

Kingspan design and construction guide



Temperature controlled panel systems (KS1 100 CS)

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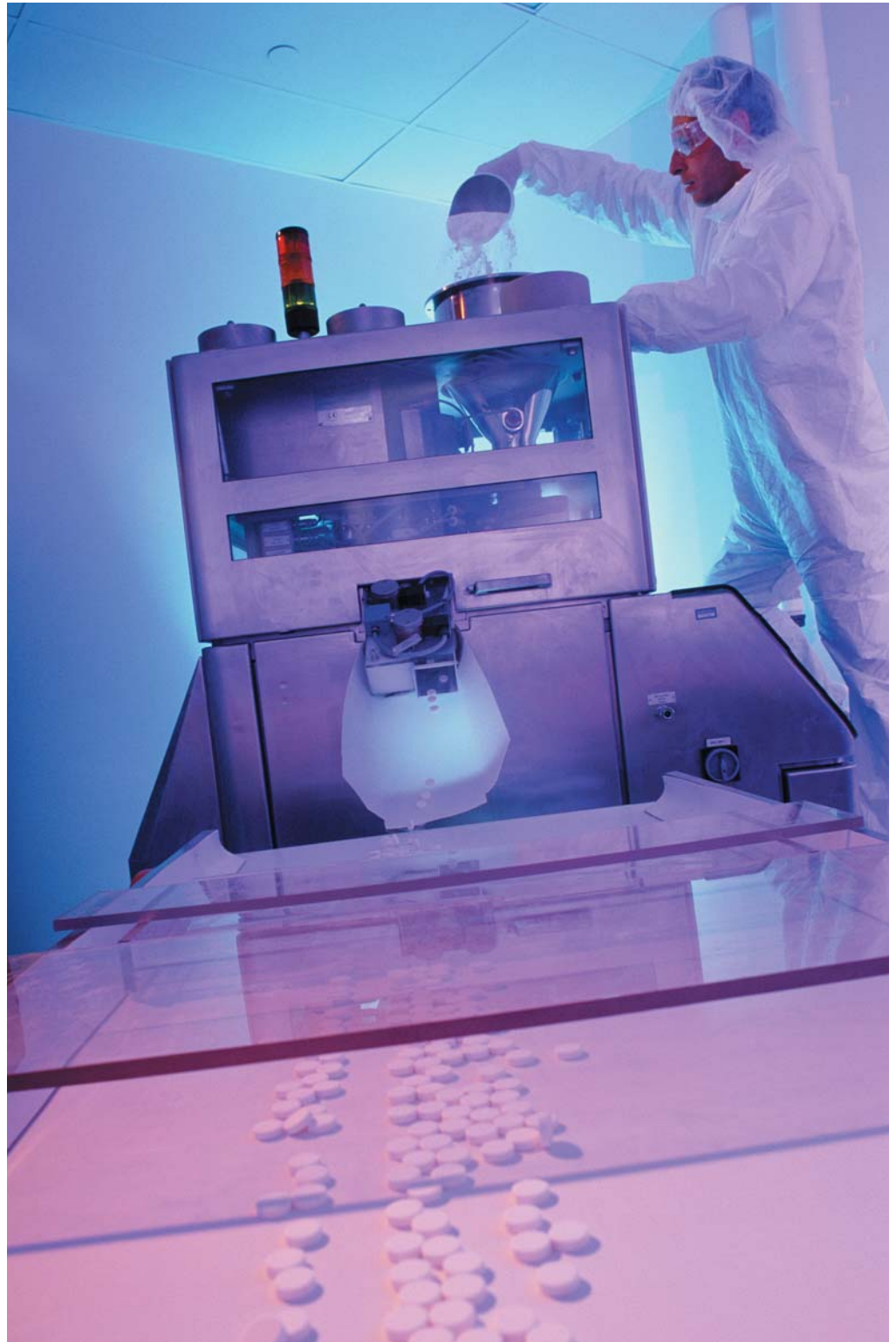
FIREsafe™

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Kingspan Insulated Panels has established a leading global position in the manufacture and supply of pre-engineered insulated panels for:

- Food processing
- Deep freeze, cold and cool stores
- Clean rooms for bio-technology and pharmaceutical industries
- Ambient temperature storage rooms

This Kingspan design and construction guide is an invaluable and comprehensive reference guide to the company's range of cold room panel products. It promotes best practice standards, superior quality, regulatory compliant design and innovative construction solutions to investors, developers, designers, constructors and occupiers.

Kingspan Insulated Panels' factory pre-engineered, single component systems optimise build speed and installed cost. Single panel solutions can provide good acoustic, fire and thermal integrity to a building, which could only be previously achieved by multiple trades constructing complex built-up systems.

Lower lifetime costs are achieved by reduced maintenance and lower energy usage, which, in turn minimises carbon dioxide (CO₂) emissions throughout the building's lifetime. The company's insulated panel systems are fully compliant to applicable building regulations as well as property insurers Factory Mutual (FM) fire certification requirements.





End-use applications

Design, specification and construction of temperature controlled buildings is a complex subject involving a whole range of end-use performance.

This guide is intended to assist designers, specifiers and constructors to identify some of the key design issues which need to be considered to enable the most suitable selection of cold room panel systems and materials to meet specific project needs.

Dimensions, weight and availability

Panels are manufactured at Kingspan's AS/NZS ISO 9001:2000 accredited Sydney site in NSW. The panels are 1100mm wide, in a range of thicknesses from 50-200mm.

Standard colour panels are white, but additional colours are available on extended lead times. Consult Kingspan directly for further information.

