**LOAD BEARING CAPACITY OF WALLS**
**For**
**METALCRAFT INSULATED PANELS LIMITED**

**PO BOX 76-894, MANUKAU CITY, AUCKLAND**

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# Axial Load Capacity Tables
# for
# Structural Insulated Panels
# for
# Metalcraft Insulated Panels Ltd

## DOCUMENT CONTROL

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# INTRODUCTION

This document is intended for designers and installers to ensure that Metalcraft Insulated Panels are specified correctly. It is to be read in conjunction with the Metalcraft Insulated Panel Systems "Design & Installation Guide", June 2017.

## 1) THE PRODUCTS

This document adds the axial load capacity of walls constructed with the following products:

- Metalcraft Aspirespan / Aspirepanel (PIR Core)
- Metalcraft Thermospan / Thermopanel (EPS Core)

The panels are manufactured from an EPS or PIR core with factory laminated 0.59 mm COLORSTEEL® flat or profile facings. These panels are available in the following thicknesses.

| Panel Type | Core | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| Metalcraft Aspirespan | PIR | ☑ | ☑ | ☑ | | ☑ | | |
| Metalcraft Aspirepanel | PIR | ☑ | ☑ | ☑ | | ☑ | | |
| Metalcraft Thermospan | EPS | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| Metalcraft Thermopanel | EPS | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |

## 2) SCOPE OF USE

The Metalcraft Insulated Panel System is certified for use as a fully finished internal or external wall system within the following scope:

- The Metalcraft Insulated Panel System must be specified and designed in accordance with all Metalcraft Insulated Panel System technical documentation.
- A maximum building height of 10 m no closer than 1.0 m to the relevant boundary
- The designer must consider the location regarding corrosion and environmental zones. The correct surface coating selection must be specified by the designer to ensure the long-term performance of the Metalcraft Insulated Panel. The designer may refer to NZ Steel product selection table for (ISO Categories 1-5) or Metalcraft Insulated Panels for technical assistance.
- It is the designer's responsibility to ensure the behaviour of the panels is satisfactory under all load combinations.
- Serviceability limit states are not included within the scope of this report. It is the designers' responsibility to ensure that all appropriate design criteria are satisfied.

***Uses of the panels beyond the limitations given above require Specific Engineering Design.***

## 3) HOW TO USE THIS GUIDE

This report shows the loadbearing capacity of Metalcraft structural insulated panels. It shows a wall height and panel thickness and the maximum allowable weight bearing down on every lm of wall length on plan. There are several ways that a wall may bear load. Therefore, there are a number of load capacity tables presented in this document. The axial load capacity for a particular panel (thickness and core type) depends on how the panel is loaded.
For example:

- The Safe Working Load applied on the top of a wall panel is shown in Table 4 on page 5.
- The Safe Working Load applied at the face of a wall panel is shown in Table 7 on page 5.

These 2 tables give the loading in kg/m at SLS. (The others give the loading in kN/m at ULS.) For example:

- A 2m high 50 mm thick Thermopanel wall can support 109 kg per lm of wall on plan if loaded eccentrically.
- A 5m high, 150mm thick Aspirepanel wall can support 791 kg per lm of wall on plan if loaded concentrically.

Normally, insulated wall panels are lightly loaded and are only expected to support a lightweight roof or ceiling (probably also made of insulated panels). The axial load capacity is not usually the governing design criterion. (Bending capacity under lateral (wind) load is usually the governing design criterion.)

## 4) LOAD CAPACITY TABLES

This document presents the axial load capacity for both concentrically loaded panels and eccentrically loaded panels.

- For the common load application details (Figure 1) the axial force is introduced into one or both faces of the wall panel by contact.
- If the load is transferred through bearing on the core, then the capacity is limited to the values shown in Table 2 to Table 7. (This would be the case in freezers and coolstores where the skin is cut out to ensure a thermal break.)
- For bearing at the base of a wall, the self-weight of the panel needs to be deducted from the axial capacity. This has been provided for the maximum recommended heights.
- If the load is transferred via rivets, then the capacity is limited to the values shown in Table 8 and Table 9. (This would be the case in freezers and coolstores where wind uplift on the roof is resisted by the wall via the wall-roof riveted connection)
- Other failure modes are discussed in Appendix A.
- Where loads are applied eccentrically, or where the panel is slender, the bending capacity of the panel under lateral loading should be reduced by the values in the corresponding tables.

