STRUCTURAL SYSTEMS MANUAL

Dimond

August2016

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For online technical information
visit **www.dimond.co.nz**

Contact the Dimond Technical Team:
0800 ROOF SPEC (0800 766377)
For Design Advice, Technical Assistance, System Specification Help

Contact your Dimond Sales Centre:
0800 DIMOND (0800 346663)
For Sales, Delivery, Availability & Pricing Information

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2.0 SCOPE OF USE

Dimond Purlin Systems are intended for use as structural support to roofing and wall cladding. The systems provide for bolted connections to primary structural framework and include Dimond Hi-Span (DHS) Purlins, Fastbrace, Dimond Brace Channels and Top Notch purlins. The systems are subject to limitations on the environment in which they are used, depending on the type of coating specified.

Dimond Purlin Systems are not intended to be used as members to which fall arrest anchor points are attached.

Dimond purlin systems are not intended to be used as vertical studs or horizontal wall girts where plaster board is fixed directly to the DHS purlin and a level 4 finish or above is required. Where a level 4 finish or above is required, Dimond recommend fixing a secondary adjustable grid framing system to the DHS purlins prior to lining with plasterboard to ensure a tighter alignment and fixing tolerances, to achieve the required finish.

It is critical to product performance that the loads applied, member spans, member sizes and bracing points are designed within the appropriate Limit State Loads and limitations published in this manual. Before commencing a project using a Dimond Purlin System, the designer must ensure relevant information is available to the end user. Failure to observe this information may result in a significant reduction in product performance. Dimond accepts no liability whatsoever for products which are used otherwise than in accordance with these recommendations.

The information contained within Purlin Systems is only applicable to Dimond Purlin and Bracing Systems – it cannot be assumed to apply to similar products from other manufacturers.

USE OUTSIDE THE STATED GUIDELINES

If the need arises to use a Dimond Purlin System outside the limitations and procedures given in this manual or if there exists any doubt on product handling or use, written approval should be obtained from Dimond for the specific project, before the project is commenced.

2.1 DURABILITY

2.1.1 SCOPE OF USE

The Dimond Purlin Systems described in this manual are subject to limitations on the environment in which they are used, depending on the type of coating specified in detail in this section.

2.1.2 COATING MATERIAL SPECIFICATIONS

Dimond Purlin Systems are manufactured from galvanised coil in the following protective galvanised zinc coating weights.

1. Standard grade (typically used for interor use) Z 275, i.e. 275 g/m² total zinc coating weight, for DHS Purlins. Fastbrace channel standard is Z450, i.e. 450 g/m² total zinc coating weight.
2. Special grade (typically used for exposed external use) Z450, i.e. 450 g/m² total zinc coating weight, for DHS Purlins and Fastbrace channel and cleat ends.

Refer to Section 2.1.3 on the selection of the appropriate grade.
Refer to Section 2.1.3.1 where extra paint protection may be required

The special grade Z450 usually requires a three-month lead time from date of order to supply for all sizes of purlins and quantities.

2.1.3 ENVIRONMENTS

2.1.3.1 GENERAL

The durability of galvanised zinc coated products is dependent on:

- the environment it will be installed in.
- the grade or weight of the zinc coating used.
- the degree and extent of the maintenance that will be undertaken over the life of the product.

Performance of galvanised zinc coated products is affected by:

- the cumulative effects of the weather.
- the amount of dust that settles on the product (which can hold moisture).
- any other wind-blown deposits that may settle on the product, promoting corrosion.

If these deposits are not removed, they will greatly lessen the durability of the product. Regular maintenance should be carried out on these areas – refer Section 2.1.6.

Standard zinc coating weight is used on most buildings where components are kept dry, protected from exposure to moisture and corrosive environments. Inside the building the galvanised zinc coated products can be used in the temperature range of +60 ºC and down to a minimum of -30 ºC.

In high risk areas such as the underside of canopies, exposed purlin systems used above underslung canopies or exposed purlin systems around large door openings facing the prevailing wind direction, attention should be given to specifying a suitably protective paint coating on the purlin and bracing. Refer Section 2.1.5. The special grade Z450 material may also be specified for the purlins. Bracing Channel and cleats are supplied standard as Z450 galv weight.

2.1.3.2 LIMITATIONS ON USE

Avoid the use of galvanised steel purlin systems without the additional protection of an appropriate coating in the following environments:

- Swimming pool covers, where high concentrations of chlorine are combined with a high humidity environment. In this situation the purlin system remains wet for long periods of time, causing a rapid consumption of the galvanised zinc coating and eventual red rusting of the base metal.
- Any use where the galvanised surface is being exposed to continuous moisture, without a chance for the surface to dry out.
- In or near marine environments, where the prevailing wind may deposit marine salts on the galvanised surface.
- In areas surrounding chemical or industrial storage buildings where any chemical attack may lessen the life of the structure or wind-driven chemical fumes may attack the galvanised coating. Please call 0800 Roofspec (0800 766 377) to discuss.
- When in contact with the ground (ie soil or clay) or where embedded in concrete.

Avoid the use of galvanised steel purlin systems:

- When in contact with timber and especially treated timber such as CCA (copper chrome arsenic) without the use of an isolating material such as Malthoid (DPC) between the timber and galvanised steel flooring sheet. This avoids any moisture or chemical reaction between the two materials.
- When in contact with the ground (ie soil or clay) or where embedded in concrete.
- When used in sub-floor areas with less than 450mm ground clearance.
- When used in sub-floor areas where ventilation does not comply with NZS 3604 Clause 6.14.
- When used within 50mm of the concrete ground slab.

2.1.4 NZBC COMPLIANCE

Past history of use of Dimond Purlin Systems indicate that provided the product use and maintenance is in line with the guidelines in this manual, Dimond Purlin Systems can reasonably be expected to meet the performance criteria in clause B1 Structure and B2 Durability of the New Zealand Building Code for a period of not less than 50 years.

2.1.5 DURABILITY STATEMENT

The use of Dimond Purlin Systems is limited to dry and non corrosive environments. It is the responsibility of the designer to assess the durability requirements of the Dimond Purlin System.

Dimond can, for specific job locations, give advice on the performance of the Dimond galvanised zinc coated purlin system. Call Dimond on 0800 Roofspec (0800 766 377).

The durability of the galvanised zinc coating can be extended by the application of a suitable paint system. Overpainting specifications for specific locations can be obtained from Ameron Coatings 0800 263 766 or Akzo Nobel Coatings Limited 0800 808 807.

2.1.6 MAINTENANCE

Dimond Purlin Systems require a minimum degree of maintenance in order that the expected performance is achieved by ensuring the galvanised surface is free from dirt buildup. Careful maintenance can extend the useful life of the Dimond Purlin System.

As a guide the following should be carried out as often as is needed (this could be as often as every three months).

a) Keep surfaces clean and free from continuous contact with moisture, dust and other debris. This includes areas such as exposed undersides of canopies.

b) Regular maintenance should include a washdown programme to remove all the accumulated dirt or salt buildup on all the galvanised surfaces with a soft brush and plenty of clean water or by water blasting at 15 MPa (2000 psi).

c) Periodically inspect and replace where necessary any bolts or fasteners that have deterioriated to the extent that red rust has become obvious over most of their surface.

d) Periodically inspect the Purlin, Girt, Fastbrace Brace Channel, Sag Rod members and all connections for signs of surface corrosion. Remove any surface corrosion and spot prime corroded areas that exhibit exposed steel substrate, and repaint to an appropriate paint manufacturer's recommendations.

Any case of severe damage or corrosion must be reported to the design engineer.

2.2 PERFORMANCE

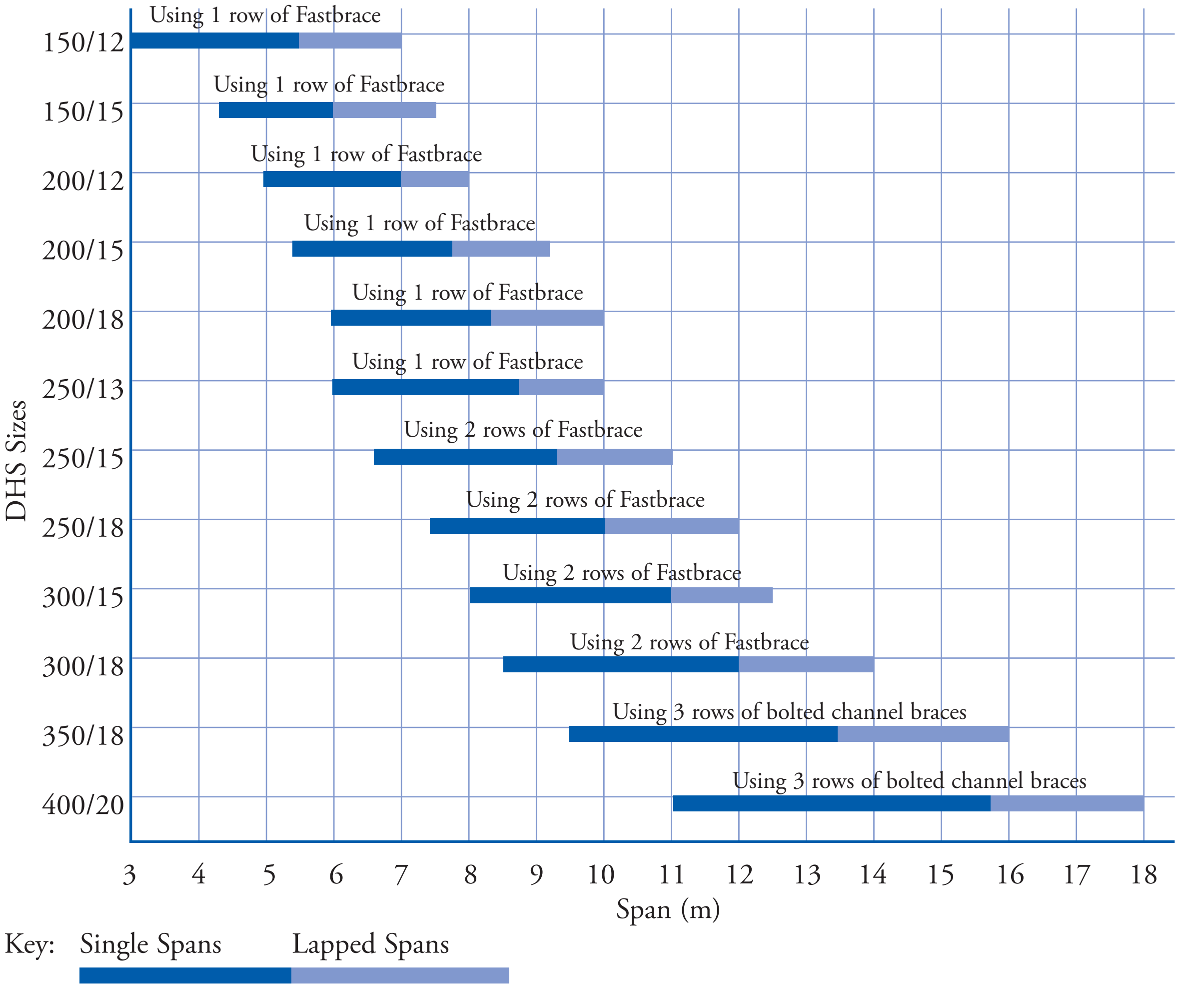
2.2.1 GENERAL DESIGN

The following charts and tables are based on typical product use and are intended as a quick reference guide only. These must not be used for design purposes or as a substitute for specific design (refer to Sections 2.3 and 2.4).

There may be specific cases in this section where the spans indicated on these charts and tables will not be achievable.

2.2.2 DHS PURLIN QUICK REFERENCE GUIDE

1. This guide is intended to be used as an indicator of the purlin and bracing options suitable for particular spans.
2. Final purlin and bracing design must be based on detailed design specific to each building.



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2.2.3 TOP NOTCH PURLIN QUICK REFERENCE GUIDE

The following quick reference guide is intended for use as a preliminary design for farm building and non-habitable sheds and is for guidance only. It is not a substitute for final design or building consent requirements.

1. The quick reference guide is based on AS/NZS 1170:2002 design actions with nominal internal (+0.3) pressures and an allowance for local peak pressures ($K_l C_{pe} + C_{pi} = 1.4$), with a maximum building height of 8 metres and a maximum building height/depth ratio of 0.6.

   Urban and rural purlins are designed for a 1 in 500 year Ultimate Limit State (ULS) wind event and wind serviceability deflections of span/150 (1 in 25 year wind event).

   Farm purlins are designed for a 1 in 100 year Ultimate Limit State (ULS) wind event and maximum wind serviceability deflections of span/90 (1 in 25 year wind event).

2. In **snow** regions specific design is required. The tables are not appropriate above 200 metres elevation for Canterbury, Otago and Southland, nor above 450 metres for the West Coast, Marlborough and the Central/Lower North Island.

3. Terrain categories (TC) are defined as follows:

   Urban areas are those built-up with numerous obstructions 3-5 metres high, such as areas of suburban housing (TC = 3).

   Sheltered Rural assumes rural with some sheltering from trees and adjacent buildings (TC = 2½).

   Rural assumes open terrain or grassland with few, well-scattered obstructions such as isolated trees and buildings (TC = 2).

   Farm indicates buildings of low importance with a low degree of hazard to life and other property on open terrain (TC = 2).

4. **Fasteners** use the following number and screw gauges, ie. 2/12g requires 2 x 12g screws:

	Top Notch Purlin			
	60	100	120	150
At purlin ends	2/12g	2/12g	2/14g	2/14g
At internal (continuous) supports	4/12g	6/12g	6/14g	8/14g

5. **Laps** shall be a minimum of 15% of maximum adjacent Top Notch span.

2.2.3 TOP NOTCH PURLIN QUICK REFERENCE GUIDE – ALL NEW ZEALAND (EXCEPT WELLINGTON & MARLBOROUGH SOUNDS)

		Urban (TC=3)			Sheltered Rural (TC=2½)			Rural (TC=2)			Farm (TC=2)		
Spacing	Span	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped
1200	1.50	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1200	1.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1200	2.00	60x0.95	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1200	2.25	100x0.75	60x0.75	60x0.75	100x0.75	60x0.75	60x0.75	100x0.75	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75
1200	2.50	100x0.75	60x0.75	60x0.75	100x0.75	60x0.95	60x0.75	100x0.75	60x0.95	60x0.95	100x0.75	60x0.75	60x0.75
1200	2.75	100x0.75	60x0.95	60x0.95	100x0.75	60x0.95	60x0.95	100x0.95	100x0.75	60x0.95	100x0.75	60x0.95	60x0.95
1200	3.00	100x0.75	100x0.75	60x0.95	100x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	100x0.75	100x0.75	60x0.95
1200	3.25	100x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	120x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75
1200	3.50	100x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75	100x0.95	100x0.75	100x0.75
1200	3.75	120x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75
1200	4.00	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	150x0.95	120x0.95	100x0.95	120x0.95	100x0.95	100x0.75
1200	4.25	150x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.95	150x1.15	120x0.95	100x0.95	150x0.95	100x0.95	100x0.75
1200	4.50	150x0.95	100x0.95	100x0.95	150x1.15	120x0.95	100x0.95	150x1.15	150x0.95	120x0.95	150x0.95	120x0.95	100x0.75
1200	4.75	150x0.95	120x0.95	100x0.95	150x1.15	120x0.95	120x0.95	150x1.15	150x0.95	120x0.95	150x1.15	120x0.95	100x0.95
1200	5.00	150x1.15	120x0.95	120x0.95	150x1.15	150x0.95	120x0.95		150x1.15	120x0.95	150x1.15	150x0.95	100x0.95
1200	5.25	150x1.15	150x0.95	120x0.95		150x0.95	150x0.95		150x1.15	150x0.95	150x1.15	150x0.95	100x0.95
1200	5.50		150x0.95	120x0.95		150x1.15	150x0.95		150x1.15	150x0.95		150x1.15	100x0.95
1200	5.75		150x0.95	150x0.95		150x1.15	150x0.95		150x1.15	150x0.95		150x1.15	120x0.95
1200	6.00		150x1.15	150x0.95		150x1.15	150x0.95			150x1.15		150x1.15	120x0.95
1200	6.25		150x1.15	150x0.95			150x0.95			150x1.15		150x1.15	150x0.95
1200	6.50		150x1.15	150x0.95			150x1.15			150x1.15			150x0.95
1200	6.75		150x1.15	150x1.15			150x1.15						150x0.95
1200	7.00			150x1.15									150x1.15
1200	7.25			150x1.15									150x1.15
1200	7.50												150x1.15

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2.2.3 TOP NOTCH PURLIN QUICK REFERENCE GUIDE – ALL NEW ZEALAND (EXCEPT WELLINGTON & MARLBOROUGH SOUNDS)