Design performance

The KS1100 CS insulated panel system has been designed for applications and use on buildings within the following performance parameters:

- Variable internal temperatures
- External temperature variations (summer to winter)
- Panel lengths – up to 11.8 metres
- Non-deleterious – no airborne fibres
- FM Certified Products

For other designs or dimensional parameters Kingspan should be contacted.

Thermal and airtightness performance

Kingspan's KS1100 CS panels are:

- Suitable for low and high temperature controlled applications
- Offer high thermal performance, maintaining the temperature of the internal environment
- Provide low air leakage performance
- Significantly reduce energy usage and running costs
- Provide a panel system which effectively controls temperature flows, vapour and humidity levels

Technical support

Kingspan Insulated Panels offer technical support for property owners, designers and contractors. Kingspan offers industry leading experience, knowledge and expertise in providing best practice construction solutions, and technical advice on any project. This includes:

- Working construction details
- Model specifications
- Site works and build method information



OH&S and installation

Kingspan can provide full technical support for panel installations, but ultimately installation and site OH&S is the responsibility of the system installer.

It is critical in the construction of the building envelope to ensure safe work practices are followed, to ensure optimal installation methods are used and to ultimately minimise any subsequent maintenance requirements for the installation.

In order to achieve these objectives installers and building structural engineers need to work hand in hand in building construction and ensure that Kingspan recommended design details are followed.

Insurer approved and certified

The installation of Kingspan KS1 100 CS panels to insurer approved guidelines – Factory Mutual (FM) approved systems to unlimited height (meets approval requirements of standard 4880 for Class 1 insulated wall and ceiling panels installation with no restrictions) ensures:

- Integrity of the structure is maintained
- No spread of fire within core
- No flaming drops (which can occur with some other insulation types)
- Low smoke emissions
- Fire insulation criteria satisfied

Fire test performance (Part C – NZBC)

Kingspan KS1 100 CS cold store panels have been tested to:

- AS 1530.4:2005; NZ/BS 476: Part 22: 1987: fire tests on building materials and structures. Method for determining the fire resistance of non-loadbearing elements of construction
- AS/NZS 1530.3:1999 for ignitability, flame propagation, heat and smoke release. For regulatory purposes the indices are 0, 0, 0, 2
- NZ/BS 476: Part 7:1987: fire tests on building materials and structures. Method of classification of the surface spread of flame product
- NZ/BS 476: Part 6:1989: fire tests on building materials and structures. Method of test for fire propagation for products
- NZ/BS 476: Part 11:1982: fire tests on building materials and structures. Method for assessing the heat emission from building materials



Introduction

The Kingspan Group was founded in 1972 as a small family business in the Republic of Ireland. The Group was initially involved in the manufacture of metal cladding and roll formed structural sections.

In the 1990's Kingspan expanded through acquisitions and the addition of manufacturing plants and sales companies in the U.K., Western and Eastern Europe, North America and the latest acquisition in the Middle East.

Insulated panels have well established credentials as a practical, energy efficient and sustainable method of building envelope design.

There are no specific performance requirements for insulated panels within Australian or New Zealand Standards, or respective Building Codes (ie BCA / NZBC) in "deemed to satisfy" situations. As a result of this, the design performance of KS1100 CS panels has been based on guidelines within the "European recommendations for Sandwich Panels".

Kingspan panels have undergone extensive structural modeling and physical testing in Australia, to ensure their suitability for the Australian / New Zealand built environment.

In all applications the panels will as an absolute minimum meet, and generally exceed the requirements of BCA and NZBC frameworks.

Panels also meet stringent Factory Mutual (FM) insurance fire performance requirements and are specifically designed as a practical option for building owners to mitigate risk from property loss and to achieve lower insurance premiums. For further details, consult the Kingspan literature on "Property and Business Fire Protection", or contact Kingspan directly.



This is a generic specification for the Kingspan KS1100 CS panel system. For specific requirements contact the Kingspan Technical Department on 03 358 7536.

Application

The following specification is for the wall, partition and ceiling construction of a Cold Store, Chill or Ambient food Production or Storage Area, where a Factory Mutual Class 1 to Standard 4880 is required. This is for an unlimited height fire-resisting product, where an insurance approved system of installation is required.

Materials and coatings

Internal liner sheet

Substrate to be 0.50mm thick Z275 Zincform G300S coated steel to AS1397.

Coating:

Permaguard Microban White (25% Gloss) – 25 microns thick

Insulation core

To consist of 50,75,100,150 or 200mm thick, closed cell, CFC and HCFC free, FM Certified Polyisocyanurate (PIR) Insulation.

The auto adhesive properties of the core bond and the internal and external panel faces together control the panel thickness achieved during manufacture.

Unexposed external liner sheet

Substrate to be 0.50mm thick Z275 Zincform G300S coated steel to AS1397.

Coating:

Permaguard Microban White (25% gloss) – 25 microns thick

Note: for other external colours, please contact Kingspan for additional lead times and cost.

	Panel thickness (mm)				
	50	75	100	150	200
Thermal transmittance (W/m ² K)	0.40	0.27	0.20	0.13	0.10
R-value (m ² K/W)	2.5	3.8	5.0	7.5	10.0

Table 1. Thermal properties of KS1100 CS panels (based on a longterm thermal conductivity of $k=0.020 \text{ Wm}^{-1}\text{K}^{-1}$)

Performance

Thermal

The panel must have a thermal transmittance and an R-value as indicated in Table 1.

For the purpose of the design of cold stores a figure of 10 Wm^{-2} is typically used as the maximum allowable heat loss through the panels – based on the European Code of Practice for the Design of Cold Store Envelopes). Table 2 gives the recommended panel thickness, based on a range of differential temperatures through the panel thickness.