Capacities are displayed in **kN/m** length of panel on plan at factored Ultimate Limit State (ULS). Safe Working loads are also provided in **kg/m** length of panel on plan. These are equivalent to the panel capacities at unfactored Serviceability Limit State (SLS) and use a load factor of 1.8 and a material factor of 0.9 to derive the SLS load from the ULS load.

***Alternative methods of load transfer require Specific Engineering Design.***

## 5) MAXIMUM PANEL HEIGHT

When the panel's height (or span between lateral restraints) to thickness exceeds 40, it is considered to be slender, and 2$^{nd}$ order effects need to be taken into account. For the purposes of the load capacity tables presented within this document, height limits are provided for each panel thickness, as shown in Table 1.

**Table 1: Maximum Panel Height (m) for 1st Order Analysis***

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 8.00 | 10.00 |
| EPS | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 8.00 | 10.00 |

*Where panel heights (or distance between lateral restraints) exceed those shown above, the panel is considered to be slender and 2nd order effects need to calculated using the elastic critical buckling load calculated for the panel, which will reduce the axial, shear and bending capacities of the panel.*

***2$^{nd}$ Order effects would be considered to be a Specific Engineering Design.***

## 6) ECCENTRICALLY LOADED WALL PANELS

Load Capacities are presented for concentrically and eccentrically loaded panels (see Figure 1). For concentrically loaded panels, there is no reduction in the lateral load capacity. For eccentrically loaded panels, we assume that the load is applied at the face of the panel making the eccentricity half the width of the panel. Eccentric loads induce bending in the panel, which reduces the lateral load capacity.

If the axial load is introduced in one face sheet only, additional moments occur due to this eccentricity. For the purposes of these load capacity tables, the eccentric load is assumed to be applied at the face of the panel. This will reduce the lateral load capacity of the panel as given in the published load-span tables as shown in Table 10, Table 14, Table 17, and Table 20.

