Fire Resistancy Technical Guide

TG-EU-FIRE-2026 | strongtie.eu

Design methods for fire resistant timber structures.

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Wood is a combustible material, that much is obvious!

Most people associate timber construction with an increased risk of fire. However, this persistent preconception does not reflect reality. Wood is an excellent thermal insulator, which makes it a highly heat-resistant material. In the event of a fire, under the extreme heat generated by the flames, wood loses only 10 to 15% of its total strength.

Another certainty is that all building materials will eventually burn over time. A building described as fireproof does not mean that it will not burn, but rather that it is more difficult to ignite. As a result, when exposed to the intense heat of a fire, steel eventually melts and concrete bursts.

To help you build safer structures and choose the right connectors for your needs, Simpson Strong-Tie provides information on the fire resistance of its products.

1. General Information

A. Charing Rate β_n

When considering the design of timber elements in fire conditions, the first thing to know is that the charing rate of timber βn is constant and depends on the type of timber used.

This steady charing rate has a major advantage: the behaviour of the wood is predictable in fire conditions.

Values according to EN1995-1-2:2004 - Table 3.1

		Charing rate β_n [mm/min]
Softwood	Glulam ($\rho_k \geq$ 290 kg/m^3)	0.7
	Solid timber ($\rho_k \geq$ 290 kg/m^3)	0.8
Hardwood	Glulam or solid timber ($\rho_k \geq$ 290 kg/m^3)	0.7
	Glulam or solid timber ($\rho_k \geq$ 450 kg/m^3)	0.55
LVL	($\rho_k \geq$ 480 kg/m^3)	0.7

B. Fire reaction and fire resistance: what are the differences?

a. Fire reaction

Fire reaction is a classification that provides a quick indication of a material's combustibility in order to determine whether the product will fuel a fire. This classification depends solely on the material used, and the reactions listed are defined after standardised testing at an approved centre.

In France, the reaction to fire of materials is defined by the decree of 21 November 2002, which specifies, among other things, that the European standard EN13-501-1 (Euroclass) deals with the classification of construction products.

The classification consists of seven categories:

- A1 and A2: non-combustible (e.g. concrete, steel);
- B: low combustibility (e.g. mineral ceiling tiles, PVC);
- C: combustible (e.g. particle board);
- D: highly combustible (e.g. solid wood);
- E: highly flammable and flame-spreading (e.g. fibreboard with a density < 400 kg/m3);
- F: unclassified or untested.

This classification is supplemented by indices that define the ability of these materials to emit smoke (s1, s2, or s3) and debris (d0, d1, or d2).

For some materials, testing is not necessary as they satisfy of the EC decision 96/603/EC amanded by the EC decision 2000/605/EC.

For example, all S250GD+Z275 steel products are classified as A1.
All Simpson Strong-Tie products are classified as A1: connectors, mechanical or chemical anchors, and fasteners. This classification is given in the ETE and/or DoP for the various products.
Please note that this parameter is not used to justify the fire resistance of a structure.

b. Fire resistance

The fire resistance of connectors should be distinguished from their reaction to fire. While the former refers to the ability of products to fulfil their function during a fire, the latter concerns the flammability of materials. In the case of connectors and fasteners, the aim is to guarantee the mechanical properties of the product in order to prevent the structure from collapsing. The justification for the fire resistance of timber structures is described in Eurocode 5 Part 2 (EN1995-1-2).

To prove the fire resistance of an assembly product in use, it is absolutely necessary to have technical certification (such as ETA, technical approval, etc.) or to carry out a specific study based on Eurocode 5 Part 1-2 (EN1995-1-2) and Eurocode 3 as a supplement (for steel elements).
The same material can be non-combustible but have poor fire resistance, and vice versa.

For example: concrete blocks are non-combustible, so their reaction to fire will be excellent (classified A1), but their fire resistance will be poor due to their friability at high temperatures (a wall may collapse because it is weakened by heat). Conversely, oak is combustible and will have a very average reaction to fire (classified as D), but fairly good fire resistance. For example, a 35 mm oak door can withstand fire for 30 minutes.

Simpson Strong-Tie certifies 30 minutes of fire resistance for 4 mm GSE, GSI, GLE and GLI joist hangers on timber, as well as hidden connectors using ETE-06/0270 and ETE-07/0245.

Similarly, certain anchors such as FM753 Crack wedge anchors can demonstrate fire resistance of up to 120 minutes.

The fire resistance of the various products in the Simpson Strong-Tie range will be discussed later in this document.

2. Fire Resistance on Timber Elements.

A. Joist Hangers

Several methods of justification are possible for structural joist hanger. If these have been tested, they can be incorporated into the structure without additional protection and justified by calculation. It is also possible to use any connector if it is well protected with protective material.

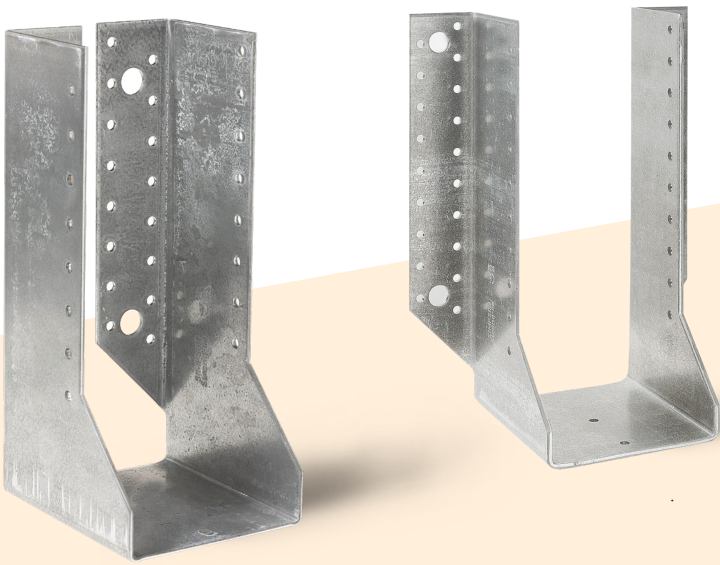
a. Calculation

Simpson Strong-Tie has conducted fire resistance tests and publishes the characteristic values $R_{k.30.fi}$ in fire situations for a duration of 30 minutes. These are given in ETA-06/0270 and are included in the technical data sheets for GLE / GLI and GSE / GSI products in 4 mm. They are given for fastening with CNA4.0x75 nails, CSA5.0x80 screws and SSH12.0x80 screws. The tests were carried out in collaboration with the Building Test Centre (UK) and the Fires S.R.O laboratory in Slovakia (SK) in accordance with EN 13501-2 and EAD130186-00-0603.

To validate the assembly, it must be verified that the fire loads $E_{d.fi}$ are lower than the resistance of the joist hanger after 30 minutes of fire.

$$E_{d.fi} \leq R_{d.30.fi} = \frac{R_{k.30.fi}}{\gamma_{M.fi}}$$

$E_{d.fi}$	Design effort in fire conditions.
$R_{d.30.fi}$	Design resistance in fire conditions after 30 minutes.
$R_{k.30.fi}$	Characteristic resistance in fire conditions after 30 minutes.
$\gamma_{M.fi}$	Partial coefficient for assemblies in fire conditions (equal to 1).



b. Product information

The minimum width of the solid timber is 100 mm and 90 mm for glulam. Fastenings on timber elements are made using CNA4.0x75 nails, CSA5.0x80 screws or SSH12.0x80 screws.

The use of longer fasteners than traditional ensures sufficient anchoring in the load-bearing timber even after half an hour of fire. After 30 minutes, a significant portion of the timber exposed to the fire will have been consumed and won't be able to take any loads.

Nails:
CNA4.0x75
or
screws:
CSA5.0x80

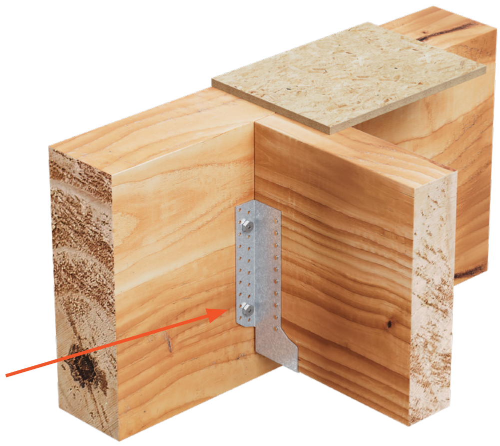
The characteristic strength values after 30 minutes $\mathbf{R_{k.fi}}$ are given in the technical data sheets for our products in the specific load bearing capacity tables (see example below of a table available in our documentation and/or on our website):

Characteristic values under fire conditions - Timber-to-timber connection For GSE-GSI 4 with CNA4.0x75 or CSA5.0x80

