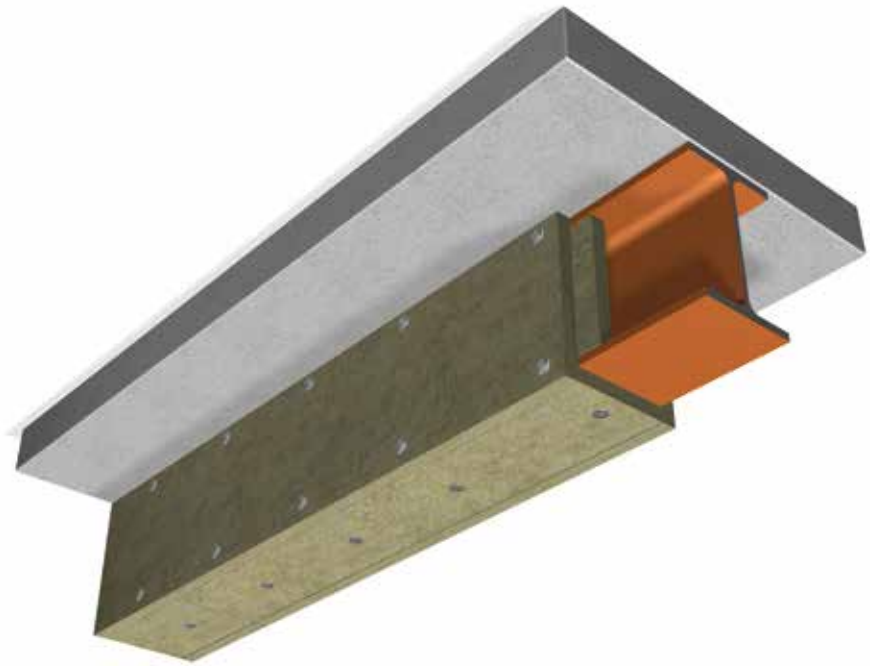
FIRE PROTECTION GUIDE 1/STEEL

LOADBEARING STEEL BEAMS & COLUMNS, STEEL TRAPEZOID ROOFS AND PARTITIONS



OWENS CORNING® PAROC®

CONTENT:

LOADBEARING STEEL BEAMS AND COLUMNS

The fire resistance requirement for a building is defined in terms of fire resistance period and stated in terms of minutes (15, 30, 45, 60, 75, 90, 120, etc. up to 240 minutes). This information is usually given in local building regulations and it depends on the height, occupants and type of the building. In practice it means that the building frame has to maintain its load bearing capacity during the fire until everybody has left the burning building. It is the responsibility of the design engineer, using design codes such as ENV1993-1-2, to specify the appropriate limiting or failure temperature for a given section.

Different load bearing materials have different fire resistance periods. These materials are usually tested by using a standard fire curve which demonstrates development of a real fire. The temperature in a standard fire rises rather quickly and then increases indefinitely.

Fire resistance test results are expressed in terms of time of failure against one or more of three criteria:

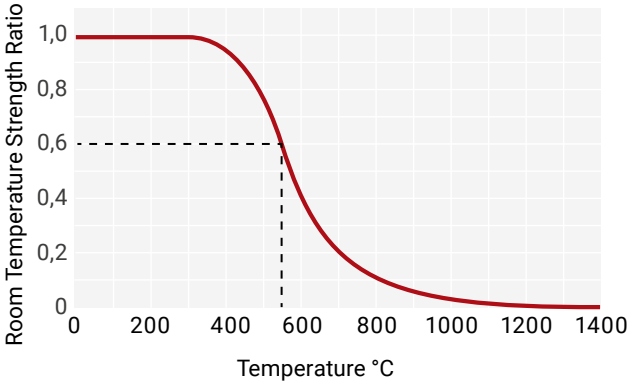
- Load bearing capacity (R)
- Integrity (passage of hot gases/flames) (E)
- Insulation (temperature raise on the cold side of the structural element, usually max. 140 °C) (I)

In some building constructions all of these are needed but for the steel frames only load bearing capacity is required e.g. R120.

DETERMINE CRITICAL TEMPERATURE AND THE SECTION FACTOR OF THE STEELÄ

All materials lose their strength as they get hot.

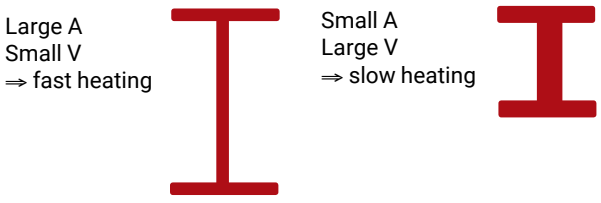
- Fully loaded steel beam exposed on four sides, fails at 550 °C, regardless of steel grade.
- Fully loaded beam exposed on three sides, fails at 620 °C.
- => Temperature 450–500 °C is commonly used as rather safe limit value.



Fires in buildings regularly exceed 1000 degrees centigrade within a relatively short period of time (30–60 minutes), yet heavily loaded steel loses its design margin of safety, about 40% at temperatures around 550°C regardless of the grade. As the temperature rises further the loss of strength is rapid and significant.

The design of fire protection is therefore based on this limiting temperature for elements exposed to fire on four sides. The aim is to keep the steel temperature below its critical temperature.

The rate of increase in temperature of a steel cross-section is determined by the ratio of the heated surface area (Am) to the volume (V). This ratio, (Am /V), has units of m^{-1} and is known as the section factor. Members with low section factors will heat up more slowly. The section factor is thus a measure of the rate at which a section will heat up in a fire and the higher its value, the greater will be the protection thickness required.



A steel section with a large surface area (A) (m²/m) will receive more heat than one with a smaller surface area. Also, the greater the volume (V) (m³/m) of the section, the greater is the heat sink. It follows therefore, that a small thick section will be slower to increase in temperature than a large thin one.

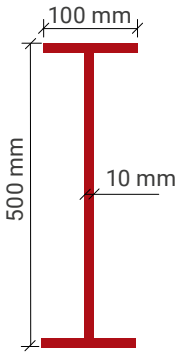
In calculating the section factor values the full volume, V, is used whether the section is exposed on three or four sides as entire steel section will be receiving heat. A, however, is the exposed surface area and that depends on the configuration of the fire protection.

Example of calculating section factor Am/V

- Surface area (Am) of one meter long beam is 1,38 m²
- Volume (V) of one meter long beam is 0,0068 m³)

A / V = 1,38 / 0,0068 = 203 m^{-1}

Section factors vary generally from 25 m^{-1} for very large sections to over 300 m^{-1} for small, slender sections.

