

8.5 Steel Construction Cladding with CETRIS[®] Cement Bonded Particleboards

8.5.1 Introduction

Steel is an inorganic material and therefore may be classified as a non-flammable substance without special testing. Upon direct exposure to fire, steel construction elements lose their load-bearing power due to exposure to high temperatures (increasing to up to 550 °C as soon as after 5 minutes of burning) and the building construction stability is compromised. It is therefore necessary to protect all steel elements adequately where fire resistance is required.

The CETRIS[®] cement bonded particleboard cladding ensures that the steel reaches the critical temperatures only after the defined period. The cladding of CETRIS[®] boards may be applied directly on the steel profiles or through an auxiliary construction.

Selection of thickness of the CETRIS[®] cement bonded particleboard cladding in the case of protection of steel constructions depends primarily on the following three factors:

- Time of required protection – fire resistance in minutes
- Design temperature
- Cross-sectional coefficient A_p/V

The time of the required protection (fire resistance) is required in the following intervals: 15, 30, 45, 60, 90 minutes.

The design temperature depends on the intensity of the element loading (coefficient of utilisation of the cross section at normal temperature θ_D). Unless specified otherwise, the value of 500 °C is used, corresponding to the coefficient range of 0.78 to 0.80.

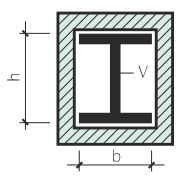
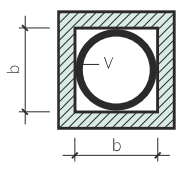
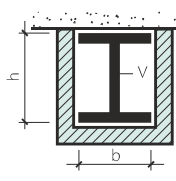


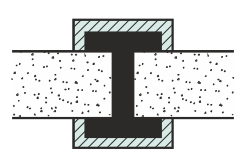
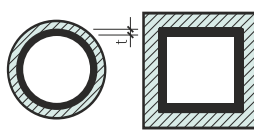
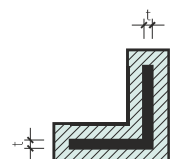
For details on determination of the coefficient of utilisation of the cross section see the ČSN EN 1993-1-2 standard, Euro code 3: Design of steel structures - Part 1 - 2: General rules – Structural fire design, chapter 4.2.4. A significant factor defining the shape of the cross section is the ratio A_p/V – cross-sectional coefficient of protected steel profile. The elements of the A_p/V ratio include:

A_p perimeter of the protected steel profile in mm.
 V area of crosswise section of the steel profile in mm².

When specifying the size of the heated perimeter it is necessary to always consider just the part of the steel construction exposed to flame in the course of fire (usually all sides of the column and three sides of the beam) – see table.


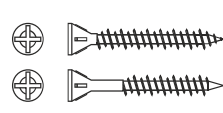
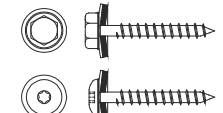
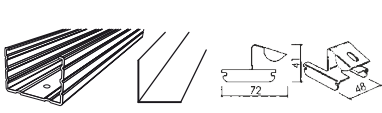

The effect of this factor is significant – subtle profiles (cross sections with high A_p/V ratios) approach the critical temperature more quickly, and therefore need to be protected with thicker cladding.

8.5.2 Calculation of Ap/V

Shape of cross-section	Exposure to fire	$AP/V(m^{-1})$	Shape of cross-section	Exposure to fire	$AP/V(m^{-1})$
	From four sides	$1000 \frac{2b + 2h}{V}$		From four sides	$1000 \frac{4b}{V}$
	From four sides	$1000 \frac{2h + b}{V}$		From four sides	$\frac{2000}{t}$
	From four sides	$1000 \frac{O}{V}$		From four sides	$\frac{1000}{t}$
	From four sides	$\frac{1000}{t}$		From four sides	$\frac{2000}{t}$