Item number	Characteristic Values in 30min fire condition										
	Fasteners				Characteristic values - Glulam GL24 [kN]			Characteristic values - Solid timber C24 [kN]			
	Header		Joist		$R_{1,k,fi}$			$R_{1,k,fi}$		$R_{4,k,fi}$	
	Qty	Type	Qty	Type	Width between 90 and 100 mm	Width between 100 and 136mm	Width between 137 and 200mm	Width between 100 and 136mm	Width between 137 and 200mm	Width between 100 and 136mm	Width between 137 and 200mm
GSE380/4X	16	CNA or CSA*	8	CNA or CSA*	1,9	1	-	1	-	3,5	-
GSE440/4X	22	CNA or CSA*	12	CNA or CSA*	3,1	2,5	-	2,5	-	4,4	-
GSE500/4X	28	CNA or CSA*	14	CNA or CSA*	3,9	3,6	-	3,6	-	5,3	-
GSE500/4X-AL	22	CNA or CSA*	12	CNA or CSA*	-	-	2,5	-	2,5	-	4,4
GSE540/4X	32	CNA or CSA*	16	CNA or CSA*	4,8	4,7	-	4,7	-	5,9	-
GSE540/4X-AL	26	CNA or CSA*	14	CNA or CSA*	-	-	3,6	-	3,6	-	5
GSE600/4X	38	CNA or CSA*	20	CNA or CSA*	6,8	7,3	-	7,3	-	6,7	-
GSE600/4X-AL	32	CNA or CSA*	18	CNA or CSA*	-	-	6	-	6	-	5,9
GSE660/4X	44	CNA or CSA*	22	CNA or CSA*	7,9	8,7	-	8,7	-	7,6	-
GSE660/4X-AL	38	CNA or CSA*	20	CNA or CSA*	-	-	7,3	-	7,3	-	6,7
GSE720/4X	50	CNA or CSA*	26	CNA or CSA*	10,1	11,4	-	11,4	-	8,5	-
GSE720/4X-AL	44	CNA or CSA*	24	CNA or CSA*	-	-	10	-	10	-	7,6
GSE780/4X	56	CNA or CSA*	28	CNA or CSA*	11,3	12,8	-	12,8	-	9,4	-
GSE780/4X-AL	50	CNA or CSA*	26	CNA or CSA*	-	-	11,4	-	11,4	-	8,5
GSE840/4X	62	CNA or CSA*	32	CNA or CSA*	13,8	15,4	-	15,4	-	10,3	-
GSE840/4X-AL	56	CNA or CSA*	30	CNA or CSA*	-	-	14,1	-	14,1	-	9,4
GSE900/4X	68	CNA or CSA*	36	CNA or CSA*	16,3	18	-	18	-	11,1	-
GSE900/4X-AL	62	CNA or CSA*	32	CNA or CSA*	-	-	15,4	-	15,4	-	10,3
GSE960/4X	74	CNA or CSA*	38	CNA or CSA*	17,6	19,3	-	19,3	-	12	-
GSE960/4X-AL	68	CNA or CSA*	34	CNA or CSA*	-	-	16,8	-	16,8	-	11,1
GSE1020/4X	80	CNA or CSA*	40	CNA or CSA*	18,8	20,6	-	20,6	-	12,9	-
GSE1020/4X-AL	74	CNA or CSA*	38	CNA or CSA*	-	-	19,3	-	19,3	-	12

Example of timber-to-timber values. The values in fire conditions are characteristic resistance values at 30 minutes R30.
*The only fasteners permitted are CNA4.0x75 nails or CSA5.0x80 screws.

2. Fire resistance on timber elements



For timber-to-timber connections, we have also developed values with our SSH screws.

Characteristic values under fire conditions - Timber-to-timber connection with SSH screws For GSE 4

Item number	Characteristic Values in 30min fire condition											
	Fasteners				Characteristic values - Glulam GL24 [kN]			Characteristic values - Glulam GL24 [kN]			Characteristic values - Solid Timber C24 [kN]	
	Header		Joist		$R_{1,k,fi}$			$R_{4,k,fi}$			$R_{1,k,fi}$	
	Qty	Type	Qty	Type	Width between 90 and 100 mm	Width between 100 and 136mm	Width between 137 and 200mm	Width between 90 and 100 mm	Width between 100 and 136mm	Width between 137 and 200mm	Width between 100 and 136mm	Width between 137 and 200mm
GSE380/4X	2	SSH12.0x80	8	CNA4.0x75	3,2	3,5	-	2,3	-	-	3	-
GSE440/4X	4	SSH12.0x80	12	CNA4.0x75	5,3	5,1	-	2,3	-	-	4,6	-
GSE500/4X	4	SSH12.0x80	14	CNA4.0x75	6,1	6	-	2,3	-	-	5,3	-
GSE500/4X-AL	2	SSH12.0x80	12	CNA4.0x75	-	-	3,7	2,3	-	2,3	-	3,5
GSE540/4X	4	SSH12.0x80	16	CNA4.0x75	6,8	6,8	-		2,3		6,5	-
GSE540/4X-AL	4	SSH12.0x80	14	CNA4.0x75	-	-	5,8	2,3	-	2,3	-	5,2
GSE600/4X	4	SSH12.0x80	20	CNA4.0x75	7,1	7,1	-		2,3		6,8	-
GSE600/4X-AL	4	SSH12.0x80	18	CNA4.0x75	-	-	6,8	3,4	-	3,4	-	6,5
GSE660/4X	6	SSH12.0x80	22	CNA4.0x75	10,1	10,1	-		3,4		9,1	-
GSE660/4X-AL	4	SSH12.0x80	20	CNA4.0x75	-	-	6,8	3,4	-	3,4	-	6,5
GSE720/4X	6	SSH12.0x80	26	CNA4.0x75	10,5	10,5	-		3,4		10	-
GSE720/4X-AL	6	SSH12.0x80	24	CNA4.0x75	-	-	10,3	3,4	-	3,4	-	9,7
GSE780/4X	6	SSH12.0x80	28	CNA4.0x75	10,6	10,6	-		3,4		10,2	-
GSE780/4X-AL	6	SSH12.0x80	26	CNA4.0x75	-	-	10,5	3,4	-	3,4	-	10,1
GSE840/4X	6	SSH12.0x80	32	CNA4.0x75	10,7	10,7	-		3,4		10,3	-
GSE840/4X-AL	6	SSH12.0x80	30	CNA4.0x75	-	-	10,6	3,4	-	3,4	-	10,1
GSE900/4X	6	SSH12.0x80	36	CNA4.0x75	10,8	10,8	-		3,4		10,3	-
GSE900/4X-AL	6	SSH12.0x80	32	CNA4.0x75	-	-	10,7	3,4	-	3,4	-	10,2
GSE960/4X	6	SSH12.0x80	38	CNA4.0x75	10,8	10,8	-		3,4		10,4	-
GSE960/4X-AL	6	SSH12.0x80	34	CNA4.0x75	-	-	10,7	3,4	-	3,4	-	10,3
GSE1020/4X	6	SSH12.0x80	40	CNA4.0x75	10,8	10,9	-		3,4		10,4	-
GSE1020/4X-AL	6	SSH12.0x80	38	CNA4.0x75	-	-	10,8	3,4	-	3,4	-	10,3

Example of timber-to-timber values. The values in fire conditions are characteristic resistance values at 30 minutes R30. The only fasteners permitted are CNA4.0x75 nails or CSA5.0x80 screws in the joist, and SSH12.0X80 (or longer) in the header.
***GLE 4 values can be found on our website**

Nails:

CNA4.0x75

or

screws:

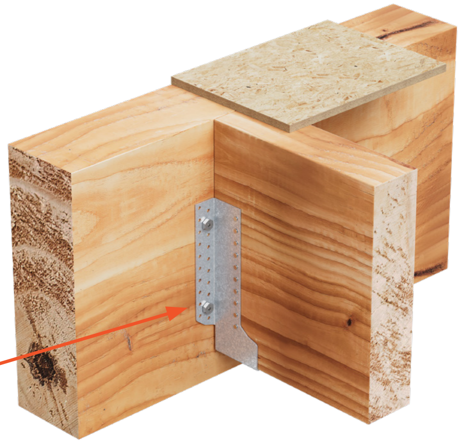
CSA5.0x80

The characteristic strength values after 30 minutes $\mathbf{R_{k.fi}}$ are given in the technical data sheets for our products in the specific load bearing capacity tables (see example below of a table available in our documentation and/or on our website):

Characteristic values under fire conditions - Timber-to-timber connection
For GLE-GLI 4 with CNA4.0x75 or CSA5.0x80

Item number	Characteristic Values in 30min fire condition						
	Fasteners				Characteristic values - Glulam GL24 [kN]	Characteristic values - Solid timber C24 [kN]	
	Header		Joist		$R_{1,k,fi}$	$R_{1,k,fi}$	$R_{4,k,fi}$
	Qty	Type	Qty	Type	Width between 90 and 160 mm	Width between 100 and 160mm	Width between 100 and 160mm
GLE300/4X	12	CNA4.0x75 or CSA5.0x80	7	CNA4.0x75 or CSA5.0x80	1,5	-	-
GLE340/4X	16	CNA4.0x75 or CSA5.0x80	9	CNA4.0x75 or CSA5.0x80	2,2	-	-
GLE380/4X	20	CNA4.0x75 or CSA5.0x80	11	CNA4.0x75 or CSA5.0x80	2,9	1	3,5
GLE440/4X	20	CNA4.0x75 or CSA5.0x80	12	CNA4.0x75 or CSA5.0x80	3,7	2,5	3,8
GLE500/4X	26	CNA4.0x75 or CSA5.0x80	15	CNA4.0x75 or CSA5.0x80	4,8	3,6	4,7
GLE540/4X	30	CNA4.0x75 or CSA5.0x80	17	CNA4.0x75 or CSA5.0x80	5,8	4,7	5,3
GLE600/4X	36	CNA4.0x75 or CSA5.0x80	20	CNA4.0x75 or CSA5.0x80	7,8	7,3	6,2
GLE660/4X	40	CNA4.0x75 or CSA5.0x80	23	CNA4.0x75 or CSA5.0x80	9,2	8,7	7
GLE720/4X	46	CNA4.0x75 or CSA5.0x80	26	CNA4.0x75 or CSA5.0x80	11,3	11,4	7,9
GLE780/4X	48	CNA4.0x75 or CSA5.0x80	29	CNA4.0x75 or CSA5.0x80	12,9	-	-
GLE840/4X	54	CNA4.0x75 or CSA5.0x80	32	CNA4.0x75 or CSA5.0x80	15	-	-
GLE900/4X	60	CNA4.0x75 or CSA5.0x80	35	CNA4.0x75 or CSA5.0x80	16,6	-	-
GLE960/4X	64	CNA4.0x75 or CSA5.0x80	38	CNA4.0x75 or CSA5.0x80	18,7	-	-
GLE1020/4X	70	CNA4.0x75 or CSA5.0x80	41	CNA4.0x75 or CSA5.0x80	20,3	-	-

Example of timber-to-timber values. The values in fire conditions are characteristic resistance values at 30 minutes R30.
*The only fasteners permitted are CNA4.0x75 nails or CSA5.0x80 screws.



