ISOVER
SAINT-GOBAIN

The Passive Fire Protection Handbook I

Structural steel – Corrugated steel – Concrete

SAINT-GOBAIN

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1. PROTECTION OF STRUCTURAL STEEL

FIRE PROTECTION INCREASE OF STRUCTURAL STEEL

Fire has become one of the greatest threats to buildings. It threatens and kills human beings, destroys properties and also leads to expensive production stoppages and high costs for consequential damage. The bearing capacity of a steel structure is substantially reduced if temperature rises due to fire. The temperature which the structure will reach in a fire will depends on the location, its size and a passive fire protection of structural steel members. ISOVER FireProtect® is a simple and reliable system that limits the temperature rise in the steel, therefore helps to save lives and protect property in the event of fire. Typical structures commonly designed using advantages of load-bearing capacities of steel are sports stadia, offices, industrial buildings, airport terminals, leisure centres, hospitals and shopping centres.

Fire protection cladding ISOVER FireProtect®

The ISOVER FireProtect system provides very efficient fire protection for structural steel. It is a quick, simple and secure system with easily worked materials and simple fixing equipment, which is assembled without complicated, expensive installation tools.

Fire classification

Fire protection system ISOVER FireProtect® was officially tested in PAVUS, a.s., authorized body AO 216. Based on proven modern and innovative system design it is possible to protect both steel columns and beams up to fire resistance R 180 within design temperatures 450 – 700 °C, for section factor up to A_p/V = 716 m^{-1}. Classification according to the latest standard EN 13501-2: 2016, testing based on EN 13381-4: 2013.

Why use ISOVER FireProtect®?

Features	Benefits
Fulfills EN 13381-4:2013	Superior fire resistance
Euroclass A1 fire rating according to EN 13501-1	Totally non-combustible, top level reaction to fire performance
Up to 5 times lighter than conventional solutions	Easy to handle
Easy to cut and fit	Standard insulators knife can be used
Fast installation	Dry way of assembly without need to use paint and glue
Off-cuts can be used	Minimises wastes on site
No need for pre-fabrication	Cost savings
High quality stone wool	Will not absorb moisture from the surrounding air and is chemically inert – will not accelerate corrosion of steel Performance will not deteriorate over time – long product life, no ageing of product Superior thermal insulation properties (low thermal conductivity)

Fixing materials and tools:

- slabs ISOVER FireProtect® 150
- Fire Screws
- stud-welded pins or pins and washers as required
- standard laggers knife
- screwdriver (preferably battery-powered) or equipment with welding gun
- rubber hammer

Figure 1. Tools to be used for mounting ISOVER FireProtect®

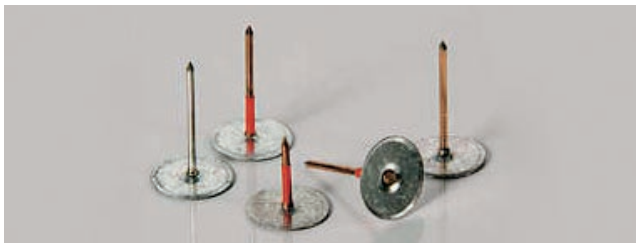
Fire Screws

Fire Screw are available in different lengths. The screw must be at least twice as long as the insulation thickness.

Length (mm)	Pcs / Packing
40	1000
60	1000
80	1000
100	500
120	500
140	500
160	200
180	200
200	200

Stud-welded pins or pins and washers

Pins have a diameter of 2.7 mm and the washer's diameter is 30 mm.



Slabs ISOVER FireProtect® 150

The production of stone wool slabs is based on the defibering of molten raw materials consisting of minerals and different amounts of artificial resins as binders, mineral oils for dust suppression and hydrophobic means. Behaviour with stainless austenitic steels – AS quality for this application according to AGI Q 132, EN 13468 and ASTM C 795. Fibres are hydrophobic according to EN 1609.

Technical parameters:

Designation code: MW – EN 14303 – T5 – CS(10)20 – ST(+)700 – WS1 – CL10

Thickness (mm)	Slabs are stored on a pallet		Packages on a pallet				
	Dimensions (mm)	m² / Pallet	Dimensions (mm)	m² / Pallet	m² / Package	Package / Pallet	Slabs / Package
20	1000 × 1200	72.00	600 × 1200	86.40	8.64	10	12
25	1000 × 1200	57.60	-	-	-	-	-
30	1000 × 1200	48.00	600 × 1200	60.48	5.04	12	7
40	1000 × 1200	36.00	600 × 1200	43.20	4.32	10	6
50	1000 × 1200	28.80	600 × 1200	34.56	2.88	12	4
60	1000 × 1200	24.00	600 × 1200	28.80	2.88	10	4
80*	1000 × 1200	19.20	600 × 1200	21.60	2.16	10	3
100*	1000 × 1200	14.40	600 × 1200	17.28	1.44	12	2

Other thicknesses and dimensions then stated can be produced at request when fulfilling minimum volume. Thickness tolerance: ±1 mm, width tolerance: ±5 mm, length tolerance: ±8 mm. * Minimal volume need to be consulted with a producer.

