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European Assessment Document for

Products for installation systems for supporting technical building equipment



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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 (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 Scope of the EAD	4
1.1 Description of the construction product	4
1.1.1 Kits for installation systems	4
1.2 Information on the intended use(s) of the construction product	11
1.2.1 Intended use(s).....	11
1.2.2 Working life/Durability	11
1.3 Specific terms used in this EAD	12
1.3.1 General.....	12
1.3.2 Symbols	12
2 Essential characteristics and relevant assessment methods and criteria.....	14
2.1 Essential characteristics of the product	14
2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product	20
2.2.1 General requirements for all tests	20
2.2.2 Reaction to fire	21
2.2.3 Bending characteristics under fire exposure	23
2.2.4 Load capacity	25
2.2.5 Channels – Methods and criteria for assessing the performance	27
2.2.6 Cantilever – Methods and criteria for assessing the performance	39
2.2.7 Pipe clamp – Methods and criteria for assessing the performance	43
2.2.8 Connection element – Methods and criteria for assessing the performance	46
2.2.9 Base connector – Methods and criteria for assessing the performance	53
2.2.10 Angle Connector – Methods and criteria for assessing the performance	55
2.2.11 Threaded rod – Methods and criteria for assessing the performance	57
3 Assessment and verification of constancy of performance	60
3.1 System(s) of assessment and verification of constancy of performance to be applied	60
3.2 Tasks of the manufacturer	61
3.3 Tasks of the notified body	62
4 Reference documents	64
ANNEX A: GENERAL SPECIFICATIONS FOR TESTS UNDER FIRE EXPOSURE.....	65
ANNEX B: DETERMINATION OF THE Resistance time function $F_{Rk}(t)$	66
ANNEX C: DETERMINATION OF THE LOAD DISPLACEMENT FUNCTION $F_{Rk,30}(\delta)$.....	69
ANNEX D: DETERMINATION OF THE MAXIMUM DEFORMATION $\delta_{max}(t)$	71
ANNEX E: ALTERNATIVE DETERMINATION OF THE CHANNEL CHARACTERISTICS WITH NONLINEAR FEM-CALCULATION	72

1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers kits for installation systems for supporting technical building equipment (in the following referred to as kit(s) for installation systems) according to the Clause 1.1.1 or components according to the Clause 1.1.2 which are also placed on the market as independent products.

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, e.g., with regard to the intended end use conditions, 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 as long as the details of the assessment methods as laid down in this EAD are respected.

1.1.1 Kits for installation systems

The kits for installation systems are made of stainless or non-stainless steels, inorganic coated or uncoated and do not contain more than 1,0 % by weight or volume (whichever is the more onerous) of homogeneously distributed organic material.

They are mounted on site without drilling or welding only by fastening with screw members. Three variants of the kits are covered by this EAD:

- Variant A: Suspension with threaded rods (Figure 1.1.1.1),
- Variant B: Suspension with special elements (Figure 1.1.1.2),
- Variant C: Lateral wall mounting with suspended cantilever (Figure 1.1.1.3).

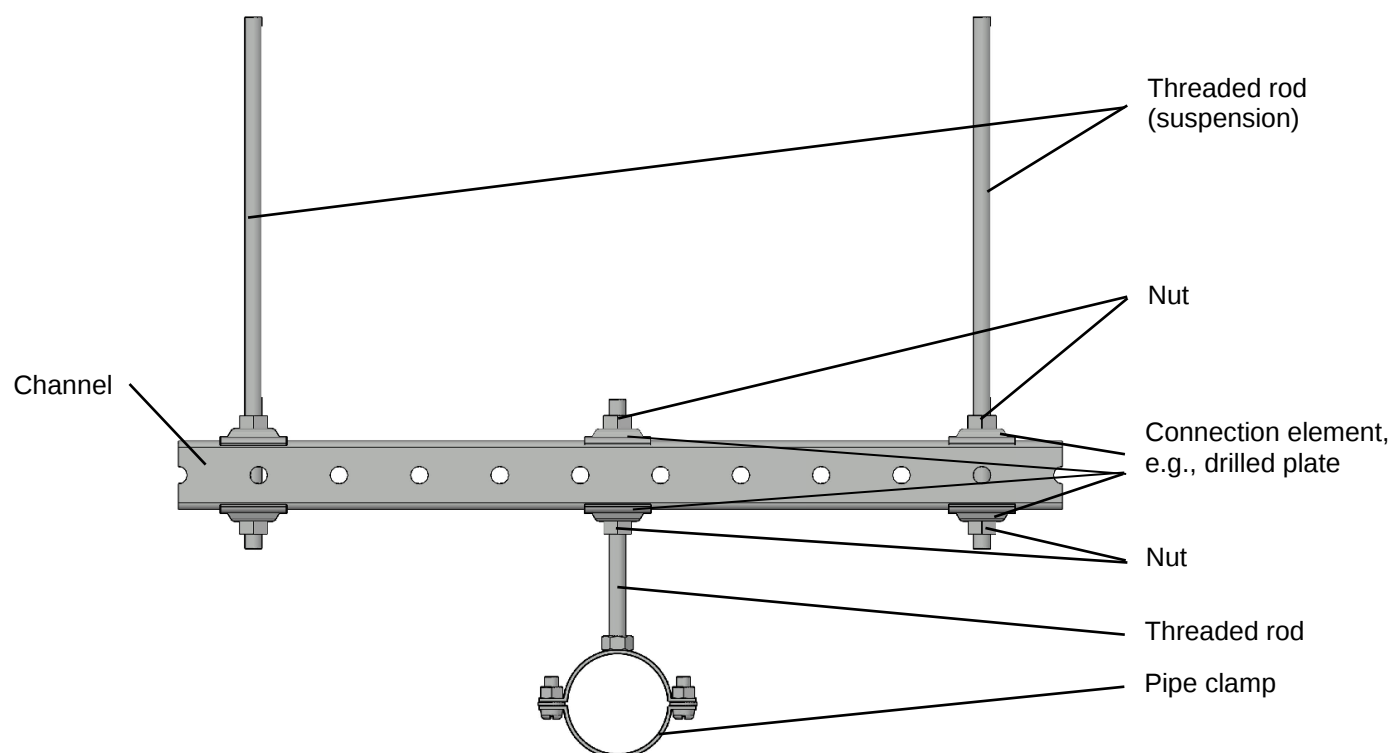


Figure 1.1.1.1: Kit-variant A: Suspension with threaded rods (in case of open channel profiles the channel opening is oriented downwards)

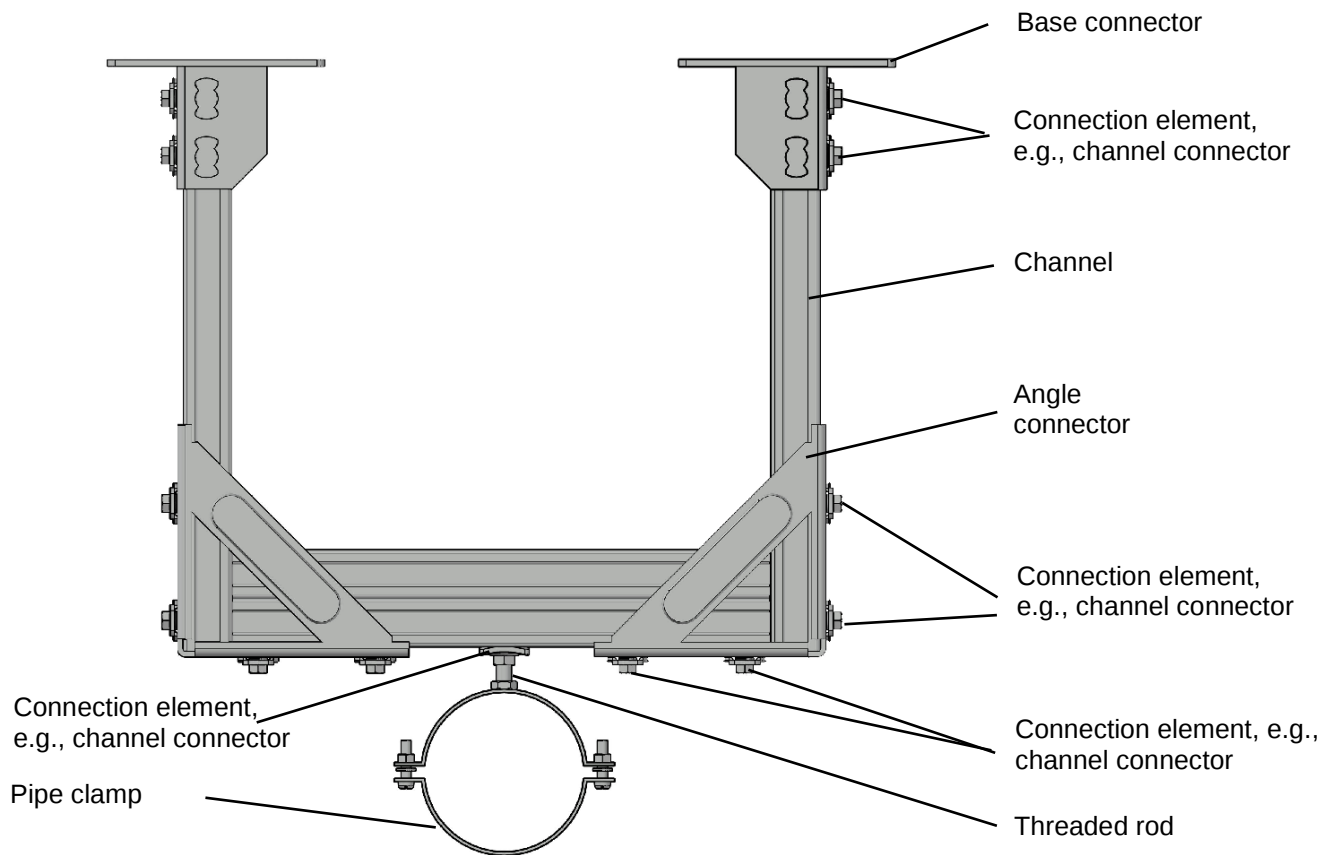


Figure 1.1.1.2: Kit-variant B: Suspension with special elements (i.e., channels, angle and base connectors; in case of open channel profiles the channel opening is oriented downwards)

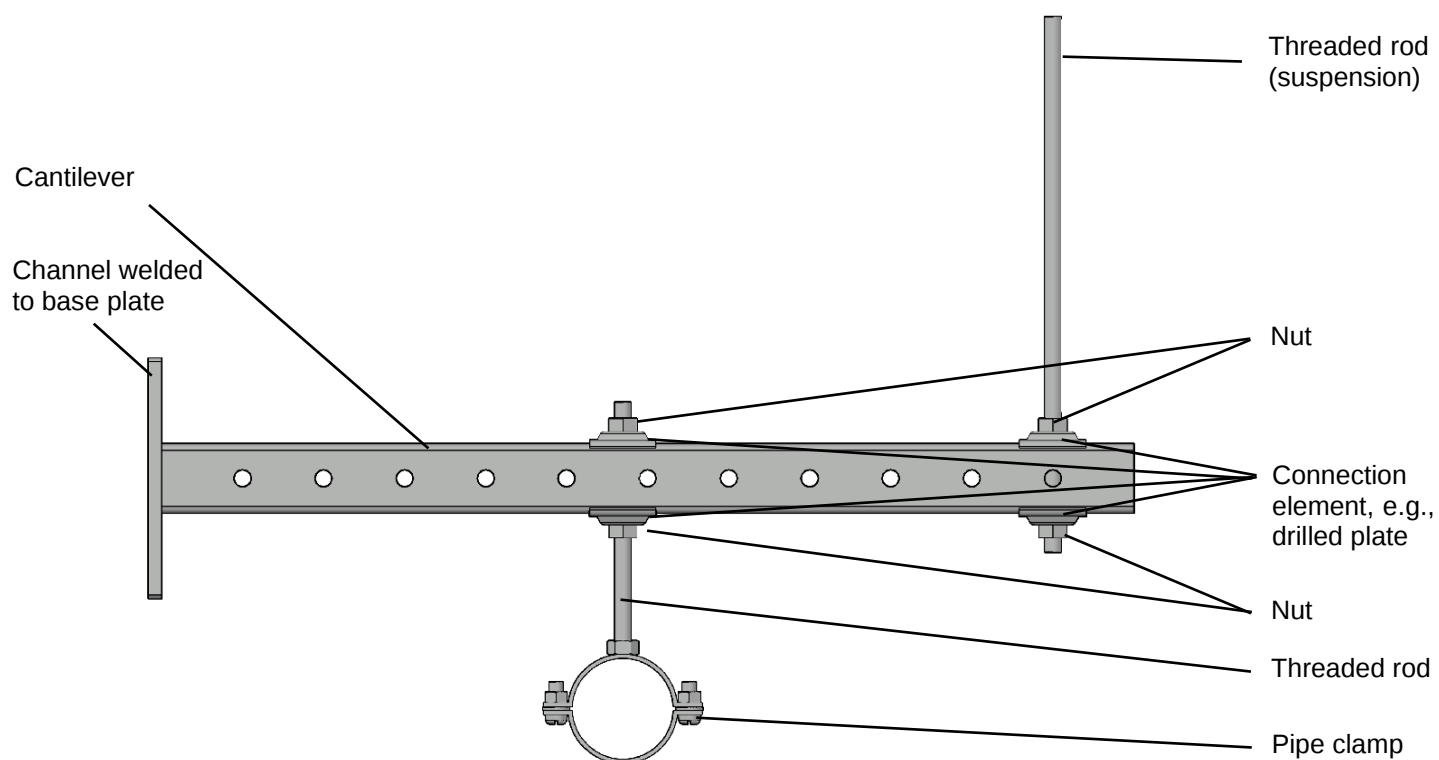
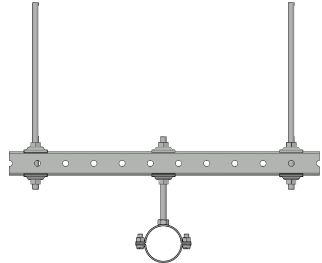
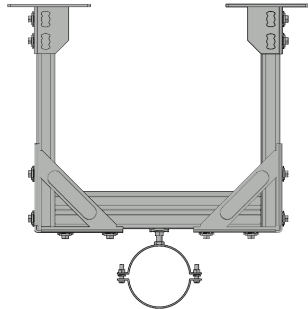
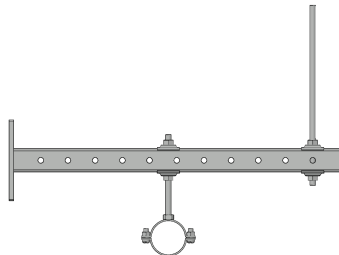


Figure 1.1.1.3: Kit-variant C: Suspended cantilever with special elements (i.e., pipe clamp connection elements; in case of open channel profiles the channel opening is oriented downwards)

The products according to Table 1.1.1.1 in whole or in essential parts are made of uncoated or inorganic coated steel.

Table 1.1.1.1: Kits covered by the EAD

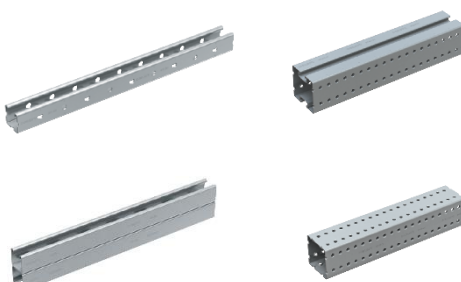
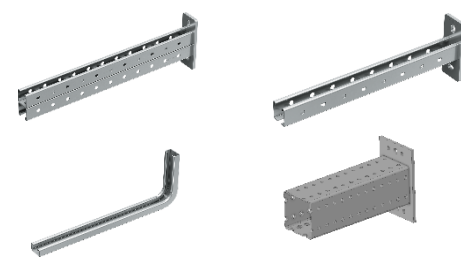
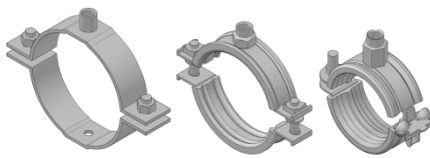
No.	Product	Description	Exemplary illustrations
1	Kit variant A	Suspension with threaded rods mounted on the ceiling (Figure 1.1.1.1). Two threaded rods suspended from a structure are attached with connection elements to a horizontal channel. The channel incorporates connection elements to attach a pipe clamp positioned below the channel.	
2	Kit variant B	Suspension with special elements mounted on the ceiling (Figure 1.1.1.2). Two vertical channels attached with connection elements to base connectors are attached with connection elements and angle connectors to a horizontal channel. The horizontal channel incorporates connection elements to attach a pipe clamp positioned below the channel.	
3	Kit variant C	Lateral wall mounted cantilever with suspension on the ceiling (Figure 1.1.1.3). Channel with welded on base plate at the end and a threaded rod for suspension from the structure and attached to the channel by means of connection elements. The channel incorporates connection elements to attach a pipe clamp positioned below the channel.	

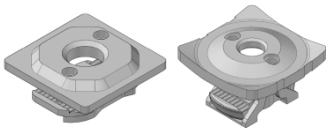
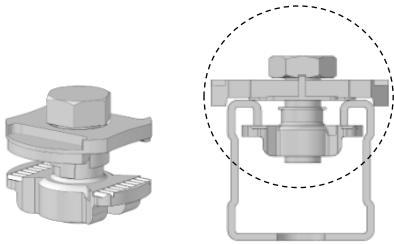
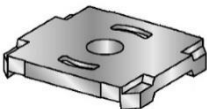
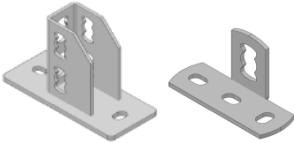
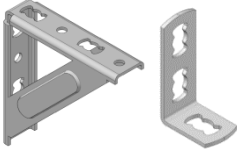
The kits are not covered by any harmonised technical specifications.

1.1.2 Components of the kits placed on the market as independent products

The components of the kits indicated in Table 1.1.1.1 are also placed on the market separately as independent single products (in the following referred to as products for installation systems).

Table 1.1.2.1: Single products covered by this EAD

No.	Product	Description	Exemplary illustrations
1	Channel	Cold-formed continuous metal element with open or closed profile section. Multiple channels can be combined by welding or other means. The channel can have teeth on the inside of the lips and holes in the channel back to introduce threaded rods.	
2	Cantilever	Horizontal channel fixed to a vertical structural element to serve as a cantilever support.	
3	Pipe clamp	Metal element designed to hold pipes in position, allowing the resulting loads to be transferred to a channel, cantilever or the substructure. The pipe clamp may incorporate a rubber or plastic inlay.	
4	Connection element E.g.: - slot nut, - saddle nut, - channel connector, - drilled plate - screws - bolts - steel plate with threaded connection or a mixture of them	General: Products attached to a channel which serve as interface to connect angle connector, base connector, threaded rods or bolts.	
		Slot nut A nut fitted to the inside of the channel lips to provide an internal thread for screws and threaded rods. Optional elements for easy mounting and positioning can be included (e.g., retaining springs)	

No.	Product	Description	Exemplary illustrations
		Saddle nut Load transferring and connection element positioned between a channel and a threaded rod. The saddle nut and attached threaded rod can be preassembled. The saddle nut can incorporate a plastic inlay.	
		Channel connector Element consisting of a nut, plate and a bolt used to connect angle connectors or base connectors to the channel. The nut of the channel connector is positioned in the continuous slot of the channel and tightened by turning the bolt. The channel connector can incorporate a plastic inlay.	
		Drilled plate Metal plate with a hole or thread used as a load-transferring and connection element between a channel and threaded rod, bolt or anchor etc.	
		Steel plate with threaded connection Flat steel plate or in U-shape with holes and a threaded connection	
5	Base connector	Load-transferring and connection element located between a channel and the substructure and connected to the channel by means of a connection element	
6	Angle connector	Load-transferring and connection element located at a junction between channels and connected to the channels by means of a connection element	

No.	Product	Description	Exemplary illustrations
7	Threaded rod	Load-transferring element with coarse thread and fine pitch thread in accordance with EN ISO 898-1 ¹ (steel) or in accordance with EN ISO 3506-1 (stainless steel)	

The products listed in Table 1.1.2.1, No. 1, are not fully covered by the harmonised technical specification EAD 330667-00-0602, for the following reasons:

- Due to their specific intended use as fastening elements and the continuous welding to the substructure, these channels exhibit limited or no deflection in case of fire, making the characteristic bending resistance and the pull-out resistance for channel back holes inapplicable.
- In contrast, channels as covered by this EAD generally exhibit a significant span, with intended uses indicating a gap between the substructure and the channels. These characteristics are not applicable to channels in accordance with EAD 330667-00-0602.
- Channels as covered by this EAD are intended to transfer loads to various substructures via threaded rods or fasteners and, therefore, require an assessment of both bending deformations and pull-out resistance for channel back holes in case of fire.
- Furthermore, as all kits and products covered by this EAD are linked with a specific intended use, distinction is made to EAD 330667-00-0602 which covers only one product with another intended use.

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

1.2.1 Intended use(s)

The kits and products for installation systems according to Tables 1.1.1.1 and 1.1.2.1 are intended to be used under dry indoor conditions for supporting:

- technical building equipment in general with the exception of the intended uses indicated in b) to d),
- pipes for the transport of water not intended for human consumption,
- pipes for the transport of gas/fuel intended for the supply of building heating/cooling systems,
- components of fixed fire-fighting systems.

1.2.2 Working life/Durability

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 kits and products for installation systems for the intended use of 50 years when installed in the works (provided that the product for installation systems is subject to appropriate installation. These provisions are based upon the current state of the art and the available knowledge and experience.

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 works².

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

¹ All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

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 referred to above.

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.

1.3 Specific terms used in this EAD

1.3.1 General

Pipe clamp range Pipe clamps of the same type to be used for different pipe diameters

1.3.2 Symbols

A	Cross-sectional area
f_y	Yield strength
$f_{y,min}$	Minimum yield strength of material
$f_{y,test}$	Yield strength of tested specimen
f_u	Ultimate strength
$f_{u,min}$	Minimum ultimate strength of material
$f_{u,test}$	Ultimate strength of tested specimen
F	Force
FEM	Finite Element Method
$F(t)$	Resistance time function (mean value curve)
F_{Rk}	Characteristic resistance
$F_{Rk,L100}, F_{Rk,L150}, F_{Rk,L200}$	Characteristic resistance for a deflection of L/100, L/150 and L/200 with span width L
$F_{Rk,max}$	Maximum of characteristic resistance
$F_{Rk}(t)$	Characteristic resistance time function (time-depended resistance under heating)
$F_{30}(\delta)$	Load displacement function (mean value curve) at $t = 30$ min under heating
$F_{Rk,30}(\delta)$	Characteristic load displacement function at $t = 30$ min under heating
F_i	Test load of the specimen i
g	self-weight of channel
GMNIA	Geometrically and Materially Nonlinear Analysis with Imperfections
i	Number of the tested specimen
I_y	Moments of inertia about y- axis
I_z	Moments of inertia about z- axis
k_n	Characteristic fractile factor (in accordance with EN 1990, Annex D, Table D.1 for unknown V_x)
L	Span width
L_0	extensometer measuring gauge
M	(bending) Moment
m	Number of pairs of variates according to Annex F or Annex G
n	Number of time intervals
STTC	Standard temperature time curve in accordance with EN 1363-1
T	Temperature ($^{\circ}\text{C}$)
t	Thickness or time
t_{fail}	Time of failure
t_{fire}	Maximum fire duration
t_i	Failure time point of the specimen i
V_x	Variation coefficient (in accordance with EN 1990)
W_y	Section moduli about y- axis
W_z	Section moduli about z- axis
$y_{c,0}$	Distance between mounting surface and centroid position about y-axis

$z_{c,0}$	Distance between mounting surface and centroid position about z-axis
ΔL	Total elongation (for time-depended strain behaviour of the channel material under constant mechanical tension during heating)
$\Delta \delta_t$	Value of correction function at time t
δ	Displacement, deflection
$\delta_{calc,t}$	Calculated channel deformation at time t
$\delta_{max}(t)$	Maximum deformation at every time interval
δ_t	Maximum channel deformation at time
ε	total strain
σ	Mechanical stress

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

The following Table 2.1.1 shows how the performance of the kits for installation systems according to Figures 1.1.1.1 to 1.1.1.3 is assessed in relation to the essential characteristics.