Temperature difference (°C)	Panel thickness (mm)				
	50	75	100	150	200
10	4.00	2.67	2.00	1.33	1.00
15	6.00	4.00	3.00	2.00	1.50
20	8.00	5.33	4.00	2.67	2.00
25	10.00	6.67	5.00	3.33	2.50
30	12.00	8.00	6.00	4.00	3.00
35	14.00	9.33	7.00	4.67	3.50
40	16.00	10.67	8.00	5.33	4.00
45	18.00	12.00	9.00	6.00	4.50
50	20.00	13.33	10.00	6.67	5.00
55	22.00	14.67	11.00	7.33	5.50
60	24.00	16.00	12.00	8.00	6.00
65	26.00	17.33	13.00	8.67	6.50
70	28.00	18.67	14.00	9.33	7.00
75	30.00	20.00	15.00	10.00	7.50
80	32.00	21.33	16.00	10.67	8.00

Table 2. Panel selection for KS1100 CS panels

Fire

Kingspan **FIREsafe** Insulated Panels tested and approved to Factory Mutual (FM) Standard 4480 to unlimited height.

Seals and fillers

Tongue and groove panel joint

The visible facing joint should be engaged such that a maximum gap of 3mm is achieved, this will ensure that the foam faces form a butt joint and maintain an effective seal.

For cold store applications, externally seal joint with a suitable sealant to provide a vapour barrier, or sealing tape.

For food production applications, internally seal joint with a MAF approved foodsafe gun grade silicone sealant.

Fasteners

Primary

Wall and partition panel

All primary fasteners must be carbon steel fasteners at 550mm centres (maximum) fixed through panel to rail supports.

Ceiling panel

All primary fixings must be either mushroom headed bolts at suitable centres or carbon steel rivets at 300mm centres (maximum) fixed through continuous galvanised steel top hats supports to the panel internal liner sheet.

Wall and partition to ceiling panel

All primary fasteners must be carbon steel rivets at 300mm centres (maximum) fixed through continuous galvanised steel angle to panel liner sheet, at panel abutments and panel / panel junction details.

Secondary

Flashing – panel

All flashing fixings are to be carbon or stainless steel rivets at 300mm centers (maximum).

Construction details

Wall / ceiling junction detail

Wall panels with a half lap rebate at the top, sized to suit the ceiling panel insulation thickness are stood up to the vertical position in the base channel. The Ceiling panels are laid horizontally and sit in the wall panel rebate. The panels are fixed together internally using a 50 x 50mm galvanised and painted (or powdercoated) steel angle.

Any gaps in the insulation are foam filled using fire rated canister applied insulation. Externally the corner is closed off using a galvanised angle. Both angles are fixed using carbon steel rivets at 300 centres. Externally a vapour seal is to be provided to prevent the ingress of moisture using foil backed PIB (polyisobutylene, or equivalent) vapour seal. Internally seal with fire rated gun grade silicone sealant, foodsafe for food production.



Corner detail

Two wall panels one with a half lap rebate along its vertical edge are joined together, internally using a 50 x 50mm galvanised painted / powdercoated steel angle. Any gaps in the insulation should be sealed with fire rated mastic. Externally the corner is closed off using a galvanised angle.

Both angles are fixed using carbon steel rivets at 300 centres. Externally a vapour seal is to be provided to prevent the ingress of moisture using foil backed PIB (or equivalent) vapour seal. Internally seal with fire rated gun grade silicone sealant, food-safe for food production.

Steelwork tolerance

The supporting steel frame must be made and assembled to an accuracy of L/600 between fixing planes (where L is the steelwork spacing between fixing points of the panel).

Installation

The installation is to be carried out by an experienced and competent sub-contractor.

Safety

The contractor is to determine and use a safe method for working throughout the installation and construction period, which complies with OH&S (Workcover) and all site-specific safety requirements.



