious layer does not have enough tensile strength, tension reinforcement is generally placed in the cementitious layer. There are two types of attaching way. For the first way, the cementitious layer is attached either on top surface or bottom surface of horizontal concrete members, especially slabs, while, for the second way, the cementitious layer is attached to jacket vertical concrete members, especially columns. There has not been any ISO standard on design, execution, and maintenance for this method with attaching cementitious layer. The ISO 5091 series serves as the first ISO standard for the intervention by attaching cementitious material layer with tension reinforcement inside.

At the same time, the ISO 5091 series is the first ISO standard developed for a specific intervention method, which conforms to the umbrella code, ISO 16311, especially ISO 16311-3 and ISO 16311-4.

The ISO 5091 series consists of four parts. ISO 5091-1 provides the issues common to all three parts, while ISO 5091-2, 3 and 4 provide the issues specific to each attaching way of cementitious material layers.

ISO 5091-2 describes a specific method of verifying the performance of a structure repaired or strengthened by means of top-surface overlaying based on the currently available latest technologies. Note, however, that the verification method described herein does not cover all kinds of verification. For necessary information, reference need to be made to the relevant standard specifications and other documents.

Given that members subject to intervention are mostly decks, the standard methods described herein are considered the latest information on design and construction of top-surface overlaying using fibre-reinforced concrete on overlaying parts. As technology advances, new materials and design and construction methods are developed and methods for evaluating the post-intervention structural performance with sufficient accuracy are established, making it possible to apply top-surface overlaying for intervention parts and members other than decks, use materials other than fibre-reinforced concrete, employ interface treatment methods other than cutting, cleaning and adhesive, etc., it is not necessarily required to adhere to what is set forth in ISO 5091.

The ISO 5091 series can serve as a practical standard for construction industry, such as client, design consultant and general contractor, to apply the structural intervention with externally attached cementitious layer. Additional technical information, which is not provided explicitly in ISO 5091 series, needs to be provided in each application case with consideration of the provisions of ISO 5091 series.

Structural intervention of existing concrete structures using cementitious materials —

Part 2: Top-surface overlaying

1 Scope

This document specifies the standards for design and construction using the top-surface overlaying method, which increases the thickness of existing concrete members by integrating cementitious materials onto the top surface of the members so as to improve the safety, serviceability, durability and other properties of a concrete structure.

This document specifies structural intervention of existing concrete structures using cementitious materials design and execution principles, and strategies for defects and on-going deterioration including, but not limited to:

- a) mechanical actions, e.g. fatigue, impact, overloading, movement caused by settlement, blast, vibration, and seismic actions;
- b) chemical and biological actions from environments, e.g. sulfate attack, alkali-aggregate reaction;
- c) physical actions, e.g. freeze-thaw, thermal cracking, moisture movement, salt crystallization, fire, and erosion;
- d) reinforcement corrosion;
- e) original construction defects that remained unaddressed from the time of construction.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5091-1:2023, *Structural intervention of existing concrete structures using cementitious materials — Part 1: General principles*

ISO 16311-3, *Maintenance and repair of concrete structures — Part 3: Design of repairs and prevention*

ISO 16311-4, *Maintenance and repair of concrete structures — Part 4: Execution of repairs and prevention*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 top-surface overlaying
method in which the thickness of the structural element associated with the top surface of the existing concrete members is increased using cementitious materials, which will generally be reinforced

Note 1 to entry: The technique enhances the performance (e.g. strength, stiffness) of the existing concrete structure and is applicable to highway bridge decks, etc.

3.2 bonding product
material, such as a primer or adhesive, that is applied to bond concrete and mortar

Note 1 to entry: The grouting material for bonding concrete and reinforcing material is also included in this term.

