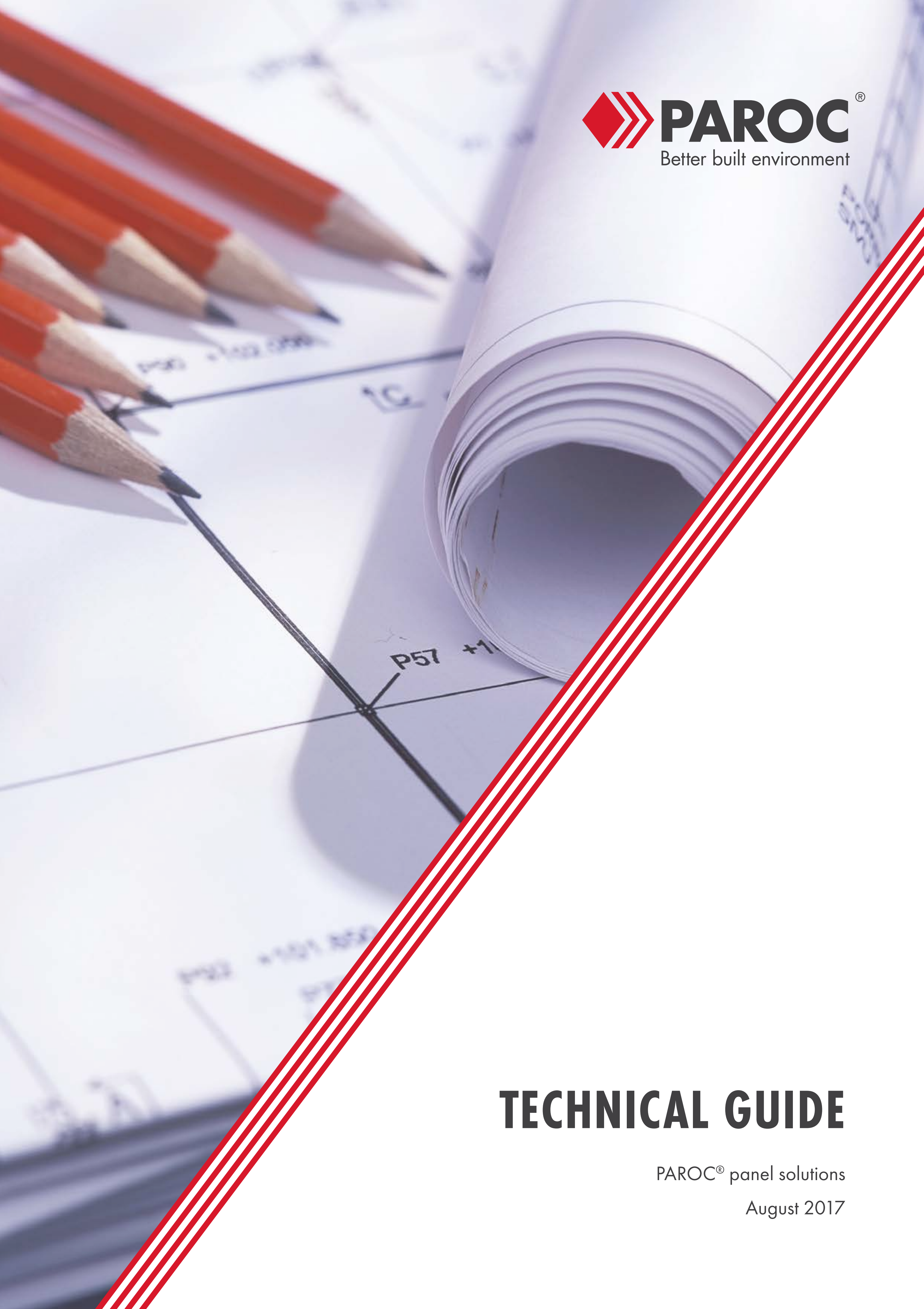


PAROC®
Better built environment

TECHNICAL GUIDE

PAROC® panel solutions

August 2017

The technical data and recommendations included in this Technical Guide are based on EN 14509 Self-supporting double skin metal faced insulating panels. In countries where Paroc Panel System has approvals or where a country has specific standards, panels and solutions are designed in accordance therewith and deviations may be made from this Technical Guide.

Paroc Panel System is only responsible for the properties of the panels included in this literature. Any other information submitted, e.g. on load assumptions, dimensioning, detail design and installation is to be considered as guiding information only.

Latest version of this guide will always be published on our website. When designing PAROC® panel solutions get also acquainted with our detail solutions which can be found on our website **www.paroc.com/panelsystem.**

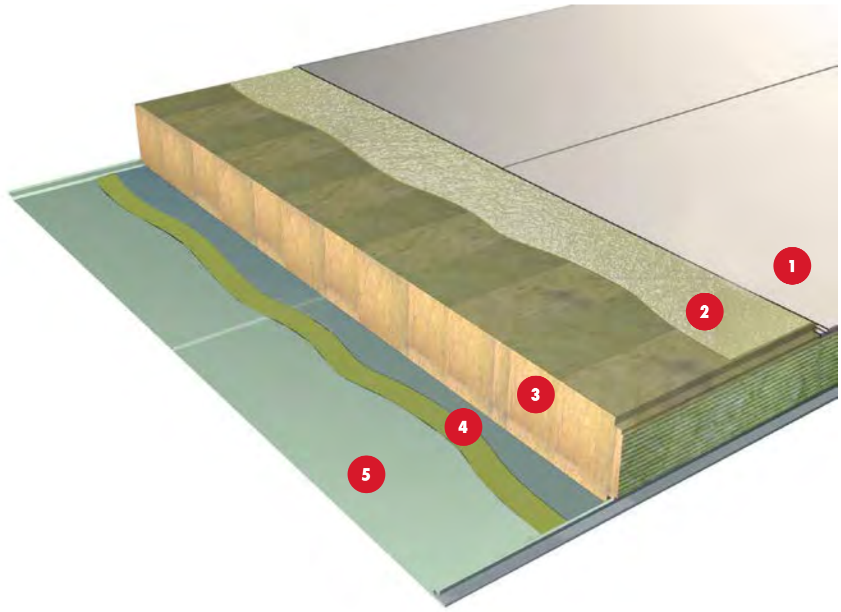
CONTENTS

1 PAROC® FIRE PROOF PANELS

1.1 GENERAL

PAROC fire proof panels are prefabricated stone wool based lightweight sandwich panels. The facings are made of steel sheet and they act together with the PAROC structural wool core to provide a composite action of high performance in strength and durability. The bonding between the core and the facings is performed by an adhesive which fully covers the surfaces.

Figure 1. *Components of PAROC panels.*



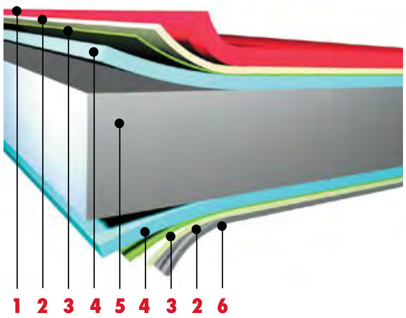
1. Zinc-coated steel sheets with top coating according to environmental demands.
2. Specially developed adhesive, that fulfils the AST® quality demands on strength and durability as well as the requirements for non-combustible products A2-s1,d0 for panels, covers the whole surface area.
3. Non-combustible (A1) core of PAROC structural stone wool lamellas give equal strength properties in each cross section of the panel.
4. Multi-layer primer to ensure the bonding between the adhesive and the zinc layered steel sheet.
5. Fire safe joint design that makes the panel tight for hot gases and flames and gives up to 4 hours (EI 240) fire resistance properties.

AST® quality (Advanced Structural Technology) results in secure strength properties, reliable long-term durability and fire safety in sandwich panels. The essential characteristics of AST® quality can not be identified visually, but they can still be measured and controlled in the manufacturing process. AST® quality is fully implemented in PAROC panels.

1.2 FACINGS

PAROC panels have surfaces made of hot dip galvanized, coil coated steel sheet. The two-sided galvanization guarantees the corrosion resistance of the steel. The primer again ensures a good adhesiveness for the coating. The exposed surface of the steel has a coil coating and the reverse side consists of a special coating for bonding stone wool.

Figure 2. *Facing structure of PAROC panels.*



1 Coil coating
2 Primer
3 Passivation layer
4 Zinc
5 Steel
6 Epoxy coating

Standard thicknesses of the coil coated steel sheet are 0.5 and 0.6 mm.
The facing thickness is usually specified as follows:

- in external walls 0.6 mm sheet externally and 0.5 mm internally
- in internal walls 0.5 mm sheet on both sides of the panel
- in ceilings 0.6 mm sheet on the upper side and 0.5 mm on the lower side
- perforated steel sheet for PAROC acoustic panel 0.6 mm
- stainless steel 0.6 mm.
- galvanized steel 0.6 mm

On request also other steel sheet thicknesses are available.

Standard surface coatings are PVDF and polyester. Available colour range is presented in a separate brochure Colours. Especially in high temperature interiors galvanized steel sheet with no substrate coating can be used. If high hygiene requirements exist FoodSafe surface coating or different types of stainless steel sheet can be chosen.

1.2.1 PVDF COATING FOR EXTERNAL FACINGS

The PVDF coating is recommended for normal exterior use. It is highly resistant to UV radiation and dirt. PVDF is recommended for uses where the coating needs colour durability and dirt resistance. Even matt PVDF is available in some colours.

1.2.2 POLYESTER COATING FOR INTERNAL FACINGS

The polyester (SP) coating is suited for both interior and exterior use, though its properties are better suited for interior use. In the food industry polyester can be used in structures that do not come in direct contact with unpacked foodstuff.

1.2.3 HYGIENIC FACINGS

In facilities for manufacturing, handling and storing in the food industry, the FoodSafe coatings can be used.

FoodSafe FS-1 coating is fully food safe and can be used where there is continuous food contact. The coating is intended only for internal use in dry conditions.

FoodSafe FS-2 coating is food safe and can be safely used where there is incidental contact with unpacked foodstuff. The coating is only for internal use in dry conditions.

Stainless steel can be used in panel faces in places with special hygiene requirements, even in structures with continuous contact with foodstuff. Stainless steel is also suitable for high class facades.

Table 1. *Properties of the coatings.*

Property	Coating					
	PVDF	PVDF HB	Matt PVDF	SP	FoodSafe	HST [5)]
Material	polyvinyliden-fluoride	polyvinyliden-fluoride	polyvinyliden-fluoride	polyester	PVC laminate	stainless steel
Application	external	external	external	internal/ external	dry internal	internal/ external
Coating thickness, µm	27	40	26	25	120	
Surface	smooth	smooth	structured	smooth	satin	
Max temperature, °C [1)]	110	110	110	90	60	
Recommended environmental category [2)]	C3	C4	C3	C3	C3	>C3 [3)]
Appearance preservation	excellent	excellent	excellent	good	good	
Gloss, Gardner 60°	30–40 [4)]	3–5	3–5	30–40	7–13	

[1)] Refers to continuous operating temperature
[2)] Corrosion classes according to DIN 55928-8
[3)] Cases in this environment need specific performance check
[4)] Slightly lower for metallic colours
[5)] Quality according to AISI 316L and EN 1.14404

1.3 CORE

The PAROC structural wool is a special stone wool in which the wool fibres are uniformly aligned to achieve controlled strength properties. It is specially treated to be water-repellent, non-hygroscopic and non-capillary. In addition, moisture has no effect on the stability of the core and the binder. The PAROC structural stone wool comes in different types.

1.4 PAROC® PANEL TYPES

The PAROC panels come in seven types with different technical performance. Panel type is chosen according to required strength, fire and thermal insulation properties:

- **AST® L** and **AST® T** for internal and external walls with high thermal insulation requirements
- **AST® S** for external and internal walls in normal use in buildings with normal fire requirements
- **AST® F**, **AST® F+** and **AST® S+** for walls with high fire requirements
- **AST® E** for ceilings but can also be used for walls in case of higher strength requirements.

1.5 PANEL PERFORMANCE

Table 2. *Technical performance of PAROC® panels.*

External and internal walls

Panel type	Panel property									
	Nominal thickness, mm	**50**	**80**	**100**	**120**	**150**	**175**	**200**	**240**	**300**
	Actual thickness, mm	53	79	99	120	151	173	202	243	305
AST® L	U-value, W/m^{2}K 1)	–	0.45	0.37	0.30	0.24	0.21	0.18	0.15	0.12
	Fire rating, min 2) horizontal/vertical	–	NPD	NPD	NPD	EI 120/EI 180	EI 120/EI 180	EI 120/EI 180	EI 120/EI 180	EI 120/EI 180
	Weight, kg/m^2 3)	–	15	17	18	21	22	24	27	31
AST® T	U-value, W/m^{2}K 1)	–	0.47	0.38	0.31	0.25	0.22	0.19	0.16	0.13
	Fire rating, min 2) horizontal/vertical	–	EI 30/EI 30	EI 45/EI 45	EI 60/EI 90	EI 60/EI 120	EI 180/EI 180	EI 180/EI 180	EI 240/EI 240	EI 240/EI 240
	Weight, kg/m^2 3)	–	16	17	19	21	23	25	28	33
AST® S	U-value, W/m^{2}K 1)	–	0.48	0.38	0.32	0.26	0.22	0.19	0.16	0.13
	Fire rating, min 2) horizontal/vertical	–	EI 30/EI 30	EI 60/EI 60	EI 90/EI 90	EI 180/EI 180	EI 180/EI 180	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240
	Weight, kg/m^2 3)	–	17	19	21	23	25	28	32	37
AST® S+	U-value, W/m^{2}K 1)	–	–	0.38	0.32	–	–	–	–	–
	Fire rating, min 2)	–	–	EI 120/EI 120	EI 120/EI 120	–	–	–	–	–
	Weight, kg/m^2 3)	–	–	19	21	–	–	–	–	–
AST® F	U-value, W/m^{2}K 1)	–	0.53	0.43	0.36	0.29	0.25	0.22	0.18	0.14
	Fire rating, min 2) horizontal/vertical	–	EI 45/EI 90	EI 45/EI 120	EI 45/EI 120	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240
	Weight, kg/m^2 3)	–	19	21	24	27	30	33	38	45
AST® F+	U-value, W/m^{2}K 1)	–	–	0.43	0.36	–	–	–	–	–
	Fire rating, min 2) horizontal/vertical	–	–	EI 120/EI 120	EI 120/EI 120	–	–	–	–	–
	Weight, kg/m^2 3)	–	–	21	24	–	–	–	–	–
AST® E	U-value, W/m^{2}K 1)	0.77	0.53	0.43	0.36	0.29	0.25	0.22	0.18	0.14
	Fire rating, min 2) horizontal/vertical	EI 45/EI 45	EI 45/EI 90	EI 45/EI 120	EI 45/EI 120	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240	EI 240/EI 240
	Weight, kg/m^2 3)	16	19	22	24	28	31	34	39	47

External walls, PAROC® shadow panels

Panel type	Panel property									
	Nominal thickness, mm	**–**	**80**	**100**	**120**	**150**	**175**	**200**	**240**	**300**
	Actual thickness, mm	–	79	99	120	151	173	202	243	305
AST® S AST® F AST® E	Fire rating, min horizontal/vertical	–	–	–	–	–	–	EI 180/–	EI 180/–	EI 180/–

Ceilings

Panel type	Panel property									
	Nominal thickness, mm	**50**	**80**	**100**	**120**	**150**	**175**	**200**	**240**	**300**
	Actual thickness, mm	53	79	99	120	151	173	202	243	305
AST® E	U-value, W/m^{2}K 1)	0.77	0.53	0.43	0.36	0.29	0.25	0.22	0.18	0.14
	Fire rating, min 2)	NPD	NPD	EI 60	EI 60	EI 60	EI 60	EI 60	EI 60	EI 60
	Weight, kg/m^2 3)	16	19	22	24	28	31	34	39	47

NPD = No performance determined (not tested), – = Not available

1) U-values including surface resistance $R_{si} + R_{se}$ = 0.17 m^{2}K/W and the influence of joints. See also section 1.6.

2) Note that PAROC® acoustic panels are not fire rated. PAROC® panels are non-combustible and classified in Euroclass A2-s1,d0. PAROC® print and PAROC® art panels are classified in C-s1,d0. In fire-rated walls spans can be limited (see table 14), see also section 3 Fire safe solutions.

3) Panels with standard facings.

Weighted sound reduction index R_W is 28…32 dB. **Maximum panel length** is 12 m but may be limited depending on panel thickness and type to ensure safe handling.

Module width is 1200 mm and cover width 1196 mm. **Tolerances** are as follows:

- panel length ±5 mm
- panel thickness ±1 mm
- cover width ±2 mm

1.6 THERMAL INSULATION

PAROC panel is a sandwich structure consisting of a homogeneous insulating layer without thermal bridges. This ensures a good and well-defined thermal insulation. Thermal transmittance, U-value, W/m^{2}K, is calculated in accordance with EN 14509 Self-supporting double skin metal faced insulating panels. The values include the surface resistance $R_{si} + R_{se}$ = 0.17 m^{2}K/W and the influence of joints. The influence of penetrating fixing screws has to be added to the U-value of the panel.

Table 3. *U-values for PAROC panels.*

Panel type	U-values, W/m²K								
	Panel thickness, mm								
	50	**80**	**100**	**120**	**150**	**175**	**200**	**240**	**300**
AST® L	–	0.45	0.37	0.30	0.24	0.21	0.18	0.15	0.12
AST® T	–	0.47	0.38	0.31	0.25	0.22	0.19	0.16	0.13
AST® S	–	0.48	0.38	0.32	0.26	0.22	0.19	0.16	0.13
AST® S+	–	0.48	0.38	0.32	0.26	0.22	0.19	0.16	0.13
AST® F	–	0.53	0.43	0.36	0.29	0.25	0.22	0.18	0.14
AST® F+	–	0.53	0.43	0.36	0.29	0.25	0.22	0.18	0.14
AST® E	0.77	0.53	0.43	0.36	0.29	0.25	0.22	0.18	0.14

Table 4. *Influence of fixing screws ΔU_f. The amount of screws is 0.7 pcs/m^2 (Ø 6.3 mm).*

Material	Δu_f, w/m²k								
	Panel thickness, mm								
	50	**80**	**100**	**120**	**150**	**175**	**200**	**240**	**300**
Carbon steel	0.02	0.013	0.01	0.009	0.007	0.006	0.005	0.004	0.004
Stainless steel	0.007	0.006	0.003	0.003	0.002	0.002	0.0015	0.001	0.001

Figure 3. *Linear thermal transmittance (Ψ-value) for some basic detail solutions.*

Ψ = 0.12 W/m

Ψ = 0.00 W/m

Ψ = 0.02 W/m for a 100 mm panel and 0.008 W/m for a 200 mm panel

1.7 TIGHTNESS

Panels intended for external walls are usually delivered with an on-line installed sealant in internal and external grooves. Panels for high or vertically installed facades always have to be provided with sealant in both grooves of the joint (see section 1.7.2).

1.7.1 AIR TIGHTNESS

Air tightness is an important factor influencing the energy consumption, migration of moisture into the structures and dirt penetration. Special attention should be paid to:

- detail solutions at foundation and roof junctions
- window and door details
- the installations of panels
- panels used in very humid conditions.