Parameter			Unit	Value								Standard
THERMAL INSULATING PROPERTIES												
Declared value of the thermal conductivity coefficient λ_D according to EN ISO 13787			°C	10	40	50	100	150	200	250	300	
			$W \cdot m^{-1} \cdot K^{-1}$	0.036	0.039	0.041	0.047	0.053	0.060	0.068	0.077	
Measured value of the thermal conductivity coefficient according to EN 12667			$W \cdot m^{-1} \cdot K^{-1}$	0.034	0.038	0.040	0.045	0.052	0.058	0.066	0.074	
Maximum service temperature			°C	700								EN 14706
Specific heat capacity c_d			$J \cdot kg^{-1} \cdot K^{-1}$	800								-
PHYSICAL PROPERTIES												
Density (thickness 20 and 25 mm)			$kg \cdot m^{-3}$	165								EN 1602, EN 13470
Density (thickness ≥ 30 mm)			$kg \cdot m^{-3}$	150								EN 1602, EN 13470
Short term water absorption W_p			$kg \cdot m^{-2}$	<< 1								EN 1609
Diffusion resistance factor			-	1,0								EN 12086
Flow resistance Ξ			$kPa \cdot s \cdot m^{-2}$	> 90								EN 29053
FIRE SAFETY PROPERTIES												
Reaction to fire			-	A1								EN 13501-1
Melting temperature t_t			°C	≥ 1000								DIN 4102 part 17
ADDITIONAL PROPERTIES												
Acoustic absorption coefficient α for perpendicular impact of acoustic waves (-) according to EN ISO 354 and EN ISO 11654	Frequency		Hz	125	250	500	1000	2000	4000			
	Thickness	20	mm	0.05	0.20	0.55	0.85	0.95	1.00			
		40	mm	0.20	0.65	0.90	0.90	0.95	0.95			
		60	mm	0.25	0.65	0.80	0.85	0.90	0.95			
		100	mm	0.40	0.70	0.85	0.95	0.95	0.95			
Definition of single number value according to EN ISO 11654	Single number value		-	α_w		NRC		Absorption class				
	Thickness	20	mm	0.50 (M, H)		0.65		D				
		40	mm	0.90		0.85		A				
		60	mm	0.85		0.90		B				
		100	mm	0.90		0.85		A				

FIXING

There are two possibilities how to fix slabs ISOVER FireProtect® 150 to the steel members:

- with Fire Screws in length corresponding to double the insulation thickness,
- with stud-welded pins or pins and washers, where diameter of the pin is 2.7 mm and diameter of the washer is 30 mm.

Both methods can be also combined.

Use of Fire Screws

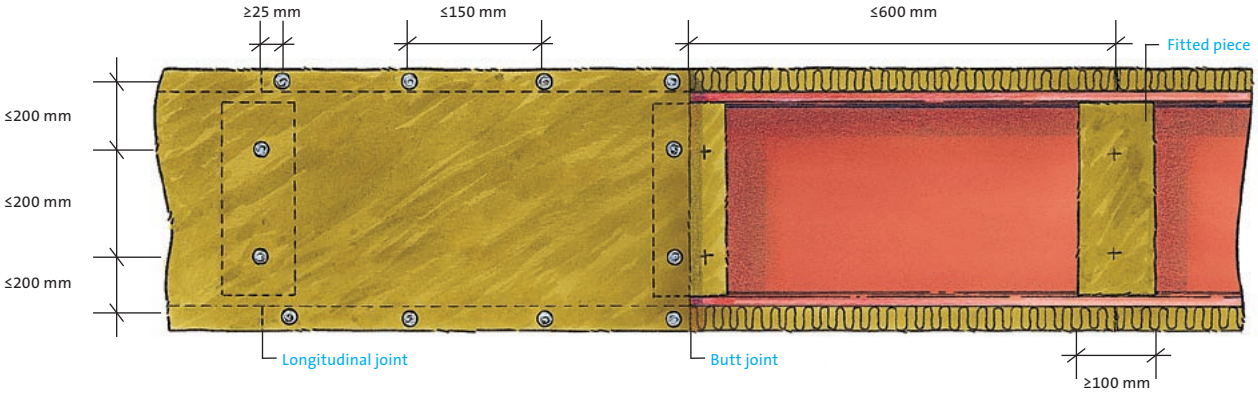
Fixing of slabs to fitted pieces

Fixing of fire protective slabs ISOVER FireProtect® 150 is done with Fire Screws to fitted pieces from the same slab of width 100 mm and length corresponding to the distance between flanges plus 2 – 3 mm. However, a minimum slab thickness of 40 mm must be used for the fitted pieces. Maximum spacing is 600 mm. Maximum distance between Fire Screws and from axis of connected slab is 200 mm.

Fixing of slabs at the corners

Adjacent slabs are at the corners connected by Fire Screws at distances 150 mm, first Fire Screw is positioned at least 25 mm from edge of the slab.