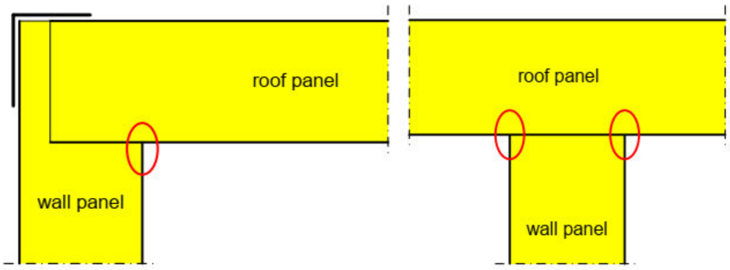



**Figure 1: Examples of Load Application Areas (Eccentric and Concentric Loading)**

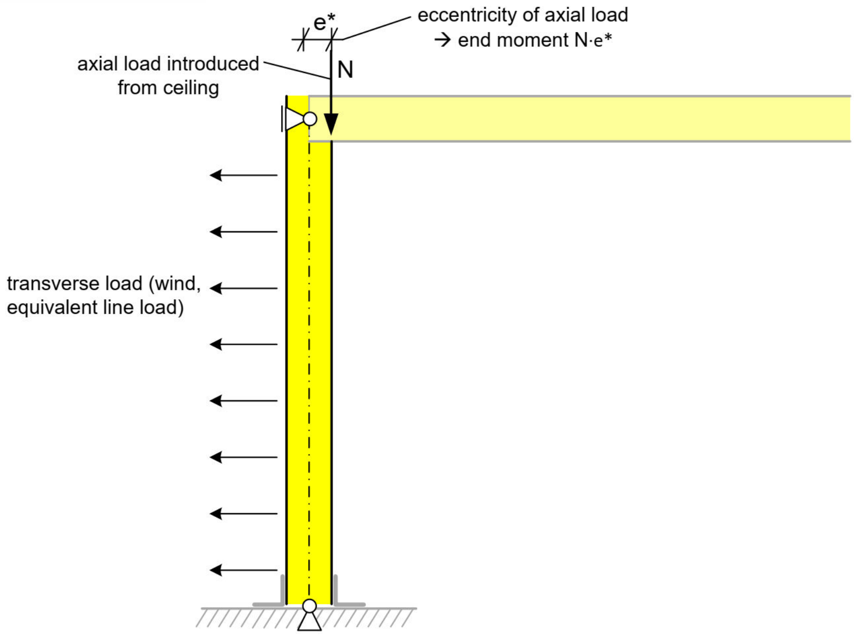



**Figure 2: Static system of wall panels: Eccentrically Loaded Wall Panels**

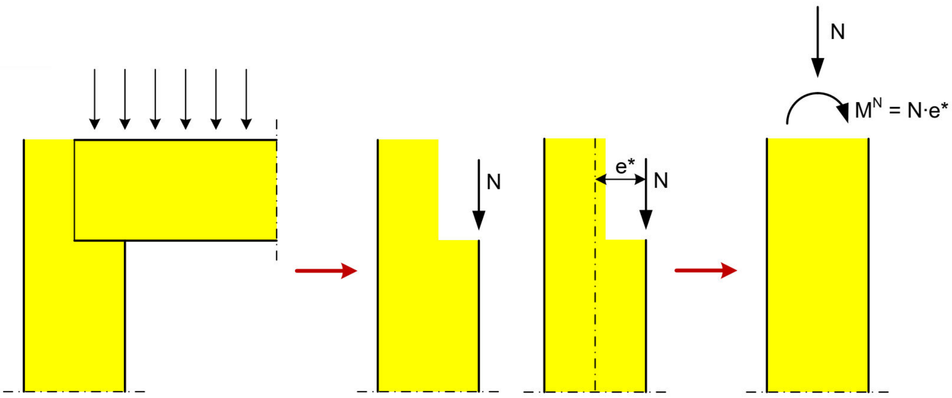


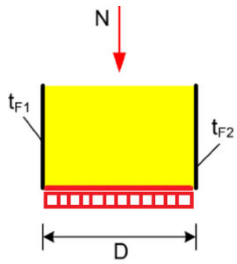

**Figure 3: Eccentric Axial Load and Induced Moment**

# AXIAL LOAD CAPACITY TABLES

## 1) CORE BEARING FAILURE

### 1.1. CONCENTRIC LOADING

**Table 2: ULS Axial Compression Capacity (kN/m) based on Core Bearing (excluding self-weight)**




| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 4.5 | 6.8 | 9 | | 13.5 | | |
| EPS | 3.9 | 5.8 | 7.7 | 9.7 | 11.6 | 15.5 | 19.4 |

**Table 3: ULS Axial Compression Capacity (kN/m) based on Core Bearing (including self-weight)**

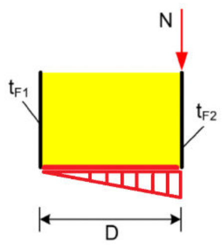
| | Panel Thickness (mm) / Panel Height (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
| Core | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 200 mm | 250 mm |
| PIR | 4.27 | 6.42 | 8.46 | | 12.58 | | |
| EPS | 3.68 | 5.46 | 7.23 | 9.10 | 10.85 | 15.24 | 18.03 |

**Table 4: SLS Safe Working Axial Load (kg/m) based on Core Bearing (including self-weight)**

| | Panel Thickness (mm) / Panel Height (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
| Core | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 200 mm | 250 mm |
| PIR | 268 | 404 | 532 | | 791 | | |
| EPS | 231 | 343 | 455 | 572 | 683 | 959 | 1134 |

### 1.2. ECCENTRIC LOADING

**Table 5: ULS Axial Compression Capacity (kN/m) based on Core Bearing (excluding self-weight)**




| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 2.3 | 3.4 | 4.5 | | 6.8 | | |
| EPS | 2.0 | 2.9 | 3.9 | 4.9 | 5.8 | 7.8 | 9.7 |

**Table 6: ULS Axial Compression Capacity (kN/m) based on Core Bearing (including self-weight)**

| | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
|---|---|---|---|---|---|---|---|
| Core | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 200 mm | 250 mm |
| PIR | 2.02 | 3.02 | 3.96 | | 5.83 | | |
| EPS | 1.73 | 2.56 | 3.38 | 4.25 | 5.05 | 7.49 | 8.33 |