Table 5. *The air tightness of PAROC structures at pressure difference 50 Pa according to EN 14509.*

Air tightness classification	
Installation direction and sealing	**Classification, m^3/m^2h**
Horizontal installation, sealant in both grooves	< 1.0
Horizontal installation, sealant only in internal groove	< 1.5
Vertical installation, sealant in both grooves	< 1.0 [1)]

[1)] For PAROC shadow panels < 1.5

These values are reached when the structures are designed and built according to PAROC panel details.

1.7.2 RAIN TIGHTNESS

Rain tightness of PAROC structures is classified in accordance with standard EN 14509 as follows:

- horizontal installation, sealant only in internal groove of the joint, structure rain tight up to 0.6 kN/m^2 (Class B)
- horizontal or vertical installation, sealant in both grooves of the joint, structure rain tight at least up to 1.2 kN/m^2 (Class A).

Based on the test results the following is recommended:

- in cases with wind loads up to 0.6 kN/m^2 and horizontally installed panels, use sealant in inside groove of the joint; if the wind loads exceed this value, use sealant in both grooves
- in buildings with vertically installed panels, use sealant in both grooves of the joint
- in high buildings and buildings with such forms that can locally cause high wind pressures, use sealant in both grooves of the joint
- detail solutions for windows, doors and other types of penetrations are to be made with flashings and sealants in order to obtain rain tightness, see detail drawings www.paroc.com/panelsystem
- the PAROC structural stone wool must be protected from long-term water influence e.g. during installation phase.

2 DIMENSIONING

2.1 GENERAL

PAROC panels are dimensioned in accordance with EN 14509. The design values E_d of the effects of the actions shall be calculated and shall be compared with the design values of the corresponding resistance R_d taking into account the appropriate material partial factors γ_m.

Ultimate limit state

$$E_d \leq R_d \text{ where}$$

$$E_d = \text{the effect of } \Sigma\, \gamma_{fi}\, \Psi_i\, S_{ki}$$

$$R_d = R_k / \gamma_m$$

Relevant load factors γ_f and combination coefficients Ψ for loads S_k have to be taken into account in accordance with national regulations. Value of the load factors 1.5 shall be used unless national regulatory requirements require other values.
In the ultimate limit state the design value of the resistance R_d in span curves and tables includes partial coefficients for material as in the table 6.

Table 6a. *Material safety factors γ_m for panel types AST®T, AST®S, AST®S+, AST®F, AST®F+ and AST®E.*

Material safety factors γ_m	Ultimate limit state	Serviceability limit state
Yielding of the face layer	1.10	1.00
Wrinkling of the face layer in the span and at an intermediate support	1.31	1.08
Shear of the core	1.31	1.08
Compression of the core	1.31	1.08
Failure of a fastener	1.33	1.00

Table 6b. *Material safety factors γ_m for panel types AST®L.*

Material safety factors γ_m	Ultimate limit state	Serviceability limit state
Yielding of the face layer	1.10	1.00
Wrinkling of the face layer in the span and at an intermediate support	1.21	1.08
Shear of the core	1.21	1.08
Compression of the core	1.21	1.08
Failure of a fastener	1.33	1.00

Serviceability limit state

$$w_d \leq w$$

Load combinations for wind and temperature in the serviceability limit state are:

- $w_d = 1.0 \times w_{wind}$
- $w_d = 0.75 \times w_{wind} + 0.6 \times w_{temp}$
- $w_d = 0.75 \times 0.6 \times w_{wind} + 1.0\, w_{temp}$

In the absence of any other information from national standards, the following indicative deflection limits may be used:

- span/100 for walls with load and temperature gradient
- span/150 for walls without temperature gradient
- span/200 for ceilings without temperature gradient.

The temperature gradient is 55 °C for single-span external walls and 0 °C for internal walls and ceilings. See also section 2.5 Deflection. In fire-rated walls spans can be limited (see table 14). See also a dimensioning example in section 2.7.

The span curves are valid for carbon steel facings only. For other facing materials, please contact Paroc Panel System.

2.1.1 VERTICAL LOADS ON PANEL EDGES

PAROC panels do not transfer high vertical loads e.g. from roof structures. Yet in some cases the panel edges are subjected to vertical loads caused by e.g. the panel above or a window. The maximum allowed load on the panel edges is 2.5 kN/m.

The vertical load is normally transferred to the bearing frame by penetrating screws. More detailed information on the capacity of fixing screws can be found in section 6.

2.1.2 SUPPORT WIDTH

The required support width for PAROC panels is determined by the span, the current load directed on the panel, the structure tolerances and the most practical way to install the panels. The recommended minimum practical support width is 50 mm for walls and 40 mm for ceilings. In multi-span structures, the minimum support width of the intermediate support is 60 mm. Note also the tolerances of the frame and the panels.

Figure 4. *Maximum allowed vertical load when the exposed panel edge is covered with U-profile.*

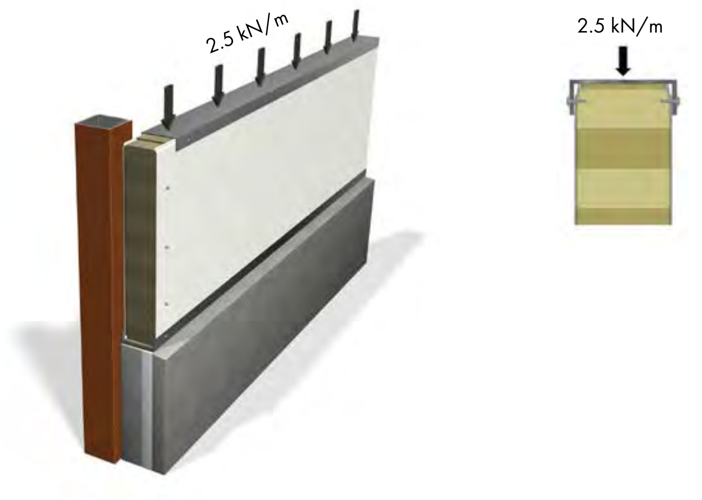
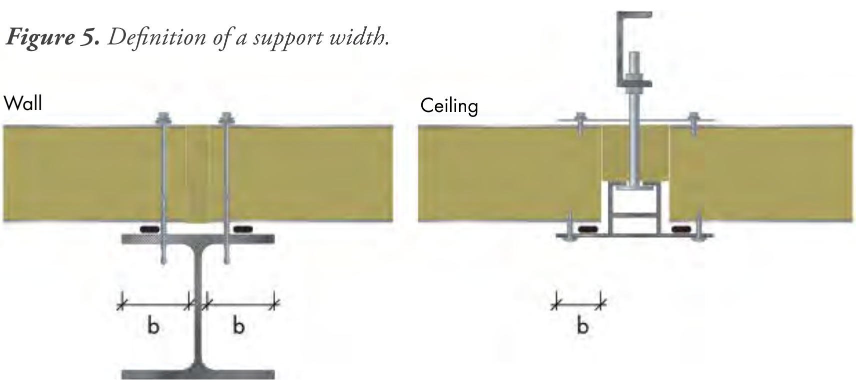


Figure 5. *Definition of a support width.*



When support width L_s is known the design value of the support resistance of panel F_{Rd} at the ultimate limit state can be calculated as follows:

at end support $F_{R1, end} = f_{Cc} \times B \times (L_s + 0.5 \times k \times e) / \gamma_M$

at internal support $F_{R2, int} = f_{Cc} \times B \times (L_s + k \times e) / \gamma_M$

When the design support force F_d is known the support width L_s can be calculated at the ultimate limit state as follows:

at end support $L_{s1,end} = (\gamma_M \times F_{d1, end} / f_{Cc}) – (0.5 \times k \times e)$

at internal support $L_{s2,int} = (\gamma_M \times F_{d2,int} / f_{Cc}) – (k \times e)$

where

F_d = design support force, kN/m

F_R = design value of the support resistance of panel, kN

f_{Cc} = declared value of the compression strength of the core, see table 7

L_s = support width (m)

k = distribution parameter = 0.5

e = distance between centroids of the faces, m
~ actual thickness of panel – 0.001 m, see table 2

B = overall width of panel = 1.2 m

γ_M = partial safety factor of stone wool for compression = 1.31

Table 7. *Compression strength of PAROC panels.*

Compression strength f_{Cc}, kN/m²						
Panel type						
AST® L	AST® T	AST® S	AST® S+	AST® F	AST® F+	AST® E
42	45	60	60	90	90	110

2.2 EXTERNAL WALLS

2.2.1 LOADS FOR EXTERNAL WALLS

External walls are dimensioned for wind loads determined by the customer. Load safety factors and pressure coefficients and partial coefficients for load have to be taken into account in accordance with national regulations as follows:

$$S_d = \gamma_d \times (C_{pe} - C_{pi}) \times q_k$$

where

S_d = design wind load
γ_d = partial coefficients for load
C_{pe} = exterior pressure coefficient
C_{pi} = interior pressure coefficient
q_k = characteristic value of wind load

If allowed by national standards, the panels can be dimensioned for the prevailing wind load at any given height of a building.

Figure 6. *Wind load as a function of building height.*

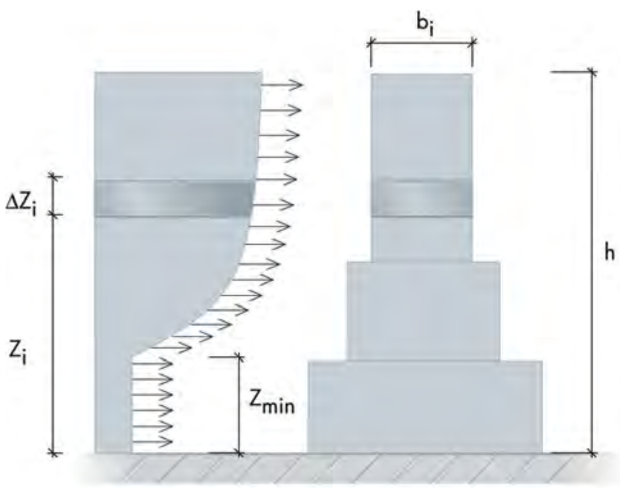
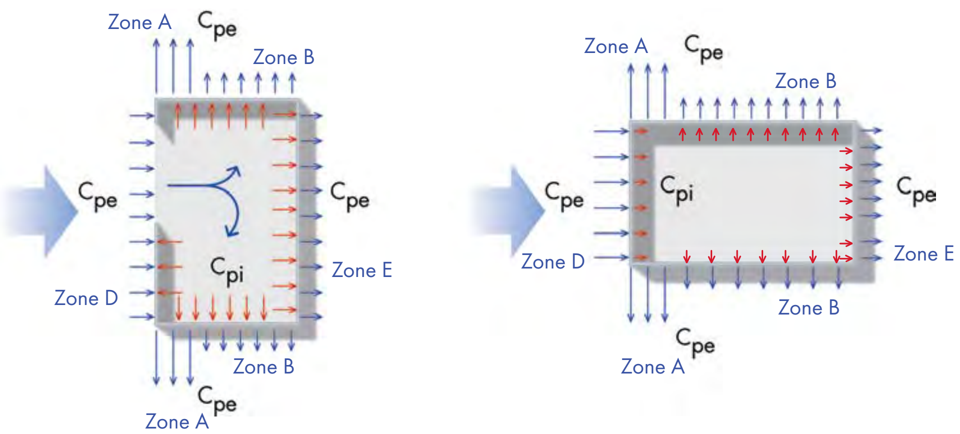


Figure 7. *Pressure coefficients.*

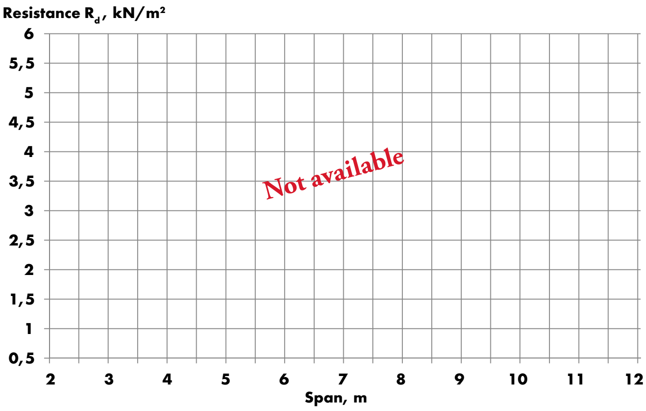


2.2.2 SPANS FOR SINGLE-SPAN EXTERNAL WALLS

- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.

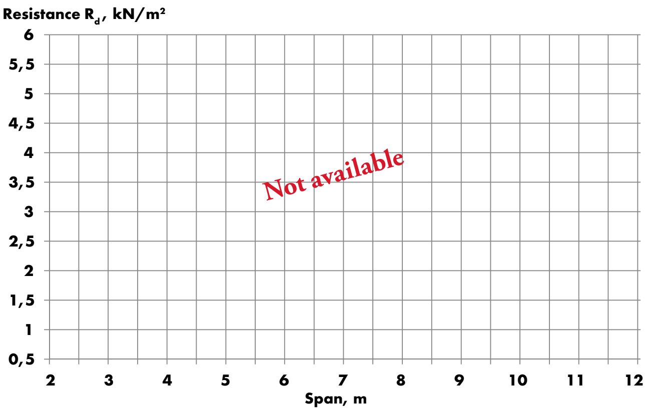
Figure 8a. *Spans for single-span external walls with temperature gradient, panel thickness 50 mm.*

Panel type AST® L 50 mm

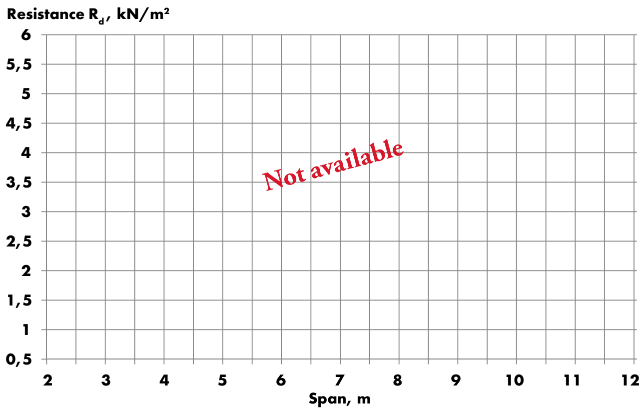


Panel type AST® T 50 mm

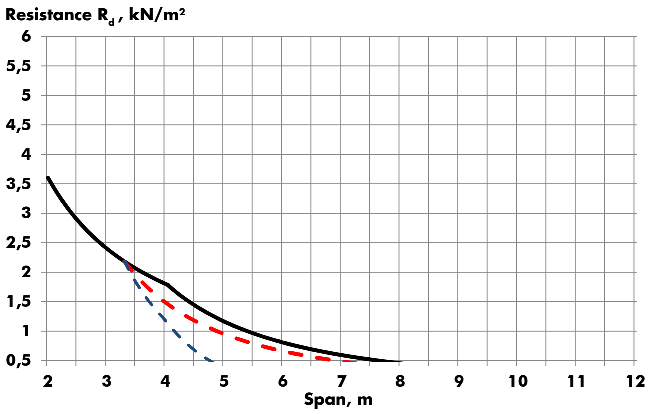
Panel type AST® S 50 mm

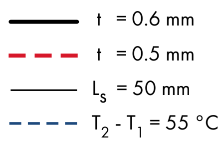


Panel type AST® F 50 mm

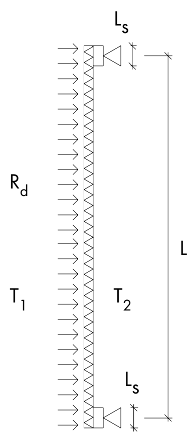


Panel type AST® E 50 mm



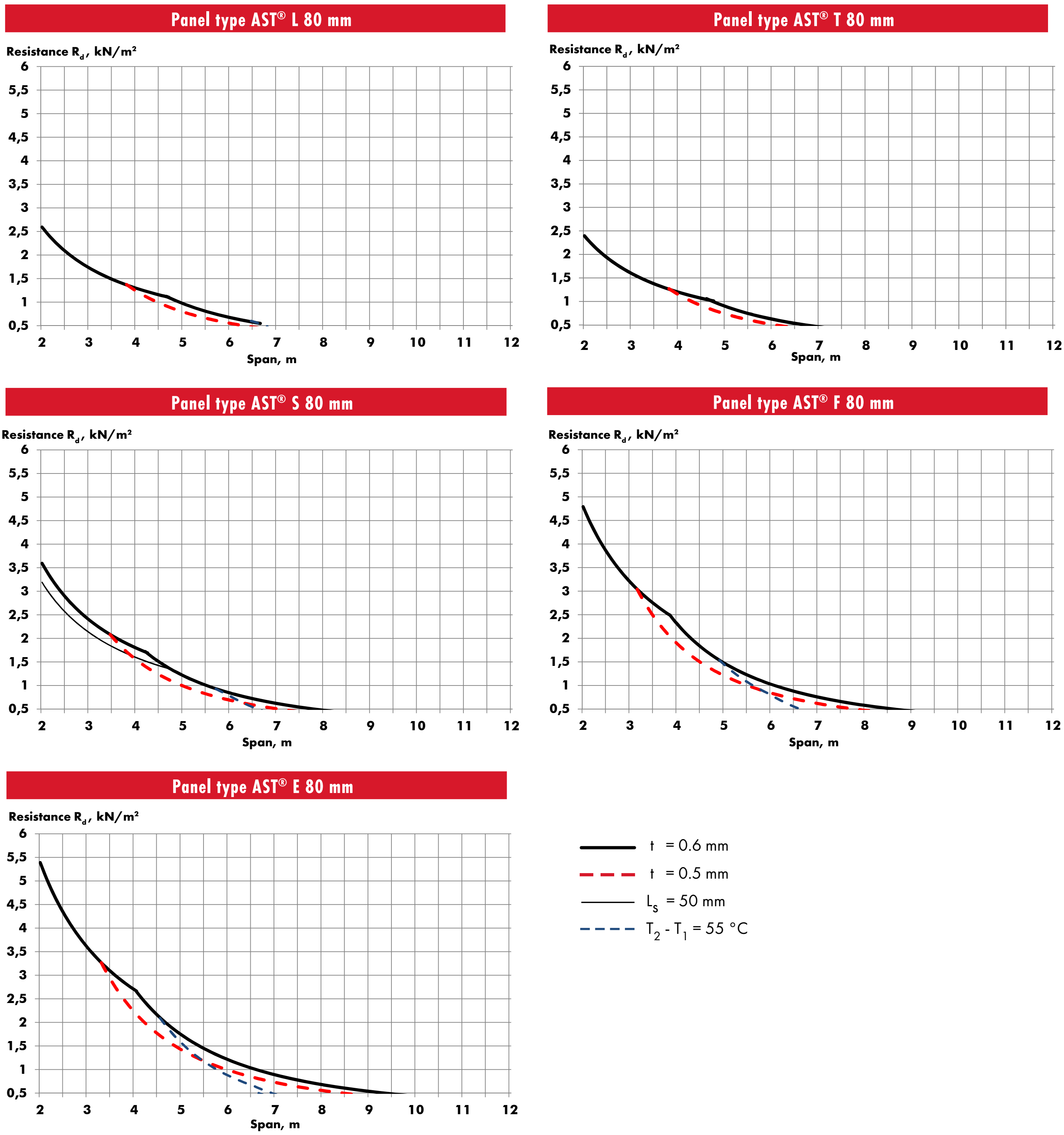


- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



t = steel sheet thickness
L_S = support width
T_2 - T_1 = 55 °C

Figure 8b. *Spans for single-span external walls with temperature gradient, panel thickness 80 mm.*



- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.