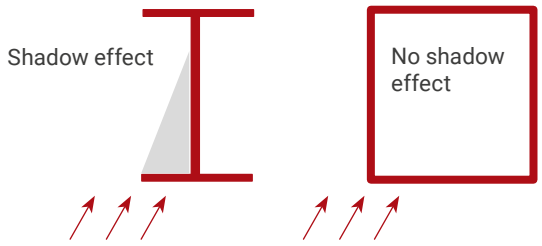


Unprotected steel

Shadow effect

In case of unprotected steel profiles, a section factor including the shadow effect can be considered. Shadow effect is caused by local shielding of irradiative heat transfer, due to shape of steel profile, e.g.

- I-profiles: k_{shadow} = 0,9 $[A_m/V]_{box}$ / $[A_m/V]$
- □-profiili: k_{shadow} = 1
- Insulated profiles = 1 (all)



Whilst the section factor can be calculated it is more usual to refer different steel manufacturers profile information where this value is given.

DETERMINE PROTECTION METHOD

The most practical way to limit the rise in steel temperature is to insulate it from the fire. In considering any fire protection system it is important to distinguish between profile, box and solid methods of application.


Profile Box Solid

Sprayed materials would normally be applied to follow the profile of the section. Special insulating concretes can be used to form solid protection. Board materials would normally be used to form a box around the section or with higher profiles following the profile.

The type of insulation has to be taken into account when designing steel structures because insulation also conducts heat. In case of protected members the section factor A_p /V is multiplied by a factor, allowing for the thermal conductivity of the protection material, divided by its thickness λ_p /d_p.

$$(A_p/V) \times (\lambda_p/d_p)$$

Summary:

The thickness of fire protection insulation needed depends on

- duration of fire resistance specified in national regulations (R30, R60, R90, R120…)
- critical temperature and the section factor of the steel
  –> perimeter of steel section exposed to fire (A)
  –> shape and size of steel section (total volume, V)
- type of protection used

FIRE PROTECTION OF STEEL PROFILES WITH PAROC FPS 17

Design tools for prediction of stone wool fire protection board thickness have been made for 30–240 minutes endurance time in a Standard Fire Exposure (R30–R240) for open and closed (I/H and RHS) steel sections.

Based on graphical or tabulated design values PAROC FPS 17 board thickness can be chosen as a function of

- fire endurance time,
- section factor A/V for the member and
- Critical steel temperature ranging from 300–700°C

A_p /V – SECTION FACTOR FOR PROTECTED MEMBERS

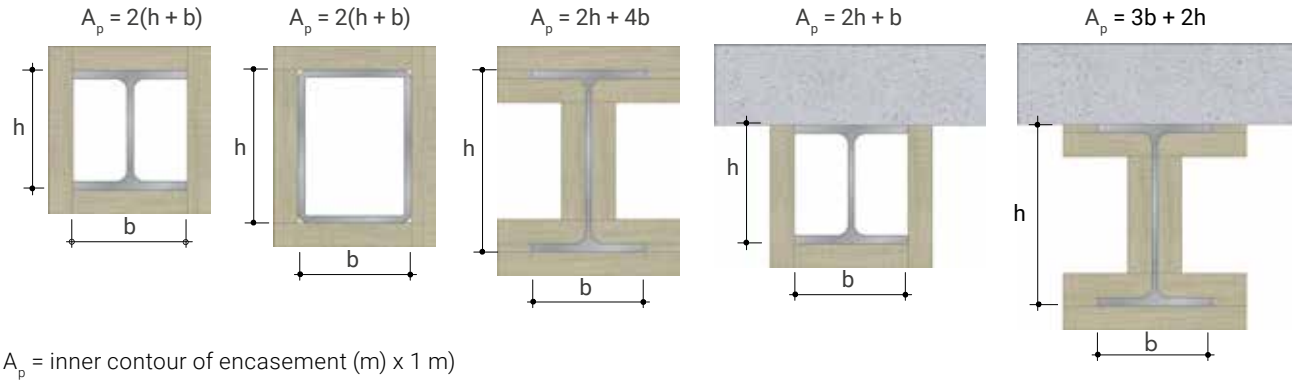
Section factor for insulated steel members:

A /V = (m^{-1})

In case of "box" protection, the surface area is taken as the sum of the inside dimensions of the smallest possible rectangular or square encasement.

RHS = retangular hollow section

When I profile has a greater height than 450 mm the insulation shall be installed following the profile.



A_p = inner contour of encasement (m) x 1 m)
V = cross-section area of steel profile (m^2) x 1 m)

Calculation example

Steel beam, encased on three sides

- Serial size: 406 mm x 178 mm x 54 kg/m
- Actual size: 402,6 mm x 177,6 mm

A = 2h + b –> 402,6 + 402,6 + 177,6 = 982,8 mm × 1000 mm = 0,9828 m^2
V = 0,00684 m^3

A/V = 0,9828 m^2/0,00684 m^3 = 143,7 m-1 = 144 m^{-1}

or

A/V = (ρ × A)/W = 7850 kg/m^3 × 0,9828 m^2/54 kg/m = 143 m^{-1}

W =Mass of steel section per meter (kg/m)

(Nominal density of steel is 7850 kg/m^3. The value of W can be obtained either from steelwork tables or by accurate measurement.)
Once the specific A/V value is known, the required thickness of the PAROC FPS 17 board for the defined fire protection can be found from the A/V tables.

You can also use ready-calculated A_p /V values from the profile manufacturers:

1. Find the section factor A_p /V by using data for the steel profile data for the steel profile from the steel supplier. For example section factor for four sides exposed HE 140 B profile is 130 m^{-1}.
2. In the following figures you can find the fire class and the needed thickness of insulation. Choose the table based on required fire resistance time, check the critical temperature and read the PAROC FPS 17 thickness from the section factor row. For example if critical temperature for the steel profile is 450°C and required fire resistance time 30 minutes, you need 20 mm PAROC FPS 17 fire protection for the section factor 130 m^{-1}.