Screws:
SSH12.0x80

For timber-to-timber connections, we have also developed values with our SSH screws.

Characteristic values under fire conditions - Timber-to-timber connection with SSH screws For GLE 4

Item number	Characteristic Values in 30min fire condition							
	Fasteners				Characteristic values - Glulam GL24 [kN]		Characteristic values - Solid timber C24 [kN]	
	Header		Joist		$R_{1,k,fi}$	$R_{4,k,fi}$	$R_{1,k,fi}$	$R_{4,k,fi}$
	Qty	Type	Qty	Type	Width between 90 and 160 mm	Width between 90 and 160 mm	Width between 100 and 160mm	Width between 100 and 160mm
GLE300/4X	2	SSH12.0x80	7	CNA4.0x75 or CSA5.0x80	2,9	1,1	-	-
GLE340/4X	2	SSH12.0x80	9	CNA4.0x75 or CSA5.0x80	3,5	1,1	-	-
GLE380/4X	2	SSH12.0x80	11	CNA4.0x75 or CSA5.0x80	3,7	1,1	-	-
GLE440/4X	4	SSH12.0x80	12	CNA4.0x75 or CSA5.0x80	5,9	2,3	5	2,3
GLE500/4X	4	SSH12.0x80	15	CNA4.0x75 or CSA5.0x80	6,9	2,3	6,1	2,3
GLE540/4X	4	SSH12.0x80	17	CNA4.0x75 or CSA5.0x80	7,1	2,3	6,7	2,3
GLE600/4X	4	SSH12.0x80	20	CNA4.0x75 or CSA5.0x80	7,2	2,3	6,9	2,3
GLE660/4X	6	SSH12.0x80	23	CNA4.0x75 or CSA5.0x80	10,7	3,4	9,9	3,4
GLE720/4X	6	SSH12.0x80	26	CNA4.0x75 or CSA5.0x80	10,8	3,4	10,3	3,4
GLE780/4X	6	SSH12.0x80	29	CNA4.0x75 or CSA5.0x80	10,9	-	-	-
GLE840/4X	6	SSH12.0x80	32	CNA4.0x75 or CSA5.0x80	10,9	-	-	-
GLE900/4X	6	SSH12.0x80	35	CNA4.0x75 or CSA5.0x80	10,9	-	-	-
GLE960/4X	8	SSH12.0x80	38	CNA4.0x75 or CSA5.0x80	14,5	-	-	-
GLE1020/4X	8	SSH12.0x80	41	CNA4.0x75 or CSA5.0x80	14,6	-	-	-

Example of timber-to-timber values. The values in fire conditions are characteristic resistance values at 30 minutes R30. The only fasteners permitted are CNA4.0x75 nails or CSA5.0x80 screws in the joist, and SSH12.0X80 (or longer) in the header.
***GLE 4 values can be found on our website**

SIMPSON Strong-Tie

c. Calculation example

An example of fire justification of an hanger is given just below.

Assumptions:

- Beam on 2 supports for habitable floor
- Timber class C24
- Dead loads: **G = 75 kg/m**
- Live loads: **Q = 160 kg/m²**
- Section: **100 x 300 mm** (note that the section must be dimensioned for fire conditions)
- Span: **4.00 m**
- Spacing: **0.60 m**
- Choice of hanger from a dimensional point of view: **GSE500/100/4**

Calculation of stresses:

- Load in fire conditions after 30 min: $E_{d.fi} = \eta_{fi}\, E_d \approx 0{,}6\, E_d$ (η_{fi} may be equal to 0.7 under certain conditions)
- Load combination: $E_d = 1{,}35\, G + 1{,}5\, Q$
- Permanent loads: partial safety factor γG **= 1.35. i.e. 75 x 1.35 = 101.25** kg/m^2
- Live loads: partial safety factor γQ **= 1.50.**
  That is, **160 x 1.5 = 240.00 kg/m²**
- Total weighted loads: E_d **= 101.25 + 240 = 341.25 kg/m²**
- Load per linear metre: 341.25 x 0.60 (centre distance) **= 204.75 kg/ml**
- Total load on the beam: 204.75 x 4.00 (span) **= 820 kg**
- Load applied to a hanger: **820 / 2 = 410 kg ≈ 4.1 kN**
- Under fire conditions: $E_{d.fi} \approx 0.6\, E_d = 0.6 \times 4.1 \approx 2.5$ kN

Calculation of the resistance capacity of a hanger:

- Under fire conditions, no k_{mod} is used in the case of assemblies.
- The $\mathbf{gamm}_{M.fi}$ for assemblies is equal to 1.
- We therefore have $R_{d.30.fi} = R_{k.30.fi} / \gamma_{M.fi}$
- Resistance capacity of the hanger: the characteristic value after 30 minutes of fire $R_{k.30.fi}$ in shear of a GSE500/100/4 hanger fixed to a C24 solid wood support with total nailing (CNA4.0x75) is equal to 3.55 kN: see GSE/4 technical data sheet.
- The resistance capacity of the GSE500/100/4 hanger is $R_{d.30.fi}$ **= 3.55 / 1 = 3.55 kN.**

Verification:

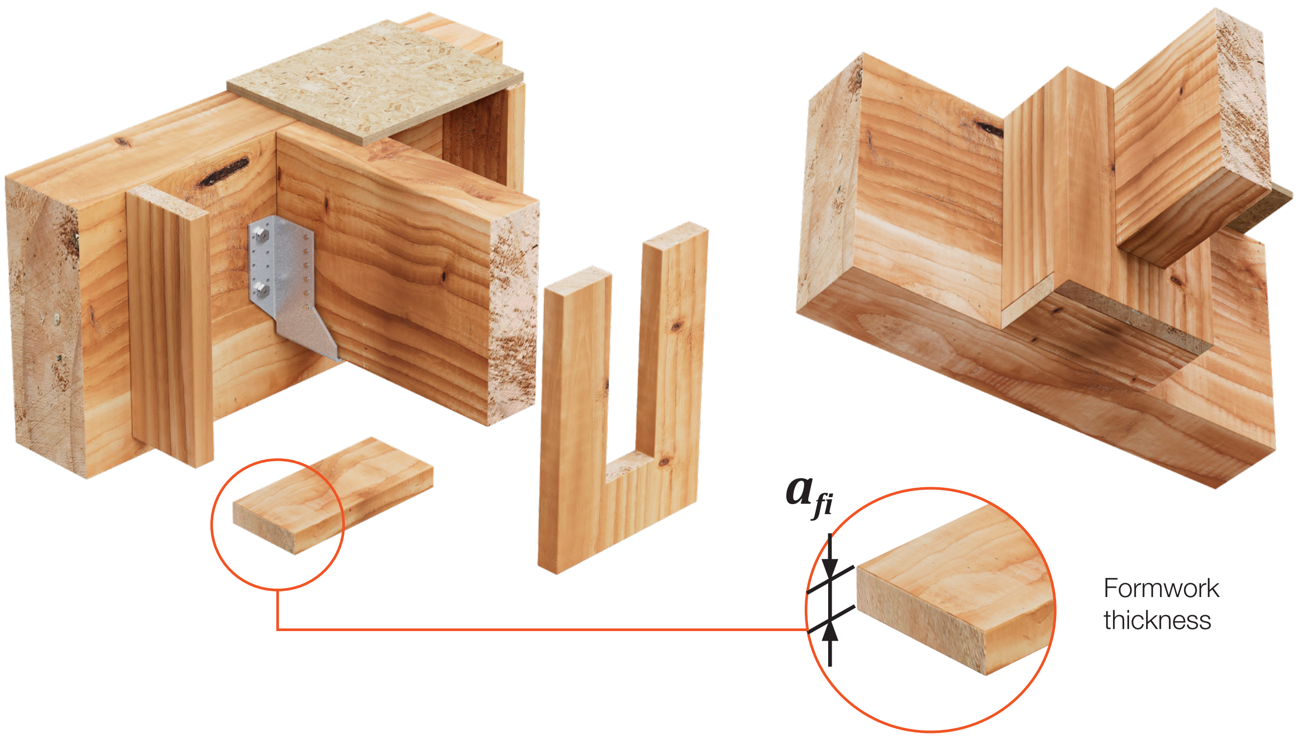
- Calculated stress $E_{d.fi}$ **= 2.5 kN < Resistance capacity** $R_{d.30.fi}$ **= 3.55 kN.**
- The GSE500/100/4 is therefore SATISFACTORY for 30 minutes of fire resistance in this configuration.

d. Protection

As explained above, there is another solution for ensuring the fire resistance of an assembly. This involves protecting the hanger (or other metal connectors) using additional elements made of materials that are more fire-resistant, such as wood or plasterboard.
For protection using timber elements, for example, the table below shows the thicknesses to be observed:

a_{fi}: thickness of the timber elements surrounding the hanger.
Note: The timber protective elements must be fixed in accordance with the rules given in EN1995-1-2 6.2.1.2 (1), (4), (6), (7).