Placement of the Fire Screws



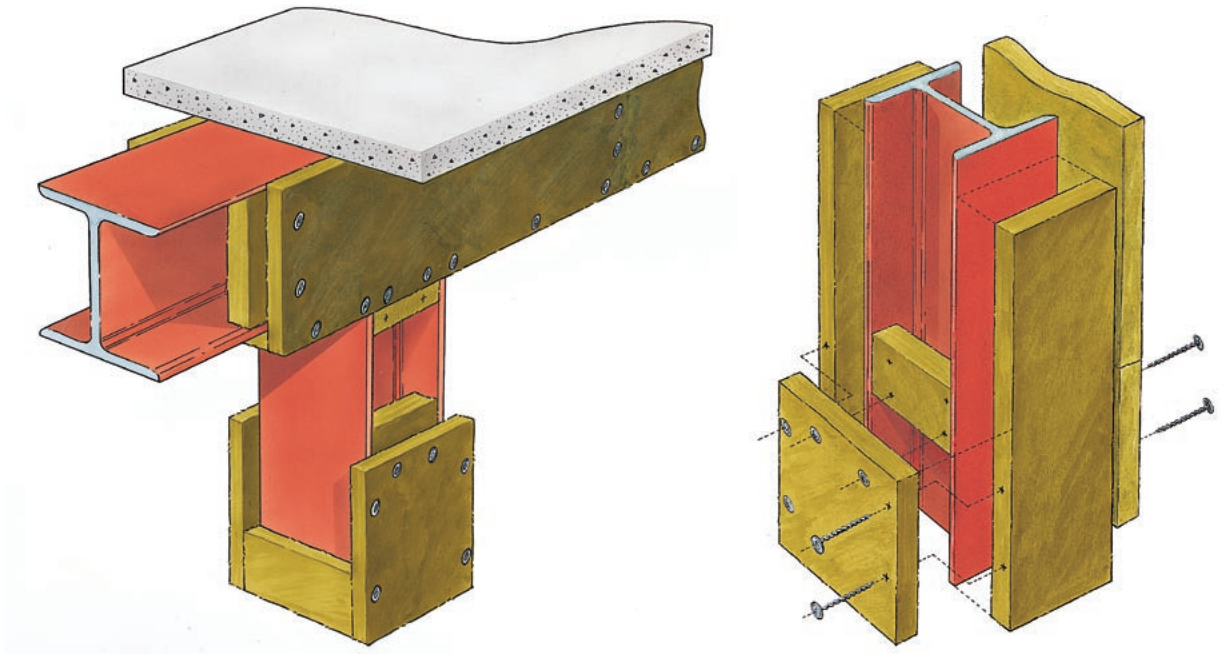


Fig. 2 Installation of ISOVER FireProtect® with Fire Screws

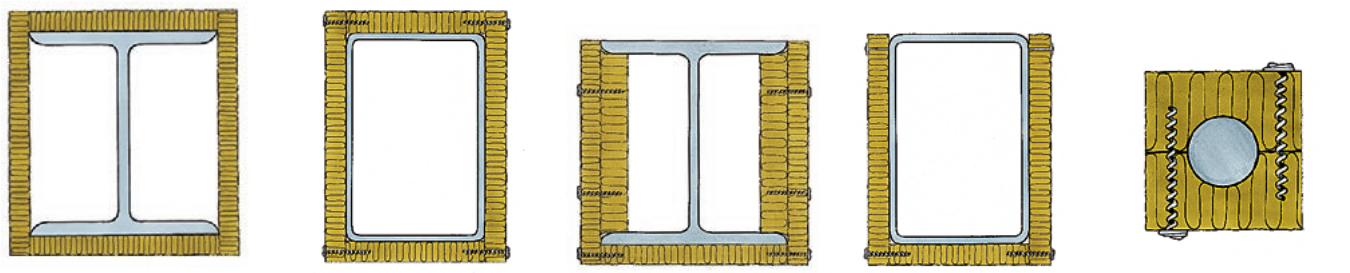


Figure 3. Position of the fixations

In the case of closed beams insulated with 3-sided cladding the upper row of Fire Screws is replaced with pins fixed to the top flange of the beam. For I-beam it is possible to use pins or Fire Screws.

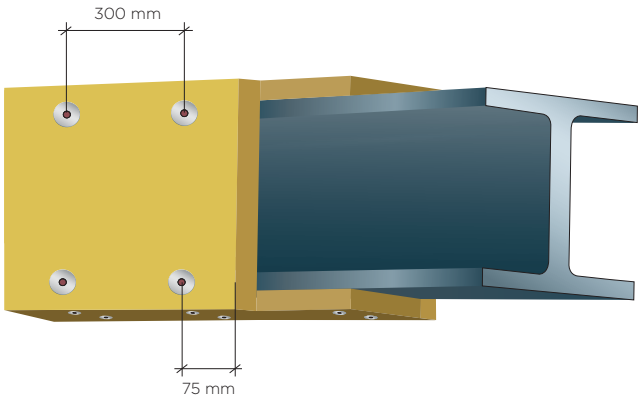


Figure 4. Fixing of ISOVER FireProtect® with pins

Use of pins

Slabs are fixed with welding pins in maximum distance of 300 mm. Maximum distance from the cladding's edges is 75 mm.

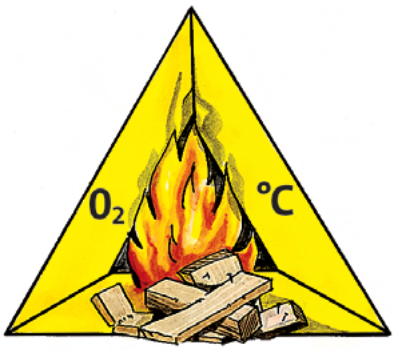
Figure 5. Both methods can be also combined – important is to keep the distances (between pins 300 mm and between Fire Screws 150 mm)

What happens in a fire?

A fire is a blaze which is out of control. The design of steel structures must take account of the reduction in strength of the steel due to temperature loads in the event of fire.

Fire

Fire is a combustion process that liberates heat and light. Combustible material, oxygen and heat must be present to feed the fire. If one of the three is absent, the fire goes out.



Progress of a fire

The progress of a fire in a building is determined first and foremost by the quantity of combustible material. The oxygen supply is also highly significant. The progress of a normal fire can be described as shown in fig. 6.

The ignition phase is the most important phase from a safety point of view. It is during this phase that it is possible to make rescue efforts and extinguish the fire.

The temperature rises quickly, and combustible materials emit flammable gases and smoke. When the flammable gases reach their flashpoint, flashover can occur.

The flame phase starts when flashover occurs. People in the room at that time have little chance of leaving alive, and the rescue teams have little chance of extinguishing the fire. In the flame phase, the temperature reaches a maximum of around 1000 °C. Fire insulation of structural steelwork ensures that the building does not collapse.

In the cooling phase, or rather the glowing phase, the carbonised remnants and embers usually emit strong radiant heat. Even during this phase, the fire insulation protects the steel structures from harmful temperature rises.

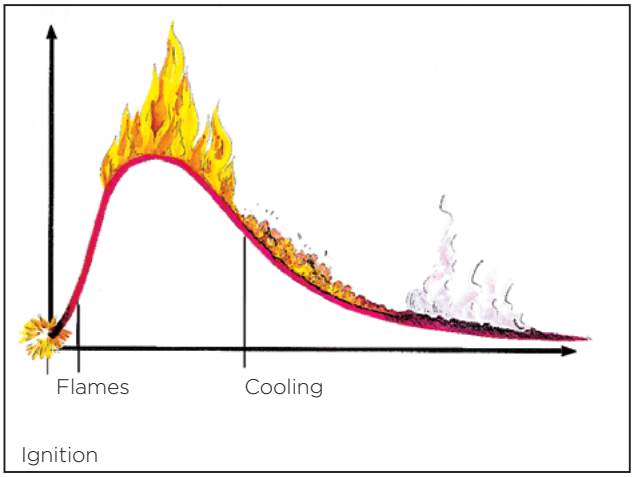


Figure 6. Progression of a fire (in a building)

Non-combustible materials

The combustibility of a material is determined in accordance with an international fire testing method (EN ISO 1182 and EN ISO 1716).