HEA-profile			HEB-profile			HEM-profile		
a	b		c	d		e	f	
								
	a	b		c	d		e	f
	A_p/V (m^{-1})	A/V (m^{-1})		A_p/V (m^{-1})	A_p/V (m^{-1})		A_p/V (m^{-1})	A_p/V (m^{-1})
HE 100 A	184	138	HE 100 B	154	115	HE 100 M	85	65
HE 120 A	185	137	HE 120 B	141	106	HE 120 B	80	61
HE 140 A	174	129	HE 140 B	130	98	HE 140 M	76	58
HE 160 A	161	120	HE 160 B	118	89	HE 160 M	71	54
HE 180 A	155	115	HE 180 B	110	83	HE 180 M	68	52
HE 200 A	145	108	HE 200 B	103	77	HE 200 M	65	49
HE 220 A	134	100	HE 220 B	97	73	HE 220 M	62	47
HE 240 A	122	91	HE 240 B	91	68	HE 240 M	52	40
HE 260 A	118	88	HE 260 B	88	66	HE 260 M	51	39
HE 280 A	113	84	HE 280 B	85	64	HE 280 M	50	38
HE 300 A	105	78	HE 300 B	81	60	HE 300 M	43	33
HE 320 A	98	74	HE 320 B	77	58			
HE 340 A	94	72	HE 340 B	75	57			
HE 360 A	91	70	HE 360 B	73	57			
HE 400 A	87	68	HE 400 B	71	56			
HE 450 A	83	66	HE 450 B	69	55			
HE 500 A	80	65	HE 500 B	67	55			
HE 550 A	79	65	HE 550 B	67	55			
HE 600 A	79	65	HE 600 B	67	56			
HE 650 A	79	65	HE 650 B	66	56			

Given insulation thicknesses in the tables are based on a designed program of fire tests on both loaded and unloaded specimens and a mathematical procedure applied to the results of the tests. Test programs were designed to determine both the insulation characteristics of a fire protection material and its physical performance under fire conditions for a range of steel sizes.

Steel sections protected with PAROC FPS 17 were tested and calculated according to EN 1363-1:2012 and ENV 13381-4:2013 in the Danish Institute of Fire and Security Technology (DBI), Denmark. This system has a European Technical Approval issued by VTT Expert Services (ETA 08/0093).

Insulation thickness for R30 steel structure a/v 130, critical steel temperature 450°C

Design temperature [°C]	Fire resistance period 30 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	20	20	20	20	20	20	20	20	20
50	20	20	20	20	20	20	20	20	20
55	20	20	20	20	20	20	20	20	20
60	20	20	20	20	20	20	20	20	20
65	20	20	20	20	20	20	20	20	20
70	20	20	20	20	20	20	20	20	20
75	20	20	20	20	20	20	20	20	20
80	20	20	20	20	20	20	20	20	20
85	20	20	20	20	20	20	20	20	20
90	20	20	20	20	20	20	20	20	20
95	20	20	20	20	20	20	20	20	20
100	20	20	20	20	20	20	20	20	20
105	20	20	20	20	20	20	20	20	20
110	20	20	20	20	20	20	20	20	20
115	20	20	20	20	20	20	20	20	20
120	20	20	20	20	20	20	20	20	20
125	20	20	20	20	20	20	20	20	20
130	20	20	20	20	20	20	20	20	20
135	20	20	20	20	20	20	20	20	20
140	20	20	20	20	20	20	20	20	20
145	20	20	20	20	20	20	20	20	20
150	20	20	20	20	20	20	20	20	20
155	20	20	20	20	20	20	20	20	20
160	20	20	20	20	20	20	20	20	20
165	20	20	20	20	20	20	20	20	20
170	20	20	20	20	20	20	20	20	20
175	20	20	20	20	20	20	20	20	20
180	20	20	20	20	20	20	20	20	20
185	20	20	20	20	20	20	20	20	20
190	20	20	20	20	20	20	20	20	20
195	20	20	20	20	20	20	20	20	20
200	25	20	20	20	20	20	20	20	20
205	25	20	20	20	20	20	20	20	20
210	25	20	20	20	20	20	20	20	20
215	25	20	20	20	20	20	20	20	20
220	25	20	20	20	20	20	20	20	20
225	25	20	20	20	20	20	20	20	20
230	25	20	20	20	20	20	20	20	20
235	25	20	20	20	20	20	20	20	20
240	25	20	20	20	20	20	20	20	20
245	30	20	20	20	20	20	20	20	20
250	30	20	20	20	20	20	20	20	20
255	30	20	20	20	20	20	20	20	20
260	30	20	20	20	20	20	20	20	20
265	30	20	20	20	20	20	20	20	20
270	30	20	20	20	20	20	20	20	20
275	30	20	20	20	20	20	20	20	20
280	30	20	20	20	20	20	20	20	20
281	30	25	20	20	20	20	20	20	20

ETA approved !

OPEN AND CLOSED STEEL SECTIONS

Insulation thickness for R60 steel structure

Design temperature [°C]	Fire resistance period 60 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	20	20	20	20	20	20	20	20	20
50	20	20	20	20	20	20	20	20	20
55	20	20	20	20	20	20	20	20	20
60	20	20	20	20	20	20	20	20	20
65	20	20	20	20	20	20	20	20	20
70	20	20	20	20	20	20	20	20	20
75	20	20	20	20	20	20	20	20	20
80	20	20	20	20	20	20	20	20	20
85	20	20	20	20	20	20	20	20	20
90	25	20	20	20	20	20	20	20	20
95	25	20	20	20	20	20	20	20	20
100	25	20	20	20	20	20	20	20	20
105	30	20	20	20	20	20	20	20	20
110	30	25	20	20	20	20	20	20	20
115	30	25	20	20	20	20	20	20	20
120	30	25	20	20	20	20	20	20	20
125	40	25	20	20	20	20	20	20	20
130	40	30	20	20	20	20	20	20	20
135	40	30	20	20	20	20	20	20	20
140	40	30	25	20	20	20	20	20	20
145	40	30	25	20	20	20	20	20	20
150	40	30	25	20	20	20	20	20	20
155	40	40	25	20	20	20	20	20	20
160	40	40	30	20	20	20	20	20	20
165	40	40	30	20	20	20	20	20	20
170	50	40	30	25	20	20	20	20	20
175	50	40	30	25	20	20	20	20	20
180	50	40	30	25	20	20	20	20	20
185	50	40	30	25	20	20	20	20	20
190	50	40	30	25	20	20	20	20	20
195	50	40	40	25	20	20	20	20	20
200	50	40	40	25	20	20	20	20	20
205	50	40	40	30	20	20	20	20	20
210	50	40	40	30	25	20	20	20	20
215	50	50	40	30	25	20	20	20	20
220	60	50	40	30	25	20	20	20	20
225	60	50	40	30	25	20	20	20	20
230	60	50	40	30	25	20	20	20	20
235	60	50	40	30	25	20	20	20	20
240	60	50	40	30	25	20	20	20	20
245	60	50	40	30	25	20	20	20	20
250	60	50	40	30	25	20	20	20	20
255	60	50	40	40	25	20	20	20	20
260	60	50	40	40	30	25	20	20	20
265	60	50	40	40	30	25	20	20	20
270	60	50	40	40	30	25	20	20	20
275	–	50	40	40	30	25	20	20	20
280	–	50	40	40	30	25	20	20	20
281	–	50	40	40	30	25	20	20	20