Cross-section dimensions b, h, t are in mm, cross-section area V in mm^2

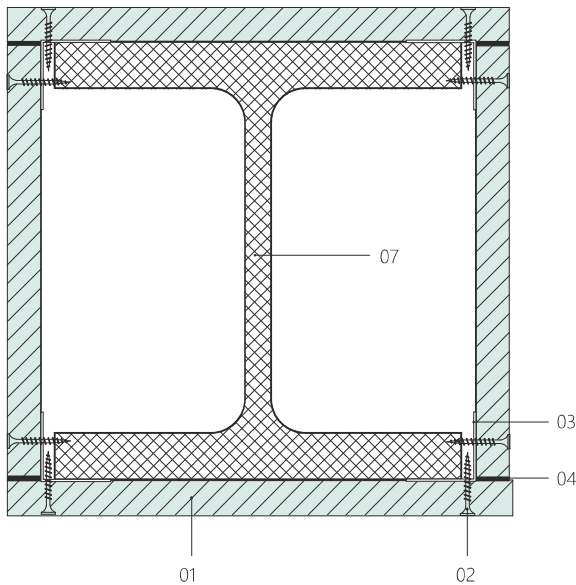
Materials for execution of fire structures

Description	Visualisation	Note
CETRIS® BASIC board Cement bonded particleboard, smooth surface, cement grey. Basic format 1,250x3,350 mm, volume mass $1320 \pm 70 \text{ kgm}^{-3}$		Thickness according to the fire resistance requirements
Screw 4,2x25, 35,4 mm Counter-sunk, self-tapping screws		Screw type according to the thickness of the cladding. Anchoring in the interior, or exterior under the thermal insulation system (ETICS)
Screw 4.2 – 4.8 x 38, 45 mm Stainless steel or galvanised screws with half-round or hex head with thrust water-tight washer		Screw type according to the thickness of the cladding and type of load-bearing construction. Anchoring on the exterior – it is necessary to pre-drill the board (hole diameter 8 (10) mm)
Auxiliary structures Galvanised sheet metal profiles CD 60x27x0.6 mm, L 50x50x0.6 mm, Clamp to flanges of "I" beams		Dimensions according to fire resistance requirements and wall height. Alternatively, it is possible to use steel profiles with a cross-section area that minimally equivalent to the CW profiles.
Fire resistant filler White material for joint filling and screw head covering.		DEXAFLAMM-R filler (manufactured by Tora Spytihnev), or fire-resistant DenBraven (acrylic, silicone) filler

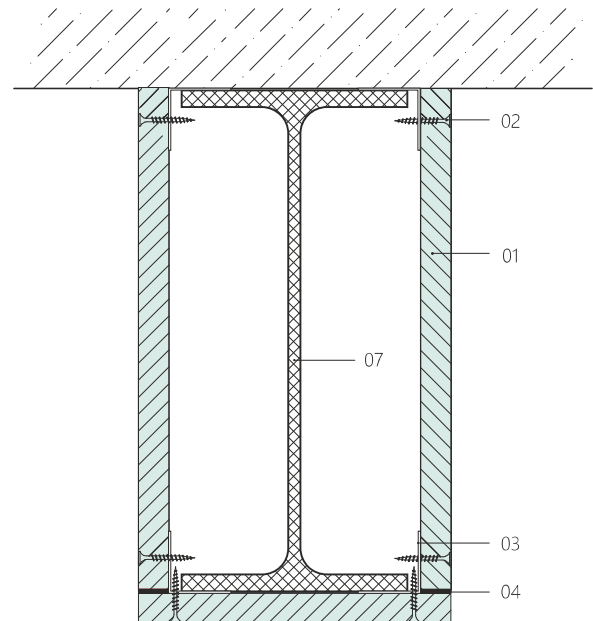
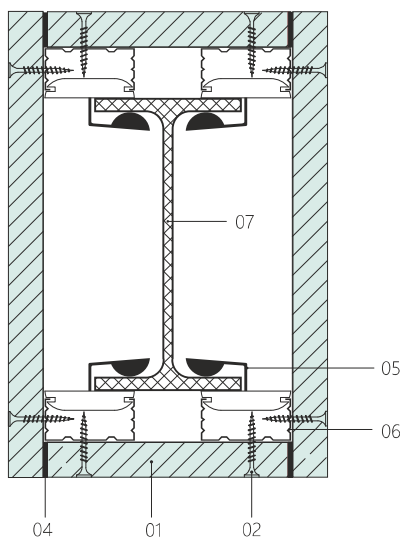
8.5.3 Methods of Cladding (Directly, or on Auxiliary Construction)

Cladding of CETRIS® cement bonded particleboards can be applied directly on the steel profile – in this case it is recommended to use the easier way of anchoring the CETRIS® boards protecting the web with the auxiliary L profile 50 × 50 × 0.6 mm. This profile is laid directly on the flange with the offset of about 6 mm from the profile edge – the gap is for the screw anchoring the upper CETRIS® board (protecting the profile flange).

