SLOVENSKI STANDARD
SIST-TP CEN/TR 17080:2018

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Projektiranje pritrjevanja za uporabo v betonu - Odprti profili za sidranje - Dodatna pravila

Design of fastenings for use in concrete - Anchor channels - Supplementary rules

Bemessung der Verankerung von Befestigungen in Beton - Ankerschienen - Ergänzende Regelungen

Conception et calcul des fixations pour béton - Rails insert - Règles supplémentaires

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21.060.01	Vezni elementi na splošno	Fasteners in general
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TECHNICAL REPORT

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Design of fastenings for use in concrete - Anchor channels - Supplementary rules

Bemessung der Verankerung von Befestigungen in Beton - Ankerschienen - Ergänzende Regelungen

This Technical Report was approved by CEN on 9 April 2017. It has been drawn up by the Technical Committee CEN/TC 250.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (CEN/TR 17080:2018) has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes", the secretariat of which is held by BSI.

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Introduction

CEN/TR 17080 provides supplementary rules for the design of anchor channels for cases not currently covered by EN 1992-4:2018, namely,

— the design of anchor channels subject to shear force acting in the longitudinal direction of the channel;

— the design for the combined action of longitudinal shear, transverse shear and tension load acting on the anchor channel; and

— the design of supplementary reinforcement for anchor channels subject to shear force in longitudinal direction.

The proposed design rules follow closely the design model for headed fasteners. They have been derived from the results of current research.

In addition, rules alternative to EN 1992-4 for the design of supplementary reinforcement to carry shear loads transverse to the longitudinal axis of the channel are given.

This Technical Report is intended to be used in conjunction with EN 1992-4.

The numerical values for partial factors and other reliability parameters are recommended values and may be changed in a National Annex of EN 1992-4, if required. The recommended values apply when:

a) the anchor channels comply with the requirements of EN 1992-4:2018, 1.2, and

b) the execution complies with the requirements of EN 1992-4:2018, 4.6 and Annex F.

NOTE The proposed design method for shear loading acting in longitudinal direction of the channel can be realized only if the relevant parameters as specified in this CEN/TR, e.g. characteristic resistances and product dependent partial factors are given in a European Technical Product Specification.

1 Scope

EN 1992-4:2018 covers anchor channels located in cracked or uncracked concrete subjected to tensile loads and/or shear loads transverse to the longitudinal channel axis as well as combinations of these loads. Shear loads acting in direction of the longitudinal axis of the channel and combinations of shear loads acting transverse and in direction of the longitudinal axis of the channel, combinations of tensile loads and shear loads acting in direction of the longitudinal axis of the channel and combinations of loads in all three directions are excluded.

This Technical Report provides design rules for anchor channels under static and quasi-static shear loads acting in direction of the longitudinal channel axis and all possible combinations of shear and tension loads acting on the channel as well as design rules for anchor channels with supplementary reinforcement to take up shear loads, additional and alternative to the provisions of EN 1992-4:2018. All relevant failure modes are considered and will be verified. Fatigue, impact and seismic loads are not covered.

The design rules in this document are only valid for anchor channels with a European Technical Product Specification. The design provisions for shear loads acting in direction of the longitudinal axis of the channel cover the following anchor channels and applications:

— Anchor channels with 2 or 3 anchors.

— Anchor channels where the shear load in the longitudinal axis of the channel is transferred to the channel by corresponding locking channel bolts creating mechanical interlock by means of a notch in the channel lips or serrated channel bolts which interlock with serrated lips of the channel (Figure 1).