Insulation thickness for R90 steel structure

Design temperature [°C]	Fire resistance period 90 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	20	20	20	20	20	20	20	20	20
50	20	20	20	20	20	20	20	20	20
55	20	20	20	20	20	20	20	20	20
60	25	20	20	20	20	20	20	20	20
65	25	20	20	20	20	20	20	20	20
70	30	25	20	20	20	20	20	20	20
75	30	25	20	20	20	20	20	20	20
80	40	30	20	20	20	20	20	20	20
85	40	30	25	20	20	20	20	20	20
90	40	30	25	20	20	20	20	20	20
95	40	40	30	20	20	20	20	20	20
100	40	40	30	25	20	20	20	20	20
105	50	40	30	25	20	20	20	20	20
110	50	40	40	30	20	20	20	20	20
115	50	40	40	30	25	20	20	20	20
120	50	50	40	30	25	20	20	20	20
125	50	50	40	30	25	20	20	20	20
130	50	50	40	40	30	20	20	20	20
135	60	50	40	40	30	25	20	20	20
140	60	50	40	40	30	25	20	20	20
145	60	50	50	40	30	25	20	20	20
150	60	50	50	40	40	25	20	20	20
155	60	60	50	40	40	30	25	20	20
160	60	60	50	40	40	30	25	20	20
165	–	60	50	40	40	30	25	20	20
170	–	60	50	40	40	30	25	20	20
175	–	60	50	50	40	30	25	20	20
180	–	60	50	50	40	30	25	25	20
185	–	60	50	50	40	40	30	25	20
190	–	60	50	50	40	40	30	25	20
195	–	60	60	50	40	40	30	25	20
200	–	–	60	50	40	40	30	25	20
205	–	–	60	50	40	40	30	25	20
210	–	–	60	50	40	40	30	25	20
215	–	–	60	50	40	40	30	25	25
220	–	–	60	50	40	40	30	30	25
225	–	–	60	50	50	40	30	30	25
230	–	–	60	50	50	40	40	30	25
235	–	–	60	50	50	40	40	30	25
240	–	–	60	50	50	40	40	30	25
245	–	–	60	50	50	40	40	30	25
250	–	–	60	50	50	40	40	30	25
255	–	–	60	50	50	40	40	30	25
260	–	–	60	50	50	40	40	30	25
265	–	–	60	60	50	40	40	30	25
270	–	–	–	60	50	40	40	30	30
275	–	–	–	60	50	40	40	30	30
280	–	–	–	60	50	40	40	30	30
281	–	–	–	60	50	40	40	30	30

Insulation thickness for R120 steel structure

Design temperature [°C]	Fire resistance period 120 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	25	20	20	20	20	20	20	20	20
50	30	25	20	20	20	20	20	20	20
55	30	25	20	20	20	20	20	20	20
60	40	30	25	20	20	20	20	20	20
65	40	40	30	20	20	20	20	20	20
70	40	40	30	25	20	20	20	20	20
75	50	40	40	30	20	20	20	20	20
80	50	40	40	30	25	20	20	20	20
85	50	50	40	40	30	20	20	20	20
90	50	50	40	40	30	25	20	20	20
95	60	50	50	40	40	25	20	20	20
100	60	50	50	40	40	30	20	20	20
105	60	60	50	40	40	30	25	20	20
110	60	60	50	50	40	40	25	20	20
115	–	60	50	50	40	40	30	25	20
120	–	60	60	50	40	40	30	25	20
125	–	60	60	50	50	40	30	25	20
130	–	–	60	50	50	40	40	30	25
135	–	–	60	50	50	40	40	30	25
140	–	–	60	60	50	40	40	30	25
145	–	–	60	60	50	40	40	30	25
150	–	–	60	60	50	50	40	40	30
155	–	–	–	60	50	50	40	40	30
160	–	–	–	60	50	50	40	40	30
165	–	–	–	60	50	50	40	40	30
170	–	–	–	60	50	50	40	40	30
175	–	–	–	60	60	50	40	40	30
180	–	–	–	60	60	50	40	40	40
185	–	–	–	60	60	50	50	40	40
190	–	–	–	–	60	50	50	40	40
195	–	–	–	–	60	50	50	40	40
200	–	–	–	–	60	50	50	40	40
205	–	–	–	–	60	50	50	40	40
210	–	–	–	–	60	50	50	40	40
215	–	–	–	–	60	50	50	40	40
220	–	–	–	–	60	50	50	40	40
225	–	–	–	–	60	50	50	40	40
230	–	–	–	–	60	60	50	40	40
235	–	–	–	–	60	60	50	40	40
240	–	–	–	–	60	60	50	50	40
245	–	–	–	–	60	60	50	50	40
250	–	–	–	–	60	60	50	50	40
255	–	–	–	–	60	60	50	50	40
260	–	–	–	–	60	60	50	50	40
265	–	–	–	–	–	60	50	50	40
270	–	–	–	–	–	60	50	50	40
275	–	–	–	–	–	60	50	50	40
280	–	–	–	–	–	60	50	50	40
281	–	–	–	–	–	60	50	50	40

Insulation thickness for R150 steel structure

Design temperature [°C]	Fire resistance period 150 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	40	30	25	20	20	20	20	20	20
50	40	30	30	20	20	20	20	20	20
55	40	40	30	25	20	20	20	20	20
60	50	40	40	30	25	20	20	20	20
65	50	50	40	40	30	20	20	20	20
70	50	50	50	40	40	25	20	20	20
75	60	50	50	40	40	30	25	20	20
80	60	60	50	50	40	40	30	20	20
85	60	60	50	50	50	40	30	25	20
90	–	60	60	50	50	40	40	30	20
95	–	60	60	50	50	40	40	30	25
100	–	–	60	60	50	50	40	40	25
105	–	–	60	60	50	50	40	40	30
110	–	–	–	60	60	50	50	40	30
115	–	–	–	60	60	50	50	40	40
120	–	–	–	–	60	50	50	40	40
125	–	–	–	–	60	60	50	40	40
130	–	–	–	–	60	60	50	50	40
135	–	–	–	–	60	60	50	50	40
140	–	–	–	–	60	60	50	50	40
145	–	–	–	–	–	60	50	50	40
150	–	–	–	–	–	60	50	50	40
155	–	–	–	–	–	60	60	50	50
160	–	–	–	–	–	60	60	50	50
165	–	–	–	–	–	60	60	50	50
170	–	–	–	–	–	60	60	50	50
175	–	–	–	–	–	60	60	50	50
180	–	–	–	–	–	–	60	50	50
185	–	–	–	–	–	–	60	50	50
190	–	–	–	–	–	–	60	50	50
195	–	–	–	–	–	–	60	50	50
200	–	–	–	–	–	–	60	60	50
205	–	–	–	–	–	–	60	60	50
210	–	–	–	–	–	–	60	60	50
215	–	–	–	–	–	–	60	60	50
220	–	–	–	–	–	–	60	60	50
225	–	–	–	–	–	–	60	60	50
230	–	–	–	–	–	–	60	60	50
235	–	–	–	–	–	–	60	60	50
240	–	–	–	–	–	–	60	60	50
245	–	–	–	–	–	–	60	60	50
250	–	–	–	–	–	–	60	60	50
255	–	–	–	–	–	–	60	60	50
260	–	–	–	–	–	–	–	60	50
265	–	–	–	–	–	–	–	60	50
270	–	–	–	–	–	–	–	60	50
275	–	–	–	–	–	–	–	60	50
280	–	–	–	–	–	–	–	60	50
281	–	–	–	–	–	–	–	60	50