Table 2.1.1 Kits: Essential characteristics 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.1	class
2	Bending characteristics under fire exposure	2.2.3	Level $F_{Rk}(t)$ [kN] $F_{Rk,30}(\delta)$ [kN] $\delta_{max,t}$ [mm]
Basic Works Requirement 4: Safety and accessibility in use			
3	Load capacity	2.2.4	Level $F_{Rk,L200}$ [kN] $F_{Rk,L150}$ [kN] $F_{Rk,L100}$ [kN] $F_{Rk,max}$ [kN]

The following Tables 2.1.2.1 to 2.1.2.7 show how the performance of the products for installation systems according to Table 1.1.2.1 is assessed in relation to the essential characteristics.

Table 2.1.2.1 Channel: 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Pull-through resistance of channel holes under fire exposure	2.2.5.1	Level $F_{RK}(t)$ [kN]
3	Bending characteristics under fire exposure (Model A: central single force; minimum/maximum and standard span L)	2.2.5.2.1 2.2.5.2.2	Level $F_{RK}(t)$ [kN], $F_{RK,30}(\delta)$ [kN] $\delta_{max,t}$ [mm] δ_{30} : maximum channel deformation at 30 minutes of fire loading δ_{60} : maximum channel deformation at 60 minutes of fire loading δ_{90} : maximum channel deformation at 90 minutes of fire loading δ_{120} : maximum channel deformation at 120 minutes of fire loading t_{max} : time of failure or maximum fire duration $t_{max} = \min[t_{fail}; 120\text{min}]$ $\delta_{t_{max}}$: maximum channel deformation at time t_{max}
4	Bending characteristics under fire exposure (Model B: four forces; minimum/maximum and standard span L)	2.2.5.3.1 2.2.5.3.2	Level $F_{RK}(t)$ [kN] $F_{RK,30}(\delta)$ [kN] $\delta_{max,t}$ [mm] δ_{30} : maximum channel deformation at 30 minutes of fire loading δ_{60} : maximum channel deformation at 60 minutes of fire loading δ_{90} : maximum channel deformation at 90 minutes of fire loading δ_{120} : maximum channel deformation at 120 minutes of fire loading t_{max} : time of failure or maximum fire duration $t_{max} = \min[t_{fail}; 120\text{min}]$ $\delta_{t_{max}}$: maximum channel deformation at time t_{max}
5	Bending characteristics under fire exposure (Model C: two forces near the threaded rods;	2.2.5.4.1	Level $F_{RK}(t)$ [kN] $F_{RK,30}(\delta)$ [kN] $\delta_{max,t}$ [mm]

No.	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
	minimum/maximum and standard span L)	2.2.5.4.2	δ_{30} : maximum channel deformation at 30 minutes of fire loading δ_{60} : maximum channel deformation at 60 minutes of fire loading δ_{90} : maximum channel deformation at 90 minutes of fire loading δ_{120} : maximum channel deformation at 120 minutes of fire loading $t_{\max}$: time of failure or maximum fire duration $t_{\max} = \min[t_{\text{fail}}, 120\text{min}]$ $\delta_{t_{\max}}$: maximum channel deformation at time $t_{\max}$
6	Stress strain behaviour of material	2.2.5.5	Level strain $\epsilon(\sigma, T)$ in [%] for each $T = [800, 850, 900, 950, 1000, 1050, 1100]^{\circ}\text{C}$ and $\sigma = [5, 10, 15, 20, 25, 30] \text{ N/mm}^2$
Basic Works Requirement 4: Safety and accessibility in use			
7	Characteristic pull-through resistance of channel back holes	2.2.5.6	Level $F_{Rk}(t)$ [kN]

Table 2.1.2.2 Cantilever: 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Resistance under fire exposure	2.2.6.1.1 2.2.6.1.2	Level $F_{Rk}(t)$ [kN] $F_{Rk,30}(\delta)$ [kN] $\delta_{max,t}$ [mm] δ_{30} : maximum channel deformation at 30 minutes of fire loading δ_{60} : maximum channel deformation at 60 minutes of fire loading δ_{90} : maximum channel deformation at 90 minutes of fire loading δ_{120} : maximum channel deformation at 120 minutes of fire loading t_{max} : time of failure or maximum fire duration $t_{max} = \min[t_{fail}; 120\text{min}]$ δ_{tmax} : maximum channel deformation at time t_{max}
Basic Works Requirement 4: Safety and accessibility in use			
3	Characteristic resistance	2.2.6.2	Level $F_{Rk,L200}$ [kN] $F_{Rk,L150}$ [kN] $F_{Rk,L100}$ [kN] $F_{Rk,max}$ [kN]

Table 2.1.2.3 Pipe-clamp: 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Resistance and deformation under fire exposure	2.2.7.1	Level $F_{Rk}(t)$ [kN] $F_{Rk,30}(\delta)$ [kN] $\delta_{max,t}$ [mm]
Basic Works Requirement 4: Safety and accessibility in use			
3	Characteristic resistance	2.2.7.2	Level F_{Rk} [kN]

Table 2.1.2.4 Connection element (like slot nut, saddle nut, channel connector, drilled plate or a mixture of it): 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Pull-out resistance under fire exposure (in the middle of the channel)	2.2.8.1	Level $F_{Rk}(t)$ [kN]
3	Shear resistance under fire exposure	2.2.8.2	Level $F_{Rk}(t)$ [kN]
4	Pull-through resistance under fire exposure	2.2.8.3	Level $F_{Rk}(t)$ [kN]
Basic Works Requirement 4: Safety and accessibility in use			
5	Characteristic pull-out resistance (in the middle of the channel)	2.2.8.4	Level F_{Rk} [kN]
6	Characteristic pull-out resistance (at channel end)	2.2.8.5	Level F_{Rk} [kN]
7	Characteristic shear resistance	2.2.8.6	Level F_{Rk} [kN]
8	Characteristic pull-through resistance	2.2.8.7	Level F_{Rk} [kN]

Table 2.1.2.5 Base-connector: 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Resistance under fire exposure	2.2.9.1	Level $F_{Rk}(t)$ [kN]
Basic Works Requirement 4: Safety and accessibility in use			
3	Characteristic resistance	2.2.9.2	Level F_{Rk} [kN]

Table 2.1.2.6 Angle-connector: 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Resistance under fire exposure	2.2.10.1	Level $F_{Rk}(t)$ [kN]
Basic Works Requirement 4: Safety and accessibility in use			
4	Characteristic resistance	2.2.10.2	Level F_{Rk} [kN]

Table 2.1.2.7 Threaded rod: 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
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.2.2	Class
2	Resistance to combined bending and tension under fire exposure	2.2.11.1	Level $F_{Rk}(t)$ [kN]
Basic Works Requirement 4: Safety and accessibility in use			
3	Strength class	2.2.11.2	Class

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

This Clause is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer, and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant essential characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

2.2.1 General requirements for all tests

2.2.1.1 Sufficient description (technical drawings) of components

For the assessment procedure, the TAB shall ensure that the kits or products for installation systems are described with sufficient accuracy using technical drawings. If available, it can make use of relevant documents prepared by the manufacturer. They do not need to be shown in the ETA, but they are fundamental for the assessment procedure, control plan and verification of constancy of performance.

Technical drawings of the kits or products shall be exact and complete, and they shall content:

- all dimensions (e.g., length, width, thickness, bending radius, hole pattern, slot wide, burred edges),
- tolerances (e.g., all tolerances not listed in accordance with ISO 2768-1),
- material specifications (e.g., S235 in accordance with EN 10025-2),
- for products with welds, the welding specifications, including relevant technical standards such as EN ISO 15614-1, EN ISO 15614-11, EN ISO 15614-12, EN ISO 15613 for welding procedure qualification, if the manufacturer uses standardized procedures,
- for products with coating, the coating specifications, including relevant technical standards, if the manufacturer uses standardized procedures.

The dimensions, material specifications and the coatings shall be stated in the ETA.

2.2.1.2 Mounting

The kits or products for installation systems shall be mounted in the relevant test rig according to the manufacturer's product installation instructions. If the manufacturer's product installation instructions are not available, all fastening elements shall be loose without any prestressing force. For kits and products, the system and load configuration, the installation conditions, and the specifications of the associated components shall be stated in the ETA.

2.2.1.3 Correction factor C for considering material properties

The material properties of the initial material of the components used for the tests shall be determined by tests in accordance with EN ISO 6892-1 and $f_{y,min}$ shall be taken from the relevant material standard.

The general correction factor C is the minimum of:

$$C = \text{Min.} \left\{ \frac{f_{y,min}}{f_{y,test}} ; \frac{f_{u,min}}{f_{u,test}} \right\} \quad (2.2.1.3.1)$$

2.2.1.4 Cross section values of the channels

Except for cases described in Clause 2.2.7, the cross-sectional values of the channels shall be stated in the ETA. These values shall include at least:

- Cross-sectional area: A [mm^2]
- Centroidal coordinates: $y_{c,0}$ and $z_{c,0}$ [mm]
- Section modulus: W_y and W_z [mm^3]
- Moment of inertia: I_y and I_z [mm^4]

2.2.2 Reaction to fire

Purpose of the assessment

The objective is to analyse fire performance and determine if fire tests are necessary, such as for rubber or plastic inlays, or if EU decisions make testing unnecessary.

Assessment method

2.2.2.1 Reaction to fire performance of the kits according to Table 1.1.1.1

The reaction to fire performance of the kits shall be assessed by considering the reaction to fire performance of their components. The entire kit shall be classified based on the worst reaction to fire class of any of its components.

Depending on the type of components, one or several of the following sub-clauses (2.2.2.1.1 to 2.2.2.1.3) shall be applied for the assessment of the reaction to fire performance of the kit's components.

The ETA shall state the reaction to fire classification of the kit. In addition, it shall be stated whether a component is considered a "small component" as defined in sub-clause 2.2.2.1.2. For details, see the following sub-clauses.

If only sub-clauses 2.2.2.1.1 and 2.2.2.1.2 apply, the ETA shall state that the kit's performance is class A1, and, for the inlay, that its contribution to fire is negligible and the conditions for which this assessment applies.

2.2.2.1.1 Steel-made products

All steel-made components as described in Clause 1.1.1 are considered to satisfy the requirements of performance class A1 of the reaction-to-fire performance, in accordance with the Commission Decision 96/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/EC, 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.

Expression of result

Therefore, when the conditions referred to above are fulfilled, the performance of the component is class A1.

2.2.2.1.2 Rubber or plastic inlays case 1: Conditions as a "small component"

Rubber inlays or plastic inlays are considered to satisfy the requirements for small components if they are in accordance with all of the following provisions:

- They have a mass ≤ 50 g
- They have a surface of maximum 2.500 mm^2 on the top side or bottom side and the length of one side doesn't exceed 250 mm (for example: Maximum $50 \text{ mm} \times 50 \text{ mm}$ or maximum diameter 57mm, the thickness results via density from the maximum mass of 50g)
- The product is intended to be used only at a distance $\geq 200 \text{ mm}$ to similar components.

Rubber inlays and plastic inlays can also be considered as a "small component", if they are in accordance with all of the following provisions:

- they are installed in such way that their top side and bottom side are completely covered by non-melting material of class A1,
- the surface of each visible lateral edge, which may be exposed in case of fire, is $\leq 2500 \text{ mm}^2$ with a total length of each visible edge $\leq 250 \text{ mm}$, and
- if they are intended to be used only at a distance $\geq 200 \text{ mm}$ to similar components (other clamps with rubber inlay or connecting components with plastic inlay).

In this case, the component can be considered as a small component and its contribution to fire can be neglected and thus, its reaction to fire performance doesn't need to be tested and classified separately.

Expression of result

The ETA shall state: Negligible small component which doesn't need to be tested and classified separately.

2.2.2.1.3 Rubber or plastic inlays case 2: Component shall be tested

Rubber inlays or plastic inlays not fulfilling the conditions as "small component" according to sub-clause 2.2.2.1.2 shall be tested, using the method(s) relevant for the corresponding reaction to fire class in accordance with EN 13501-1. The products shall be classified in accordance with Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1.

The following provisions shall apply for the relevant tests:

The necessary tests in accordance with EN ISO 11925-2 shall be performed with edge exposure as well as with surface exposure on specimens as follows:

- a) flat slabs or mats made from the material of the respective component or cut sections of this component, mounted in a free-hanging test position without any substrate behind,
- b) flat slabs or mats made from the material of the respective component or cut sections of this component, mechanically fixed on a standard steel sheet in accordance with EN 13238, if tests fail with a specimen configuration according to "a)"

The necessary tests in accordance with EN 13823 (Single Burning Item test - SBI) shall be performed on specimens built-up with flat slabs or mats made from the material of the respective component which are placed side by side with butt joints on a standard steel sheet in accordance with EN 13238. Each single piece of the slabs or mats shall be mechanically fixed on the standard substrate with four small metal nails or screws (one fixing means in each corner of the slabs or mats).

The following product parameters shall be considered for the components when preparing the test specimens and executing the tests:

- variations of a product family (as defined by a combination of certain raw materials and certain type of production process)
- highest and lowest thickness, if relevant
- highest and lowest density, if relevant.

The results of tests considering the aforementioned parameters and conditions are fully valid for:

- the intended use of the rubber inlays or plastic inlays as part of the kits for installation systems made of steel (see Clause 1.1.1) or metal with a melting point of at least $1000 \text{ }^{\circ}\text{C}$,
- all variations of the defined product family,
- the tested thickness or the whole range between those thickness values tested,
- the tested density or the whole range between those density values tested.

Expression of result

The reaction to fire class of the inlays tested shall be stated in the ETA together with those parameters and conditions (see above) for which the classification is valid.

2.2.2.2 Reaction to fire performance of the products according to Table 1.1.2.1

For products made of steel Clause 2.2.2.1.1 is applicable.

Otherwise, the products shall be tested, using the test method(s) relevant for the corresponding reaction to fire class in accordance with EN 13501-1. The products shall be classified in accordance with Commission Delegated Regulation (EU) 2016/364 in conjunction with EN 13501-1.

In case that the product is equipped with one or more rubber or plastic inlays, Clauses 2.2.2.1.2 and 2.2.2.1.3 are applicable. In case the inlay cannot be considered a small component but has to be tested according to Clause 2.2.2.1.3, the performance of the inlay represents the performance of the product.

2.2.3 Bending characteristics under fire exposure

Purpose of the assessment

The objective of the test is to measure the deflection at certain loads (due to weight forces) during heating according to the standard temperature time curve (STTC) and to measure the time to failure.

Bending characteristics are composed of:

- Characteristic time function $F_{RK}(t=30, 60, \dots)$ [kN] at the place of load introduction and at the end of the time intervals (every 30 minutes),
- Load displacement function $F_{RK,30}(\delta=5, 10, \dots)$ [kN] at the place of load introduction and at time $t=30\text{min}$. for deformation steps (every 5 millimetre),
- Maximum deformation $\delta_{\max}(t)$ at the place of load introduction and for every time interval.

Assessment method

The assessment method is to introduce test forces (by applying loads, e.g., weights on the kit) and heating it up according to Annex A.

Minimum 5 test specimens of the kits A, B or C according to Figures 2.2.4.1 to 2.2.4.2 shall be mounted in a furnace according to the manufacturer's product installation instructions (e.g., tightening moments for screws, friction values for thread, etc.). If there is no manufacturer's product installation instruction, all fastening elements shall be loose. This is to avoid influences from different preload and frictional forces on the form fit. The form fit results, for example, from the shearing of the toothing or the fastener.

In case the manufacturer requests to have another configuration assessed, a deviating test setup shall be used in addition. In any case, the test setup(s) shall be provided in the ETA along with an indication of the relevant product performance.

The 5 test specimens shall be loaded with the loads according to Table 2.2.3.1.

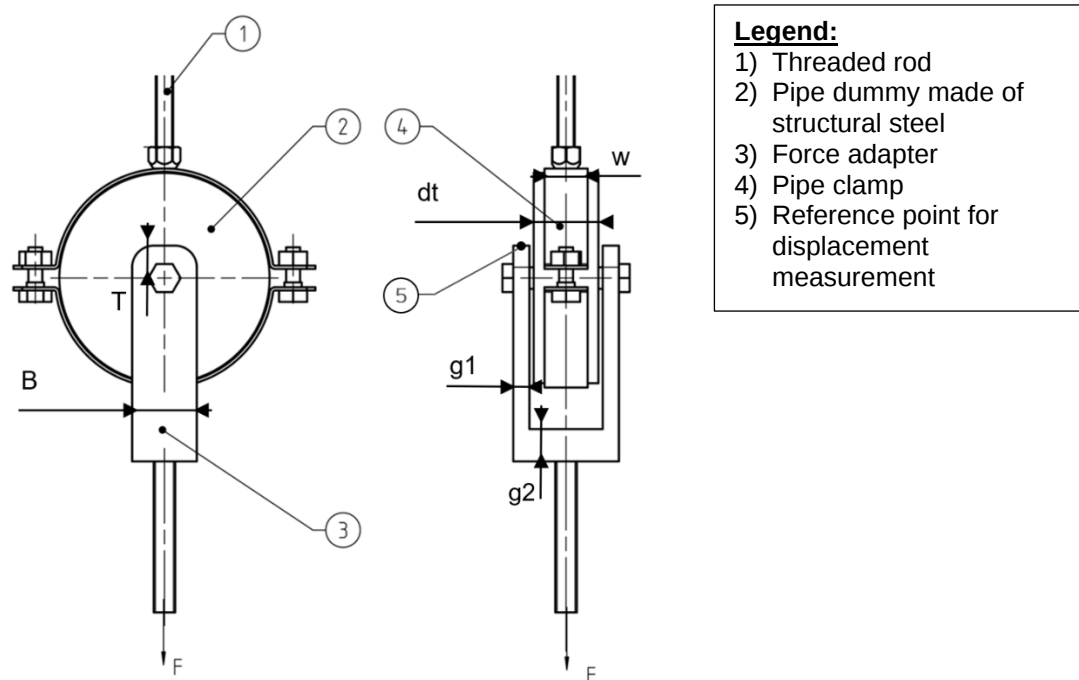
$F_{RK,L100}$ shall be determined in advance according to Clause 2.2.4.

For the load introduction components, the following dimensions shall be considered. All dimensions apply to pipe clamps with or without rubber or plastic inlay. The dummy thickness (dt) shall be:

- for pipe clamp width (w) $\leq 35\text{mm}$: $(w+10) \text{ mm} \leq dt \leq 45\text{mm}$
- for pipe clamp width (w) $> 35\text{mm}$: the pipe clamp width $dt = (w) + 10 \text{ mm}$

For all other dimensions and

- for dummies with $D \leq 100$ see Figure 2.2.3.1
as an alternative 2 flanges may be used with the dimensions 100 mm x 50 mm x 15 mm
- for dummies with $D > 100$, 2 flanges shall be used according to Figure 2.2.3.2



Pipe dummy Ø D [mm]	B [mm]	g1 g2 [mm]	Distance centre hole to edge T [mm]
$D \leq 100$	≤ 60	≤ 15	≥ 30

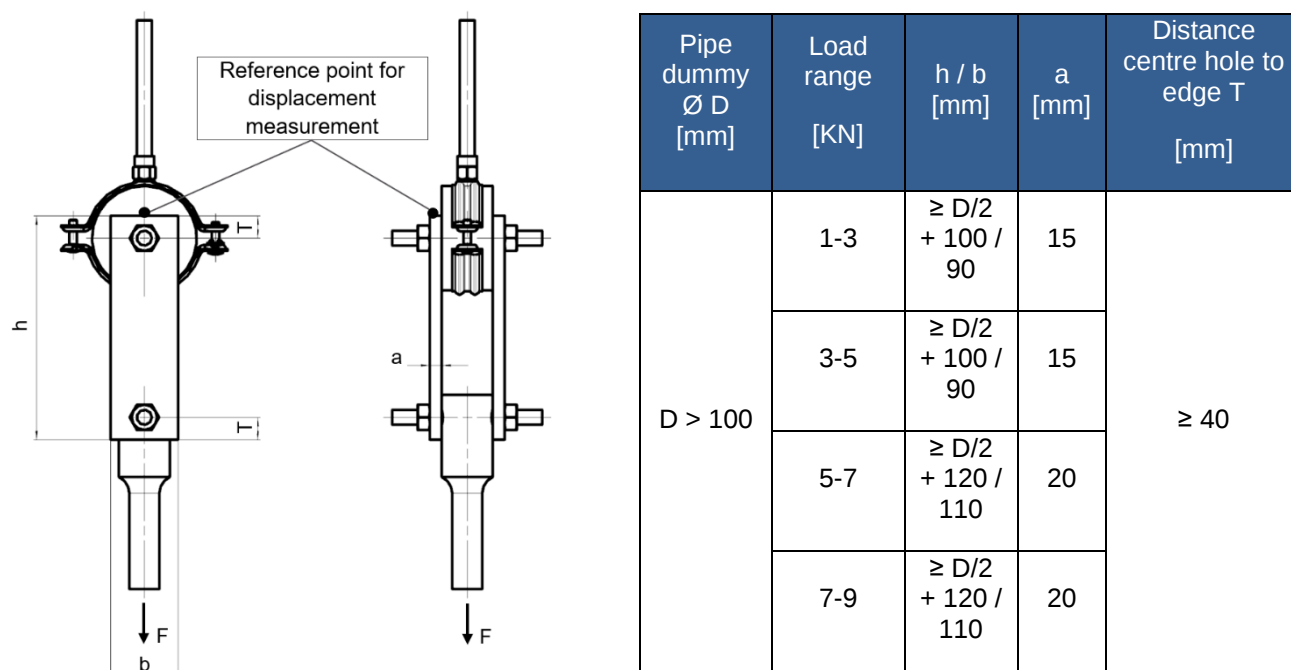
Figure 2.2.3.1: Detail for introducing the weight force F into the kit for pipe dummy $D \leq 100$ Figure 2.2.3.2: Detail for the flanges to introduce the weight force F into the kit for pipe dummy $D > 100$ mm

Table 2.2.3.1: Stages of loads for 5 specimens

No. of specimen	Test forces F [kN]	Time to failure t _i [min]
1	$0,075 \cdot F_{Rk,L100}$	
2	$0,1 \cdot F_{Rk,L100}$	
3	$0,2 \cdot F_{Rk,L100}$	
4	$0,4 \cdot F_{Rk,L100}$	
5	$0,6 \cdot F_{Rk,L100}$	

The test shall be carried out according to Annex A.

For further evaluations see:

- Annex B (excluding the requirement to define F_i based on failure timing per Table B.1) for determination of the resistance time function $F_{Rk}(t)$,
- Annex C for determination of the load displacement function $F_{Rk,30}(d)$,
- Annex D for determination of the maximum deformation $d_{max}(t)$,

Expression of results

- The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:
 - $F_{Rk}(30)$ for $t=30$ min,
 - $F_{Rk}(60)$ for $t=60$ min,
 - $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

- The results are the parameters of the load displacement function $F_{Rk,30}$ and at least the resistances for deformations in steps of 5 mm for $\delta=5$ mm, $\delta=10$ mm, $\delta=15$ mm etc.
- Maximum deformation $\delta_{max}(t)$ for each time interval according to Annex B, Table B.1, with $t \geq 30$ minutes

2.2.4 Load capacity

Purpose of the assessment

The objective of the test is to measure the forces at defined points of deflection for the test setup and to determine the ultimate load.

Assessment method

The assessment method involves pulling on the kit (on the force transducer part 3 from Figure 2.2.3.1) in a displacement-controlled manner and measuring the resulting forces. For each type of kit (see kit variants A, B or C according to Figures 1.1.1.1 to 1.1.1.3) a minimum of 5 specimens shall be tested.

In case the manufacturer requests to have another, additional configuration assessed, a deviating test setup shall be used. In any case, the test setup(s) shall be provided in the ETA along with an indication of the relevant product performance.