		Urban (TC=3)			Sheltered Rural (TC=2½)			Rural (TC=2)			Farm (TC=2)		
Spacing	Span	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped
1700	1.50	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1700	1.75	60x0.75	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1700	2.00	60x0.95	60x0.75	60x0.75	100x0.95	60x0.75	60x0.75	100x0.75	60x0.95	60x0.75	60x0.95	60x0.75	60x0.75
1700	2.25	100x0.75	60x0.75	60x0.75	100x0.75	60x0.95	60x0.95	100x0.75	100x0.75	60x0.95	100x0.75	60x0.95	60x0.95
1700	2.50	100x0.75	60x0.95	60x0.95	100x0.75	100x0.75	60x0.95	100x0.95	100x0.75	100x0.75	100x0.75	100x0.75	60x0.95
1700	2.75	100x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	100x0.95	100x0.75	100x0.75
1700	3.00	100x0.95	100x0.75	100x0.75	100x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75	100x0.95	100x0.75	100x0.75
1700	3.25	120x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75
1700	3.50	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	150x1.15	120x0.95	100x0.95	150x0.95	100x0.95	100x0.75
1700	3.75	150x0.95	100x0.95	100x0.75	150x0.95	120x0.95	100x0.95		150x0.95	100x0.95	150x0.95	120x0.95	100x0.75
1700	4.00	150x0.95	120x0.95	100x0.95	150x1.15	120x0.95	100x0.95		150x0.95	120x0.95	150x1.15	120x0.95	100x0.95
1700	4.25	150x1.15	120x0.95	100x0.95	150x1.15	150x0.95	120x0.95		150x1.15	120x0.95	150x1.15	150x0.95	100x0.95
1700	4.50	150x1.15	150x0.95	100x0.95		150x1.15	120x0.95		150x1.15	150x0.95		150x0.95	100x0.95
1700	4.75	150x1.15	150x0.95	120x0.95		150x1.15	150x0.95		150x1.15	150x0.95		150x1.15	120x0.95
1700	5.00		150x1.15	120x0.95		150x1.15	150x0.95			150x1.15		150x1.15	120x0.95
1700	5.25		150x1.15	150x0.95			150x0.95			150x1.15		150x1.15	150x0.95
1700	5.50		150x1.15	150x0.95			150x1.15			150x1.15			150x0.95
1700	5.75			150x0.95			150x1.15			150x1.15			150x1.15
1700	6.00			150x1.15			150x1.15						150x1.15
1700	6.25			150x1.15									150x1.15
1700	6.50												150x1.15
1700	6.75												150x1.15
1700	7.00												
1700	7.25												
1700	7.50												

2.2.3 TOP NOTCH PURLIN QUICK REFERENCE GUIDE – WELLINGTON & MARLBOROUGH SOUNDS

		Urban (TC=3)			Sheltered Rural (TC=2½)			Rural (TC=2)			Farm (TC=2)		
Spacing	Span	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped
1200	1.50	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1200	1.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75
1200	2.00	60x0.95	60x0.75	60x0.75	100x0.75	60x0.75	60x0.75	100x0.75	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75
1200	2.25	100x0.75	60x0.75	60x0.75	100x0.75	60x0.95	60x0.95	100x0.75	60x0.95	60x0.95	100x0.75	60x0.95	60x0.95
1200	2.50	100x0.75	60x0.95	60x0.95	100x0.75	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	100x0.75	100x0.75	60x0.95
1200	2.75	100x0.75	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75
1200	3.00	100x0.75	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	100x0.95	100x0.75	100x0.75
1200	3.25	100x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75
1200	3.50	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	150x0.95	120x0.95	100x0.95	150x0.95	100x0.95	100x0.75
1200	3.75	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.95	150x1.15	120x0.95	100x0.95	150x0.95	120x0.95	100x0.75
1200	4.00	150x0.95	100x0.95	100x0.95	150x1.15	120x0.95	100x0.95	150x1.15	150x0.95	120x0.95	150x1.15	120x0.95	100x0.95
1200	4.25	150x1.15	120x0.95	120x0.95	150x1.15	150x0.95	120x0.95		150x0.95	120x0.95	150x1.15	150x0.95	100x0.95
1200	4.50	150x1.15	120x0.95	120x0.95	150x1.15	150x0.95	120x0.95		150x1.15	150x0.95		150x0.95	100x0.95
1200	4.75	150x1.15	150x0.95	120x0.95		150x1.15	150x0.95		150x1.15	150x0.95		150x1.15	120x0.95
1200	5.00		150x0.95	150x0.95		150x1.15	150x0.95		150x1.15	150x0.95		150x1.15	120x0.95
1200	5.25		150x1.15	150x0.95		150x1.15	150x0.95			150x1.15		150x1.15	150x0.95
1200	5.50		150x1.15	150x0.95			150x1.15			150x1.15			150x0.95
1200	5.75		150x1.15	150x1.15			150x1.15						150x1.15
1200	6.00			150x1.15									150x1.15
1200	6.25			150x1.15									150x1.15
1200	6.50												150x1.15
1200	6.75												150x1.15
1200	7.00												
1200	7.25												
1200	7.50												

2.2.3 TOP NOTCH PURLIN QUICK REFERENCE GUIDE – WELLINGTON & MARLBOROUGH SOUNDS

		URBAN (TC=3)			Sheltered Rural (TC=2½)			Rural (TC=2)			Farm (TC=2)		
Spacing	Span	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped	Single	Double	Lapped
1700	1.50	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.75	60x0.95	60x0.95	60x0.75	60x0.75	60x0.75	60x0.75
1700	1.75	60x0.95	60x0.75	60x0.75	60x0.95	60x0.75	60x0.75	100x0.75	100x0.75	60x0.95	60x0.95	60x0.75	60x0.75
1700	2.00	100x0.75	60x0.95	60x0.75	100x0.75	60x0.95	60x0.95	100x0.75	100x0.75	100x0.75	100x0.75	60x0.95	60x0.75
1700	2.25	100x0.75	100x0.75	60x0.95	100x0.95	100x0.75	100x0.75	100x0.95	100x0.95	100x0.75	100x0.75	100x0.75	60x0.95
1700	2.50	100x0.95	100x0.75	100x0.75	100x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	100x0.95	100x0.75	100x0.75
1700	2.75	100x0.95	100x0.75	100x0.75	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	120x0.95	100x0.95	100x0.75
1700	3.00	120x0.95	100x0.95	100x0.75	150x0.95	100x0.95	100x0.75	150x1.15	120x0.95	100x0.75	120x0.95	100x0.95	100x0.75
1700	3.25	150x0.95	100x0.95	100x0.75	150x1.15	120x0.95	100x0.95		150x0.95	100x0.95	150x0.95	100x0.95	100x0.75
1700	3.50	150x1.15	120x0.95	100x0.95		150x0.95	100x0.95		150x1.15	120x0.95	150x1.15	120x0.95	100x0.95
1700	3.75	150x1.15	150x0.95	100x0.95		150x0.95	120x0.95		150x1.15	150x0.95		150x0.95	100x0.95
1700	4.00		150x0.95	120x0.95		150x1.15	150x0.95		150x1.15	150x1.15		150x0.95	100x0.95
1700	4.25		150x1.15	120x0.95		150x1.15	150x1.15			150x1.15		150x1.15	120x0.95
1700	4.50		150x1.15	150x0.95		150x1.15	150x1.15			150x1.15		150x1.15	150x0.95
1700	4.75		150x1.15	150x0.95			150x1.15					150x1.15	150x0.95
1700	5.00			150x1.15			150x1.15						150x1.15
1700	5.25			150x1.15			150x1.15						150x1.15
1700	5.50			150x1.15									150x1.15
1700	5.75												150x1.15
1700	6.00												
1700	6.25												
1700	6.50												
1700	6.75												
1700	7.00												
1700	7.25												
1700	7.50												

2.2.4 ROOFING QUICK REFERENCE GUIDE

This table is taken from the Roofing and Cladding Systems Manual and should be used as a quick reference guide on span and curvature limitations for all Dimond Roofing and Wall Cladding profiles.

For detailed Serviceability and Ultimate Limit State design, please refer to Section 2.1.4 – Specific Design by Profile, of the Roofing and Cladding Systems Manual.

Basis to the tables:

Roofing – the spans are based on restricted access foot traffic limits only or where the Ultimate Wind Load does not exceed 1.5kPa. A restricted access roof is where there is occasional foot traffic, that is educated to walk on the purlin lines, in the profile pans, or carefully across two profile ribs. Walkways will be installed where regular traffic is expected and "Restricted Access" signs placed at access points.

Refer to section 2.1.4 - Specific Design by Profile of the Roofing and Cladding Systems Manual to check the Load/Span Capability in the Ultimate and Serviceability tables.

Walls – spans are limited by acceptable appearance or an ultimate wind load of 2 kPa.

Roofing Fasteners – average of 4 screw fasteners per sheet per purlin. Based on hex-head screws without washers. The number of fasteners can be reduced by specific design (refer to Section 2.1.4 – Specific Design by Profile, in the Roofing and Cladding Systems Manual).

Drape Curve – radii are limited by acceptable roof appearance, refer to Section 2.4.2 of the Roofing and Cladding Systems Manual.

Crimp and Roll Curve – radii are limited by machine capabilities.

Overhang – for restricted access roofs. The unsupported area is not intended to be used as an access way.

2.2.4 ROOFING QUICK REFERENCE GUIDE *continued*

Product		Thickness BMT	Nominal sheet weight per square metre	Maximum Span**				Minimum radius for drape curve	Minimum radius for crimp or roll curve	Maximum overhang unsupported
				Restricted Access Roofing		Walls				
				End Span	Internal	End Span	Internal			
		(mm)	(kg/m²)	(m)	(m)	(m)	(m)	(m)	(mm)	(mm)
Steelspan 900 Minimum pitch 3 degrees	Steel (G550)	0.4+	4.6	2.0	3.0	2.4	3.7	N/R	N/A	250
		0.55	6.2	2.9	4.3	3.3	5.0	120	N/A	450
		0.75+	8.3	4.0	6.0	N/A	N/A	120	N/A	600
	Aluminium H36	0.7+	2.6	1.6	2.5	1.7	2.6	N/R	N/A	250
		0.9	3.3	2.5	3.8	2.6	3.9	120	N/A	350
	Duraclad	1.7	2.8	1.0	1.5	1.4	2.1	30	N/A	250
Topspan Minimum pitch 3 degrees	Steel (G550)	0.4+	4.6	2.0	3.0	2.4	3.7	N/A	N/A	250
		0.55	6.2	2.9	4.3	3.3	5.0	120	N/A	450
		0.75+	8.3	4.0	6.0	N/A	N/A	120	N/A	600
	Aluminium H36	0.7+	2.6	1.6	2.5	1.7	2.6	N/R	N/A	250
		0.9	3.3	2.5	3.8	2.6	3.9	120	N/A	350
	Duraclad	1.7	2.8	1.0	1.5	1.4	2.1	30	N/A	250
BB900 Minimum pitch 3 degrees	Steel (G550)	0.4	4.6	1.5	2.2	1.9	2.9	N/R	N/A	250
		0.55	6.2	2.3	3.4	2.7	4.1	90	N/A	350
		0.75	8.3	2.7	4.0	N/A	N/A	90	N/A	500
	Aluminium H36	0.7	2.6	1.1	1.7	1.6	2.4	N/R	N/A	200
		0.9	3.3	1.9	2.8	2.8	3.7	90	N/A	300
	Duraclad	1.7	2.8	0.8	1.2	1.8	2.1	24	N/A	200
DP955 Minimum pitch 3 degrees	Steel (G550)	0.4	4.6	1.6	2.4	2.0	3.0	N/R	N/A	250
		0.55	6.2	2.7	4.0	2.9	4.3	70	N/A	350
LT7 Minimum pitch 3 degrees	Steel (G550)	0.4	4.6	1.2	1.8	1.6	2.4	80	900	250
		0.55	6.2	1.9	2.9	1.9	2.9	50	400	350
	Aluminium H36	0.7	2.6	0.9	1.3	1.2	1.8	80	N/A	200
		0.9	3.3	1.5	2.3	1.9	2.9	50	400	300
	Duraclad	1.7	2.8	0.8	1.2	1.3	2.0	24	N/A	200
V-Rib Minimum pitch 4 degrees	Steel (G550)	0.4	4.5	1.2	1.8	1.9	2.9	20	400	200
		0.55	6.1	1.7	2.5	2.3	3.5	16	400	300
	Aluminium H36	0.7	2.5	0.9	1.2	1.6	2.4	20	N/A	150
		0.9	3.2	1.4	2.1	1.9	2.9	16	N/A	250
	Duraclad	1.7	2.8	0.8	1.2	0.9	1.4	20	N/A	150

Note: N/A = not available, N/R = not recommended, *= roll curve only
** Maximum spans are based on restricted access foot traffic limits only. Refer to section 2.1.4 - Specific Design by Profile of the Roofing and Cladding Systems Manual to check load/span capability for wind loads in the Ultimate and Serviceability tables along with manufacturing locality for each profile.
+ = Available only on request, subject to minimum order quantities. Check availability with Dimond

2.2.4 ROOFING QUICK REFERENCE GUIDE *continued*

Product		Thickness BMT	Nominal sheet weight per square metre	Maximum Span**				Minimum radius for drape curve	Minimum radius for crimp or roll curve	Maximum overhang unsupported
				Restricted Access Roofing		Walls				
				End Span	Internal	End Span	Internal			
		(mm)	(kg/m²)	(m)	(m)	(m)	(m)	(m)	(mm)	(mm)
Styleline Min pitch 3°	Steel (G550)	0.4	4.2	1.0	1.6	1.6	2.4	80	900	200
		0.55	5.7	1.5	2.2	2.0	3	40	400	250
	Aluminium H36	0.7	2.4	0.8	1.2	1.2	1.8	80	N/A	100
		0.9	3.0	1.1	1.7	1.7	2.6	40	400	200
	Duraclad	1.7	2.8	0.7	1.1	1.1	1.7	12	N/A	100
Veedek™ Min pitch 3°	Steel (G550)	0.4	4.2	1.0	1.6	1.6	2.4	N/R	N/A	200
		0.55	5.7	1.5	2.2	2.0	3	N/R	N/A	250
	Aluminium H36	0.7	2.4	0.8	1.2	1.2	1.8	N/R	N/A	100
		0.9	3.0	1.1	1.7	1.7	2.6	N/R	N/A	200
	Duraclad	1.7	2.8	0.7	1.1	1.1	1.7	N/R	N/A	100
Corrugate Min pitch 8°	Steel (G550)	0.4	4.2	0.8	1.2	1.0	1.5	12	450*	100
		0.55	5.6	1.0	1.5	1.2	1.9	10	450*	150
	Aluminium H36	0.7	2.3	0.5	0.8	0.8	1.2	12	450*	75
		0.9	3.0	0.8	1.2	1.4	2.1	10	450*	150
	Duraclad	1.7	2.8	0.6	0.9	0.9	1.3	8	N/A	100
Dimondek 630 Min pitch 3°	Steel (G550)	0.48	6.1	2.2	3.3	1.4	2.1	250	N/A	150
		0.55	6.7	2.4	3.6	1.7	2.6	250	N/A	250
Dimondek 400 Min pitch 3°	Steel (G300)	0.55	6.8	1.1	1.6	1.0	1.3	70	N/A	250
		0.75	9.2	1.5	2.2	1.3	1.9	70	N/A	300
	Aluminium H36	0.9	3.6	0.9	1.3	0.7	1.0	70	N/A	200
	Copper 1/2 Hard	0.55	7.4	0.9	1.4	0.7	1.1	70	N/A	200
Dimondek 300 Min pitch 3°	Steel (G300)	0.55	7.6	1.3	2	1.2	1.9	N/R	N/A	250
		0.75	10.2	1.5	2.3	1.5	2.3	N/R	N/A	350
	Aluminium H36	0.9	4.1	1.1	1.6	1.0	1.5	N/R	N/A	200
	Copper 1/2 Hard	0.55	8.2	1.1	1.8	1.1	1.7	N/R	N/A	200
Super Six Min pitch 3°	Duraclad	1.7	2.8	1	1.2	1.8	2	28	N/A	250
Dimondclad Wall cladding only	Steel (G550)	0.4	4.1	N/R	N/R	0.9	1.4	N/R	N/A	100
	Aluminium H36	0.7	2.3	N/R	N/R	0.9	1.4	N/R	N/A	75
		0.9	2.9	N/R	N/R	0.9	1.4	N/R	N/A	100
Baby Corrugate Wall cladding only	Steel (G550)	0.4	3.9	N/R	N/R	0.4	0.6	N/R	N/A	75
		0.55	5.2	N/R	N/R	0.4	0.8	N/R	N/A	75
Fineline Wall cladding only	Steel (G550)	0.55	4.8	N/R	N/R	0.3	0.3	N/R	N/A	N/R
	Aluminium H36	0.9	2.6	N/R	N/R	0.3	0.3	N/R	N/A	N/R

Note: N/A = not available, N/R = not recommended, *= roll curve only
** Maximum spans are based on restricted access foot traffic limits only. Refer to section 2.1.4 - Specific Design by Profile of the Roofing and Cladding Systems Manual to check load/span capability for wind loads in the Ultimate and Serviceability tables along with manufacturing locality for each profile.