	Minimum thickness - Timber C24	
	30 min	60 min
a_{fi} (mm)	33	66



In this case, only the thickness of the protective elements and the supporting and load-bearing elements need to be dimensioned for hot conditions. The assembly itself must be justified for cold conditions only. The advantage of this protective solution is that it allows for up to one hour of fire resistance.

Finally, another protection solution consists of adding intumescent paint to metal parts exposed to fire to slow down their temperature rise and thus improve their performance.
Simpson Strong-Tie can supply you with mechanically welded parts or standard parts with intumescent paint.

B. Concealed Beam Hangers

In the case of concealed beam hangers, designing is generally quite simple. Hidden connectors are protected by the timber of the supported element. Thus, the fire resistance of the assembly is justified by designing the thickness of the wood around the connector, allowing it to maintain its mechanical performance when cold.

Please note that when the connector is made of aluminium, only a duration of 30 minutes can be justified. For steel connectors, the justification can be up to 60 minutes. All of this is covered by ETA-07/0245.

The distance between the support and the supported element must be less than ≤ 3 mm. If this distance is less than ≤1 mm, d_{g2} can be reduced to d_{g1}.

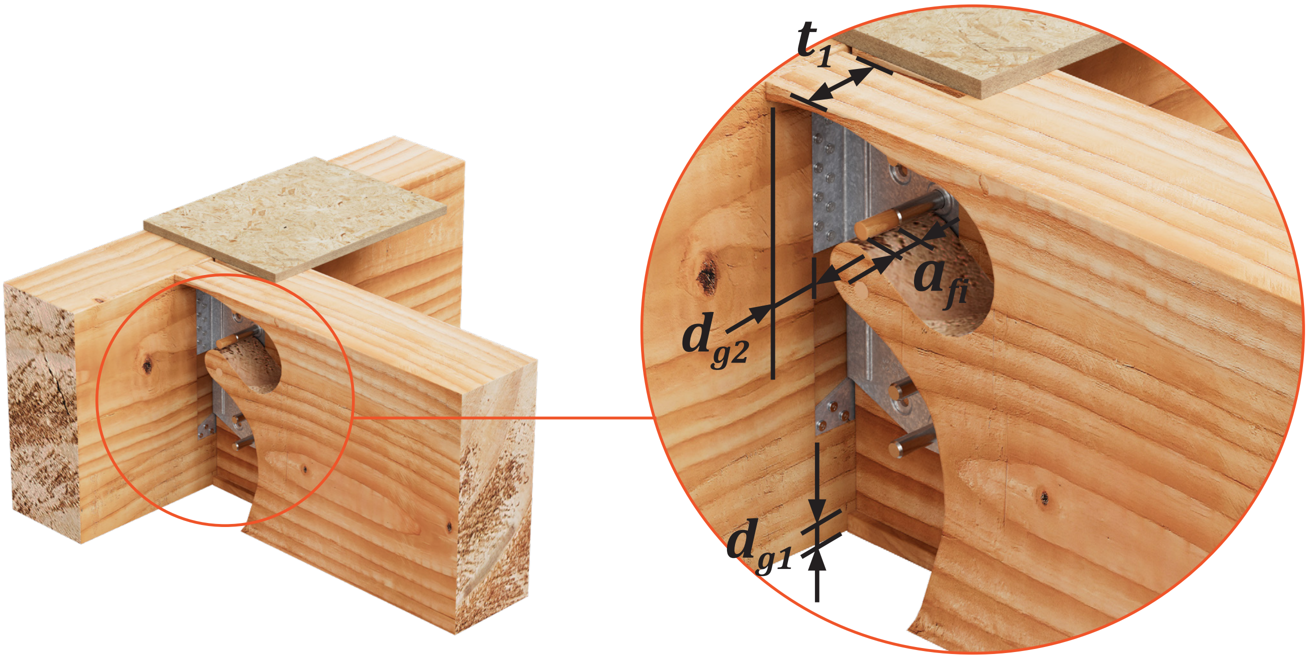
The supported beam must therefore have a minimum width of 2 x t_1 + notch width, provided that d_{g2} is also respected.

a. Concealed beam hangers

Steel (TU, CBH, BTC):

	Minimum thickness - Timber C24	
	30 min	60 min
t_1 (mm)	50	50
a_{fi} (mm)	10	30*
d_{g1} (mm)	10	30
d_{g2} (mm)	20	60

*Must be in the form of plugs.

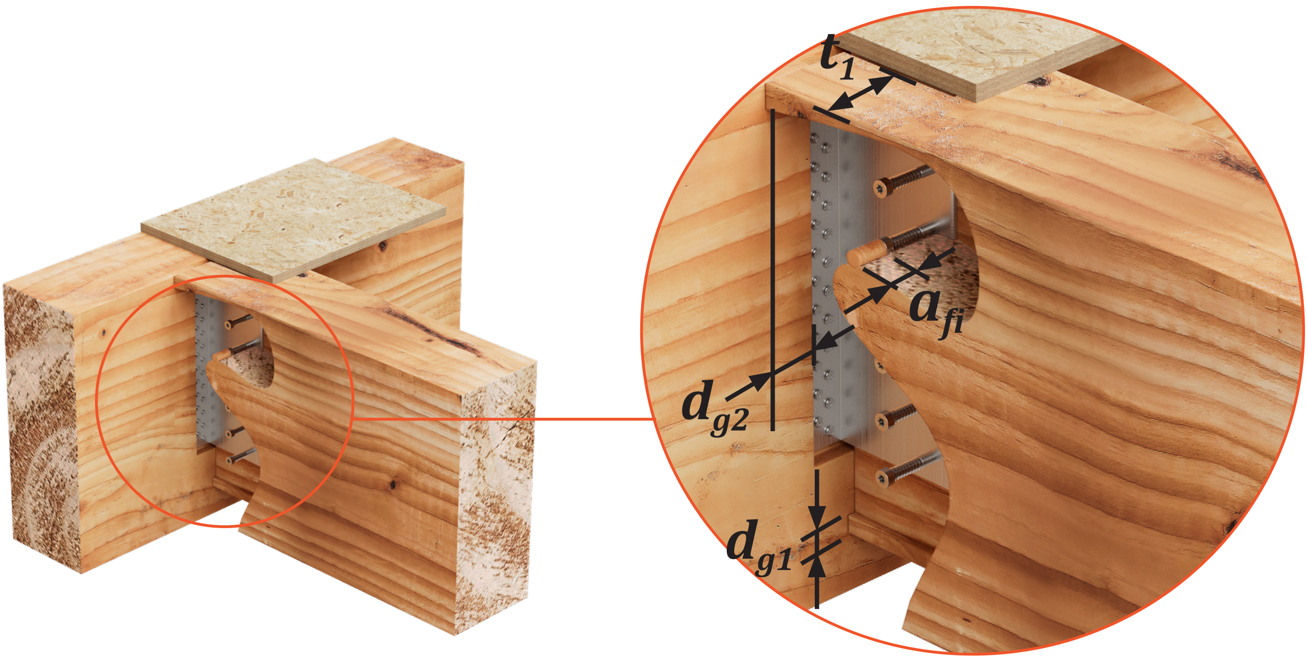


Aluminium (BTALU / BTCALU) :

In the case of aluminium connectors, it is only possible to justify half an hour of fire resistance.

	Minimum thickness - Timber C24
	30 min
t_1 (mm)	50
a_{fi} (mm)	10
d_{g1} (mm)	30
d_{g2} (mm)	30

t_1 : minimum thickness of the timber elements on either side of the bracket.
a_{fi} : minimum distance between the edge of the joist and the end of the dowels (may be in the form of plugs).
d_{g1} : minimum thickness of the protective wedge.
d_{g2} : minimum thickness of timber covering around the bottom part.
The supported beam must therefore be at least 2 x t_1 + notch width wide, provided that d_{g2} is also respected.

