EUROPEAN ASSESSMENT DOCUMENT

EAD 330667-00-0602

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HOT-ROLLED MOUNTING CHANNEL

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation No (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1   SCOPE OF THE EAD

1.1   Description of the construction product

This European Assessment Document (EAD) covers the system of hot-rolled mounting channels and appropriate channel bolts made of carbon steel or stainless steel.

The product is not covered by a harmonised European standard (hEN).

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

(1)   The construction product (Hot-rolled mounting channel) consists of a channel profile with two lips produced of carbon steel or stainless steel as illustrated in Fig. 1.1 . This EAD covers hot-rolled mounting channels with a smooth surface of the channel lips in combination with channel bolts with a smooth surface on the underside of the channel bolt head in contact with the channel (see Fig. 1.1).

(2)   The materials for the Hot-rolled mounting channels are listed in Table 1.2. If the hot-rolled mounting channel consists of components involving different materials, the different materials shall be noted.

The hot-rolled mounting channels are welded on a steel plate as shown in Fig. 1.1. A fixture shall be connected to the hot-rolled mounting channel by channel bolts (hook head channel bolts) with appropriate hexagon nuts and washers in accordance with Fig. 1.1.

1.1.1   Channel profile

(1)   The channel profile consists of carbon steel or stainless steel.

(2)   The channel profile is made by hot-forming manufacturing process.

(3)   The channel profile dimensions and channel length are given in Table 1.1 shall be kept.

Table 1.1:   Minimum and maximum dimensions of hot-rolled mounting channels covered by this EAD.

Channel height h_{ch}	≥ 15 mm ≤ 51 mm
Channel width b_{ch}	≥ 25 mm ≤ 76 mm
channel length l_{ch}	≥ 100 mm

1.1.2   Channel bolts (hook-head channel bolts)

(1)   The geometry of the channel bolt head fits into the internal shape of the channel.

(2)   A marking at the end of the channel bolt shows the correct placement of the channel bolt.

(3)   Shape of shaft and thread follow EN ISO 4018 [9]

(4)   The indication of the strength class follows EN ISO 898-1 [10] and/or EN ISO 3506-1 [11].
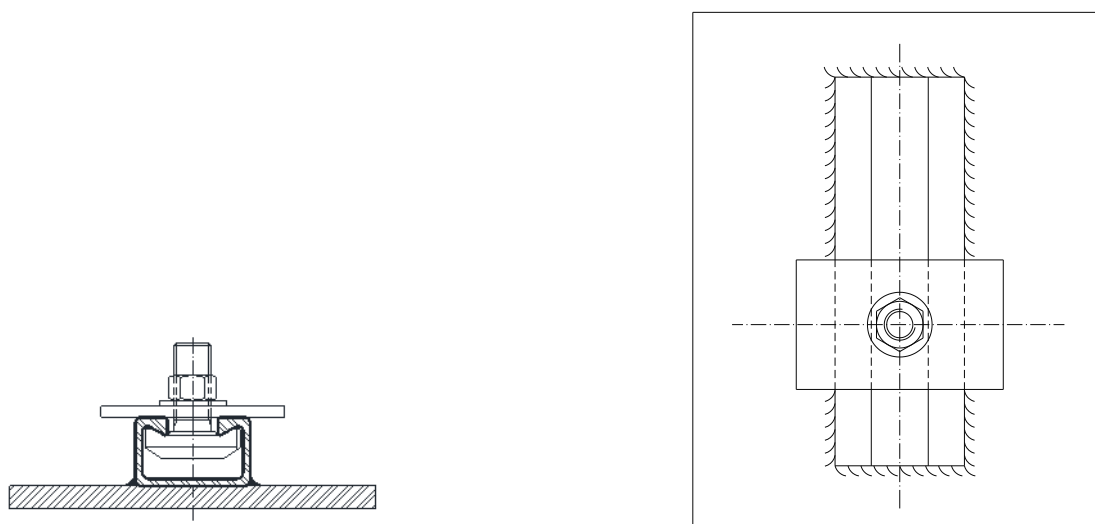
a)   Hot-rolled mounting channel   b)   Hot-rolled mounting channel

Fig. 1.1:   Example of a hot-rolled mounting channels with corresponding channel bolt

Table 1.2:   Designations and materials

Part	Designation	Material
1	Channel	Steel acc. to EN 10025 [4]
		Steel acc. to EN 10149 [13]
		Stainless steel acc. to EN 10088 [5]
3	Channel bolt	Shaft and thread form following EN ISO 4018 [6]
		Carbon steel, $4.6 \leq$ strength class ≤ 8.8 acc. to EN ISO 898 [7]
		Stainless steel, $50 \leq$ strength class ≤ 70 following EN ISO 3506 [8]
4	Washer	Steel, hardness class ≥ 200 HV acc. to EN ISO 7089 [15], EN 10025 [4]
		Stainless steel, hardness class ≥ 200 HV acc. to EN ISO 7089 [15], EN 10088 [5]
5	Nut EN ISO 4032:2012 [11] and	Steel, strength class 5, 6 or 8, acc. to EN ISO 898 [7]
		Stainless steel, strength class 50 or 70 acc. to EN ISO 3506-2

Part	Designation	Material
	EN ISO 4034:2012 [12]	[8]

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

(1) This EAD covers hot-rolled mounting channels welded on a steel plate. The installation is described in the manufacturer's product installation instruction. The manufacturer's Product Installation Instructions (MPII) is clear and provides all necessary information for a safe installation.

(2) This EAD covers hot-rolled mounting channel under static or quasi-static loads.

(3) The hot-rolled mounting channel may be used to transmit tensile loads, shear loads perpendicular to the longitudinal channel axis or any combination of these loads in accordance with Fig. 2. into the concrete. The shear load may be applied without or with lever arm in respect to the steel surface.

(4) Loads with an arbitrary distance may be applied at any position within a defined distance from the end of the channel.

(5) Any fixture may be fixed to the hot-rolled mounting channel using a channel bolt.

tension load: z-direction

shear load: y-direction
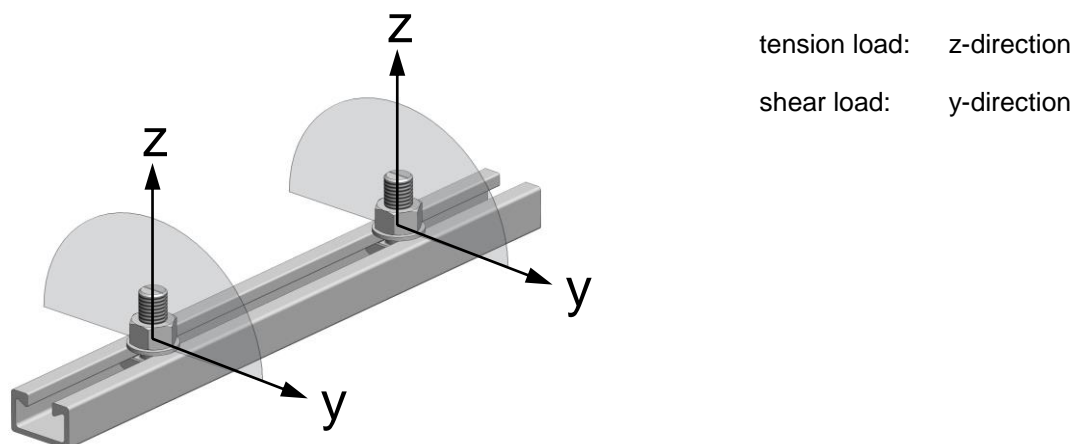
Fig. 1.2:   Admissible load directions covered by this EAD: tension loads and shear loads perpendicular to the longitudinal axis

(6) This EAD provides assessment requirements resulting in performance characteristics consistent with and to be used in the design provisions of

(7) EN 1992-4 [1]

(8) Technical Report Anchor channels [2]

(9) Note: Since EN 1992-4 has not yet been published the TR Anchor channels is intended to bridge the time span until the publication of EN 1992-4. The design method given in the TR Anchor channels complies with the final draft of EN 1992-4. Once EN 1992-4 has been published no ETA should be issued with reference to this Technical Report.