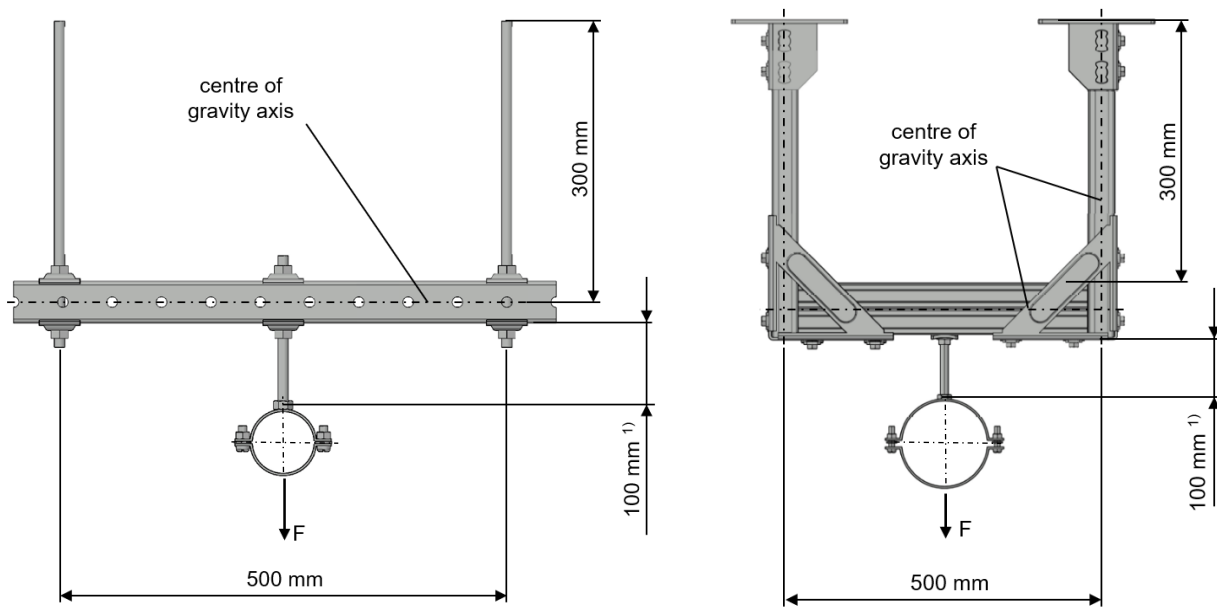


Figure 2.2.4.1: Standard test setup for kits A and B, pipe clamp in the middle; 300 mm is the distance from the top edge of the product to the centre of gravity of the channel cross-section.
¹⁾ Distance between the surface of the channel and the nut of the pipe clamp

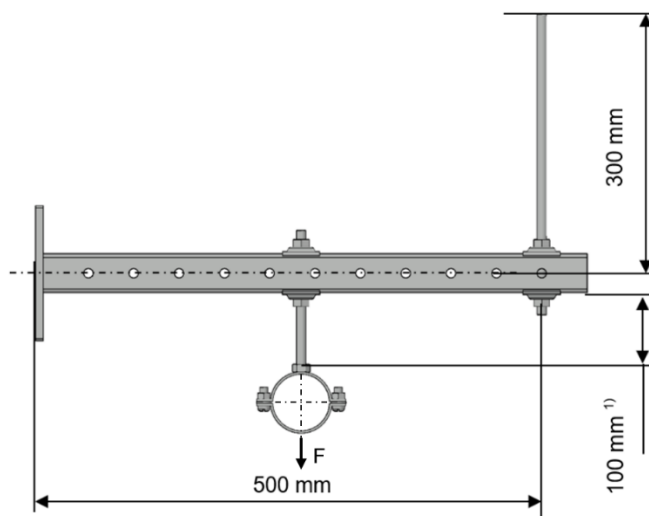


Figure 2.2.4.2: Standard test setup for kit C, pipe clamp in the middle of 500 mm
¹⁾ Distance between the surface of the channel and the nut of the pipe clamp

The pipe clamp shall be loaded in a displacement-controlled way with a loading speed of 10 mm/minute (with a tolerance of $\pm 1\%$) until failure occurs. The force shall be measured minimum 10 times per second.

At each deflection ($L/200$, $L/150$; $L/100$ of span width L) the force shall be measured, and the maximum force at which failure occurs. The deflection shall be measured between mounting surface and force measurement unit at the centre of the pipe clamp diameter.

The measured values shall be multiplied with the correction factor C according to Clause 2.2.1.3. The characteristic values shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The results are four statistically determined forces:

- $F_{Rk,L200}$ (for a deflection of $L/200$)
- $F_{Rk,L150}$ (for a deflection of $L/150$)
- $F_{Rk,L100}$ (for a deflection of $L/100$)
- $F_{Rk,max}$ (for failure)

2.2.5 Channels – Methods and criteria for assessing the performance

2.2.5.1 Pull-through resistance of channel back holes under fire exposure

Purpose of the assessment

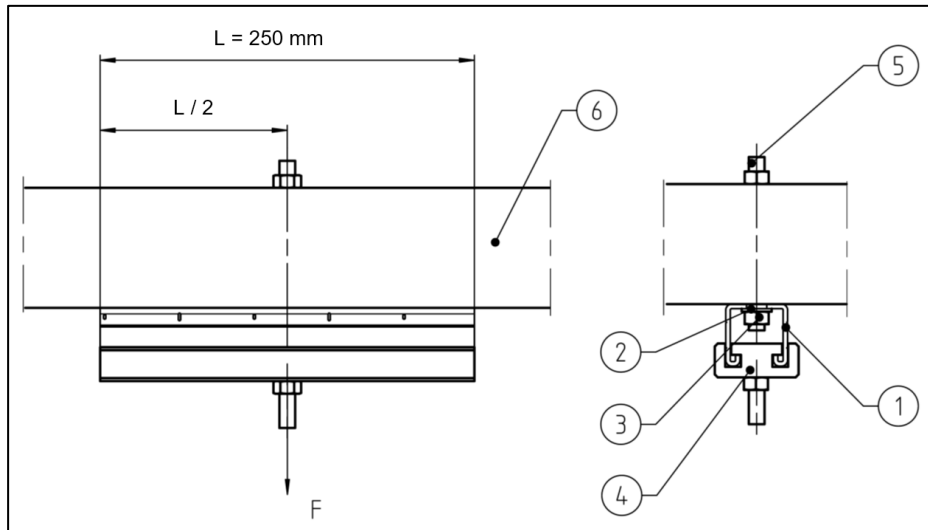
The objective of the test is to measure the time to failure at certain loads during heating according to the standard temperature time curve (STTC).

Assessment method

The assessment method involves introducing the load (weight force) to the specimen via an adapter and heating it until failure occurs. The adapter shall fit the channel geometry and have a length of minimum 200 mm. It shall not compromise the structural integrity of the test assembly and shall maintain its performance under fire exposure and mechanical loading. It is required to ensure uniform distribution of contact pressure along the channel lips.

The assessment method involves introducing the load (weight force) to the specimen via an adapter which is evenly fitted to the channel lips, and heating it until failure occurs.

See Figure 2.2.5.1.1 for details of the test setup.



Legend

- 1) Channel (subject of assessment)
 - 2) Flat washer
 - 3) Hexagon nut
 - 4) Steel adapter
 - 5) Threaded rod
 - 6) Furnace ceiling
- All dimensions in [mm]

Figure 2.2.5.1.1: Test setup

The elements of the assessment method (threaded rod, adapter, washer, nut and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1.

For further evaluations, see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

In addition, based on the request of the manufacturer further tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.5.2 Bending characteristics under fire exposure – Model A: Central single force; minimum/maximum and standard span L

The assessment can be done by testing, by calculation or both. The determination of the performance by testing is the reference method.

In the ETA an information shall be given whether testing or calculation has been used for assessment.

2.2.5.2.1 Assessment by testing

Purpose of the assessment

The objective of the test is to measure the deflection at certain loads (due to weight forces) during heating according to the standard temperature-time curve (STTC) and to measure the time to failure.

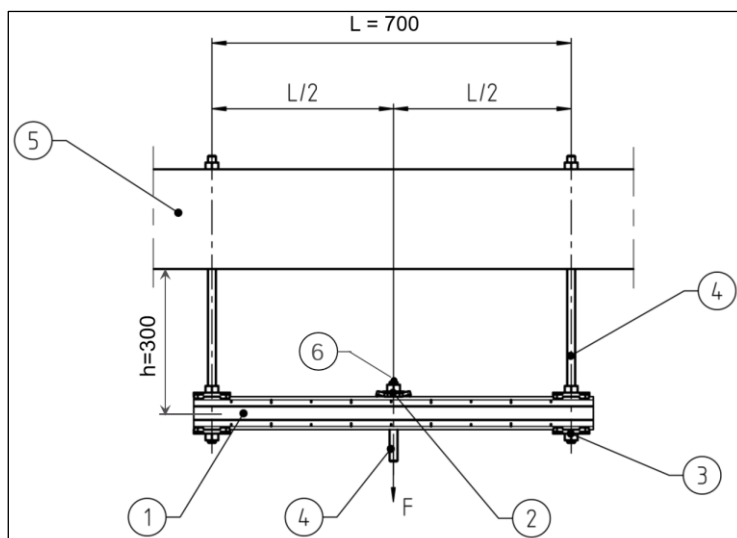
Bending resistance is composed of:

- Characteristic time function $F_{Rk}(t=30, 60, \dots)$ [kN] at the place of load introduction and at the end of the time intervals (every 30 minutes)
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at the place of load introduction and at time $t=30$ min. for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{max}(t)$ at the place of load introduction and for every time interval

Assessment method

The assessment method involves introducing a weight force (F) via a threaded rod and a connection element, as described in Table 1.1.2.1, No. 4, into the channel. The setup shall then be heated in a furnace until failure occurs, and the deflections shall be measured. See Figure 2.2.5.2.1.1 for details of the test setup.

The standard setup is a suspended channel with a suspension of $h=300$ mm and span of $L=700$ mm, optionally with minimum and maximum heights (h) and spans (L), with the force applied at the centre of the span.



Legend

- 1) Channel (subject of assessment)
- 2) Saddle nut
- 3) Drilled plate
- 4) Threaded rod
- 5) Furnace ceiling
- 6) Reference point for

Figure 2.2.5.2.1.1: Test setup

The elements of the assessment method (threaded rods, connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

To evaluate the time-dependent deformations of the channel, the thermal elongation of the threaded rod shall be subtracted from the measured values.

$$\delta_t = \delta_{\text{meas},t} - \delta_{\text{th,threaded rod},t}$$

δ_t maximum channel deformation at time t

$\delta_{\text{meas},t}$ measured channel deformation at time t

$\delta_{\text{th,threaded rod},t}$ calculated thermal elongation of threaded rod in accordance with EN 1993-1-2, Clause 5.3.1.2 or Annex C.4.3

For further evaluations see:

- Annex B for determination of the resistance time function $F_{Rk}(t)$,
- Annex C for determination of the load displacement function $F_{Rk,30}(\delta)$,
- Annex D for determination of the maximum deformation $\delta_{\text{max}}(t)$.

Expression of results

- Characteristic forces $F_{Rk}(t=30, 60, \dots)$ [kN] at the end of the time intervals (every 30 minutes). Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at time $t=30\text{min.}$ for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{\text{max}}(t)$ for every time interval.

2.2.5.2.2 Assessment by calculation

Alternatively, the deflections can be determined by calculation according to Annex E.

2.2.5.3 Bending characteristics under fire exposure – Model B: four forces; minimum/maximum and standard span L

The assessment can be done by testing, by calculation or both. The determination of the performance by testing is the reference method.

In the ETA an information shall be given whether testing or calculation has been used for assessment.

2.2.5.3.1 Assessment by testing

Purpose of the assessment

The objective of the test is the measurement of deflection at certain loads (due to weight forces) during heating according the standard temperature time curve (STTC) and the measurement of the time to failure

Bending resistance is composed of:

- Characteristic time function $F_{Rk}(t=30, 60, \dots)$ [kN] at the place of load introduction and at the end of the time intervals (every 30 minutes)
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at the place of load introduction and at time $t=30\text{min.}$ for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{\text{max}}(t)$ at the place of load introduction and for every time interval

Assessment method

The assessment method is to introduce 4 forces F via threaded rod and connection element, as described in Table 1.1.2.1, No. 4 into the channel and to heat up in a furnace until it fails and measure the deflections. See Figure 2.2.5.3.1.1 for details of the test setup. The standard setup is a suspended channel with a suspension of $h=300$ mm and a span of $L=700$ mm, optionally with minimum and maximum heights (h) and spans (L), with the 4 forces applied uniformly distributed over the span a , optionally with minimum and maximum spans (L).

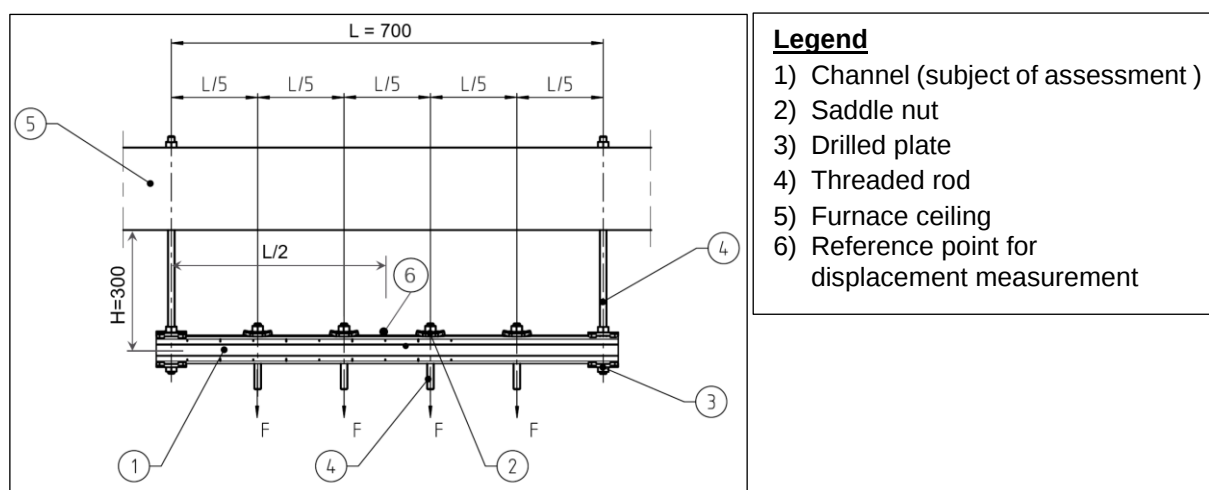


Figure 2.2.5.3.1.1: Test setup

The elements of the assessment method (threaded rods, connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

To evaluate the time-dependent deformations of the channel, the thermal elongation of the threaded rod shall be subtracted from the measured values.

$$\delta_t = \delta_{\text{meas},t} - \delta_{\text{th,threaded rod},t}$$

δ_t maximum channel deformation at time t

$\delta_{\text{meas},t}$ measured channel deformation at time t

$\delta_{\text{th,threaded rod},t}$ calculated thermal elongation of threaded rod in accordance with EN 1993-1-2, Clause 5.3.1.2 or Annex C.4.3

- For further evaluations see Annex B for determination of the resistance time function $F_{Rk}(t)$,
- Annex C for determination of the load displacement function $F_{Rk,30}(\delta)$,
- Annex D for determination of the maximum deformation $\delta_{\text{max}}(t)$.

Expression of results

- Characteristic forces $F_{Rk}(t=30, 60, \dots)$ [kN] at the end of the time intervals (every 30 minutes). Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at time $t=30$ min. for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{\text{max}}(t)$ for every time interval.

2.2.5.3.2 Assessment by calculation

Alternatively, the deflections can be determined by calculation according to Annex E.

2.2.5.4 Bending characteristics under fire exposure – Model C: two forces near the threaded rods; minimum/maximum and standard span L

The assessment can be done by testing, by calculation or both. The determination of the performance by testing is the reference method.

In the ETA an information shall be given whether testing or calculation has been used for assessment.

2.2.5.4.1 Assessment by testing

Purpose of the assessment

The objective of the test is the measurement of deflection at certain loads (due to weight forces) during heating according to the standard temperature time curve (STTC) and the measurement of the time to failure.

Bending resistance is composed of:

- Characteristic time function $F_{Rk}(t=30, 60, \dots)$ [kN] at the place of load introduction and at the end of the time intervals (every 30 minutes)
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at the place of load introduction and at time $t=30\text{min.}$ for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{\max}(t)$ at the place of load introduction and for every time interval

Assessment method

The assessment method is to introduce 2 forces F via threaded rod and connection element, as described in Table 1.1.2.1, No. 4 into the channel and to heat up in a furnace until it fails and to measure the deflections. See Figure 2.2.5.4.1.1 for details of the test setup. The standard setup is a suspended channel with a suspension of $h=300\text{ mm}$ and a span of $L=700\text{ mm}$, optionally with minimum and maximum heights (h) and spans (L), with the forces applied at a distance of 100 mm from the threaded rods.

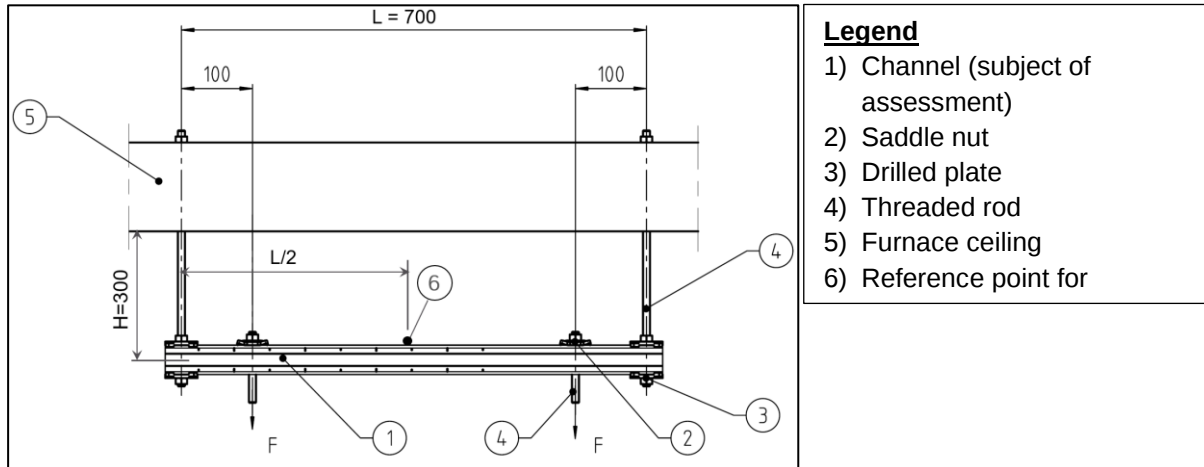


Figure 2.2.5.4.1.1: Test setup

The elements of the assessment method (threaded rods, connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

To evaluate the time-dependent deformations of the channel, the thermal elongation of the threaded rod shall be subtracted from the measured values.

$$\delta_t = \delta_{\text{meas},t} - \delta_{\text{th,threaded rod},t}$$

δ_t maximum channel deformation at time t

$\delta_{\text{meas},t}$ measured channel deformation at time t

$\delta_{th, threaded\ rod, t}$ calculated thermal elongation of threaded rod in accordance with EN 1993-1-2, Clause 5.3.1.2 or Annex C.4.3

For further evaluations see:

- Annex B for determination of the resistance time function $F_{Rk}(t)$,
- Annex C for determination of the load displacement function $F_{Rk,30}(\delta)$,
- Annex D for determination of the maximum deformation $\delta_{max}(t)$.

Expression of results

- Characteristic forces $F_{Rk}(t=30, 60, \dots)$ [kN] at the end of the time intervals (every 30 minutes). Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at time $t=30\text{min.}$ for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{max}(t)$ for every time interval.

2.2.5.4.2 Assessment by calculation

Alternatively, the deflections can be determined by calculation according to Annex E.

2.2.5.5 Stress strain behaviour of material

Purpose of the assessment

The objective of the assessment is based on the measurement of the temperature-dependent mechanical strains of the channel material under constant mechanical tension.

Assessment method

The performance characteristics are determined by means of unsteady thermal creep tests according to Clause 2.2.5.5.1 for 6 stress levels $\sigma_0 = [5, 10, 15, 20, 25, 30]$ N/mm².

Expression of results

For each temperature T_{ev} , $T_{ev} = [800, 850, 900, 950, 1000, 1050, 1100]^{\circ}\text{C}$:

- strain $\epsilon(\sigma, T_{ev})$ at stress level σ_0 according to Clause 2.2.5.5.2

2.2.5.5.1 Thermal creep tests

Test specimens

For every stress level σ_0 at least three specimens according to Figure 2.2.5.5.1.1 cut off from the channel material are needed, which leads to a total of at least 18 specimens. The shape results in EN ISO 6892-2, Annex A, extended by 2x 25mm to avoid influences of the heavy clamping devices on temperature development in the elongation measurement area. Deviating from EN ISO 6892-2, Annex A, L_0 shall be set to the lowest possible value with the standard value $L_0 = 20$ mm. With respect to the geometric properties $L_{c,0}$, b_0 , r , B , C , D and E , EN ISO 6892-2, Table A.1, shall be applied.

The range with respect to the material thickness t shall be from 0,1 to 8,3mm, the retaining drillings of diameter D are optional to avoid slippage at the clamping area. The test specimens shall be cut by milling, grinding or waterjet cutting to avoid influences on the material properties due to work hardening. Therefore, punching, bending, laser cutting and cutting burning are excluded.

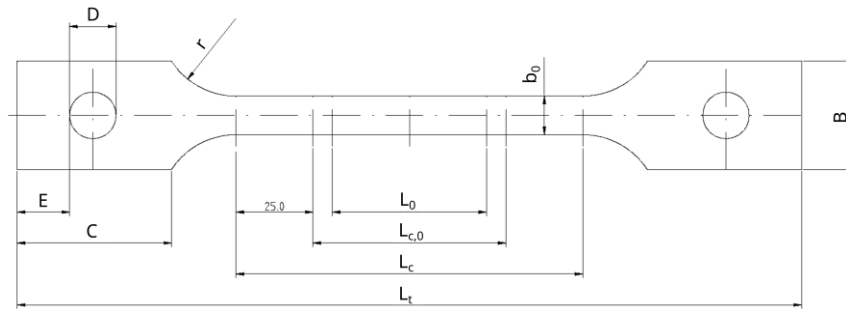


Figure 2.2.5.5.1.1: Test specimen based on EN ISO 6892-2, Annex A

Testing procedure

Unsteady thermal creep tests shall be conducted using a tensile testing machine within a high-temperature furnace. The furnace shall fully enclose the specimen and its mounting fixtures, which shall be connected to the machine's crossbeams via tension rods passing through sealed openings in the furnace's lower and upper shells. The specimens shall be mounted at room temperature (20°C) in the test rig according to Figure 2.2.5.5.1.2.

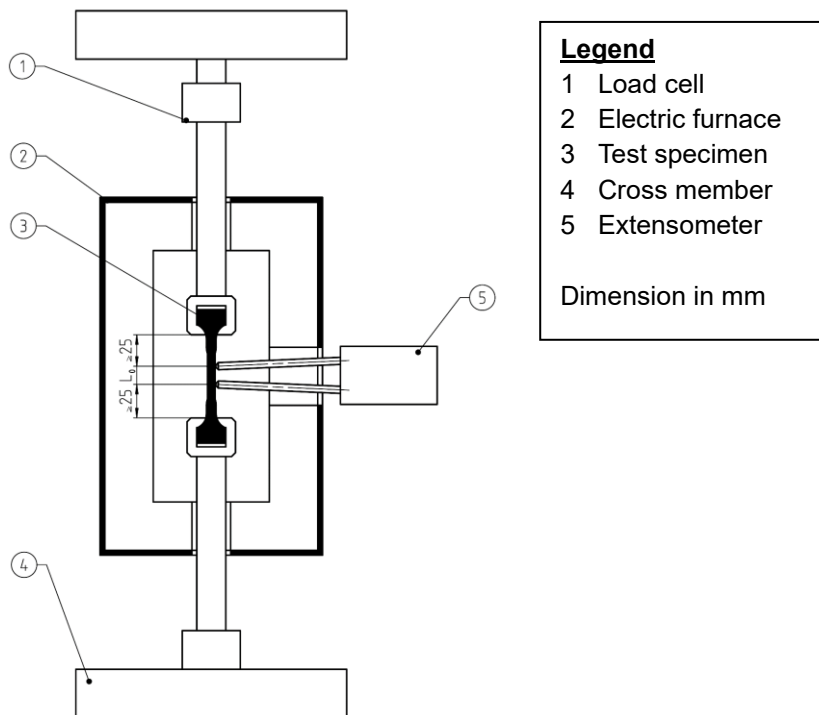


Figure 2.2.5.5.1.2: Test rig

After that a force F depending on the stress level σ_0 shall be applied to the specimens. During testing, the applied force F shall be kept constant.

$$F = A_{\text{meas},0} * \sigma_0 \quad (2.2.5.5.1.1)$$

$A_{\text{meas},0}$: measured cross section area of each specimen [mm²] at time $t=0$

For each stress level σ_0 at least three creep tests shall be carried out.