**Table 7: SLS Safe Working Axial Load (kg/m) based on Core Bearing (including self-weight)**

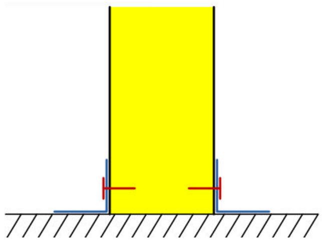
| | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
|---|---|---|---|---|---|---|---|
| Core | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 200 mm | 250 mm |
| PIR | 127 | 190 | 249 | | 367 | | |
| EPS | 109 | 161 | 213 | 267 | 318 | 471 | 524 |

## 2) RIVET CAPACITY (SHEAR CAPACITY UNDER TENSION OR COMPRESSION)

### 2.1. Concentric Loading (Both Skins)

**Table 8: ULS Axial Capacity (kN/m) Based on Rivet Capacity (Both Skins)**

| | Rivet Spacing (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| PIR | 12.2 | 8.1 | 6.1 | 4.9 | 4.1 | 3.5 | 3 |
| EPS | 12.2 | 8.1 | 6.1 | 4.9 | 4.1 | 3.5 | 3 |



### 2.1. Eccentric Loading (Both Skins)

**Table 9: ULS Axial Capacity (kN/m) Based on Rivet Capacity (One Skins)**

| | Rivet Spacing (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| PIR | 6.1 | 4.1 | 3.0 | 2.4 | 2.0 | 1.7 | 1.5 |
| EPS | 6.1 | 4.1 | 3.0 | 2.4 | 2.0 | 1.7 | 1.5 |

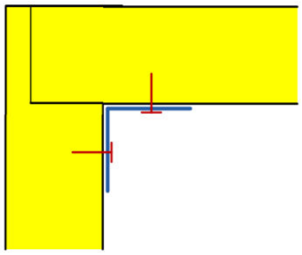


**Table 10: Reduction in Lateral Load Capacity due to Axial Load (kPa) at Max Height**

| Height | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
|---|---|---|---|---|---|---|---|
| | Panel Thickness (mm) | | | | | | |
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *0.3* | *0.14* | *0.08* | *0.05* | *0.03* | *0.02* | *0.02* |
| EPS | *0.3* | *0.14* | *0.08* | *0.05* | *0.03* | *0.02* | *0.02* |

*This is the amount to take off the full lateral capacity provided in the product data sheets when the panel is subject to wind loading on the face of the panel in additional to the axial loading via the rivets.*

# APPENDIX A: OTHER FAILURE MODES

Load capacity tables are provided here for a number of other loading scenarios. These can be divided into local failure modes and global failure modes. In all cases, the load capacities are higher than the figures given for core bearing failure or rivet failure presented in the body of this document. The local failure modes are a function of the materials and thickness of the panel. Global failure modes are a function of the height of the panel as well as the material properties. 2nd Order effects (P-Δ) are a function of the applied load and the type of loading. For the purposes of these tables creep has been ignored.

**Local failure modes include:**

1. Core Shear Failure (Figure 4 B)
2. Skin Crippling (Figure 5)
3. Skin Yielding (under Tension)
4. Microstructural changes on faces (Figure 4 C)
5. Face wrinkling (Figure 4 D)
6. Face dimpling (Figure 4 E)