LOAD SPANS DIAGRAMS – Internal walls

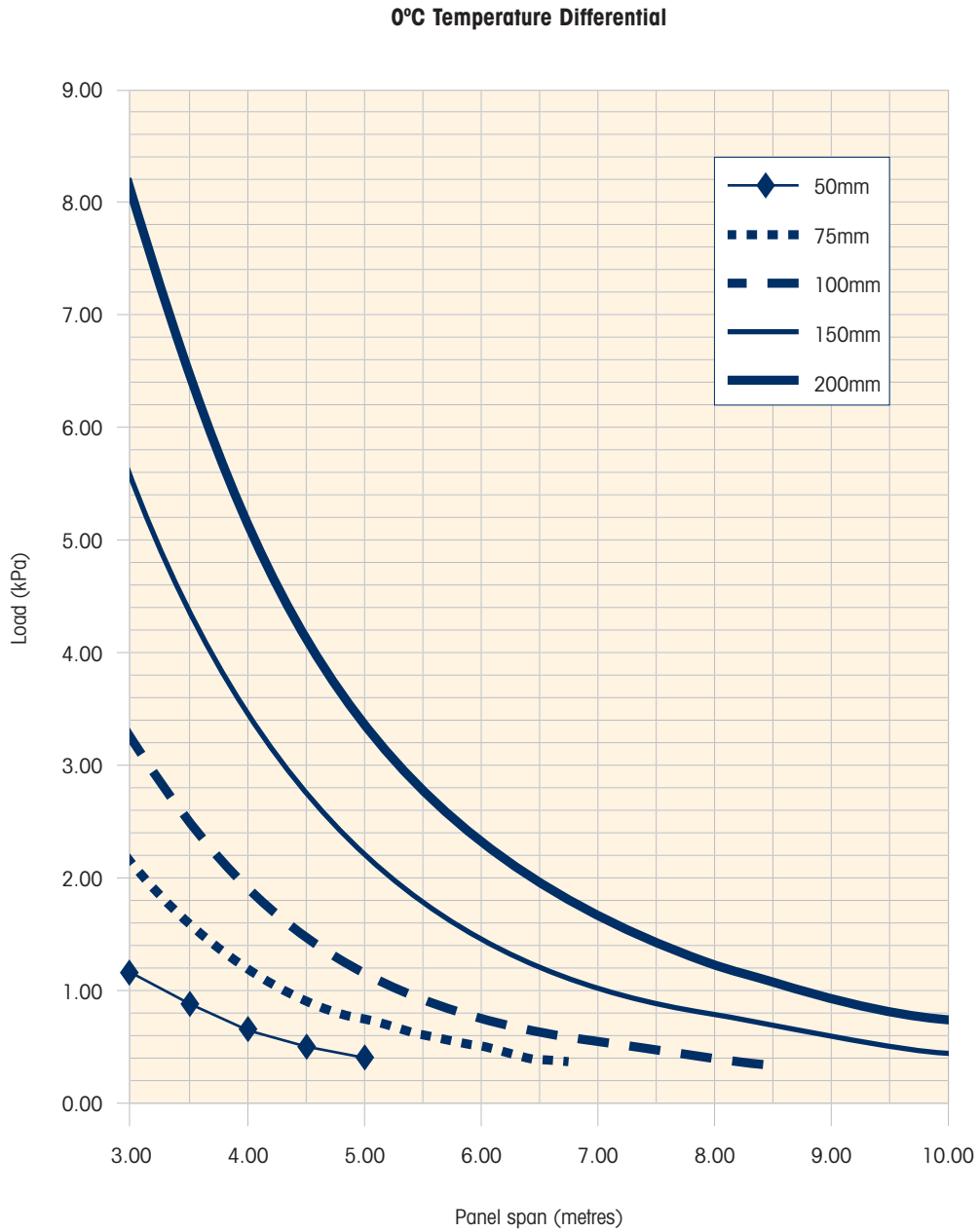


Figure 1. Internal wall span for KS1100 CS panel. No applied loads are considered. Panel deflection is limited to Span/150. Temperature across panel is 0°C