1.2.2 Working life/ Durability

(1) The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the hot-rolled mounting channel for the intended use of 50 years when installed in the works (provided that the hot-rolled mounting channel is subject to appropriate installation (see 1.1)). These provisions are based upon the current state of the art and the available knowledge and experience.

(2) When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

(3) The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

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[2] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the working life referred to above.

1.3   Specific terms used in this EAD
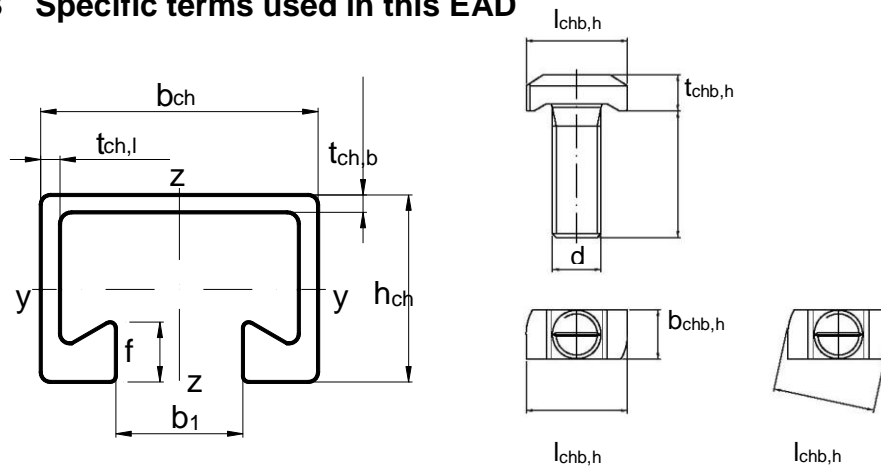
Fig. 1.3: Specific terms of the hot-rolled mounting channel and channel bolts

The definitions and symbols used in this EAD are given in EN 1992-4 [1] and Technical Report Anchor channels [2] and below.

b_1	=	channel opening	[mm]
b_{ch}	=	channel width	[mm]
$b_{chb,h}$	=	width of head of channel bolt	[mm]
d	=	diameter of channel bolt	[mm]
f	=	height of channel lips	[mm]
h_{ch}	=	channel height	[mm]
$l_{chb,h}$	=	length of channel bolt head	[mm]
$t_{ch,l}$	=	thickness of channel flanges	[mm]
$t_{ch,b}$	=	thickness of channel back	[mm]
$t_{chb,h}$	=	height of channel bolt head	[mm]
$s_{min,cbo}$	=	mimimum spacing between channel bolts	[mm]

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1 shows how the performance of the hot-rolled mounting channel is assessed in relation to the essential characteristics.

Table 2.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance (level, class, description)
	Basic Works Requirement 1: Mechanical resistance and stability		
1	Characteristic resistance for tension under static and quasi-static loading	2.2.2	Level ($N^0_{Rk,s,l}$, $N_{Rk,s}$, $s_{l,N}$,)
2	Characteristic resistance for shear under static and quasi-static loading	2.2.3	Level ($V^0_{Rk,s,l}$, $V_{Rk,s}$, $s_{l,V}$,)
3	Installation parameters	2.2.4	Level ($s_{min,cbo}$, $T_{inst,}$)
4	Geometric values	2.2.5	Level (h_{ch}, b_{ch}, $t_{ch,l}$, $t_{ch,b}$, b_1, f, $l_{chb,h}$, $t_{chb,h}$, $b_{chb,h}$, d, l_y)
5	Durability	2.2.6	Description
6	Characteristic resistance for fatigue tensile loading	2.2.7	Level (ΔN_{Rsk})
	Basic Works Requirement 2: Safety in case of fire		
7	Reaction to fire	2.2.8	Class((A1) according to EN 13501-1)

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

Characterisation of hot-rolled mounting channel to be assessed shall be done in accordance with available specifications, notably the hot-rolled mounting channel shall be characterised according to Table 2.2.

Table 2.2   Material and dimensions of the product

No	Product property	Testing procedure
(1)	(2)	(3)
1	Dimensions acc. Fig.1	Measuring or optical
2	Tensile Load (N_p) or tensile strength (f_{uk})	Similar to ISO 898-1
3	Yield strength (f_{yk} or $N_{p0.2}$)	Similar to ISO 898-1
4	Core hardness and Surface hardness (at specified functioning relevant points of the product)(where relevant)	Tests acc. to EN ISO 6507 or EN ISO 6508
5	Zinc plating (where relevant)	measurement
6	Fracture elongation A_5	Similar to ISO 898-1

2.2.1   General

(1)   The characteristic resistances are determined both by tests within the context of this EAD and by the calculating methods according to EN 1992-4 [1] or Technical Report 047 "Calculation method for the performance of anchor channel [2] taking into account the provisions according to this EAD.

(2)   Testing shall be done according to Table 2.3 and the following sections.

(3)   The tests shall be performed according to this EAD.

(4)   In tests with hot-rolled mounting channels, the channel bolts shall not be pre-stressed, if not noted otherwise for a specific test series.

(5)   For each individual test the peak load shall be determined, the failure mode shall be given and the load-displacement relationship shall be recorded continuously, if not noted otherwise with a specific test series.

Table 2.3   Required tests under static or quasi-static actions (tension and shear)

N°	Tests acc. to the following sections	Concrete	Number of tests	Channel	Material	Channel bolt	
						∅	Quality
1	2.2.2.1 Failure of channel lips, pull-out channel bolt [2],[12]	—	≥ 5[1]	all	all	see 2.2.2.1	
2	2.2.2.2 Channel bolt head	—	≥ 5	see 2.2.2.2	all	see 2.2.2.2	
3	2.2.2.3 Bending strength of channel	—	—	—	—	see 2.2.2.3	
4	2.2.2.4 Torque tests	—	≥ 5	all	all	all	all
5	2.2.3.2 Bending or failure of channel lips	—	≥ 5[1],[2]	all	all	see 2.2.3.2	
6	2.2.3.3 Bending of channel bolt	—	—	—	—	see 2.2.3.3	
7	2.2.3.4 Interaction for combined tension and shear loads	—	—	—	—	see 2.2.3.4	
8	2.2.7.1 Steel fatigue failure	—	≥ 20	all	all	min	min[3]

[1]   If the coefficient of variation of the failure loads is v ≤ 5%, the number of tests can be reduced to n= 3.