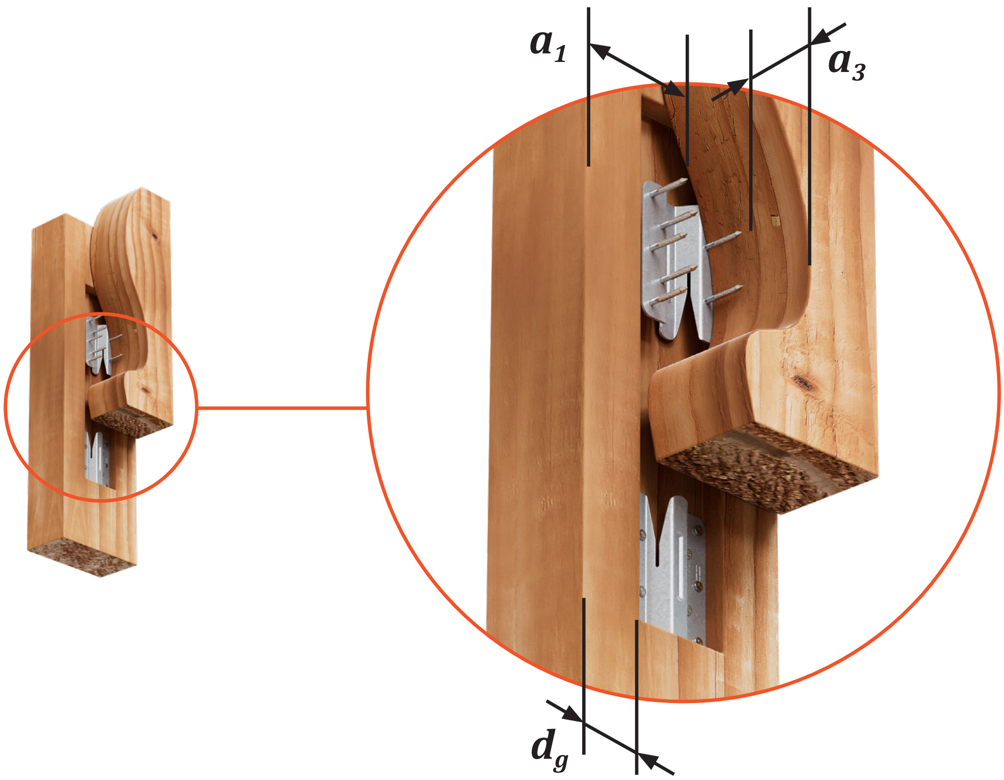


b. Hidden Connectors

Steel (ETSN, ICST):

	Minimum thickness - Timber C24	
	30 min	60 min
d_g (mm)	10	30
a_1 (mm)	40	55
a_3 (mm)	28	58

d_g: thickness of the protective timber element.
a_1: distance from the near edge to the screw axis.
a_3: distance from the near edge to the screw tip.

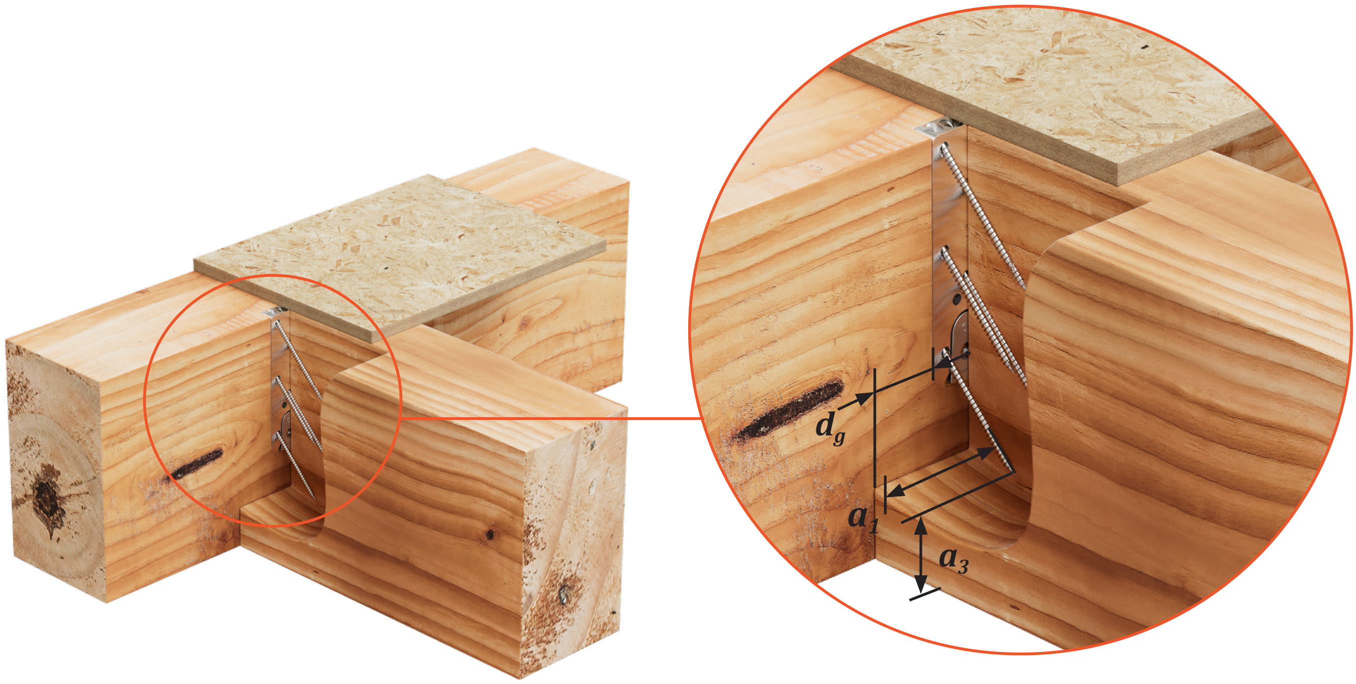


Slot is mandatory on this type of connector.

Aluminium (EGCM / EGCL):

	Minimum thickness - Timber C24
	30 min
d_g (mm)	30
a_1 (mm)	40
a_3 (mm)	28

d_g: thickness of the protective timber element.
a_1: distance from the near edge to the screw axis.
a_3: distance from the near edge to the screw tip.



C. Screws

Only tension screws can be justified in fire situations. Therefore, fully threaded screws are generally preferred for this application.

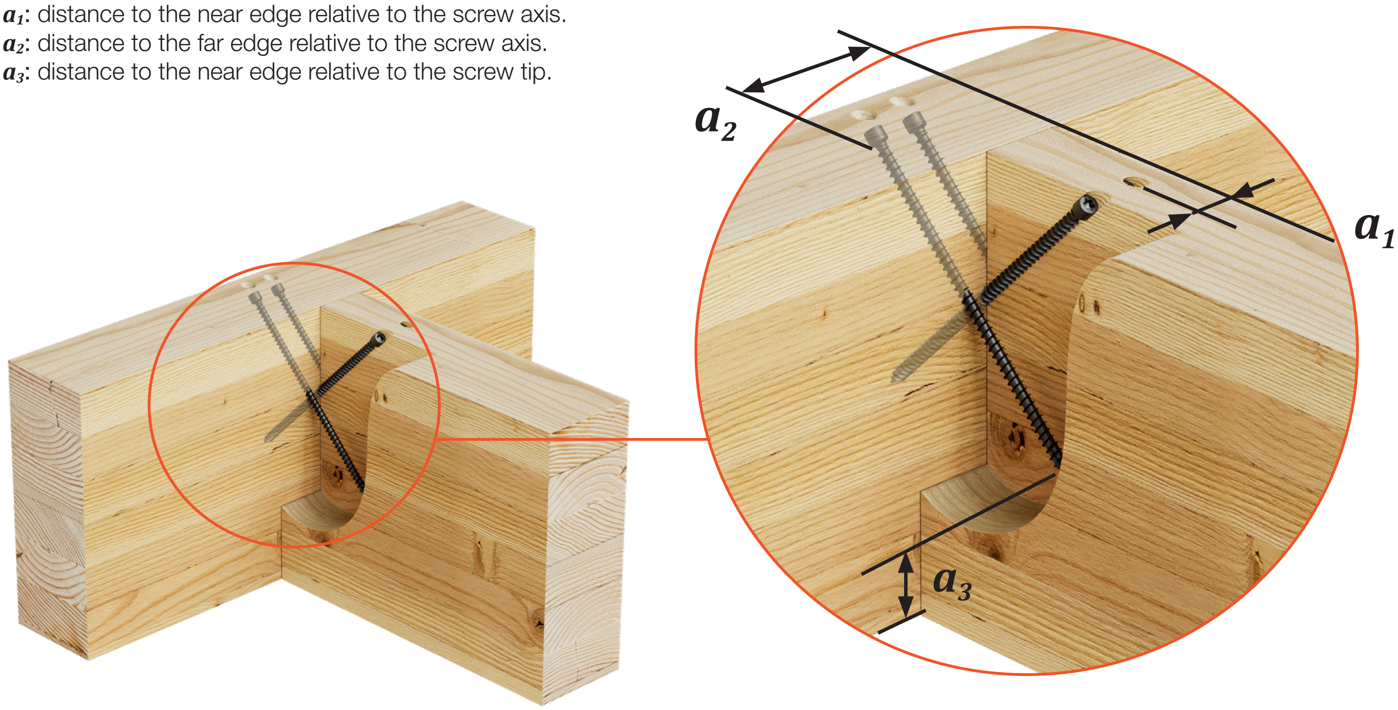
a. General information

As with hidden connectors, where the screws are embedded in the wood, justification is essentially based on compliance with edge distance rules. In this case, EN1995-1-2 is the document used to justify these distances.
To do this, the following must be checked:

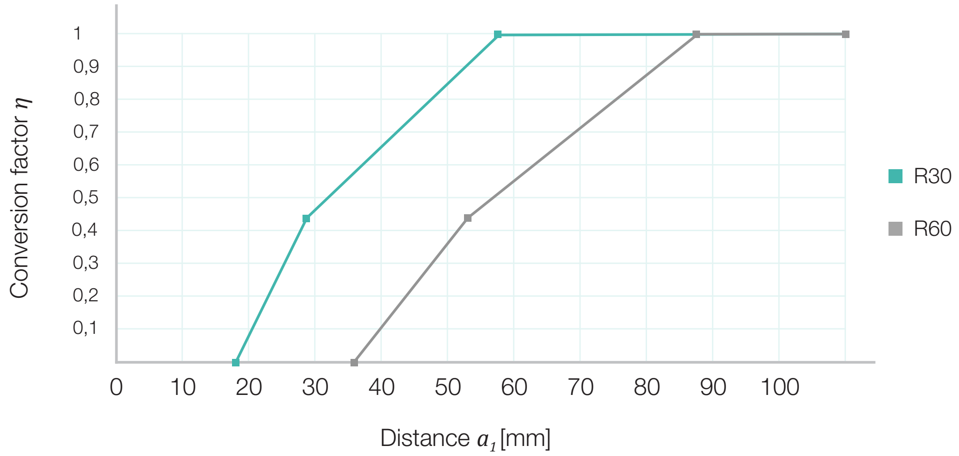
$E_{d.fi}$: stress under fire conditions.
$R_{d.fi}$: resistance under fire conditions.
η : conversion factor.
R_{20} : 20% fractile of resistance capacity.
$\gamma_{M.fi}$: partial coefficient for timber under fire conditions (equal to 1).
k_{fi} : coefficient of transition from the 20% fractile to the 5% fractile for axially stressed assemblies (=1.05).
$R_{ax.k}$: résistance caractéristique de la vis en traction.
The value η depends on the distance a_1 (see figure below for the definition of distance a_1)

$$E_{d.fi} \leq R_{d.30.fi} = \eta \times \frac{R_{20}}{\gamma_{M.fi}} = \eta \times k_{fi} \times \frac{R_{ax.k}}{\gamma_{M.fi}}$$

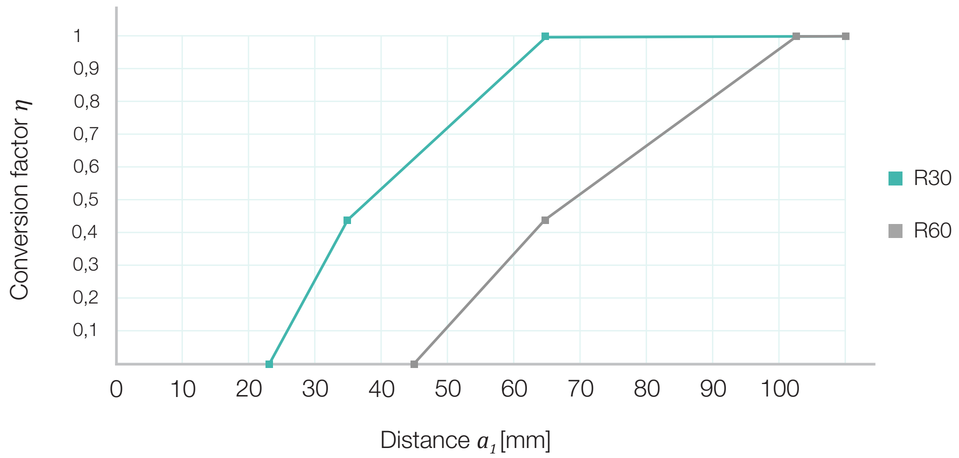
a_1: distance to the near edge relative to the screw axis.
a_2: distance to the far edge relative to the screw axis.
a_3: distance to the near edge relative to the screw tip.



The curves below can be used to find this value.



Note: This graph is only valid for $a_2 \geq a_1$+40 et $a_3 \geq a_1$+20. If $a_2 \geq a_1$ et $a_3 \geq a_1$ + 20 the curves are as follows:



Note: The exact formulas describing the curves are given below and in EN1995-1-2 6.4 (6.11).

$$\eta = \begin{cases} 0 & \text{for } a_1 \leq 0{,}6\ t_{fi.d} & \text{(a)} \\ \dfrac{0{,}44\ a_1 - 0{,}264\ t_{d.fi}}{0{,}2\ t_{d.fi} + 5} & \text{for } 0{,}6\ t_{d.fi} \leq a_1 \leq 0{,}8\ t_{d.fi} + 5 & \text{(b)} \\ \dfrac{0{,}56\ a_1 - 0{,}36\ t_{d.fi} + 7{,}32}{0{,}2\ t_{d.fi} + 23} & \text{for } 0{,}8\ t_{d.fi}\ 5 \leq a_1 \leq t_{d.fi} + 28 & \text{(c)} \\ 1{,}0 & \text{for } a_1 \geq t_{d.fi} + 28 & \text{(d)} \end{cases}$$

The gap between the two timber elements must be kept to a minimum. It is necessary to check that the distances to the edges are respected both in fire conditions and when cold.

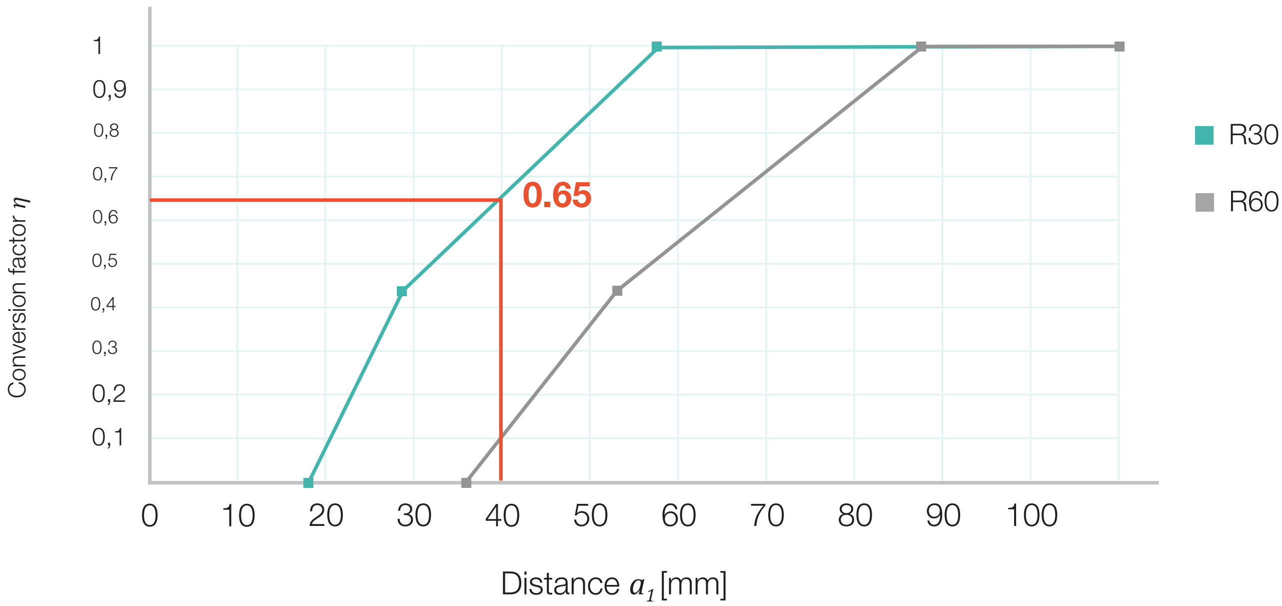
b. Calculation Example - Screws

Assumptions:

- Screws used in tension: SDCFC8.0x280
- Half of the screw thread is in each element
- a_1 = 40 mm, a_2 = 85 mm, a_3 = 60 mm
- Characteristic tensile strength of the screw when cold: $R_{ax.k}$ = 14.47 kN
- Calculation of strength after 30 minutes under fire conditions

Calculation of the screw's resistance capacity:

- Given distances a_1, a_2 et a_3, the following graph should be used



- We therefore obtain $\eta \approx 0.65$
- The maximum capacity of the screw for 30 minutes of fire is therefore:

$$R_{d.fi} = \eta \text{ x } \frac{R_{20}}{\gamma_{M.fi}} = \eta \text{ x } k_{fi} \text{ x } \frac{R_{ax.k}}{\gamma_{M.fi}} \simeq 0.65 \text{ x } 1.05 \text{ x } \frac{14.47}{1} \simeq 9.88 \text{ kN}$$

3. Fire Resistance on Concrete Elements

A. Joist Hangers

a. Calculation

As with timber elements, Simpson Strong-Tie has conducted fire resistance tests on concrete and published the characteristic values $R_{k.30.fi}$ in fire conditions for a duration of 30 minutes. These are given in ETA-06/0270 and are included in the technical data sheets for 4 mm GSE products. They are given for fastening with CNA4.0x75 nails and CSA5.0x80 screws and FM 753 Crack in concrete. The tests were carried out in collaboration with the Building Test Centre (UK) in accordance with EN 13501-2 and EAD130186-00-0603.