2.3 SPECIFIC DESIGN – DHS PURLINS

2.3.1 INTRODUCTION

Dimond Hi-Span (DHS) Purlin Systems have been designed to comply with AS/NZS 4600:1996, based on physical testing and analysis carried out by the University of Sydney, who are recognised for their international expertise in the area of cold form design. The structural analysis software consisted of several modules including cross-sectional analysis, an AS/NZS 4600:1996 design module, in-plane structural analysis, and finite element lateral buckling analysis.

Methods in AS/NZS 4600:1996 for determining pure shear, combined bending/shear, lateral buckling and distortional buckling have, in some cases, resulted in lower purlin capacities than previously published. These are included in the design tables in this manual.

Appropriate design load combinations for each Limit State should be determined in accordance with AS/NZS 1170:2002. It is recommended these be expressed as uniformly distributed bending loads (kN/m) and axial compression loads (kN) for direct comparison with the tabulated data in this manual.

Self weight of the DHS Purlin Systems is not included in any load tables and must be calculated as part of the total dead load of the building elements supported by the purlin.

2.3.2 DESIGN CONSIDERATIONS

Data presented in this section is intended for use by structural engineers. Load situations other than uniformly distributed and axial loads will require specific design.

Design Capacities in the Limit State format have been derived by the application of a capacity factor, f:

Bending f_b = 0.90
Compression f_c = 0.85

A design yield strength of 500 MPa has been used for DHS purlins and girts. This is in line with the minimum specified yield for G500 material and is significantly less than the consistent minimum yield stress in the G450 material used in manufacture.

Design capacity of the DHS Purlin System is largely dependent on the amount of restraint provided to the purlin section. These design tables assume that bracing prevents both lateral movement and rotation of the section at that point.

It is also assumed that screw-fixed cladding significantly prevents lateral movement of the flange to which it is attached. Where this assumption does not hold, it is recommended that the number of braces required is specified such that the purlin load capacity, f_bW_{bx} is not less than the capacity for the Fully Restrained case (FR).

Uniformly loaded bending capacities (kN/m) and axial compression capacities (kN) are given for purlins and girts with 1, 2 or 3 braces. The Fully Restrained (FR) case may be used when the compression flange is fully restrained against lateral movement.

The Serviceability Linear Load, W_s (kN/m), is the load at which midspan deflection equates to span/150. As deflection is proportional to loading, W_s loads may be factored by the deflection ratio for any deflection within the limit of the linear load capacities.

Continued on next page

2.3.2 DESIGN CONSIDERATIONS *continued*

As a guide to acceptable deflection limits for serviceability of DHS used as purlins or girts, for wind and dead load actions, Dimond recommend the following limits:

- Where there is no ceiling:
  – Deflection for $W_s \leq$ Span/150
  – Deflection for G $\leq$ Span/300
- Where there is a ceiling:
  – Deflection for $W_s \leq$ Span/200
  – Deflection for G $\leq$ Span/360.

For specific deflection limits reference must be made to AS/NZS 1170.0:2002.

These tables are intended for use where roofing or cladding is attached to one DHS purlin or girt flange. Loads are assumed to be applied about the major axis of symmetry (X-X). Loads for intermediate spans may be calculated by linear interpolation.

For roofs, the dead load of roofing and purlins is assumed to be tied across the ridge or into the ridge beam for monoslope roofs. This avoids purlins sagging out of plane down the roof slope.

For walls, the following table gives the maximum allowable wall heights for Dimond bracing systems, where the dead load of cladding and girts is assumed to be carried in tension to an eaves beam by Fastbrace or brace channels. Specific design of the brace system and connections is required for wall heights greater than the limits shown or where the bracing is designed to carry compression loads.

	Maximum Wall Height	
Purlin Thickness BMT (mm)	**Fastbrace**	**Bolted Channel Bracing**
1.15, 1.25	5.0m	15.0m
1.45	6.5m	15.0m
1.75	8.0m	15.0m
1.95	–	15.0m

Basis to Table

1. Spacing between bracing lines and/or portal frames not greater than 3.5m.
2. Weight of cladding not greater than 6.7kg/m^2.

In order to minimise deflections in the girt member, we recommend a maximum spacing between bracing lines and/or portal frames of 3.5 metres.

Gravity type loads can be assumed to act perpendicular to the roof plane for roof pitches up to 10 degrees provided the DHS purlins are placed with their flanges facing up the slope. For pitches greater than 10 degrees, load components about the minor axis of symmetry (Y-Y) should also be considered.

Specific design is required for loads suspended from DHS purlin systems (such as ducting and piping). Hangers must be connected to the web of the purlins or to the bottom flange within 25mm of the web. Under no circumstances should loads be hung off the purlin lips.

Specific design is required to AS/NZS 4600 when designing DHS purlins as truss or portal members.

Continued on next page

2.3.2 DESIGN CONSIDERATIONS *continued*

The following table lists design capacities and distortional buckling stresses that were used in determining the load span tables.

Distortional Buckling Stresses and Design Capacities in Compression, Bending and Shear

	Compression	Bending			Shear	
DHS size	$f_c N_s$ (kN)	$f_b M_{sx}$ (kNm)	$f_{odx(TW)}$ (MPa)	$f_b M_{bdx}$ (kNm)	k_v	$f_v V_{vy}$ (kN)
DHS 150/12	94.7	6.93	413	5.82	7.80	14.03
DHS 150/15	133.4	9.60	526	7.93	7.53	27.27
DHS 200/12	101.2	9.85	321	8.62	7.62	10.06
DHS 200/15	142.8	14.15	409	11.82	7.45	19.78
DHS 200/18	188.9	18.96	498	15.21	7.33	34.31
DHS 250/13	123.3	15.00	290	13.36	8.03	10.75
DHS 250/15	153.6	18.82	339	16.40	7.89	16.53
DHS 250/18	203.3	25.29	412	21.18	7.73	28.54
DHS 300/15	161.9	23.85	271	21.39	8.00	13.83
DHS 300/18	214.6	31.89	330	27.74	7.83	23.85
DHS 350/18	222.4	38.37	301	33.48	7.70	19.97
DHS 400/20	270.1	53.28	300	45.29	7.51	23.50

- $f_c N_s$: Design section capacity in pure compression, determined in accordance with AS/NZS 4600:1996 Clause 3.4.1 with $f_c = 0.85$.
- $f_b M_{sx}$: Design section capacity in pure bending about the major (x) axis, determined in accordance with AS/NZS 4600:1996 Clause 3.3.2 with $f_b = 0.95$ and the web modelled as a single stiffened flat element.
- $f_b M_{bdx}$: Design member capacity in pure bending about the major (x) axis based on failure by distortional buckling, determined in accordance with AS/NZS 4600:1996 Clause 3.3.3.3 with $f_b = 0.90$. The corresponding distortional buckling stress ($f_{odx(TW)}$) is determined using a rational elastic buckling analysis of the whole cross-section.
- k_v: Shear buckling coefficient for the web following the procedures outlined in Section R6.2 of the ECCS document entitled *European Recommendations for Steel Construction: The Design of Profiled Sheeting* (ECCS, 1983). The ECCS procedures provide a sound basis for determining k_v where a stiffening swage is present in the web.
- $f_v V_{vy}$: Design shear capacity for a shear force in the direction of the y-axis, determined in accordance with AS/NZS 4600:1996 Clause 3.3.5 with $f_v = 0.90$.

2.3.3 COMBINED BENDING AND COMPRESSION DESIGN

When purlins are designed to act under combined bending and axial loads, for example purlins transmitting end wall loads to braced bays, interaction of combined bending and axial loads may be shown in the following equations:

1. If $N^*/\phi_c N_c \leq 0.15$, the following interaction equation may be used:

$$\frac{N^*}{\phi_c N_c} + \frac{W_x^*}{\phi_b W_{bx}} \leq 1.0$$

This is usually the case when purlins are used primarily as bending members near capacity and are also required to take a nominal level of axial compression.

If $N^*/\phi_c N_c > 0.15$ then the following equations must be used:

2. $$\frac{N^*}{\phi_c N_c} + \frac{C_{mx} W_x^*}{\phi_b W_{bx} \alpha_{nx}} \leq 1.0$$

3. $$\frac{N^*}{\phi_c N_s} + \frac{W_x^*}{\phi_b W_{bx}} \leq 1.0$$

where

N^*	=	Design axial compressive load (kN).
$\phi_c N_c$	=	Axial compression member capacity (kN) in the absence of other actions.
$\phi_c N_s$	=	Axial compression section capacity (kN). Refer Section 2.3.2 Design Considerations.
W_x^*	=	Design bending load (kN/m) about the x axis.
$\phi_b W_{bx}$	=	Uniformly loaded bending capacity (kN/m) about the x axis.
C_{mx}	=	Restraint coefficient about the x, y axes respectively. It is reasonable to assume C_{mx} is 1.0 for unrestrained supports (i.e. simply supported) and 0.85 for restrained supports (end or internal spans).
α_{nx}	=	$1 - [N^*/\phi_c N_{ex}]$.
$\phi_c N_{ex}$	=	Euler buckling capacity (kN) about the major axis of symmetry (X-X).

Flexure about the minor axis of symmetry (Y-Y) is assumed to be zero. If biaxial flexure is expected, specific design is required.

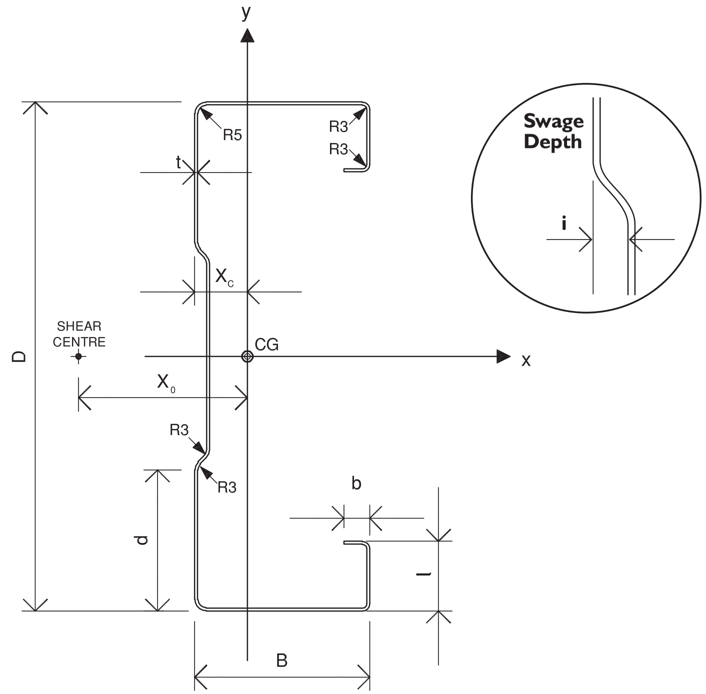
Solution of the interaction equation involves solving for the design axial compressive load (N^*), yielding the remaining axial capacity or directly substituting the known variables. These methods are illustrated in the sample calculations in Section 2.3.11.3.

Where DHS purlins are designed to take solely axial load, the design of the bolted connections must be considered. For example a DHS purlin designed as a load-bearing post, held top and bottom with bolts, will likely be limited by the capacity of bolts used.

2.3.4 DHS SECTION PROPERTIES

DHS Section	Depth D mm	Width B mm	Thickness t mm	Mass kg/m	Weight kN/m	d mm	Swage Depth i mm	b mm	l mm	x_c mm	x_0 mm
DHS 150/12	150	65	1.15	2.99	0.030	54	4	10	23	24.0	56.6
DHS 150/15	150	65	1.45	3.74	0.037	54	4	10	23	23.9	56.1
DHS 200/12	200	75	1.15	3.71	0.037	62	4	10	28	26.3	62.0
DHS 200/15	200	75	1.45	4.65	0.046	62	4	10	28	26.2	61.4
DHS 200/18	200	75	1.75	5.59	0.055	62	4	10	28	26.1	60.8
DHS 250/13	250	85	1.25	4.87	0.048	67	6	12	33	29.4	67.1
DHS 250/15	250	85	1.45	5.63	0.056	67	6	12	33	29.3	66.7
DHS 250/18	250	85	1.75	6.76	0.067	67	6	12	33	29.3	66.2
DHS 300/15	300	100	1.45	6.66	0.066	67	7	12	38	34.0	76.1
DHS 300/18	300	100	1.75	8.01	0.079	67	7	12	38	33.9	75.6
DHS 350/18	350	100	1.75	8.83	0.087	77	7	12	43	32.7	73.4
DHS 400/20	400	100	1.95	10.74	0.106	79	7	12	48	31.8	70.9

Note: Mass assumes a total coated weight for the standard zinc coating of 275 g/m².



DHS Section	FULL (GROSS) SECTION PROPERTIES											EFFECTIVE SECTION PROPERTIES					
	A_g mm²	I_x 10^6mm⁴	I_y 10^6mm⁴	Z_x 10^3mm³	$Z_{y(+ve)}$ 10^3mm³	$Z_{y(-ve)}$ 10^3mm³	r_x mm	r_y mm	b_y mm	J mm⁴	I_w 10^9mm⁶	$A_{e(fy)}$ mm²	I_{ex} 10^6mm⁴	$I_{ey(+ve)}$ 10^6mm⁴	$I_{ey(-ve)}$ 10^6mm⁴	Z_{ex} 10^3mm³	$Z_{ey(+ve)}$ 10^3mm³	$Z_{ey(-ve)}$ 10^3mm³
DHS 150/12	381	1.33	0.24	17.8	5.9	10.2	59.2	25.3	166	168	1.44	223	1.18	0.24	0.16	14.6	5.9	4.9
DHS 150/15	477	1.66	0.30	22.2	7.3	12.6	59.1	25.1	165	334	1.76	314	1.57	0.30	0.22	20.2	7.3	6.6
DHS 200/12	473	2.90	0.40	29.0	8.2	15.2	78.4	29.1	207	208	4.04	238	2.37	0.40	0.25	20.7	8.2	6.2
DHS 200/15	593	3.63	0.49	36.3	10.1	18.9	78.2	28.9	206	415	4.96	336	3.22	0.49	0.33	29.8	10.1	8.6
DHS 200/18	712	4.34	0.59	43.4	12.0	22.4	78.1	28.7	206	726	5.82	445	4.12	0.59	0.42	39.9	12.0	10.8
DHS 250/13	620	5.86	0.66	46.8	11.8	22.4	97.2	32.6	246	323	10.47	290	4.62	0.66	0.39	31.6	11.8	8.6
DHS 250/15	717	6.76	0.76	54.1	13.6	25.8	97.1	32.5	245	502	11.97	361	5.62	0.76	0.47	39.6	13.6	10.5
DHS 250/18	861	8.10	0.90	64.8	16.1	30.7	97.0	32.3	245	879	14.13	478	7.20	0.90	0.60	53.2	16.1	13.8
DHS 300/15	849	11.55	1.22	77.0	18.4	35.8	116.7	37.9	292	595	27.41	381	8.93	1.22	0.73	50.2	18.4	13.5
DHS 300/18	1020	13.86	1.45	92.4	22.0	42.7	116.5	37.7	292	1042	32.47	505	11.46	1.45	0.92	67.1	22.0	17.6
DHS 350/18	1125	20.22	1.60	115.6	23.7	48.8	134.1	37.7	333	1149	48.48	523	16.36	1.60	0.96	80.8	23.7	18.0
DHS 400/20	1368	31.31	1.91	156.5	28.0	60.0	151.3	37.4	380	1734	75.70	635	25.75	1.91	1.14	112.2	28.0	21.4

Note: Notation used is consistent with Table 1.4 in AS/NZS 4600:1996 (+ve) = Lip in compression (–ve) = Web in compression

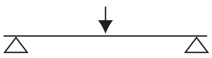
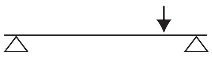
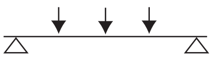
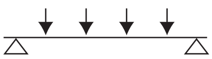
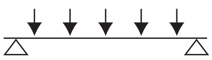
Dimond

2.3.5 CONVERSION FORMULAE FROM POINT LOADS TO EQUIVALENT UNIFORM BENDING LOADS

For DHS Purlins – Ultimate Strength

Formula $W = F \times \frac{P}{L}$

Where W = Uniform bending load
F = Factor “F” from table below
P = Point load ↓
L = Length of span

Type	Symbol	Factor “F”			
		Simple	End or Internal	Lapped End	Lapped Internal
One equidistant point load		2	1.75	1.75	1.5
One eccentric point load		1.5	1.5	1.5	1
Two equidistant point loads		2.67	2.5	2.5	1.75
Three equidistant point loads		4	3	3	2.5
Four equidistant point loads		4.8	4	4	3
Five equidistant point loads		6	5	5	4

These formulae are only applicable to DHS Purlins. Refer to the Top Notch Purlin Section 2.4.4 for Top Notch formulae.