[2]   Five tests need to be conducted with the channel bolt positioned over an anchor.

[3]   The fatigue strength of the channel bolts can be determined before testing the complete system. The tests of the system must be carried out with those channel bolts which achieved the minimum fatigue strength

(6)   The 5%-fractile of the ultimate loads of a test series shall be calculated according to statistical methods for a confidence level of 90%. In general a normal distribution and an unknown standard deviation shall be assumed.

$$F_{5\%} = F_m \cdot \left(1 - k_s \cdot V_{test}\right)$$
(2.1)

F_m =   mean failure load of a test series

k_s =   tolerance factor corresponding to a 5 percent probability of non-exceedance with a confidence of 90%, in general derived from a Gaussian distribution for which the population standard deviation is unknown, values for specific sample sizes n may be taken from statistical handbooks (e.g.[17]).

V_{test} =   coefficient of variation of failure loads of a test series

(7)   The test results shall be normalized to the nominal values (strength and dimensions). The normalization shall take into account the mode of failure.

(8)   The characteristic resistances N_{Rk} and V_{Rk} evaluated from the results of tests shall be rounded down in 0,1 kN steps.

(9)   The levels given in Table 2.1 shall be stated in the ETA.

2.2.2   Characteristic resistance for tension under static and quasi-static loading

2.2.2.1   Steel failure of the channel lips and subsequent pull-out of channel bolt under tension load (Table 2.3, line 1)

(1)   Purpose: Determination of the characteristic resistance of the channel against bending and local rupture of the channel lips.

(2)　Required tests:

　　　a) Tests according to Table 2.3, line 1 shall be performed. All channel sizes with all materials specified by the manufacturer shall be tested. The channel bolt with the smallest head size and maximum steel strength that, when tested, still results in steel failure of a part of the hot-rolled mounting channel other than the channel bolt shall be used. If the largest channel bolt still results in bolt failure, the bolt failure load shall be taken as load corresponding to lip failure.

(3)　Test conditions:

　　　The tests may be performed on channels not cast into concrete

　　　a) The test may be performed with a channel bolt with the smallest head size and maximum steel strength that, when tested, still results in steel failure of a part of the hot-rolled mounting channel other than the channel bolt.

　　　The channel bolt shall not be pre-stressed and the tension load shall be applied to the channel bolt shaft without a fixture or washer.

　　　The test shall be conducted with a test rig as shown in Fig. 2.1. Report load-displacement curve, failure load and failure mode of each test.
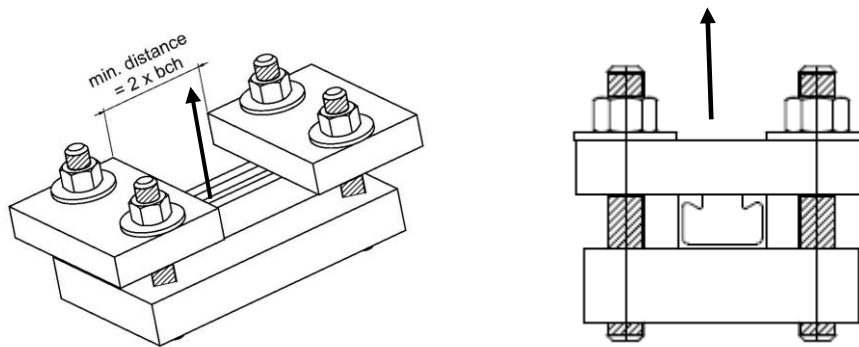

Fig. 2.1:　Test rig for steel failure tests

(4)　If test series 1 of Table 2.3 has been performed, the characteristic resistance $N_{Rk,s,l}$ shall be determined according to Equation (2.2) taking into account the actual dimensions and actual steel strength.

$$N_{Rk,s,l} = N_{Rk,s,l,test} \cdot \frac{f_{uk}}{f_{u,test}} \cdot \frac{t_{ch,nom}}{t_{ch,test}} \qquad [N] \qquad (2.2)$$

$N_{Rk,s,l,test}$	=	5%-fractile of the ultimate loads measured in test series 3 according to Table 2.3	[N]
f_{uk}	=	nominal characteristic tensile strength of channel	[N/mm²]
$f_{u,test}$	=	actual tensile strength of channel back	[N/mm²]
$t_{ch,nom}$	=	nominal thickness of channel lips	[mm]
$t_{ch,test}$	=	actual thickness of channel lips	[mm]

(5)　If the thickness of the channel lips varies as a function of the distance from the end of the lips the nominal and actual thickness of the channel back may be used in equation (2.2) instead of the thickness of the channel lips.

2.2.2.2   Steel failure of the channel bolt under tension load (Table 2.3, line 2)

(1)   Purpose: Determination of the characteristic resistance of the channel bolt.

(2)   Required tests: Perform the tests according to Table 2.3, line 2. Channel bolts of all materials shall be tested. Channel bolts with the smallest ratio of head thickness multiplied by the width of the channel bolt head to cross section of channel bolt shaft for a given channel size shall be used as components of the test specimens. Additionally at the option of the manufacturer, in case of failure of the bolt head, the channel bolt with the next larger ratio head thickness multiplied by the width of channel bolt head to cross section of channel bolt shaft may be tested until failure of the channel bolt shaft is observed. If it is not obvious which channel bolt is unfavourable, all channel bolt sizes shall be tested.

(3)   Test conditions: The test is carried out on hot-rolled mounting channels not cast into concrete. The channel bolts may be tested in a channel section that is sufficiently restraint to cause failure of the channel bolt (see Fig. 2.2 a)). Alternatively, channel bolts may be tested in a steel template (see Fig. 2.2 b)) which shall represent the inner profile of the channels (angle of channel lips and width of slot). If the channel bolt is intended to be used for different channel sizes, conduct the tests in the channel profile (see Fig. 2.2 a)) or template (see Fig. 2.2 b)) with the maximum width of the slot. Insert the channel bolt in the channel profile or template respectively, and apply the tension load with a coupling nut to avoid thread failure. No fixture or washer between the coupling nut and the steel template or channel section shall be used. Report the failure load and failure mode of each test.
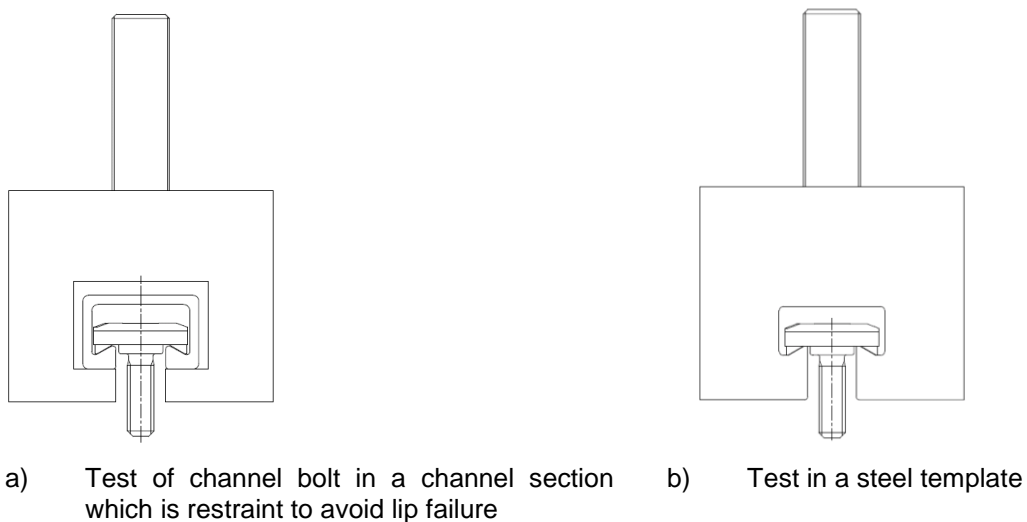

a)   Test of channel bolt in a channel section   b)   Test in a steel template
       which is restraint to avoid lip failure