Insulation thickness for R180 steel structure

Design temperature [°C]	Fire resistance period 180 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	40	40	40	30	20	20	20	20	20
50	50	40	40	40	25	20	20	20	20
55	50	50	40	40	40	25	20	20	20
60	60	50	50	50	40	30	25	20	20
65	60	60	50	50	50	40	30	20	20
70	60	60	60	50	50	40	40	30	20
75	–	60	60	60	50	50	40	40	25
80	–	–	60	60	60	50	50	40	30
85	–	–	–	60	60	50	50	40	40
90	–	–	–	–	60	60	50	50	40
95	–	–	–	–	60	60	50	50	40
100	–	–	–	–	–	60	60	50	50
105	–	–	–	–	–	60	60	50	50
110	–	–	–	–	–	–	60	50	50
115	–	–	–	–	–	–	60	60	50
120	–	–	–	–	–	–	60	60	50
125	–	–	–	–	–	–	60	60	50
130	–	–	–	–	–	–	–	60	50
135	–	–	–	–	–	–	–	60	60
140	–	–	–	–	–	–	–	60	60
145	–	–	–	–	–	–	–	60	60
150	–	–	–	–	–	–	–	60	60
155	–	–	–	–	–	–	–	60	60
160	–	–	–	–	–	–	–	60	60
165	–	–	–	–	–	–	–	60	60
170	–	–	–	–	–	–	–	–	60
175	–	–	–	–	–	–	–	–	60
180	–	–	–	–	–	–	–	–	60
185	–	–	–	–	–	–	–	–	60
190	–	–	–	–	–	–	–	–	60
195	–	–	–	–	–	–	–	–	60
200	–	–	–	–	–	–	–	–	60
205	–	–	–	–	–	–	–	–	60
210	–	–	–	–	–	–	–	–	60
215	–	–	–	–	–	–	–	–	60
220	–	–	–	–	–	–	–	–	60
225	–	–	–	–	–	–	–	–	60
230	–	–	–	–	–	–	–	–	60
235	–	–	–	–	–	–	–	–	60
240	–	–	–	–	–	–	–	–	60
245	–	–	–	–	–	–	–	–	60
250	–	–	–	–	–	–	–	–	60
255	–	–	–	–	–	–	–	–	–
260	–	–	–	–	–	–	–	–	–
265	–	–	–	–	–	–	–	–	–
270	–	–	–	–	–	–	–	–	–
275	–	–	–	–	–	–	–	–	–
280	–	–	–	–	–	–	–	–	–
281	–	–	–	–	–	–	–	–	–

Insulation thickness for R210 steel structure

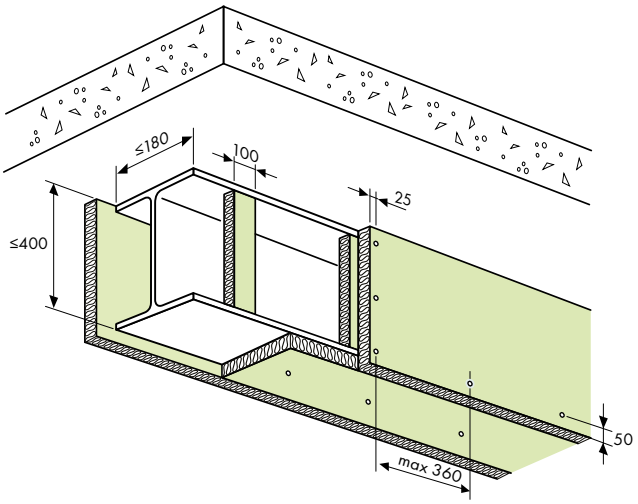
Design temperature [°C]	Fire resistance period 210 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	50	50	50	40	40	30	20	20	20
50	50	50	50	50	40	40	25	20	20
55	60	60	50	50	50	40	40	25	20
60	60	60	60	60	50	50	40	40	25
65	–	–	60	60	60	50	50	40	40
70	–	–	–	–	60	60	50	50	40
75	–	–	–	–	–	60	60	50	50
80	–	–	–	–	–	–	60	60	50
85	–	–	–	–	–	–	60	60	50
90	–	–	–	–	–	–	–	60	60
95	–	–	–	–	–	–	–	60	60
100	–	–	–	–	–	–	–	–	60
105	–	–	–	–	–	–	–	–	60
110	–	–	–	–	–	–	–	–	60
115	–	–	–	–	–	–	–	–	60
120	–	–	–	–	–	–	–	–	–
125	–	–	–	–	–	–	–	–	–
130	–	–	–	–	–	–	–	–	–
135	–	–	–	–	–	–	–	–	–

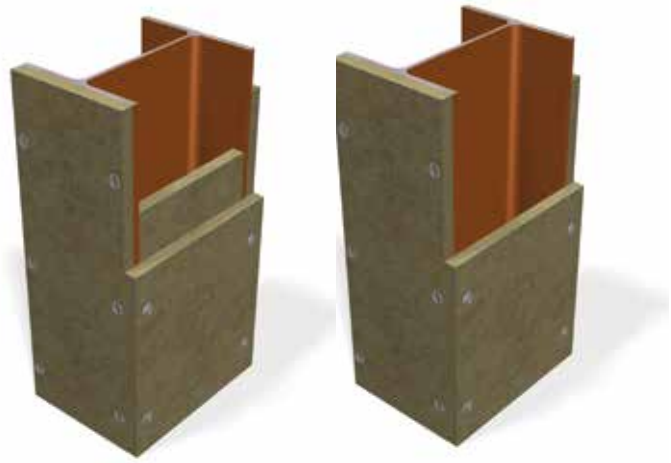
Insulation thickness for R240 steel structure