Slabs ISOVER FireProtect® 150 contains so little flammable binder that in practice it does not contribute to the fire. Therefore, the material is classified as non-combustible with reaction to fire A1 according to EN 13501-1.

Steel strength

Steel strength is reduced at high temperatures. The critical temperature is the temperature at which yield stress occurs in the steel. The critical temperature of the steel therefore depends on the degree to which its strength is used structurally.

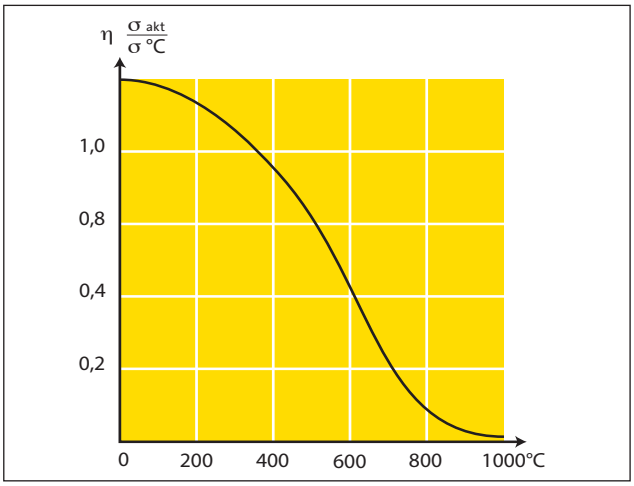


Figure 7. The strength of the steel as a function of the temperature

Steel structures

In the design of a steel structure, consideration must be given to how the steel would be affected under the influence of fire, causing the tension in the steel to decrease with increasing temperature. ISOVER FireProtect® is a very efficient system for limiting temperature rise of the supporting steel structure, thus prolonging its fire resistance.

Fire resistance

Coarse structures have the best fire resistance. How quickly a steel structure is heated in a given fire is measured by the ratio of profile steel fire exposed surfaces and profile heat capacity. This relationship is expressed through the so-called section factor, A_p/V. Ap is the internal perimeter of the insulation in meters, V is the steel cross-sectional area in m^2. Examples of profiles with a low section factor are HEB and HEM. High section factor means quick heating of the steel. This means that slender structural steel requires thicker fire insulation.

Calculation

The fire resistance of a steel structure is calculated on the basis of the critical steel temperature. Calculation of the critical steel temperature is based on steel cross-section load ratio.

Normally, you can calculate the required insulation thickness at the critical steel temperature of 500 °C. You can check with the designer for that project on the critical steel temperature for the different structures and find out if it is higher compared to the amount of steel used in a normal situation. A higher critical steel temperature of the steel will require thinner insulation thickness. More information can be found in EN 1993-1-2: Eurocode 3: Design of steel structures – Part 1-2: General rules - Structural fire design.

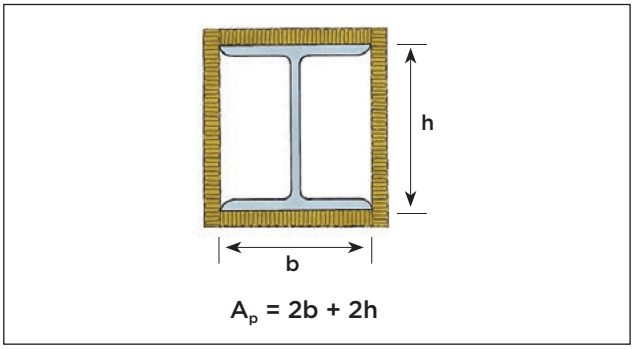
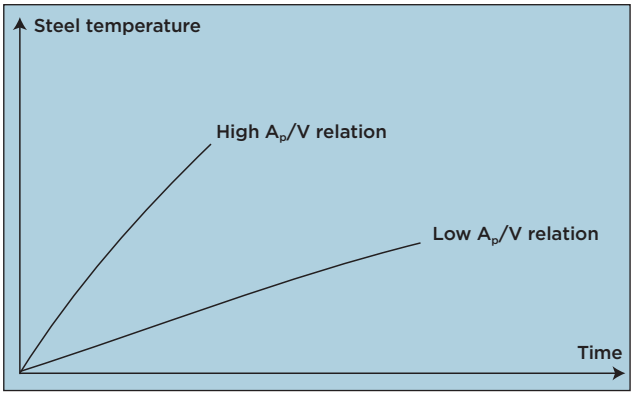


Figure 8. Examples of profiles with a low section factor are HEB and HEM. High section factor means quick heating of the steel. This means that slender structural steel requires thicker fire insulation.

Section factor
A_p = internal perimeter of the insulation (m)
V = steel cross-sectional area (m^2)