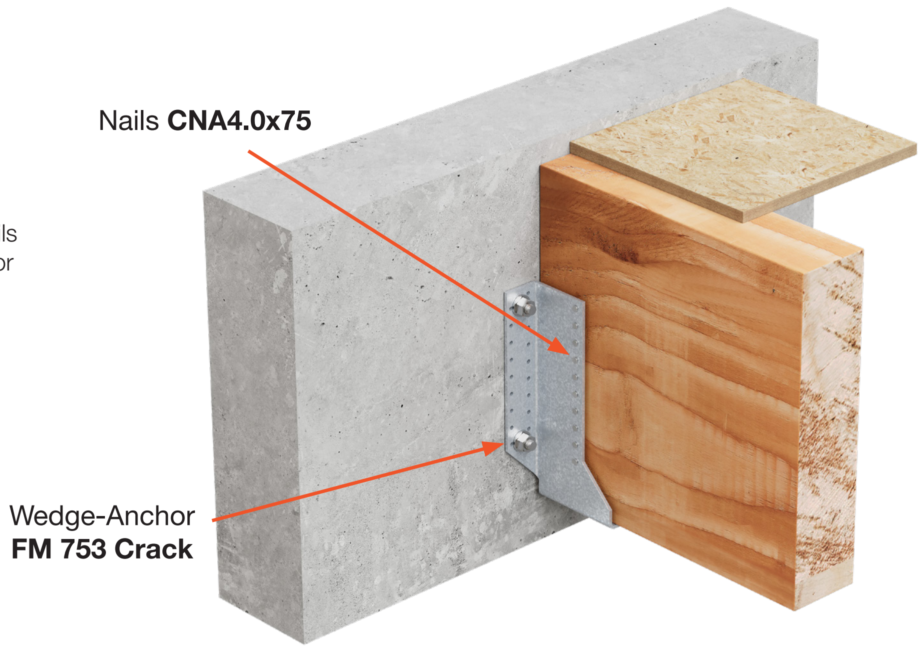
To validate the assembly, it must be verified that the loads in a fire conditions $E_{d.fi}$ are lower than the resistance of the joist hanger after 30 minutes of fire $R_{d.30.fi}$.

$$E_{d.fi} \leq R_{d.30.fi} = \frac{R_{k.30.fi}}{\gamma_{M.fi}}$$

$E_{d.fi}$: design effort in fire conditions.
$R_{d.30.fi}$: design resistance in fire conditions after 30 minutes.
$R_{k.30.fi}$: characteristic resistance in fire conditions after 30 minutes.
$\gamma_{M.fi}$: partial coefficient for assemblies in fire conditions (equal to 1).

b. Product Information

The minimum width of the solid timber is 100 mm and 90mm for glulam. The timber elements are fastened using CNA4.0x75 nails or CSA5.0x80 screws. FM 753 Crack anchor bolts are used for the concrete element.



The table below shows the values for 4 mm GSE on concrete.

Characteristic values under fire conditions - Timber to concrete

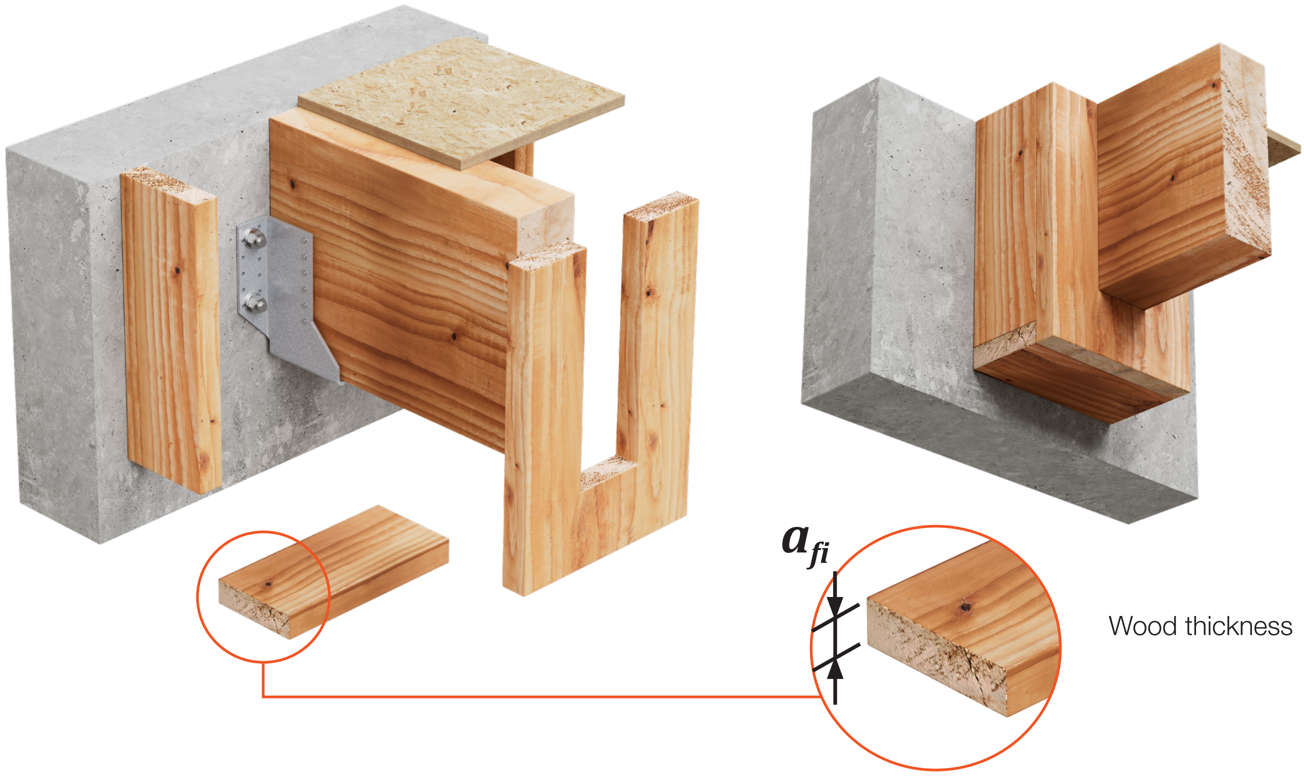
Item number	Characteristic Values in 30min fire condition							
	Fasteners				Characteristic values - Solid Timber C24 [kN]			
	Header		Joist		$R_{1,k,fi}$		$R_{4,k,fi}$	
	Qty	Type	Qty	Type	Width between 100 and 136mm	Width between 137 and 200mm	Width between 100 and 136mm	Width between 137 and 200mm
GSE380/4X	2	FM-753 CRACK 3DG M12x110	8	CNA4.0x75 or CSA5.0x80	10	-	2,1	-
GSE440/4X	4	FM-753 CRACK 3DG M12x110	12	CNA4.0x75 or CSA5.0x80	20	-	4,1	-
GSE500/4X	4	FM-753 CRACK 3DG M12x110	14	CNA4.0x75 or CSA5.0x80	20	-	4,1	-
GSE500/4X-AL	2	FM-753 CRACK 3DG M12x110	12	CNA4.0x75 or CSA5.0x80	-	10	-	2,1
GSE540/4X	4	FM-753 CRACK 3DG M12x110	16	CNA4.0x75 or CSA5.0x80	20	-	4,1	-
GSE540/4X-AL	4	FM-753 CRACK 3DG M12x110	14	CNA4.0x75 or CSA5.0x80	-	20	-	4,1
GSE600/4X	4	FM-753 CRACK 3DG M12x110	20	CNA4.0x75 or CSA5.0x80	20	-	4,1	-
GSE600/4X-AL	4	FM-753 CRACK 3DG M12x110	18	CNA4.0x75 or CSA5.0x80	-	20	-	4,1
GSE660/4X	6	FM-753 CRACK 3DG M12x110	22	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE660/4X-AL	4	FM-753 CRACK 3DG M12x110	20	CNA4.0x75 or CSA5.0x80	-	20	-	4,1
GSE720/4X	6	FM-753 CRACK 3DG M12x110	26	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE720/4X-AL	6	FM-753 CRACK 3DG M12x110	24	CNA4.0x75 or CSA5.0x80	-	20,6	-	6,2
GSE780/4X	6	FM-753 CRACK 3DG M12x110	28	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE780/4X-AL	6	FM-753 CRACK 3DG M12x110	26	CNA4.0x75 or CSA5.0x80	-	20,6	-	6,2
GSE840/4X	6	FM-753 CRACK 3DG M12x110	32	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE840/4X-AL	6	FM-753 CRACK 3DG M12x110	30	CNA4.0x75 or CSA5.0x80	-	20,6	-	6,2
GSE900/4X	6	FM-753 CRACK 3DG M12x110	36	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE900/4X-AL	6	FM-753 CRACK 3DG M12x110	32	CNA4.0x75 or CSA5.0x80	-	20,6	-	6,2
GSE960/4X	6	FM-753 CRACK 3DG M12x110	38	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE960/4X-AL	6	FM-753 CRACK 3DG M12x110	34	CNA4.0x75 or CSA5.0x80	-	20,6	-	6,2
GSE1020/4X	6	FM-753 CRACK 3DG M12x110	40	CNA4.0x75 or CSA5.0x80	20,6	-	6,2	-
GSE1020/4X-AL	6	FM-753 CRACK 3DG M12x110	38	CNA4.0x75 or CSA5.0x80	-	20,6	-	6,2

Example of values for timber on concrete. The values in fire conditions are characteristic resistance values at 30 minutes R30. *In order to justify the fire resistance of the anchor group, the anchors in the load-bearing structure must be FM 753 Crack mechanical anchors. The only fasteners permitted in the beam are CNA4.0x75 nails or CSA5.0x80 screws.

c. Protection

	Minimum thickness - Timber C24	
	30 min	60 min
a_{fi} (mm)	33	66

It is also possible to protect assemblies using materials that enable the desired holding times to be achieved.