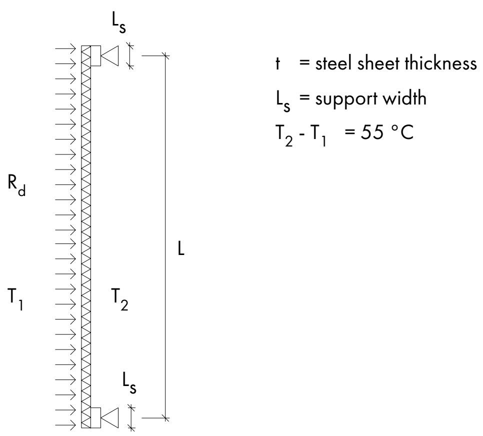
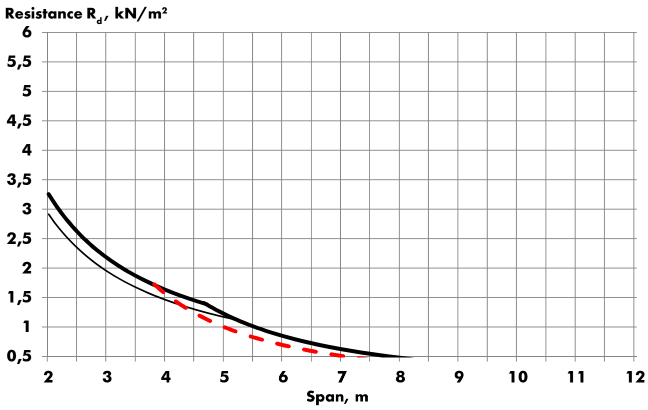
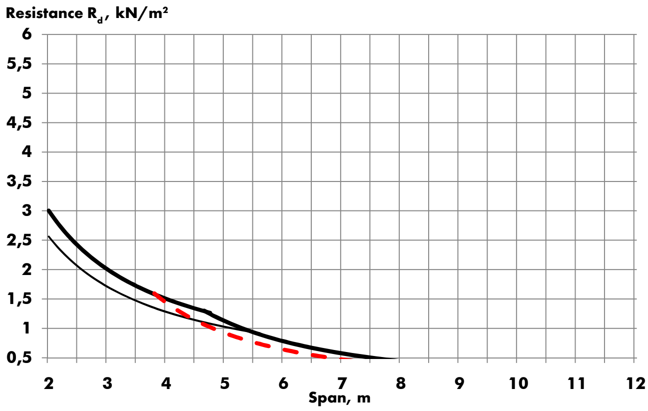


Figure 8c. *Spans for single-span external walls with temperature gradient, panel thickness 100 mm.*

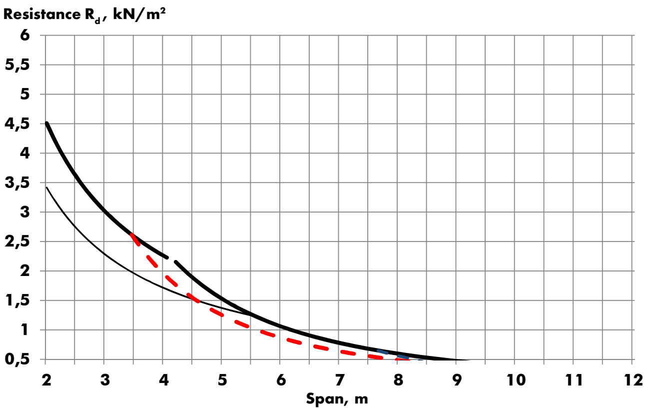
Panel type AST® L 100 mm



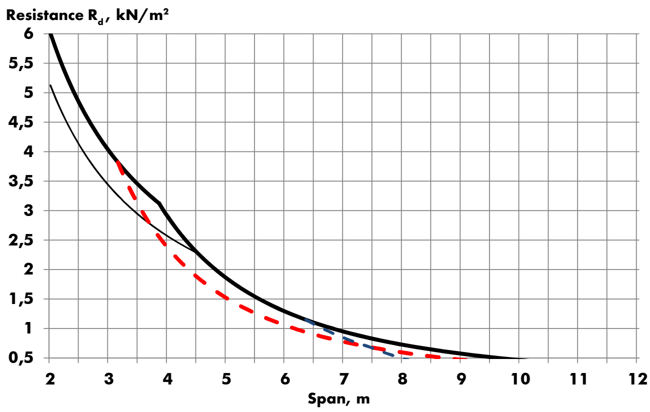
Panel type AST® T 100 mm



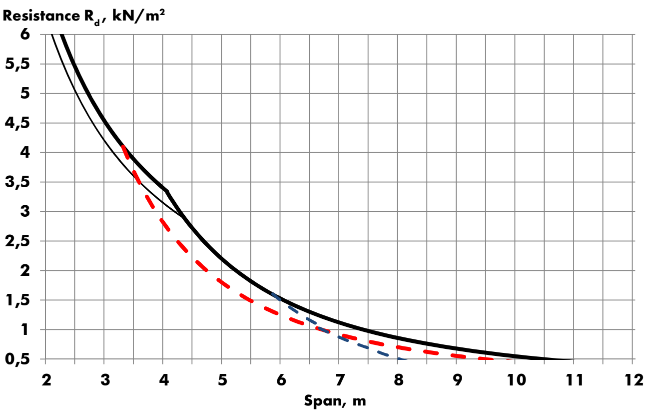
Panel type AST® S and AST® S+ 100 mm

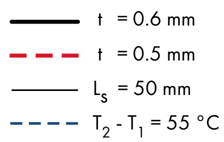


Panel type AST® F and AST® F+ 100 mm

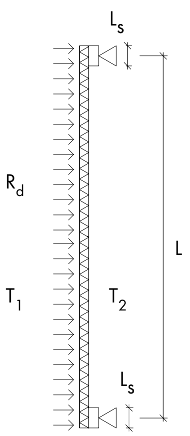


Panel type AST® E 100 mm





- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



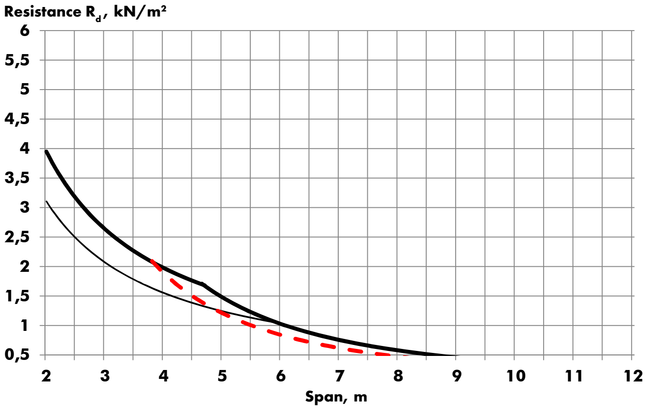
t = steel sheet thickness

L_S = support width

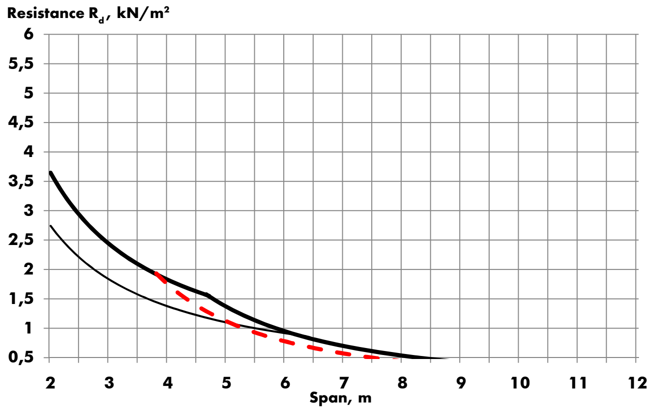
$T_2 - T_1$ = 55 °C

Figure 8d. *Spans for single-span external walls with temperature gradient, panel thickness 120 mm.*

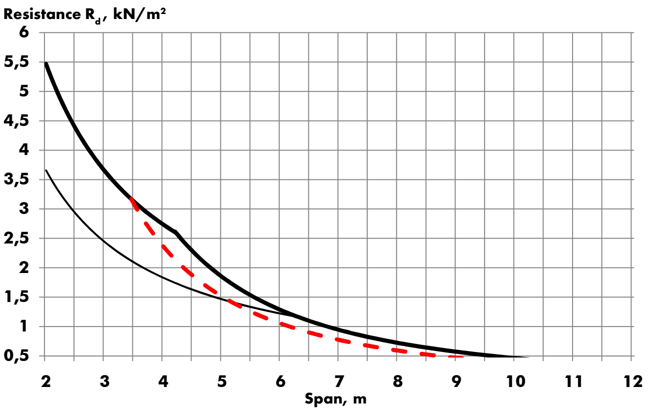
Panel type AST® L 120 mm



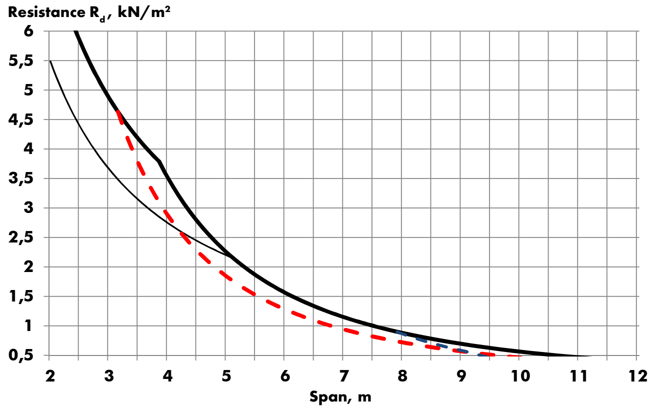
Panel type AST® T 120 mm



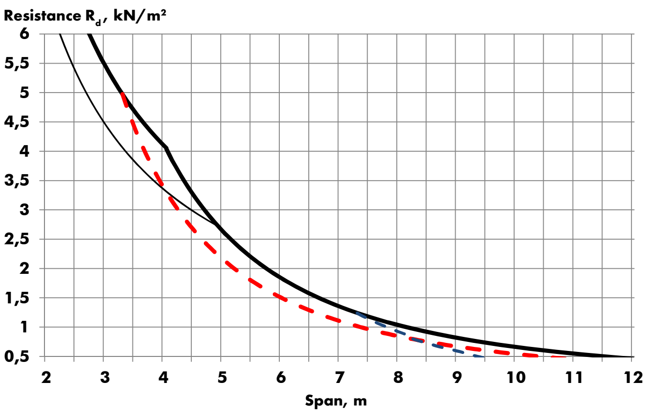
Panel type AST® S and AST® S+ 120 mm

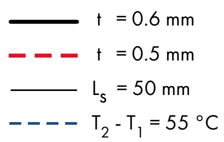


Panel type AST® F and AST® F+ 120 mm

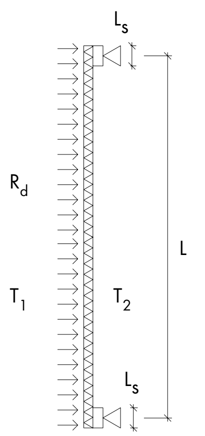


Panel type AST® E 120 mm





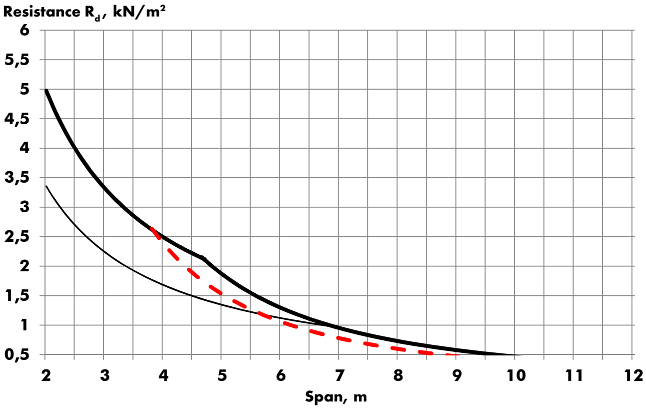
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



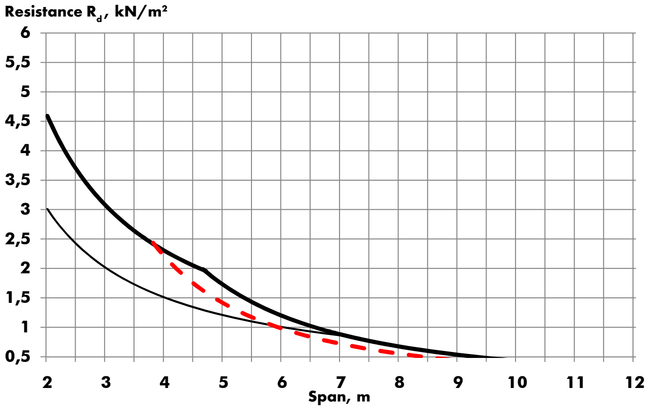
t = steel sheet thickness
L_s = support width
$T_2 - T_1$ = 55 °C

Figure 8e. *Spans for single-span external walls with temperature gradient, panel thickness 150 mm.*

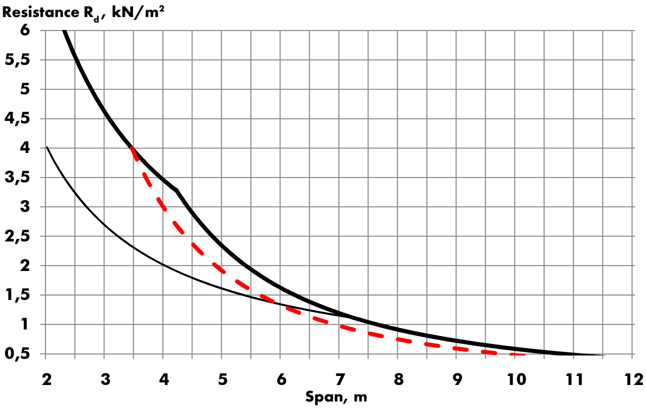
Panel type AST® L 150 mm



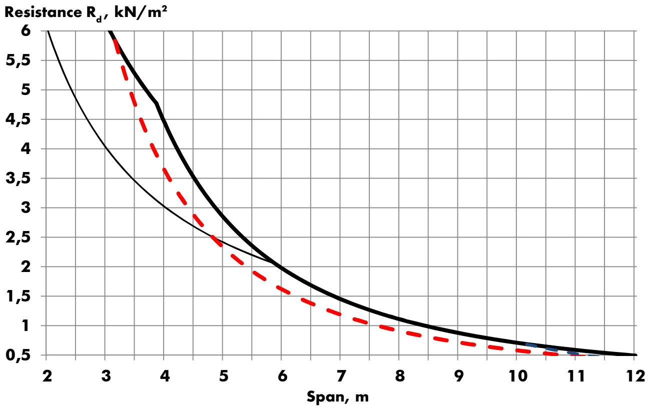
Panel type AST® T 150 mm



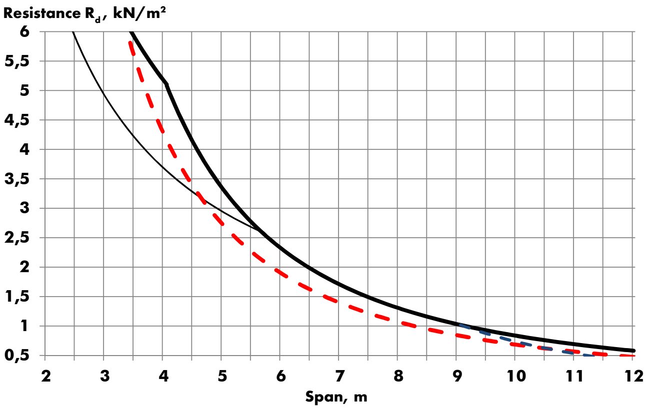
Panel type AST® S 150 mm

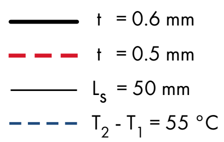


Panel type AST® F 150 mm

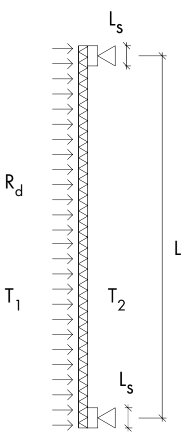


Panel type AST® E 150 mm





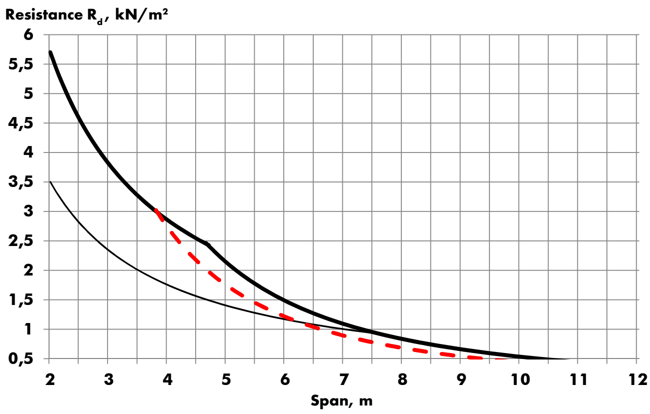
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



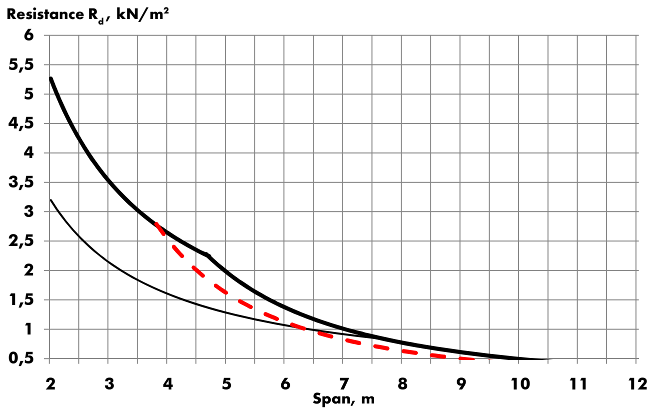
t = steel sheet thickness
L_s = support width
T_2 - T_1 = 55 °C

Figure 8f. *Spans for single-span external walls with temperature gradient, panel thickness 175 mm.*