Design temperature [°C]	Fire resistance period 240 minutes								
	300	350	400	450	500	550	600	650	700
Section factor [m^{-1}]	Thickness in mm of fire protection material to maintain steel temperature below design temperature								
47	60	60	50	50	50	50	40	25	20
50	60	60	60	60	50	50	50	40	20
55	–	–	60	60	60	60	50	50	40
60	–	–	–	–	–	60	60	60	50
65	–	–	–	–	–	–	–	60	60
70	–	–	–	–	–	–	–	–	60
75	–	–	–	–	–	–	–	–	60
80	–	–	–	–	–	–	–	–	–

INSTALLATION

1. The insulation is fastened by PAROC Head Pin or welding steel pins (Ø 2,7 mm) with washers (Ø 30 mm).
2. Pins are fastened maximum 50 mm in from each joint.
3. The maximum distance between fasteners is 360 mm.
4. For flanges with a width of 180 mm or below minimum one pin should be used placed in the centre of the board. In total this means 4 pins per insulation board.
   For flanges with a width above 180 mm two pins should be used placed in each side 50 mm in from the edge of the flange, corresponding to a total of 8 pins per insulation board.
5. Behind the horizontal joints in each side board, a 100 mm wide butt joint board shall be placed. Consisting of the same insulation board with the same thickness and in the height fitting the space between the upper and lower flange. The butt joint board is mounted to each side boards with special fire springs PAROC XFS 001. The springs should be placed in the centre of each profile with a height of 400 mm or lower and for profiles with a height above 400 mm two springs should be placed in the 1/3 point and 2/3 point.
6. Both boards are cut over-sized so they fit tight. No glue or equal is needed.
7. All edges of the profile are fully covered by the boards.
8. At installation on beams the boards on the sides shall cover the bottom layer boards and not vice versa.
9. No openings in fire protection are allowed.





PAROC XFS 001 Fire spring

PAROC Head Pin

- Fire protection made by inorganic stone wool is very durable. Maintenance is only needed if there will be some impact damage. Damage is very easy to repair just by changing the current part of the insulation.
- PAROC FPS 17 system shall be used in indoor spaces with normal indoor temperature and moisture conditions.

INSTALLATION OF PAROC FPS 17

Installation for H & I profiles

1. When installing insulation for H or I profiles, a mounting plate made from the same fire protection insulation must be installed behind the insulation board connections.

2. Cut the mounting board pieces into sections 100 mm wide and long enough to suit the profile. Leave an extra 2–3 mm margin in length. Always use boards of the same width that were used earlier for the profile. Instructions for installing the mounting plate to the fire protection insulation are shown on the previous page.

Welding

3. Ensulation is fixed using the PAROC head pins or similar base plate (Ø 30 mm) head pins (Ø 2.7 mm). The head pins chosen should be 2–3 mm longer than the insulation thickness.

4. The insulation board must form a uniform corner with the steel profile. No steel sections should be visible. Please refer to the welding device instructions for installing the head pins in the correct manner.

5. Welding is performed using the PAROC pin welding device or similar devices intended for the task. The head pin is a steel pin coated in copper that includes a head plate.

Installation of RHS-profiles

Insulation should be fixed to the top of RHS profiles by butt welding.

The steel pins are fixed at intervals of less than 360 mm and less than 50 mm from joints in the insulation.

Product information of PAROC FPS 17

Property	Standard
Width x Length: 600 x 1200 mm	EN 822
Thickness: 20–120 mm Tolerances: T5; EN12 162	EN 823
Reaction to Fire: A1	EN 13 501-1
Thermal conductivity: λD = 0,038 W/mK	EN 13 162

Application

An effective fire protection board especially intended for insulating steel and concrete structures, and for fire retardant doors.

Package type

Plastic Packages on a Pallet or Loose Product on a Pallet.

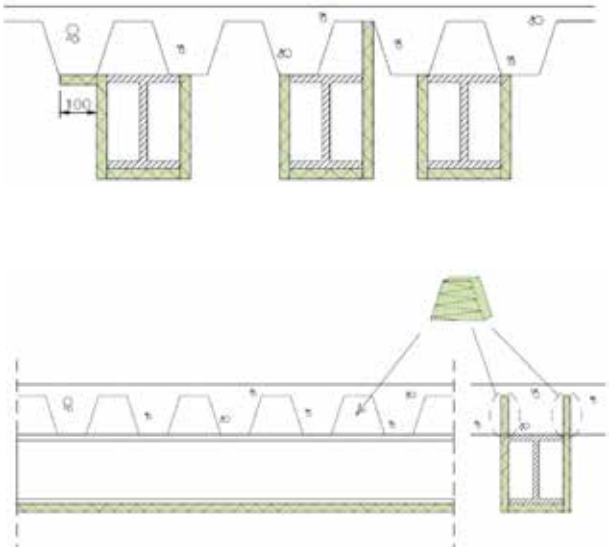
CONNECTION DETAIL

When the fire protected steel beam is mounted under a composite steel deck the following construction details shall be taken into account. It should be noted that fire protection of the load-bearing trapezoidal steel sheet and fire protection of the load bearing beam shall always be considered separately.

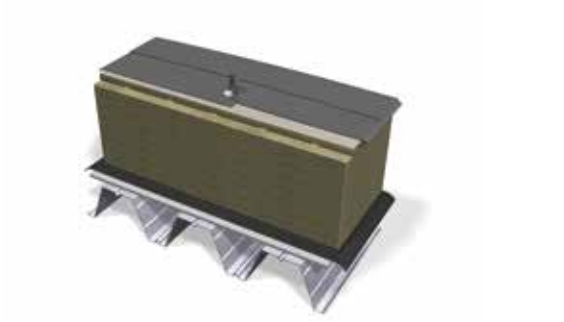
The fire protection board has to be installed tightly against the deck. No gaps are allowed.

In case of a gap in the corrugation of the adjoining corrugated deck, a fire insulation of width of 100 mm shall be fixed adjacent to the fire insulating board on the profile.

If the profile is installed across the corrugated steel deck, precut pieces of the same insulation are pressed into the corrugation before the installation of the fire insulation on the vertical side of the profile. Pieces should be glued to the metal sheet with fire resistant sealant or similar.



ROOF STRUCTURES



Steel trapezoid roofs are widely used for different kind of buildings. These roofs usually consist of steel beams, steel trapezoid profile, vapor barrier, thermal insulation and roof membrane. As the each component in this structure has very different fire behavior it is better to test the whole system to see how it behaves in fire.

The load-bearing capacity of trapezoid steel without fire protection is about 15–30 min minutes depending on the structure. The steel sheet bends but the load-bearing capability remains longer. When there is no insulation used on top of the load bearing steel sheet, the heat goes through the metal and dissipates upwards and the steel temperature rises slower. When insulation is installed on top of the steel sheet, the temperature of the metal rises very quickly. This is why you need to take into account the insulation amount above the corrugated steel sheet when designing the fire protection thickness below the corrugated steel construction.