3.3 filling material
material injected to fill the gap between a reinforcing material, such as intermediate penetrating tie, and concrete

3.4 filling property
degree of filling of cracks and adhesion of crack filling material to substrate

3.5 very high early strength cement
type of cement with a typical mix proportion that develops a compressive strength as high as 20 N/mm² to 30 N/mm² within 2 h to 3 h of placement

3.6 reinforcing material
steel or FRP material used to sustain, restore or improve the mechanical performance of a structure

3.7 polymer hydraulic cement mortar
hydraulic composition made cementitious materials and fine aggregate modified by the addition of a polymer

3.8 overlaying material
cementitious material, potentially reinforced, added on the top surface of an existing concrete structure for the purpose of making an intervention to enhance the performance of that structure

3.9 FRP grid
resin-impregnated FRP reinforcing materials formed into a grid shape

4 Investigation of existing structure

4.1 General

The investigation of the existing structure for intervention using the top-surface overlaying method shall be as set forth in ISO 5091-1:2023, Clause 4.

4.2 Investigation

4.2.1 Investigation using documents, records

The investigation of the existing structure using documents, records, etc. for top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 4.

If the intervention has already been performed, maintenance records need to be inspected.

4.2.2 On-site investigation

The on-site investigation for considering the application of top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 4.

To ensure smooth construction work with top-surface overlaying on the site, the storage space and arrangement of construction machines and materials, traffic restrictions and so forth should be checked in the prior investigation phase.

5 Intervention design

5.1 General

The intervention plan for considering the application of top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 5.

The structural plan for degraded part removal, patching repair, concrete replacement, etc. shall be formulated based on the correct judgment of the degradation status to ensure that the performance level and design service life of the structure required from the intervention are achieved.

In structural details, a bonding method shall be established that ensures the integrity between the existing parts and overlaying parts so that the intervention effect of top-surface overlaying is obtained.

5.2 Structural plan

The structural plan for considering the application of top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 5.

In designing intervention work, appropriate decisions shall be made on the method to remove degraded concrete, the materials and method for patching repair, whether partial concrete replacement is necessary and the range of replacement, the construction method of top-surface overlaying, etc. before starting construction with top-surface overlaying, considering these circumstances. Materials for patching repair for the top surface of decks are required to shrink little, be excellent in crack resistance and deformation-following capability and Young's modulus equal to or smaller than that of the existing concrete.

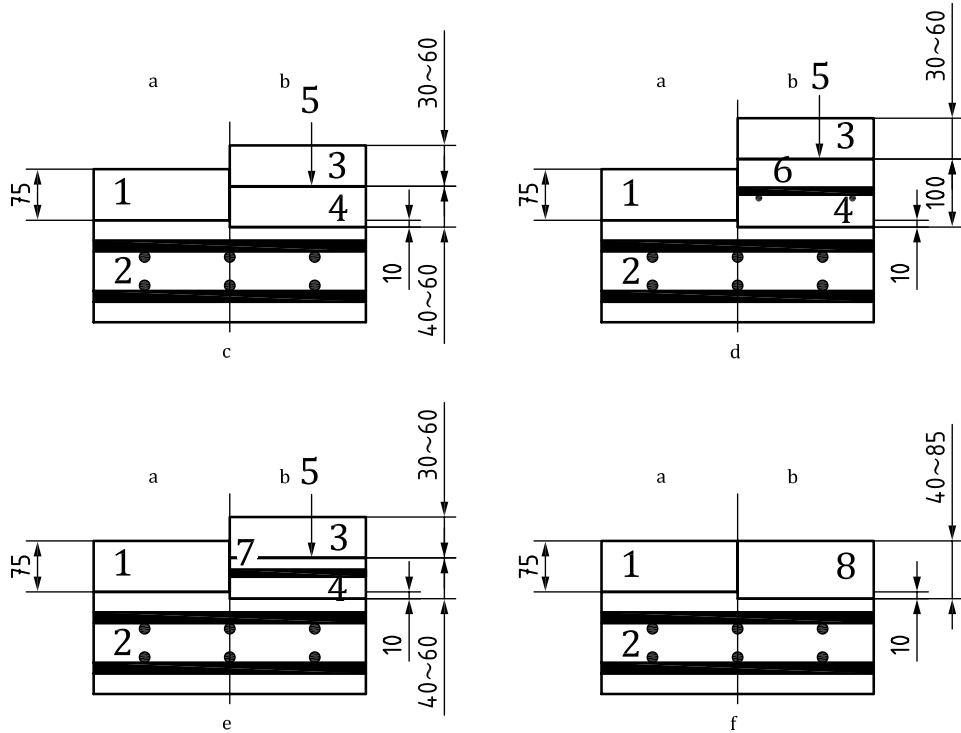
The intrusion of water into the inside of decks needs to be completely prevented and it is important to apply waterproofing and ensure water drainage on the waterproof top surface. In order to ensure that the repaired or strengthened structure sustains its performance as mentioned above, it is necessary to take measures to prevent re-degradation while taking into consideration the maintenance following completion of intervention as well.