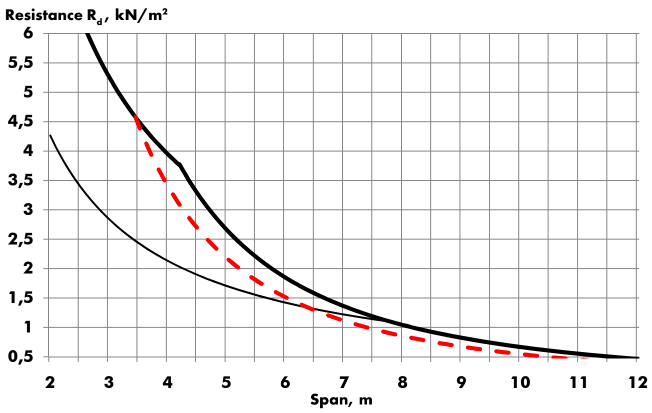
Panel type AST® L 175 mm



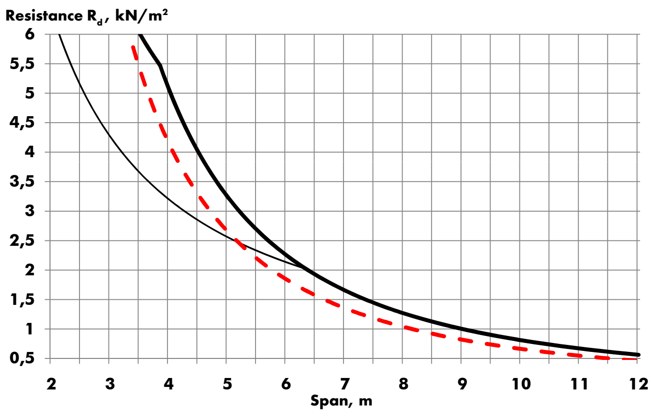
Panel type AST® T 175 mm



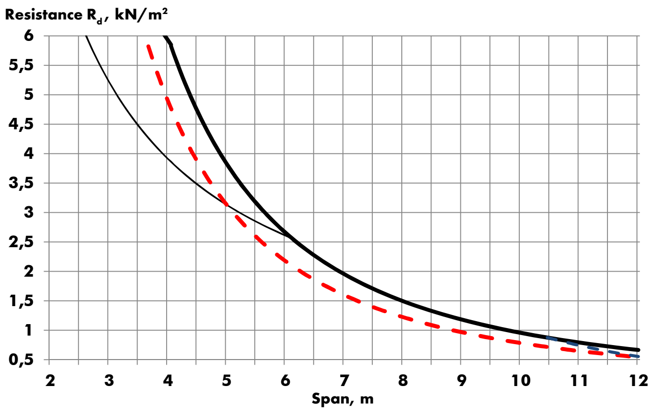
Panel type AST® S 175mm



Panel type AST® F 175 mm

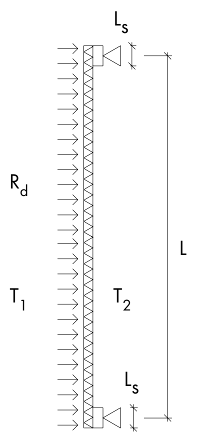


Panel type AST® E 175 mm



t = 0.6 mm
t = 0.5 mm
L_s = 50 mm
$T_2 - T_1$ = 55 °C

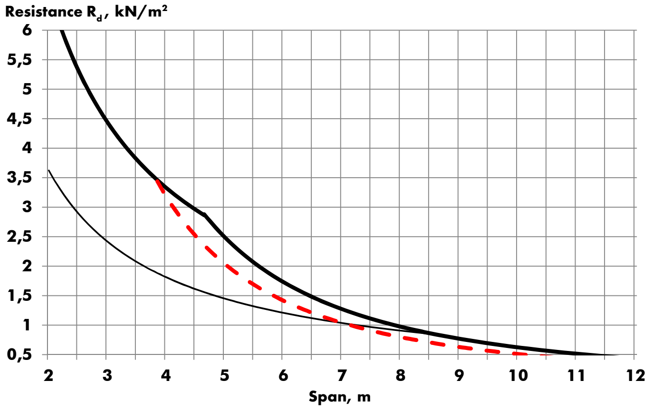
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



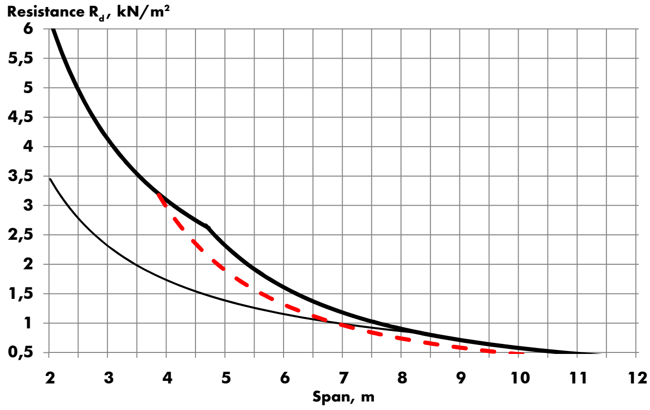
t = steel sheet thickness
L_s = support width
$T_2 - T_1$ = 55 °C

Figure 8g. *Spans for single-span external walls with temperature gradient, panel thickness 200 mm.*

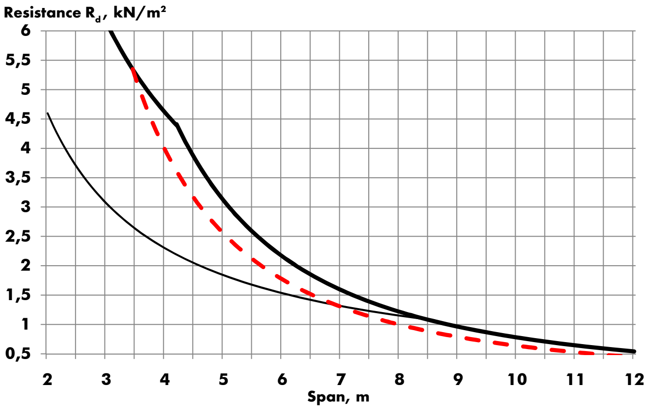
Panel type AST® L 200 mm



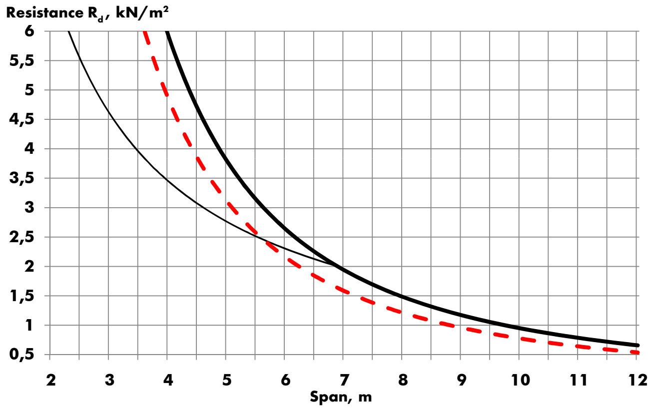
Panel type AST® T 200 mm



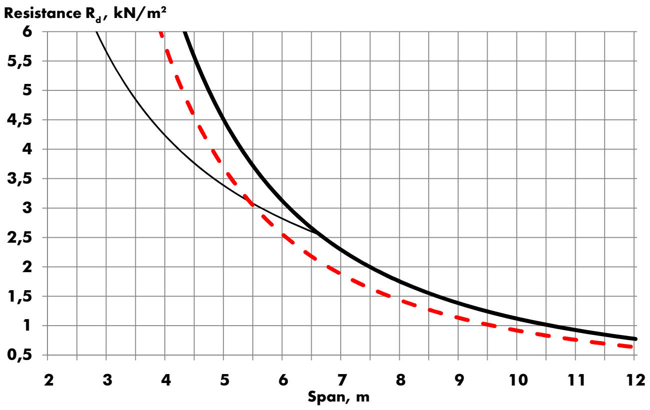
Panel type AST® S 200 mm

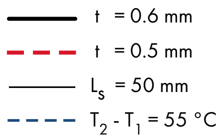


Panel type AST® F 200 mm

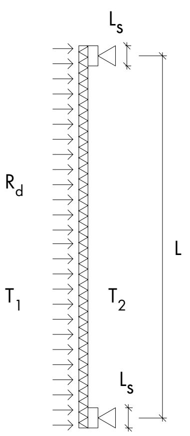


Panel type AST® E 200 mm





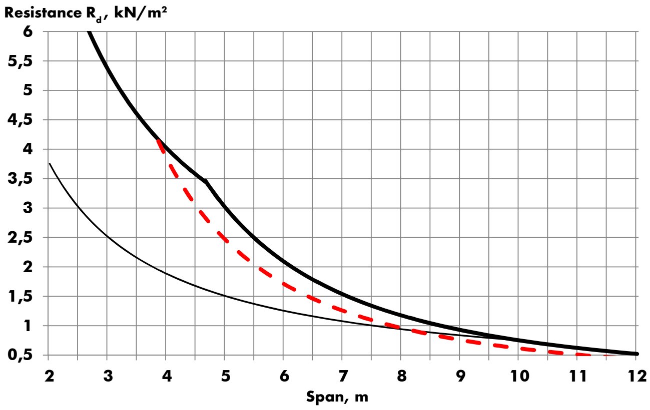
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



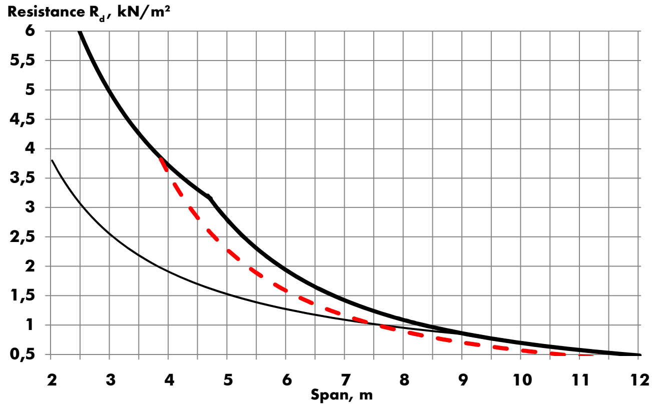
t = steel sheet thickness
L_S = support width
T_2 - T_1 = 55 °C

Figure 8b. *Spans for single-span external walls with temperature gradient, panel thickness 240 mm.*

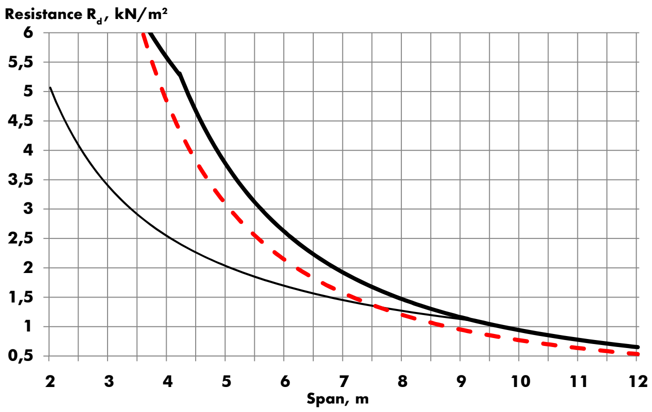
Panel type AST® L 240 mm



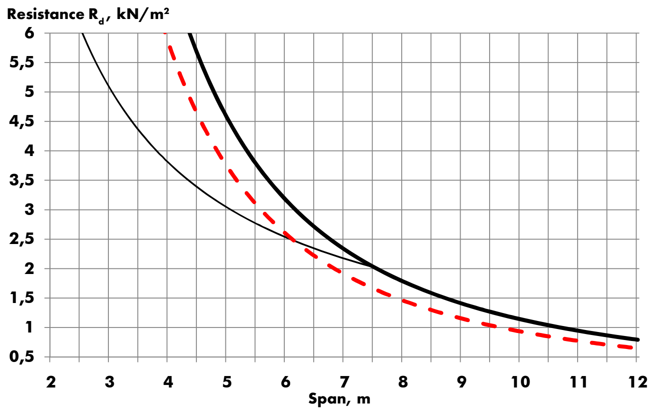
Panel type AST® T 240 mm



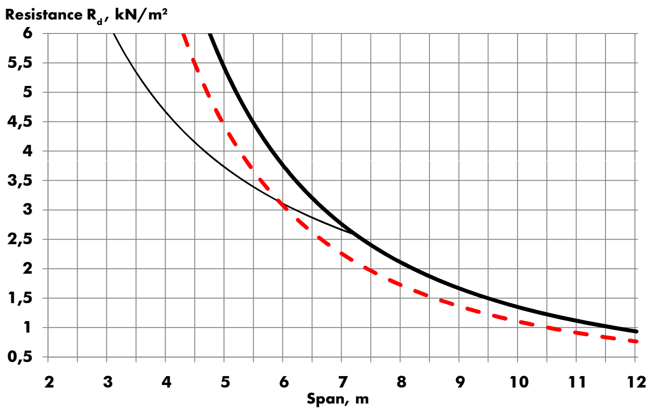
Panel type AST® S 240 mm

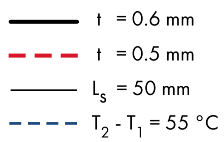


Panel type AST® F 240 mm

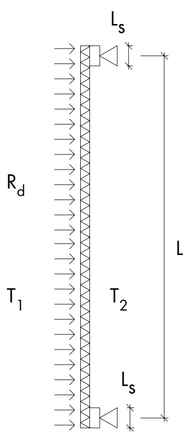


Panel type AST® E 240 mm





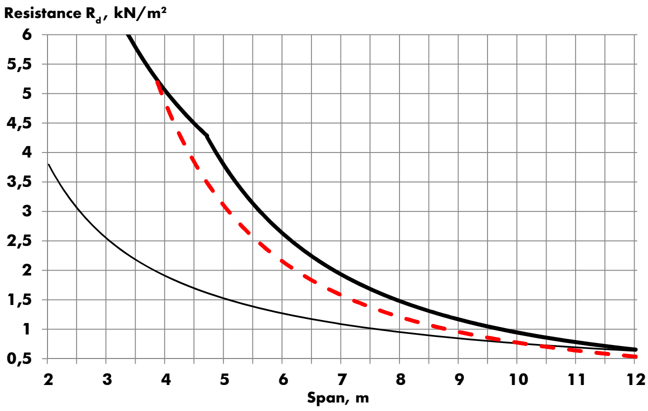
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



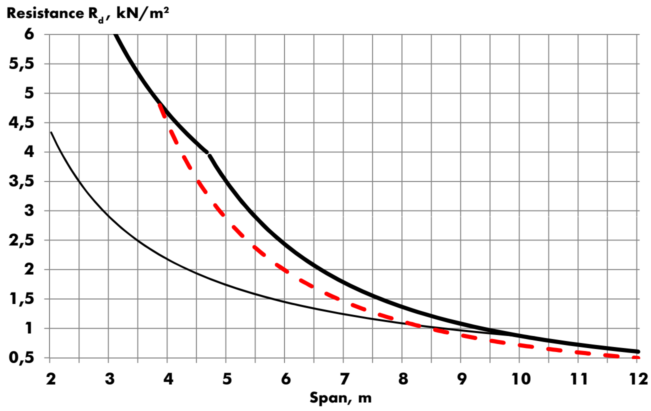
t = steel sheet thickness
L_S = support width
T_2 - T_1 = 55 °C

Figure 8i. *Spans for single-span external walls with temperature gradient, panel thickness 300 mm.*

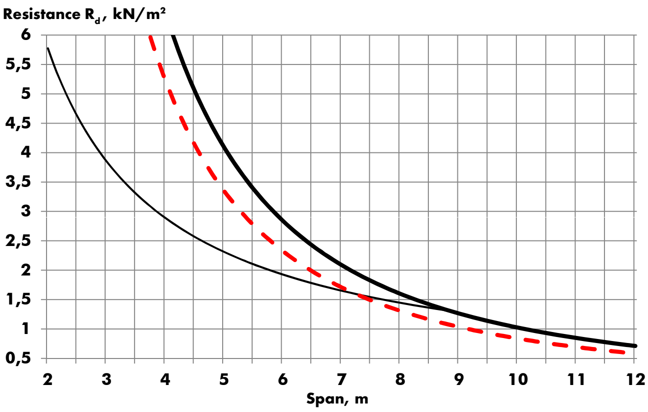
Panel type AST® L 300 mm



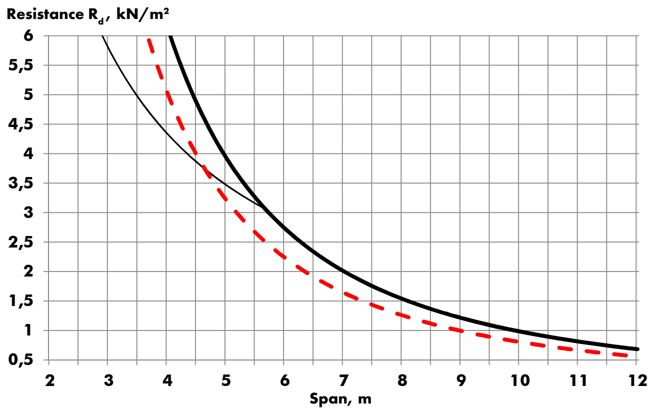
Panel type AST® T 300 mm



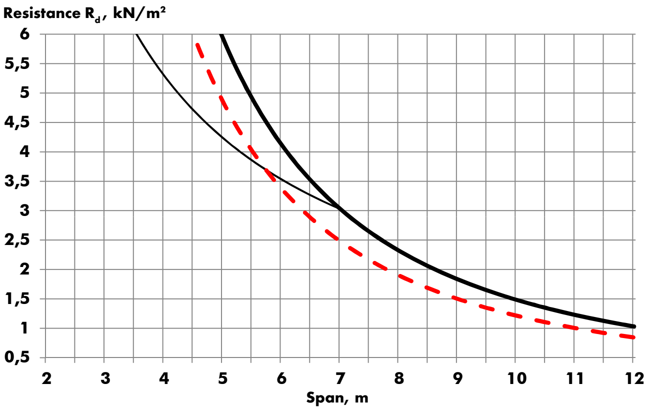
Panel type AST® S 300 mm

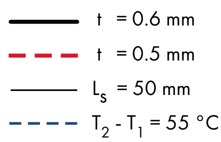


Panel type AST® F 300 mm

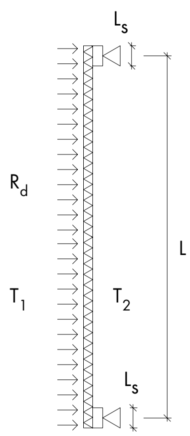


Panel type AST® E 300 mm





- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.2.1.
- In fire-rated walls spans can be limited (see table 14).
- See also a dimensioning example in section 2.7.



t = steel sheet thickness
L_s = support width
$T_2 - T_1$ = 55 °C

2.2.3 SPANS FOR MULTI-SPAN EXTERNAL WALLS

In multi-span structures the panels at intermediate supports are subject to both shear force and bending moment caused by the load. In addition, there is a bending moment caused by the temperature gradient over the panel. Therefore the spans have been limited. Support widths and number of fixings have to be dimensioned case by case.