Fig. 2.2:   Tests on channel bolts

(4)   In case of failure of the shaft of the channel bolt the value $N_{Rk,s}$ shall be calculated according to equation (2.3). The 5%-fractile of the measured failure loads for bolt failure (not normalized) shall be larger than $N_{Rk,s}$.

$$N_{Rk,s} \quad = \quad A_s \cdot f_{uk} \leq N_{Rk,s,test} \qquad\qquad \text{[N]} \qquad (2.3)$$

A_s	=	stressed cross section of channel bolt	[mm²]
f_{uk}	=	nominal characteristic tensile strength of channel bolt shaft	[N/mm²]
$N_{Rk,s,test}$		5%-fractile of the ultimate loads measured in test series 4 according to Table 2.3, not normalized	[N]

(5)   In case of failure of the channel bolt head the characteristic resistance $N_{Rk,s}$ shall be calculated according to equation (2.4) taking into account the actual steel strength of the channel bolt shaft.

$$N_{Rk,s} \quad = \quad N_{Rk,s,test} \cdot \frac{f_{uk}}{f_{u,test}} \qquad\qquad [N] \qquad (2.4)$$

$N_{Rk,s,test}$ = see Equ. (2.3)   [N]

f_{uk} = nominal characteristic tensile strength of channel bolt shaft   [N/mm²]

$f_{u,test}$ = actual tensile strength of channel bolt shaft   [N/mm²]

(6)   The smaller of the values calculated according to equation (2.3) and (2.4) shall be reported as $N_{Rk,s}$ in the ETA.

2.2.2.3   Steel failure by exceeding the bending strength of the channel under tension load (Table 2.3, line 3)

(1)   Purpose: Determination of the characteristic resistance in case of bending failure of the channel

(2)   Required tests:

     a) No tests are required

     b) The characteristic bending resistance of the channel shall be calculated according to EN 1993-1-1 [16]

        The length, spacing and thickness of the welding seams shall be calculated according to EN 1993-1-8 [24]

2.2.2.4   Assessment of maximum installation torque moment (Table 2.3, line 4)

(1)   Purpose: Determination of the maximum installation torque moment that can be applied without inducing damage to the channel bolt and/or channel.

(2)   Required tests: Perform torque tests with channel bolts of all sizes and materials and coatings in channels of all sizes and materials specified for the tested channel bolt. Exceptions see below:

     a) If the results of torque tests with the most unfavourable combination material and coating are accepted for all variants only the most unfavourable variant need to be tested. If the most unfavourable combination cannot be established channel bolts with all materials and coatings shall be tested.

     b) Only the smallest, medium and largest diameters of channel bolts need to be tested in hot-rolled mounting channels with the medium size of the range of hot-rolled mounting channels specified by the manufacturer for the tested channel bolts, if the pre-stressing force $N_{95\%}$ is calculated according to equation (2.5) with a value k = min (0,2; k_{test}) where k_{test} is determined according to equation (2.6).

     c) No torque tests are required with channel bolts without lubricants or friction-reducing coatings if the pre-stressing force $N_{95\%}$ is calculated according to equation (2.5) with k = 0,15.

$$N_{95\%} \quad = \quad \frac{\alpha \cdot T_{inst}}{k \cdot d} \qquad\qquad [N] \qquad (2.5)$$

$N_{95\%}$ = 95%-fractile of the pre-stressing force at T = $\alpha \cdot T_{inst}$ [N]

α = 1,0 for verifications in accordance with 2.2.2.4 (7)

    = 1,3 for verifications in accordance with 2.2.2.4 (8)

T_{inst} = installation torque moment specified by the manufacturer and given in the ETA   [Nmm]

k	=	friction factor to be taken as lower bound value (5%-fractile)	[-]
d	=	diameter of the channel bolt shaft	[mm]

$$k_{test} \quad = \quad k_{test,m} \cdot \left(1 - k_s \cdot v_{test}\right) \qquad \text{[N]} \qquad (2.6)$$

$k_{test,m}$	=	mean of the values $k_{test,i}$ calculated according to equation (2.7)	[N]

$$k_{test,i} \quad = \quad \dfrac{\alpha \cdot T_{inst}}{N_{test,i}} \qquad\qquad\qquad\qquad (2.7)$$

$N_{test,i}$	=	pre-stressing force at $T = \alpha \cdot T_{inst}$ measured in test i	[N]
		$\alpha, T_{inst,d}$ see equation (2.5)	
		k_s, v_{test} see equation (2.1)	

(3)   Test conditions: The torque tests shall be carried out on hot-rolled mounting channels not cast into concrete. A test set-up similar to the one shown in Fig. 2.1 shall be used. Double-side abrasive paper of sufficient roughness shall be placed between washer and test fixture to prevent rotation of the washer relative to the fixture during application of the torque. The diameter of the clearance hole in the fixture shall correspond to the value given in Table 2.4 below. Apply torque up to a torque moment $T \geq 1{,}3 \, T_{inst}$

Table 2.4   Diameter of clearance hole in the fixture

external diameter d or d_{nom} (mm)	6	8	10	12	14	16	18	20	22	24	27	30
diameter d_f of clearance hole in the fixture (mm)	7	9	12	14	16	18	20	22	24	26	30	33

(4)   If torque tests have been performed according to 2.2.2.4 calculate the 95%-fractile of the measured pre-stressing forces, $N_{95\%,test}$, according to equation (2.8)

$$N_{95\%,test} \quad = \quad N_{m,test} \cdot \left(1 + k_s \cdot v_{test}\right) \qquad \text{[N]} \qquad (2.8)$$

$N_{m,test}$	=	mean pre-stressing force at $T = \alpha \cdot T_{inst}$	[N]
k_s, v_{test}	=	see equation (2.1)	
α, T_{inst}	=	see equation (2.5)	

(5)   If torque tests have been performed according to 2.2.2.4 (2) a) calculate the 95%-fractile of the pre-stressing force, $N_{95\%}$, according to equation (2.5) with k = min (0.2; k_{test}) with k_{test} according to equation (2.6).

(6)   If no torque tests have been performed (compare 2.2.2.4 (2) b)) calculate the 95%-fractile of the pre-stressing force, $N_{95\%}$, according to equation (2.5) with k = 0.15.

(7)   The 95%-fractile of the pre-stressing force ($N_{95\%,test}$ or $N_{95\%}$ respectively) at $T = 1{,}0 \cdot T_{inst}$ ($\alpha = 1{,}0$)) shall not exceed $N_{Rk,s,l}$ according to 2.2.2.1.