**Global failure modes include:**

A. General (Euler) Buckling (Figure 4 A)
B. 2nd Order Effects (P-Δ) (Figure 6)

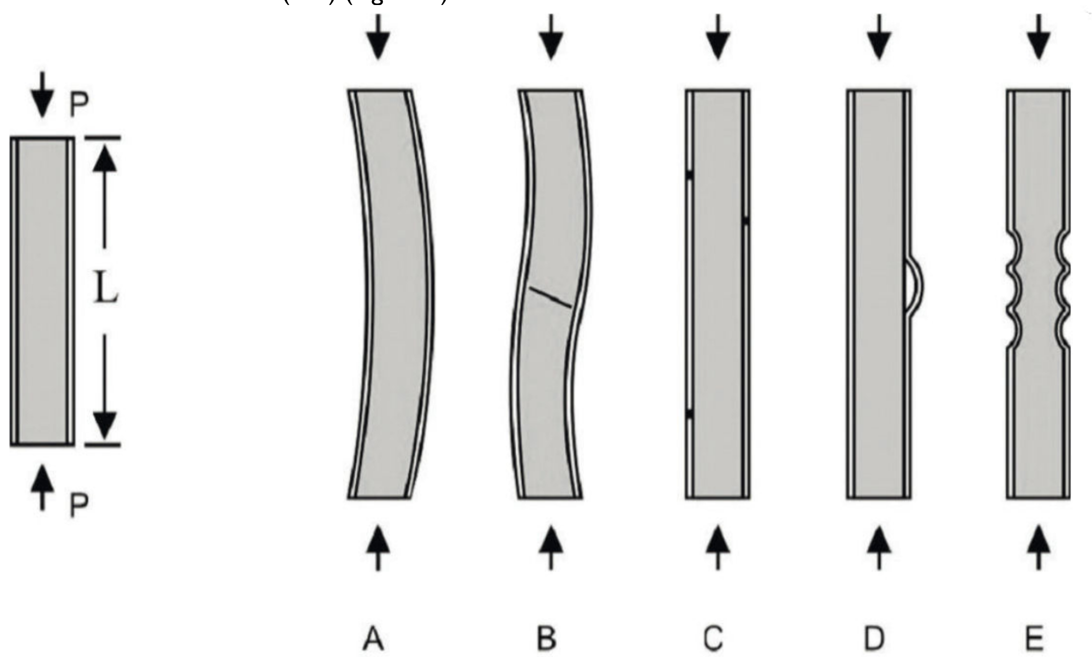
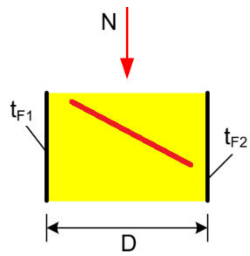



**Figure 4: Possible deformations of SIPS due to axial load**

## A1) CORE SHEAR FAILURE

**Table 11: Axial Compression Capacity (kN/m) based on Core Shear Failure**

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 107 | 161 | 215 | 269 | 323 | 431 | 539 |
| EPS | 82 | 124 | 166 | 207 | 249 | 332 | 514 |



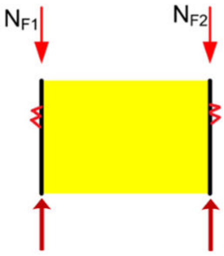
## A1) SKIN CRIPPLING

Axial forces may not only cause wrinkling failure in mid-span, but also a local failure at the load application area, where the normal force is introduced into the panel, e.g. at the connection between wall and roof or between wall and foundation. The failure mode of the load application area is usually crippling of the face at the loaded cut edge. This stability failure mode is strongly related to crippling of the compressed face in mid-span.

Figure 5: Crippling of face at load application area

### A2.1. Concentric Loading (Both Skins)

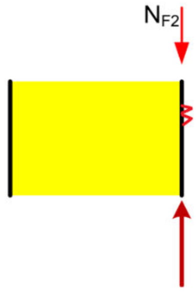
Table 12: Axial Compression Capacity (kN/m) based on Skin Crippling (Both Skins)




| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 67 | 67 | 67 | 67 | 67 | 67 | 67 |
| EPS | 67 | 67 | 67 | 67 | 67 | 67 | 67 |

### A2.2. Eccentric Loading (One Skin)

Table 13: Axial Compression Capacity (kN/m) based on Skin Crippling (One Skin)




| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 |
| EPS | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 |

Table 14: Reduction in Lateral Load Capacity due to Axial Crippling Load (kPa) at Max Height

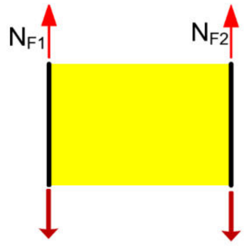
| Height | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
|---|---|---|---|---|---|---|---|
| | Panel Thickness (mm) | | | | | | |
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *1.67* | *1.12* | *0.84* | *0.67* | *0.56* | *0.42* | *0.33* |
| EPS | *1.67* | *1.12* | *0.84* | *0.67* | *0.56* | *0.42* | *0.33* |

*This is the amount to take off the full lateral capacity provided in the product data sheets when the panel is subject to wind loading on the face of the panel in additional to the axial loading via the rivets.*

# A3) SKIN YIELDING (UNDER TENSION)

## A3.1. Concentric Loading (Both Skins)

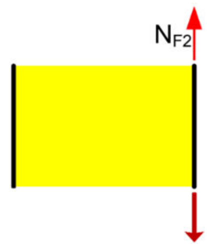
**Table 15: Axial Tension Capacity (kN/m) based on Skin Yield (Both Skins)**




| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 319 | 319 | 319 | 319 | 319 | 319 | 319 |
| EPS | 319 | 319 | 319 | 319 | 319 | 319 | 319 |