The formula assumes all point loads are equal in magnitude.

These factors “F” are an approximation to the pure derivation and are to be used as a guide only.

2.3.6 INTRODUCTION TO DHS PURLIN SYSTEMS CAPACITY TABLES

The capacity tables given in Sections 2.3.7 and 2.3.8 relate to the following span configurations:

Single span – pinned at both ends.
End span – pinned at one end and fixed at the other.
Internal span – fixed at both ends.

Note: End and internal spans can be continuous or lapped.

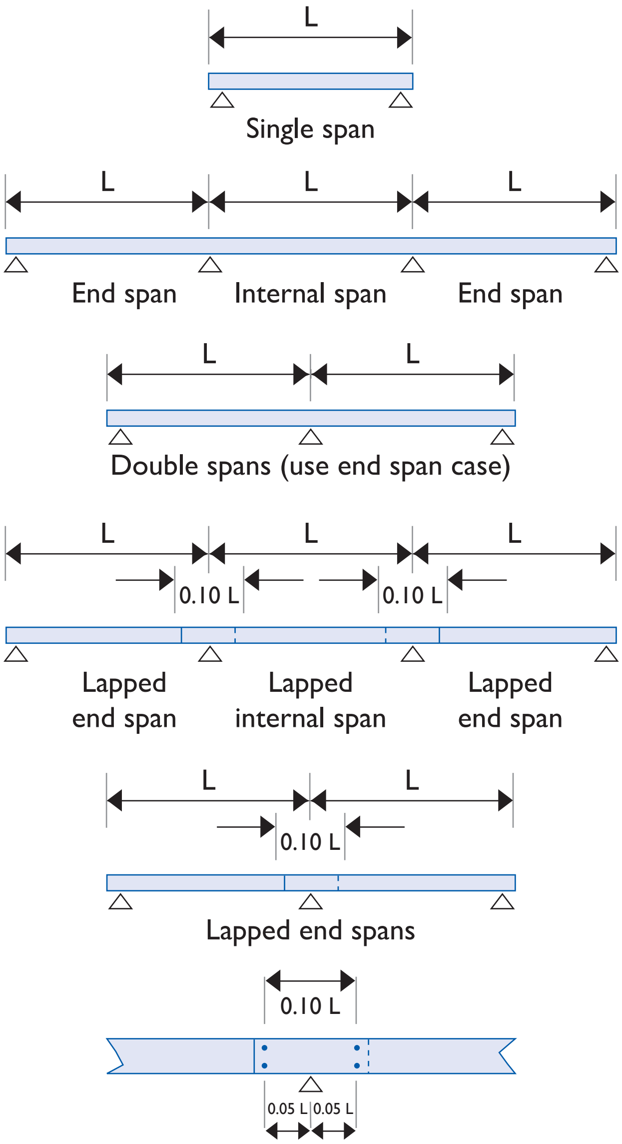
No bolt slip or member rotation has been allowed for at fixed ends.

Use of end span tables with corresponding internal span tables assumes that the end span is within plus 5% or minus 10% of the internal spans, provided that for a 3 span configuration both end spans are reduced by the same amount. Otherwise specific design to AS/NZS 4600 is required.

As a guide, single spans are used most frequently, particularly where purlins are set down between the rafters. Deflections may govern on larger spans.

End and continuous configurations may be used where lower deflections are required.

Lapped end and lapped internal configurations are more economical on large purlin spans where better strength and lower deflections are required.



All lap lengths are to be a minimum of 0.1 of the maximum span, measured from bolt centre to bolt centre each end of the lap, positioned equally each side of the portal rafter. Refer detail N in Section 2.3.16.15.

L = Span length

2.3.7 DHS LOAD SPAN TABLES – SINGLE SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S
3.0	5.17	5.17	5.17	5.17	4.73																									
3.5	3.80	3.80	3.80	3.80	3.02	5.18	5.18	5.18	5.18	3.92	5.63	5.63	5.63	5.63	5.86															
4.0	2.91	2.91	2.91	2.91	2.05	3.96	3.96	3.96	3.96	2.65	4.31	4.31	4.31	4.31	4.03	5.91	5.91	5.91	5.91	5.51	7.60	7.60	7.60	7.60	6.80	5.37	5.37	5.37	5.37	7.48
4.5	2.30	2.30	2.30	2.30	1.45	3.09	3.13	3.13	3.13	1.86	3.40	3.40	3.40	3.40	2.90	4.67	4.67	4.67	4.67	3.91	6.00	6.00	6.00	6.00	4.82	4.77	4.77	4.77	4.77	5.37
5.0	1.73	1.86	1.86	1.86	1.06	2.29	2.53	2.53	2.53	1.36	2.69	2.75	2.75	2.75	2.16	3.78	3.78	3.78	3.78	2.87	4.86	4.86	4.86	4.86	3.54	4.27	4.27	4.27	4.27	3.99
5.5	1.26	1.54	1.54	1.54	0.80	1.67	2.09	2.09	2.09	1.02	2.09	2.28	2.28	2.28	1.65	3.02	3.12	3.12	3.12	2.17	3.85	4.02	4.02	4.02	2.66	3.43	3.53	3.53	3.53	3.05
6.0	0.94	1.29	1.29	1.29	0.62	1.24	1.76	1.76	1.76	0.78	1.63	1.91	1.91	1.91	1.29	2.35	2.62	2.62	2.62	1.68	2.94	3.38	3.38	3.38	2.05	2.73	2.96	2.96	2.96	2.39
6.5	0.71	1.10	1.10	1.10	0.49	0.94	1.50	1.50	1.50	0.62	1.27	1.63	1.63	1.63	1.02	1.79	2.23	2.23	2.23	1.33	2.24	2.88	2.88	2.88	1.61	2.20	2.53	2.53	2.53	1.91
7.0	0.55	0.94	0.95	0.95	0.39	0.72	1.26	1.29	1.29	0.49	1.00	1.40	1.40	1.40	0.82	1.39	1.93	1.93	1.93	1.07	1.73	2.48	2.48	2.48	1.29	1.75	2.18	2.18	2.18	1.55
7.5	0.43	0.78	0.82	0.82	0.32	0.56	1.03	1.12	1.12	0.40	0.81	1.21	1.22	1.22	0.67	1.09	1.68	1.68	1.68	0.87	1.36	2.16	2.16	2.16	1.05	1.41	1.90	1.90	1.90	1.28
8.0						0.44	0.84	0.99	0.99	0.33	0.65	1.02	1.07	1.07	0.56	0.87	1.47	1.47	1.47	0.72	1.07	1.90	1.90	1.90	0.86	1.15	1.66	1.67	1.67	1.07
8.5											0.53	0.86	0.95	0.95	0.47	0.70	1.25	1.30	1.30	0.60	0.85	1.60	1.68	1.68	0.72	0.94	1.43	1.48	1.48	0.90
9.0											0.43	0.74	0.85	0.85	0.39	0.57	1.07	1.16	1.16	0.50	0.69	1.34	1.50	1.50	0.60	0.79	1.23	1.32	1.32	0.77
9.5											0.35	0.62	0.76	0.76	0.34	0.47	0.89	1.04	1.04	0.43	0.56	1.11	1.34	1.34	0.51	0.66	1.06	1.18	1.18	0.66
10.0											0.29	0.53	0.67	0.69	0.29	0.38	0.75	0.94	0.94	0.37	0.46	0.93	1.21	1.21	0.44	0.56	0.92	1.06	1.06	0.57
10.5																0.32	0.63	0.85	0.85	0.32	0.38	0.79	1.10	1.10	0.38	0.48	0.79	0.97	0.97	0.49
11.0																					0.32	0.67	0.97	1.00	0.33	0.40	0.68	0.86	0.88	0.43
11.5																					0.27	0.57	0.85	0.92	0.29	0.34	0.59	0.77	0.80	0.38
12.0																										0.29	0.52	0.68	0.74	0.33
12.5																										0.25	0.45	0.61	0.68	0.29
13.0																														
13.5																														
14.0																														
14.5																														
15.0																														
15.5																														
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16.5																														
17.0																														
17.5																														
18.0																														

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – SINGLE SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15				
	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s
3.0															
3.5															
4.0															
4.5															
5.0	5.24	5.24	5.24	5.24	4.90	6.77	6.77	6.77	6.77	6.35	5.53	5.53	5.53	5.53	7.44
5.5	4.31	4.33	4.33	4.33	3.75	5.60	5.60	5.60	5.60	4.81	5.03	5.03	5.03	5.03	5.69
6.0	3.44	3.64	3.64	3.64	2.94	4.63	4.70	4.70	4.70	3.73	4.61	4.61	4.61	4.61	4.46
6.5	2.77	3.10	3.10	3.10	2.35	3.74	4.01	4.01	4.01	2.95	3.86	4.05	4.05	4.05	3.56
7.0	2.21	2.67	2.67	2.67	1.91	2.98	3.45	3.45	3.45	2.37	3.18	3.49	3.49	3.49	2.89
7.5	1.78	2.33	2.33	2.33	1.57	2.36	3.01	3.01	3.01	1.94	2.64	3.04	3.04	3.04	2.39
8.0	1.45	2.04	2.04	2.04	1.30	1.88	2.64	2.64	2.64	1.60	2.17	2.67	2.67	2.67	1.99
8.5	1.20	1.79	1.81	1.81	1.09	1.52	2.34	2.34	2.34	1.34	1.79	2.36	2.36	2.36	1.68
9.0	0.99	1.54	1.61	1.61	0.92	1.24	2.08	2.09	2.09	1.13	1.49	2.11	2.11	2.11	1.43
9.5	0.82	1.34	1.45	1.45	0.78	1.02	1.80	1.87	1.87	0.96	1.26	1.85	1.89	1.89	1.23
10.0	0.68	1.16	1.31	1.31	0.67	0.85	1.57	1.69	1.69	0.82	1.07	1.62	1.71	1.71	1.07
10.5	0.57	1.00	1.19	1.19	0.58	0.71	1.35	1.53	1.53	0.71	0.91	1.43	1.55	1.55	0.93
11.0	0.48	0.86	1.08	1.08	0.51	0.59	1.16	1.40	1.40	0.62	0.79	1.26	1.41	1.41	0.82
11.5	0.41	0.75	0.96	0.99	0.45	0.50	0.99	1.28	1.28	0.54	0.68	1.12	1.29	1.29	0.72
12.0	0.35	0.66	0.86	0.91	0.39	0.42	0.86	1.16	1.17	0.47	0.59	0.98	1.18	1.18	0.64
12.5	0.30	0.58	0.77	0.83	0.35	0.36	0.74	1.04	1.08	0.42	0.52	0.86	1.07	1.09	0.57
13.0	0.26	0.51	0.69	0.77	0.31	0.31	0.65	0.94	1.00	0.37	0.45	0.76	0.97	1.01	0.51
13.5						0.27	0.57	0.84	0.93	0.33	0.40	0.67	0.88	0.93	0.46
14.0						0.23	0.50	0.75	0.86	0.30	0.35	0.60	0.80	0.87	0.41
14.5											0.30	0.54	0.72	0.81	0.37
15.0											0.27	0.48	0.66	0.76	0.33
15.5											0.24	0.43	0.60	0.71	0.30
16.0															
16.5															
17.0															
17.5															
18.0															

Span (m)	DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s
3.0															
3.5															
4.0															
4.5															
5.0															
5.5															
6.0															
6.5	5.17	5.25	5.25	5.25	4.63										
7.0	4.26	4.52	4.52	4.52	3.77	5.15	5.46	5.46	5.46	5.17					
7.5	3.54	3.94	3.94	3.94	3.11	4.27	4.76	4.76	4.76	4.26	5.95	6.26	6.26	6.26	6.54
8.0	2.91	3.46	3.46	3.46	2.60	3.52	4.18	4.18	4.18	3.56	4.91	5.66	5.66	5.66	5.46
8.5	2.41	3.07	3.07	3.07	2.20	2.91	3.70	3.70	3.70	3.00	4.06	5.01	5.01	5.01	4.60
9.0	2.02	2.74	2.74	2.74	1.86	2.43	3.30	3.30	3.30	2.56	3.39	4.47	4.47	4.47	3.92
9.5	1.70	2.45	2.45	2.45	1.59	2.05	2.96	2.96	2.96	2.20	2.85	4.01	4.01	4.01	3.37
10.0	1.45	2.17	2.21	2.21	1.37	1.74	2.63	2.67	2.67	1.91	2.42	3.62	3.62	3.62	2.92
10.5	1.23	1.91	2.01	2.01	1.18	1.49	2.31	2.42	2.42	1.66	2.07	3.22	3.28	3.28	2.54
11.0	1.04	1.69	1.83	1.83	1.03	1.28	2.04	2.21	2.21	1.46	1.79	2.85	2.99	2.99	2.23
11.5	0.89	1.50	1.67	1.67	0.91	1.11	1.81	2.02	2.02	1.29	1.55	2.52	2.73	2.73	1.97
12.0	0.76	1.32	1.54	1.54	0.80	0.97	1.60	1.86	1.86	1.15	1.35	2.23	2.51	2.51	1.75
12.5	0.66	1.16	1.42	1.42	0.71	0.84	1.40	1.71	1.71	1.02	1.17	1.96	2.31	2.31	1.56
13.0	0.57	1.03	1.30	1.31	0.63	0.73	1.24	1.57	1.58	0.92	1.01	1.73	2.14	2.14	1.40
13.5	0.50	0.91	1.18	1.21	0.57	0.63	1.10	1.42	1.46	0.82	0.87	1.54	1.98	1.98	1.26
14.0	0.43	0.81	1.07	1.13	0.51	0.55	0.98	1.29	1.36	0.74	0.76	1.37	1.80	1.84	1.14
14.5	0.38	0.73	0.97	1.05	0.46	0.48	0.88	1.18	1.27	0.66	0.66	1.22	1.64	1.72	1.03
15.0	0.33	0.66	0.89	0.98	0.41	0.42	0.79	1.07	1.19	0.60	0.58	1.10	1.49	1.61	0.94
15.5	0.29	0.59	0.81	0.92	0.38	0.37	0.71	0.98	1.11	0.55	0.51	0.99	1.36	1.50	0.85
16.0	0.26	0.53	0.73	0.86	0.34	0.33	0.64	0.89	1.04	0.50	0.45	0.89	1.24	1.41	0.77
16.5	0.23	0.47	0.66	0.81	0.31	0.29	0.58	0.80	0.98	0.45	0.40	0.81	1.12	1.33	0.71
17.0						0.26	0.53	0.73	0.92	0.41	0.36	0.73	1.02	1.25	0.65
17.5						0.23	0.48	0.67	0.87	0.38	0.32	0.67	0.93	1.18	0.59
18.0						0.21	0.44	0.61	0.82	0.35	0.29	0.61	0.85	1.11	0.54