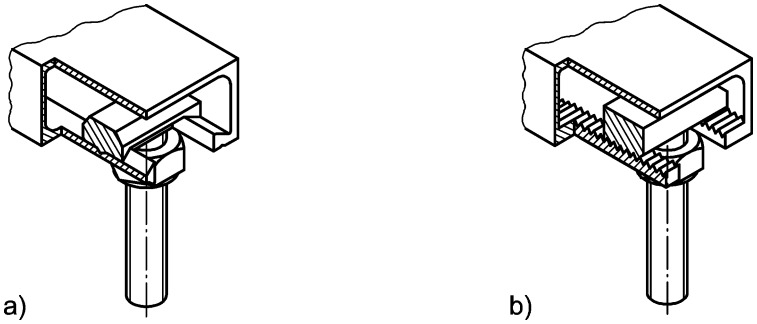
— Anchor channels produced from steel with at least two metal anchors rigidly connected to the back of the channel (e.g. by welding, forging or screwing). The anchor channels are placed flush with the concrete surface. A fixture is connected to the anchor channel by channel bolts with nut and washer.

— Anchor channels close to the edge placed either parallel or transverse to the edge of the concrete member. The design provisions for concrete edge failure do not cover channel orientations inclined to the concrete edge.

The design method for anchor channels loaded in shear in direction of the longitudinal axis of the channel follows closely the existing design model for headed fasteners. For reasons of simplicity modifications specific for anchor channels are used where necessary.

The design provisions for the supplementary reinforcement to take up shear loads in case of anchor channels situated parallel to the edge and loaded in shear transverse to the longitudinal axis apply to anchor channels with unlimited number of anchors.

Examples of anchor channels and channel bolts ensuring mechanical interlock are given in Figure 1.



Key

a) notching channel bolt creating a notch in the channel

b) channel with serrated lips and matching locking channel bolt

Figure 1 — Anchor channels with mechanical interlock - Examples

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.

EN 1992–1-1, *Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 1992–1-2, *Eurocode 2: Design of concrete structures — Part 1-2: General rules — Structural fire design*

EN 1992-4:2018, *Eurocode 2 — Design of concrete structures — Part 4: Design of fastenings for use in concrete*

3 Terms, definitions, symbols and units

For the purposes of this document, the terms and definitions given in EN 1992-4 and the following apply.

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

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

NOTE This clause includes only terms, definitions and symbols supplementary to EN 1992-4.

3.1 Terms and definitions

3.1.1
notching channel bolt
channel bolt (EN 1992-4:2018, 3.1.10) creating a notch in the channel lip to transfer a shear load by mechanical interlock in the longitudinal axis of the channel (Figure 1a))

3.1.2
locking channel bolt
channel bolt (EN 1992-4:2018, 3.1.10) interlocking with serrated channels lips by means of matching serrations (Figure 1b))

3.1.3
serrated channel
anchor channel (EN 1992-4:2018, 3.1.2) with special serrations formed into the lips of the channel. The channel bolts used to fix to this channel have matching serrations (Figure 1b))

3.1.4
direction x
direction in the longitudinal axis of the channel

3.1.5
direction y
direction transverse to the longitudinal axis of the channel

3.2 Symbols:

N_{Ed}^{a}	design tension force acting on the anchor
N_{Ed}^{cb}	design tension force acting on the channel bolt
N_{Ed}^{ch}	design tension force acting on the channel
$N_{Rd,i}$	design tension resistance for a certain failure mode
$N_{Rd,s}$	design tension resistance for steel failure modes, in general
$N_{Rd,s,a}$	design tension steel resistance of the anchor
$N_{Rd,s,c}$	design tension steel resistance of the connection between channel and anchor
$N_{Rd,s,cb}$	design tension steel resistance of the channel bolt
$N_{Rd,s,l}$	design tension steel resistance of the channel lip and mechanical interlock
$N_{Rk,hook,i}$	characteristic tension resistance of the hooked part of a rebar
$N_{Rk,bond,i}$	characteristic tension bond resistance of a rebar
$V_{Ed,x}^{a}$	design shear force acting on the anchor in direction of the channel axis
$V_{Ed,y}^{a}$	design shear force acting on the anchor transverse to the channel axis
$V_{Ed,x}^{cb}$	design shear force acting on the channel bolt in direction of the channel axis
$V_{Ed,y}^{cb}$	design shear force acting on the channel bolt transverse to the channel axis
$V_{Rd,s}$	design shear resistance for steel failure modes, in general
$V_{Rd,s,a}$	design shear steel resistance of the anchor
$V_{Rd,s,a,x}$	design shear steel resistance of the anchor in direction of the x-axis
$V_{Rd,s,a,y}$	design shear steel resistance of the anchor in direction of the y-axis
$V_{Rd,s,c,x}$	design shear steel resistance of the connection between anchor and channel in direction of the x-axis
$V_{Rd,s,c,y}$	design shear steel resistance of the connection between anchor and channel in