5.3 Structural details

The structural details for considering the application of top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 5. An increase in the self-weight due to the overlay shall also be considered appropriately.

For a structure repaired or strengthened with top-surface overlaying to fulfil the required performance, the existing parts and overlaying parts need to function together as a composite structure. [Figure 1](#) shows examples of the cross-section of decks to which top-surface overlaying is applied.

If the stiffness of the existing part is vastly different from that of the overlaying part, the strength, Young's modulus and other properties of the existing concrete and overlaying materials need to be considered.



Key

- 1 existing asphalt pavement
- 2 existing RC deck
- 3 asphalt pavement
- 4 overlaying concrete
- 5 water resistant layer
- 6 reinforcing steel
- 7 reinforcing FRP grid
- 8 overlaying concrete (concrete pavement)
- a Before overlaying.
- b After overlaying.
- c Top-surface overlaying with asphalt pavement.
- d Steel-reinforced top-surface overlaying with asphalt pavement.
- e FRP grid reinforced top-surface overlaying with asphalt pavement.
- f Top surface overlaying.

Figure 1 — Examples of the cross-section of decks to which top-surface overlaying is applied

6 Materials

6.1 General

The materials used for top-surface overlaying shall be of proven quality to ensure that the required performance is fulfilled for a necessary period.

6.2 Materials in existing structure

The characteristic values and design values of the materials in the existing structure shall be as set forth in ISO 5091-1:2023, Clause 6.

When setting the material properties of the existing structure based on documents, records, etc. according to ISO 16311-2, the partial safety factor for materials should be determined taking into consideration the impact of degradation. On the other hand, when the functionality of the existing structure is restored using patching repair materials or the like prior to top-surface overlaying, the material properties of the repair materials should be considered appropriately according to their impact.

6.3 Materials used in repairing or strengthening parts

6.3.1 Cementitious materials

The cementitious materials used for top-surface overlaying shall be as set forth in ISO 5091-1:2023, 4.3.2. Water, cement, aggregate, fibre, mineral admixture and chemical admixture, polymeric resins mixed with cement and others used for the cementitious materials shall be those compliant with the relevant standards or those proven to have the required levels of quality based on existing test results or through confirmation tests.

If shrinkage cracking of cementitious materials presents a problem, an expansive additive, which expands upon setting and hardening may be used as a mineral admixture. When very high early strength cement is combined with an expansive additive, the skeleton of the cement hardened body is formed early and, therefore, there are cases in which an expansive additive generates expansive hydration early is used.

It is necessary to use an appropriate material according to the required performance.

6.3.2 Reinforcing materials

The reinforcing materials used for top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 6. In top-surface overlaying for decks, grid-shaped steel and FRP reinforcing materials may be used as reinforcements in addition to reinforcing steel.

6.3.3 Bonding products

The bonding products used for top-surface overlaying shall be as set forth in ISO 5091-1:2023, Clause 6.

In top-surface overlaying for decks, adhesive may be used on the placement interface to achieve integrity between cementitious materials and existing decks.

6.3.4 Waterproof materials

The waterproof material to be used for top-surface overlaying shall be selected so as to fulfil the required performance, taking into consideration the construction conditions and environment, variations in quality, etc.

6.3.5 Pavement materials

With regard to the pavement material to be placed after top-surface overlaying for highway bridge decks, its performance of bonding with the waterproof material shall be taken into consideration.

If the bonding between the pavement material and waterproof material is insufficient, it is possible that the required waterproof performance will not be obtained.