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – END SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S
3.0	4.75	4.75	4.75	4.75	10.78	7.05	7.05	7.05	7.05	14.30	4.57	4.57	4.57	4.57	21.64															
3.5	3.69	3.69	3.69	3.69	6.78	5.18	5.18	5.18	5.18	9.01	3.74	3.74	3.74	3.74	13.63	6.46	6.46	6.46	6.46	18.50	9.71	9.71	9.71	9.71	23.62	4.39	4.39	4.39	4.39	26.55
4.0	2.91	2.91	2.91	2.91	4.54	3.96	3.96	3.96	3.96	6.03	3.11	3.11	3.11	3.11	9.13	5.27	5.27	5.27	5.27	12.39	7.60	7.60	7.60	7.60	15.83	3.73	3.73	3.73	3.73	17.78
4.5	2.30	2.30	2.30	2.30	3.19	3.13	3.13	3.13	3.13	4.24	2.63	2.63	2.63	2.63	6.41	4.37	4.37	4.37	4.37	8.70	6.00	6.00	6.00	6.00	11.11	3.21	3.21	3.21	3.21	12.49
5.0	1.86	1.86	1.86	1.86	2.33	2.53	2.53	2.53	2.53	3.10	2.25	2.25	2.25	2.25	4.67	3.68	3.68	3.68	3.68	6.34	4.86	4.86	4.86	4.86	8.10	2.79	2.79	2.79	2.79	9.10
5.5	1.54	1.54	1.54	1.54	1.78	2.09	2.09	2.09	2.09	2.35	1.94	1.94	1.94	1.94	3.51	3.12	3.12	3.12	3.12	4.76	4.02	4.02	4.02	4.02	6.08	2.45	2.45	2.45	2.45	6.84
6.0	1.29	1.29	1.29	1.29	1.39	1.76	1.76	1.76	1.76	1.82	1.69	1.69	1.69	1.69	2.70	2.62	2.62	2.62	2.62	3.67	3.38	3.38	3.38	3.38	4.69	2.17	2.17	2.17	2.17	5.27
6.5	1.10	1.10	1.10	1.10	1.11	1.50	1.50	1.50	1.50	1.44	1.49	1.49	1.49	1.49	2.12	2.23	2.23	2.23	2.23	2.88	2.88	2.88	2.88	2.88	3.69	1.93	1.93	1.93	1.93	4.14
7.0	0.95	0.95	0.95	0.95	0.89	1.29	1.29	1.29	1.29	1.16	1.31	1.31	1.31	1.31	1.70	1.93	1.93	1.93	1.93	2.33	2.48	2.48	2.48	2.48	2.97	1.73	1.73	1.73	1.73	3.31
7.5	0.82	0.82	0.82	0.82	0.73	1.11	1.12	1.12	1.12	0.95	1.17	1.17	1.17	1.17	1.40	1.68	1.68	1.68	1.68	1.92	2.16	2.16	2.16	2.16	2.43	1.56	1.56	1.56	1.56	2.69
8.0	0.70	0.72	0.72	0.72	0.60	0.93	0.99	0.99	0.99	0.78	1.05	1.05	1.05	1.05	1.16	1.47	1.47	1.47	1.47	1.61	1.90	1.90	1.90	1.90	2.01	1.41	1.41	1.41	1.41	2.22
8.5	0.59	0.64	0.64	0.64	0.50	0.78	0.86	0.87	0.87	0.66	0.91	0.94	0.94	0.94	0.98	1.30	1.30	1.30	1.30	1.36	1.68	1.68	1.68	1.68	1.68	1.28	1.28	1.28	1.28	1.85
9.0	0.49	0.55	0.57	0.57	0.43	0.65	0.74	0.78	0.78	0.55	0.79	0.85	0.85	0.85	0.84	1.14	1.16	1.16	1.16	1.15	1.46	1.50	1.50	1.50	1.43	1.17	1.17	1.17	1.17	1.56
9.5	0.41	0.47	0.51	0.51	0.36	0.54	0.63	0.70	0.70	0.47	0.68	0.74	0.76	0.76	0.72	0.98	1.04	1.04	1.04	0.98	1.25	1.34	1.34	1.34	1.22	1.07	1.07	1.07	1.07	1.34
10.0	0.34	0.40	0.46	0.46	0.31	0.45	0.53	0.63	0.63	0.40	0.59	0.64	0.69	0.69	0.62	0.85	0.93	0.94	0.94	0.85	1.06	1.20	1.21	1.21	1.05	0.98	0.98	0.98	0.98	1.16
10.5						0.39	0.45	0.57	0.57	0.35	0.50	0.56	0.62	0.62	0.54	0.72	0.82	0.85	0.85	0.73	0.90	1.04	1.10	1.10	0.91	0.86	0.90	0.90	0.90	1.01
11.0						0.33	0.39	0.52	0.52	0.30	0.44	0.50	0.57	0.57	0.47	0.61	0.72	0.78	0.78	0.64	0.77	0.91	1.00	1.00	0.79	0.75	0.82	0.83	0.83	0.88
11.5											0.38	0.43	0.52	0.52	0.42	0.53	0.62	0.71	0.71	0.56	0.66	0.78	0.92	0.92	0.69	0.66	0.73	0.77	0.77	0.78
12.0											0.33	0.38	0.47	0.47	0.37	0.46	0.54	0.65	0.65	0.50	0.57	0.68	0.84	0.84	0.61	0.57	0.65	0.72	0.72	0.69
12.5											0.29	0.33	0.44	0.44	0.33	0.40	0.47	0.60	0.60	0.44	0.50	0.59	0.77	0.77	0.54	0.50	0.58	0.67	0.67	0.62
13.0											0.26	0.29	0.40	0.40	0.30	0.35	0.41	0.56	0.56	0.39	0.43	0.51	0.72	0.72	0.48	0.45	0.51	0.62	0.62	0.55
13.5																0.30	0.36	0.51	0.51	0.35	0.38	0.45	0.66	0.66	0.43	0.40	0.45	0.58	0.58	0.49
14.0																0.27	0.32	0.47	0.48	0.31	0.33	0.40	0.61	0.62	0.38	0.35	0.40	0.54	0.54	0.45
14.5																					0.29	0.35	0.55	0.57	0.35	0.31	0.36	0.49	0.50	0.40
15.0																					0.25	0.31	0.50	0.54	0.31	0.28	0.32	0.45	0.47	0.37
15.5																										0.25	0.29	0.41	0.44	0.33
16.0																										0.23	0.26	0.38	0.41	0.31
16.5																														
17.0																														
17.5																														
18.0																														

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – END SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S
3.0																														
3.5																														
4.0	5.41	5.41	5.41	5.41	21.61	8.47	8.47	8.47	8.47	27.70	5.01	5.01	5.01	5.01	34.35															
4.5	4.61	4.61	4.61	4.61	15.17	7.12	7.12	7.12	7.12	19.45	4.36	4.36	4.36	4.36	24.13															
5.0	3.97	3.97	3.97	3.97	11.06	6.05	6.05	6.05	6.05	14.18	3.82	3.82	3.82	3.82	17.59	6.11	6.11	6.11	6.11	22.56	5.67	5.67	5.67	5.67	32.21					
5.5	3.45	3.45	3.45	3.45	8.31	5.20	5.20	5.20	5.20	10.65	3.39	3.39	3.39	3.39	13.21	5.35	5.35	5.35	5.35	16.95	5.04	5.04	5.04	5.04	24.20					
6.0	3.03	3.03	3.03	3.03	6.40	4.52	4.52	4.52	4.52	8.20	3.02	3.02	3.02	3.02	10.18	4.73	4.73	4.73	4.73	13.05	4.51	4.51	4.51	4.51	18.64	5.53	5.53	5.53	5.53	29.35
6.5	2.68	2.68	2.68	2.68	5.03	3.95	3.95	3.95	3.95	6.45	2.71	2.71	2.71	2.71	8.00	4.21	4.21	4.21	4.21	10.27	4.07	4.07	4.07	4.07	14.66	5.01	5.01	5.01	5.01	23.08
7.0	2.38	2.38	2.38	2.38	4.03	3.45	3.45	3.45	3.45	5.16	2.45	2.45	2.45	2.45	6.41	3.76	3.76	3.76	3.76	8.22	3.69	3.69	3.69	3.69	11.74	4.57	4.57	4.57	4.57	18.48
7.5	2.13	2.13	2.13	2.13	3.27	3.01	3.01	3.01	3.01	4.20	2.22	2.22	2.22	2.22	5.21	3.38	3.38	3.38	3.38	6.68	3.35	3.35	3.35	3.35	9.54	4.18	4.18	4.18	4.18	15.02
8.0	1.91	1.91	1.91	1.91	2.70	2.64	2.64	2.64	2.64	3.46	2.02	2.02	2.02	2.02	4.29	3.05	3.05	3.05	3.05	5.50	3.07	3.07	3.07	3.07	7.86	3.84	3.84	3.84	3.84	12.38
8.5	1.73	1.73	1.73	1.73	2.25	2.34	2.34	2.34	2.34	2.90	1.85	1.85	1.85	1.85	3.58	2.77	2.77	2.77	2.77	4.59	2.81	2.81	2.81	2.81	6.55	3.53	3.53	3.53	3.53	10.32
9.0	1.57	1.57	1.57	1.57	1.90	2.09	2.09	2.09	2.09	2.47	1.70	1.70	1.70	1.70	3.01	2.52	2.52	2.52	2.52	3.86	2.59	2.59	2.59	2.59	5.52	3.27	3.27	3.27	3.27	8.69
9.5	1.40	1.43	1.43	1.43	1.64	1.87	1.87	1.87	1.87	2.12	1.56	1.56	1.56	1.56	2.56	2.31	2.31	2.31	2.31	3.28	2.39	2.39	2.39	2.39	4.69	3.03	3.03	3.03	3.03	7.39
10.0	1.23	1.30	1.30	1.30	1.42	1.66	1.69	1.69	1.69	1.84	1.44	1.44	1.44	1.44	2.19	2.12	2.12	2.12	2.12	2.82	2.21	2.21	2.21	2.21	4.02	2.82	2.82	2.82	2.82	6.34
10.5	1.08	1.17	1.19	1.19	1.23	1.45	1.53	1.53	1.53	1.60	1.33	1.33	1.33	1.33	1.89	1.95	1.95	1.95	1.95	2.43	2.05	2.05	2.05	2.05	3.47	2.62	2.62	2.62	2.62	5.47
11.0	0.95	1.04	1.08	1.08	1.08	1.28	1.40	1.40	1.40	1.41	1.24	1.24	1.24	1.24	1.65	1.77	1.80	1.80	1.80	2.13	1.91	1.91	1.91	1.91	3.02	2.45	2.45	2.45	2.45	4.76
11.5	0.83	0.92	0.99	0.99	0.96	1.12	1.24	1.28	1.28	1.24	1.15	1.15	1.15	1.15	1.45	1.58	1.66	1.66	1.66	1.88	1.78	1.78	1.78	1.78	2.64	2.29	2.29	2.29	2.29	4.16
12.0	0.72	0.82	0.91	0.91	0.85	0.97	1.11	1.17	1.17	1.10	1.05	1.07	1.07	1.07	1.29	1.41	1.53	1.54	1.54	1.67	1.66	1.66	1.66	1.66	2.33	2.15	2.15	2.15	2.15	3.66
12.5	0.64	0.73	0.83	0.83	0.76	0.85	0.99	1.08	1.08	0.98	0.94	1.00	1.00	1.00	1.15	1.26	1.38	1.42	1.42	1.49	1.52	1.55	1.55	1.55	2.06	2.02	2.02	2.02	2.02	3.24
13.0	0.56	0.65	0.77	0.77	0.68	0.74	0.88	1.00	1.00	0.87	0.83	0.93	0.94	0.94	1.03	1.12	1.24	1.31	1.31	1.34	1.35	1.46	1.46	1.46	1.84	1.88	1.90	1.90	1.90	2.88
13.5	0.50	0.58	0.72	0.72	0.61	0.65	0.78	0.93	0.93	0.78	0.74	0.84	0.88	0.88	0.93	1.00	1.12	1.21	1.21	1.20	1.20	1.36	1.37	1.37	1.66	1.67	1.79	1.79	1.79	2.57
14.0	0.45	0.51	0.66	0.66	0.55	0.57	0.68	0.86	0.86	0.70	0.66	0.76	0.82	0.82	0.84	0.89	1.02	1.13	1.13	1.09	1.08	1.23	1.29	1.29	1.50	1.49	1.69	1.69	1.69	2.31
14.5	0.40	0.46	0.62	0.62	0.50	0.51	0.61	0.80	0.80	0.63	0.59	0.68	0.78	0.78	0.76	0.80	0.92	1.05	1.05	0.98	0.96	1.11	1.21	1.21	1.36	1.34	1.55	1.59	1.59	2.09
15.0	0.36	0.41	0.57	0.58	0.45	0.45	0.54	0.75	0.75	0.57	0.53	0.62	0.73	0.73	0.69	0.72	0.83	0.98	0.98	0.89	0.87	1.00	1.14	1.14	1.23	1.20	1.40	1.51	1.51	1.90
15.5	0.32	0.37	0.52	0.54	0.41	0.40	0.48	0.70	0.70	0.52	0.48	0.55	0.69	0.69	0.63	0.65	0.75	0.92	0.92	0.82	0.78	0.90	1.08	1.08	1.12	1.09	1.26	1.43	1.43	1.73
16.0	0.29	0.34	0.48	0.51	0.38	0.36	0.43	0.65	0.66	0.47	0.43	0.50	0.65	0.65	0.57	0.59	0.68	0.86	0.86	0.75	0.71	0.82	1.02	1.02	1.03	0.98	1.14	1.35	1.35	1.58
16.5	0.26	0.31	0.44	0.48	0.35	0.32	0.39	0.59	0.62	0.43	0.39	0.45	0.61	0.62	0.53	0.54	0.62	0.81	0.81	0.68	0.64	0.74	0.97	0.97	0.94	0.89	1.04	1.29	1.29	1.45
17.0	0.23	0.28	0.41	0.45	0.32	0.29	0.35	0.55	0.58	0.39	0.36	0.41	0.57	0.58	0.48	0.49	0.56	0.76	0.76	0.63	0.58	0.68	0.92	0.92	0.87	0.81	0.94	1.22	1.22	1.33
17.5						0.26	0.31	0.51	0.55	0.36	0.33	0.38	0.52	0.55	0.45	0.44	0.51	0.70	0.72	0.58	0.53	0.62	0.85	0.87	0.80	0.74	0.86	1.16	1.16	1.23
18.0						0.23	0.28	0.46	0.52	0.33	0.30	0.34	0.49	0.52	0.41	0.40	0.47	0.65	0.68	0.54	0.49	0.56	0.79	0.82	0.74	0.68	0.79	1.10	1.11	1.13