Rising of steel temperature



Fire resistance 30 min

	Design temperature (°C)								
	450	500	525	550	560	600	620	650	700
Section factor (m^{-1})	Fire protection thickness (mm) to keep steel temperature under design temperature								
≤ 50	20	20	20	20	20	20	20	20	20
60	20	20	20	20	20	20	20	20	20
70	20	20	20	20	20	20	20	20	20
80	20	20	20	20	20	20	20	20	20
90	20	20	20	20	20	20	20	20	20
100	20	20	20	20	20	20	20	20	20
110	20	20	20	20	20	20	20	20	20
120	20	20	20	20	20	20	20	20	20
130	20	20	20	20	20	20	20	20	20
140	20	20	20	20	20	20	20	20	20
150	20	20	20	20	20	20	20	20	20
160	20	20	20	20	20	20	20	20	20
170	20	20	20	20	20	20	20	20	20
180	20	20	20	20	20	20	20	20	20
200	20	20	20	20	20	20	20	20	20
200	20	20	20	20	20	20	20	20	20
210	20	20	20	20	20	20	20	20	20
220	20	20	20	20	20	20	20	20	20
230	20	20	20	20	20	20	20	20	20
240	20	20	20	20	20	20	20	20	20
250	20	20	20	20	20	20	20	20	20
260	20	20	20	20	20	20	20	20	20
270	20	20	20	20	20	20	20	20	20
280	20	20	20	20	20	20	20	20	20
290	20	20	20	20	20	20	20	20	20
300	20	20	20	20	20	20	20	20	20
310	20	20	20	20	20	20	20	20	20
320	20	20	20	20	20	20	20	20	20
330	20	20	20	20	20	20	20	20	20
340	20	20	20	20	20	20	20	20	20
350	20	20	20	20	20	20	20	20	20
360	20	20	20	20	20	20	20	20	20
370	25	20	20	20	20	20	20	20	20
380	25	20	20	20	20	20	20	20	20
390	25	20	20	20	20	20	20	20	20
400	25	20	20	20	20	20	20	20	20
410	25	20	20	20	20	20	20	20	20
420	25	20	20	20	20	20	20	20	20
430	25	20	20	20	20	20	20	20	20
440	25	20	20	20	20	20	20	20	20
450	30	20	20	20	20	20	20	20	20
460	30	20	20	20	20	20	20	20	20
470	30	20	20	20	20	20	20	20	20
480	30	20	20	20	20	20	20	20	20
490	30	20	20	20	20	20	20	20	20
500	30	20	20	20	20	20	20	20	20
510	30	20	20	20	20	20	20	20	20
520	30	20	20	20	20	20	20	20	20
530	30	20	20	20	20	20	20	20	20
540	30	20	20	20	20	20	20	20	20
550	30	20	20	20	20	20	20	20	20
560	40	20	20	20	20	20	20	20	20
570	40	20	20	20	20	20	20	20	20
580	40	25	20	20	20	20	20	20	20
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610	40	25	20	20	20	20	20	20	20
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640	40	25	20	20	20	20	20	20	20
650	40	25	20	20	20	20	20	20	20
660	40	25	20	20	20	20	20	20	20
670	40	25	20	20	20	20	20	20	20
680	40	25	20	20	20	20	20	20	20
690	40	25	20	20	20	20	20	20	20
700	40	25	20	20	20	20	20	20	20
710	40	25	20	20	20	20	20	20	20
716	40	30	20	20	20	20	20	20	20

Fire resistance 45 min

	Design temperature (°C)								
	450	500	525	550	560	600	620	650	700
Section factor (m^{-1})	Fire protection thickness (mm) to keep steel temperature under design temperature								
≤ 50	20	20	20	20	20	20	20	20	20
60	20	20	20	20	20	20	20	20	20
70	20	20	20	20	20	20	20	20	20
80	20	20	20	20	20	20	20	20	20
90	20	20	20	20	20	20	20	20	20
100	20	20	20	20	20	20	20	20	20
110	20	20	20	20	20	20	20	20	20
120	20	20	20	20	20	20	20	20	20
130	20	20	20	20	20	20	20	20	20
140	20	20	20	20	20	20	20	20	20
150	20	20	20	20	20	20	20	20	20
160	20	20	20	20	20	20	20	20	20
180	20	20	20	20	20	20	20	20	20
180	20	20	20	20	20	20	20	20	20
190	20	20	20	20	20	20	20	20	20
200	20	20	20	20	20	20	20	20	20
210	20	20	20	20	20	20	20	20	20
220	20	20	20	20	20	20	20	20	20
230	20	20	20	20	20	20	20	20	20
240	25	20	20	20	20	20	20	20	20
250	25	20	20	20	20	20	20	20	20
260	25	20	20	20	20	20	20	20	20
270	25	20	20	20	20	20	20	20	20
280	30	20	20	20	20	20	20	20	20
290	30	20	20	20	20	20	20	20	20
300	30	20	20	20	20	20	20	20	20
310	30	20	20	20	20	20	20	20	20
320	30	20	20	20	20	20	20	20	20
330	40	20	20	20	20	20	20	20	20
340	40	25	20	20	20	20	20	20	20
350	40	25	20	20	20	20	20	20	20
360	50	50	40	40	30	25	20	20	20
370	60	50	40	40	40	25	20	20	20
380	60	50	40	40	40	25	20	20	20
390	60	50	40	40	40	25	20	20	20
400	60	50	50	40	40	25	25	20	20
410	60	50	50	40	40	30	25	20	20
420	60	50	50	40	40	30	25	20	20
430	60	50	50	40	40	30	25	20	20
440	60	50	50	40	40	30	25	20	20
450	60	50	50	50	40	30	25	20	20
460	60	60	50	50	40	40	30	20	20
470	60	60	50	50	50	40	30	20	20
480	80	60	50	50	50	40	30	20	20
490	80	60	50	50	50	40	30	25	20
500	80	60	50	50	50	40	30	25	20
510	80	60	60	50	50	40	40	25	20
520	80	60	60	50	50	40	40	25	20
530	80	60	60	50	50	40	40	25	20
540	80	60	60	50	50	40	40	25	20
550	80	60	60	50	50	40	40	30	20
560	80	60	60	60	50	40	40	30	20
570	80	60	60	60	50	50	40	30	20
580	80	80	60	60	50	50	40	30	20
590	80	80	60	60	60	50	40	30	20
600	80	80	60	60	60	50	40	30	20
610	80	80	60	60	60	50	40	40	20
620	80	80	60	60	60	50	40	40	20
630	80	80	80	60	60	50	50	40	20
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650	80	80	80	60	60	50	50	40	20
660	80	80	80	60	60	50	50	40	20
670	80	80	80	60	60	50	50	40	20
680	80	80	80	60	60	50	50	40	20
690	80	80	80	60	60	50	50	40	20
700	80	80	80	80	60	60	50	40	25
710	80	80	80	80	60	60	50	40	25
716	80	80	80	80	60	60	50	40	25