(8)   The 95%-fractile of the pre-stressing force ($N_{95\%,test}$ or $N_{95\%}$, respectively) at $T = 1{,}3 \cdot T_{inst}$ ($\alpha = 1{,}3$)) shall not exceed the characteristic resistance of the channel bolt evaluated in accordance with 2.2.2.2 multiplied by the ratio f_{yk}/f_{uk} where f_{yk} (f_{uk}) are the nominal yield strength (ultimate strength) of the channel bolt.

(9)   If the conditions according to 2.2.2.4 (7) to (8) are not fulfilled, then the installation torque moment shall be reduced until the requirements are fulfilled.

(10)   The installation torque moment T_{inst} for general application and steel-steel contact, which fulfils the above listed requirements, shall be stated in the ETA for each size, kind of manufacturing, material and coating of the channel bolt if applicable and each size and material of the channel if applicable.

2.2.3   Characteristic resistance for shear under static and quasi-static loading

2.2.3.1   Steel failure of the channel bolt under shear load without lever arm (Table 2.3, line 5)

(1)   Purpose: Determination of the characteristic resistance $V_{Rk,s}$ for steel failure of the channel bolt under shear loading without lever arm.

(2)   Required tests: No tests are required

(3)   The characteristic resistance for steel failure of the channel bolt under shear loading without lever arm, $V_{Rk,s}$, shall be calculated according to equation (2.9).

$$V_{Rk,s} \quad = \quad \alpha_s \cdot N_{Rk,s} \qquad\qquad [N] \qquad\qquad (2.9)$$

α_s =   0,6 (for carbon steel, strength class < 8.8 and stainless steel, $50 \leq$ strength class ≤ 70)   [-]

        =   0,5 (for carbon steel, strength class = 8.8)   [-]

A_s, f_{uk} see equation (2.3)

(4)   The characteristic resistances, $V_{Rk,s}$, of all channel bolt sizes in all materials and steel grades shall be given in the ETA.

2.2.3.2   Local steel failure of channel lips (Table 2.3, line 6)

(1)   Purpose: Determination of the characteristic resistance of the channel under shear loading in case of bending and local failure of the channel lips resp. welding seams.

(2)   Required tests:

        a) If $V_{Rk,s,l} \leq N_{Rk,s,l}$ is accepted, no tests are required.

        b) Tests according to Table 2.3, line 6 are required, if $V_{Rk,s,l} > N_{Rk,s,l}$ is applied for. All hot-rolled mounting channel sizes and steel types shall be tested.

(3)   Test conditions: The test is carried out on hot-rolled mounting channels not cast into concrete (see Fig. 2.3). The hot-rolled mounting channels have to be fixed on a steel plate by welding on the front end of the mountain channel. The length of the channel shall correspond to the min. bolt distance for each channel size. The substructure for the tests must provide sufficient strength to accommodate the horizontal loads. Apply a shear load in the middle of the channel bolt until failure. Record the applied shear load, the corresponding displacement of the anchor channel, the ultimate load and the failure mode.

        If other channel lengths and/or welding seams (other spacing, other thickness etc.) will be used, the tests have to be performed with these boundary conditions.
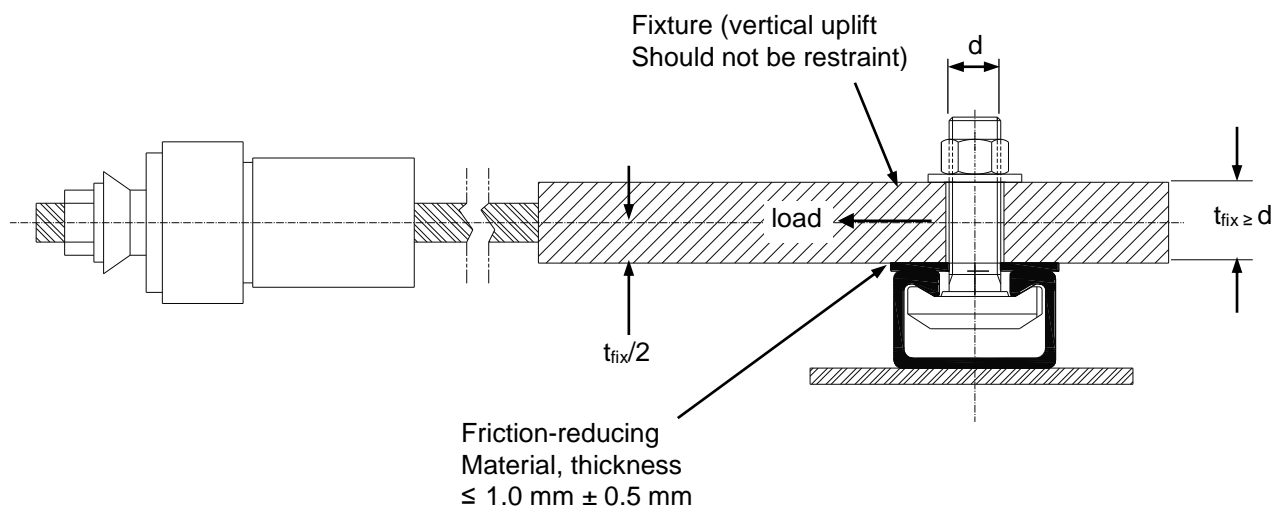
Fig. 2.3: Example of test rig for the shear load tests acc. to table 2.3, line 6

(4)   The characteristic resistance of the channel lips, $V_{Rk,s,l}$, shall be determined according to equation (2.10) taking into account the actual steel strength of the channel back and the actual dimensions of the channel lips.

$$V_{Rk,s,l} = V_{Rk,s,l,test} \cdot \frac{f_{uk}}{f_{u,test}} \cdot \frac{t_{ch,nom}}{t_{ch,test}} \qquad [N] \qquad (2.10)$$

$V_{Rk,s,l,test}$	=	5%-fractile of the ultimate loads measured in test series 13	[N]
f_{uk}	=	nominal characteristic tensile strength of channel	[N/mm²]
$f_{u,test}$	=	actual mean tensile strength of channel back	[N/mm²]
$t_{ch,nom}$	=	nominal dimension of channel lips or channel back	[mm]
$t_{ch,test}$	=	actual dimension of channel lips or channel back	[mm]

2.2.3.3   Steel failure by bending of the channel bolt under shear load with lever arm (Table 2.3, line 7)

(1)   <u>Purpose:</u> Determination of the characteristic bending resistance of the channel bolt subjected to shear load with lever arm.

(2)   <u>Required tests:</u> No tests are required.