LOAD SPANS DIAGRAMS – Internal walls

25°C Temperature Differential

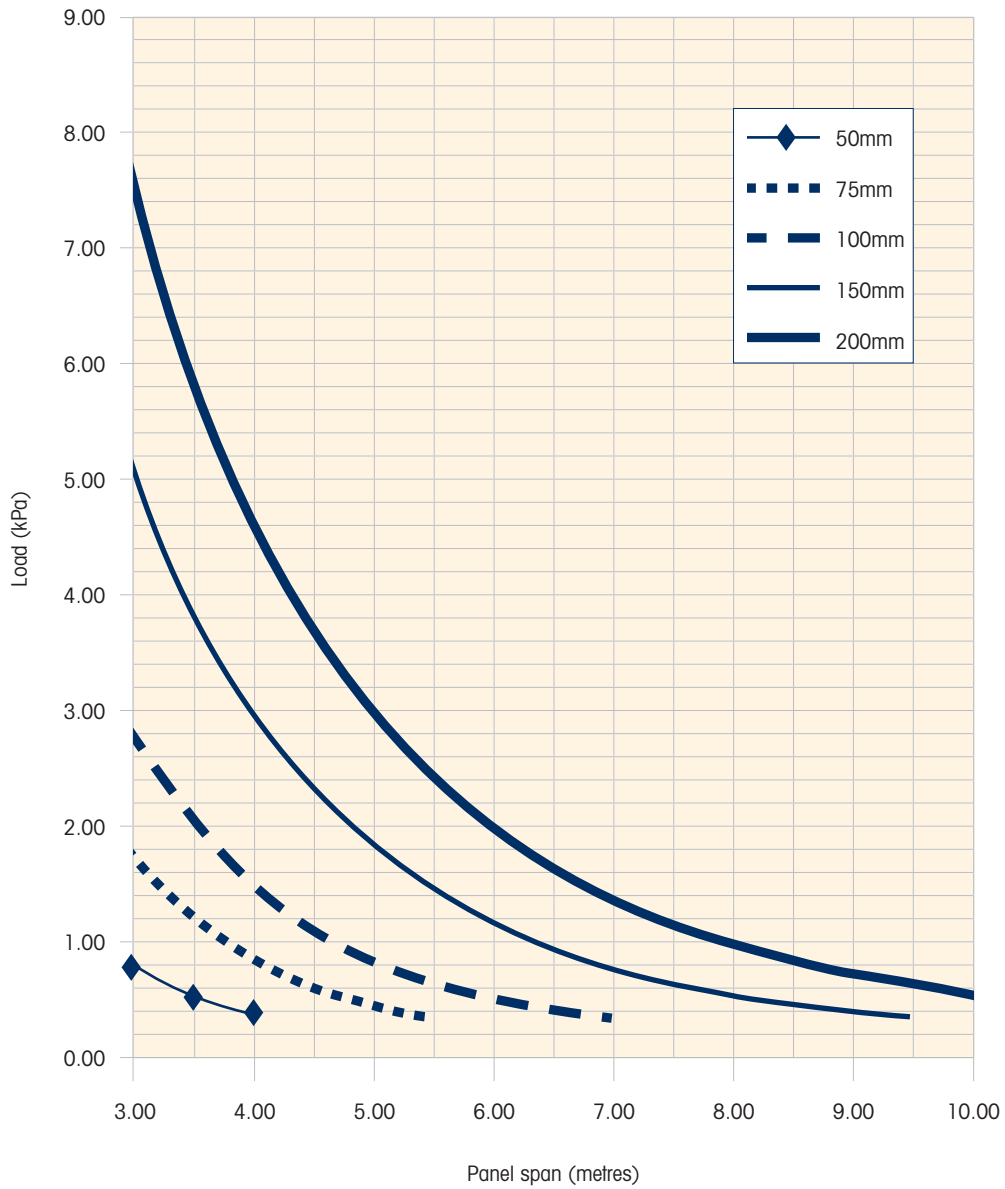


Figure 2. Internal wall span for KS1100 CS panel. No applied loads are considered. Panel deflection is limited to Span/150. Temperature across panel is 25°C

LOAD SPANS DIAGRAMS – Internal walls

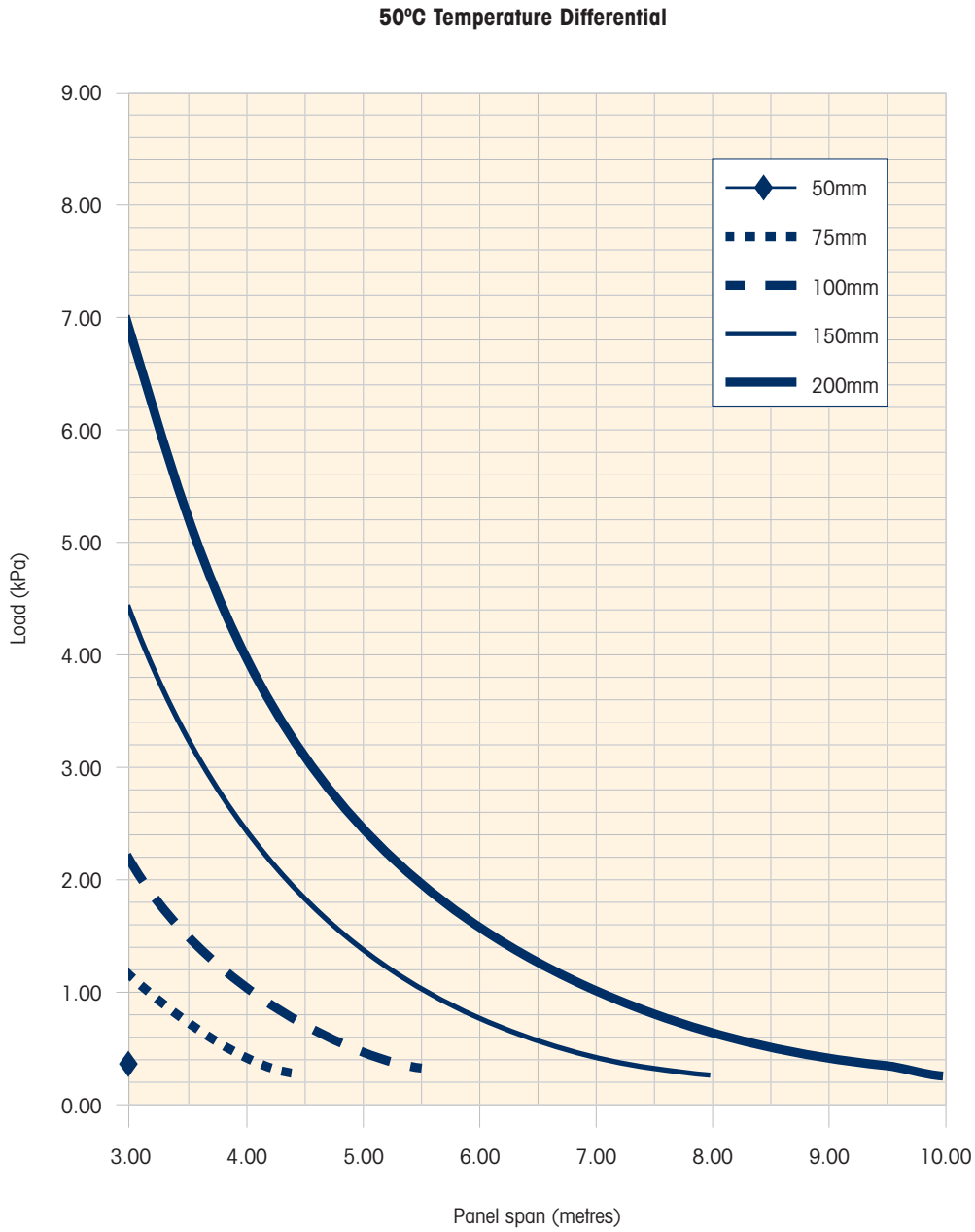


Figure 3. Internal wall span for KS1100 CS panel. No applied loads are considered. Panel deflection is limited to $\text{Span}/150$. Temperature across panel is 50°C

Load span details

Wall panel construction

Internal walls

Construction within an external building envelope is not normally subject to wind and snow loads, therefore the highest loads are imposed loads for foot, plant, and equipment, which typically occur during site erection. A uniformly distributed load of 0.3kPa is usually the minimum design requirement, for a span which does not exceed L/150 as a deflection criteria.

In some cases internal temperature gradients may exist between rooms, such as between a chiller / freezer for example. In such cases additional temperature stresses need to be taken into account in wall panel design.