As a supporting shell, steel trapezoid profile shall usually be protected from the fire to prevent premature failure of the entire roof structure.

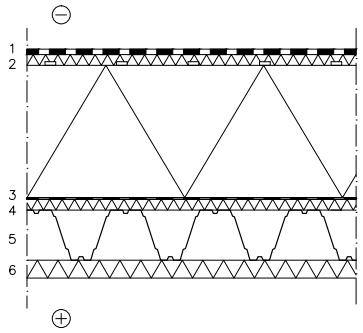
Fire protection of trapezoid steel sheet
As insulation above the metal sheet effects to fire resistance test result, it is not possible to get classification only for the fire protective product beneath of the structure. The test has to be done for the whole construction. Paroc roof solution has been tested according to EN 1365-2:2014 and classification according to EN 13501-1:2007 + A1:2009.

FIRE RESISTANCE CLASS RE 60 / REI 60

1. PVC or bitumen membrane
2. **30 mm PAROC ROB 100**
   200 mm PAROC ROL 30
   fixed to metal sheet by SFS Intect ISO-TAK RP45 BS-S-4,8 or similar
3. Vapor barrier (for example 4 mm thick bitumen membrane)
4. **30 mm PAROC Robster**
5. Trapezoidal steel sheet (T130M-75L-930 steel thickness 0,7 mm joined together with self-drilling screws, SD3-T154,8x19 in spacing of 300 mm)
6. **50 mm PAROC FPS 17** (fixed to steel sheet by using self-drilling screws Intect BS 4,8x70 with washers PAROC XFW 003, 6 pc/board)

The distance of the screw from the edge of the fire protection board shall be ≤ 100 mm. The exact location of the screw should be evaluated on a case-by-case basis according to the used trapezoid steel sheet. The screws should be installed as far as possible from each other.

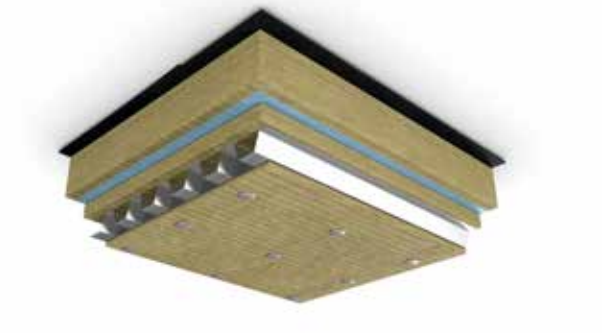
Due to cavities in steel sheet in area of partition walls, penetrations and roof ends, corrugations has to be sealed separately on both sides of the joint tightly by using precut pieces of PAROC FPS 17 or PAROC ROX 2 products. Pieces should be glued to the metal sheet with fire seal or similar.



Design conditions:

- Max distance of load bearing beams underneath is 4 m
- Trapezoidal steel sheet is fixed to the load bearing structure
- Applied load in the test was 0,9 kN/m^2
- It is allowed to increase the thickness of thermal insulation
- Slope of the roof within range of 0–15°

Note: The failure limit in fire test for deflection is 312,5 mm/ 44 mm/min.

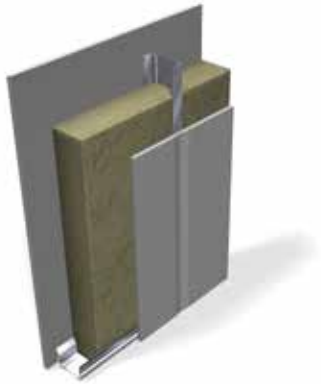


FIRE PARTITIONS WITH STEEL FRAME

Light weight fire partitioning walls are typically constructed of plaster board partitions. Fire-rated partitions are internal walls that provide vertical fire separation in structures such as dividing walls. These walls are typically non-load bearing. A fire-rated partition is a partition for which the fire resistance performance has been determined according to the appropriate European standards. Similarly, the reaction to fire performance of the exposed surfaces is also determined by the appropriate fire test standards. The requirement to determine the fire resistance and the reaction to fire performance of a partition is stated in national building regulations.

Once a fire has become fully developed it attacks the structure of the compartment and tries to spread beyond the compartment of origin. A fire-rated (fire-resisting) partition prevents this by creating a structure (i.e., a compartment) which does not collapse and contains the fire for a given period of time. It is necessary to determine the fire resistance of the partition by assessing the behavior when subjected to defined heating and pressure conditions, which may be encountered in a fully developed fire.

Fire resistance tests employ a standard temperature/time curve, and pressure distribution for this purpose. The fire resistance of such partitions ranges from 30 to 240 minutes (or more). Paroc has an ETA 07/0071 for non-load bearing partitions with steel frames for fire resistance classes EI 60 and EI 90. Tests has been done according to EN 1364-1:1999 and classification according to EN 13501-2:2007+A1:2009. The assessment of airborne sound insulation is based on EN-ISO 140-3 and EN-ISO 717-1.



- 12.5 mm gypsum board (normal)
- 66–95 mm steel frame, cc 600 mm, t = 0.46 mm/ 66–100 mm **PAROC eXtra**
- 12.5 mm plaster board (normal)

Max height of the wall 4 m

Fire resistance class EI 60

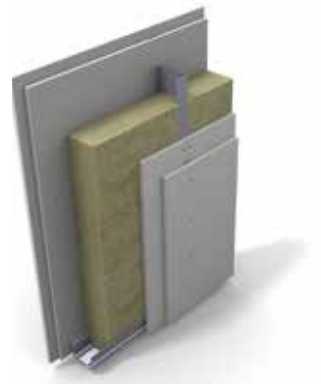
Sound insulation

66 mm

R_W	=	**40 dB**
$R_W + C5_{0-3150}$	=	**37 dB**

95 mm

R_W	=	**45 dB**
$R_W + C_{50-3150}$	=	**40 dB**
$R`_W$	=	**36 dB**
$R`_W + C_{50-3150}$	=	**32 dB**



- 2 layers of 12.5 mm gypsum board (normal, overlapped seams)
- 95–100 mm steel frame, cc 600 mm, t = 0.46 mm/ 95–100 mm **PAROC eXtra**
- 2 layers of 12.5 mm plaster board (normal, overlapped seams)

Max height of the wall 4 m

Fire resistance class EI 90

Sound insulation

R_W	=	**55 dB**
$R_W + C_{50-3150}$	=	**48 dB**
$R`_W$	=	**44 dB**
$R`_W + C_{50-3150}$	=	**40 dB**

- 2 layers of 12.5 mm gypsum board (normal, overlapped seams)
- 66–70 mm steel frame, cc 600 mm, staggered in 95–100 mm ceiling and floor profile.
  95–100 mm **PAROC eXtra**
- 2 layers of 12.5 mm plaster board (normal, overlapped seams)