Table 8. *Spans for multi-span external walls, panel type AST® S.*

- pressure coefficient C_p 1.0 / -1.0
- external steel sheet 0.6 mm and internal steel sheet 0.5 mm
- intermediate support width ≥ 60 mm
- max deflection L/100
- colour group from table 10

Panel thickness, mm	Colour group	2-span, m			3-span, m		
		Wind load, kN/m²			Wind load, kN/m²		
		0.5	0.8	1.1	0.5	0.8	1.1
50	I	3.02	2.67	2.46	4.00	3.34	2.91
	II	3.02	2.67	2.46	4.00	3.34	2.91
	III	2.01	1.92	1.85	2.40	2.15	2.00
80	I	3.48	3.11	2.88	4.00	3.86	3.40
	II	3.48	3.11	2.88	4.00	3.86	3.40
	III	2.27	2.18	2.12	2.51	2.32	2.18
100	I	3.75	3.37	3.13	4.00	4.00	3.66
	II	3.75	3.37	3.13	4.00	4.00	3.66
	III	2.44	2.36	2.30	2.60	2.44	2.32
120	I	3.96	3.59	3.35	4.00	4.00	3.88
	II	3.96	3.59	3.35	4.00	4.00	3.88
	III	2.54	2.46	2.40	2.57	2.44	2.34
150	I	4.17	3.82	3.58	4.00	4.00	4.00
	II	4.17	3.82	3.58	4.00	4.00	4.00
	III	2.78	2.62	2.56	2.60	2.50	2.42
175	I	4.28	3.94	3.72	4.00	4.00	4.00
	II	4.23	3.90	3.55	4.00	4.00	4.00
	III	2.72	2.66	2.61	2.52	2.45	2.39
200	I	4.37	4.06	3.84	4.00	4.00	4.00
	II	4.20	3.92	3.73	4.00	4.00	4.00
	III	2.76	2.7	2.66	2.48	2.42	2.37
240	I	4.42	4.16	3.96	4.00	4.00	4.00
	II	4.06	3.86	3.40	4.00	4.00	3.82
	III	2.76	2.72	2.36	2.36	2.33	2.36
300	I	3.91	3.74	3.62	3.89	3.63	3.44
	II	2.88	2.84	2.80	2.40	2.37	2.34
	III	2.19	2.18	2.00	1.69	1.68	1.68

2.3 INTERNAL WALLS

2.3.1 LOADS FOR INTERNAL WALLS

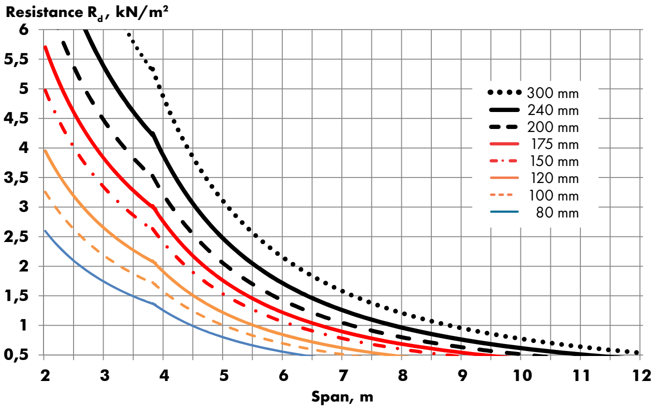
Internal walls are dimensioned for loads determined by the customer. Load factors, pressure coefficients and partial coefficients for load have to be taken into account in accordance with national regulations. The design load S_d shall be at least 0.5 kN/m^2 because internal walls are often subject to the highest load during the construction phase when the panels are moved and handled on site.

2.3.2 SPANS FOR SINGLE-SPAN INTERNAL WALLS

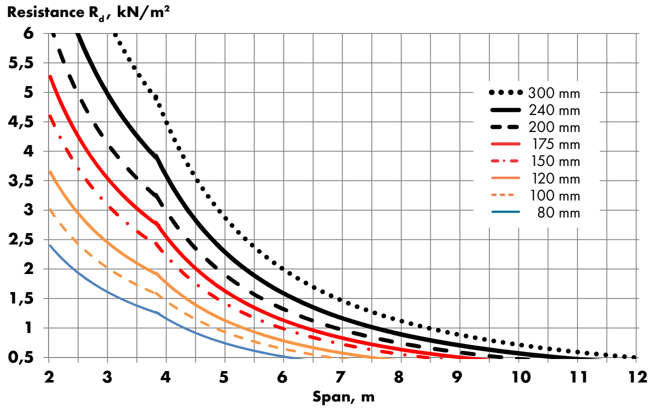
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.3.1.
- In fire-rated walls spans can be limited (see table 14).

Figure 9. *Spans for single-span internal walls without temperature gradient, panel thickness 50–300 mm.*

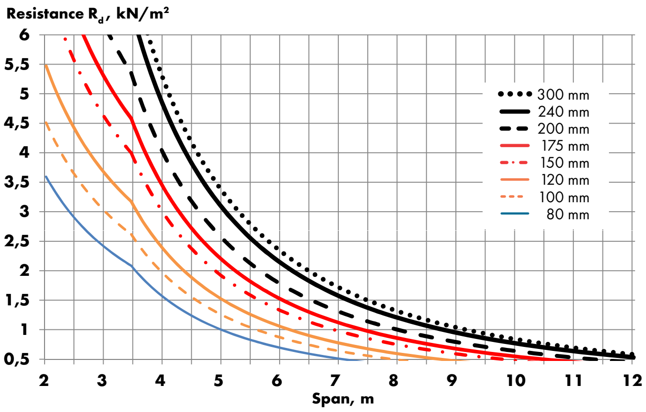
Panel type AST® L



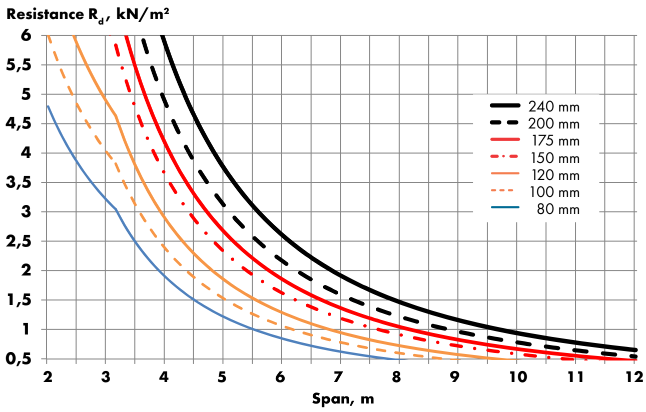
Panel type AST® T



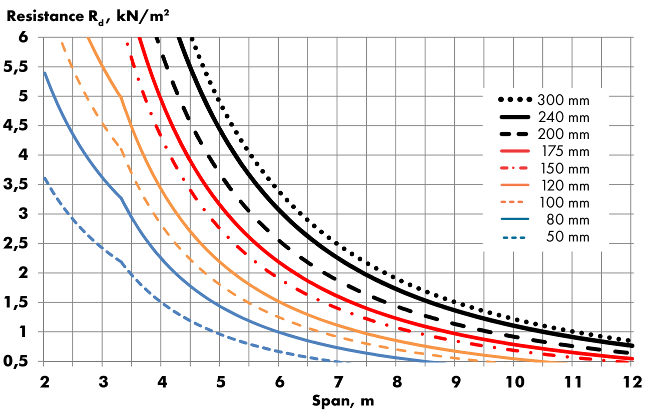
Panel type AST® S and AST® S+



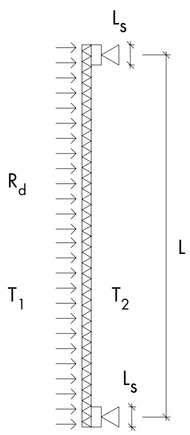
Panel type AST® F and AST® F+



Panel type AST® E



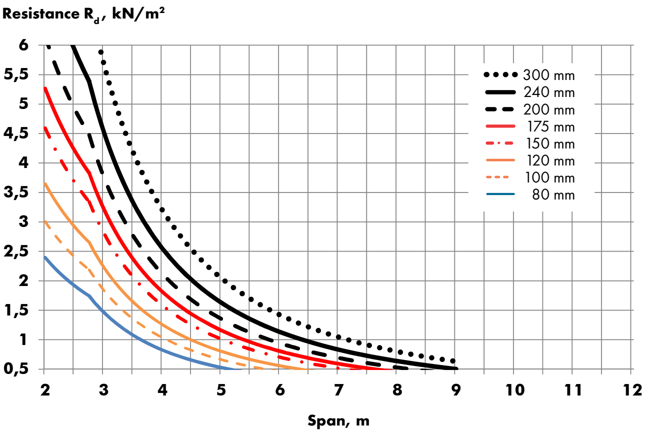
- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.3.1.
- In fire-rated walls spans can be limited (see table 14).



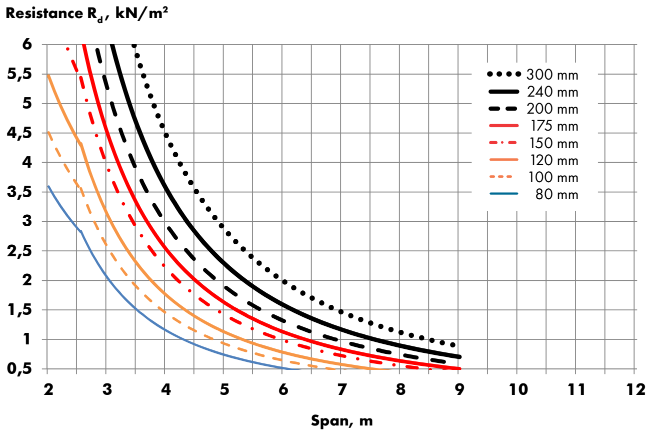
$T_2 – T_1 = 0$ °C
Thickness of the perforated steel sheet
t = 0.5 mm
Support width L_s = 50 mm

Figure 10. *Spans for PAROC acoustic panels in single-span internal walls without temperature gradient.*

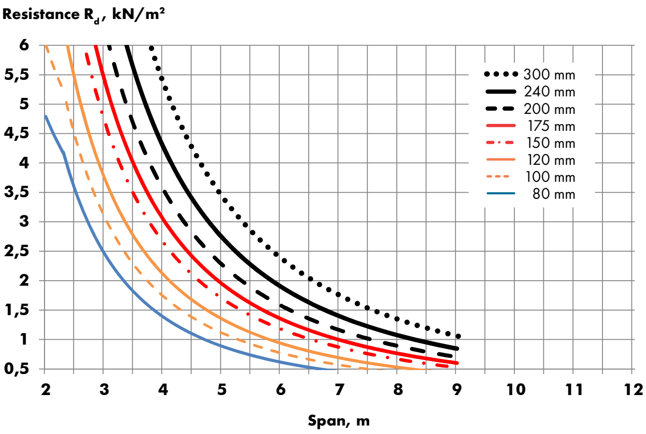
Panel type AST® L and AST® T 80–300 mm



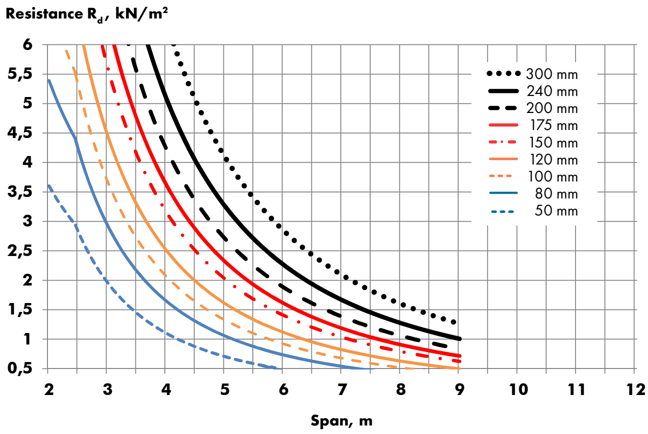
Panel type AST® S 80–300 mm



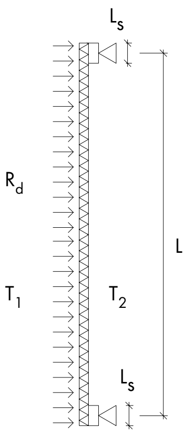
Panel type AST® F 80–300 mm



Panel type AST® E 100–300 mm



- R_d is panel's design value of the resistance including material safety factors (not load safety factors). These curves are calculated for uniformly distributed load in the ultimate limit state.
- Design value of the load S_d it to be determined according to section 2.3.1.
- In fire-rated walls spans can be limited (see table 14).



$T_2 - T_1 = 0$ °C
Thickness of the perforated steel sheet
t = 0.6 mm
Support width L_s = 50 mm

2.4 CEILINGS

2.4.1 LOADS FOR CEILINGS

Ceilings are divided in two types, non-walk-on ceilings and walk-on ceilings:

- **Non-walk-on ceilings** are dimensioned only for the panel dead weight and possible loads from suspensions in the panels. No walking is allowed on these ceilings after installation nor to use the ceiling as support for equipment, ducts etc.
- **Walk-on ceilings** can be dimensioned for the panel dead weight, point load for foot traffic and uniformly distributed service load of 25 kg/m² if no other load information is available.

PAROC panels are not intended to be used as permanent working surfaces, nor are they intended to be used as support for machines, ducts etc. Such devices are to be suspended from a separate load-bearing structure. If the walk-on ceiling has to be protected (see section 2.4.3), the weight of the protection has to be taken into account in dimensioning.

2.4.2 SPANS FOR SINGLE-SPAN CEILINGS

Panel type AST® E is always used in ceilings.

Table 9. *Spans for PAROC panel type AST® E in walk-on and non-walk-on ceilings. These values are even valid for PAROC acoustic panels when the perforated surface is downwards.*

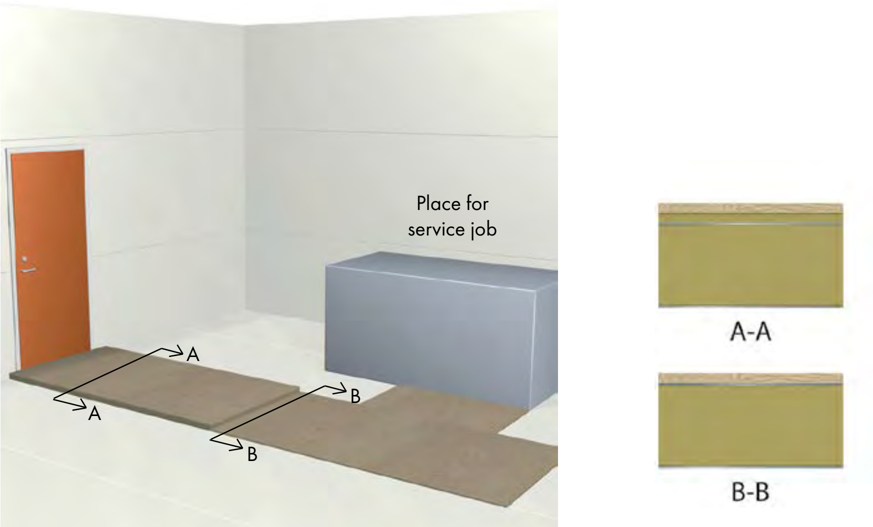
- loads according to section 2.4.1
- upper steel sheet 0.6 mm and lower steel sheet 0.5 mm
- support width ≥ 40 mm
- temperature gradient over the panel 0 °C
- max deflection L/200

Ceiling type	Maximum span, m								
	Panel thickness, mm								
	50	80	100	120	150	175	200	240	300
Walk-on	3.7	5.1	6.1	7.0	8.1	8.9	9.8	10.6	10.9
Non-walk-on	4.4	6.1	7.3	8.3	9.6	10.5	11.4	12.0	12.0

2.4.3 PROTECTION OF WALK-ON CEILINGS

Normal, temporary foot traffic does not damage the panels. Where heavy foot traffic occurs, such as ascending spots, doorways and equipment installation locations, the panels should be protected using load-distributing boards on top of 10 - 20 mm thick rigid mineral wool. For other walkways and installation places a 15 mm thick plywood board protection is enough. Loads from permanent walkways on PAROC ceilings should be transferred to the bearing frame.

Figure 11. *Protection of ceilings.*



Heavy loads, such as blowers etc. applied during installation, have to be checked. The panels should always be protected during the installation phase using load-distributing plywood boards. Such protection should also be used for stepladders etc. point loads.

Cut-outs in the ceiling weaken the panel strength. Foot traffic close to cut-outs should be avoided.

2.5 DEFLECTION

The panels deflect due to imposed loads, e.g. in the form of wind pressure and wind suction, and due to temperature gradient over the panel. It is important to take the deflection into account in the design of details.

Thermal deflection is defined as a bending deformation due to the temperature gradient over the panel thickness. The panel deflects towards the warmer face.
The following face temperature values can be used if no other values are known:

- **Interior face**
  +20 °C in winter
  +25 °C in summer

- **Exterior face**
  the lowest value in winter
  -20 °C in Central Europe
  -30 °C in Northern Europe
  the highest value in summer depends on the surface colour and reflecting capacity, see table 10.

Table 10. *Colour groups, absorption coefficients and temperatures for the exterior surfaces in summer.*

Colour group	Colours	Absorption coefficient	Temperature of external surface
I	RR20, R106, R108, R143, R807	10–25 %	+55 °C
II	RR21, RR24, RR34, RR40	25–60 %	+65 °C
III	R502, RR23, RR35, RR29, RR41, stainless steel	60–92 %	+80 °C

Table 11. *Deflection due to temperature gradient over the panel. For other temperature gradients the deflections can be calculated by multiplying the values from the table in proportion to the temperature gradient.*

Span, m	ΔT, °C	Deflection, mm Panel thickness, mm							
		80	100	120	150	175	200	240	300
3.0	40	7	6	5	4	3	3	2	2
	55	9	8	6	5	4	4	3	2
4.5	40	15	12	10	8	7	6	5	4
	55	21	17	14	11	10	8	7	6
6.0	40	27	22	18	14	13	11	9	7
	55	38	30	25	20	17	15	12	10
7.5	40	42	34	28	22	20	17	14	11
	55	59	47	39	31	27	23	19	15
9.0	40	61	49	40	32	28	24	20	16
	55	85	68	57	44	39	33	28	22

Table 12. *Deflection due to a uniform load.*

Span, m	Load, kN/m²	Deflection, mm Panel thickness, mm							
		80	100	120	150	175	200	240	300
3.0	0.1	1	1	1	1	1	1	1	0
	0.3	2	2	1	1	1	1	1	0
	0.6	4	3	2	2	1	1	1	1
	1.0	7	5	4	3	2	2	2	1
4.5	0.1	2	2	1	1	1	1	1	0
	0.3	7	5	4	3	2	2	1	1
	0.6	15	10	8	5	4	3	3	2
	1.0	–	17	13	9	7	6	4	3
6.0	0.1	7	5	3	2	2	1	1	1
	0.3	20	14	10	7	5	4	3	2
	0.6	38	25	20	13	11	8	6	4
	1.0	–	–	33	22	18	14	10	7
7.5	0.1	15	10	7	5	4	3	2	1
	0.3	46	30	21	14	11	9	6	4
	0.6	–	–	43	28	22	17	13	9
	1.0	–	–	–	47	37	29	21	15
9.0	0.1	30	20	14	9	7	5	4	3
	0.3	–	57	42	27	21	16	12	8
	0.6	–	–	–	55	43	32	23	16
	1.0	–	–	–	–	71	54	39	26

Normally the deflection due to load in the serviceability limit state is of interest. This means the wind load occurring a couple of times annually and not the load dimensioning the panel, which in most standards is a wind load occurring about once in 50 years.