For the maximum panel height of a self supported internal wall or partition, the following rule of thumb applies:

$$\text{Max length} / 80 = \text{panel thickness}$$

This formula is based on the aforementioned deflection and load design parameters for internal walls. Where this span is exceeded, secondary support for the panel will be required.

External walls

External walls are subject to greater wind pressure and suction loadings due to winds and temperature gradients across the panels, the latter which will vary from summer to winter.

Design parameters used in the tables in this guide consider the extreme cases of winter cold external surface temperatures (-10°) (increasing panel pressure) and summer (55°C) hot surface temperatures (increasing panel suction).

To minimise the number of panel joints and junctions in construction, cold stores are generally constructed with panels installed in their vertical plane with single panels to the full height of the store. In cases where intermediate supports are required, multi-span loads need to be determined and Kingspan should be consulted.

Two and multi-span walls

At intermediate supports the panels are subjected to a combination of shear and bending due to the panel load. This will also include a moment due to the temperature gradient across the panel.

Ceiling panel construction

Internal ceilings

Internal ceilings are designed in accordance with AS/NZS 1170, which recommends that the panel be designed to allow for the panel dead weight, a point load from foot traffic of 0.9kN and a uniformly distributed load of 0.25MPa. The deflection limit which restricts the panel spanning capability is L/200.

When dimensioning for ceilings / roofs, allowance should be made for the load imposed by a person(s) during panel installation. Additional considerations are required if the ceiling /roof is to be of a "walk-on" type, and should include additional panel protection in the trafficable area. For further details consult Kingspan.

Any additional loadings due to plant and equipment, or trafficable walkways / access supported by the ceiling panels and / or building structure should be provided for at the design stage.

Panel lengths

Exact panel lengths to be determined by the installation contractor from the construction drawings. Maximum length 11.8m.

Panel supports

Internal wall and partition panel

The panel must be limited to the following spans:

Panel size (mm)	Maximum panel span (m) internal wall
50	5.2
75	7.0
100	9.1
150	11.8
200	11.8

Table 3. Maximum internal wall spans for KS1100 CS panels

Panel spans are based on a uniform load of 0.3kPa, and a maximum deflection of L/150.

The secondary support system for panels should be manufactured from galvanised steel, (No aluminium should be used) with a minimum panel bearing width of 50mm.

Internal ceiling panel

The panel must be limited to the following spans as indicated in Table 4.

Panel Size (mm)	Maximum Panel Span (m) Internal Ceiling
50	3.7
75	4.6
100	6.0
150	9.1
200	11.0

Table 4. Maximum ceiling spans for KS1100 CS panels

Maximum spans are based on the panel dead load plus a live load of 0.25kPa, a point load of 0.9kN, and a maximum deflection of L/200.

Where panels are required to support temperature differentials across the panel faces, the tables provided in the guide should be used. For other conditions Kingspan should be consulted.

A ceiling suspension system, having the appropriate load test certification, should be sourced from a reputable supplier and installed to their specification. The support sections and fixing brackets should be manufactured from galvanised steel, (no aluminium to be used) with a minimum panel bearing width of 50mm.

LOAD SPANS TABLES – External walls

KS1100 CS single span condition / ultimate limit state																
Panel size (mm)	Load type	Uniformly distributed load (kPa) (Pressure [P] and Suction [S]) with temperature gradient. Internal wall temperature of 25°C. Span in metres														
		3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
50	P	0.62	0.38													
	S	0.70	0.44													
75	P	1.50	1.02	0.70	0.49	0.34										
	S	1.60	1.10	0.77	0.55	0.40										
100	P	2.53	1.80	1.30	0.95	0.71	0.53	0.40	0.30							
	S	2.64	1.89	1.38	1.03	0.77	0.59	0.45	0.35							
150	P	4.82	3.61	2.74	2.11	1.64	1.29	1.03	0.82	0.66	0.54	0.44	0.36			
	S	4.95	3.72	2.85	2.20	1.73	1.37	1.09	0.88	0.72	0.59	0.48	0.40			
200	P	7.29	5.61	4.38	3.46	2.77	2.23	1.81	1.48	1.22	1.01	0.85	0.71	0.60	0.51	0.43
	S	7.43	5.74	4.50	3.57	2.86	2.32	1.89	1.56	1.29	1.08	0.90	0.76	0.65	0.55	0.47

Table 5. External wall span for KS1100 CS panel with a 25°C internal temperature

KS1100 CS single span condition / ultimate limit state																
Panel size (mm)	Load type	Uniformly distributed load (kPa) (Pressure [P] and Suction [S]) with temperature gradient. Internal wall temperature of 0°C. Span in metres														
		3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
50	P	1.01														
	S	0.31														
75	P	1.98	1.42	1.05												
	S	1.12	0.69	0.42												
100	P	3.07	2.27	1.71	1.32	1.02	0.81									
	S	2.09	1.42	0.97	0.66	0.45	0.31									
150	P	5.45	4.17	3.25	2.56	2.05	1.66	1.35	1.11	0.93	0.78					
	S	4.32	3.16	2.34	1.75	1.32	1.00	0.77	0.59	0.45	0.35					
200	P	7.98	6.23	4.95	3.98	3.24	2.66	2.20	1.84	1.55	1.31	1.12	0.96	0.83	0.72	
	S	6.75	5.11	3.93	3.05	2.39	1.89	1.50	1.20	0.97	0.78	0.63	0.51	0.42	0.34	