Alternatively the cladding of CETRIS® cement bonded particleboards may also be assembled to an auxiliary construction – for example on CD profiles clamped to flanges of the I beams or suspensions.



- 01 CETRIS® board cladding
- 02 screw 4.2 × 25 (35, 45, 55) mm
- 03 auxiliary "L" profile 50×50×0.6 mm
- 04 fire resistant filler
- 05 clamp to flanges of "I" beam
- 06 CD profile 60×27×0.6 mm
- 07 protected steel cross-section



8.5.4 Dimension Tables

Resistance to fire classification R 15									
Design temperature (°C)	350	400	450	500	550	600	650	700	750
Am / V (1/m)	Thickness of CETRIS cement bonded particleboard to keep the temperature below the design temperature (mm)								
45	10	10	10	10	10	10	10	10	10
60	10	10	10	10	10	10	10	10	10
80	10	10	10	10	10	10	10	10	10
100	10	10	10	10	10	10	10	10	10
120	10	10	10	10	10	10	10	10	10
140	10	10	10	10	10	10	10	10	10
160	10	10	10	10	10	10	10	10	10
180	10	10	10	10	10	10	10	10	10
200	10	10	10	10	10	10	10	10	10
220	10	10	10	10	10	10	10	10	10
240	10	10	10	10	10	10	10	10	10
260	10	10	10	10	10	10	10	10	10
280	10	10	10	10	10	10	10	10	10
300	10	10	10	10	10	10	10	10	10
320	10	10	10	10	10	10	10	10	10
340	10	10	10	10	10	10	10	10	10
360	10	10	10	10	10	10	10	10	10
380	10	10	10	10	10	10	10	10	10
402	10	10	10	10	10	10	10	10	10
Resistance to fire classification R 30									
45	10	10	10	10	10	10	10	10	10
60	12	10	10	10	10	10	10	10	10
80	14	12	10	10	10	10	10	10	10
100	14	12	12	10	10	10	10	10	10
120	14	14	12	10	10	10	10	10	10
140	16	14	12	10	10	10	10	10	10
160	16	14	14	12	10	10	10	10	10
180	16	14	14	12	12	10	10	10	10
200	16	14	14	12	12	10	10	10	10
220	16	16	14	12	12	10	10	10	10
240	16	16	14	14	12	12	10	10	10
260	16	16	14	14	12	12	10	10	10
280	16	16	14	14	12	12	10	10	10
300	16	16	14	14	12	12	10	10	10
320	16	16	14	14	12	12	10	10	10
340	16	16	14	14	12	12	10	10	10
360	16	16	14	14	12	12	10	10	10
380	18	16	16	14	12	12	10	10	10
402	18	16	16	14	14	12	10	10	10