## A3.2. Eccentric Loading (One Skin)

**Table 16: Axial Tension Capacity (kN/m) based on Skin Yield (One Skin)**



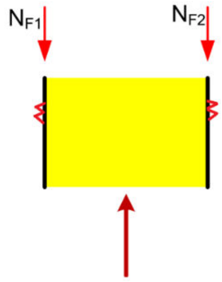

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 159 | 159 | 159 | 159 | 159 | 159 | 159 |
| EPS | 159 | 159 | 159 | 159 | 159 | 159 | 159 |

**Table 17: Reduction in Lateral Load Capacity due to Axial Tension Load (kPa) at Max Height**

| Height | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
|---|---|---|---|---|---|---|---|
| | Panel Thickness (mm) | | | | | | |
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *8.00* | *5.30* | *4.00* | *3.20* | *2.70* | *2.00* | *1.60* |
| EPS | *8.00* | *5.30* | *4.00* | *3.20* | *2.70* | *2.00* | *1.60* |

*This is the amount to take off the full lateral capacity provided in the product data sheets when the panel is subject to wind loading on the face of the panel in additional to the axial loading via the rivets. Figures in red exceed the theoretical bending capacity. Thus, the capacity in tension when eccentrically loaded should be limited to the skin crippling values.*

# A4) FACE WRINKLING & DIMPLING




## A4.1. Concentric Loading (Both Skins)

**Table 18: Axial Capacity (kN/m) Limited by Wrinkling Load (Both Skins)**

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 84 | 84 | 84 | 84 | 84 | 84 | 84 |
| EPS | 299 | 299 | 299 | 299 | 299 | 299 | 299 |

## A4.2. Eccentric Loading (One Skin)

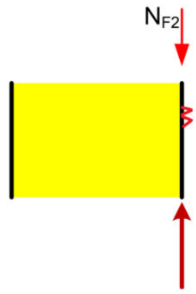



**Table 19: Axial Capacity (kN/m) Limited by Wrinkling Load (One Skin)**

| | Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | 42 | 42 | 42 | 42 | 42 | 42 | 42 |
| EPS | 150 | 150 | 150 | 150 | 150 | 150 | 150 |

**Table 20: Reduction in Lateral Load Capacity due to Axial Wrinkling Load (kPa) at Max Height**

| Height | 2.00 m | 3.00 m | 4.00 m | 5.00 m | 6.00 m | 8.00 m | 10.00 m |
|---|---|---|---|---|---|---|---|
| | Panel Thickness (mm) | | | | | | |
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *2.10* | *1.40* | *1.05* | *0.84* | *0.70* | *0.53* | *0.42* |
| EPS | *7.48* | *4.99* | *3.74* | *2.99* | *2.24* | *1.87* | *1.50* |

*This is the amount to take off the full lateral capacity provided in the product data sheets when the panel is subject to wind loading on the face of the panel in additional to the axial loading via the rivets. Figures in red exceed the theoretical bending capacity.*

## A5) BUCKLING

**Table 21: Axial Capacity (kN/m) Limited by Euler Buckling for a Panel Height = 3m**

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *68* | *120* | 174 | 231 | 288 | 404 | 521 |
| EPS | *58* | *100* | 143 | 187 | 232 | 323 | 414 |

**Table 22: Axial Capacity (kN/m) Limited by Euler Buckling for a Panel Height = 6m**

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *27* | *54* | *87* | *123* | *163* | 248 | 338 |
| EPS | *25* | *49* | *77* | *108* | *141* | 211 | 285 |

**Table 23: Axial Capacity (kN/m) Limited by Euler Buckling for a Panel Height = 9m**

| | Panel Thickness (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Core | 50 | 75 | 100 | 125 | 150 | 200 | 250 |
| PIR | *14* | *30* | *50* | *73* | *100* | *162* | 231 |
| EPS | *14* | *28* | *47* | *68* | *92* | *145* | 205 |

*Figures shown in shaded italics are for slender panels*

## A6) SECOND ORDER EFFECTS IN SLENDER PANELS

If slender building components are loaded by axial compression loads, effects of 2$^{nd}$ order theory have to be taken into account, i.e. deformations are considered in determination of bending moment and transverse force. Under 2$^{nd}$ order theory, stresses do not increase proportionally to the axial load. The axial force increases deflection and results in an increase of moment and transverse force. Thus, bending moment M, transverse force V, and deflection w, are increased by an amplification factor α.