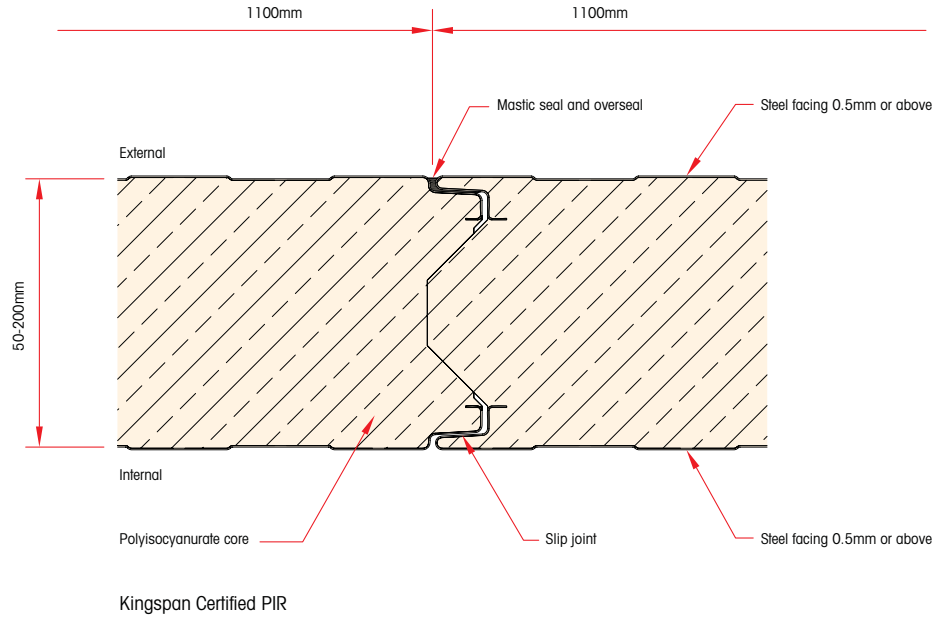
Table 6. External wall span for KS1100 CS panel with a 0°C internal temperature

KS1100 CS single span condition / ultimate limit state																
Panel size (mm)	Load type	Uniformly distributed load (kPa) (Pressure [P] and Suction [S]) with temperature gradient. Internal wall temperature of -25°C. Span in metres														
		3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
50	P															
	S															
75	P	2.17														
	S	0.64														
100	P	3.29	2.46	1.88	1.46											
	S	1.55	0.94	0.55	0.30											
150	P	5.70	4.40	3.45	2.75	2.21	1.80	1.48								
	S	3.70	2.59	1.83	1.30	0.91	0.64	0.44								
200	P	8.25	6.48	5.18	4.19	3.43	2.83	2.36	1.98	1.67	1.43	1.22				
	S	6.07	4.49	3.36	2.53	1.92	1.46	1.11	0.85	0.64	0.49	0.36				

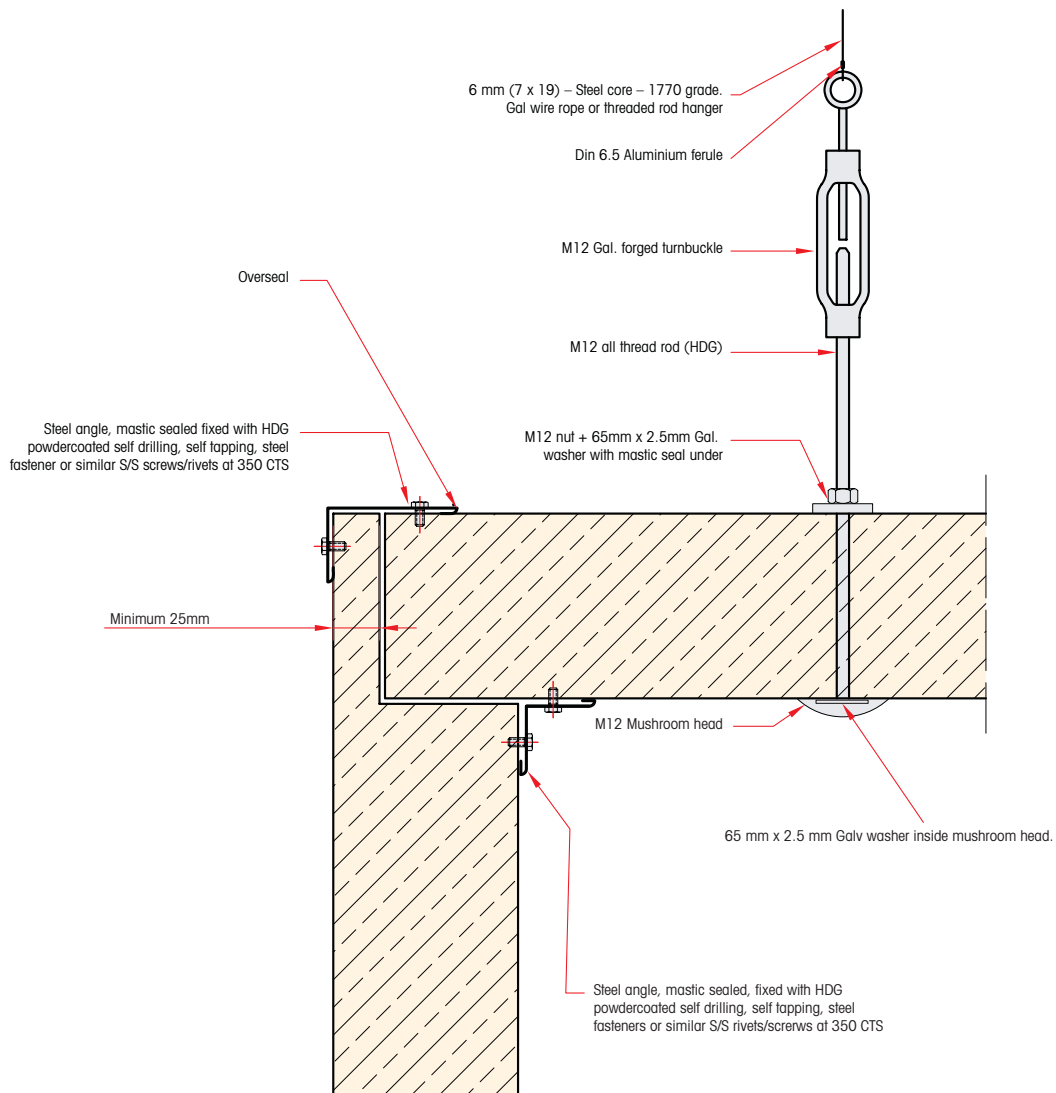
Table 7. External wall span for KS1100 CS panel with a -25°C internal temperature