Resistance to fire classification R 45									
Design temperature (°C)	350	400	450	500	550	600	650	700	750
Am / V (l/m)	Thickness of CETRIS cement bonded particleboard to keep the temperature below the design temperature (mm)								
45	16	14	12	10	10	10	10	10	10
60	18	16	14	12	12	10	10	10	10
80	20	18	16	14	14	12	12	10	10
100	20	18	18	16	14	14	12	12	10
120	22	20	18	16	16	14	14	12	12
140	22	20	18	18	16	16	14	12	12
160	22	20	20	18	16	16	14	14	12
180	22	22	20	18	18	16	16	14	12
200	22	22	20	20	18	16	16	14	14
220	22	22	20	20	18	18	18	14	14
240	22	22	20	20	18	18	18	16	14
260	22	22	20	20	18	18	18	16	14
280	22	22	22	20	18	18	18	16	14
300	24	22	22	20	20	18	18	16	14
320	24	22	22	20	20	18	18	16	16
340	24	22	22	20	20	18	18	16	16
360	24	22	22	20	20	18	18	16	16
380	24	22	22	20	20	18	18	16	16
402	24	22	22	20	20	18	18	16	16
Resistance to fire classification R 60									
45	22	20	18	16	14	12	12	10	10
60	24	22	20	18	16	14	14	12	12
80		24	22	20	18	18	16	14	14
100			24	22	20	18	18	16	16
120			24	22	22	20	18	18	16
140				24	22	20	20	18	18
160				24	24	22	20	20	18
180				24	24	22	22	20	18
200					24	22	22	20	20
220					24	24	22	22	20
240					24	24	22	22	20
260						24	24	22	20
280						24	24	22	22
300						24	24	22	22
320						24	24	22	22
340							24	24	22
360							24	24	22
380							24	24	22
402							24	24	22



Resistance to fire classification R 90									
Design temperature (°C)	350	400	450	500	550	600	650	700	750
Am / V (1/m)	Thickness of CETRIS cement bonded particleboard to keep the temperature below the design temperature (mm)								
45				24	22	20	18	18	16
60						24	22	20	18
80								24	22
100									24

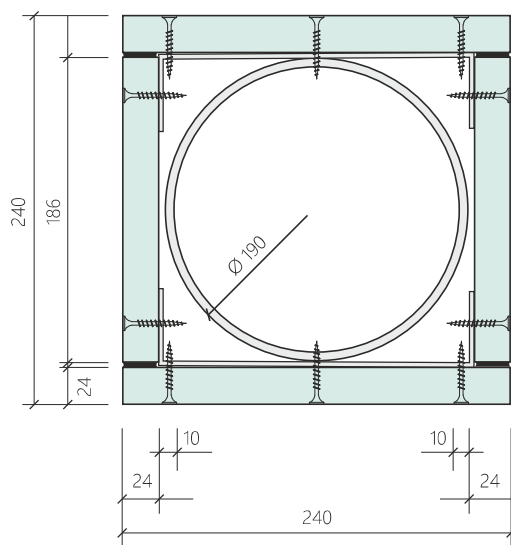
Notes to the table:

- The values apply to pillars (with fire load from 4 sides) with a cross-sectional coefficient of 45-402 m⁻¹ and beams (with fire load from 3 or 4 sides) with a cross-sectional coefficient of 50-402 m⁻¹
- The CETRIS[®] board cladding can be used for right angle, circular, closed and open steel profiles. The maximum height of the web of the steel profile is 600 mm.
- the dimension tables apply to all steel classes excluding S 185 and all types of steels marked E (according to EN 10 025 or EN 10 113).
- Types of profiles:
 - open cross-section profiles (type I, H, , T, U)
 - for rolled or welded profiles

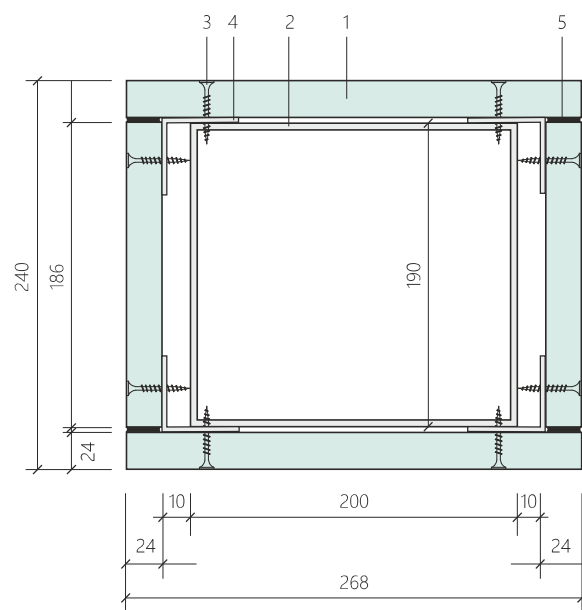
8.5.5 General Principles of Cladding Assembly