Table 13. *Wind load as a function of wind speed.*

Type	Wind speed and wind load	
	Speed, m/s	Load, kN/m²
Light	3–5	0.01
Fresh breeze	8–11	0.05
Moderate gale	14–17	0.15
Storm	24–28	0.42
Hurricane	33	0.70

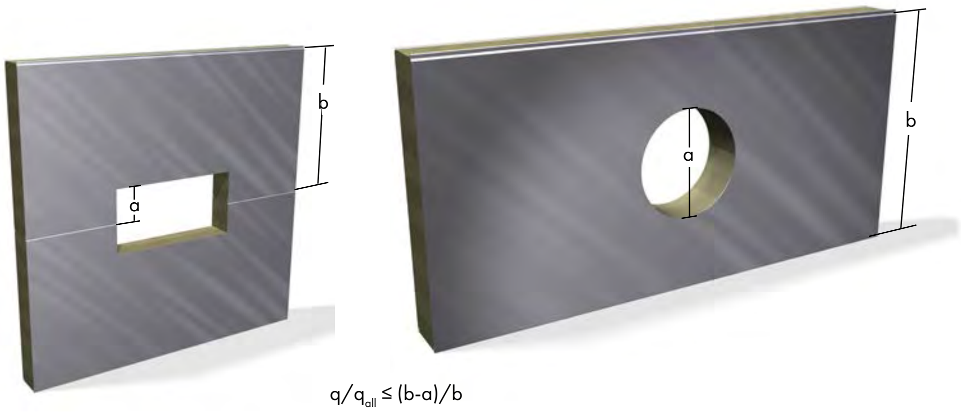
Figure 12. *Detail solutions taking deflection into account.*

2.6 OPENINGS AND CUT-OUTS

When dimensioning PAROC panels, it is to be taken into account that openings and cut-outs for doors, windows, pipe penetrations etc. weaken the panel strength. Panels with cut-outs are to be dimensioned to take the loads they are subject to irrespective of the openings. If this is not possible, loads directed on the panels are to be transferred to adjacent panels or using auxiliary structures to the building frame. In case of large openings the structures can be made of steel profiles transferring the load to the building main frame.

Cut-outs for pipe penetrations etc. are normally small and do not reduce the strength of PAROC panels so much that special measures are needed. If required, panels with higher strength class can be used at openings.

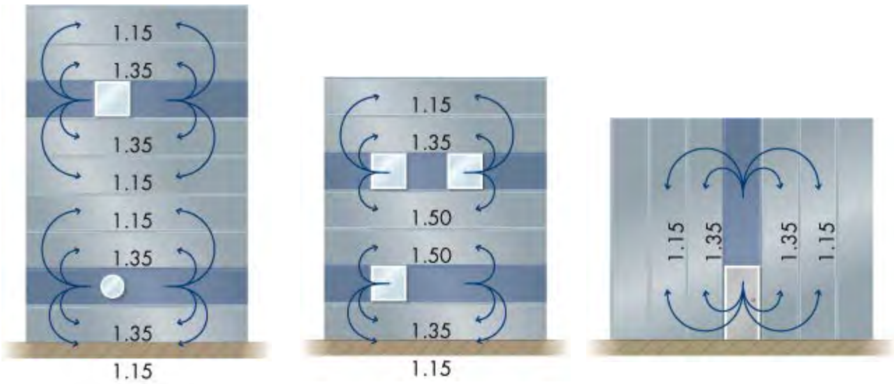
Figure 13. *Maximum load for panels with cut-outs q. Allowed load capacity for the whole panel q_{all} can be taken from the dimensioning curves at the actual span and with largest support width.*



$q/q_{all} \leq (b-a)/b$

If the degree of cut-out exceeds the ratio q/q_{all}, the load is either to be transferred to adjacent panels in accordance with figure 14 or, if this is not possible, to be directed on the load-bearing frame by auxiliary structures. See also dimensioning example in the following section.

Figure 14. *Load distribution factors.*



2.7 DIMENSIONING EXAMPLE

External wall, horizontal installation

Frame	Span L = 7.2 m
Panel type	AST® S
Panel thickness	200 mm
Facings	outside 0.6 mm, dark colour (colour group III, see table 10)
	inside 0.5 or 0.6 mm

Wind load	q_k = 0.7 kN/m², characteristic value
Load safety factor	γ_d = 1.5
Pressure coefficients	c_p = 0.7 (exterior pressure) + 0.3 (interior suction) = 1.0 (zone D)
	c_p = -0.8 (exterior suction) + 0.2 (interior pressure) = -1.0 (zone B)
	c_p = -1.2 (exterior suction) + 0.2 (interior pressure) = -1.4 (zone A)

Design wind pressure	$W_{d,D}$ = 1.5 x (1.0 x 0.7) kN/m² = 1.05 kN/m² (zone D)
Design wind suction	$W_{d,B}$ = 1.5 x (-1.0 x 0.7) kN/m² = -1.05 kN/m² (zone B)
	$W_{d,A}$ = 1.5 x (-1.4 x 0.7 kN/m² = -1.47 kN/m² (zone A)

The design value of resistance for the panel in question is obtained from the span curve in figure 8g.

In case of wind pressure (zone D) the resistance is determined by the panel external steel sheet, thickness 0.6 mm: $R_{d,0.6}$ = 1.5 kN/m² > $W_{d,D}$ = 1.05 kN/m²

In case of wind suction (zone B) the internal steel sheet is dimensioning, thickness 0.5 mm:
$R_{d,0.5}$ = 1.25 kN/m² > $W_{d,B}$ = |-1.05| kN/m²

In case of wind suction at corner (zone A) the internal steel sheet is dimensioning, thickness 0.6 mm is needed: $R_{d,0.5}$ = 1.5 kN/m² > $W_{d,A}$ = |-1.47| kN/m²

Thus the panels fulfil the requirement.

An opening

Assume that a window is installed in the panel. The window is 1200 mm high, i.e. equal to panel width.
In accordance with figure 14, the load distribution factor is 1.35 to adjacent panels and 1.15 to the next ones.

Load on adjacent panels when the load distribution factor is 1.35:
Design wind pressure $W_{d,D}$ = 1.35 x 1.5 x (1.0 x 0.7) kN/m² = 1.42 kN/m² (zone D)
Design wind suction $W_{d,B}$ = 1.35 x 1.5 x (-1.0 x 0.7) kN/m² = |-1.42| kN/m² (zone B)

The adjacent panels can thus take the load from the cut-out when the internal steel sheet thickness is 0.6 mm and $R_{d,0.6}$ = 1.5 kN/m² for the both steel sheets.

Load on the next panels when the load distribution factor is 1.15:
Design wind pressure $W_{d,D}$ = 1.15 x 1.5 x (1.0 x 0.7) kN/m² = 1.21 kN/m² (zone D)
Design wind suction $W_{d,B}$ = 1.15 x 1.5 x (-1.0 x 0.7) kN/m² = |-1.21| kN/m² (zone B)

The next panels can thus take the load from the cut-out when the internal steel sheet thickness is 0.5 mm and $R_{d,0.5}$ = 1.25 kN/m².

Support widths

The design value of resistance for the panel minimum support width of 50 mm in question is obtained from the same span curve in figure 8g.

In case of wind pressure (zone D) the resistance is determined by the panel minimum support width:

$$R_{d,support} = 1.28\ kN/m^2 > W_{d,D} = 1.05\ kN/m^2$$

In case of wind pressure on adjacent panels of the window when the load distribution factor is 1.35:
Design wind pressure $W_{d,D}$ = 1.35 x 1.5 x (1.0 x 0.7) = 1.42 kN/m² (zone D) is higher than $R_{d,support}$ of 50 mm.
The required support width is determined as follows (see also section 2.1.2 Support width):

$$L_s = ((1.31 \times 0.5 \times 7.2\ m \times 1.42\ kN/m^2)/60\ kN/m^2) - 0.5 \times 0.201\ m/2 = 0.061\ m \geq 61\ mm$$

Fastening with penetrating panel fixings

For determining the required number of fixing screws see section 6.2.1. Allowed load for penetrating panel fastener with washer ø 19 mm is F_{all} = 1.0 kN (see table 18).

The number of fixing screws/panel end is calculated as follows:
In case of wind suction (zone B)

N = 0.5 x 7.2 m x 1.2 m x (-1.0 x 0.7 kN/m²)/1.0 kN
= 3.0, which means 3 fasteners/panel end

In case of wind suction (zone A)

N = 0.5 x 7.2 m x 1.2 m x (-1.4 x 0.7 kN/m²)/1.0 kN
= 4.2, which means 5 fasteners/panel end

In case of wind pressure load on adjacent panels of the window when the load distribution factor is 1.35 (or if 1.5):

N = 0.5 x 7.2 m x 1.2 m x 1.35 x (-1.0 x 0.7 kN/m²)/1.0 kN
= 4.1 (or 4.5), which means 5 fasteners/panel end

In case of wind pressure load on the next panel of the window when the load distribution factor is 1.15:

N = 0.5 x 7.2 m x 1.2 m x 1.15 x (-1.0 x 0.7 kN/m²)/1.0 kN
= 3.5, which means 4 fasteners/panel end

Deflection

The deflection for the panel in question is obtained from the tables 11 and 12.
The deflection due to a uniform wind load is approximately 17 mm when wind suction (zone B) is w_k = (-0.8 - 0.2) x 0.7 kN/m^2 = - 0.7 kN/m^2.

The deflection due to temperature gradient over the panel with dark colour is approximately 22 mm when temperature gradient is (+80 °C – 25 °C) = +55 °C in summer.

Load combinations:
w_1 = 1.0 x 0.75 x 100 % x 17 mm + 1.0 x 60 % x 22 mm = 26 mm which means L/277.
w_2 = 1.0 x 0.75 x 60 % x 17 mm + 1.0 x 100 % x 22 mm = 30 mm which means L/240.
w_3 = 1.0 x 100 % x 17 mm = 17 mm which means L/424.

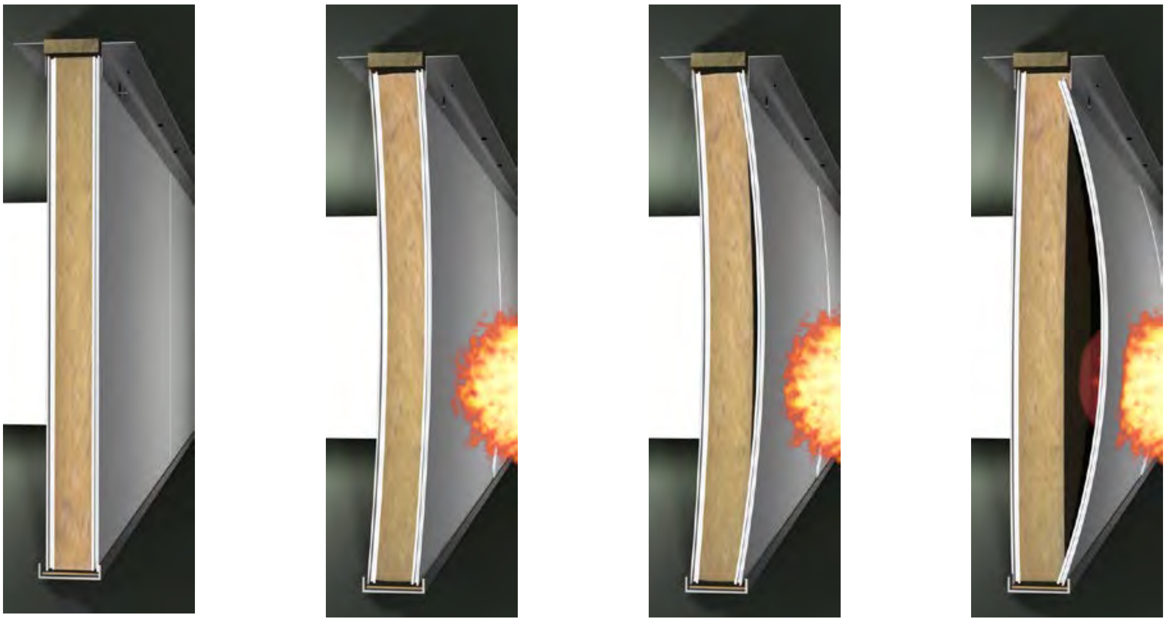
The deflection due to other load combinations is calculated correspondingly.
It is important to take the deflection into account in the design of details.

3 FIRE SAFE SOLUTIONS

3.1 GENERAL

PAROC panels are non-combustible, Euroclass A2-s1,d0 in accordance with the standard EN 13501-1 (PAROC® print and PAROC® art panels are classified in Euroclass C-s1,d0). Fire resistance for PAROC structures has been classified according to the standards EN 13501-2, EN 15254-5 and EN 15254-7.

Figure 15. *The behaviour of PAROC panels in fire.*



Before fire the floor will carry the dead load of the panel.

Panel bows towards fire; the floor will still carry the dead load of the panel.

Most of the flexural strength of the panel is lost when the bond between exposed face and core fails.
Panel dead load is then carried by suspension cleats.

The cold side of the panel bows outwards away from fire when temperature rises and the external steel sheet expands.
Panel dead load suspended by cleats.

3.2 FIRE-RATED WALLS

Fire-rated walls are non-loadbearing which means that it is not allowed to transfer loads from e.g. roof structures down onto a PAROC wall. Fire classifications in the table 14 are not valid for PAROC panels with facings of stainless steel or with facings of galvanized steel or PAROC acoustic panels.

Table 14. *Maximum spans for fire-rated walls and ceilings, valid for panels with facing of coated steel sheet.*

Panel type	Panel thickness, mm	Maximum spans for fire-rated walls, m Horizontal/Vertical installation							
		EI 15	EI 30	EI 45	EI 60	EI 90	EI 120	EI 180	EI 240
AST® L	150	12/12	12/12	12/12	12/11.1	11.7/10.6	9.9/10.6	–/4	
	175	12/12	12/12	12/12	12/11.1	11.7/10.6	9.9/10.6	–/4	
	200	12/12	12/12	12/12	12/11.1	11.7/10.6	9.9/10.6	–/4	
	240–300	12/12	12/12	12/12	12/11.1	11.7/10.6	9.9/10.6	–/4	
AST® T	80	4/4	4/4						
	100	4/12	4/12	4/4					
	120	4/12	4/12	4/12	4/4	–/4			
	150	12/12	12/12	12/12	4/4	–/4	–/4		
	175	12/12	12/12	12/12	11[1]/11[1]	4/4[1]	4/4[1]	4/4	
	200	12/12	12/12	12/12	11[1]/11[1]	4/4[1]	4/4[1]	4/4	
	240–300	12/12	12/12	12/12	11[1]/11[1]	4/12	4/12	4/12	4/4
AST® S	80	4/11[1]	4/11[1]						
	100	4/12	4/12	4/11[1]	4/4				
	120	4/12	4/12	4/11[1]	4/11[1]	4/4			
	150	12/12	12/12	12/11[1]	11[1]/11[1]	11[1]/4[1]	11[1]/4	11[1]/4	
	175	12/12	12/12	12/11[1]	11[1]/11[1]	11[1]/4[1]	11[1]/4[1]	11[1]/4	
	200–300	12/12	12/12	12/12	11[1]/12	11[1]/12	11[1]/12	11[1]/12	4/4
AST® S+	100	12/12	12/11.7	11.8/8.7	11.3/8.2	3/8.2	3/3		
	120	12/12	12/11.7	11.8/8.7	11.3/8.2	3/8.2	3/8		
AST® F	80	4/11	4/11[1]	4/4[1]	–/4[1]	–/4			
	100	12/12	12/12	11[1]/12	–/12	–/12	–/4		
	120	12/12	12/12	11[1]/12	–/12	–/12	–/12		
	150	12/12	12/12	12/12	12/12	11[1]/12	11[1]/12	9[1]/4	9[1]/4
	175	12/12	12/12	12/12	12/12	11[1]/12	11[1]/12	9[1]/4	9[1]/4
	200–300	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12
AST® F+	100	12/12	12/12	12/10.3	12/9.8	11.7/9.8	3/9.8		
	120	12/12	12/12	12/10.3	12/9.8	11.7/9.8	3/9.8		
AST® E	50	4/11	4/4[1]	4/4					
	80	4/11	4/11[1]	4/4[1]	–/4[1]	–/4			
	100	12/12	12/12	11[1]/12	–/12	–/12	–/4		
	120	12/12	12/12	11[1]/12	–/12	–/12	–/12		
	150	12/12	12/12	12/12	12/12	11[1]/12	11[1]/12	9[1]/4	9[1]/4
	175	12/12	12/12	12/12	12/12	11[1]/12	11[1]/12	9[1]/4	9[1]/4
	200–300	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12
AST® S/Shadow AST® F/Shadow AST® E/Shadow	200–300	12/–	12/–	12/–	12/–	12/–	12/–	11.7/–	

Panel type	Panel thickness, mm	Maximum spans for fire-rated ceilings, m							
		EI 15	EI 30	EI 45	EI 60	EI 90	EI 120	EI 180	EI 240
AST® E ceiling	100	7.3 [2]	7.3 [2]	7.3 [2]	6				
	120	8.3 [2]	8.3 [2]	7.5	6				
	150	9.6 [2]	9.6 [2]	7.5	6				
	175	10.5 [2]	10.5 [2]	7.5	6				
	200–300	11 [2]	10.8	7.5	6				

NOTE!

1) A span of up to 12.0 m is allowed if stitching is used in the panel to panel joint every 3.00 m on both sides of panel.

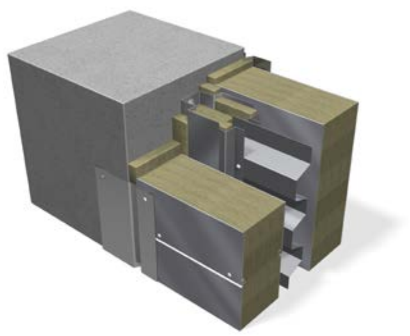
NOTE!

2) The spans of ceiling panels have been reduced to ensure the safe installation work on site.

Span lengths according to EN 15254-5:2009 for walls and EN 15254-7:2011 for ceilings.
All panels shall be dimensioned for normal loads which can decrease the spans given in table.
Practical possibilities for panel handling and transportation may also reduce the panel length.

3.2.1 EI-M CLASSIFIED FIRE WALL

EI-M classified fire wall has been tested according to standards EN 1364-1 and EN 1363-2. Classifications EI-M 60…EI-M 120 are available.
For more information, please contact Paroc Panel System.



3.3 FIRE-RATED CEILINGS

Non-loadbearing PAROC ceilings have fire-rating EI 60 against fire from below. In fire-rated ceilings the panel joints on top are connected together with screws c/c 500 mm. Panel type AST® E is always used in ceilings. Spans for fire-rated ceilings are to be dimensioned case by case.