	direction of the y-axis
$V_{Rd,s,l,x}$	design steel resistance of the local flexure of the channel in x-direction
$V_{Rd,s,l,y}$	design steel resistance of the local flexure of the channel in y-direction
$V_{Rd,s,M}$	design steel shear resistance for shear force with lever arm
$V_{Rk,re,max}$	characteristic resistance of failure of concrete in front of anchor channel arranged close and parallel to the edge and loaded perpendicular to the edge with supplementary reinforcement
$V_{Rk,s,l,x}$	characteristic steel resistance of the local flexure of the channel in x-direction
$V_{Rk,s,l,y}$	characteristic steel resistance of the local flexure of the channel in y-direction
$V_{Rk,s,a,x}$	characteristic steel shear resistance of the anchor in direction of the x-axis
$V_{Rk,s,a,y}$	characteristic steel shear resistance of the anchor in direction of the y-axis
$V_{Rk,s,c,x}$	characteristic steel shear resistance of the connection between anchor and channel in direction of the x-axis
$V_{Rk,s,c,y}$	characteristic steel shear resistance of the connection between anchor and channel in direction of the y-axis
$V_{Rk,s,M}$	characteristic steel shear resistance for shear force with lever arm
ψ_1, ψ_2, ψ_3	effectiveness factors for the supplementary reinforcement
ψ_{cr}	factor to account for cracks along the longitudinal axis of the stirrups
$s_{l,V}$	characteristic spacing for channel lip failure under shear
s_{cbo}	spacing of channel bolts
$A_{s,a}$	stressed cross section area of the anchor
$A_{s,cb}$	stressed cross section area of the channel bolt
$f_{uk,a}$	nominal ultimate steel strength of anchor
$f_{uk,cb}$	nominal ultimate steel strength of channel bolt
$\gamma_{Ms,l,x}$	partial factor for steel failure of the channel lips in x-direction
c_c	concrete cover of stirrups in direction to the edge
c_{ch}	distance between end of the channel and concrete edge
e_i	distance of the stirrup leg from the anchor under consideration
n_a	number of anchors of an anchor channel

3.3 Units

In this Technical Report SI-units are used. Unless stated otherwise in the formulae, the following units are used: Dimensions are given in mm, cross sections in mm^2, section modulus in mm^3, moment of inertia in mm^4, forces and loads in N and stresses, strengths and moduli of elasticity in N/mm^2.

4 Basis of design

EN 1992-4 applies generally.

The transfer of shear load acting in the direction of the longitudinal axis of the channel by mechanical interlock from the channel bolt to the channel is more sensitive to installation than in the cases of tension and transverse shear loading. For this reason, an additional factor is incorporated in the partial factor for material as follows:

$$\gamma_{Ms,l,x} = \gamma_{inst} \cdot \gamma_{Ms,l} \tag{4.1}$$

where

γ_{inst} product dependent factor to account for sensitivity to installation, given in the relevant European Technical Product Specification.

Anchor channels should provide safe and effective resistance to load. This is ensured by considering the effect of installation conditions on the design resistance via the factor γ_{inst}. For anchor channels that have been qualified to resist shear loads in the longitudinal direction, the value of the factor γ_{inst} which takes into account the sensitivity of the anchor channel to installation to be applied to the verification of the channel lip and mechanical interlock between channel lip and notching channel bolt (Figure 1a)) or serrated channel lip and matching locking channel bolt (Figure 1b)) depends mainly on the conversion of torque to tension force on the channel bolt and on inaccuracies in the placement of the channel such as recessed anchor channels. The relationship between torque and tension force can vary considerably for different products. In the prequalification procedure parameters governing the installation safety should be considered.