The subscript “meas” denotes “measured”, referring to values obtained directly from experimental measurements during each individual creep test (e.g., $\sigma_{\text{meas},n}$, $\epsilon_{\text{meas},n}$, $T_{\text{meas},n}$). This is to distinguish them from nominal or target values (e.g., σ_0), and evaluated mean values across multiple tests (e.g., $\sigma(T_{\text{ev}})$, $\epsilon(\sigma, T_{\text{ev}})$).

The test specimens shall be heated while maintaining the required stress level σ_0 . The time-dependent target air temperature $T(t)$ [°C] within the furnace shall meet the following equations with an accuracy of 5%:

$$t < t_1 \quad T(t) = T_1(t) = r \cdot t + 20^\circ\text{C} \quad (2.2.5.5.1.2)$$

$$t \geq t_1 \quad T(t) = T_2(t) = 20^\circ\text{C} + 345 \cdot \log_{10}(8 \cdot (t - t_1 + t_0) + 1) \quad (2.2.5.5.1.3)$$

with

r heating rate of the furnace $r \geq 20\text{K/min}$

t_0 time at which the rate of STTC corresponds to heating rate r of the furnace $T'_{\text{STTC}}(t_0) = r$

$$t_0 = 345 / (r \cdot \ln(10)) - 1/8$$

t_1 time at which temperature $T_{\text{STTC}}(t_0)$ is reached when heating with heating rate r

$$t_1 = (345 \cdot \log_{10}(8 \cdot t_0 + 1)) / r$$

The time-dependent target air temperature $T(t)$ is illustrated in Figure 2.2.5.5.1.3 for $r=50\text{K/min}$ as an example.

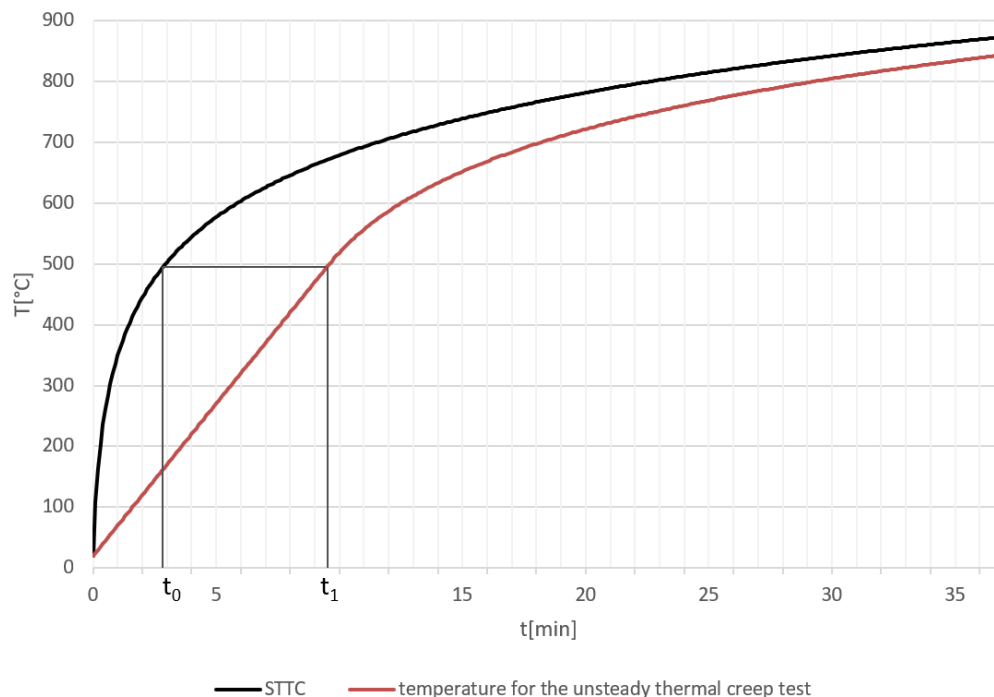


Figure 2.2.5.5.1.3: Time-dependent target air temperature $T(t)$ for heating rate $r=50\text{K/min}$ (red) compared to standard temperature / time curve (STTC, black)

An electronically controllable load cell shall monitor and continuously record tensile stress on the test specimens. Elongation shall be measured by a high-temperature extensometer with two ceramic probes projecting into the furnace. These probes shall trace the elongation $\Delta L(T)$ and $\Delta L(t)$, respectively, of the measured length L_0 directly on the specimen and transmit this data to an external displacement gauge for continuous recording. It shall be ensured, that:

- the extensometer is suitable for the temperatures applied and exhibits an accuracy of 1% or 0,1mm (the more precise limit shall be used),
- the extensometer does not form a thermal bridge (the local temperature on the measurement tip measured on the surface of specimen shall deviate maximum 1°C).

The heating system shall be controlled by an ambient temperature sensor positioned 1 to 2 mm from the middle of the test specimen's surface. For thick-walled specimens (sheet thickness > 5mm), the temperature shall also be measured above and below the elongation measurement length. The test shall stop either when the specimen fails or when the maximum furnace temperature is reached.

2.2.5.5.2 Evaluation

For each test n , the temperature-dependent measured strains $\epsilon_{\text{meas},n}(T_{\text{meas},n})$ and the temperature-dependent applied stresses $\sigma_{\text{meas},n}(T_{\text{meas},n})$ shall be determined:

$$\epsilon_{\text{meas},n}(T_{\text{meas},n}) = \Delta L(T_{\text{meas},n})/L_0 \quad (2.2.5.5.2.1)$$

$$\sigma_{\text{meas},n}(T_{\text{meas},n}) = F_{\text{meas}}(T_{\text{meas},n})/A_{\text{meas},0} \quad (2.2.5.5.2.2)$$

with

$T_{\text{meas},n}$ measured values of time-dependent furnace/specimen temperature for test n

$F_{\text{meas},n}$ measured values of the applied load for test n

The applied stress is always related to the cross-sectional area $A_{\text{meas},0}$ of each specimen at time $t=0$.

The applied stress $\sigma_{\text{meas},n}(T_{\text{meas},n})$ shall be used for evaluation instead of the nominal stress level σ_0 to obtain results as accurate as possible. The same applies to the use of the applied temperature $T_{\text{meas},n}$ in contrast to the nominal temperature according to Figure 2.2.5.5.1.3.

To evaluate the temperature-dependent mechanical strains of the material, the thermal strains shall be subtracted from the measured values.

$$\epsilon_{\text{meas},n,m}(T_{\text{meas},n}) = \epsilon_{\text{meas},n}(T_{\text{meas},n}) - \epsilon_{h,n}(T_{\text{meas},n}) \quad (2.2.5.5.2.3)$$

$\epsilon_{\text{meas},n,m}(T_{\text{meas},n})$ mechanical portion of measured temperature-dependent strain $\epsilon_{\text{meas},n}(T_{\text{meas},n})$ for test n
 $\epsilon_{h,n}(T_{\text{meas},n})$ calculated thermal strain depending on applied furnace/specimen temperature $T_{\text{meas},n}$ for test n in accordance with EN 1993-1-2, Clause 5.3.1.2 or Annex C.4.3

As the next step, for each discrete temperature $T_{\text{ev}} = [800, 850, 900, 950, 1000, 1050, 1100]^\circ\text{C}$, the applied stresses $\sigma_{\text{meas},n}(T_{\text{ev}})$ and mechanical portions of measured time-dependent strains $\epsilon_{\text{meas},n,m}(T_{\text{ev}})$ are read for each test n from the experimentally determined curves $\sigma_{\text{meas},n}(T_{\text{meas},n})$ and $\epsilon_{\text{meas},n,m}(T_{\text{meas},n})$:

$\epsilon_{\text{meas},n,m}(T_{\text{ev}})$ mechanical portion of measured strain for test n at evaluation temperature T_{ev}

$\sigma_{\text{meas},n}(T_{\text{ev}})$ applied stress for test n at evaluation temperature T_{ev}

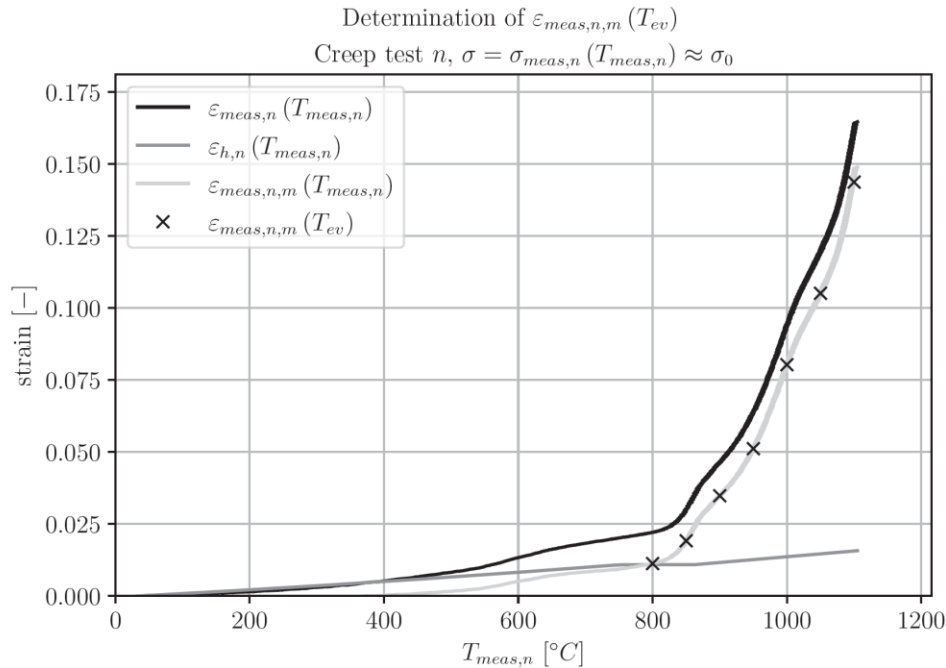


Figure 2.2.5.5.2.1: Example to determine $\varepsilon_{\text{meas},n,m}(T_{\text{ev}})$

The performance properties $\varepsilon(\sigma, T_{\text{ev}})$ shall be determined by calculating the mean values of $\varepsilon_{\text{meas},n,m}(T_{\text{ev}})$ and $\sigma_{\text{meas},n}(T_{\text{ev}})$ for each evaluation temperature and group of results belonging to a stress level σ_0 :

$$\sigma(T_{\text{ev}}) = (\sigma_{\text{meas},1}(T_{\text{ev}}, \sigma_0) + \sigma_{\text{meas},2}(T_{\text{ev}}, \sigma_0) + \dots + \sigma_{\text{meas},n}(T_{\text{ev}}, \sigma_0))/n \quad (2.2.5.5.2.4)$$

$$\varepsilon(\sigma, T_{\text{ev}}) = (\varepsilon_{\text{meas},1,m}(T_{\text{ev}}, \sigma_0) + \varepsilon_{\text{meas},2,m}(T_{\text{ev}}, \sigma_0) + \dots + \varepsilon_{\text{meas},n,m}(T_{\text{ev}}, \sigma_0))/n \quad (2.2.5.5.2.5)$$

with n_{σ_0} : number of valid results for stress level σ_0 considered, $n_{\sigma_0} \geq 3$

Following EN 1993-1-2, Figure 5.3 or Annex C.4.2, the evaluation is valid for $\varepsilon(\sigma, T_{\text{ev}}) \leq 0,15$. From this strain limit onwards, a linear weakening stress-strain function down to the point $(\varepsilon=0,2, 0)$ shall be applied following EN 1993-1-2, Figure 5.3 or Annex C.4.2.

In the elastic range where strains are small, the temperature-dependent gradient $\Delta\sigma/\Delta\varepsilon$ shall be determined basing on $k_{E,\theta} \cdot E$ in accordance with EN 1993-1-2, Table 5.3 or Table C.1.

The final results in the form of stress-strain dependencies for the evaluation temperatures T_{ev} (analogous to EN 1993-1-2, Table 5.3 or Table C.1) may be stated in the ETA in the form of diagrams or Tables. Figure 2.2.5.5.2.2 shows an example diagram for one evaluation temperature.

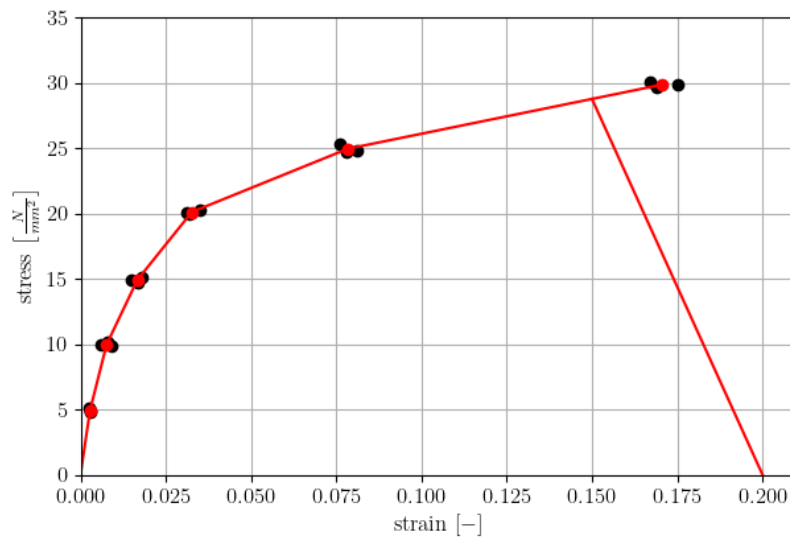


Figure 2.2.5.2.2: Example of stress-strain-dependency for one evaluation temperature T_{ev} (black: individual results $\epsilon_{meas,n,m}(T_{ev})$ and $\sigma_{meas,n}(T_{ev})$, red: mean values $\sigma(T_{ev})$ and $\epsilon(\sigma, T_{ev})$ and mean value curve)

For temperatures $\leq 750^{\circ}\text{C}$ the stress-strain dependencies in accordance with EN 1993-1-2, Table 5.3 or Table C.1, shall be used. Linear interpolation shall be used to determine the stress-strain dependencies for intermediate temperatures.

2.2.5.6 Characteristic pull-through resistance of channel back holes

Purpose of the assessment

The objective of the assessment is to determine the pull-through resistance of channel holes at the back of the channel.

Assessment method

The assessment method involves pulling on the threaded rod in the middle of the adapter which is evenly fitted to channel lips until failure occurs. See Figure 2.2.5.6.1 for details of the test setup.

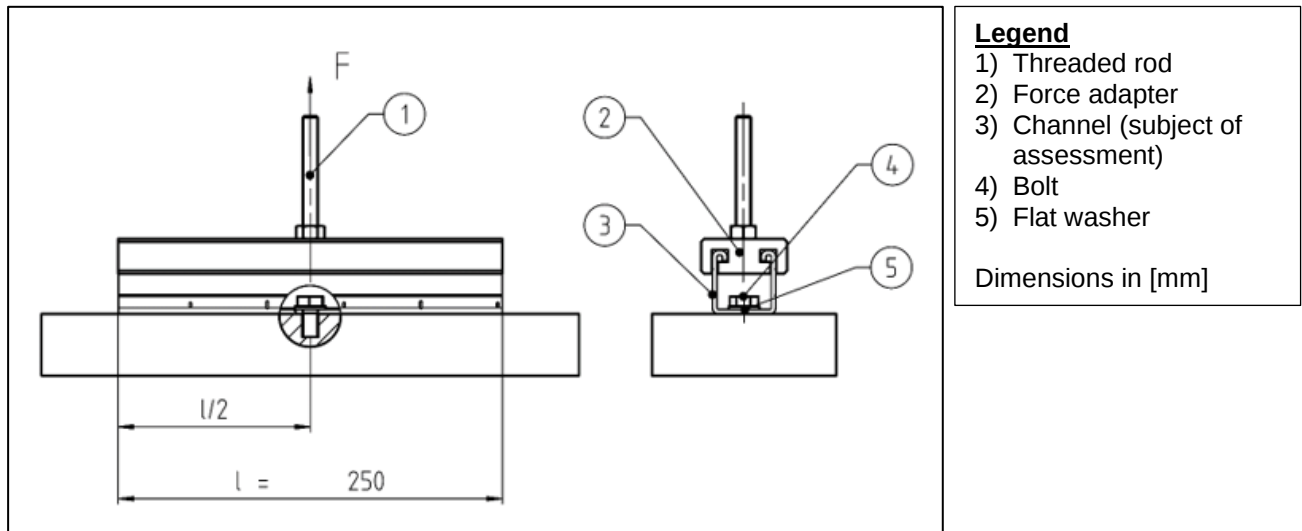


Figure 2.2.5.6.1: Test setup.

The elements of the assessment method (threaded rod, adapter, flat washer, bolt and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally using an adapter which is fitted to the channel lips. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance $\pm 1\%$) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_X .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN].

2.2.6 Cantilever – Methods and criteria for assessing the performance

2.2.6.1 Resistance under fire exposure

The assessment can be done by testing, by calculation or both. The determination of the performance by testing is the reference method.

In the ETA an information shall be given whether testing or calculation has been used for assessment.

2.2.6.1.1 Assessment by testing

Purpose of the assessment

The objective of the test is to measure the deflection at certain loads (due to weight forces) during heating according to the standard temperature time curve (STTC) and to measure the time to failure.

The bending resistance is composed of:

- Characteristic time function $F_{Rk}(t=30, 60, \dots)$ [kN] at the place of load introduction and at the end of the time intervals (every 30 minutes)
- Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at the place of load introduction and at time $t=30\text{min.}$ for deformation steps (every 5 millimetre)
- Maximum deformation $\delta_{\max}(t)$ at the place of load introduction and for every time interval

Assessment method

The assessment method involves introducing a weight force (F) via a threaded rod and connection element, as described in Table 1.1.2.1, No. 4 into a suspended or non-suspended cantilever, heating it in a furnace until it fails and measuring the deflections. See Figures 2.2.6.1.1 and 2.2.6.1.2 for details of the test setups.

The standard setup is a suspended channel with a suspension of $h = 300$ mm and a span of $L = 500$ mm, optionally with minimum and maximum heights (h) and spans (L), with the force applied at the centre of the span.

In case the manufacturer requests to have another configuration assessed, a deviating test setup shall be used. In any case, the test setup(s) shall be provided in the ETA along with an indication of the relevant product performance.

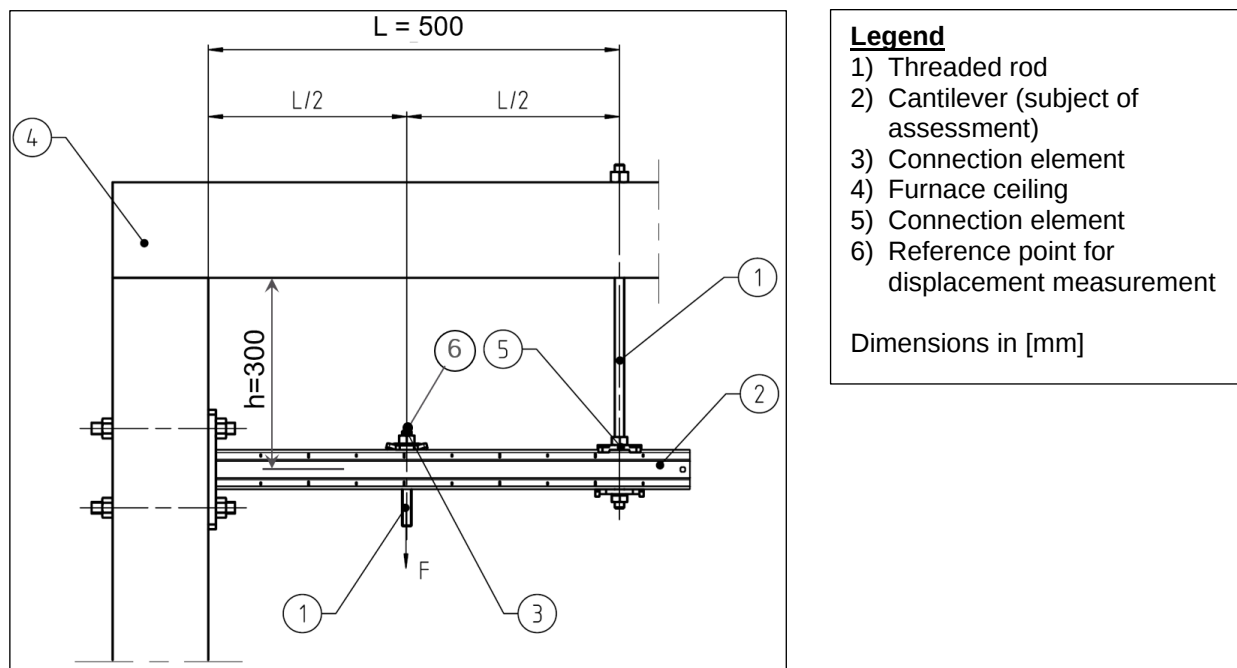


Figure 2.2.6.1.1: Test setup suspended cantilever

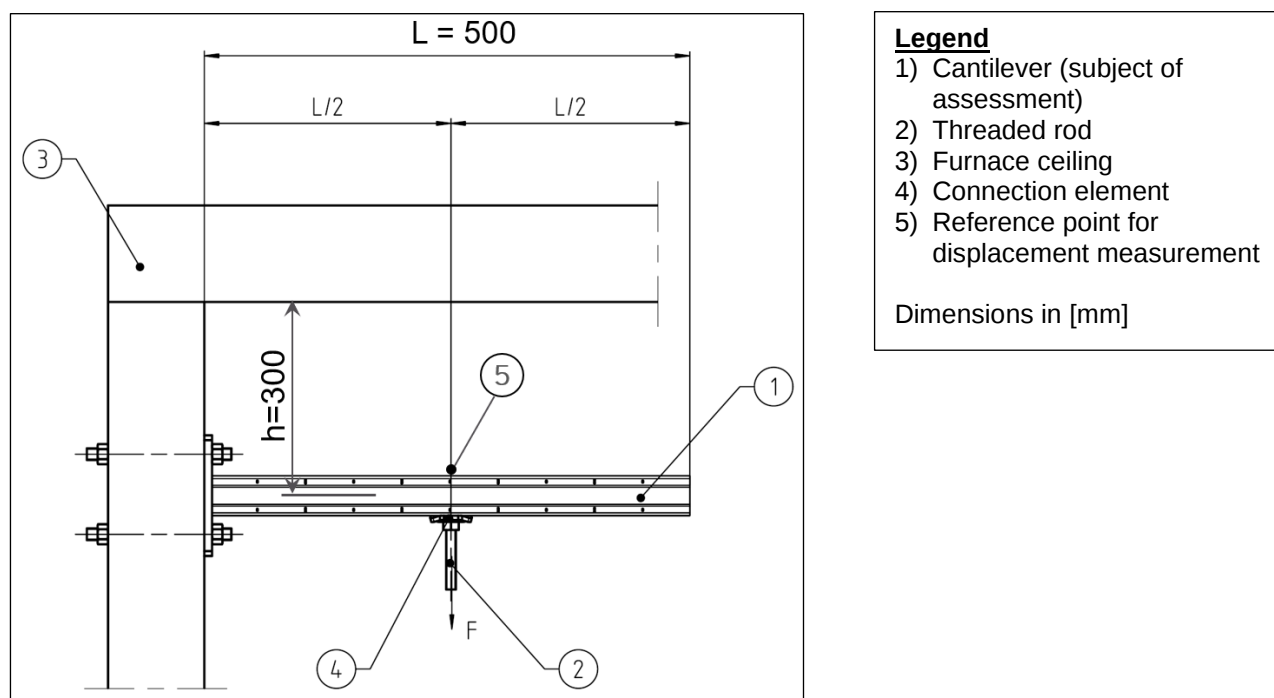


Figure 2.2.6.1.2: Test setup non-suspended cantilever

The elements of the assessment method (threaded rods, connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

For further evaluation see:

- a) Annex B for the determination of the Resistance time function $F_{Rk}(t)$,
- b) Annex C for the determination of the load displacement function $F_{Rk,30}(\delta)$,
- c) Annex D for the determination of the maximum deformation $\delta_{max}(t)$.