(3)   The characteristic bending resistance $M^0_{Rk,s}$ of the channel bolt shall be determined according to equation (2.11).

$$M^0_{Rk,s} = \begin{array}{l} 1,2 \cdot W_{el} \cdot f_{uk} \quad \leq 0,5 \cdot N_{Rk,s,l} \cdot a \\ \qquad\qquad\qquad \leq 0,5 \cdot N_{Rk,s} \cdot a \end{array} \qquad [Nmm] \qquad (2.11)$$

W_{el}	=	elastic section modulus of channel bolt calculated with the equivalent diameter of the stressed cross section	[mm³]
f_{uk}	=	nominal characteristic tensile strength of channel bolt shaft	[N/mm²]
$N_{Rk,s,l}$	=	characteristic resistance of channel lips, see 2.2.2.1	[N]

a =   Distance between tension and compression force acting on the channel lips generated by the bending moment (see Fig. 2.4)

$$= \frac{1}{3}\left(b_{cbo,2} + d_{w,2} + d_{ch}\right) \qquad \text{[mm]} \qquad (2.12)$$

$b_{cbo,2}$ =   length of channel bolt head   [mm]

d_{ch} =   width of channel opening   [mm]

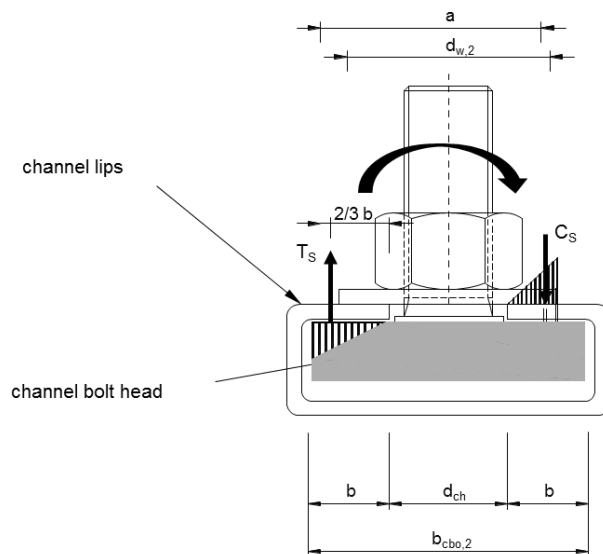$d_{w,2}$ =   diameter of washer   [mm]

Fig. 2.4:   Static system for calculating the forces on the channel lips generated by a bending moment on the channel bolt

2.2.3.4   Steel failure of the hot-rolled mounting channel due to combined tension and shear loads on hot-rolled mounting channels (Table 2.3, line 8)

(1)   Purpose: Determination of the exponent α_1 in the interaction equations for channel steel failure according to EN 1992-4 [1] or Technical Report Anchor channels [2].

(2)   Required tests:

a) No tests are required if $V_{Rk,s,l} \leq N_{Rk,s,l}$ or $\alpha_1 = 1$ is accepted.

b) As the failure mode of mountain channels is steel failure, the Exponent α_1 can be taken from Table 7.6, line 2, EN 1992-4 [1].

2.2.4   Installation parameters

The parameters T_{inst} is specified by the manufacturer. This parameter shall be used and assessed in the test series according to Table 2.3.

The parameter $s_{min,cbo} = 5\ d$.

2.2.5   Geometric values

The geometric values h_{ch}, b_{ch}, $t_{ch,l}$, $t_{ch,b}$, b_1, f, $l_{chb,h}$, $t_{chb,h}$, $b_{chb,h}$, d refer to figure 1.3. These parameters are determined by measuring.

The moment of inertia I_y is calculated according to the common valid formula: $I_y = \int z^2\ dA$.

2.2.6   Durability

Supporting evidence that corrosion will not occur is not required if the steel parts of the hot-rolled mounting channel are protected against corrosion. The protection against corrosion depends on the area of application and is categorised into C1-C4 in accordance with standard EN ISO 12944-2:

(1)   No special corrosion protection is necessary for steel parts as coatings provided for preventing corrosion during storage prior to use and for ensuring proper functioning zinc coating with a minimum thickness of 5 microns) is considered sufficient.

(2)   Metal parts of the hot-rolled mounting channel made of steel material 1.0038 or 1.0044 acc. EN 10025-2 [4], 1.0976 or 1.0979 acc. EN 10149-1 and -2 [13], 1.0213, 1.0214, 1.1132, 1.5525 or 1.5535 acc. to EN 10263-2, -3, and -4 [15], 1.5523 acc. EN 10269 [14] or 1.0401 acc. EN 10277-2 [20] hot dip galvanized according EN ISO 1461 [18] or EN ISO 10684 [19] with at least 50 μm thickness can be used.

(3)   Metal parts of the hot-rolled mounting channel made of stainless steel material 1.4401, 1.4404, 1.4571, 1.4578, 1.4362, 1.4062, 1.4162 or 1.4662 according to EN 10088-4 and 5 [25] can be used.

(4)   Metal parts of the hot-rolled mounting channel made of stainless steel material 1.4439, 1.4462 or 1.4539 according to EN 10088-4 and 5 [25] can be used.

The manufacturer declares the material number(s) as listed above.

2.2.7   Characteristic resistance for fatigue tensile loading

2.2.7.1   Steel fatigue failure of hot-rolled mounting channel due to repeated tension loads (Table 2.3, line 8)

(1)   Purpose:

Determination of the characteristic fatigue resistance of the hot-rolled mounting channel for repeated tensile loading.

(2)   Required tests:

Tests according to Table 2.3, line 8 shall be performed. The samples shall be tested to failure. In case of fatigue-tested specimen without rupture the test shall be stopped and started at a higher stress range again until failure occurs. The number of cycles at failure shall be determined and the failure mode shall be given. The following values shall be recorded:

- number of load cycles n;
- minimum load $N_{Ek,min}$;
- maximum load $N_{Ek,max}$

(3)   Test conditions:

The tests shall only be carried out on the final product, e.g. inclusive the coating for corrosion resistance. The test shall be conducted with a test rig as shown in Fig. 2.1.

The hot-rolled mounting channel shall be loaded with a sinusoidal load process. The tests have to be carried out load controlled via special non-pre-stressed screws which led to the lowest ultimate load. The load has to be controlled with the smallest $N_{Ek,min}$ as operable ($N_{Ek,min} \approx 0$) and $N_{Ek,max} = N_{Ek,min} + \Delta N_{Ek}$. The testing frequency shall be chosen to 0.1 to 20 Hz subject to the measured load process. Consequently low frequency shall be chosen for high stress ranges with resulting large plastic deformations.

The function of the normalized S-N curve according to Fig. 2.5 shall be determined by evaluating the individual tests.
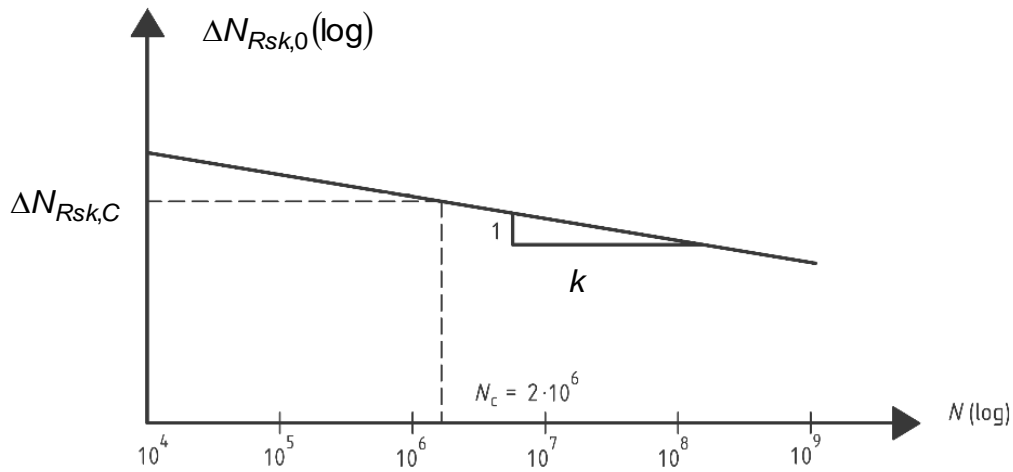
Fig. 2.5:   S-N curve for steel fatigue

Tests which are stopped without failure and started again on a higher stress range may be evaluated if the fatigue failure did not occur within the first loading. This is given when the results are within the range of the other tests.