Max height of the wall 4 m

Fire resistance class EI 90

Sound insulation

R_W	=	**58 dB**
$R_W + C_{50-3150}$	=	**51 dB**
$R`_W$	=	**48 dB**
$R`_W + C_{50-3150}$	=	**44 dB**

Ceiling or floor profile 140–150 mm

- 2 layers of 12.5 mm gypsum board (normal, overlapped seams)
- 2 x 60–70 mm steel frame, cc 600 mm, air gap between the studs
  2 x 66–70 mm **PAROC eXtra**
- 2 layers of 12.5 mm plaster board (normal, overlapped seams)

Max height of the wall 4 m

Fire resistance class EI 90

Sound insulation

R_W	=	**63 dB**
$R_W + C_{50-3150}$	=	**56 dB**
$R`_W$	=	**56 dB**
$R`_W + C_{50-3150}$	=	**52 dB**

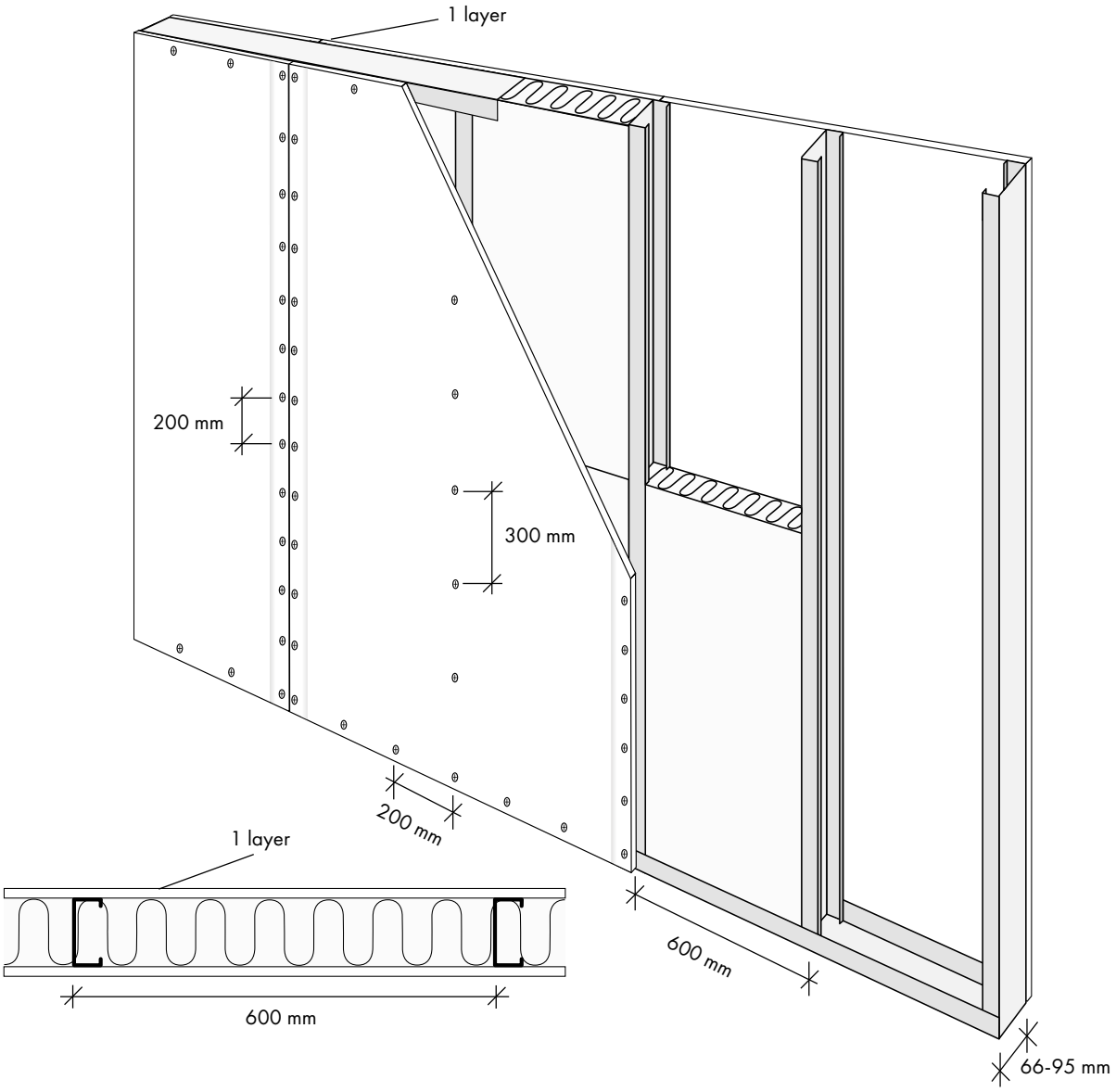
INSTALLATION

General structure and connections shall be done according to steel frame manufacturer`s instructions.

Insulation shall be installed to fulfil the cavity totally. Insulation slabs shall be supported in place with 4.2 x 38 mm screws 2 pcs/slab, on the plain side of the steel stud.

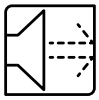
Distance between screws used for gypsum boards shall be max. 200 mm on sides and in the middle of the board 300 mm. Length of the screw depends on the amount of gypsum board layers; with one layer L = 25 mm and two layers L = 35 mm.

The tightening between the partition and ceiling and floor shall be done according to the installation instructions of the gypsum board manufacturer with stone wool and non-combustible sealant. The tightening shall also be done for possible gaps like electrical installations to secure the air tightness of the gap.



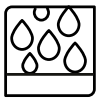
DURABLE

REUSABLE



SOUND REDUCING

FIRE PROOF



MOISTURE PROOF

SAFE

ENERGY EFFICIENT

PAROC® stands for energy-efficient and fire safe insulation solutions of stone wool for new and renovated buildings, marine and offshore, acoustics and other industrial applications. Behind those products, there is an 80-year history of stone wool production knowhow backed with technical insulation expertise and innovation.

Building Insulation offering covers a wide range of products and solutions for all traditional building insulation. The building insulation products are mainly used for the thermal, fire and sound insulation of exterior walls, roofs, floors and basements, intermediate floors and partitions. Sound absorbing ceilings and wall panels for interior acoustic control, as well as industrial noise control products, are available in the range.

Technical Insulation offering includes thermal, fire and sound insulation in HVAC systems, industrial processes and pipework, industrial equipment as well as shipbuilding and offshore industry.

For more information please visit ***www.paroc.com***

November 2019
2081BIEN1119

OWENS CORNING PAROC