Expression of results

- a) Characteristic forces $F_{Rk}(t=30, 60, \dots)$ [kN] at the end of the time intervals (every 30 minutes). Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.
- b) Load displacement function $F_{Rk,30}(\delta=5, 10, \dots)$ [kN] at time $t=30\text{min.}$ for deformation steps (every 5 millimetre)
- c) Maximum deformation $\delta_{max}(t)$ for every time interval.

2.2.6.1.2 Assessment by calculation

For this purpose, the procedure according to Annex E shall be modified, taking into account the following points:

- The channel with the span of the suspended cantilever shall be calculated and validated.
- The time-dependent resistance of the weld seam shall be determined experimentally as described above considering the cantilever with maximum span loaded in mid-span.
- The calculated thermal elongation of the threaded rod in accordance with EN 1993-1-2, Clause 5.3.1.2 or Annex C.4.3, shall be added to the calculated time-dependent deformations according to Annex E.

2.2.6.2 Characteristic resistance

Purpose of the assessment

The objective of the test is to measure the forces at defined points of deflection for the test setup and to determine the ultimate load.

Assessment method

The assessment method involves introducing a force (F) via a threaded rod and connection element, as described in Table 1.1.2.1, No. 4 into a suspended or non-suspended cantilever in a displacement-controlled manner and measuring the resulting forces and deflections. See Figures 2.2.6.2.1 and 2.2.6.2.2 for details of the test setup.

In case the manufacturer requests to have another configuration assessed, a deviating test setup shall be used. In any case, the test setup(s) shall be provided in the ETA along with an indication of the relevant product performance.

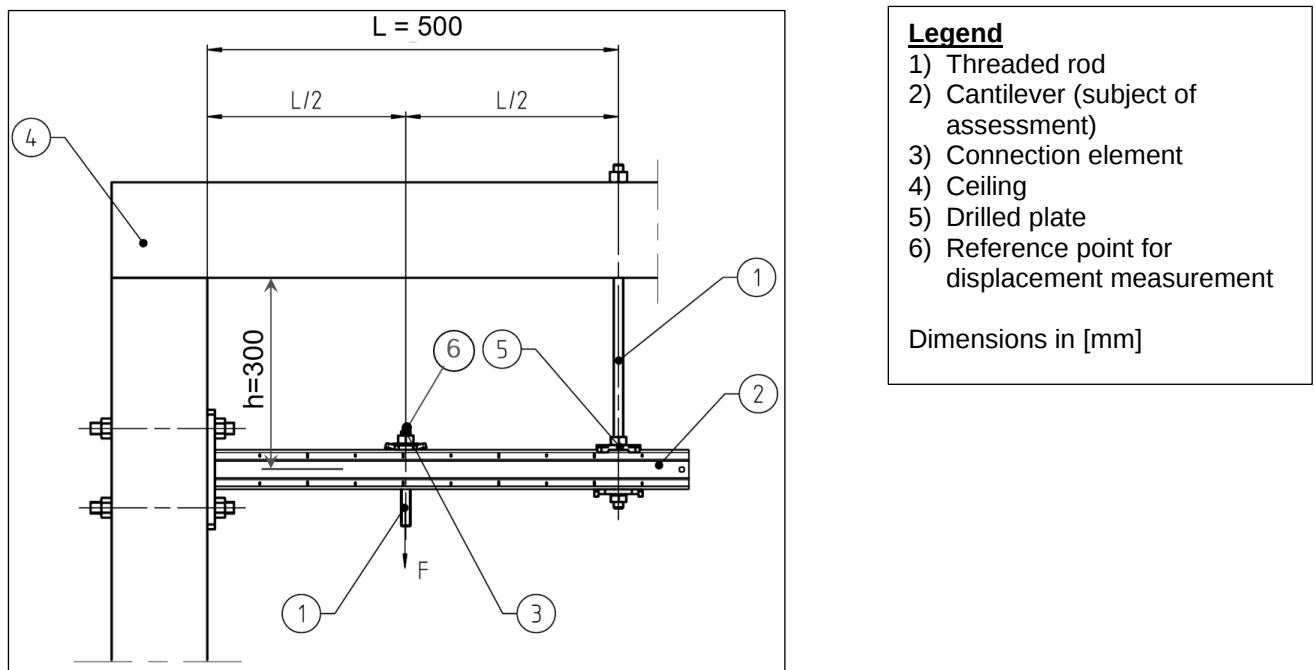


Figure 2.2.6.2.1: Test setup suspended cantilever

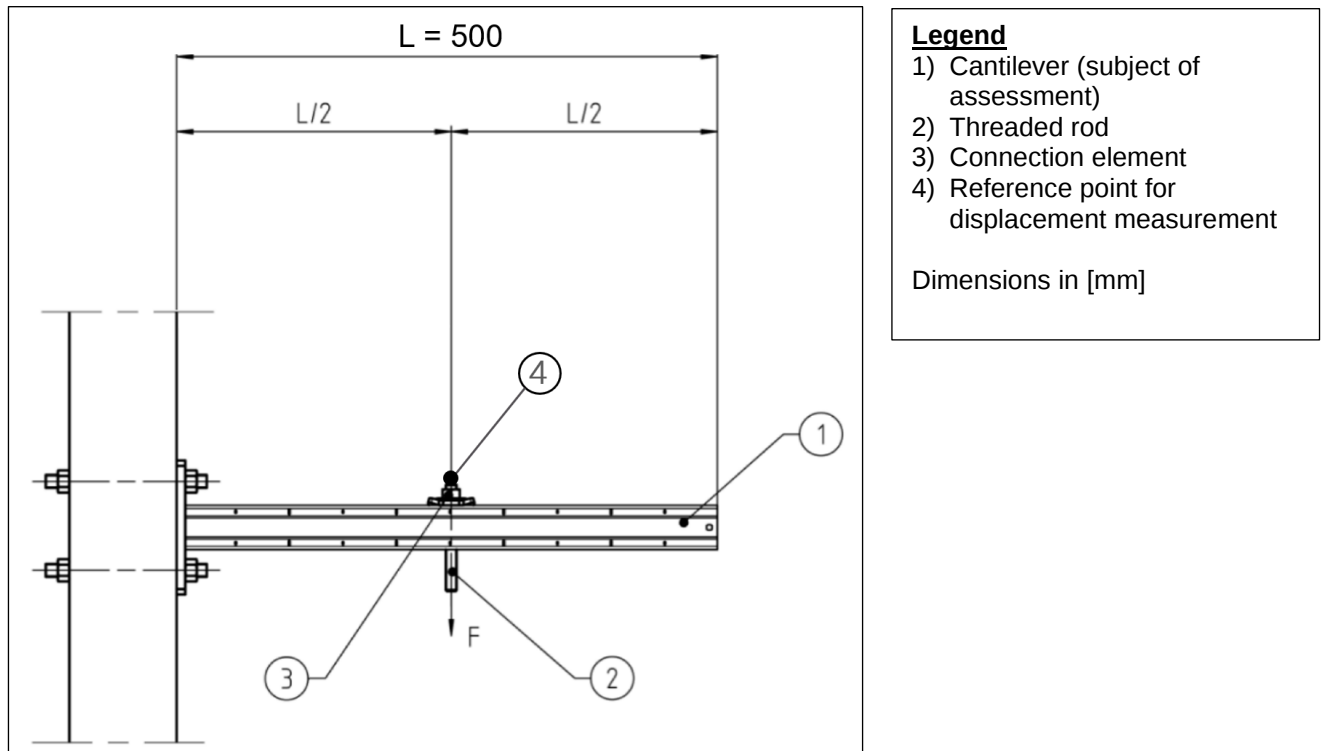


Figure 2.2.6.2.2: Test setup non-suspended cantilever

The elements of the assessment method (threaded rods, connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally by way of a threaded rod and a connection element, as described in Table 1.1.2.1, No. 4. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance $\pm 1\%$) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

At each deflection ($L/200$, $L/150$; $L/100$ of span width L) the force shall be measured and the maximum load until failure occurs. The deflection shall be measured between mounting surface and force measurement unit.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3. The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The result are four statistically determined forces:

- $F_{Rk,L200}$ (for a deflection of $L/200$)
- $F_{Rk,L150}$ (for a deflection of $L/150$)
- $F_{Rk,L100}$ (for a deflection of $L/100$)
- $F_{Rk,max}$ (for failure)

2.2.7 Pipe clamp – Methods and criteria for assessing the performance

2.2.7.1 Resistance and deformations under fire exposure

Purpose of the assessment

The objective of the test is to measure the deflection at certain loads (due to weight forces) during heating according to the standard temperature-time curve (STTC) and to measure the time to failure.

Resistance and deformation are composed of:

- a) Resistance time function $F_{Rk}(t)$, which describes the time to failure with different loads influenced by fire,
- b) Load displacement function $F_{Rk,30}(\delta)$, which describes the deflection after 30 minutes with different loads influenced by fire,
- a) Maximum of measured deflections $\delta_{max,t}$ in all time intervals over all different loads under influence of fire.

Assessment method

The assessment method involves introducing a weight force F via a force adapter and a pipe dummy into a pipe clamp, heating the test specimen in a furnace until it fails and measuring its deflections.

The following provisions shall apply for the selection of the test specimens. The pipe clamp range shall be clustered in subgroups. Within these subgroups the following properties are identical:

1. Cross sectional geometry of the pipe clamp steel band,
2. Material specifications,
3. Closing mechanism,
4. Joint between threaded boss and pipe clamp band,
5. Threaded boss with the least favourable cross section.

The smallest and largest clamp size from each of these subgroups shall always be tested with the smallest diameter of the threaded rod.

See Figure 2.2.7.1.1 for details of the test setup.

The diameter of the pipe dummies shall correspond to the maximum diameter of the clamping range as covered by the ETA. The test specimen shall be fixed by means of threaded rods running through sealed openings in the furnace ceiling. The dimensions of the load introduction components shall follow the provisions described in Clause 2.2.3.

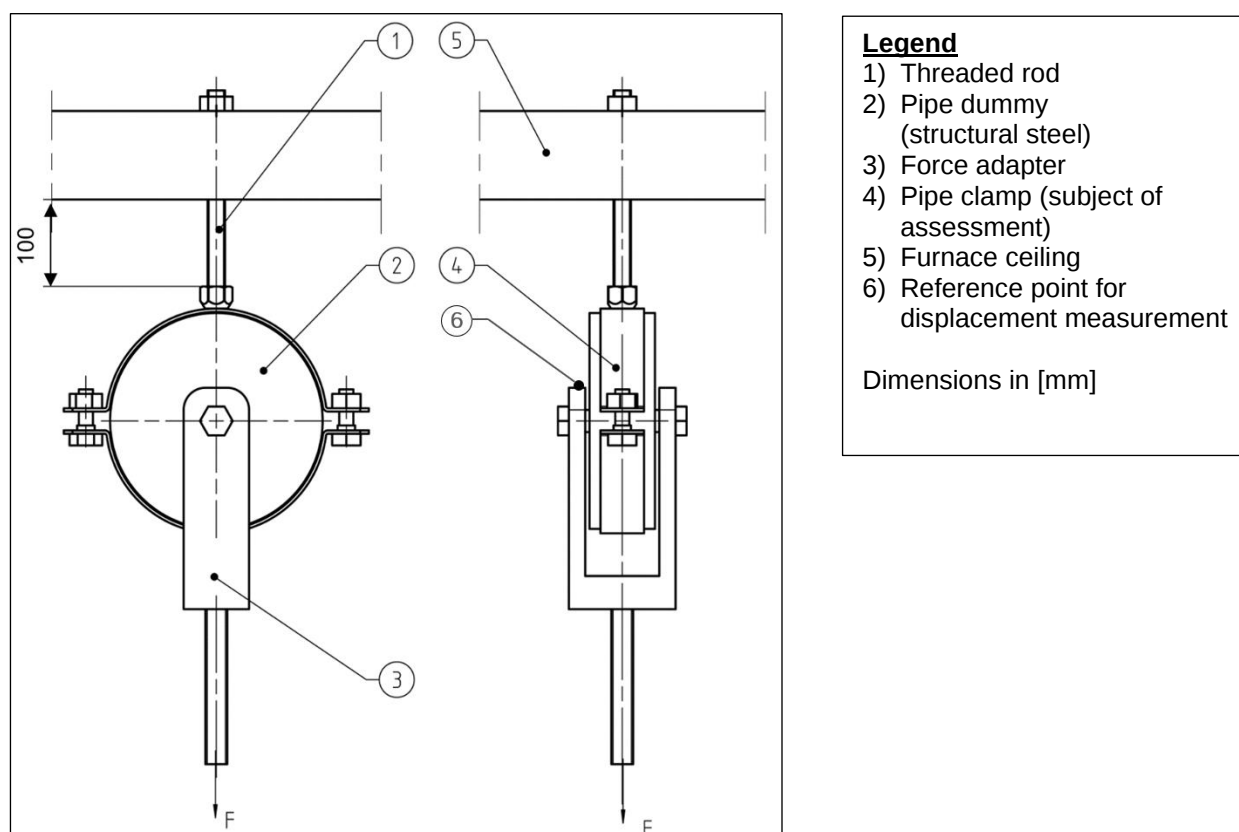


Figure 2.2.7.1.1: Test setup

The elements of the assessment method (threaded rod, adapter, dummy and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

For further evaluations see:

- a) Annex B for the determination of the resistance time function $F_{Rk}(t)$,
- b) Annex C for the determination of the load displacement function $F_{Rk,30}(\delta)$,
- c) Annex D for the determination of the maximum of measured deformation $\delta_{max}(t)$.

It is always the minimum assessed F_{Rk} of a subgroup that shall apply to the complete subgroup.

Expression of results

- a) The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:
 - $F_{Rk}(30)$ for $t=30$ min,
 - $F_{Rk}(60)$ for $t=60$ min,
 - $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

- b) The results are the parameters of the load displacement function $F_{Rk,30}$ and at least the resistances for deformations in steps of 5 mm for $\delta=5$ mm, $\delta=10$ mm, $\delta=15$ mm etc.
- c) Maximum deformation $\delta_{max}(t)$ for each time interval according to Annex B, Table B.1, with $t \geq 30$ minutes.

2.2.7.2 Characteristic resistance

Purpose of the assessment

The objective of the test is to measure deflections at different forces and the ultimate force.

Assessment method

The assessment method involves pulling on the pipe clamp with a pipe dummy and measuring the resulting forces. See Figure 2.2.7.2.1 for details of the test setup.

The following provisions shall apply for the selection of the test specimens. The pipe clamp range shall be clustered in subgroups. Within these subgroups the following properties are identical:

1. Cross sectional geometry of the pipe clamp steel band,
2. Material specifications,
3. Closing mechanism,
4. Joint between threaded boss and pipe clamp band,
5. Threaded boss with the least favourable cross section.

The smallest and largest clamp size from each of these subgroups shall always be tested with the smallest diameter of the threaded rod.

The diameter of the pipe dummy shall correspond to the maximum diameter of the clamping range of the test specimen.

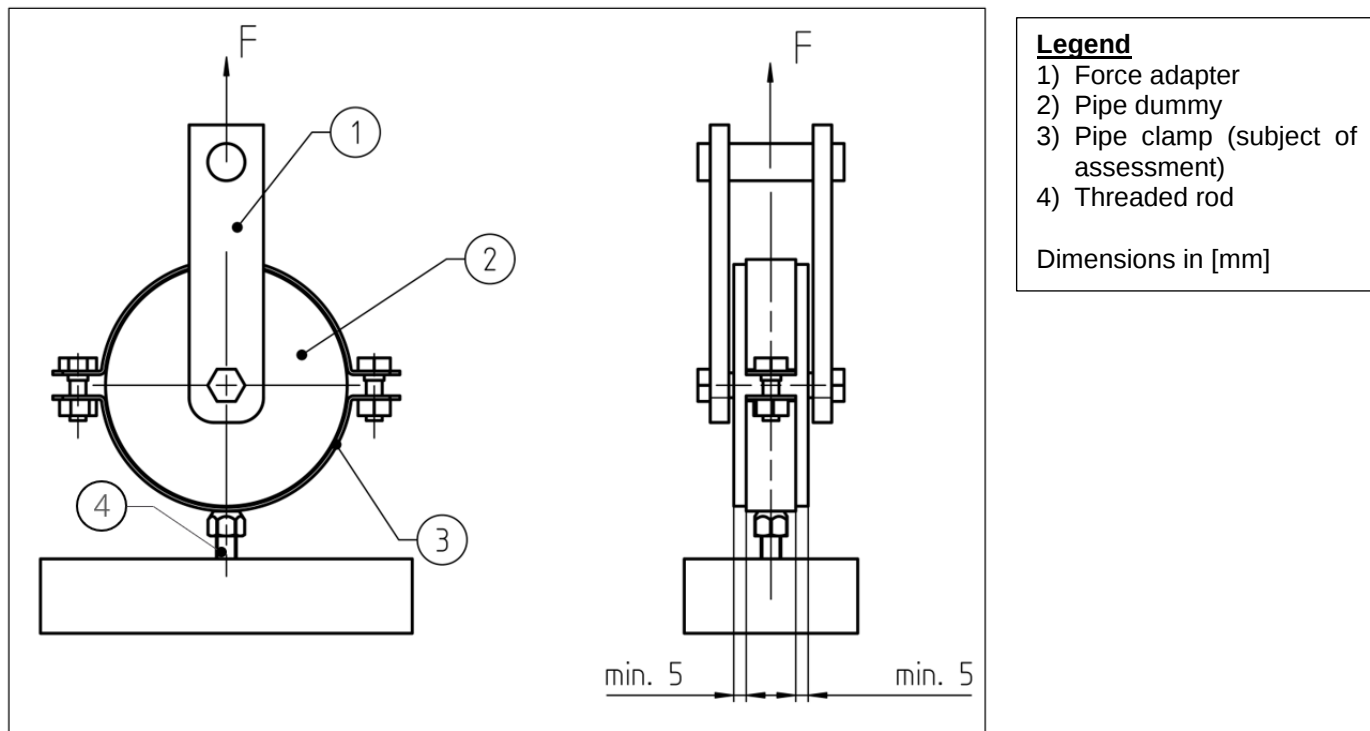


Figure 2.2.7.2.1: Test setup

The elements of the assessment method (threaded rod, adapter, dummy and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally by the pipe dummy. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance $\pm 1\%$) until failure occurs.

The specimen shall be replaced with a new one of the same type and size and testing shall be resumed until a total of at least five tests has been completed.

The measured values shall be multiplied with the correction factor C according to Clause 2.2.1.3.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_X .

It is always the minimum assessed F_{Rk} of a subgroup that shall apply to the complete subgroup.

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN].

2.2.8 Connection element – Methods and criteria for assessing the performance

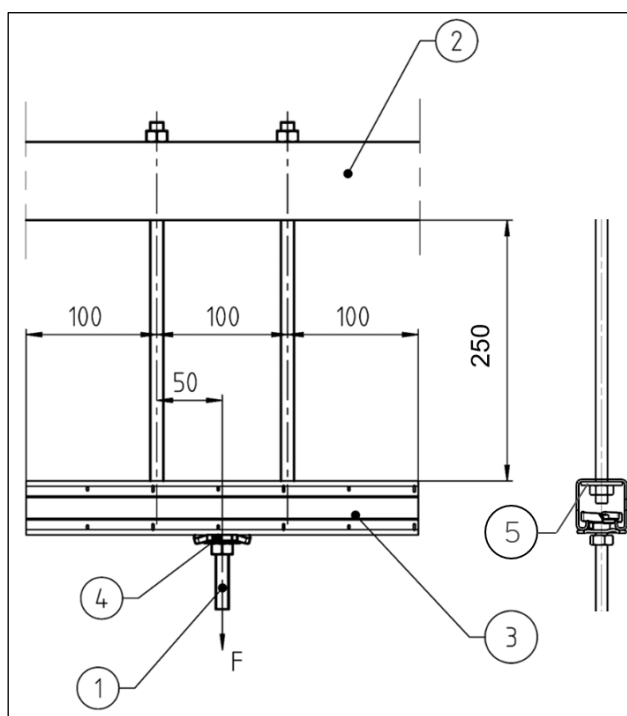
2.2.8.1 Pull-out resistance under fire exposure (in the middle of the channel)

Purpose of the assessment

The objective of the test is to measure the time to failure at certain loads during heating according to the standard temperature-time curve (STTC).

Assessment method

The assessment method involves applying a weight force to the specimen via the threaded rod of a connection element (such as a saddle nut) and heating it until it fails. See Figure 2.2.8.1.1 for details of the test setup.



Legend

- 1) Threaded rod
- 2) Furnace ceiling
- 3) Channel
- 4) Connection element
(subject of assessment
e.g., saddle nut etc.)
- 5) Steel plate and nut

Dimensions in [mm]

Figure 2.2.8.1.1: Test setup (in case of open channel profiles the channel opening is oriented downwards)

To prevent the nuts on the vertical threaded rods from being pulled through the channel's back hole, a steel plate with an appropriately sized hole shall be placed under the nuts.

The plate shall be at least 3 mm x 35 mm and wide enough to reach the channel's bending radius while lying flat against the back.

The elements of the assessment method (threaded rods, steel plate, nut and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

For further evaluations see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.8.2 Shear resistance under fire exposure

Purpose of the assessment

The objective of the test is to measure the time to failure at certain loads during heating according to the standard temperature-time curve (STTC).

Assessment method

The assessment method involves applying a weight force to the specimen via threaded rod/adaptor and heating it until it fails. See Figure 2.2.8.2.1 for details of the test setup.

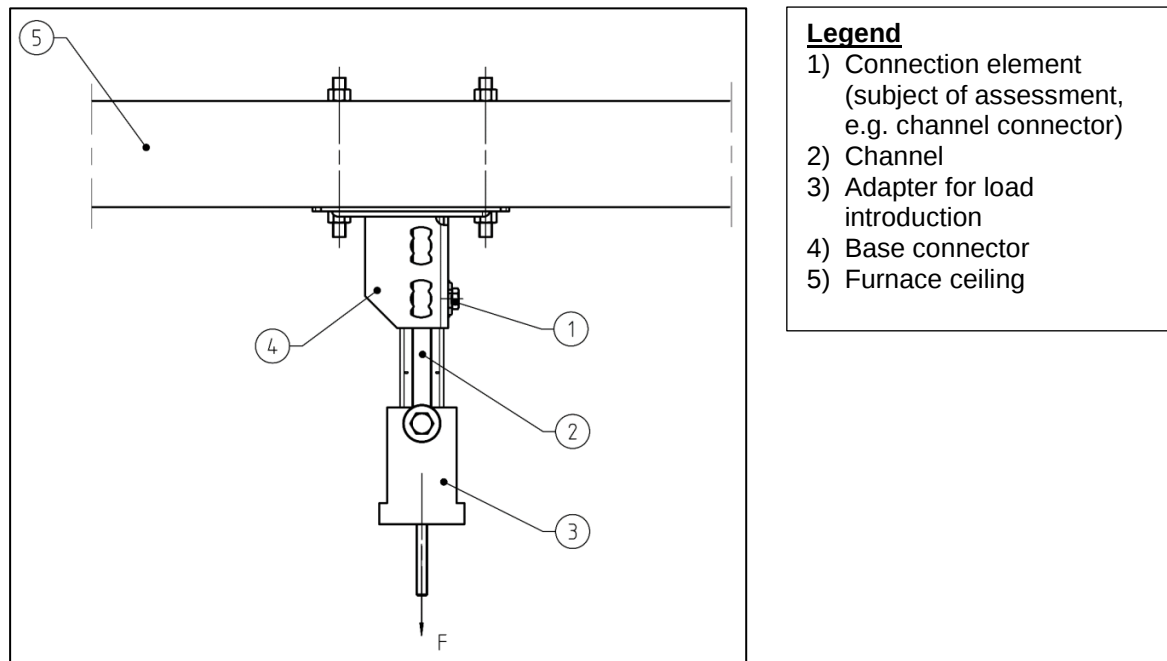


Figure 2.2.8.2.1: Test setup

The elements of the assessment method (channel, adapter, base connector and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens. For further evaluations see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer, additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.8.3 Pull-through resistance under fire exposure

Purpose of the assessment

The objective of the test is to measure the time to failure at certain loads during heating according to the standard temperature-time curve (STTC).