Therefore γ_{inst} shall be determined as part of the prequalification of the anchor channel. It is product dependent.

The value of γ_{inst} should not be altered. For the ideal case of anchor channels completely insensitive to installation and installation conditions, γ_{inst} is 1,0. For anchor channels that show sensitivity to the quality of the installation, the value of γ_{inst} is higher.

5 Durability

EN 1992-4 applies.

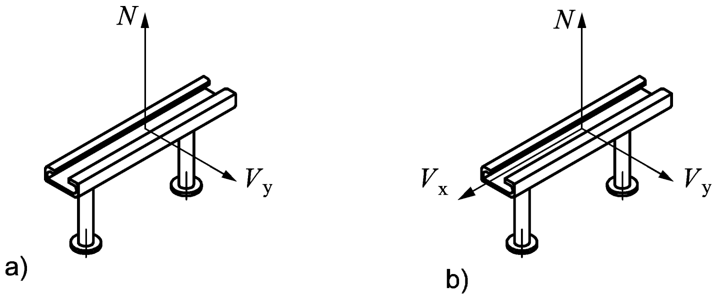
6 Derivation of forces acting on anchor channels - Analysis

6.1 General

The loads may act at any arbitrary position of the anchor channel within the length provided by the European Technical Product Specification.

The load directions covered in EN 1992-4:2018 and this document are shown in Figure 2. The loads may occur in any combination.

Anchor channels transfer tension by means of a channel bolt into the channel and from the channel via anchors fixed to the bottom of the channel profile into the concrete. Shear loads are transferred by means of channel bolt into the channel and from the channel and the anchors into the concrete. For reasons of simplicity in the latter case it is assumed that only the anchors contribute to the load transfer into the concrete. This facilitates the determination of the resistance in case of combined shear and tension loads acting on the anchor channel.



Key

a) EN 1992-4:2018

b) this CEN/TR in conjunction with EN 1992-4:2018

Figure 2 — Load directions

The load distribution to the anchors of an anchor channel depends on the load direction and the location of the anchor channel.

For tensile loads and shear loads acting transverse to the longitudinal axis of the channel the loads on the anchors depend on the stiffness of the anchor channel independent of the location of the anchor channel with respect to the edge of the concrete member, see EN 1992-4:2018, 6.3.

For shear loads acting in direction of the longitudinal channel axis the following shall be observed:

— In case of anchor channels situated remote from the edge it is assumed that the shear loads are distributed equally to all anchors of the anchor channel, see 6.3.2.1.

— In case of anchor channels installed transverse and close to the concrete edge for the verification of concrete edge failure only the anchor closest to the edge is considered to carry the shear load (see 6.3.2.2.2). For the verification of concrete pry-out failure and steel failure of the anchors the shear loads are distributed as for anchor channels remote from the edge.

— In case of anchor channels installed parallel and close to the concrete edge the shear loads are distributed equally to all anchors of the anchor channel, see 6.3.2.2.3.

6.2 Tension loads

EN 1992-4:2018, 6.3 applies.

6.3 Shear loads

6.3.1 Shear loads $V_{Ed,y}$ acting transverse to the longitudinal axis of the channel

EN 1992-4:2018, 6.3 applies. V_{Ed} shall be replaced by $V_{Ed,y}$.

6.3.2 Shear loads $V_{Ed,x}$ acting in direction of the longitudinal axis of the channel

6.3.2.1 Anchor channels remote from edges

(1) Anchor channels are assumed remote from edges if the edge distance in all directions is $c \geq \max(10\ h_{ef}$ or $60\ d_a)$ (Figure 3).