Fire resistance 60 min

	Design temperature (°C)								
	450	500	525	550	560	600	620	650	700
Section factor (m^{-1})	Fire protection thickness (mm) to keep steel temperature under design temperature								
≤ 50	20	20	20	20	20	20	20	20	20
60	20	20	20	20	20	20	20	20	20
70	20	20	20	20	20	20	20	20	20
80	20	20	20	20	20	20	20	20	20
90	20	20	20	20	20	20	20	20	20
100	20	20	20	20	20	20	20	20	20
110	20	20	20	20	20	20	20	20	20
120	20	20	20	20	20	20	20	20	20
130	20	20	20	20	20	20	20	20	20
140	25	20	20	20	20	20	20	20	20
150	25	20	20	20	20	20	20	20	20
160	30	20	20	20	20	20	20	20	20
170	30	25	20	20	20	20	20	20	20
180	40	25	20	20	20	20	20	20	20
200	40	25	20	20	20	20	20	20	20
200	40	30	25	20	20	20	20	20	20
210	40	30	25	20	20	20	20	20	20
220	40	40	30	25	20	20	20	20	20
230	50	40	30	25	25	20	20	20	20
240	50	40	30	25	25	20	20	20	20
250	50	40	40	30	25	20	20	20	20
260	50	40	40	30	30	20	20	20	20
270	50	40	40	30	30	20	20	20	20
280	60	50	40	40	30	25	20	20	20
290	60	50	40	40	30	25	20	20	20
300	60	50	40	40	40	25	20	20	20
310	60	50	50	40	40	25	20	20	20
320	60	50	50	40	40	25	25	20	20
330	60	50	50	40	40	30	25	20	20
340	80	60	50	40	40	30	25	20	20
350	80	60	50	50	40	30	25	20	20
360	80	80	80	80	80	60	60	50	40
370	100	80	80	80	80	60	60	50	40
380	100	80	80	80	80	60	60	50	40
390	100	80	80	80	80	60	60	50	40
400	100	80	80	80	80	80	60	60	50
410	100	80	80	80	80	80	60	60	50
420	100	100	80	80	80	80	80	60	50
430	100	100	80	80	80	80	80	60	50
440	100	100	100	80	80	80	80	60	50
450	100	100	100	80	80	80	80	80	50
460	100	100	100	80	80	80	80	80	60
470	100	100	100	100	80	80	80	80	60
480	100	100	100	100	100	80	80	80	60
490	100	100	100	100	100	80	80	80	60
500	100	100	100	100	100	80	80	80	60
510	100	100	100	100	100	80	80	80	80
520	100	100	100	100	100	100	80	80	80
530	100	100	100	100	100	100	80	80	80
540		100	100	100	100	100	100	80	80
550		100	100	100	100	100	100	80	80
560		100	100	100	100	100	100	80	80
570		100	100	100	100	100	100	100	80
580		100	100	100	100	100	100	100	80
590			100	100	100	100	100	100	80
600			100	100	100	100	100	100	80
610				100	100	100	100	100	80
620				100	100	100	100	100	100
630					100	100	100	100	100
640						100	100	100	100
650						100	100	100	100
660						100	100	100	100
670							100	100	100
680								100	100
690								100	100
700									100
710									100
716									100

Fire resistance 90 min

	Design temperature (°C)								
	450	500	525	550	560	600	620	650	700
Section factor (m^{-1})	Fire protection thickness (mm) to keep steel temperature under design temperature								
≤ 50	20	20	20	20	20	20	20	20	20
60	20	20	20	20	20	20	20	20	20
70	25	20	20	20	20	20	20	20	20
80	30	20	20	20	20	20	20	20	20
90	40	25	25	20	20	20	20	20	20
100	40	30	25	20	20	20	20	20	20
110	40	40	30	25	25	20	20	20	20
120	50	40	40	30	30	25	20	20	20
130	50	40	40	40	30	25	25	20	20
140	60	50	40	40	40	30	25	25	20
150	60	50	50	40	40	40	30	25	20
160	80	60	50	50	50	40	40	30	20
170	80	60	60	50	50	40	40	30	25
180	80	60	60	50	50	50	40	40	25
200	80	80	60	60	60	50	50	40	30
200	80	80	80	60	60	50	50	40	30
210	80	80	80	80	60	60	50	50	40
220	100	80	80	80	80	60	60	50	40
230	100	80	80	80	80	60	60	50	40
240	100	80	80	80	80	80	60	60	50
250	100	100	80	80	80	80	60	60	50
260	100	100	100	80	80	80	80	60	50
270	100	100	100	100	80	80	80	80	50
280		100	100	100	100	80	80	80	60
290		100	100	100	100	80	80	80	60
300		100	100	100	100	100	80	80	60
310			100	100	100	100	80	80	80
320			100	100	100	100	100	80	80
330				100	100	100	100	80	80
340					100	100	100	100	80
350						100	100	100	80
357						100	100	100	80

Fire resistance 120 min

	Design temperature (°C)								
	450	500	525	550	560	600	620	650	700
Section factor (m^{-1})	Fire protection thickness (mm) to keep steel temperature under design temperature								
≤ 50	25	20	20	20	20	20	20	20	20
60	30	25	20	20	20	20	20	20	20
70	40	30	30	25	25	20	20	20	20
80	50	40	40	30	30	25	20	20	20
90	60	50	40	40	40	30	30	25	20
100	60	50	50	50	40	40	40	30	20
110	80	60	60	50	50	40	40	40	25
120	80	80	60	60	60	50	50	40	30
130	80	80	80	60	60	50	50	50	40
140	100	80	80	80	80	60	60	50	40
150	100	80	80	80	80	80	60	60	50
160	100	100	80	80	80	80	80	60	50
170	100	100	100	80	80	80	80	80	60
180		100	100	100	100	80	80	80	60
200		100	100	100	100	100	80	80	80
200			100	100	100	100	100	80	80
210					100	100	100	100	80
220						100	100	100	80
230							100	100	100
240								100	100
250									100
260									100