3.4 FIRE SAFE DETAIL SOLUTIONS

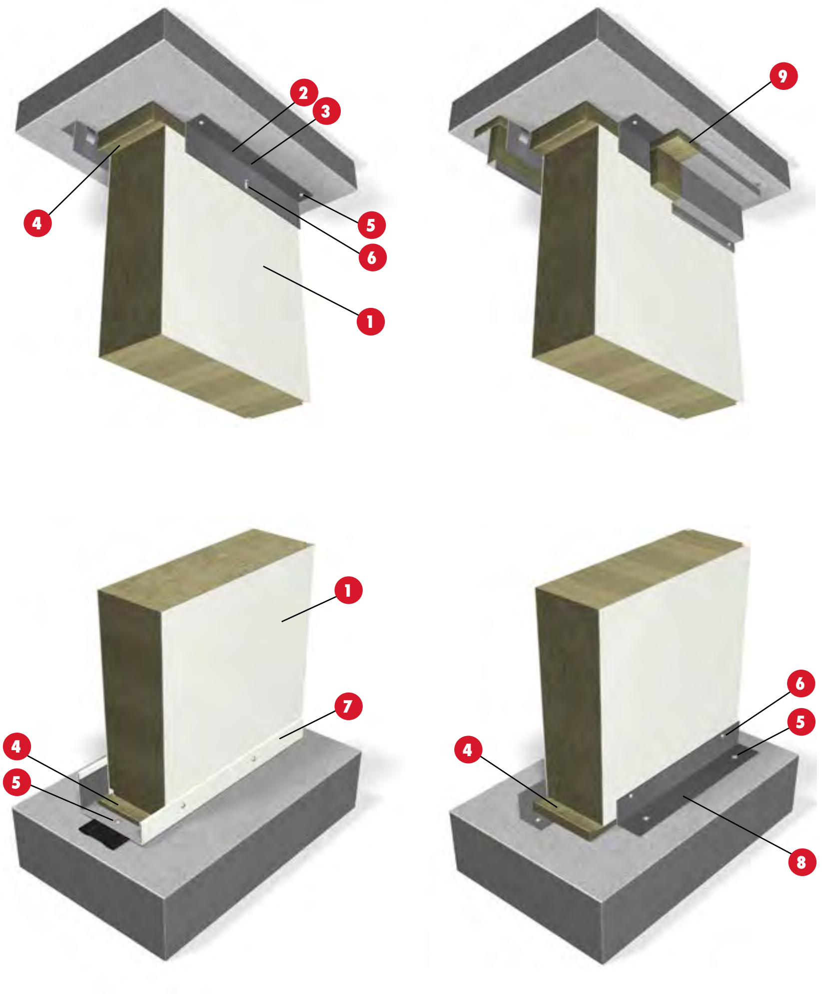
When designing fire-rated structures, it is of utmost importance to execute the detail solutions so that the whole structure meets the requirements on stability, insulation and integrity. Panels for fire-rated structures need no sealant in the joint which is sufficiently tight against hot flue gases. For flashings and profiles in structures subject to fire, only steel fasteners can be used. In fire-partitioning structures panel fixings have to be protected with stone wool.

Table 15. *Fire protection of panel fixings in fire-partitioning structures.*

Structure	Thickness of fire protection, mm				
	EI 60	EI 90	EI 120	EI 180	EI 240
Wall, span ≤ 6 m	–	–	30	40	50
Wall, span > 6 m	–	30	30	40	50
Ceiling	30	30	30	–	–

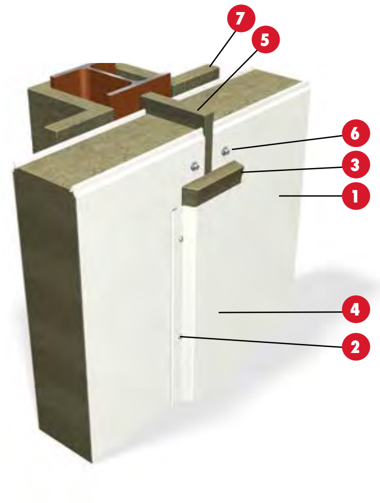
Figure 16. *Some essential detail solutions. For further information see PAROC principle details in www.paroc.com/panelsystem or please contact Paroc Panel System.*

Joint vertically installed fire-resisting wall – ceiling.



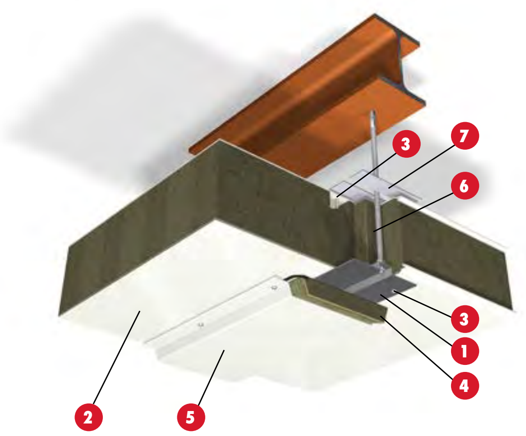
1 PAROC panel
2 Flexible L-profile if wall height > 3.5 m
or
3 L-profile if wall height ≤ 3,5 m
4 Stone wool
5 Fastener
6 Screw
7 Flashing
8 L-profile, t = 1.5 mm
9 Fire protection according to table 15

Panel joint in horizontal installation.



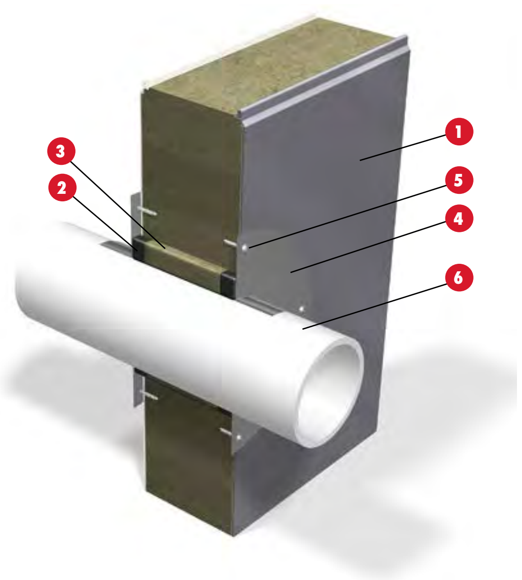
1 PAROC panel
2 Screw
3 Fire protection according to table 15
4 Flashing
5 Stone wool
6 Panel fixing
7 Fire protection of the frame stated by customer

Fire-protected fastening of ceiling panels.



1 Top hat profile
2 PAROC panel
3 Screw
4 Fire protection 30 mm
5 Flashing
6 Stone wool
7 Steel sheet stripe

Penetrations in fire-rated structures.



1 PAROC panel
2 Expanding fire protection sealing compound 1)
3 Stone wool
4 Flashing
5 Fixing
6 Duct

1) According to supplier´s guidelines

4 ACOUSTIC SOLUTIONS

4.1 SOUND INSULATION

In acoustic applications both perforated and non-perforated PAROC panels can be used.

Figure 17. *Sound reduction index for PAROC panel (panel type AST® S 50 mm, 150 mm, 240 mm and panel type AST® F 150 mm) as well as PAROC acoustic panel (panel type AST® S 100 mm).*

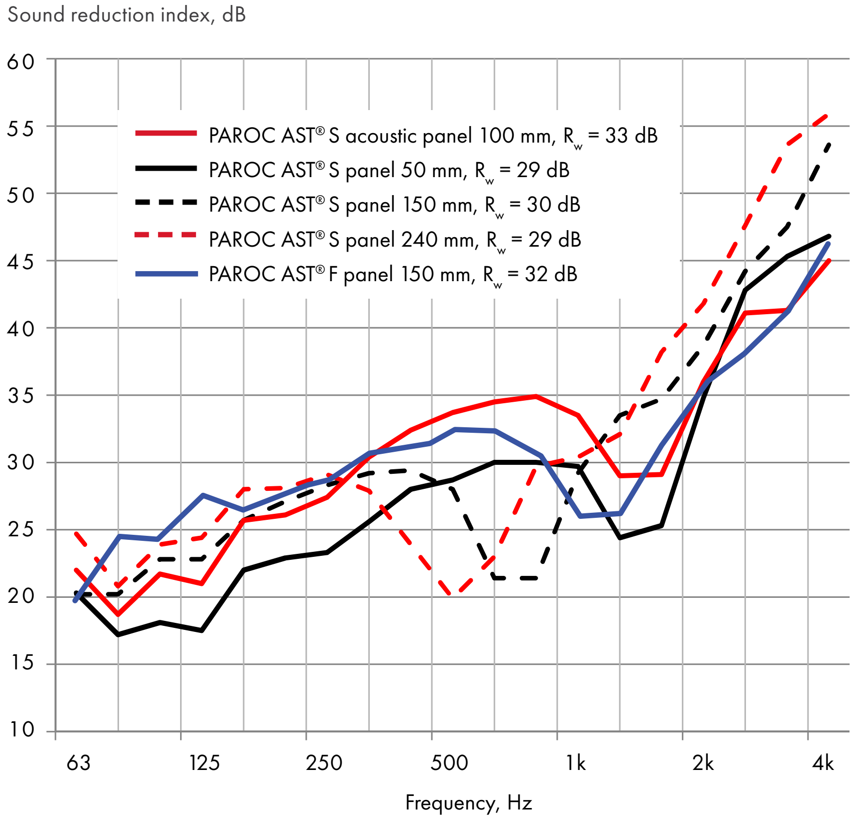


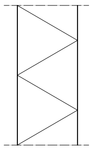
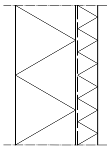
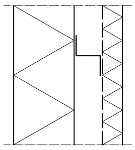
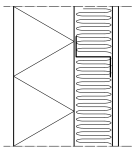
Table 16. *Weighted sound reduction of PAROC panels at various noise spectra, panel type AST® S.*

Sound reduction, dB	Panel thickness, mm							
	50	80	100	120	150	200	240	300
R_w	29	30	30	30	30	29	29	29
R_w +C	27	27	27	27	27	28	28	28
R_w +C_{tr}	26	25	25	25	25	26	26	26

R_w + C can be used e.g. for
- train noise at high and medium speeds
- road traffic over 80 km/h
- jet noise, short distances
- industry noise (medium and high frequency)

R_w + C_{tr} can be used e.g. for
- street traffic noise
- train noise at low speeds
- jet noise, long distances
- industry noise (low and medium frequency)

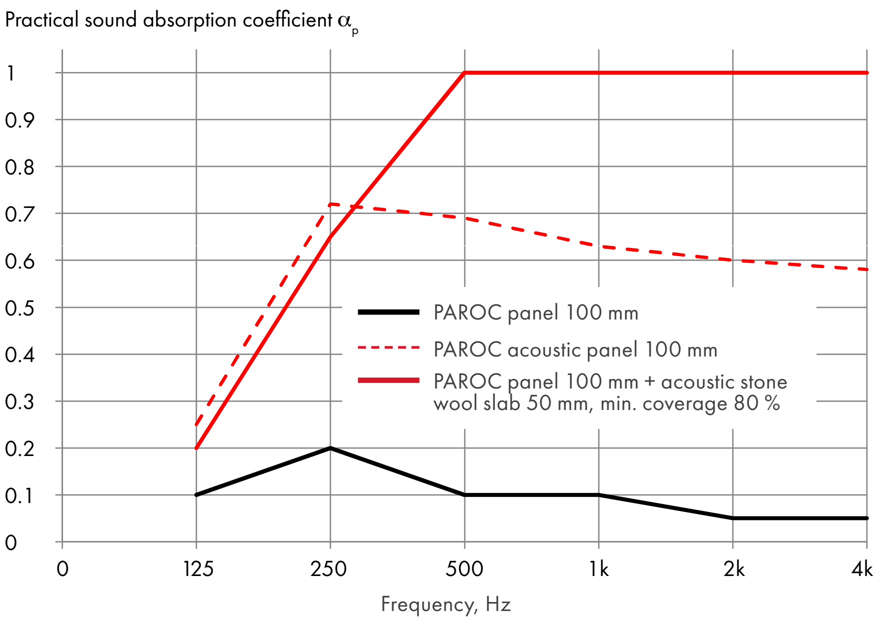
Table 17. *Weighted sound reduction of PAROC panels with additional structures at various noise spectra, panel type AST® F.*

Structure		Sound reduction, dB		
		R_w	+C	C_{tr}
AST® F 150 mm, 0.6/0.6		32	30	29
AST® F 150 mm, 0.6/0.6 + AST® E 50 Acoustic		49	47	43
AST® F 150 mm, 0.6/0.6 + 70 mm z-profile 1.5 + AST® 50 Acoustic		54	51	45
AST® F 150 mm, 0.6/0.6 + Stone wool 95 + Z-profile 0.5 + Corrugated steel 0.6		53	49	42

4.2 SOUND ABSORPTION

In standard execution PAROC panels have a steel sheet facing. Thus the sound absorption is in principle like a reflecting surface (similar as in a conventional sheet metal wall). PAROC acoustic panel has a perforated facing on one surface which improves the panel's sound absorption properties. It can be used in normal dry internal climatic conditions.

Figure 18. *Practical sound absorption coefficient α_p for various PAROC structures.*



5 HYGIENE SOLUTIONS

5.1 GENERAL

In food industry demands on hygienic conditions are high. Special attention must be paid to material properties, joints between structures, detail solutions as well as cleaning and maintenance. The tightness of panel structures and sealants creates a basis for hygienic walls and ceilings.

PAROC panel surfaces are smooth and panel joints are water and airtight. The smooth surfaces as well as water and air tight hygienic joints of PAROC panels without dirt traps make the wall and ceiling structures easy to keep clean. For washable walls it is recommended to use sealants both in the tongue and groove joint of panels and on the surface of the joints. Both sealants are applied on site. The sealant is to be chosen according to actual requirements and supplier's guidelines.

5.2 PAROC PANELS IN HYGIENE SOLUTIONS

The panel surface coatings can be chosen according to requirements as follows:

- **polyester** is used in dry conditions, it does not release any particles
- **FoodSafe** is used when surfaces need to be washed often but have a limited wet time; under normal conditions it neither releases any poisonous substances nor does it function as a substratum for micro-organisms
- **stainless steel** is used as facings in most demanding circumstances.

PAROC panel core is water repellent and does not absorb water and withstands moisture variations very well. If core wool surfaces at panel edges or cut-outs are exposed for a longer period during construction, a special hygiene control coating can be applied for additional protection against mould, fungi, yeasts and bacteria.

Tests made by the independent research institute VTT (Technical Research Centre of Finland) regarding the microbiological growth in PAROC panel core, show that PAROC panels are safe to be used in food industry applications and there is no risk for contamination of PAROC panel structures:

- the bacteria cells such as Salmonella or Listeria do not grow or spread in panel core and disappear very soon
- spores such as mould (Aspergillus) do not grow or spread and disappear slower than bacteria cells
- panel core in hard conditions does not support the survival of microbes.

IARC, the International Agency for Research on Cancer, has classified mineral wool, like stone wool used in PAROC panels, to Group 3 "Not classifiable as to its carcinogenicity to humans". Normally there will be no release of fibres from panels if the design instructions and jointing details are followed.

5.3 HYGIENE IN USE

When designing hygienic applications special attention shall be paid to:

- durability of structures and surfaces such as resistance against wearing and tearing
- easiness of cleaning such as washability
- easiness of maintenance such as repairing or painting in case of damage.

Paroc Panel System recommends the following actions to be taken to avoid all risks of contamination especially in wet circumstances:

- smallish holes/damage shall be immediately repaired to keep bacteria and moisture outside the panels
- larger holes/damage shall be repaired by closing the hole/damaged area temporarily with steel sheet or equal; to avoid all risks the damaged panel(s) are recommended to be changed within 30 to 45 days after the damage
- when fixing anything on the panels the fixing holes shall be sealed with compound suitable for the environment.

More information can be found in the brochure Use and Maintenance Guide.

6 FASTENINGS

6.1 PANEL FIXINGS

The panel fixings are to be selected taking into account the loads and the aggressiveness of the surrounding environment both indoors and outdoors. Externally visible as well as in aggressive environments and in high air humidity panel fixings are always to be of stainless steel. As the environment class often is difficult to determine, the use of stainless steel panel fixings is recommended. The profiles used for fixing the panels or as support are usually made of 1 - 4 mm thick galvanized steel and they are to be dimensioned by the designer.

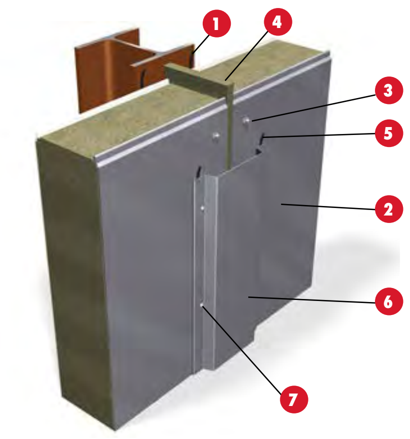
6.2 FASTENING OF WALL PANELS

PAROC panels can be installed horizontally, vertically or diagonally. The panels are usually fastened using either penetrating panel fixings or by pressing the panels between profiles. It is important that the panels are not fixed in only one of the surface sheets. When dimensioning the fastening of multi-span panels, please contact Paroc Panel System for advice.

6.2.1 FASTENING WITH PENETRATING PANEL FIXINGS

This method is used both for external and internal walls with horizontal or vertical installation. There are panel fixing alternatives for various frame materials.

Figure 19. *Fastening of PAROC panels using penetrating panel fixings.*



1 Vapour sealant
2 PAROC panel
3 Panel fixing
4 Stone wool
5 Sealant
6 Flashing
7 Flashing screw

The number of panel fixings depends on the load (suction) and on the panel length/span, panel weight and possible loads from windows etc. Form factors – especially in edge zones – are also to be taken into account.
The minimum number of fixings is 2 screws per panel end at a minimum distance of 20 mm from the panel end. The number of fixing screws/panel end is calculated using the following formula:

$$N = 0.5 \text{ x } L \text{ x } b \text{ x } C_p \text{ x } q_w / F_{all}$$

where:

N = number of screws/panel end
L = panel length, m
b = panel width, m
C_p = pressure coefficient for suction load (external suction + pressure inside, see figure 7)
q_w = characteristic wind load kN/m^2
F_{all} = allowed load for the panel fixings in accordance with table 18.

The number of fasteners for tensile in the ultimate limit state is calculated using the following formula:

$F_d \leq n \times N_{R,d}$
$\gamma_f \times F_k \leq n \times N_{R,k} / \gamma_m$
$F_k \leq n \times N_{R,k} (\gamma_m \times \gamma_f) = n \times F_{t,all}$

where:

F_d = influence/panel end, design value (includes partial coefficient)
n = number of screws/panel end
$N_{R,d}$ = tensile strength of a fastener, design value (includes partial coefficient)
$N_{R,k}$ = characteristic tensile strength of a fastener
F_k = characteristic load/panel end
γ_f = partial coefficient for load = 1.5
γ_m = partial coefficient for material = 1.33
F_{all} = allowed load/fastener (taken into account partial coefficient)

Table 18. *Allowed loads for penetrating panel fasteners. Local deviations may occur in some countries.*

Panel fasteners Ø 5.5/6.3 mm	**Allowed load F_{all}, kN**								
	Tensile						**Shear**		
	AST® L and AST® T			AST® S, AST® S+, AST® F, AST® F+ and AST® E			All panel types		
	$N_{R,k}$	$N_{R,d}$	$F_{t,all}$	$N_{R,k}$	$N_{R,d}$	$F_{t,all}$	$V_{R,k}$	$V_{R,d}$	$F_{v,all}$
With washer Ø 19 mm	1.60	1.20	0.80	2.00	1.50	1.00	2.00	1.50	1.00
With washer Ø 29 mm	1.60	1.20	0.80	2.15	1.62	1.10	2.00	1.50	1.00
With countersink washer Ø 40 mm	1.60	1.20	0.80	2.15	1.62	1.10	2.00	1.50	1.00

The above values are valid under the condition that the tensile and shear values (given by the screw supplier) for fasteners when fixed to the underlying structure do not go below these.

6.2.2 FASTENING USING PROFILES

In vertical installations, the panels can be fastened using profiles. This is mostly applied for internal walls where a telescopic connection against the ceiling is normally required (see figure 12).