Assessment method

The assessment method involves applying a weight force F to the threaded rod of the load distribution plate of the specimen and to heating it until fails. See Figure 2.2.8.3.1 for details of the test setup.

The load shall be introduced with a load distribution plate on the channel backside.

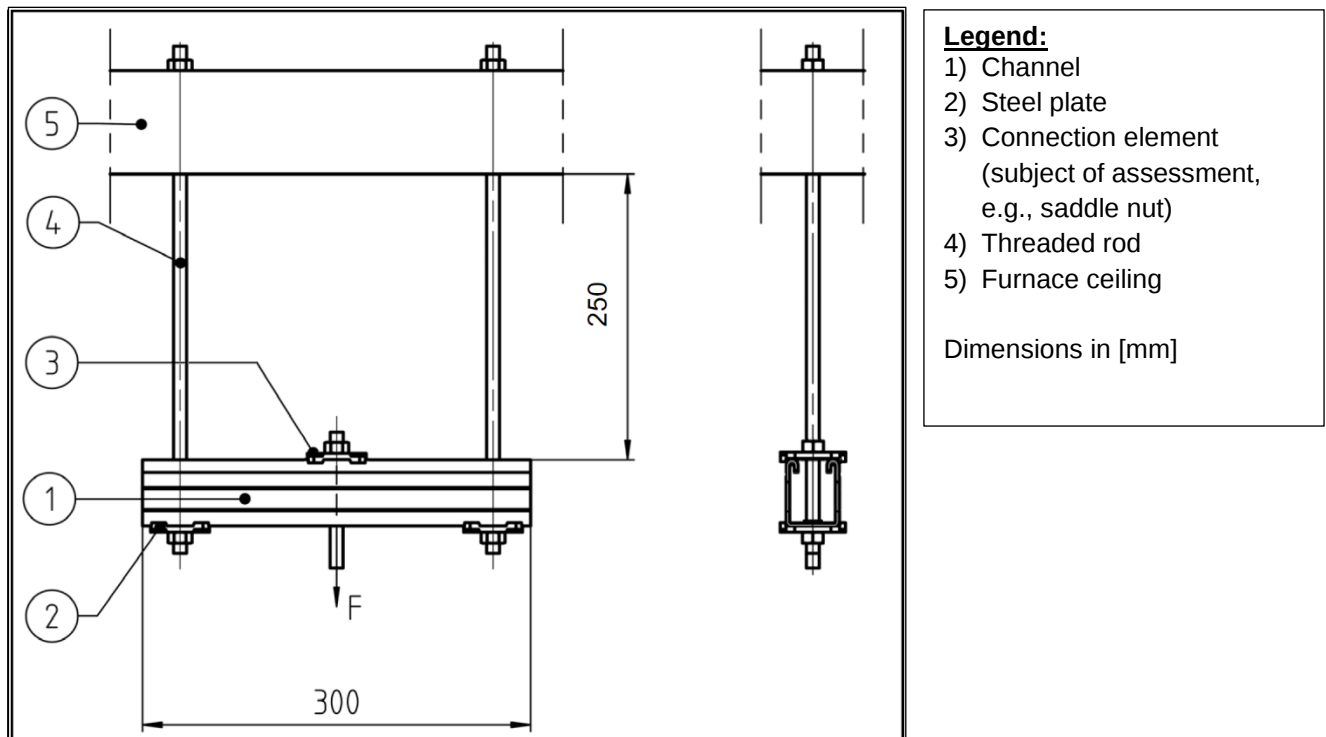


Figure 2.2.8.3.1: Test setup

The elements of the assessment method (threaded rods, channel and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens. For further evaluations see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.8.4 Characteristic pull-out resistance (in the middle of the channel)

Purpose of the assessment

The objective of the assessment is to determine the characteristic pull-out resistance of a connection element (for example a saddle nut), when fixed in the middle of a suspension system channel.

Assessment method

The assessment method involves pulling on the threaded rod at the midpoint of the span until failure occurs.

See Figure 2.2.8.4.1 for details of the test setup.

The threaded rods in this suspended system pass through the holes in the back of the installation channel and shall be secured with a nut to prevent the rod from being pulled through the channel holes.

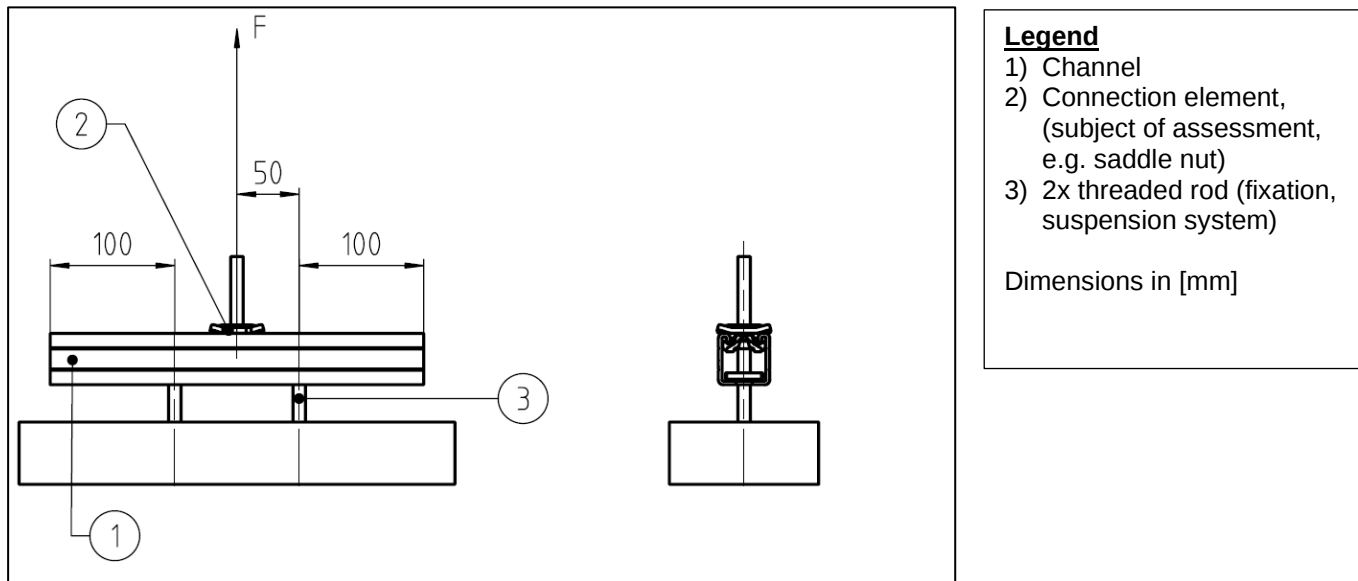


Figure 2.2.8.4.1: Test setup

The elements of the assessment method (threaded rods, channel and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally by the threaded rod and connection element. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance +/-1%) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN] in conjunction with the associated channel.

2.2.8.5 Characteristic pull-out resistance at the channel end

Purpose of the assessment

The objective of the assessment is to determine the characteristic pull-out resistance of a connection element (for example a saddle nut), when fixed at the end of the channel.

Assessment method

The assessment method is based on pulling on the threaded rod and connection element at the channel end until it fails. See Figure 2.2.8.5.1 for details of the test setup.

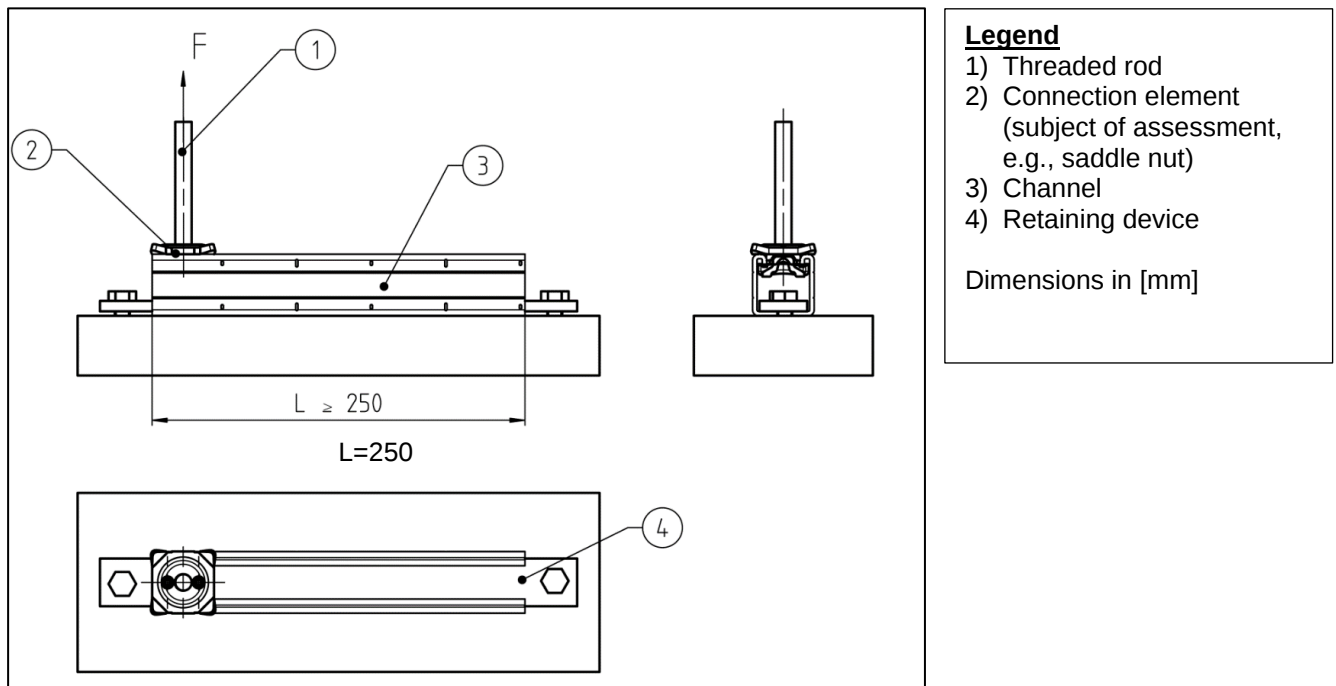


Figure 2.2.8.5.1: Test setup

The elements of the assessment method (threaded rod, channel, retaining device and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied at the channel end by the threaded rod and connection element. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance +/-1%) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN], in conjunction with the associated channel.

2.2.8.6 Characteristic shear resistance

Purpose of the assessment

The objective of the assessment is to determine the characteristic shear resistance of a connection element (for example a channel connector), mounted at the end of the channel.

Assessment method

The assessment method involves applying a weight force to the specimen via threaded rod/adaptor until it fails. See Figure 2.2.8.6.1 for details of the test setup.

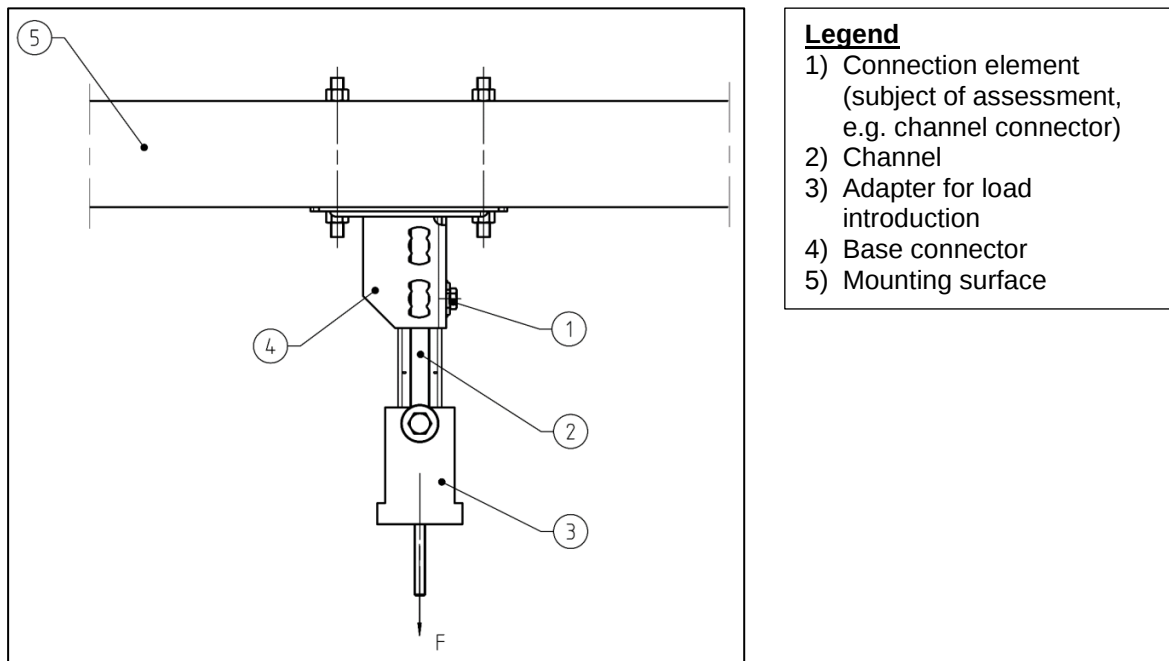


Figure 2.2.8.6.1: Test setup

The elements of the assessment method (channel, adapter, base connector and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally into the vertical channel. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance $\pm 1\%$) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_X .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN], in conjunction with the associated channel.

2.2.8.7 Characteristic pull-through resistance

Purpose of the assessment

The objective of the assessment is to determine the characteristic pull-through resistance of a connection element (for example a drilled plate), when fixed at the end of the channel.

Assessment method

The assessment method is based on pulling on the threaded rod in the middle of the span until it fails. See Figure 2.2.8.7.1 for details of the test setup.

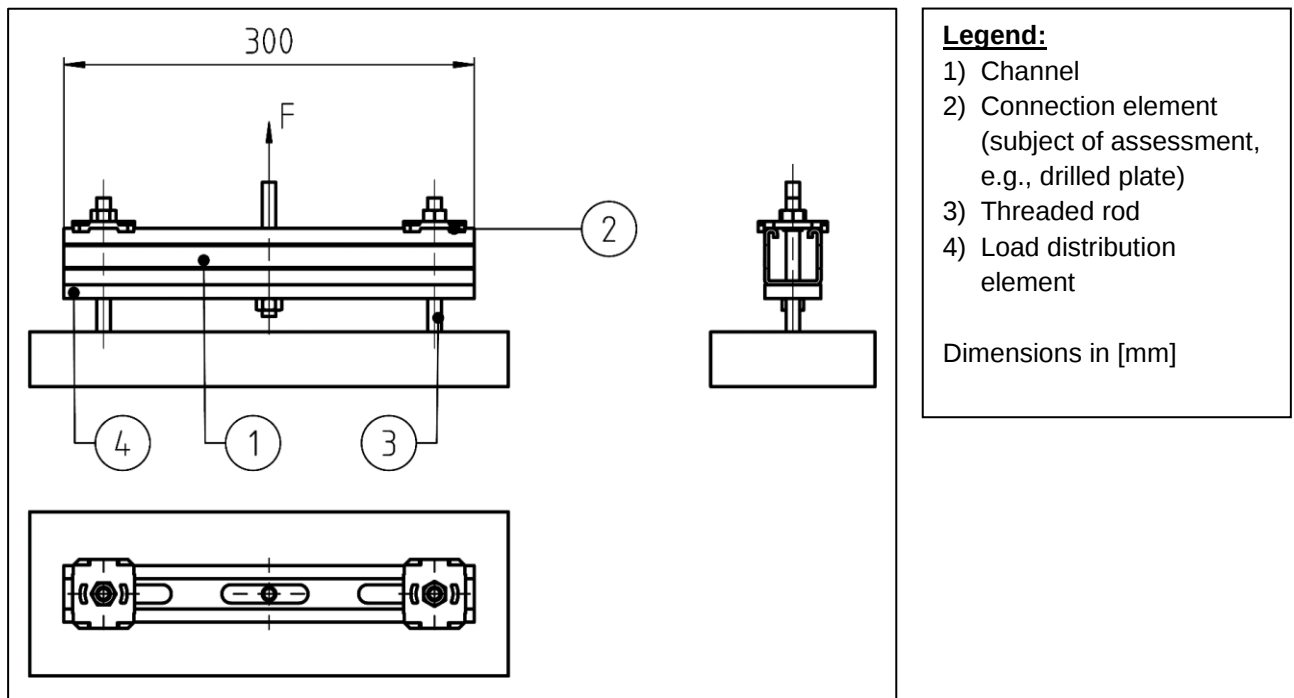


Figure 2.2.8.7.1: Test setup

The elements of the assessment method (channel, threaded rods, load distribution element and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally by way of the load distribution element. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance +/-1%) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN] in conjunction with the associated channel.

2.2.9 Base connector – Methods and criteria for assessing the performance

2.2.9.1 Resistance under fire exposure

Purpose of the assessment

The objective of the test is to measure the time to failure at certain loads (due to weight forces) during heating according to the standard temperature-time curve (STTC).

Assessment method

The assessment method involves applying a weight force to the specimen via threaded rod/adaptor and heating it until it fails. See Figure 2.2.9.1.1 for details of the test setup.

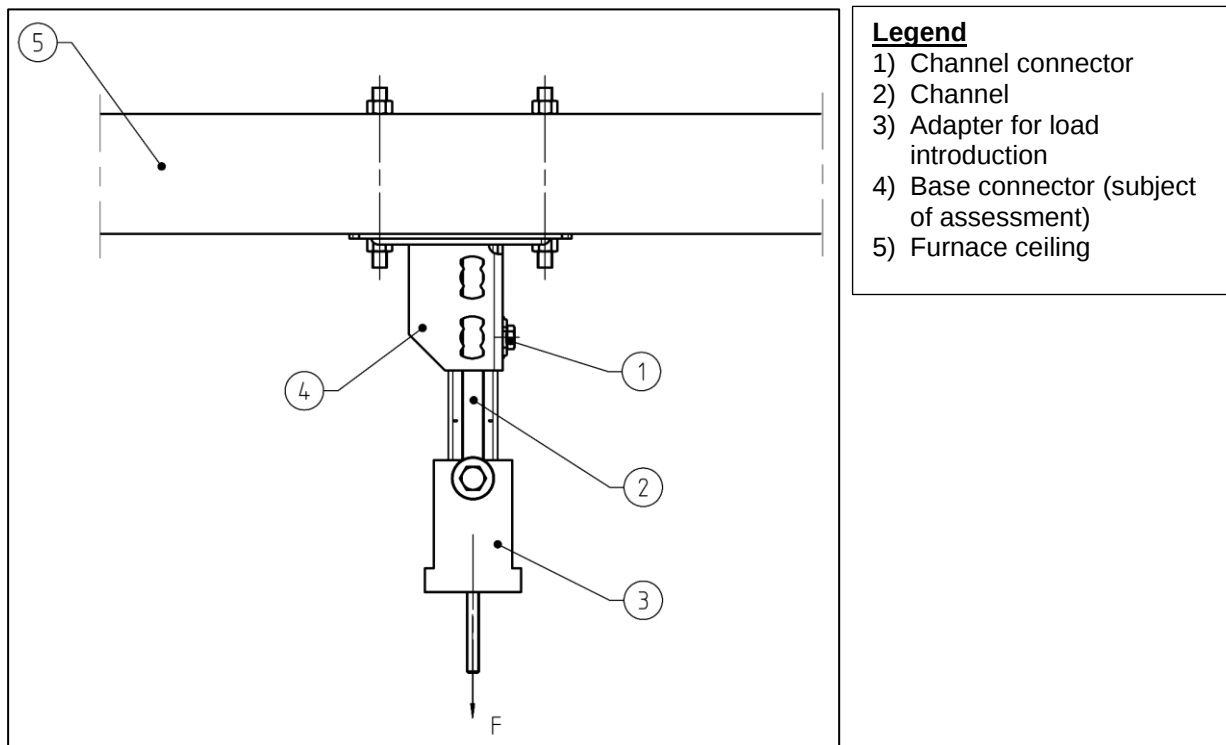


Figure 2.2.9.1.1: Test setup

The elements of the assessment method (channel, adapter, connector and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

For further evaluations see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.9.2 Characteristic resistance

Purpose of the assessment

The objective of the assessment is to determine the characteristic resistance F_{Rk} of a base connector.

Assessment method

The assessment method is based on pulling on the channel until it fails. See Figure 2.2.9.2.1 for details of the test setup.

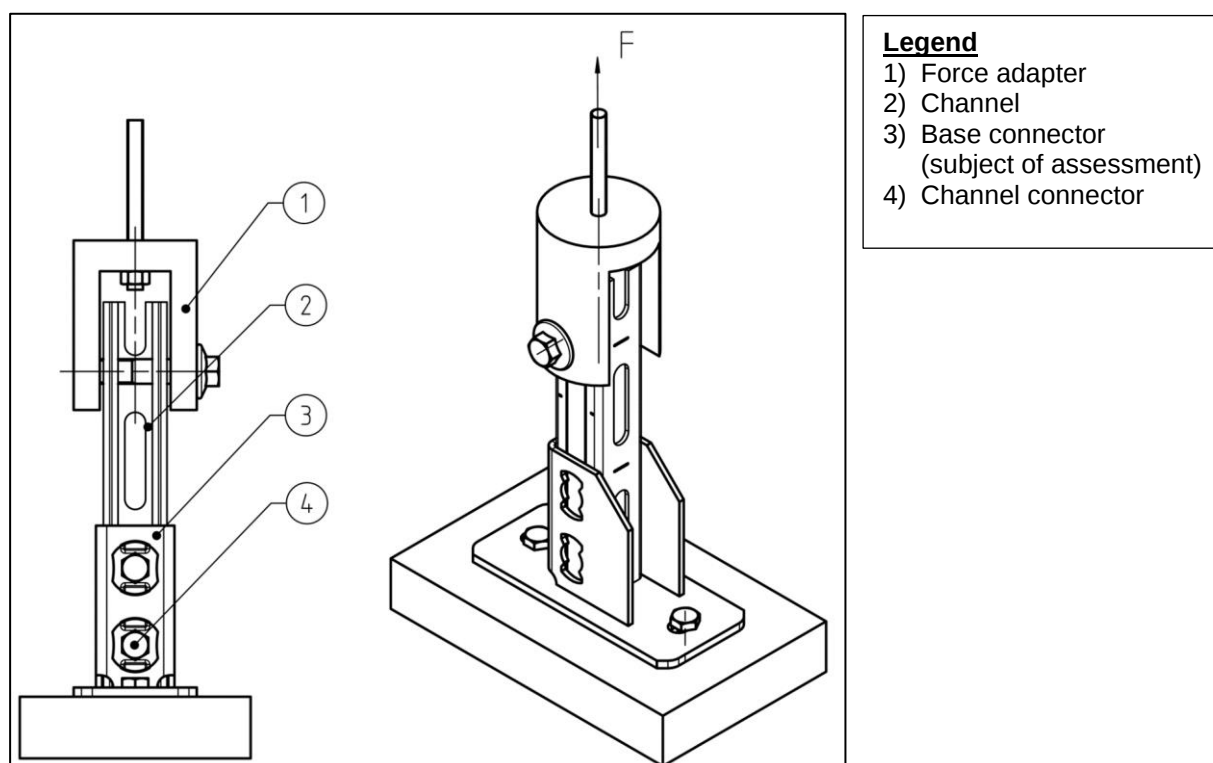


Figure 2.2.9.2.1: Test setup

The elements of the assessment method (channel, adapter, connector and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally into the channel. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance $\pm 1\%$) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN] in conjunction with the associated channel and connection elements.