Fire resistance 180 min

	Design temperature (°C)								
	450	500	525	550	560	600	620	650	700
Section factor (m^{-1})	Fire protection thickness (mm) to keep steel temperature under design temperature								
≤ 50	50	40	40	40	40	30	25	25	20
60	60	50	50	50	50	40	40	30	25
70	80	80	60	60	60	50	50	40	40
80	100	80	80	80	80	60	60	50	50
90	100	100	80	80	80	80	80	60	50
100		100	100	100	100	80	80	80	60
110			100	100	100	100	80	80	80
120					100	100	100	100	80
130							100	100	100
140								100	100
150									100

Fire resistance REI 90 according to EN 13501-2

Trapezoidal roof systems are very cost effective, lightweight and suited to a wide variety of applications, including new build and refurbishment. The load-bearing capacity of corrugated steel without fire protection is 15 – 45 minutes depending on the structure and insulation used on the top of the steel sheet. The steel sheet bends and if the anchoring to the support is good enough if uses advantages of membrane and the load-bearing capability remains for a significant amount of time.

When there is no insulation used on top of the corrugated steel sheet, the heat goes through the metal and dissipates upwards and the steel temperature rises slower.

When corrugated steel is used as a load-bearing structure for the roof construction and insulation is installed on top of the corrugated steel board, the temperature of the metal rises very quickly. ISOVER FireProtect® is a simple and reliable system that limits the temperature rise in the steel sheet and helps roof to withstand longer from collapse.

Figure 9. System ISOVER FireProtect® for fire protection of corrugated steel is characterized by light weight and small height, but also a direct fixing to the corrugated steel without need of help of suspension construction

Fire classification

Fire protection system ISOVER FireProtect® was officially tested in PAVUS, a.s., authorized body AO 216. It is possible to protect roof made of corrugated steel up to fire resistance REI 90. Classification according to the latest standard EN 13501-2: 2016, testing based on EN 1365-2: 2015.

Figure 10. Sample after 30 minutes – fire protection system ISOVER FireProtect® fulfils its function for 100 %, roof is without any deformation (bending stress, the same as would be under cold conditions)

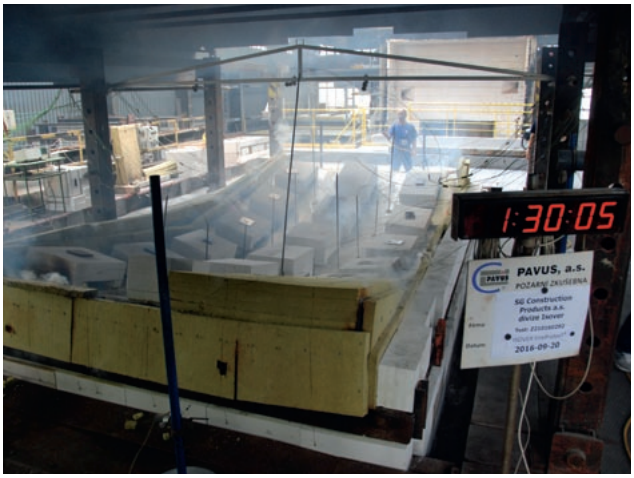


Figure 11. Sample after 90 minutes – roof deformation protected with ISOVER FireProtect® is close to limit deformation given by test standard EN 1365-2 (fluent transition from bending stress to membrane)

Fixing

Assembly of slabs ISOVER FireProtect® 150 in thickness 60 mm is quick and simple and secure system with easily worked materials and simple fixing – stud-welded pins or pins and washers in maximal distance of 300 mm. Maximum distance from the cladding's edges is 75 mm. Approximate pin's quantity is 13 pcs/m^2.

Fire resistance increase of concrete members and slabs according to EN 13501-2

Concrete is specified in buildings and civil engineering projects for several reasons, sometimes cost, and sometimes speed of construction or architectural appearance, but one of concrete's major inherent benefits is its performance in fire, which may be overlooked in the race to consider all the factors affecting design decisions. Concrete usually performs well in building fires, however, concrete structures must still be designed for fire effects. Structural components still must be able to withstand dead and live loads without collapse even though the rise in temperature causes a decrease in the strength and modulus of elasticity for concrete and steel reinforcement. In addition, fully developed fires cause expansion of structural components and the resulting stresses and strains must be resisted. This rise in temperature dramatically reduces the mechanical properties of concrete and steel.

ORDEXAL® B system is designed to increase the fire resistance of concrete slabs (decks) up to R 360 and of concrete beams up to R 240 according to EN 13381-3: 2015. The additional fire protection of the hollow core or massive concrete slabs/beams slows down the temperature rise of reinforcing steels. The goal is to maintain the bearing capability in the side on tension.

Composition

ORDEXAL® B system consists of mineral wool slabs Isover PYRO of 20 mm thickness and heat-resistant glue-cement Dexaflamm B. The slabs are glued in their full surface to the reinforced concrete structure by the heat-resistant cement.

Fire protection slabs

Mineral wool slabs of 20 mm thickness, with nominal density 190 kg/m^3, supplied in basic dimensions 500 x 1000 mm, pack of 10 pieces in foil. The slabs can be cut by a standard laggers knife, circular saw with sintered carbide blade and extraction or a hand saw with fine teeth.

Cement description

The heat resistant glue-cement Dexaflamm B is supplied in 15 or 50 kg plastic barrels or 25 kg paper bags. The cement is prepared by mixing the content of the barrel of dry mixture (50 kg) to about 12 litres of clean water by a stirrer, drill extender or mixer with forced mixing. The mixing time is 2-5 min. After mixing let the compound leave to stand for about 5 minutes and then mix briefly again. When mixing small quantities, observe the ratio of dry mixture and water. Time of processability is about 90 minutes.