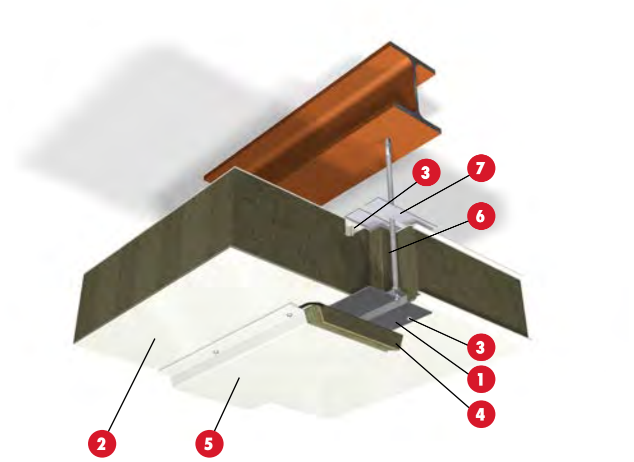
Table 19. *Thickness of L-profiles, values are valid for allowed pressure load ≤ 0.3 kN/m².*

Height of the wall, m	Thickness of L-profiles, mm			
	Deflection of structure, mm			
	25	50	75	100
3.5	1.25	1.5	2.0	2.0
4	1.5	2.0	2.0	2.5
5	1.5	2.0	2.0	2.5
6	2.0	2.0	2.5	3.0
7	2.0	2.5	2.5	3.0
8	2.0	2.5	3.0	3.5
9	2.0	2.5	3.0	3.5
10	2.5	3.0	3.0	3.5

6.3 FASTENING OF CEILING PANELS

Ceiling panels are installed with top hat profiles which are fastened to the support system. It is recommended to use at least 1000 mm long top hat profiles.

Figure 20. *Fastening of PAROC panels with top hat profiles.*



1 Top hat profile
2 PAROC panel
3 Screw
4 Fire protection 30 mm
5 Flashing
6 Stone wool
7 Steel sheet stripe

Allowed load for Panels System's standard top hat profile KL12 is 3.8 kN/side for panel type AST® E. The panels always are to be fixed to each other in order to obtain a catenary force in case of fire. The connecting steel sheets are fastened with screws to the panel faces. The fastenings have to be dimensioned for the catenary force

$F_{cat} = q_{tot} \times L.$

Figure 21. *Catenary force F_{cat}.*

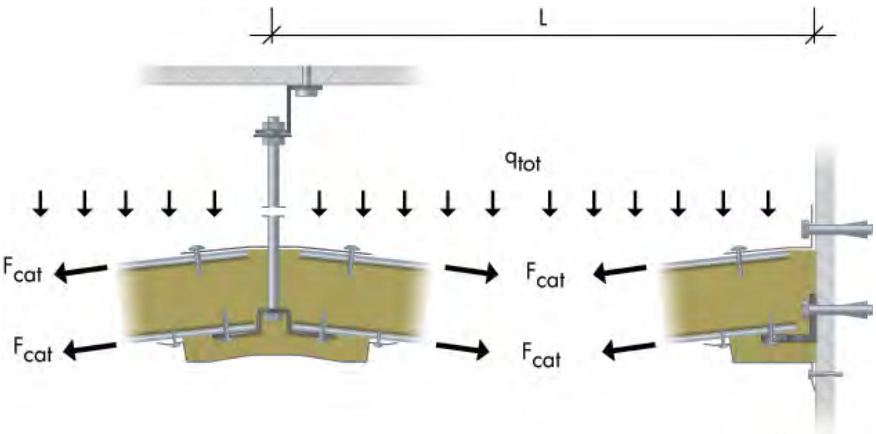


Table 20. *Allowed shear loads for screws in case of fire.*

Screw	Allowed shear load F_{kN}, kN
Ø 6.3 mm	1.3
Ø 4.2 mm	1.0

6.4 FASTENING OF PANELS IN FIRE-RATED STRUCTURES

Fastening of panels in fire-rated structures is dimensioned according to this section. Fire protection of fastening systems is shown in section 3.2.

6.5 FIXING OF FLASHINGS

Flashings are fastened using stainless fixing screws or pop rivets according to the following instructions:

- flashings are fixed with screws or rivets c/c 300 mm
- avoid fixing screws in the flashing joints in order to make the joints more mobile a mobile flashing joint is needed at every 12th flashing metre when the flashings are made of steel, and every 6th flashing metre when aluminium flashings are used
- for external use, flashings with flanges have to be used
- for internal use, flashings with slightly folded edges can also be used
- in horizontal panel installation flashing joints and panel joints should be coincident, if possible.

6.6 SUSPENSIONS

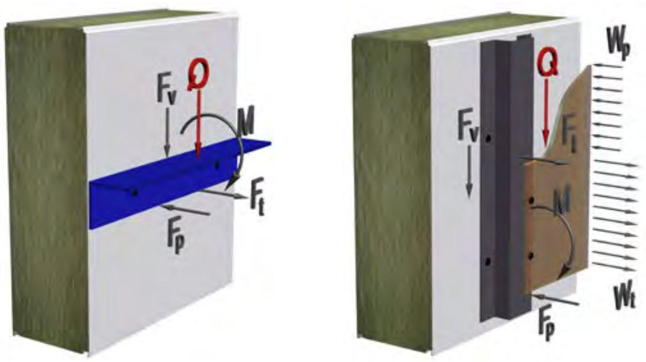
6.6.1 FORCES

In general, loads are caused by the structure's own weight, wind pressure and wind suction. Variable loads may also be caused by snow or ice accumulated in the structures. In addition, any thermal movements caused by temperature and moisture variations in the structures and their impact on fastenings have to be considered. If the suspension causes a dynamic load, penetrating fixing screws have to be used. Also remember to dimension panel fixing screws for suspended loads.

The maximum allowed weight of additional cladding is 45 kg/m^2. The cladding is fixed to profiles, and the maximum distance between profiles is 600 mm when installed in the length direction of the panel and 1200 mm when installed across the panel.

Suspensions may cause shear forces F_v in the panel surface and/or tensile force F_t or pressure force F_p perpendicular to the panel surface.

Figure 22. *Loads caused by suspension.*



Shear force F_v
Tensile force F_t
Pressure force F_p

6.6.2 ALLOWED LOADS

A precondition for suspensions is that the panel facings do not detach (delaminate) from the core material. Therefore it is required that the adhesive bonding has a characteristic strength exceeding 100 kPa. All PAROC panel types have characteristic values of adhesive bonding strength exceeding this limit.

It is important to use rivets and screws for the suspensions that are appropriate for fixing structures to steel sheets. The table below presents allowed loads for Bulb-tite and Peel rivets as well as for overlapping steel sheet screws intended for fixing steel sheets.

Table 21. *Allowed loads for surface fixing screws, when the minimum distance between screws is 120 mm. The values are valid for all panel types and for steel sheet thickness 0.5, 0.6 and 0.7 mm.*

Fastener	Allowed load, N			
	Shear $F_{v\ all}$	Tensile, wall $F_{t\ all}$		Tensile, ceiling $F_{t\ all}$
		AST® L and AST® T	AST® S, AST® S+, AST® F, AST® F+ and AST® E	AST® E
Overlapping steel sheet screw Ø 4.8–6.3 mm	500	200	250	200
Bulb-tite/Peel rivet	500	300	400	300

When dimensioning the suspensions, the following restrictions have to be taken into account:

1. Shear force caused by suspension

$$F_v \leq n \times F_{v\ all}$$

where

F_v = sum of shear forces caused by suspension, N (characteristic value)
n = number of fixing screws
$F_{v\ all}$ = allowed shear force for one fixing screw, N (table 21)

The highest allowed shear force for a support profile is 2.5 kN/m, with Bulb-tite/Peel rivets at 200 mm centres.

2. Tensile force caused by suspension

$$F_t \leq n \times F_{t\ all}$$

where

F_t = sum of tensile forces caused by suspension, N (characteristic value)
n = number of fixing screws
$F_{t\ all}$ = allowed tensile force for one fixing screw, N (table 21)

The highest allowed tensile force for a support profile is 2.0 kN/m, with screws at 120 mm centres and Bulb-tite/Peel rivets at 200 mm centres.

3. Pressure force caused by suspension

$$F_p \leq F_{p\ all} = f_{Cc,k} \times (A_s + B \times e) / (\gamma_M \times \gamma_F)$$

where

F_p = sum of pressure forces caused by suspension, N (characteristic value)
$F_{p\ all}$ = allowed pressure on steel sheet facing, N
$f_{Cc,k}$ = characteristic pressure strength of wool core, N/mm² (table 22)
A_s = stiff support area of profile, mm²
B = perimeter of support area of profile, mm
e = measure, mm, (table 22) according to test results, when support width of profile a ≥ 60 mm. When the width a < 60 mm, the measure has to be reduced by a coefficient $k_e = 1 - (60 - a)/60$
γ_M = pressure material safety coefficient, [1.33]
γ_F = load safety coefficient, [1.5]

Table 22. *Characteristic pressure strength of wool core $f_{Cc,k}$ and e-measure for various panel types.*

Panel type	AST® L	AST® T	AST® S	AST® S+	AST® F	AST® F+	AST® E
$f_{Cc,k}$	0.042 N/mm²	0.045 N/mm²	0.060 N/mm²	0.060 N/mm²	0.090 N/mm²	0.090 N/mm²	0.110 N/mm²
e-measure	50 mm	50 mm	40 mm	40 mm	30 mm	30 mm	20 mm

4. If simultaneously subject to both tensile and shear force (EN 1993-1-3)

$$(F_t / F_{t\,all}) + (F_v / F_{v\,all}) \leq 1$$

5. If simultaneously subject to both pressure and shear force

$$(F_p / F_{p\,all}) + (F_v / F_{v\,all}) \leq 1$$

6. If simultaneously subject to both tensile and pressure force in same structural component (for instance suction and pressure)

$$(F_t / F_{t\,all})^2 + (F_p / F_{p\,all})^2 \leq 1$$

If the profile or support plate to be fastened is subject to both tensile load and pressure load, and is fixed by both adhesive bonding and mechanically in the panel steel sheet facing, the following restrictions have to be verified for the adhesive tensile strength and pressure strength:

Adhesive tensile strength $F_{t\,all} = f_{Ct,k} \times (A_s + B \times e) / (k \times \gamma_M \times \gamma_F)$

where

$F_{t\,all}$ = allowed adhesive tensile strength on steel sheet facing, N
$f_{Ct,k}$ = characteristic adhesive tensile strength of wool core, N/mm² (table 23)
A_s = stiff support area of profile, mm², support width a has to be ≥ 60 mm
B = perimeter of support area of profile, mm
e = measure, mm, (table 22) according to test results
k = coefficient for durability according to test results, [1.5]
γ_M = material safety coefficient of adhesive tensile strength, [1.33]
γ_F = load safety coefficient, [1.5]

Table 23. *Characteristic adhesive tensile strength of wool core $f_{Ct,k}$ and e-measure for various panel types.*

Panel type	AST® L	AST® T	AST® S	AST® S+	AST® F	AST® F+	AST® E
$f_{Ct,k}$	0.110 N/mm²	0.110 N/mm²	0.130 N/mm²	0.130 N/mm²	0.180 N/mm²	0.180 N/mm²	0.230 N/mm²
e-measure	50 mm	50 mm	40 mm	40 mm	30 mm	30 mm	20 mm

Simultaneously the following condition for pressure force has to be valid:

$$F_{p\,all} = f_{Cc,k} \times (A_s) / (\gamma_M \times \gamma_F)$$

where

$F_{p\,all}$ = allowed pressure on steel sheet facing, N
$f_{Cc,k}$ = characteristic pressure strength of wool core, N/mm² (table 22)
A_s = stiff support area of profile, mm², without spreading the pressure area
γ_M = material safety coefficient of pressure, [1.33]
γ_F = load safety coefficient, [1.5]

Dimensioning example

Wall panel of type AST® S has been specified with a thickness of 240 mm and steel sheet facing thickness of 0.6/0.5. A cladding of pre-assembled brick wall sections is to be fixed on the surface. The brick wall sections are suspended in horizontal support profiles at 600 mm centres vertically. The brick wall sections are of thickness 20 mm, length 1200 mm and height 600 mm. They have a dead weight of 40 kg/m^2. The support area of the profiles has a height of 25 mm and a width of 20 mm.

The characteristic value of the wind load is q_k = 0.77 kN/m^2. The pressure coefficients are for the pressure C_{p1} = +1.0 (zone D) and suction C_{p1} = -1.0 (zone B) and in the corner zone C_{p1} = -1.4 (zone A).

The load safety coefficient is γ_F = 1.5.

The profiles have a material thickness t ≤ 1.5 mm and thus overlapping steel sheet screws with $F_{v\,all}$ = 0.5 kN and $F_{t\,all}$ = 0.25 kN can be used.

1. Shear force caused by suspension

Shear force on one horizontal profile, F_v = 0.4 kN/m^2 x 0.6 m = 0.24 kN/m

Number of fixing screws n ≥ F_v / $F_{v\,all}$ = 0.24 kN/m / 0.5 kN = 0.48 screws/m

2. Tensile force caused by wind suction and eccentric load

Wind suction $F_{T,w}$ = -1.0 x 0.77 kN/m^2 x 0.6 m = -0.462 kN/m (zone B)

Moment on support profiles caused by eccentric structure:

M = (0.020 + (0.5 x 0.020)) mm x 0.24 kN/m = 0.0072 kNm/m, which gives the following tensile force on the upper support profile:

F_{Mt} = 0.0072 kNm/m / 0.6 m = - 0.012 kN/m

Number of fixing screws n ≥ ($F_{T,w}$ + $F_{M,t}$) / $F_{t\,all}$ = (0.462 kN/m + 0.012 kN/m) / 0.25 kN = 1,89 screws/m

The wind impact in the corner zone is calculated correspondingly:

Wind suction F_t = -1.4 x 0.77 kN/m^2 x 0.6 m = -0.65 kN/m (zone A)

Number of fixing screws n ≥ ($F_{t,w}$+ $F_{M,t}$) / $F_{t\,all}$ = (0.65 kN/m + 0.012 kN/m) / 0.25 kN = 2.63 screws/m

3. Pressure caused by wind pressure and eccentric load

Wind pressure $F_{P,w}$ = +1.0 x 0.77 kN/m^2 x 0.6 m = +0.462 kN/m (zone D)

Moment on lower support profile caused by eccentric structure:

F_{Mp} = - F_{Mt} = +0.012 kN/m

F_p = ($F_{P,w}$ + F_{Mp}) = (0.462 kN/m + 0.012 kN/m) = 0.474 kN/m = 382 N/m

The allowed pressure on the 25 mm (a) wide support profile is calculated as follows:

$F_{p\,all} = f_{Cc,k} \times (A_s + B \times e) / (\gamma_M \times \gamma_F)$

With a support width a ≤ 60 mm, the e-measure in table 22 for panel type AST® S is to be reduced as follows:

e = k_e x 40 mm, where k_e = 1- (60 - a)/60 = 1 - (60 - 25)/60 = 0.417

e = 0.417 x 40 mm = 16 mm

The allowed pressure $F_{p\,all}$ = 0.060 N/mm^2 x (25 mm x 1000 mm + 2 x 1000 mm x 16 mm) / (1.33 x 1.5) = 1714 N/m, which is higher than F_p = 474 N/m.

In the following the simultaneous impact of shear, tensile and pressure force is examined. The distance between fixing screws is obtained by adding the number of fixing screws required by the shear and tensile forces:

In wind zone B n ≥ (0.48 +1.89) screws/m = 2.37 screws/m, which gives a screw distance of s ≤ 422 mm, and the distance s = 400 mm is selected.

In wind zone A n ≥ (0.48 +2.63) screws/m = 3.11 screws/m, which gives a screw distance of s ≤ 320 mm, and the distance s = 300 mm is selected.

4. If fixing screw simultaneously subject to both tensile and shear force (EN 1993-1-3)

In wind zone B:
$(F_t/F_{t\,all}) + (F_v/F_{v\,all})$ = (400/1000 x 0.474 kN/0.25 kN) + (400/1000 x 0.24 kN/0.5 kN) = 1.004 ≈ 1.0

In wind zone A:
$(F_t/F_{t\,all}) + (F_v/F_{v\,all})$ = (300/1000 x 0.76 kN/0.25 kN) + (300/1000 x 0.24 kN/0.5 kN) = 0.93 < 10

5. If simultaneously subject to both pressure and shear force

$(F_p/F_{p\,all}) + (F_v/F_{v\,all})$ = (474 N/m / 1714 N/m) + (400/1000 x 0.24 kN/0.5 kN) = 0.47 < 1.0

6. If same structural component subject to both tensile and pressure force

In wind zone B:
$(F_t/F_{t\,all})^2 + (F_p/F_{all})^2$ = (400/1000 x 0.474 kN/0.25 kN)^2 + (474 N/m / 1714 N/m)^2 = 0.65 < 1.0

In wind zone A:
$(F_t/F_{t\,all})^2 + (F_p/F_{all})^2$ = (300/1000 x 0.662 kN/0.25 kN)^2 + (474 N/m / 1714 N/m)^2 = 0.71 < 1.0

The brick wall cladding can thus be fixed with profiles at 600 mm centres,
fixing screw distance s = 400 mm in wind zone B and s = 300 mm in wind zone A.

The load calculations do not include any impact by moisture, ice and accumulated snow.

The temperature differences between the wall panel and the profile structures of the brick wall cladding are estimated to remain low. With a fixing profile of the length 2.4 m and dT< 70 °C (winter -30 °C and summer +40 °C), the total length variation is dL = α x dT x L = 1.2 x 10^{-5} x 70 °C x 2400 mm = 2.0 mm. The oval fixing holes in the fixing profile allow small movements.
The temperature movements do not cause any additional load on the screw fixings.

7 APPROVALS AND CERTIFICATES

PAROC panels are CE-marked products. PAROC panels are type approved for fire resistance, strength and thermal insulation in several countries. Approved properties are subject to continual quality control by official bodies and by Paroc Panel System's internal quality control. Paroc Panel System conforms to ISO 9001 Quality Standard. This means that the full chain from raw materials, through production and deliveries operates according to a certified quality system. Paroc Panel System is certified by Det Norske Veritas. The Technical Research Centre of Finland (VTT) has granted a building product certificate (CPR) to PAROC panels.

PAROC PANEL SYSTEM – EXPERIENCE SINCE 1986

PAROC sandwich panels are steel-faced light-weight panels with a stone wool core used in public, commercial and industrial construction.

PRODUCTS

Paroc Panel System manufactures steel-faced, stone wool sandwich panels for façades, partition walls and ceilings. The panels are safe, light-weight and easy to install, as well as aesthetically pleasing. They help refinish façades in no time. PAROC panels have many exceptional properties: they are non-combustible, strong, heat-insulating and airtight.

COMPETENCE

The high quality of our products is made possible by our knowledgeable and committed staff. We offer customer-focused solutions that are safe, functional and stylish. We provide added value to our partners by maintaining a successful and inspiring atmosphere where people are focused on development and professional knowledge. Our goal is to remain the number 1 supplier of stone wool core sandwich panels.

SALES AND PRODUCTION

Our international sales and distribution network covers most of Europe and the Middle East. Northern Europe is our main market. Our extensive experience and reliability as a partner have secured us the position of number 1 supplier in Nordic countries. PAROC panels are manufactured in Parainen, Finland.

PAROC®

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PAROC PANEL SYSTEM OY AB
Sysilahden teollisuusalue 2
21600 Parainen
Phone +358 (0)46 876 8000
panelinfo@paroc.com
www.paroc.com/panelsystem