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – INTERNAL SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
(m)	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s
3.0																														
3.5	5.18	5.18	5.18	5.18	14.11	7.77	7.77	7.77	7.77	18.74	4.93	4.93	4.93	4.93	28.35															
4.0	4.17	4.17	4.17	4.17	9.45	5.95	5.95	5.95	5.95	12.55	4.15	4.15	4.15	4.15	18.99															
4.5	3.43	3.43	3.43	3.43	6.64	4.70	4.70	4.70	4.70	8.81	3.54	3.54	3.54	3.54	13.34	6.06	6.06	6.06	6.06	18.10	9.01	9.01	9.01	9.01	23.12	4.20	4.20	4.20	4.20	25.98
5.0	2.79	2.79	2.79	2.79	4.84	3.80	3.80	3.80	3.80	6.42	3.06	3.06	3.06	3.06	9.72	5.15	5.15	5.15	5.15	13.19	7.30	7.30	7.30	7.30	16.85	3.69	3.69	3.69	3.69	18.94
5.5	2.31	2.31	2.31	2.31	3.63	3.14	3.14	3.14	3.14	4.83	2.67	2.67	2.67	2.67	7.30	4.42	4.42	4.42	4.42	9.91	6.03	6.03	6.03	6.03	12.66	3.26	3.26	3.26	3.26	14.23
6.0	1.94	1.94	1.94	1.94	2.80	2.64	2.64	2.64	2.64	3.72	2.34	2.34	2.34	2.34	5.62	3.83	3.83	3.83	3.83	7.63	5.07	5.07	5.07	5.07	9.75	2.91	2.91	2.91	2.91	10.96
6.5	1.65	1.65	1.65	1.65	2.20	2.25	2.25	2.25	2.25	2.92	2.07	2.07	2.07	2.07	4.42	3.35	3.35	3.35	3.35	6.00	4.32	4.32	4.32	4.32	7.67	2.61	2.61	2.61	2.61	8.62
7.0	1.42	1.42	1.42	1.42	1.76	1.94	1.94	1.94	1.94	2.35	1.84	1.84	1.84	1.84	3.54	2.89	2.89	2.89	2.89	4.81	3.72	3.72	3.72	3.72	6.14	2.35	2.35	2.35	2.35	6.90
7.5	1.24	1.24	1.24	1.24	1.45	1.69	1.69	1.69	1.69	1.92	1.65	1.65	1.65	1.65	2.88	2.52	2.52	2.52	2.52	3.91	3.24	3.24	3.24	3.24	4.99	2.13	2.13	2.13	2.13	5.61
8.0	1.09	1.09	1.09	1.09	1.21	1.48	1.48	1.48	1.48	1.59	1.48	1.48	1.48	1.48	2.37	2.21	2.21	2.21	2.21	3.22	2.85	2.85	2.85	2.85	4.11	1.94	1.94	1.94	1.94	4.62
8.5	0.96	0.96	0.96	0.96	1.02	1.31	1.31	1.31	1.31	1.33	1.34	1.34	1.34	1.34	1.97	1.96	1.96	1.96	1.96	2.68	2.52	2.52	2.52	2.52	3.43	1.77	1.77	1.77	1.77	3.85
9.0	0.86	0.86	0.86	0.86	0.87	1.17	1.17	1.17	1.17	1.13	1.22	1.22	1.22	1.22	1.66	1.75	1.75	1.75	1.75	2.26	2.25	2.25	2.25	2.25	2.89	1.62	1.62	1.62	1.62	3.24
9.5	0.77	0.77	0.77	0.77	0.74	1.05	1.05	1.05	1.05	0.96	1.11	1.11	1.11	1.11	1.41	1.57	1.57	1.57	1.57	1.93	2.02	2.02	2.02	2.02	2.47	1.49	1.49	1.49	1.49	2.76
10.0	0.69	0.69	0.69	0.69	0.64	0.95	0.95	0.95	0.95	0.83	1.01	1.01	1.01	1.01	1.22	1.41	1.41	1.41	1.41	1.67	1.82	1.82	1.82	1.82	2.12	1.38	1.38	1.38	1.38	2.36
10.5	0.63	0.63	0.63	0.63	0.55	0.86	0.86	0.86	0.86	0.72	0.93	0.93	0.93	0.93	1.06	1.28	1.28	1.28	1.28	1.46	1.65	1.65	1.65	1.65	1.84	1.27	1.27	1.27	1.27	2.04
11.0	0.57	0.57	0.57	0.57	0.48	0.78	0.78	0.78	0.78	0.63	0.85	0.85	0.85	0.85	0.93	1.17	1.17	1.17	1.17	1.28	1.50	1.50	1.50	1.50	1.61	1.18	1.18	1.18	1.18	1.77
11.5	0.52	0.52	0.52	0.52	0.42	0.72	0.72	0.72	0.72	0.55	0.78	0.78	0.78	0.78	0.82	1.07	1.07	1.07	1.07	1.13	1.38	1.38	1.38	1.38	1.41	1.10	1.10	1.10	1.10	1.55
12.0	0.48	0.48	0.48	0.48	0.37	0.66	0.66	0.66	0.66	0.48	0.71	0.71	0.71	0.71	0.73	0.98	0.98	0.98	0.98	1.00	1.26	1.26	1.26	1.26	1.25	1.02	1.02	1.02	1.02	1.37
12.5	0.44	0.44	0.44	0.44	0.33	0.60	0.60	0.60	0.60	0.43	0.66	0.66	0.66	0.66	0.65	0.90	0.90	0.90	0.90	0.89	1.16	1.16	1.16	1.16	1.11	0.95	0.95	0.95	0.95	1.21
13.0	0.41	0.41	0.41	0.41	0.29	0.56	0.56	0.56	0.56	0.38	0.61	0.61	0.61	0.61	0.58	0.84	0.84	0.84	0.84	0.80	1.08	1.08	1.08	1.08	0.99	0.89	0.89	0.89	0.89	1.08
13.5						0.51	0.50	0.52	0.52	0.34	0.56	0.56	0.56	0.56	0.52	0.77	0.77	0.77	0.77	0.71	1.00	1.00	1.00	1.00	0.88	0.83	0.83	0.83	0.83	0.97
14.0						0.46	0.46	0.48	0.48	0.31	0.52	0.52	0.52	0.52	0.47	0.72	0.72	0.72	0.72	0.64	0.93	0.93	0.93	0.93	0.79	0.78	0.78	0.78	0.78	0.88
14.5											0.48	0.48	0.49	0.49	0.43	0.67	0.67	0.67	0.67	0.58	0.86	0.86	0.86	0.86	0.71	0.74	0.74	0.74	0.74	0.79
15.0											0.44	0.44	0.46	0.46	0.39	0.63	0.63	0.63	0.63	0.52	0.81	0.81	0.81	0.81	0.65	0.69	0.69	0.69	0.69	0.72
15.5											0.41	0.40	0.42	0.43	0.35	0.59	0.58	0.59	0.59	0.48	0.76	0.75	0.76	0.76	0.59	0.65	0.65	0.65	0.65	0.66
16.0											0.37	0.37	0.39	0.40	0.32	0.54	0.53	0.55	0.55	0.43	0.69	0.69	0.71	0.71	0.53	0.61	0.61	0.62	0.62	0.60
16.5											0.35	0.34	0.36	0.38	0.30	0.50	0.49	0.52	0.52	0.40	0.64	0.63	0.67	0.67	0.49	0.56	0.56	0.58	0.58	0.55
17.0																0.46	0.45	0.48	0.49	0.36	0.58	0.58	0.62	0.63	0.45	0.52	0.52	0.54	0.55	0.51
17.5																0.43	0.42	0.45	0.46	0.33	0.54	0.52	0.57	0.59	0.41	0.48	0.48	0.51	0.52	0.47
18.0																0.39	0.38	0.41	0.43	0.31	0.49	0.48	0.53	0.56	0.38	0.45	0.44	0.47	0.49	0.43

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – INTERNAL SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 250/15 1B	2B	3B	FR	W_s	DHS 250/18 1B	2B	3B	FR	W_s
3.0										
3.5										
4.0										
4.5	6.13	6.13	6.13	6.13	31.56	9.68	9.68	9.68	9.68	40.46
5.0	5.33	5.33	5.33	5.33	23.01	8.31	8.31	8.31	8.31	29.49
5.5	4.68	4.68	4.68	4.68	17.29	7.21	7.21	7.21	7.21	22.16
6.0	4.14	4.14	4.14	4.14	13.31	6.31	6.31	6.31	6.31	17.07
6.5	3.68	3.68	3.68	3.68	10.47	5.56	5.56	5.56	5.56	13.42
7.0	3.29	3.29	3.29	3.29	8.38	4.93	4.93	4.93	4.93	10.75
7.5	2.96	2.96	2.96	2.96	6.81	4.40	4.40	4.40	4.40	8.74
8.0	2.68	2.68	2.68	2.68	5.61	3.94	3.94	3.94	3.94	7.20
8.5	2.43	2.43	2.43	2.43	4.68	3.51	3.51	3.51	3.51	6.00
9.0	2.22	2.22	2.22	2.22	3.94	3.13	3.13	3.13	3.13	5.05
9.5	2.03	2.03	2.03	2.03	3.35	2.81	2.81	2.81	2.81	4.30
10.0	1.86	1.86	1.86	1.86	2.87	2.54	2.54	2.54	2.54	3.68
10.5	1.71	1.71	1.71	1.71	2.48	2.30	2.30	2.30	2.30	3.18
11.0	1.58	1.58	1.58	1.58	2.16	2.10	2.10	2.10	2.10	2.77
11.5	1.46	1.46	1.46	1.46	1.89	1.92	1.92	1.92	1.92	2.42
12.0	1.36	1.36	1.36	1.36	1.66	1.76	1.76	1.76	1.76	2.15
12.5	1.25	1.25	1.25	1.25	1.48	1.62	1.62	1.62	1.62	1.91
13.0	1.16	1.16	1.16	1.16	1.32	1.50	1.50	1.50	1.50	1.72
13.5	1.08	1.08	1.08	1.08	1.19	1.39	1.39	1.39	1.39	1.54
14.0	1.00	1.00	1.00	1.00	1.07	1.29	1.29	1.29	1.29	1.39
14.5	0.93	0.93	0.93	0.93	0.97	1.20	1.20	1.20	1.20	1.26
15.0	0.87	0.87	0.87	0.87	0.88	1.13	1.13	1.13	1.13	1.15
15.5	0.81	0.81	0.81	0.81	0.81	1.05	1.05	1.05	1.05	1.05
16.0	0.76	0.76	0.76	0.76	0.74	0.99	0.99	0.99	0.99	0.96
16.5	0.70	0.70	0.72	0.72	0.68	0.93	0.93	0.93	0.93	0.88
17.0	0.65	0.65	0.68	0.68	0.62	0.87	0.87	0.87	0.87	0.81
17.5	0.61	0.60	0.64	0.64	0.57	0.81	0.81	0.83	0.83	0.74
18.0	0.56	0.56	0.59	0.60	0.53	0.76	0.76	0.78	0.78	0.68

Span (m)	DHS 300/15 1B	2B	3B	FR	W_s	DHS 300/18 1B	2B	3B	FR	W_s
3.0										
3.5										
4.0										
4.5	5.63	5.63	5.63	5.63	50.18					
5.0	4.98	4.98	4.98	4.98	36.58					
5.5	4.44	4.44	4.44	4.44	27.48					
6.0	3.98	3.98	3.98	3.98	21.17	6.36	6.36	6.36	6.36	27.15
6.5	3.60	3.60	3.60	3.60	16.65	5.70	5.70	5.70	5.70	21.35
7.0	3.27	3.27	3.27	3.27	13.33	5.13	5.13	5.13	5.13	17.10
7.5	2.98	2.98	2.98	2.98	10.84	4.64	4.64	4.64	4.64	13.90
8.0	2.73	2.73	2.73	2.73	8.93	4.22	4.22	4.22	4.22	11.45
8.5	2.51	2.51	2.51	2.51	7.44	3.85	3.85	3.85	3.85	9.55
9.0	2.31	2.31	2.31	2.31	6.27	3.52	3.52	3.52	3.52	8.04
9.5	2.14	2.14	2.14	2.14	5.33	3.24	3.24	3.24	3.24	6.84
10.0	1.98	1.98	1.98	1.98	4.57	2.98	2.98	2.98	2.98	5.86
10.5	1.84	1.84	1.84	1.84	3.95	2.75	2.75	2.75	2.75	5.06
11.0	1.72	1.72	1.72	1.72	3.43	2.55	2.55	2.55	2.55	4.40
11.5	1.60	1.60	1.60	1.60	3.00	2.37	2.37	2.37	2.37	3.85
12.0	1.50	1.50	1.50	1.50	2.64	2.20	2.20	2.20	2.20	3.39
12.5	1.41	1.41	1.41	1.41	2.34	2.06	2.06	2.06	2.06	3.00
13.0	1.32	1.32	1.32	1.32	2.08	1.92	1.92	1.92	1.92	2.67
13.5	1.24	1.24	1.24	1.24	1.85	1.80	1.80	1.80	1.80	2.38
14.0	1.17	1.17	1.17	1.17	1.66	1.69	1.69	1.69	1.69	2.13
14.5	1.10	1.10	1.10	1.10	1.50	1.58	1.58	1.58	1.58	1.92
15.0	1.04	1.04	1.04	1.04	1.35	1.47	1.47	1.47	1.47	1.74
15.5	0.99	0.99	0.99	0.99	1.23	1.38	1.38	1.38	1.38	1.59
16.0	0.93	0.93	0.93	0.93	1.12	1.30	1.30	1.30	1.30	1.45
16.5	0.89	0.89	0.89	0.89	1.03	1.22	1.22	1.22	1.22	1.33
17.0	0.84	0.84	0.84	0.84	0.95	1.15	1.15	1.15	1.15	1.23
17.5	0.80	0.80	0.80	0.80	0.87	1.08	1.08	1.08	1.08	1.13
18.0	0.76	0.76	0.76	0.76	0.81	1.02	1.02	1.02	1.02	1.05

Span (m)	DHS 350/18 1B	2B	3B	FR	W_s	DHS 400/20 1B	2B	3B	FR	W_s
3.0										
3.5										
4.0										
4.5										
5.0										
5.5										
6.0	5.90	5.90	5.90	5.90	38.77					
6.5	5.35	5.35	5.35	5.35	30.50					
7.0	4.87	4.87	4.87	4.87	24.42	5.97	5.97	5.97	5.97	38.44
7.5	4.46	4.46	4.46	4.46	19.85	5.48	5.48	5.48	5.48	31.25
8.0	4.10	4.10	4.10	4.10	16.36	5.06	5.06	5.06	5.06	25.75
8.5	3.78	3.78	3.78	3.78	13.63	4.68	4.68	4.68	4.68	21.47
9.0	3.49	3.49	3.49	3.49	11.49	4.35	4.35	4.35	4.35	18.08
9.5	3.24	3.24	3.24	3.24	9.76	4.05	4.05	4.05	4.05	15.37
10.0	3.01	3.01	3.01	3.01	8.37	3.78	3.78	3.78	3.78	13.18
10.5	2.81	2.81	2.81	2.81	7.23	3.54	3.54	3.54	3.54	11.39
11.0	2.62	2.62	2.62	2.62	6.29	3.32	3.32	3.32	3.32	9.90
11.5	2.45	2.45	2.45	2.45	5.50	3.12	3.12	3.12	3.12	8.66
12.0	2.30	2.30	2.30	2.30	4.84	2.93	2.93	2.93	2.93	7.63
12.5	2.16	2.16	2.16	2.16	4.28	2.76	2.76	2.76	2.76	6.75
13.0	2.03	2.03	2.03	2.03	3.81	2.61	2.61	2.61	2.61	6.00
13.5	1.92	1.92	1.92	1.92	3.40	2.47	2.47	2.47	2.47	5.35
14.0	1.81	1.81	1.81	1.81	3.05	2.34	2.34	2.34	2.34	4.80
14.5	1.71	1.71	1.71	1.71	2.74	2.21	2.21	2.21	2.21	4.32
15.0	1.62	1.62	1.62	1.62	2.48	2.10	2.10	2.10	2.10	3.90
15.5	1.53	1.53	1.53	1.53	2.24	2.00	2.00	2.00	2.00	3.54
16.0	1.45	1.45	1.45	1.45	2.04	1.90	1.90	1.90	1.90	3.21
16.5	1.38	1.38	1.38	1.38	1.86	1.81	1.81	1.81	1.81	2.93
17.0	1.31	1.31	1.31	1.31	1.70	1.72	1.72	1.72	1.72	2.68
17.5	1.25	1.25	1.25	1.25	1.56	1.64	1.64	1.64	1.64	2.46
18.0	1.19	1.19	1.19	1.19	1.44	1.57	1.57	1.57	1.57	2.26

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – LAPPED END SPAN

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 150/12					DHS 150/15					DHS 200/12				
	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s
3.0	5.66	5.66	5.66	5.66	12.02	8.98	8.98	8.98	8.98	15.96	5.18	5.18	5.18	5.18	24.15
3.5	4.45	4.45	4.45	4.45	7.57	6.62	6.62	6.62	6.62	10.05	4.28	4.28	4.28	4.28	15.21
4.0	3.58	3.58	3.58	3.58	5.07	5.06	5.06	5.06	5.06	6.73	3.60	3.60	3.60	3.60	10.19
4.5	2.94	2.94	2.94	2.94	3.56	4.00	4.00	4.00	4.00	4.73	3.06	3.06	3.06	3.06	7.15
5.0	2.38	2.38	2.38	2.38	2.59	3.24	3.24	3.24	3.24	3.44	2.64	2.64	2.64	2.64	5.21
5.5	1.96	1.96	1.96	1.96	1.95	2.68	2.68	2.68	2.68	2.59	2.30	2.30	2.30	2.30	3.92
6.0	1.65	1.65	1.65	1.65	1.50	2.25	2.25	2.25	2.25	2.00	2.02	2.02	2.02	2.02	3.02
6.5	1.40	1.40	1.40	1.40	1.20	1.92	1.92	1.92	1.92	1.58	1.78	1.78	1.78	1.78	2.37
7.0	1.21	1.21	1.21	1.21	0.97	1.61	1.65	1.65	1.65	1.27	1.59	1.59	1.59	1.59	1.90
7.5	1.00	1.05	1.05	1.05	0.80	1.33	1.44	1.44	1.44	1.04	1.42	1.42	1.42	1.42	1.54
8.0	0.83	0.91	0.93	0.93	0.66	1.10	1.22	1.26	1.26	0.86	1.27	1.27	1.27	1.27	1.27
8.5	0.68	0.78	0.82	0.82	0.55	0.90	1.03	1.12	1.12	0.72	1.11	1.15	1.15	1.15	1.06
9.0	0.56	0.65	0.73	0.73	0.47	0.74	0.86	1.00	1.00	0.61	0.95	1.03	1.04	1.04	0.90
9.5	0.47	0.54	0.66	0.66	0.40	0.62	0.72	0.89	0.89	0.52	0.80	0.89	0.95	0.95	0.77
10.0	0.39	0.46	0.59	0.59	0.34	0.52	0.61	0.81	0.81	0.45	0.69	0.78	0.87	0.87	0.67
10.5	0.33	0.38	0.54	0.54	0.30	0.44	0.51	0.73	0.73	0.39	0.59	0.67	0.80	0.80	0.58
11.0						0.37	0.44	0.65	0.67	0.34	0.51	0.58	0.72	0.72	0.51
11.5						0.31	0.37	0.58	0.61	0.30	0.44	0.50	0.66	0.66	0.45
12.0											0.39	0.44	0.60	0.61	0.40
12.5											0.34	0.39	0.54	0.56	0.36
13.0											0.30	0.34	0.48	0.52	0.32
13.5											0.26	0.30	0.44	0.48	0.29
14.0															
14.5															
15.0															
15.5															
16.0															
16.5															
17.0															
17.5															
18.0															