Design tables

1) Rectangular **reinforced concrete columns** protected with ORDEXAL® B in thickness 20 mm exposed to fire from one or more sides

Fire resistance (min)	Minimum dimension of column (mm) Width of diameter of column b Axial distance of reinforcement a	
R 60	b = 200	a = 25
R 120	b = 250	a = 25
R 180	b = 350	a = 25

2) Concrete non-bearing walls with or without reinforcement, protected with ORDEXAL® B in thickness 20 mm exposed to fire from one side

Fire resistance (min)	Minimum thickness of the concrete wall d (mm)
EI 120	70
EI 180	90

Note: When exposed to fire from one or the other side, fire protection system has to be applied from both sides of the wall

3) Reinforced concrete walls protected with ORDEXAL® B in thickness 20 mm exposed to fire from one side

Fire resistance (min)	Minimum thickness of the wall d (mm) /Axial distance of reinforcement a (mm)
REI 120	120/10
REI 180	140/25

Note: When exposed to fire from one or the other side, fire protection system has to be applied from both sides of the wall

4) Reinforced concrete walls protected with ORDEXAL® B in thickness 20 mm exposed to fire from both sides

Fire resistance (min)	Minimum thickness of the wall d (mm) /Axial distance of reinforcement a (mm)
R 120	120/10
R 180	130/10

5) Simply supported reinforced concrete or prestressed concrete beams, protected from three sides with ORDEXAL® B in thickness 20 mm

Fire resistance (min)	Minimum width of beam b (mm)/ Average axial distance of reinforcement a (mm)
R 120	80/25
R 180	120/40

6) Simply supported reinforcement concrete or prestressed concrete slabs with reinforcement in one direction, protected from bottom side with ORDEXAL® B in thickness 20 mm

Fire resistance (min)	Minimum thickness of the slab h_s (mm) /Axial distance of reinforcement a (mm)
REI 120	60/10
REI 180	100/30

Note: Table is valid also for hollow slab panels with effective thickness $h_s = h \cdot [A_c/(b \cdot h)]^{0,5}$
Where: h is actual thickness of the panel, topping included (countable layer thickness ≥ 30 mm)
A_c is area of concrete cross-section, topping included
b width of the panel

7) Simply supported reinforcement concrete or prestressed concrete ribbed slabs, protected with ORDEXAL® B in thickness 20 mm

Fire resistance (min)	Minimum thickness of reinforced slab h_s (mm)/ Axial distance of reinforcement a (mm)	Minimum width of the rib b (mm)/ Axial distance of reinforcement a (mm)
REI 120	60/10	80/15
REI 180	100/15	120/45

8) Thin slabs (fixed) with thickness 40 mm and 50 mm from reinforced concrete with reinforcement in one or two directions, protected with ORDEXAL® B in thickness 20 mm, 30 mm or 40 mm

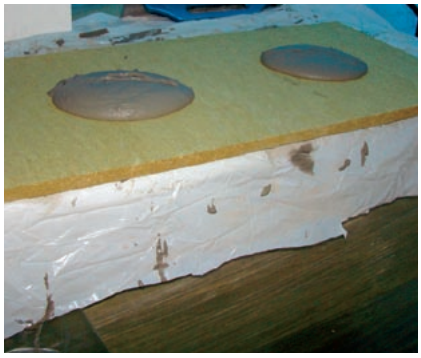
Fire resistance (min)	Minimum thickness of reinforced slab h_s (mm)/ Axial distance of reinforcement a (mm)	Fire protection thickness of ORDEXAL® B (mm) applied from the bottom side
REI 60	40/10	20
REI 90	50/10	20
REI 90	40/10	30
REI 120	50/10	30
REI 120	40/10	40
REI 120	50/10	40

Values are not valid for prestressed concrete!

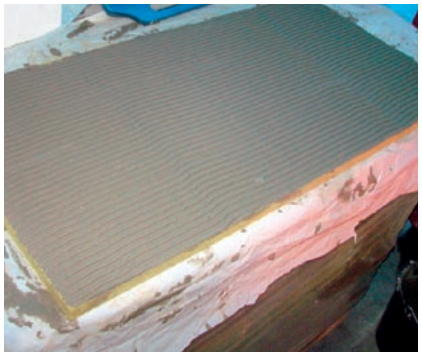
Pictorial instructions for the installation of system ORDEXAL® B

Inspect the slab and the tools used

Prepare Dexaflamm B cement

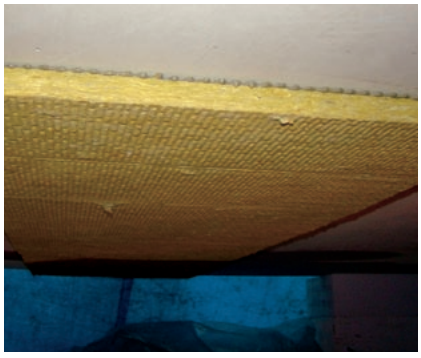


Apply an adequate amount of the cement on the slab



Spread the cement with a notched trowel over the entire surface of the slab

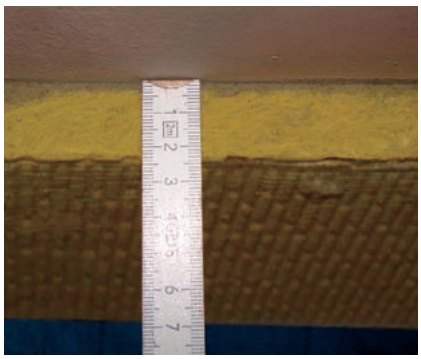
Press the first slab to the baseline and remove any excessive glue



Check the bonding over the entire surface - Dexaflamm B cement is slightly pushed out and visible

Installation of the first row of slabs - inspect the straightness of the row

Install other slabs by pressing them against the edge of the already installed slabs (the edges are not glued)



Check the system thickness, 20 mm slab, 3-4 mm layer of cement

Finished ORDEXAL® B lining

In case of a beam, the sides are glued first

The flange is glued in the end

FURTHER INFORMATION ABOUT ISOVER FIREPROTECT

For more information about ISOVER FireProtect, please contact the local Isover representative in your country.

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