Notes: Maximum allowable span deflection of L/150. No imposed loads included (other than temperature). Temperature load unfactored. Maximum summer temperature is 55°C (white panels). Minimum winter temperature is -10°C.

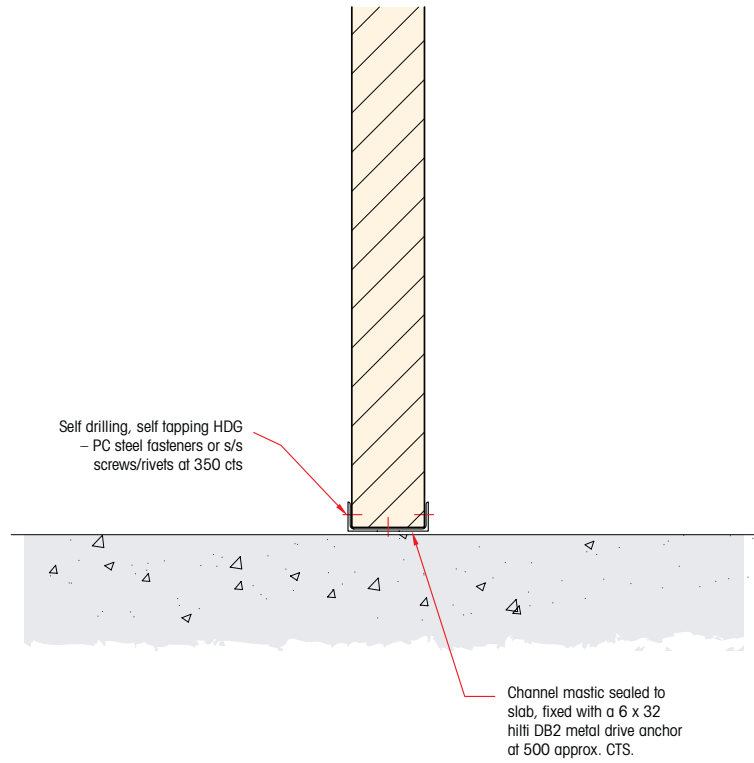
TYPICAL DESIGN DETAILS – 1. Intermediate wall support



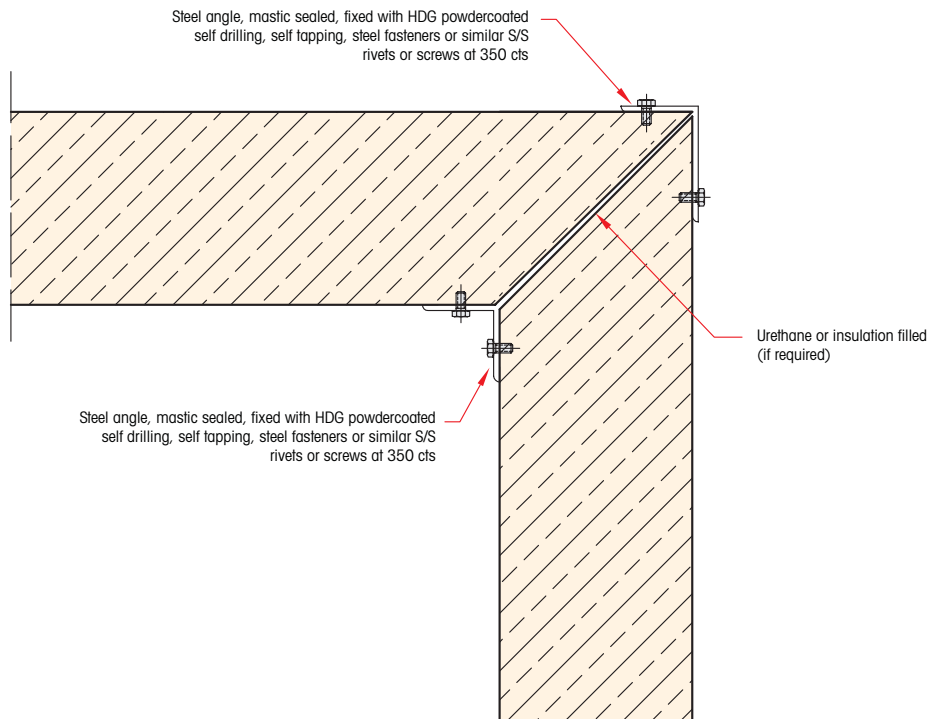
TYPICAL DESIGN DETAILS – 2. Wall / ceiling junction detail



TYPICAL DESIGN DETAILS – 3. Wall base detail



TYPICAL DESIGN DETAILS – 4. Wall corner detail





Constructive Thinking

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