- The minimum CETRIS[®] board thickness is 10 mm and the maximum thickness is 24 mm.
- The maximum spacing of anchoring screws must not exceed 400 mm, when using CETRIS[®] 14 mm boards or thinner the distance must be reduced to 200 mm. The minimum distance from the edge is 25 mm. The screw must be at least 10 mm longer than the thickness of the fixed board.
- A sunken head screws may be used for interior anchoring. Upper layers of CETRIS[®] boards in exteriors must be anchored with screws with semi-circular or hexagonal heads and water tight compressive washers and the CETRIS[®] board must be pre-drilled (min. hole diameter: 8 mm) and the pre-drilled holes must be filled with fire resistant filler (DEXAFLAMM-R, Den Braven fire resistant filler).
- All joints between CETRIS[®] boards of 3 – 10 mm width, wall and corner contacts must be filled with fire resistant filler.
- When laying a cladding of circular closed profiles, it is necessary to create an auxiliary structure for the CETRIS[®] boards, e.g. from L profiles. The L profiles must overlap at least at two points and mechanically jointed with the circular profile—see Figure (a)
- When cladding of square closed profiles with metal profiles, it is necessary on 2 sides of the cross-sections to mechanically join the CETRIS[®] board cladding with the steel cross-section, see Figure (b)

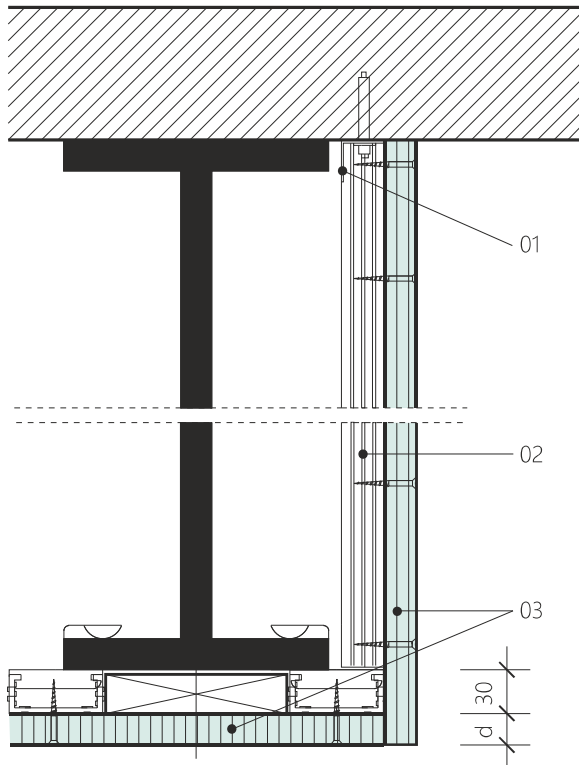
a) cladding of round closed profiles



b) cladding of square closed profiles

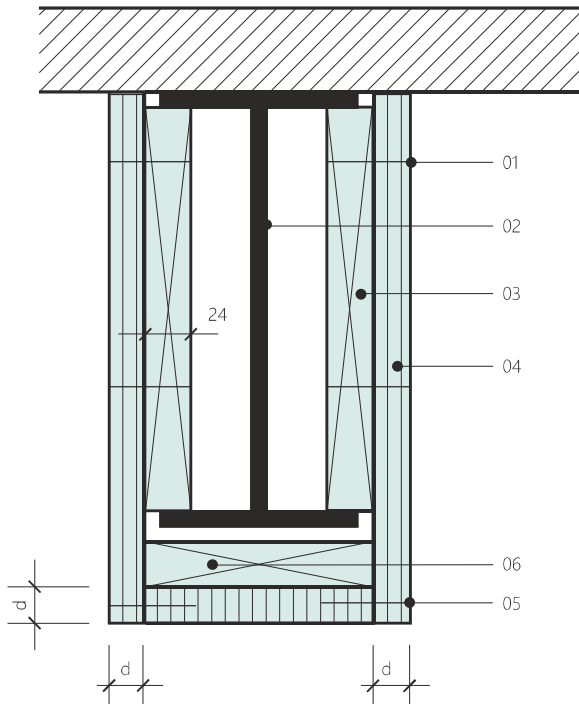


Transverse section



- 01 UD profile 28 x 27 x 0.6 mm
- 02 CD profile 60 x 27 x 0.6 mm, span 400 to 600 mm, according to the height of the beam and under the joints
- 03 CETRIS® cement bonded particleboards