Span (m)	DHS 200/15					DHS 200/18					DHS 250/13				
	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s
3.0															
3.5															
4.0	6.24	6.24	6.24	6.24	13.83	9.41	9.41	9.41	9.41	17.66	4.21	4.21	4.21	4.21	19.84
4.5	5.22	5.22	5.22	5.22	9.71	7.67	7.67	7.67	7.67	12.40	3.65	3.65	3.65	3.65	13.94
5.0	4.43	4.43	4.43	4.43	7.08	6.22	6.22	6.22	6.22	9.04	3.20	3.20	3.20	3.20	10.16
5.5	3.80	3.80	3.80	3.80	5.32	5.14	5.14	5.14	5.14	6.79	2.83	2.83	2.83	2.83	7.63
6.0	3.29	3.29	3.29	3.29	4.09	4.31	4.31	4.31	4.31	5.23	2.52	2.52	2.52	2.52	5.88
6.5	2.86	2.86	2.86	2.86	3.22	3.68	3.68	3.68	3.68	4.11	2.25	2.25	2.25	2.25	4.62
7.0	2.46	2.46	2.46	2.46	2.58	3.17	3.17	3.17	3.17	3.29	2.03	2.03	2.03	2.03	3.70
7.5	2.14	2.14	2.14	2.14	2.09	2.76	2.76	2.76	2.76	2.68	1.84	1.84	1.84	1.84	3.01
8.0	1.88	1.88	1.88	1.88	1.72	2.42	2.43	2.43	2.43	2.21	1.67	1.67	1.67	1.67	2.48
8.5	1.60	1.67	1.67	1.67	1.45	2.04	2.15	2.15	2.15	1.85	1.53	1.53	1.53	1.53	2.06
9.0	1.37	1.49	1.49	1.49	1.24	1.72	1.92	1.92	1.92	1.57	1.40	1.40	1.40	1.40	1.74
9.5	1.15	1.29	1.33	1.33	1.06	1.44	1.65	1.72	1.72	1.34	1.28	1.28	1.28	1.28	1.48
10.0	0.97	1.13	1.20	1.20	0.92	1.21	1.42	1.55	1.55	1.15	1.18	1.18	1.18	1.18	1.27
10.5	0.82	0.97	1.09	1.09	0.80	1.03	1.21	1.41	1.41	1.00	1.02	1.09	1.09	1.09	1.09
11.0	0.70	0.82	0.99	0.99	0.70	0.87	1.03	1.28	1.28	0.87	0.88	0.99	1.01	1.01	0.95
11.5	0.60	0.71	0.91	0.91	0.62	0.75	0.89	1.17	1.17	0.76	0.77	0.88	0.94	0.94	0.84
12.0	0.52	0.61	0.83	0.83	0.54	0.64	0.77	1.08	1.08	0.67	0.67	0.77	0.88	0.88	0.74
12.5	0.45	0.53	0.77	0.77	0.48	0.55	0.66	0.99	0.99	0.60	0.59	0.67	0.82	0.82	0.66
13.0	0.39	0.46	0.70	0.71	0.43	0.48	0.58	0.90	0.92	0.53	0.52	0.59	0.76	0.76	0.59
13.5	0.34	0.40	0.63	0.66	0.38	0.42	0.50	0.81	0.85	0.48	0.46	0.53	0.72	0.72	0.53
14.0	0.30	0.36	0.57	0.61	0.35	0.37	0.44	0.72	0.79	0.43	0.41	0.47	0.65	0.67	0.48
14.5	0.27	0.31	0.51	0.57	0.31	0.32	0.39	0.64	0.74	0.39	0.37	0.42	0.60	0.63	0.43
15.0						0.28	0.34	0.57	0.69	0.35	0.33	0.38	0.54	0.59	0.39
15.5						0.25	0.30	0.51	0.64	0.32	0.30	0.34	0.50	0.56	0.36
16.0						0.22	0.27	0.46	0.60	0.29	0.27	0.31	0.45	0.53	0.33
16.5											0.24	0.28	0.41	0.50	0.30
17.0															
17.5															
18.0															

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_s: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – LAPPED END SPAN

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S	1B	2B	3B	FR	W_S
3.0																														
3.5																														
4.0	6.18	6.18	6.18	6.18	24.11	9.86	9.86	9.86	9.86	30.91	5.61	5.61	5.61	5.61	38.33															
4.5	5.31	5.31	5.31	5.31	16.93	8.36	8.36	8.36	8.36	21.71	4.89	4.89	4.89	4.89	26.92															
5.0	4.61	4.61	4.61	4.61	12.34	7.17	7.17	7.17	7.17	15.82	4.32	4.32	4.32	4.32	19.62															
5.5	4.04	4.04	4.04	4.04	9.27	6.21	6.21	6.21	6.21	11.89	3.85	3.85	3.85	3.85	14.74	6.19	6.19	6.19	6.19	18.91	5.69	5.69	5.69	5.69	27.01					
6.0	3.57	3.57	3.57	3.57	7.14	5.43	5.43	5.43	5.43	9.16	3.45	3.45	3.45	3.45	11.36	5.50	5.50	5.50	5.50	14.57	5.12	5.12	5.12	5.12	20.80					
6.5	3.17	3.17	3.17	3.17	5.62	4.78	4.78	4.78	4.78	7.20	3.12	3.12	3.12	3.12	8.93	4.92	4.92	4.92	4.92	11.46	4.64	4.64	4.64	4.64	16.36	5.66	5.66	5.66	5.66	25.76
7.0	2.84	2.84	2.84	2.84	4.50	4.23	4.23	4.23	4.23	5.76	2.83	2.83	2.83	2.83	7.15	4.43	4.43	4.43	4.43	9.17	4.22	4.22	4.22	4.22	13.10	5.18	5.18	5.18	5.18	20.62
7.5	2.55	2.55	2.55	2.55	3.65	3.77	3.77	3.77	3.77	4.69	2.58	2.58	2.58	2.58	5.81	4.00	4.00	4.00	4.00	7.46	3.86	3.86	3.86	3.86	10.65	4.76	4.76	4.76	4.76	16.76
8.0	2.30	2.30	2.30	2.30	3.01	3.38	3.38	3.38	3.38	3.86	2.36	2.36	2.36	2.36	4.79	3.64	3.64	3.64	3.64	6.14	3.55	3.55	3.55	3.55	8.77	4.39	4.39	4.39	4.39	13.81
8.5	2.09	2.09	2.09	2.09	2.51	2.99	2.99	2.99	2.99	3.22	2.17	2.17	2.17	2.17	3.99	3.31	3.31	3.31	3.31	5.12	3.27	3.27	3.27	3.27	7.31	4.06	4.06	4.06	4.06	11.51
9.0	1.90	1.90	1.90	1.90	2.11	2.65	2.67	2.67	2.67	2.71	2.00	2.00	2.00	2.00	3.36	3.03	3.03	3.03	3.03	4.31	3.02	3.02	3.02	3.02	6.16	3.77	3.77	3.77	3.77	9.70
9.5	1.71	1.74	1.74	1.74	1.80	2.30	2.39	2.39	2.39	2.30	1.85	1.85	1.85	1.85	2.86	2.78	2.78	2.78	2.78	3.67	2.80	2.80	2.80	2.80	5.24	3.51	3.51	3.51	3.51	8.25
10.0	1.48	1.60	1.60	1.60	1.54	2.00	2.16	2.16	2.16	1.97	1.71	1.71	1.71	1.71	2.45	2.56	2.56	2.56	2.56	3.14	2.60	2.60	2.60	2.60	4.49	3.27	3.27	3.27	3.27	7.07
10.5	1.28	1.42	1.47	1.47	1.33	1.73	1.92	1.96	1.96	1.72	1.59	1.59	1.59	1.59	2.12	2.37	2.37	2.37	2.37	2.71	2.42	2.42	2.42	2.42	3.88	3.06	3.06	3.06	3.06	6.11
11.0	1.11	1.25	1.36	1.36	1.16	1.49	1.69	1.79	1.79	1.51	1.48	1.48	1.48	1.48	1.84	2.15	2.19	2.19	2.19	2.36	2.26	2.26	2.26	2.26	3.37	2.87	2.87	2.87	2.87	5.31
11.5	0.97	1.10	1.25	1.25	1.03	1.28	1.49	1.63	1.63	1.33	1.38	1.38	1.38	1.38	1.61	1.91	2.03	2.03	2.03	2.06	2.12	2.12	2.12	2.12	2.95	2.69	2.69	2.69	2.69	4.65
12.0	0.85	0.97	1.16	1.16	0.91	1.11	1.31	1.50	1.50	1.18	1.25	1.29	1.29	1.29	1.42	1.68	1.86	1.89	1.89	1.82	1.98	1.98	1.98	1.98	2.60	2.53	2.53	2.53	2.53	4.09
12.5	0.75	0.85	1.07	1.07	0.81	0.96	1.14	1.38	1.38	1.06	1.10	1.21	1.21	1.21	1.25	1.48	1.67	1.76	1.76	1.61	1.78	1.86	1.86	1.86	2.30	2.38	2.38	2.38	2.38	3.62
13.0	0.66	0.75	0.99	0.99	0.73	0.84	1.00	1.28	1.28	0.95	0.97	1.12	1.13	1.13	1.11	1.31	1.50	1.65	1.65	1.43	1.58	1.75	1.75	1.75	2.04	2.19	2.25	2.25	2.25	3.22
13.5	0.59	0.67	0.90	0.92	0.65	0.74	0.88	1.18	1.18	0.85	0.87	1.00	1.07	1.07	1.00	1.17	1.34	1.54	1.54	1.29	1.41	1.62	1.65	1.65	1.82	1.95	2.13	2.13	2.13	2.87
14.0	0.52	0.60	0.82	0.85	0.59	0.65	0.77	1.10	1.10	0.77	0.77	0.89	1.00	1.00	0.90	1.04	1.20	1.44	1.44	1.16	1.25	1.45	1.56	1.56	1.63	1.74	2.01	2.01	2.01	2.57
14.5	0.46	0.53	0.75	0.79	0.53	0.57	0.68	1.01	1.03	0.69	0.69	0.80	0.95	0.95	0.81	0.94	1.07	1.34	1.34	1.06	1.12	1.30	1.47	1.47	1.47	1.56	1.81	1.91	1.91	2.32
15.0	0.41	0.48	0.68	0.74	0.49	0.51	0.61	0.93	0.96	0.63	0.62	0.71	0.89	0.89	0.74	0.84	0.97	1.26	1.26	0.96	1.01	1.17	1.39	1.39	1.33	1.40	1.62	1.81	1.81	2.09
15.5	0.36	0.43	0.63	0.69	0.44	0.45	0.54	0.85	0.90	0.57	0.56	0.64	0.85	0.85	0.67	0.76	0.87	1.17	1.18	0.87	0.91	1.05	1.32	1.32	1.21	1.26	1.46	1.72	1.72	1.90
16.0	0.32	0.38	0.57	0.65	0.40	0.40	0.48	0.77	0.84	0.52	0.51	0.58	0.80	0.80	0.62	0.69	0.79	1.08	1.10	0.80	0.82	0.95	1.25	1.25	1.11	1.14	1.32	1.63	1.63	1.72
16.5	0.29	0.34	0.52	0.61	0.37	0.36	0.43	0.71	0.79	0.47	0.46	0.53	0.74	0.76	0.57	0.62	0.72	0.99	1.04	0.73	0.75	0.86	1.19	1.19	1.01	1.04	1.20	1.55	1.55	1.57
17.0	0.26	0.31	0.47	0.58	0.34	0.32	0.39	0.64	0.74	0.43	0.42	0.48	0.68	0.72	0.52	0.55	0.65	0.92	0.98	0.68	0.68	0.78	1.11	1.13	0.93	0.94	1.09	1.48	1.48	1.44
17.5	0.23	0.28	0.43	0.54	0.31	0.29	0.35	0.58	0.70	0.40	0.38	0.44	0.63	0.68	0.48	0.50	0.60	0.85	0.92	0.62	0.62	0.71	1.03	1.07	0.86	0.86	0.99	1.41	1.41	1.32
18.0	0.21	0.25	0.40	0.51	0.29	0.26	0.31	0.53	0.66	0.37	0.35	0.40	0.59	0.65	0.44	0.45	0.54	0.79	0.87	0.57	0.57	0.65	0.95	1.02	0.79	0.79	0.91	1.33	1.35	1.22

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_S: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – LAPPED INTERNAL SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 150/12 1B	2B	3B	FR	W_s	DHS 150/15 1B	2B	3B	FR	W_s
3.0										
3.5										
4.0	5.43	5.43	5.43	5.43	11.72	8.46	8.46	8.46	8.46	15.56
4.5	4.51	4.51	4.51	4.51	8.23	6.68	6.68	6.68	6.68	10.93
5.0	3.80	3.80	3.80	3.80	6.00	5.41	5.41	5.41	5.41	7.96
5.5	3.24	3.24	3.24	3.24	4.51	4.47	4.47	4.47	4.47	5.98
6.0	2.76	2.76	2.76	2.76	3.47	3.76	3.76	3.76	3.76	4.61
6.5	2.35	2.35	2.35	2.35	2.73	3.20	3.20	3.20	3.20	3.62
7.0	2.02	2.02	2.02	2.02	2.18	2.76	2.76	2.76	2.76	2.90
7.5	1.76	1.76	1.76	1.76	1.77	2.40	2.40	2.40	2.40	2.36
8.0	1.55	1.55	1.55	1.55	1.46	2.11	2.11	2.11	2.11	1.94
8.5	1.37	1.37	1.37	1.37	1.22	1.87	1.87	1.87	1.87	1.62
9.0	1.22	1.22	1.22	1.22	1.02	1.63	1.67	1.67	1.67	1.37
9.5	1.06	1.10	1.10	1.10	0.88	1.40	1.50	1.50	1.50	1.17
10.0	0.92	0.99	0.99	0.99	0.76	1.22	1.35	1.35	1.35	1.00
10.5	0.80	0.90	0.90	0.90	0.66	1.05	1.22	1.22	1.22	0.87
11.0	0.69	0.82	0.82	0.82	0.58	0.90	1.11	1.11	1.11	0.76
11.5	0.59	0.75	0.75	0.75	0.51	0.78	1.02	1.02	1.02	0.67
12.0	0.51	0.69	0.69	0.69	0.45	0.68	0.93	0.94	0.94	0.59
12.5	0.45	0.63	0.63	0.63	0.40	0.59	0.84	0.86	0.86	0.52
13.0	0.39	0.56	0.58	0.58	0.36	0.52	0.75	0.80	0.80	0.46
13.5	0.35	0.51	0.54	0.54	0.32	0.46	0.67	0.74	0.74	0.42
14.0	0.31	0.46	0.50	0.50	0.29	0.41	0.60	0.69	0.69	0.37
14.5						0.36	0.54	0.63	0.64	0.34
15.0						0.32	0.48	0.58	0.60	0.30
15.5										
16.0										
16.5										
17.0										
17.5										
18.0										

Span (m)	DHS 200/12 1B	2B	3B	FR	W_s	DHS 200/15 1B	2B	3B	FR	W_s
3.0										
3.5										
4.0	5.04	5.04	5.04	5.04	23.54					
4.5	4.35	4.35	4.35	4.35	16.53					
5.0	3.79	3.79	3.79	3.79	12.05	6.60	6.60	6.60	6.60	16.35
5.5	3.34	3.34	3.34	3.34	9.05	5.72	5.72	5.72	5.72	12.29
6.0	2.96	2.96	2.96	2.96	6.97	5.01	5.01	5.01	5.01	9.46
6.5	2.64	2.64	2.64	2.64	5.48	4.41	4.41	4.41	4.41	7.44
7.0	2.37	2.37	2.37	2.37	4.39	3.91	3.91	3.91	3.91	5.96
7.5	2.14	2.14	2.14	2.14	3.57	3.49	3.49	3.49	3.49	4.84
8.0	1.93	1.93	1.93	1.93	2.94	3.13	3.13	3.13	3.13	3.99
8.5	1.76	1.76	1.76	1.76	2.45	2.79	2.79	2.79	2.79	3.33
9.0	1.61	1.61	1.61	1.61	2.06	2.49	2.49	2.49	2.49	2.80
9.5	1.47	1.47	1.47	1.47	1.75	2.23	2.23	2.23	2.23	2.38
10.0	1.35	1.35	1.35	1.35	1.50	2.01	2.01	2.01	2.01	2.04
10.5	1.25	1.25	1.25	1.25	1.30	1.79	1.83	1.83	1.83	1.76
11.0	1.10	1.15	1.15	1.15	1.13	1.59	1.66	1.66	1.66	1.53
11.5	0.98	1.07	1.07	1.07	0.99	1.41	1.52	1.52	1.52	1.34
12.0	0.86	0.99	0.99	0.99	0.87	1.24	1.40	1.40	1.40	1.18
12.5	0.76	0.92	0.92	0.92	0.77	1.08	1.29	1.29	1.29	1.05
13.0	0.68	0.86	0.86	0.86	0.68	0.95	1.19	1.19	1.19	0.94
13.5	0.61	0.78	0.80	0.80	0.61	0.84	1.10	1.10	1.10	0.85
14.0	0.54	0.71	0.75	0.75	0.55	0.74	1.03	1.03	1.03	0.76
14.5	0.49	0.65	0.70	0.70	0.50	0.66	0.94	0.96	0.96	0.69
15.0	0.44	0.59	0.65	0.65	0.46	0.59	0.86	0.89	0.89	0.63
15.5	0.40	0.54	0.61	0.61	0.42	0.53	0.78	0.84	0.84	0.57
16.0	0.36	0.50	0.56	0.57	0.38	0.48	0.72	0.78	0.78	0.53
16.5	0.32	0.45	0.52	0.54	0.35	0.43	0.65	0.74	0.74	0.48
17.0	0.29	0.41	0.48	0.50	0.32	0.39	0.59	0.69	0.69	0.44
17.5	0.27	0.38	0.44	0.48	0.29	0.35	0.53	0.64	0.65	0.40
18.0						0.32	0.48	0.59	0.62	0.37