(4)   All tests according to Table 2.3 shall be evaluated by means of a regression using the Basquin approach (straight line in a double-logarithmic scale) according to equation (2.13):

$$\log n = C - k \cdot \log \Delta N_{Rsm,0} \tag{2.13}$$

For data sets as shown in Fig. 2.6, the regression parameters C and k have to be determined using the method of linear least squares according to ISO 12107, 8.2.1.
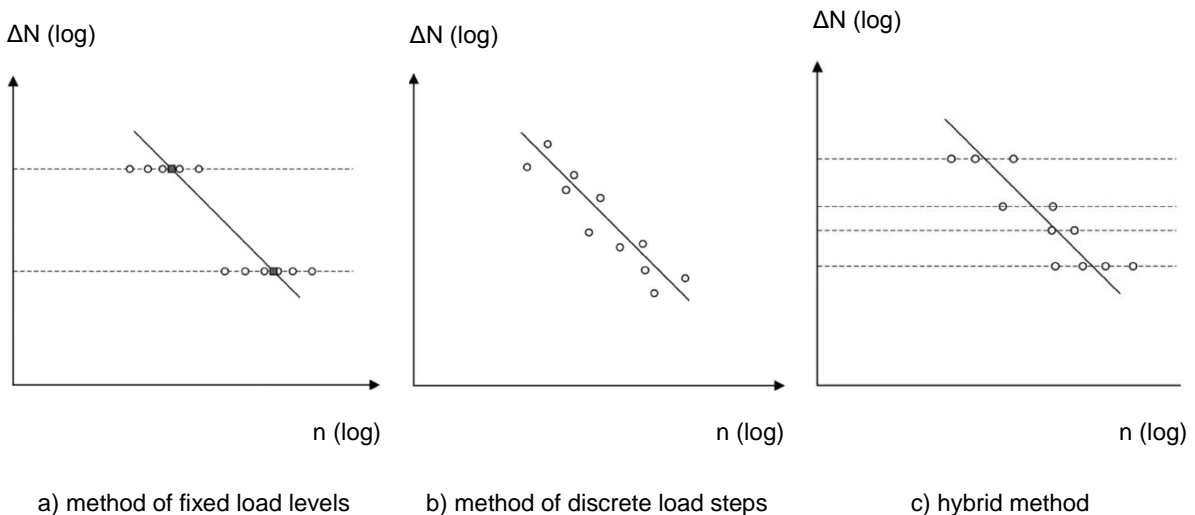
a) method of fixed load levels   b) method of discrete load steps   c) hybrid method

Fig. 2.6:   Methods of fatigue testing in the finite life regime

(5)   The characteristic resistance has to be calculated due to the statistical evaluation of the fitted curve. The characteristic fatigue resistance is defined as the 5%-fractile values with a confidence level of 90%. Taking into account the standard deviation σ according to ISO 12107, 8.2.1 the characteristic resistance can be calculated as follows:

$$\log \Delta N_{Rsk,0} = \frac{1}{k} \cdot \left(C - \log n - k_1 \cdot \sigma \right) \tag{2.14}$$

The coefficient k_1 corresponds to $k(0,05; 0,90; m-2)$ according to ISO 12107, Tab. B.1.

(6)   Caused by the statistical calculations the 5%-fractiles for the fatigue resistance shall be generated as a normalized S-N curve for a reference number of load cycles n_C. The analytical description of the S-N curve is defined by equation (2.15). A reference to EN 1993-1-9, 7.1 can be made.

$$\left(\Delta N_{Rsk,0} \right)^k \cdot n = \left(\Delta N_{Rsk,C} \right)^k \cdot n_C \tag{2.15}$$

The values k, n_C and $\Delta N_{Rsk,C}$ have to be given in the relevant ETA. The value $n_C = 2 \cdot 10^6$ load cycles is recommended. For simplification, a transformation of equation (2.15) can be performed.

$$\Delta N_{Rsk,0} = \Delta N_{Rsk,C} \cdot \left(\frac{n}{n_C} \right)^{-1/k} \tag{2.16}$$

The normalized S-N curve according to equation (2.15) or equation (2.16) describes a straight line in a double-logarithmic scale as it is shown in Fig. 2.5.

(7)   The fatigue resistances $\Delta N_{Rsk,0}$ directly taken from the S-N curve are valid only for fatigue loads with a very small minimum load level ($N_{Ek,min} = 0$). In order to consider the influence of the load level for fatigue loading on higher minimum loads ($N_{Ek,min} > 0$), the characteristic fatigue resistance ΔN_{Rsk} must be determined in dependence of the ultimate resistance $N_{Rk,s}$ using the Goodman relation as follows:

$$\Delta N_{Rsk} = \Delta N_{Rsk,0} \cdot \left(1 - \frac{N_{Ek,min}}{N_{Rk,s}} \right) \tag{2.17}$$

2.2.7.2   Additional tests

Additional tests are not required.

2.2.8   Reaction to fire

The hot-rolled mounting channel (including bolts) is considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the EC Decision 96/603/EC (as amended) without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

Therefore the performance of the product is class A1.

3   ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1   System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is: Decision 98/214/EC

The system is: **2+**.

3.2   Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of hot-rolled mounting channel in the procedure of assessment and verification of constancy of performance are laid down in Table 3.1 (control plan).

Table 3.1 is an example only; the control plan depends on the individual manufacturing process and has to be established between notified body and manufacturer for each product.

The manufacturer of the hot-rolled mounting channel shall demonstrate that the manufacturing plant is capable of performing the selected welding process in accordance with the applicable standards.

Table 3.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
(1)	(2)	(3)	(4)	(5)	(6)
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]*					
Raw material					
1	Material and material properties of channel	Inspection certificate 3.1 according to EN 10204:2004	control plan	1	Each manufacturing batch
2	Dimensions and material properties of special screws	Inspection certificate 3.1 according to EN 10204:2004 [1]			
For the welding of the anchors on the channel back the manufacturer shall possess the corresponding recognition for the intended welding process.					
[1] This does not apply, if tension tests with special screws acc. line 7 are carried out					

Continuation on next page

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
(1)	(2)	(3)	(4)	(5)	(6)
Tests after production steps					
3	Determination of the functional measurements (thickness, width, height and opening) of the channels	Gauge	control plan	3 [2]	2000 consecutive meter of the hot-rolled mounting channels resp. per 10,000 short hot-rolled mounting channel resp. once per production week
4	Checking the thickness of the weld, lengths of the weld	Gauge		3 [2]	
5	Determination of the ultimate load of the hot-rolled mounting channel by centric tension tests loaded in the line of the axis of the anchor via anchor and channel. The load shall be transferred into the channel by a load-carrying device with the corresponding geometry of appropriate heads of the bolt.	Section 2.2.2.1		3 [2]	
6 [3]	Determination of the ultimate load of the bolts by centric tension tests loaded in the line of the axis of the bolt. The load shall be transferred into the head of the screw by a load-carrying device with the corresponding geometry of appropriate channel profiles. The test shall be carried out for each bolt, each channel profile and each type of material of bolt	Section 2.2.2.2		3	
7	Determination of the thickness of the corrosion protection	Visual, measurement		3 [2]	

[2]   for each channel profile and each type of material of channel profile and anchor
[3]   alternatively if inspection certificate 3.1 is not available resp. the characteristic resistance due to steel failure of the bolt does not comply to material properties acc. to EN ISO 898-1 [7] and EN ISO 3506-1 [8]

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for the hot-rolled mounting channel are laid down in Table 3.2.