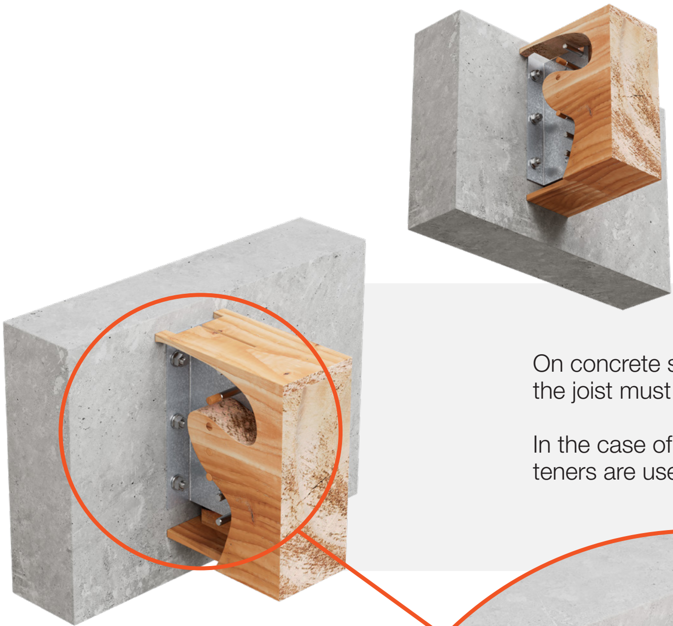


B. Concealed Beam Hangers

Steel, timber and concrete will make it possible to achieve half an hour, or even an hour, of fire resistance quite easily.

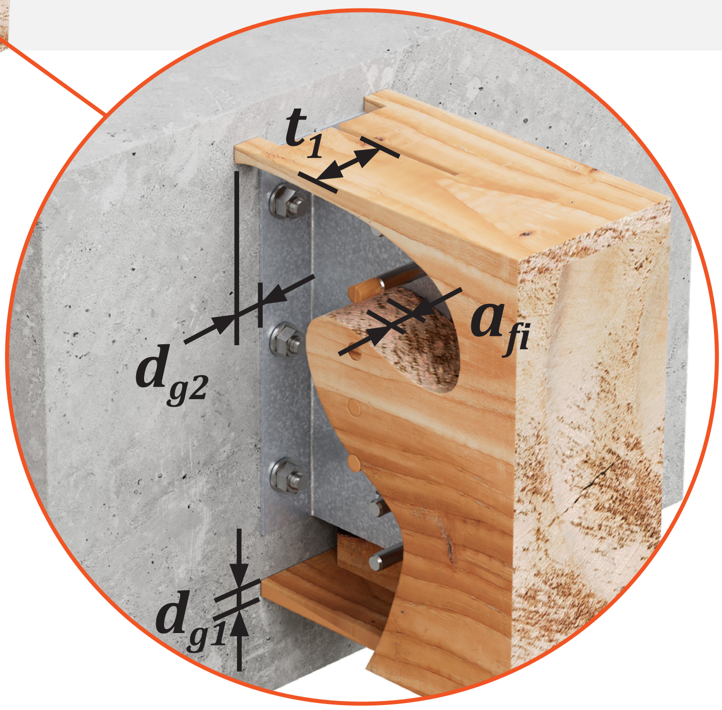
	Minimum thickness - Timber C24	
	30 min	60 min
t_1 (mm)	50	50
a_{fi} (mm)	10	30*
d_{g1} (mm)	10	30
d_{g2} (mm)	20	60

t_1: minimum thickness of the timber elements on either side of the bracket.
a_{fi}: minimum distance between the edge of the joist and the end of the dowels (may be in the form of plugs).
d_{g1}: minimum thickness of the protective wedge.
d_{g2}: minimum thickness of timber covering around the bottom part.
The supported beam must therefore be at least 2 x t_1 + notch width wide, provided that d_{g2} is also respected.



On concrete support, the distance between the support and the joist must be less than ≤ 3 mm.

In the case of protection or hidden connectors, standard fasteners are used (STD, SDD, etc.).



C. Anchors

Anchors use a different method of justification. It is based on products certified for this use, then on a calculation method using the data from this certification.

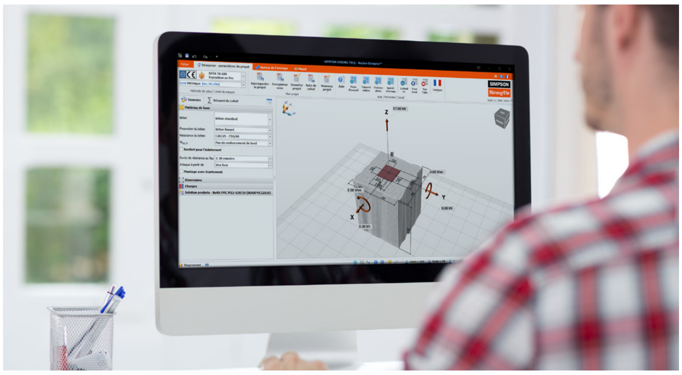
Product testing is therefore carried out in accordance with TR020. Eurocode 2 Part 4 and Part Fire are then used to perform the calculation.

TR020 allows certification for up to 120 minutes.

In the Simpson Strong-Tie range, the products covered by this certification are:

- FM-753 Crack 3DG (option 1)
- FM-753 Crack A4 (option 1 - stainless steel)
- CLR Plus (option 1)
- KEM EP (option 1 Chemical)
- KEM H (option 1 Chemical)
- KEM V (option 1 Chemical)
- KEM V Winter (option 1 Chemical)

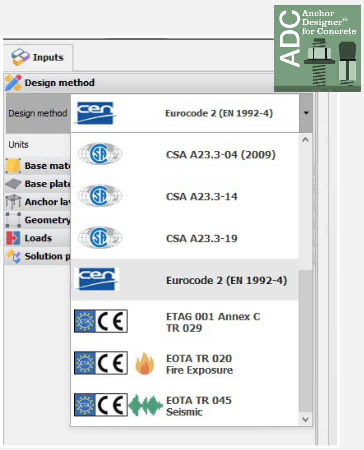
To simplify the design of these anchors, the Anchor Designer for Concrete software incorporates these calculation methods.



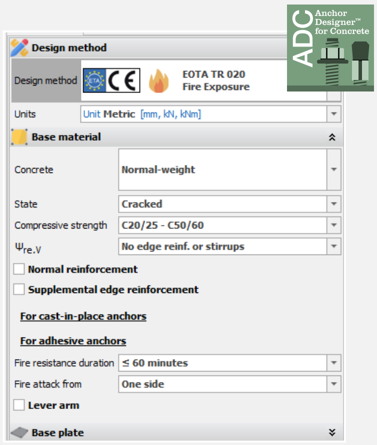
Once you have selected TR020, you can perform calculations under fire conditions. You must then choose the duration of the fire to be considered (30, 60, 90 or 120 minutes) and the number of sides of the concrete element that will be exposed to the fire.

The Anchor Designer for Concrete software is available free of charge on our website: www.strongtie.eu > Anchor Designer.

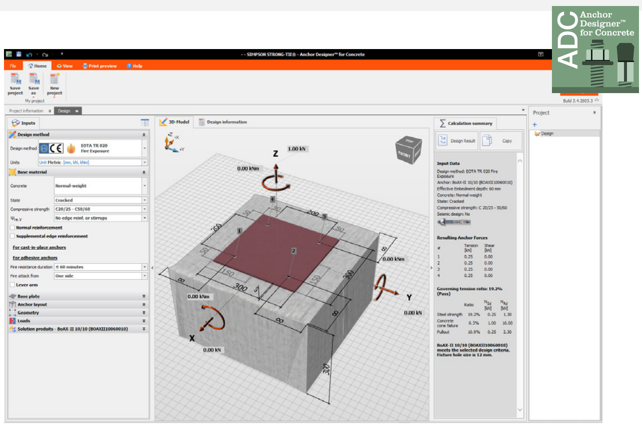
1. Choose calculation method to fire



2. Calculation parameters



3. Results of a anchor fire calculation



Reference Documents

Simpson Strong-Tie® relies on current standards to develop each of its products and provides a list of reference texts below.

Regulations

Eurocode 5 Part 2 (EN1995-1-2) explains two possibilities for the fire resistance of steel connection:

1. First one is to calculate or test the fire resistance of exposed steel connectors.
2. The second one use the protection brought by other additionnal material (wood, plasterboards, paint,...)

Eurocode 2 Part 2 (EN1992-1-2) and Eurocode 2 Part 4 Annex D (EN1992-4 Annex D) explain the fire resistance of concrete and anchors. Anchor Disgner software add the TR020 to include the evaluation method for anchors in fire condition.

Eurocode 3 Part 2 (EN1993-1-2) explain the design method for steel structure and connection. Bolted connection and steel plate fire resistance are given in this document.

EN13-501-1 talk about the Euroclass of the different type of material.

Glossary

Chemical anchoring: Anchor whose threaded part is secured using a mixture of hardener and resin.

Mechanical anchoring: Anchoring plug that attaches to concrete mechanically.

Plugging: Fastening a connector to a concrete or masonry support using anchor bolts or chemical anchoring.

Combustion: Consumption of an element by fire.

Hot dimensioning: Using load and resistance values under fire conditions to justify an assembly.

Cold justification: Considering the resistance values of a connector or screw under normal conditions of use.

Countersinking: Machining a wooden element to embed a connector or screw.

Intumescent paint: A coating that swells when exposed to heat, creating a kind of ‘meringue’ that serves as passive protection.

Load bearing capacity: The ability of a connector or screw to absorb the stresses associated with its use.