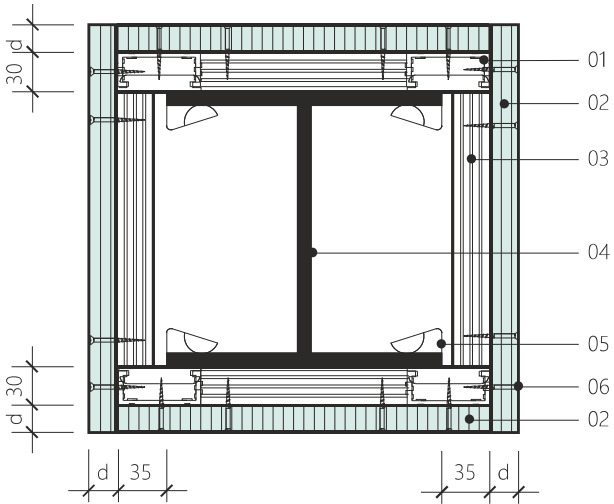
Transverse section



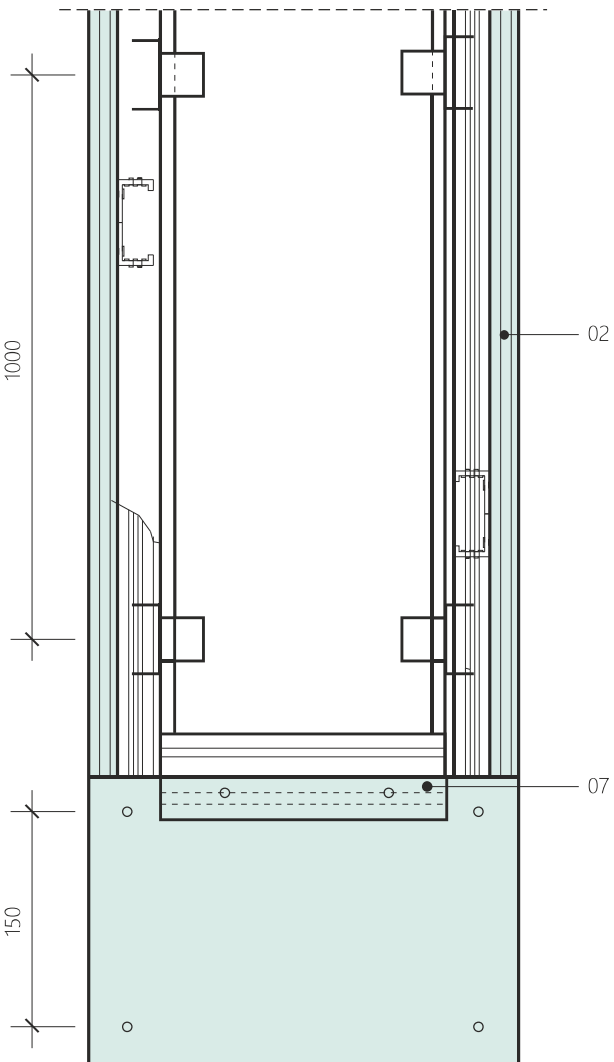
- 01 screws
- 02 steel beam
- 03 assembly insert of CETRIS® cement bonded particleboard
- 04 CETRIS® cement bonded particleboard
- 05 screws
- 06 CETRIS® board in the case of single-layer cladding for joint coverage



Horizontal section



Vertical section



- 01 CD profile 60 x 27 x 0.6 mm
- 02 CETRIS® cement bonded particleboard
- 03 CD profile 60 x 27 x 0.6 mm (under the gaps)
- 04 steel column
- 05 Knauf clamps
- 06 screws
- 07 CD profile 60 x 27 x 0.6 mm (under the gaps)