2.2.10 Angle Connector – Methods and criteria for assessing the performance

2.2.10.1 Resistance under fire exposure

Purpose of the assessment

The objective of the test is to measure the time to failure at certain loads (due to weight forces) during heating according to the standard temperature-time curve (STTC).

Assessment method

The assessment method involves applying a weight force to the specimen and heating it until it fails. See Figure 2.2.10.1.1 for details of the test setup.

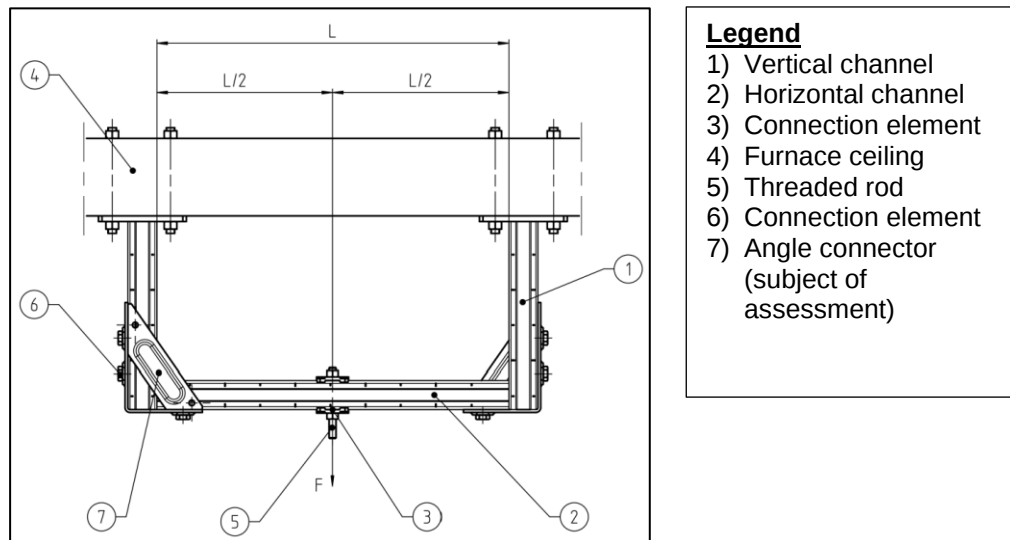


Figure 2.2.10.1.1: Test setup

The elements of the assessment method (channels, connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

The test loads shall be divided by 2. For further evaluations see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.10.2 Characteristic resistance

Purpose of the assessment

The objective of the assessment is to determine the characteristic resistance F_{Rk} of an angle connector.

Assessment method

The assessment method involves centric load tests until failure occurs on symmetrical systems consisting of angle connectors attached to horizontally and vertically arranged channels by means of connection elements, as described in Table 1.1.2.1, No. 4. See Figure 2.2.10.2.1 for details of the test setups.

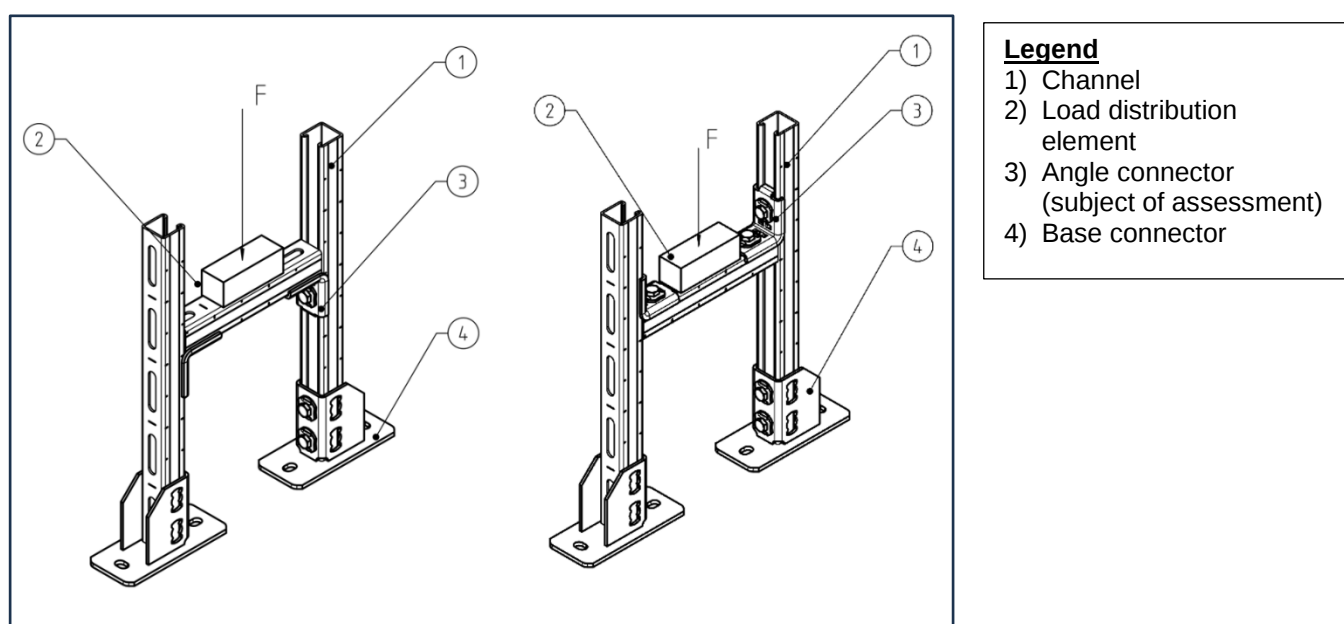


Figure 2.2.10.2.1: Test setup for angle connectors arranged below and above the horizontal channel

The elements of the assessment method (channels, connection elements, load distribution element and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading.

The force shall be applied centrally into the channel. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute, tolerance $\pm 1\%$) until failure occurs.

The specimen shall be replaced by a new one of the same type and size and testing resumed until a total of at least five tests have been completed. The maximum load until failure occurs shall be measured.

The measured values shall be multiplied with the correction factor C according to 2.2.1.3 and divided by 2.

The characteristic resistance F_{Rk} shall then be determined in accordance with EN 1990, Annex D, Table D.1, for unknown V_x .

Expression of results

The result is the statistically determined characteristic resistance F_{Rk} [kN] in conjunction with the associated channels and connection elements.

2.2.11 Threaded rod – Methods and criteria for assessing the performance

2.2.11.1 Resistance to combined bending and tension under fire exposure

Purpose of the assessment

The objective of the test is to measure the time to failure under specific loads during heating, following the standard temperature-time curve (STTC), by observing the bending and resulting tensile load on the threaded rod.

Assessment method

The assessment method involves introducing a weight force F via threaded rod and standard ring nut into the horizontal threaded rod and then heating it in a furnace until failure occurs. See Figure 2.2.11.1.1 for details of the test setup.

The test setup consists of a horizontally positioned threaded rod cantilever fastened to a steel profile projecting vertically from the ceiling of the furnace. The steel profile shall be suitably selected and securely installed to prevent horizontal displacement during the test. The node presented by the threaded rod and steel profile shall be formed in such a way that these two parts remain rigidly connected to each other for the duration of the test. A suitable eye nut composed out of steel shall be used to attach the test load with a loading device at the end of the horizontally positioned threaded rod cantilever.

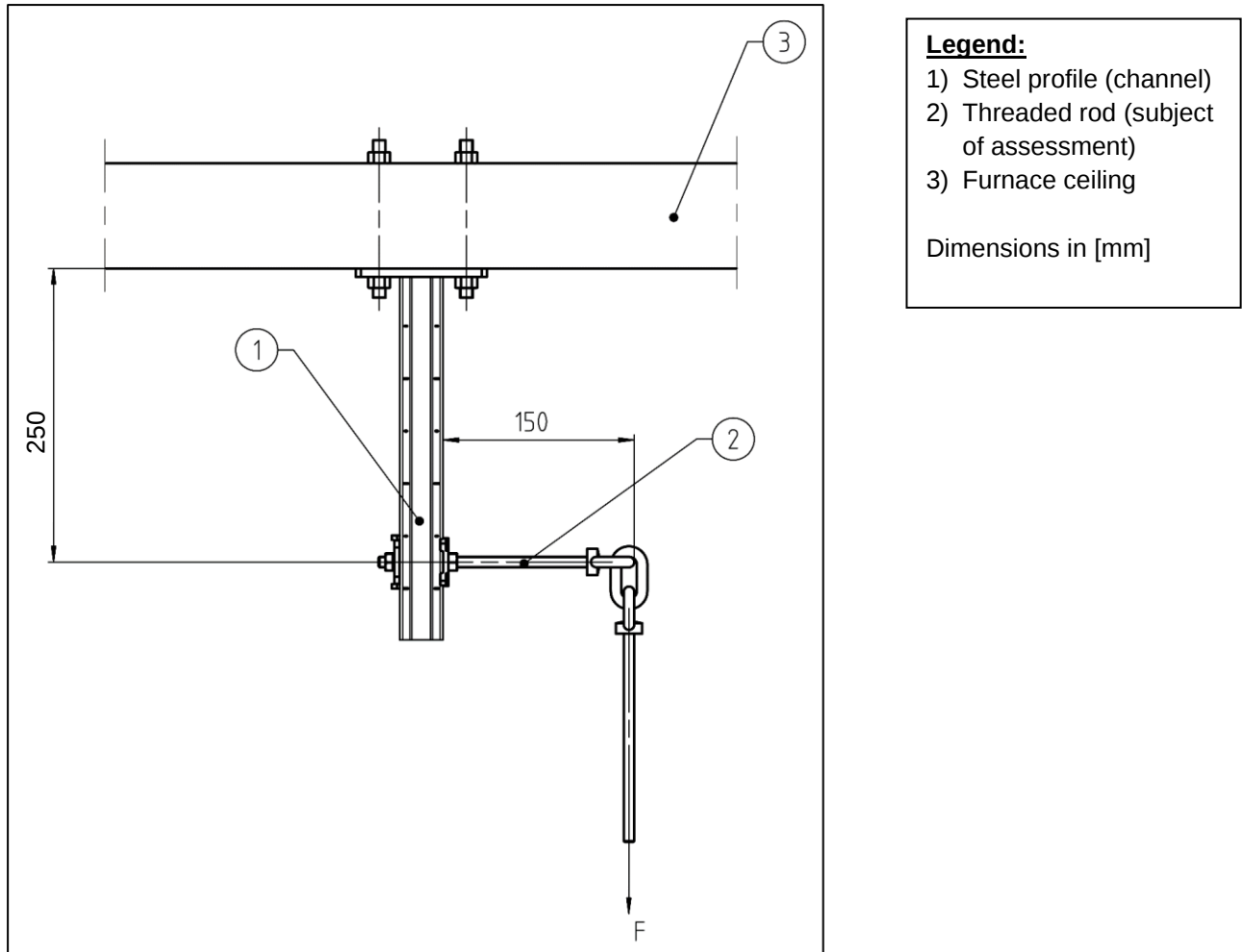


Figure 2.2.11.1.1: Test setup

The elements of the assessment method (channel, steel profile connection elements and substrate) shall not compromise the structural integrity of the test assembly and shall maintain their performance under mechanical loading, to the extent possible under fire exposure conditions.

The test shall be carried out according to Annex A for the test specifications under fire exposure and with the test loads according to Annex B, Table B.1, to allow an assessment for a fire exposure period of minimum 30 minutes. As indicated in Table B.1, this requires minimum 3 test specimens.

For evaluations see Annex B for the determination of the resistance time function $F_{Rk}(t)$.

Expression of results

The results are the values of the resistance time function $F_{Rk}(t)$ [kN] in steps of 30 minutes:

- $F_{Rk}(30)$ for $t=30$ min,
- $F_{Rk}(60)$ for $t=60$ min,
- $F_{Rk}(90)$ for $t=90$ min.

Based on the request of the manufacturer additional tests and assessments can be done with different periods of fire exposure. In any case, the test setup(s) and the results together with the indication of the fire exposure period shall be given in the ETA.

2.2.11.2 Strength class

Purpose of the assessment

The objective of the assessment is to determine the strength class using a tension test in accordance with EN ISO 898-1, Table 9 (test series FF2 – finished stud bolts with full load capacity), and test setup described in Clause 9.

Assessment method

See EN ISO 898-1. This includes:

- ultimate force (concerning the cross-section of external thread)
- force at yield-strength (concerning the cross-section of external thread) and
- elongation concerning the diameter.

Expression of results

The expression of result is the achieved (highest) strength class in accordance with EN ISO 898-1.

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 depends on their intended use(s). The kits and products for installation systems are intended to be used for supporting:

- a) technical building equipment in general with the exception of the intended uses indicated in b) to d),
- b) pipes for the transport of water not intended for human consumption,
- c) pipes for the transport of gas/fuel intended for the supply of building heating/cooling systems,
- d) components of fixed fire-fighting systems.

a) Support for technical building equipment in general with the exception of the intended uses indicated in b) to d)

For the products covered by this EAD the applicable European legal act is Commission Decision 97/161/EC.

The system is 2+.

b) Support of pipes for the transport of water not intended for human consumption

The applicable European legal act is Commission Decision 1999/472/EC, as amended by Commission Decision 2001/596/EC.

The applicable AVCP system is 4 for any use except for uses subject to regulations on reaction to fire or on energy conservation.

For uses subject to regulations on reaction to fire the applicable AVCP systems regarding reaction to fire are 1, or 3, or 4 depending on the conditions defined in the said Decision.

For uses subject to regulations on energy conservation the applicable AVCP system is 3.

c) Support of pipes for the transport of gas/fuel intended for the supply of building heating/cooling systems

The applicable European legal act is Commission Decision 1999/472/EC, as amended by Commission Decision 2001/596/EC.

The applicable AVCP system is 3 for any use except for uses subject to regulations on reaction to fire.

For uses subject to regulations on reaction to fire or the resistance to fire the applicable AVCP system regarding reaction to fire is 1.

d) Support of components of fixed fire-fighting systems

The applicable European legal act is Commission Decision 96/577/EC, as amended by Commission Decision 2002/592/EC.

The system is 1.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1. For kits: The manufacturer (regarding the components he buys from the market with DoP) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

Table 3.2.1: 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
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Material and geometric properties	Checking the acceptance test certificate EN 10204 Measurement of dimensions and tolerances	Compliance with the specified tolerances and mechanical properties from the deposited drawings	1	Each manufacturing lot (of a single part/component)
2	Check of the functional dimensions	Gauge	Compliance with the specified tolerances from the deposited drawings	1	Each manufacturing lot (of a single part/component)
3	Load capacity of the kit	Clause 2.2.4	see control plan	3	<u>1/year</u>
4	Characteristic pull-through resistance of channel holes	Clause 2.2.5.6	See control plan	3	<u>1/year</u>
5	Characteristic resistance of cantilever	Clause 2.2.6.2	See control plan	3	<u>1/year</u>
6	Characteristic resistance of pipe clamp	Clause 2.2.7.2	See control plan	3	<u>1/year</u>
7	Characteristic resistance of connection element	Clauses 2.2.8.4 through 2.2.8.7	See control plan	3	<u>1/year</u>
8	Characteristic resistance of base connector	Clause 2.2.9.2	See control plan	3	<u>1/year</u>
9	Characteristic resistance of angle connector	Clause 2.2.10.2	See control plan	3	<u>1/year</u>
10	Reaction to fire for rubber and plastic inlays case 2	Clause 2.2.2.1.3	Clause 2.2.2.1.3	at least 1 (depending on the obtained class and the test method(s) to be applied)	Once per two years

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 kits and products for installation systems are laid down in Tables 3.3.1 and 3.3.2 depending on the intended uses.

For products intended to be used for support for technical building equipment in general with the exception of the intended uses indicated in Clause 3.1, b) and c), as well as intended for support of components of fixed fire-fighting systems, the cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance are laid down in Table 3.3.1.

Table 3.3.1 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
Initial inspection of the manufacturing plant and of factory production control <i>(for systems 1+, 1 and 2+ only)</i>					
1	The notified body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the Product.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	see control plan	1	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control <i>(for systems 1+, 1 and 2+ only)</i>					
3	The notified body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	see control plan	1	1/year

For products intended to be used for the support of pipes for the transport of water not intended for human consumption or for the support of pipes for the transport of gas/fuel intended for the supply of building heating/cooling systems the intervention of the notified body under AVCP system 1 is only necessary for reaction to fire for products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).

In this case, the cornerstones of the actions to be undertaken by the notified body under AVCP system 1 are laid down in Table 3.3.2.

Table 3.3.2 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
Initial inspection of the manufacturing plant and of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire (for system 1 only)					
1	The notified body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product covered by the European Technical Assessment, taking especially into account a limiting of organic material, the addition of fire retardants and/or another clearly identifiable stage in the production process which results in the improvement of the reaction to fire classification. In particular the following items shall be appropriately considered – presence of suitable test equipment – presence of trained personnel – the suitability of the factory production control established by the manufacturer – full implementation of the prescribed test plan	Verification of the complete FPC, to be implemented by the manufacturer	See control plan	See control plan	Before production start and after relevant changes (e.g., starting a new production line or modification of the production process)
Continuous surveillance, assessment and evaluation of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire (for system 1 only)					
2	It shall be verified that the system of factory production control and the specified manufacturing process are maintained, taking especially into account a limiting of organic material, the addition of fire retardants and/or another clearly identifiable stage in the production process which results in the improvement of the reaction to fire classification. In particular the following items shall be appropriately considered: – Inspection of factory, of the production of the product and of the facilities for factory production control – Evaluation of the documents concerning factory production control Issuing a report of surveillance	Verification of the controls carried out by the manufacturer on the process and on the product as indicated in Table 3.2.1 concerning reaction to fire	See control plan	See control plan	Once a year

4 REFERENCE DOCUMENTS

EN 1363-1:2020	Fire resistance tests - Part 1: General Requirements
EN 1990:2023	Eurocode – Basis of structural and geotechnical design
EN 1993-1-1:2022	Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings
EN 1993-1-2:2024	Eurocode 3: Design of steel structures – Part 1-2: Structural fire design
EN 1993-1-5:2024	Eurocode 3 - Design of steel structures - Part 1-5: Plated structural elements
EN 1993-1-6:2007+AC:2009+A1:2017	Eurocode 3 - Design of steel structures - Part 1-6: Strength and stability of shell structures
EN 10025-2:2019	Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels
EN 10204:2004	Metallic products – Types of inspection documents
EN 13238:2010	Reaction to fire tests for building products – Conditioning procedures and general rules for selection of substrates
EN 13501-1:2018	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests
EN 13823:2020+A1:2022	Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item
EN ISO 898-1:2013+AC:2013	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013 + Cor 1: 2013)
EN ISO 3506-1:2020	Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs with specified grades and property classes (ISO 3506-1:2020)
EN ISO 6892-1:2019	Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2019)
EN ISO 6892-2:2018	Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature (ISO 6892-2:2018)
EN ISO 11925-2:2020	Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2:2020)
EN ISO 15613:2004	Requirements and qualification of welding procedure for metallic materials — Qualification based on a pre-production welding test
EN ISO 15614-1:2017+A1:2019	Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2017/A1:2019)
EN ISO 15614-11:2002	Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 11: Electron and laser beam welding (ISO 15614-11:2002)
EN ISO 15614-12:2021	Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding (ISO 15614-12:2021)
ISO 2768-1:1989	General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications
EAD 330667-00-0602	Hot-rolled mounting channel

ANNEX A: GENERAL SPECIFICATIONS FOR TESTS UNDER FIRE EXPOSURE

The experimental setup and performance of the test shall comply with EN 1363-1.

The dimensions and material characteristics of the installation system shall be documented.

The test specimen shall be fastened according to the concerning test setup and according to the manufacturer's product installation instructions.

The specimen shall be loaded by centrically arranged test loads which are connected to the specimen or the pipe dummy via tension rods.

With test specimens that are fastened exclusively to the ceiling of the furnace, their distance from the adjacent walls, or from the next adjacent test specimen, shall be at least 200 mm in order to rule out any influences.

The test specimens shall be positioned at least 500 mm away from the burners.

An air pressure in the furnace of 0 ± 2 Pa in the area of the centre axis of the test specimens shall apply.

Even in the case of maximum deformation of the specimens, the test loads shall have a sufficient drop height in the furnace so that failure of the specimen can be detected.

Proper observation and documentation of the behaviour or failure of the test specimens at all times during the fire shall be ensured by means of windows or cameras. The specimens shall be exposed according to the standard temperature curve in accordance with EN 1363-1, Clause 5.1.1.

The individual burners shall be controlled via thermal elements in accordance with EN 1363-1, Clause 4.5.1.1.

The thermal elements shall be so arranged to allow temperature recording at a level close to critical areas of the specimens where failure is expected to happen first, e.g., close to saddle nuts or close to the middle of a horizontal channel with a central load. Thermal elements shall be arranged in such a way that they can follow the deformation of the specimen.

The displacement shall be measured at 1-minute intervals or shorter (see EN 1363-1, Clause 10.4.4.2) with a tolerance of ± 1 mm.

ANNEX B: DETERMINATION OF THE RESISTANCE TIME FUNCTION $F_{Rk}(t)$

Purpose of the determination

A load-failure curve is determined by loading the component with a constant (weight) force F [kN]. Normally, the independent variable (in this case the weight force F) would be plotted on the horizontal x-axis and the dependent variable (the resulting time to failure t [min]) on the vertical y-axis. In this determination here, the axes are reversed during the calculation, because the time to failure shall be estimated for an acting force.

Determination method:

For assessment of the resistance under fire exposure for the time interval n according to Table B.1, the testing shall be conducted at least until the time interval $n+1$.

The level of each test weight force F_i to be applied to a test specimen shall be defined in a way that the minimum number of test specimens with the applied test force F_i and an exposure time when failure occurs t_i within the relevant time interval n according to Table B.1 is reached. Due to variety of products, it is not possible to define an initial force F_i or load levels to reach a certain result within the Table B.1. Therefore, it is necessary to carry out preliminary tests with different forces in order to determine plausible forces or force levels which can be defined as test force F_i .

Table B.1

No. of time interval n	Duration of test under fire exposure [minutes]	Minimum number of specimens with test loads F_i that collapse during the time interval n
1	0 - 30	1
2	31 - 60	2
3	61 - 90	1
4	91 - 120	1
5	121 - 150	1
6	151 - 180	1
7	181 - 210	1
8	211 - 240	1
9	241 - 300	1
10	301 - 360	1
11	361 - 420	1

Pairs of variates [test force F_i / exposure time when failure occurs t_i] shall be determined from the tests on specimens with the applied test force $F_{T,i}$. A one-time shifting of an excess specimen test data point to the upper limit of the previous time interval that has no measurement data is permissible. The excess specimen test's data point that is closest to the previous interval limit in terms of time t_i shall be selected for the shift, see Figure B.1.

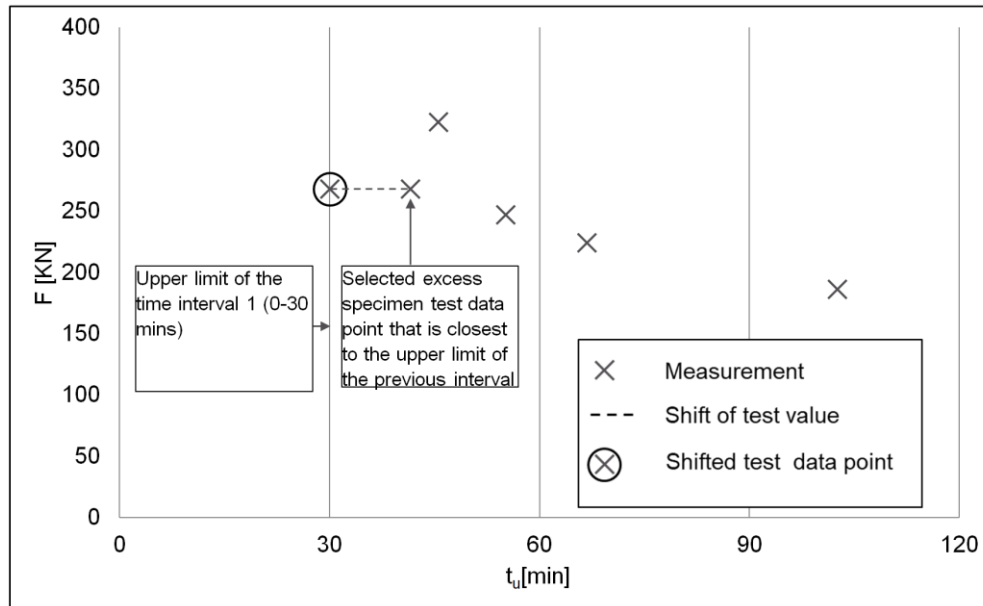


Figure B.1: Example of shifting a test data point

Regarding the one-time shifting of an excess specimen test's data point to the immediately preceding interval an extrapolation of experimentally determined force is inadmissible.