For determination of the amplification factor, the elastic buckling load $N_{cr}$ of the sandwich panel loaded by a concentric axial has to be determined. This consists of the part $N_{ki}$ considering the bending rigidity of the face sheets and the shear rigidity of the core.

***The load-capacity tables presented here do not take into account 2$^{nd}$ Order effects.***

***2$^{nd}$ Order effects would be considered to be a Specific Engineering Design***

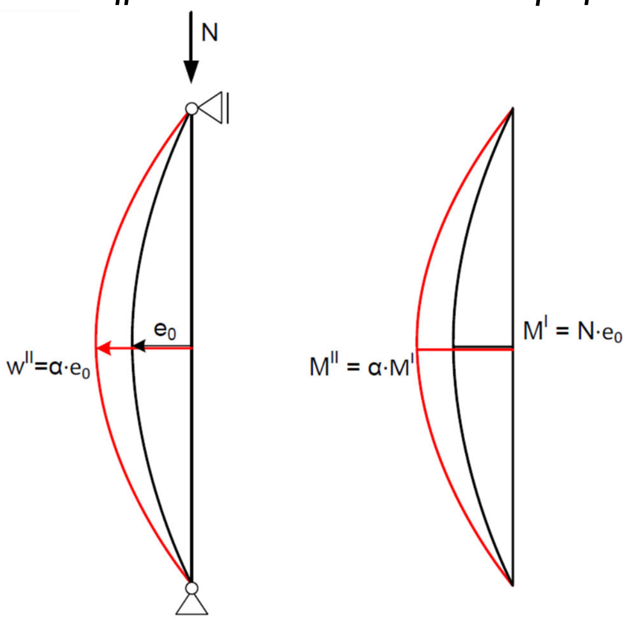



**Figure 6: 2nd Order Effects in Slender Panels**

## A7) LONG-TERM BEHAVIOUR

Both, core materials (EPS and PIR) show creep effects under long-term loads, e.g. dead-weight load and snow. If a constant load acts on a panel over a long period of time, the shear strain increases with constant shear stress. Usually only two creep coefficients $\phi$ are used. The creep coefficient $\phi_{2000}$ (at time t = 2000 h) is used to consider snow loads; the creep coefficient $\phi_{100000}$ (at time t = 100000 h) is used to consider permanent loads (self-weight).

Creep effects have not only to be considered in the design of serviceability limit state (deformation limit) but also in the design of ultimate limit state (load-bearing capacity), i.e. creeping must be taken into account for the determination of moment and transverse force.

***The load-capacity tables presented here do not take into account creep.***

***Creep effects would be considered to be a Specific Engineering Design.***

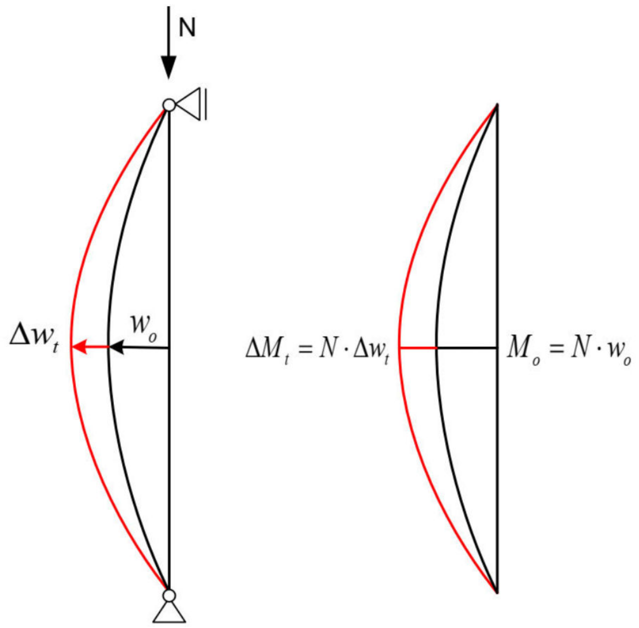



Figure 7: Creeping of Axially Loaded Panels