Table 3.2   Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
(1)	(2)	(3)	(4)	(5)	(6)
Initial inspection of the manufacturing plant and of factory production control					
1	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the mounting channel.	-	Laid down in control plan	-	1
Continuous surveillance, assessment and evaluation of factory production control					
2	Verifying that the system of factory production control and the specified automated manufacturing process are maintained taking account of the control plan.	-	Laid down in control plan	-	1/year

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

[1]	EN 1992-4	Eurocode 2: Design of concrete structures; Part 4: Design of fastenings for use in concrete.
[2]	EOTA TR 047	Technical Report 047, Calculation method for the performance of anchor channels;
[3]	EOTA TR 020	Technical Report 020, Evaluation of Anchorages in Concrete concerning Resistance to Fire;
[4]	EN 10025-1+2	Hot rolled products of structural steels. Part 1: General technical delivery conditions; Part 2: Technical delivery conditions for non-alloy structural steels;
[5]	EN 10088-1+3	Stainless steels Part 1: List of stainless steels, Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes;
[6]	EN ISO 4018	Hexagon head screws – Product grade C;
[7]	EN ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel. Part 1: Bolts, channel bolts and studs with specified property classes –Coarse thread and fine pitch thread; Part 2: Nuts with specified property classes-Coarse thread and fine pitch thread.
[8]	EN ISO 3506-1+2	Mechanical properties of corrosion-resistant stainless steel fasteners. Part 1: Bolts, channel bolts and studs, Part 2: Nuts;
[9]	EN 10204	Metallic products - Types of inspection documents;
[10]	EN 10263-2, -3 + 4	Steel rod, bars and wire for cold heading and cold extrusion
		Part 2: Technical delivery conditions for steels not intended for heat treatment after cold working
		Part 3: Technical delivery conditions for case hardening steels
		Part 4: Technical delivery conditions for quenching and tempering;
[11]	EN ISO 4032	Hexagon regular nuts (style 1) – Product grades A and B;
[12]	EN ISO 4034	Hexagon regular nuts (style 1) - Product grade C;
[13]	EN 10149-1+2	Hot-rolled flat products made of high yield strength steels for cold forming. Part 1: General technical delivery conditions; Part 2: Technical delivery conditions for thermomechanically rolled steels;
[14]	EN 10269	Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties, including corrigendum;
[15]	EN ISO 7089	Plain washers – Normal series – Product grade A;
[16]	EN 1993-1-1	Eurocode 3: Design of steel structures. Part 1-1: General rules and rules for buildings, including corrigendum;
[17]	Owen, D.	Handbook of Statistical Tables, Addison/Wesley Publishing Company Inc., 1962.
[18]	EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles- Specifications and test methods

[19] EN ISO 10684	Fasteners – Hot dip galvanized coatings
[20] EN 10277-2	Bright steel products – Technical delivery conditions. Part 2: Steels for general engineering purposes
[21] EN 1993-1-9	Eurocode 3: Design of steel structures. Part 1-9: Fatigue
[22] ISO 12107	Metallic materials – Fatigue testing – Statistical planning and analysis of data
[23] EN 13501-1	Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests
[24] EN 1993-1-8	Eurocode 3: Design of steel structures. Part 1-8: Design of joints
[25] EN 10088-4+5	Stainless steels Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steel for construction purposes, Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes;

INFORMATIVE ANNEX A1 - METHOD AND CRITERIA FOR ASSESSMENT

The method and criteria of 2.2 for assessment are only valid if the following conditions are met during design of the fastening and installation of the hot-rolled mounting channel (see also EN 1992-4, Annex F [1] or Technical Report Anchor channel [2]):

(1)   The following installation values have to be observed

- minimum spacing of the special screws,

- distances between the welding seams

(2)   The edge distance and length and thickness and distance of the web and special screws have to be kept to the specified values.

(3)   Use of the hot-rolled mounting channel only as supplied by the manufacturer without exchanging the components.

(4)   The qualification of an hot-rolled mounting channel according to this EAD requires following test series

a)   Tests to evaluate compliance of hot-rolled mounting channels with manufacturer's specification as set forth in (7) below.

b)   Service condition tests to establish essential characteristics of the hot-rolled mounting channel as set forth in Section 2.2.1. These values are required to verify the hot-rolled mounting channel according to EN 1992-4 [1] or Technical Report Anchor channels [2] taking into account the provisions in 1.1.

(5)   The tests according to 2.2, (4), a) and the minimum number of tests according to Table 2.3 shall be performed by an independent test agency.

(6)   The product description shall be provided in the ETA including:

a)   Generic or trade name.

b)   Height, width and length of Hot-rolled mounting channel.

c)   Geometry of channel bolts to be used in a certain channel size.

d)   Constituent materials and appropriate physical properties of channel and channel bolts including yield and tensile strength, hardness (if applicable), and coatings (if applicable).

e)   Protective coating of the hot-rolled mounting channels or channel bolt (if applicable).

(7)   The independent test agency shall measure the relevant dimensions (e.g. thickness of the channel back) and material properties (e.g. channel or channel bolts). The test results shall be checked by the independent test agency or the independent evaluation agency against the manufacturer's product specifications. The results obtained shall be evaluated to make sure that the measured values are within the manufacturer's specification including tolerances.

(8)   Installation by appropriately qualified personnel under the supervision of the person responsible for technical matters on site, in accordance with the manufacturer's installation instructions (MPII) given in the relevant ETA and information given in the design drawings

(9)   The hot-rolled mounting channel is only be used as supplied by the manufacturer without exchanging any component.

(10)   Size and spacing of channel bolts shall correspond to the design drawings.

(11)   The channel bolt (marking according to relevant ETA) shall be oriented perpendicular to the longitudinal channel axis.

(12) The installation torque moment T_{inst} given in the relevant ETA shall not be exceeded.

(13) For all types of hot-rolled mounting channels the installation torque moment shall be applied using a calibrated torque wrench with a measuring error of ± 5% of the maximum applied torque moment.

(14) The hot-rolled mounting channel shall be packed and stored such that corrosion of the product is avoided.

(15) Packages shall be labelled such that the product and manufacturing batch as well as the intended use is identifiable.

(16) The manufacturer's installation instruction which affects the characteristic data for the intended use shall be given on the package or package insert.