The test force F_i shall be illustrated in a diagram according to the determined resistance duration against fire exposure t_i (see Figure B.2).

The formula (mean value curve) according to equation (B.1) shall be determined by regression of m pairs of variates (F_i / t_i).

$$F(t) = c_1 + c_2 / t \quad (\text{B.1})$$

Where c_1 and c_2 are the coefficients:

$$c_2 = \frac{m \cdot \sum_{i=1}^m \frac{F_i}{t_i} - \left(\sum_{i=1}^m \frac{1}{t_i} \right) \cdot \left(\sum_{i=1}^m F_i \right)}{m \cdot \sum_{i=1}^m \frac{1}{t_i^2} - \left(\sum_{i=1}^m \frac{1}{t_i} \right)^2} \quad (\text{B.2})$$

$$c_1 = \frac{\sum_{i=1}^m F_i}{m} - c_2 \cdot \frac{\sum_{i=1}^m \frac{1}{t_i}}{m} \quad (\text{B.3})$$

The mean value curve according to equation (B.1) shall be reduced by an additional factor $c_3 < 1$ in such a way that the curve runs through the pair of variates for the most unfavourable test result. The lower limit curve according to equation (B.4) is thus obtained as a result, describing the characteristic resistance $F_{Rk}(t)$.

$$F_{Rk}(t) = c_3 (c_1 + c_2 / t) \quad (\text{B.4})$$

$F_{Rk}(t)$ shall not be greater than F_{Rk} and with scope of application within the time-boundaries of:

$$\min t_i < t < \max t_i$$

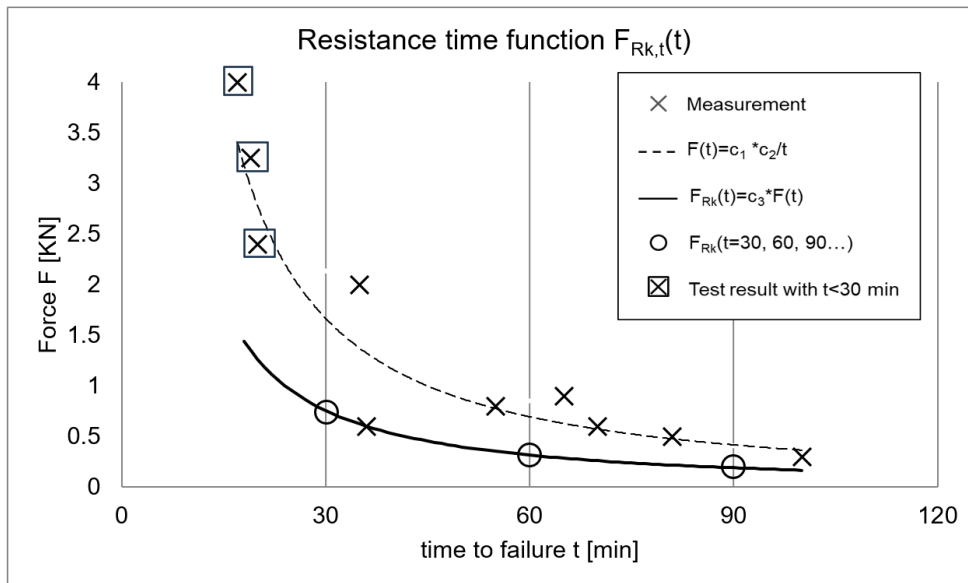


Figure B.2: Determination of the resistance time function (exemplary illustration for $m = 10$ specimens)

Result of determination:

The result of this determination is a time-depended characteristic resistance function $F_{Rk}(t)$, that makes it possible to determine the maximum force for a desired failure duration and give the characteristic forces at the end of the time intervals (every 30 minutes):

- $F_{Rk}(30)$ for $t=30$ min.
- $F_{Rk}(60)$ for $t=60$ min.
- $F_{Rk}(90)$ for $t=90$ min. etc.

ANNEX C: DETERMINATION OF THE LOAD DISPLACEMENT FUNCTION $F_{RK,30}(\Delta)$

Purpose of the determination

The purpose is to determine the load displacement function under fire exposure for $t=30$ min and to determine the forces for deformations in increments of at least 5 mm.

Explanation: A force-deformation curve is determined at time 30 min. by loading the component with a constant weight force F [kN]. Normally, the independent variable (in this case the weight force F) would be plotted on the horizontal x-axis and the dependent variable (i.e., the resulting deformation $\delta(F)$) on the vertical y-axis. In this determination here, the axes are reversed during the calculation, because the deformation after 30 minutes shall be estimated for an acting force F .

Determination method:

Only test specimens with a collapse time exceeding 30 minutes according to Annex B shall be taken into account in the assessment. Pairs of variates $[F_i / \delta_{i,30}]$ shall be determined from these tests. See also Figure B.2 as an example with 7 measurements where the time to failure exceeds 30 minutes and the corresponding pairs of $[F_i / \delta_{i,30}]$ shall be determined from the displacement/time diagram for the given force as shown in Figure D.1:

[test force F_i / vertical displacement after 30 minutes exposure under the test force $\delta_{i,30}$].

The displacement shall be measured at the position where the highest displacement of the tested system is expected. The test forces F_i shall be illustrated in a diagram depending on the determined displacement $\delta_{i,30}$ (see Figure C.1). The formula (mean value curve) according to equation (C.1) shall be determined by regression of m pairs of variates $[F_i / \delta_{i,30}]$.

$$F_{30}(\delta) = a_1 \cdot \delta^{a_2} \quad (C.1)$$

Where a_1 and a_2 are:

$$a_2 = \frac{m \sum_{i=1}^m (\ln(\delta_{i,30}) \cdot \ln(F_i)) - \sum_{i=1}^m \ln(\delta_{i,30}) \cdot \sum_{i=1}^m \ln(F_i)}{m \sum_{i=1}^m (\delta_{i,30})^2 (\delta_{i,30}) - (\sum_{i=1}^m \ln(\delta_{i,30}))^2} \quad (C.2)$$

$$a_1 = \exp \left(\frac{1}{m} \sum_{i=1}^m \ln(F_i) - \frac{a_2}{m} \sum_{i=1}^m \ln(\delta_{i,30}) \right) \quad (C.3)$$

The mean value curve according to equation (C.1) shall be reduced by an additional factor $a_3 < 1$ in such a way that the curve runs through the pair of variates for the most unfavourable test result. The lower limit curve according to equation (C.4) is obtained as a result, describing the resistance after exposure for 30 minutes with the displacement δ .

$$F_{RK,30}(\delta) = a_3 (a_1 \cdot \delta^{a_2}) \quad (C.4)$$

With scope of application within the deflection-boundaries of:

$$\text{Min } (\delta_{i,30}) \leq \delta \leq \text{max}(\delta_{i,30})$$

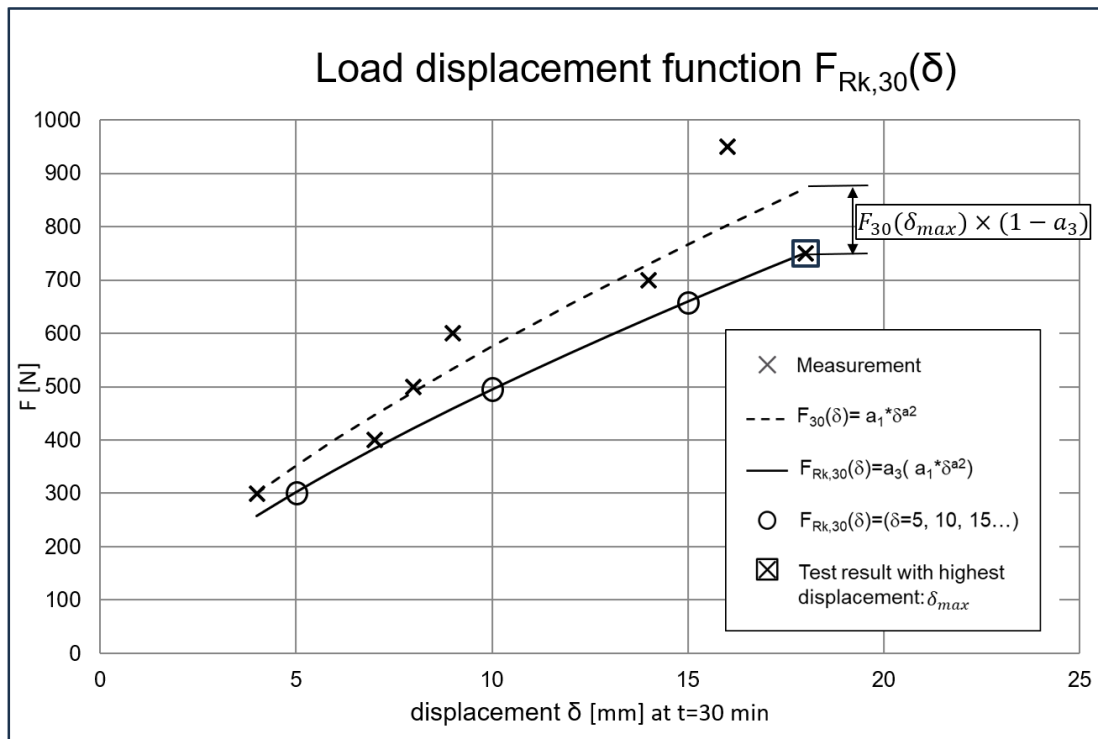


Figure C.1: Determination of the load displacement function (exemplary illustration for $m = 7$ specimens with time to failure > 30 minutes)

Result of determination:

The result of this determination is the load displacement function under fire exposure for $t = 30 \text{ min}$ and the forces for deformations in increments of at least 5 mm:

- $F_{Rk30}(\delta=5 \text{ mm})$ for a displacement of 5 mm
- $F_{Rk30}(\delta=10 \text{ mm})$ for a displacement of 10 mm
- $F_{Rk30}(\delta=15 \text{ mm})$ for a displacement of 15 mm etc.

ANNEX D: DETERMINATION OF THE MAXIMUM DEFORMATION $\Delta_{\max}(t)$

Purpose of the determination

The purpose is to measure the maximum deformation for each time interval according to Annex B, Table B.1, with $t \geq 30$ minutes

Determination method:

The maximum deformation for each time interval according to Annex B, Table B.1 for $t \geq 30$ minutes shall be measured.

Result of determination:

The maximum measured deformation $\delta_{\max}(t)$ for each time-interval.

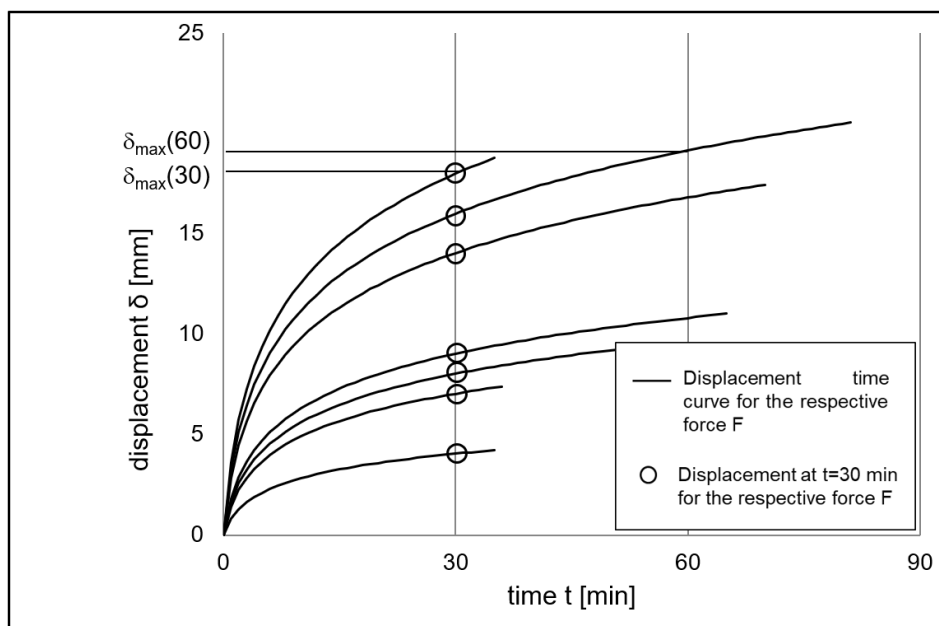


Figure D.1: Determination of the deformation $\delta_{\max}(t)$ for each time-interval (exemplary illustration for $m = 7$ specimens and $\delta_{\max}(30)$ and $\delta_{\max}(60)$)

ANNEX E: ALTERNATIVE DETERMINATION OF THE CHANNEL CHARACTERISTICS WITH NONLINEAR FEM-CALCULATION

Purpose of the assessment

The objective of the assessment is the determination of deflections at certain loads (due to weight forces) during heating according to the standard temperature time curve (STTC) and determination of the time to failure.

The performance characteristics to be determined are

- δ_{30} maximum channel deformation after 30 minutes of fire loading
- δ_{60} maximum channel deformation after 60 minutes of fire loading
- δ_{90} maximum channel deformation after 90 minutes of fire loading
- δ_{120} maximum channel deformation after 120 minutes of fire loading
- $t_{\max}$ time of failure or maximum fire duration $t_{\max} = \min[t_{\text{fail}}; t_{\text{fire}}]$
- $\delta_{t_{\max}}$ maximum channel deformation at time $t_{\max}$

Assessment method

The performance characteristics shall be determined for

- different spans
- 3 different loading types according to Table E.1
- 6 different maximum stresses $\sigma_{\max}$ according to Table E.1 and Clause 2.2.5.5
- 2 different mounting directions of slotted channels (channel opening upwards and downwards)

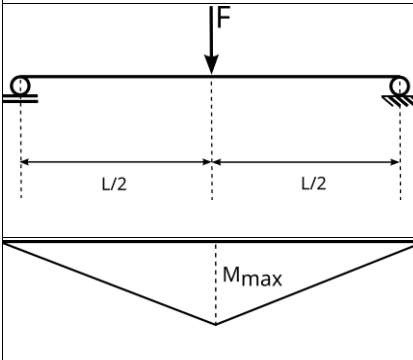
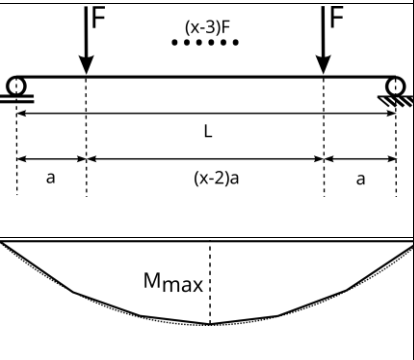
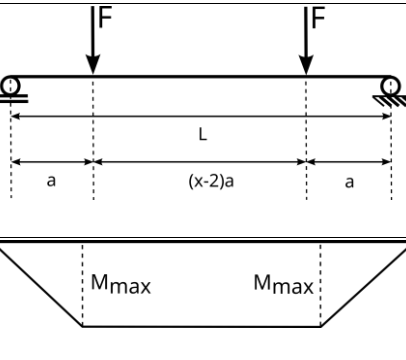
(in total 36 configurations per span). The standard setup is a suspended channel with a span of $L=700$ mm, optionally with minimum and maximum spans (L) according to Clauses 2.2.5.2, 2.2.5.3 and 2.2.5.4. In case the manufacturer requests to have another configuration be assessed such deviating setup shall be used. In any case, the configuration(s) shall be given in the ETA together with the indication of the relevant product performance.

Expression of results

For each configuration

- a) maximum channel deformation δ_t at the end of each time interval (every 30 minutes)
- b) time of failure or maximum fire duration $t_{\max} = \min[t_{\text{fail}}; t_{\text{fire}}]$
- c) maximum channel deformation $\delta_{t_{\max}}$ at time $t_{\max}$

Table E.1

single load in mid-span	discretized uniformly distributed load	2 single loads close to support
with triangular moment shape	with nearly parabolic moment shape	with trapezoidal moment shape
		
L: span a: distance of holes/oblong holes/perforations used for load application $x=L/a$ F: external load M_{max}: maximum bending moment resulting from external load disregarding self-weight $M_{max,self}$: maximum bending moment resulting from self-weight: $M_{max,self} = g \cdot L^2/8$ $\sigma_{max} = (M_{max} + M_{max,self})/W_{el}$ $\sigma_{max} = [5, 10, 15, 20, 25, 30] \text{ N/mm}^2$ g: self-weight of channel [N/mm] W_{el}: section modulus for the axis considered, cross-section without holes (x-2)a: distance between the outer single loads (x-3)F: number of uniformly distributed single loads F positioned between the outer single loads, totaling (x - 1) single loads		

Determination of performance characteristics by calculation (FEM)

The determination of the performance characteristics by FEM shall follow the provisions of EN 1993-1-2, Clause 8. In particular, the suitability of the model used shall be demonstrated by means of validation and verification.

The general suitability of the FE software used for carrying out thermo-mechanical simulations shall be demonstrated by recalculating suitable validation cases.

Modelling and calculation

For all channel configurations considered (see Table E.1), 3D geometry models shall be made. The discretization shall be done using 3D shell elements or continuum elements. Modelling of support and load introduction areas shall be carried out realistic and conservative.

The structural analysis shall be carried out by means of geometrically and materially non-linear simulations of the imperfect system (Geometrically and Materially Nonlinear Analysis with Imperfections / GMNIA in accordance with EN 1993-1-6, Table 5.2).

The equivalent geometric imperfections in accordance with EN 1993-1-1, Clause 7.3.1(2), shall be considered in the form of the most unfavourable global and the most unfavourable local eigen shapes. The eigen shapes shall be determined by means of elastic buckling analyses. For the magnitude of the equivalent imperfections, EN 1993-1-1, Clause 7.3.3.2, and EN 1993-1-5, Clause 4.6, apply. The imperfections are superimposed at 100 % each, with no reduction applied to any accompanying imperfection. Consideration of residual stresses is not required.

The non-linear and time-dependent material properties for the numerical simulations shall be taken into account for the specific material batch used in the course of model validation. Therefore, the temperature-dependent stress-elongation relationships determined according to Clause 2.2.5.5 shall be considered (see Figure 2.2.5.5.2.1).

The time-dependent temperature shall be applied to the numerical model by means of mapping of the standard temperature / time curve (STTC). With respect to the timely discretization, an appropriate time step size shall be chosen to avoid numerical oscillation of the solution.

The validation of the modelling shall be carried out in compliance with EN 1993-1-2, Clause 8.4(1), by means of comparison of the calculation results with the results of at least 6 full-scale tests as described below. The validation and verification shall make sure, that the deformation behaviour and failure modes observed in the validation tests are modelled phenomenologically correct over the entire time period.

If the calculated time-dependent deformations deviate from the test results by more than 10% on the unsafe side, a global correction function shall be determined as shown below. In accordance with the provisions given within the Eurocodes, deviations of up to approximately 10% between numerical calculations and experimental results are generally considered acceptable. Later design methodologies account for inherent uncertainties in material properties, geometric imperfections and modelling simplifications which justify tolerances within this range.

The approach to the correction function also stipulates that all calculation results shall be corrected additively as soon as even one comparison between test and calculation is too far on the unsafe side (including those that are on the safe side already). This procedure leads to results which are on the safe side for the entire data set.

The performance characteristics shall be determined by adding the correction function to all calculation results.

$$\bar{\delta}_t = \bar{\delta}_{\text{calc},t} + \Delta\bar{\delta}_t \quad (\text{E.1})$$

$\bar{\delta}_t$ maximum channel deformation at time t

$\bar{\delta}_{\text{calc},t}$ calculated channel deformation at time t

$\Delta\bar{\delta}_t$ value of correction function at time t

$$\Delta\bar{\delta}_t = \max[\Delta\bar{\delta}_{t,\text{VT}1}, \Delta\bar{\delta}_{t,\text{VT}2}, \Delta\bar{\delta}_{t,\text{VT}3}, \Delta\bar{\delta}_{t,\text{VT}4}, \Delta\bar{\delta}_{t,\text{VT}5}, \Delta\bar{\delta}_{t,\text{VT}6}] \quad (\text{E.2})$$

$\Delta\bar{\delta}_{t,\text{VT}1...6}$: value of correction function at time t for validation test (VT) 1...6

$$\Delta\bar{\delta}_{t,\text{VT}1...6} = \bar{\delta}_{t,\text{meas},\text{VT}1...6} - \bar{\delta}_{t,\text{calc},\text{VT}1...6} \quad (\text{E.3})$$

$\bar{\delta}_{t,\text{meas},\text{VT}1...6}$: measured value of maximum channel deformation at time t for validation test (VT) 1...6

$\bar{\delta}_{t,\text{calc},\text{VT}1...6}$: calculated value of maximum channel deformation at time t for validation test (VT) 1...6

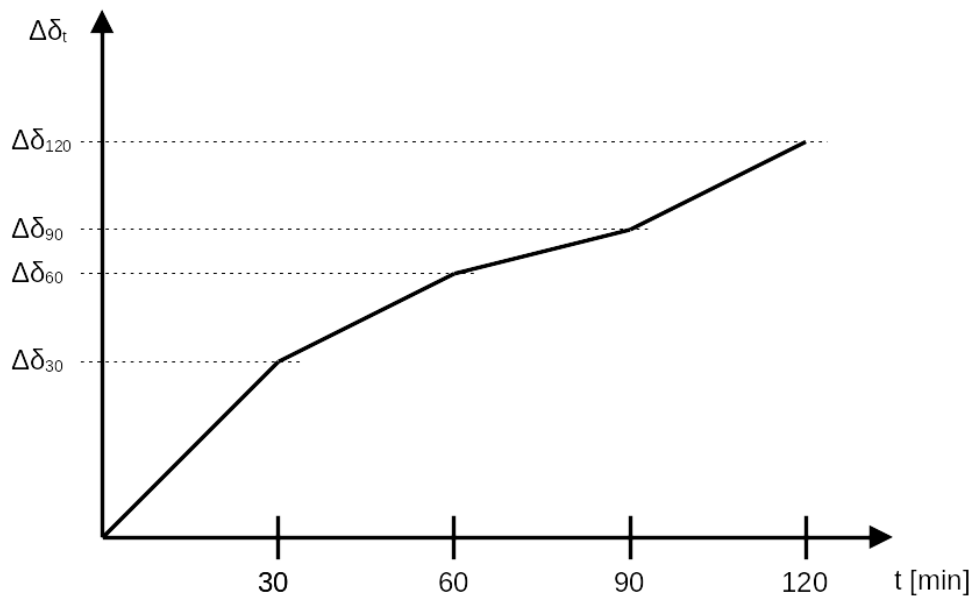


Figure E.1: Example for correction function

Validation tests

At least 6 full-scale validation tests shall be carried out according to Clauses 2.2.5.2.1, 2.2.5.3.1 and 2.2.5.4.1. The tested channel configurations shall be chosen from the configurations specified in Table E.1 considering:

- different spans including the smallest, a medium and the largest one,
- different maximum stresses including the smallest and the largest one,
- all types of loading and
- both opening directions.

If it is not possible to realize the test due to, for example, too high external loads, it is permissible to deviate from the requirements in one point with good reasoning.

The evaluation of the time-dependent deformations shall be carried out according to Clauses 2.2.5.2.1, 2.2.5.3.1 and 2.2.5.4.1. Test results may only be used for validation if the channel deformation could be measured over the entire time period and no failure of the support area or the load application in the form of a tear-off of the threaded rods occurred.

During the validation process, the calculation method shall be adjusted, to ensure that the permissible deviation on the unsafe side between the calculation results and the test results, as defined above, is not exceeded.