Span (m)	DHS 200/18 1B	2B	3B	FR	W_s	DHS 250/13 1B	2B	3B	FR	W_s
3.0										
3.5										
4.0										
4.5										
5.0	9.98	9.98	9.98	9.98	20.89	4.43	4.43	4.43	4.43	23.47
5.5	8.55	8.55	8.55	8.55	15.69	3.95	3.95	3.95	3.95	17.63
6.0	7.21	7.21	7.21	7.21	12.09	3.55	3.55	3.55	3.55	13.58
6.5	6.14	6.14	6.14	6.14	9.51	3.20	3.20	3.20	3.20	10.68
7.0	5.29	5.29	5.29	5.29	7.61	2.91	2.91	2.91	2.91	8.55
7.5	4.61	4.61	4.61	4.61	6.19	2.65	2.65	2.65	2.65	6.95
8.0	4.05	4.05	4.05	4.05	5.10	2.43	2.43	2.43	2.43	5.73
8.5	3.59	3.59	3.59	3.59	4.25	2.24	2.24	2.24	2.24	4.77
9.0	3.20	3.20	3.20	3.20	3.58	2.06	2.06	2.06	2.06	4.02
9.5	2.87	2.87	2.87	2.87	3.04	1.91	1.91	1.91	1.91	3.42
10.0	2.59	2.59	2.59	2.59	2.61	1.77	1.77	1.77	1.77	2.93
10.5	2.29	2.35	2.35	2.35	2.25	1.64	1.64	1.64	1.64	2.53
11.0	2.01	2.14	2.14	2.14	1.96	1.53	1.53	1.53	1.53	2.20
11.5	1.76	1.96	1.96	1.96	1.71	1.43	1.43	1.43	1.43	1.93
12.0	1.53	1.80	1.80	1.80	1.51	1.34	1.34	1.34	1.34	1.69
12.5	1.34	1.66	1.66	1.66	1.34	1.25	1.25	1.25	1.25	1.50
13.0	1.18	1.53	1.53	1.53	1.20	1.15	1.18	1.18	1.18	1.33
13.5	1.04	1.42	1.42	1.42	1.07	1.03	1.11	1.11	1.11	1.19
14.0	0.93	1.32	1.32	1.32	0.96	0.92	1.04	1.04	1.04	1.06
14.5	0.82	1.20	1.23	1.23	0.87	0.83	0.98	0.98	0.98	0.96
15.0	0.73	1.09	1.15	1.15	0.79	0.74	0.93	0.93	0.93	0.87
15.5	0.65	0.99	1.08	1.08	0.71	0.67	0.88	0.88	0.88	0.78
16.0	0.59	0.90	1.01	1.01	0.65	0.61	0.82	0.83	0.83	0.71
16.5	0.52	0.81	0.95	0.95	0.59	0.55	0.76	0.79	0.79	0.65
17.0	0.47	0.73	0.89	0.89	0.54	0.51	0.70	0.75	0.75	0.60
17.5	0.43	0.67	0.82	0.84	0.50	0.46	0.64	0.71	0.71	0.55
18.0	0.38	0.61	0.76	0.80	0.46	0.42	0.59	0.67	0.68	0.51

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_s: Load at a deflection of span/150.

2.3.7 DHS LOAD SPAN TABLES – LAPPED INTERNAL SPANS

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s	1B	2B	3B	FR	W_s
3.0																														
3.5																														
4.0																														
4.5																														
5.0																														
5.5	5.76	5.76	5.76	5.76	21.43	9.12	9.12	9.12	9.12	27.47	5.28	5.28	5.28	5.28	34.07															
6.0	5.14	5.14	5.14	5.14	16.50	8.05	8.05	8.05	8.05	21.16	4.77	4.77	4.77	4.77	26.24															
6.5	4.61	4.61	4.61	4.61	12.98	7.16	7.16	7.16	7.16	16.64	4.34	4.34	4.34	4.34	20.64															
7.0	4.16	4.16	4.16	4.16	10.39	6.40	6.40	6.40	6.40	13.32	3.96	3.96	3.96	3.96	16.52	6.37	6.37	6.37	6.37	21.19	5.86	5.86	5.86	5.86	30.26					
7.5	3.77	3.77	3.77	3.77	8.45	5.75	5.75	5.75	5.75	10.83	3.64	3.64	3.64	3.64	13.43	5.81	5.81	5.81	5.81	17.23	5.39	5.39	5.39	5.39	24.61					
8.0	3.43	3.43	3.43	3.43	6.96	5.19	5.19	5.19	5.19	8.92	3.35	3.35	3.35	3.35	11.07	5.31	5.31	5.31	5.31	14.20	4.98	4.98	4.98	4.98	20.27	6.07	6.07	6.07	6.07	31.92
8.5	3.14	3.14	3.14	3.14	5.80	4.71	4.71	4.71	4.71	7.44	3.10	3.10	3.10	3.10	9.23	4.88	4.88	4.88	4.88	11.83	4.62	4.62	4.62	4.62	16.90	5.64	5.64	5.64	5.64	26.61
9.0	2.88	2.88	2.88	2.88	4.89	4.29	4.29	4.29	4.29	6.27	2.87	2.87	2.87	2.87	7.77	4.49	4.49	4.49	4.49	9.97	4.29	4.29	4.29	4.29	14.24	5.27	5.27	5.27	5.27	22.41
9.5	2.65	2.65	2.65	2.65	4.15	3.92	3.92	3.92	3.92	5.33	2.67	2.67	2.67	2.67	6.61	4.15	4.15	4.15	4.15	8.48	4.00	4.00	4.00	4.00	12.10	4.93	4.93	4.93	4.93	19.06
10.0	2.44	2.44	2.44	2.44	3.56	3.60	3.60	3.60	3.60	4.57	2.49	2.49	2.49	2.49	5.66	3.85	3.85	3.85	3.85	7.27	3.74	3.74	3.74	3.74	10.38	4.62	4.62	4.62	4.62	16.34
10.5	2.26	2.26	2.26	2.26	3.08	3.27	3.27	3.27	3.27	3.94	2.33	2.33	2.33	2.33	4.89	3.57	3.57	3.57	3.57	6.28	3.50	3.50	3.50	3.50	8.96	4.34	4.34	4.34	4.34	14.11
11.0	2.10	2.10	2.10	2.10	2.67	2.98	2.98	2.98	2.98	3.43	2.18	2.18	2.18	2.18	4.25	3.33	3.33	3.33	3.33	5.46	3.29	3.29	3.29	3.29	7.80	4.09	4.09	4.09	4.09	12.27
11.5	1.95	1.95	1.95	1.95	2.34	2.69	2.73	2.73	2.73	3.00	2.05	2.05	2.05	2.05	3.72	3.10	3.10	3.10	3.10	4.78	3.09	3.09	3.09	3.09	6.82	3.86	3.86	3.86	3.86	10.74
12.0	1.79	1.82	1.82	1.82	2.06	2.41	2.51	2.51	2.51	2.64	1.92	1.92	1.92	1.92	3.28	2.90	2.90	2.90	2.90	4.20	2.91	2.91	2.91	2.91	6.00	3.65	3.65	3.65	3.65	9.45
12.5	1.61	1.70	1.70	1.70	1.82	2.16	2.31	2.31	2.31	2.34	1.81	1.81	1.81	1.81	2.90	2.72	2.72	2.72	2.72	3.72	2.75	2.75	2.75	2.75	5.31	3.45	3.45	3.45	3.45	8.36
13.0	1.44	1.59	1.59	1.59	1.62	1.93	2.13	2.13	2.13	2.08	1.71	1.71	1.71	1.71	2.58	2.55	2.55	2.55	2.55	3.30	2.60	2.60	2.60	2.60	4.72	3.27	3.27	3.27	3.27	7.43
13.5	1.29	1.49	1.49	1.49	1.44	1.73	1.98	1.98	1.98	1.85	1.61	1.61	1.61	1.61	2.30	2.40	2.40	2.40	2.40	2.95	2.46	2.46	2.46	2.46	4.22	3.11	3.11	3.11	3.11	6.64
14.0	1.15	1.40	1.40	1.40	1.29	1.54	1.84	1.84	1.84	1.66	1.52	1.52	1.52	1.52	2.06	2.20	2.26	2.26	2.26	2.65	2.33	2.33	2.33	2.33	3.78	2.95	2.95	2.95	2.95	5.95
14.5	1.04	1.31	1.31	1.31	1.17	1.37	1.71	1.71	1.71	1.49	1.44	1.44	1.44	1.44	1.85	2.00	2.13	2.13	2.13	2.38	2.21	2.21	2.21	2.21	3.40	2.81	2.81	2.81	2.81	5.36
15.0	0.94	1.22	1.24	1.24	1.05	1.22	1.60	1.60	1.60	1.35	1.36	1.37	1.37	1.37	1.68	1.81	2.01	2.01	2.01	2.15	2.10	2.10	2.10	2.10	3.07	2.68	2.68	2.68	2.68	4.84
15.5	0.85	1.12	1.16	1.16	0.95	1.10	1.50	1.50	1.50	1.23	1.23	1.30	1.30	1.30	1.52	1.64	1.90	1.90	1.90	1.95	1.98	2.00	2.00	2.00	2.78	2.55	2.55	2.55	2.55	4.38
16.0	0.77	1.03	1.09	1.09	0.87	0.99	1.39	1.41	1.41	1.12	1.12	1.23	1.23	1.23	1.38	1.49	1.80	1.80	1.80	1.77	1.79	1.90	1.90	1.90	2.53	2.44	2.44	2.44	2.44	3.99
16.5	0.70	0.95	1.02	1.02	0.80	0.89	1.28	1.32	1.32	1.03	1.02	1.17	1.17	1.17	1.26	1.36	1.71	1.71	1.71	1.61	1.63	1.81	1.81	1.81	2.31	2.26	2.33	2.33	2.33	3.63
17.0	0.64	0.88	0.96	0.96	0.73	0.81	1.18	1.25	1.25	0.95	0.93	1.12	1.12	1.12	1.15	1.24	1.62	1.62	1.62	1.48	1.49	1.73	1.73	1.73	2.11	2.06	2.23	2.23	2.23	3.32
17.5	0.59	0.81	0.91	0.91	0.67	0.73	1.09	1.18	1.18	0.87	0.85	1.07	1.07	1.07	1.05	1.14	1.50	1.54	1.54	1.35	1.37	1.65	1.65	1.65	1.93	1.88	2.13	2.13	2.13	3.04
18.0	0.53	0.75	0.85	0.86	0.62	0.66	1.01	1.11	1.11	0.81	0.78	1.02	1.02	1.02	0.97	1.05	1.40	1.46	1.46	1.24	1.25	1.58	1.58	1.58	1.78	1.73	2.04	2.04	2.04	2.80

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** W_s: Load at a deflection of span/150.

2.3.8 DHS LOAD SPAN TABLES – SINGLE SPANS

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0	65.4	76.4	77.0	77.1	247.9																									
3.5	57.3	70.8	71.5	71.6	182.1	80.2	99.4	100.5	100.6	227.3	73.2	85.4	86.2	86.2	397.2															
4.0	49.2	64.7	65.6	65.7	139.4	67.9	90.8	92.2	92.3	174.0	66.4	81.1	82.1	82.1	304.1	93.6	114.5	115.9	116.0	380.6	123.3	151.2	153.2	153.3	455.1	91.2	106.4	107.5	107.6	614.5
4.5	41.5	58.5	59.6	59.6	110.1	55.9	82.0	83.4	83.6	137.5	59.5	76.5	77.7	77.7	240.2	83.8	108.0	109.7	109.8	300.7	110.0	142.6	144.9	145.0	359.5	84.2	102.3	103.7	103.8	485.5
5.0	35.2	52.3	53.4	53.5	89.2	46.8	72.7	74.5	74.7	111.4	52.6	71.7	73.0	73.1	194.6	74.1	101.2	103.1	103.2	243.6	95.4	133.4	136.1	136.2	291.2	77.0	98.0	99.6	99.7	393.2
5.5	29.9	46.1	47.3	47.4	73.7	39.9	62.8	64.7	64.9	92.0	45.9	66.7	68.2	68.3	160.8	64.6	94.1	96.3	96.4	201.3	81.7	124.0	126.9	127.1	240.7	69.9	93.4	95.3	95.4	325.0
6.0	25.8	40.3	41.5	41.5	61.9	34.6	53.9	55.6	55.7	77.3	40.4	61.7	63.3	63.4	135.1	55.9	87.0	89.4	89.5	169.1	70.6	114.4	117.6	117.8	202.2	62.8	88.7	90.8	90.9	273.1
6.5	22.5	35.4	36.6	36.7	52.8	30.4	46.9	48.3	48.4	65.9	35.9	56.6	58.4	58.5	115.1	48.8	79.8	82.3	82.5	144.1	61.9	103.8	107.7	107.9	172.3	55.8	83.8	86.1	86.2	232.7
7.0	19.9	31.1	32.1	32.2	45.5	26.9	41.2	42.4	42.6	56.8	32.1	51.6	53.5	53.6	99.3	43.1	72.7	75.3	75.5	124.2	54.8	93.2	97.2	97.4	148.6	50.0	78.8	81.4	81.5	200.6
7.5	17.8	27.6	28.4	28.5	39.6	24.1	36.6	37.6	37.7	49.5	28.7	46.7	48.6	48.8	86.5	38.4	65.6	68.4	68.5	108.2	49.0	82.9	86.9	87.1	129.4	45.0	73.8	76.6	76.7	174.7
8.0						21.8	32.7	33.6	33.7	43.5	25.7	42.4	44.2	44.3	76.0	34.5	59.0	61.8	62.0	95.1	44.2	74.2	77.6	77.8	113.7	40.9	68.8	71.7	71.8	153.6
8.5											23.2	38.7	40.3	40.4	67.3	31.3	53.1	55.6	55.7	84.2	40.2	66.9	69.9	70.1	100.7	37.3	63.9	66.9	67.0	136.0
9.0											21.1	35.5	37.0	37.0	60.0	28.5	48.1	50.3	50.4	75.1	36.7	60.7	63.3	63.5	89.8	34.1	59.0	62.2	62.3	121.3
9.5											19.3	32.7	34.0	34.1	53.9	26.1	43.8	45.8	45.9	67.4	33.8	55.3	57.7	57.8	80.6	31.0	54.4	57.4	57.6	108.9
10.0											17.7	30.1	31.5	31.5	48.6	24.1	40.1	41.9	42.0	60.9	31.2	50.7	52.8	53.0	72.8	28.3	50.4	53.2	53.3	98.3
10.5																22.3	36.9	38.5	38.6	55.2	28.8	46.7	48.6	48.7	66.0	26.0	46.9	49.4	49.6	89.1
11.0																					26.5	43.2	44.8	45.0	60.1	24.0	43.7	46.1	46.2	81.2
11.5																					24.6	40.0	41.6	41.7	55.0	22.3	40.9	43.1	43.2	74.3
12.0																										20.7	38.4	40.4	40.5	68.2
12.5																										19.3	36.1	38.0	38.1	62.9
13.0																														
13.5																														
14.0																														
14.5																														
15.0																														
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17.5																														
18.0																														

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – SINGLE SPANS

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0																														
3.5																														
4.0																														
4.5																														
5.0	95.9	122.2	124.3	124.4	453.6	126.3	161.7	164.5	164.6	543.6	114.7	137.8	139.9	139.9	775.1															
5.5	86.9	116.5	118.9	119.0	374.9	114.2	154.2	157.4	157.5	449.2	106.8	133.3	135.6	135.7	640.6															
6.0	78.0	110.6	113.3	113.4	315.0	102.2	146.3	149.9	150.1	377.5	98.7	128.5	131.2	131.3	538.3															
6.5	69.3	104.5	107.5	107.6	268.4	89.7	138.2	142.2	142.4	321.6	90.6	123.5	126.5	126.6	458.6	119.8	163.9	168.0	168.1	550.4										
7.0	61.9	98.3	101.5	101.7	231.4	78.8	130.0	134.3	134.5	277.3	82.7	118.3	121.6	121.8	395.4	109.2	157.0	161.5	161.7	474.5	112.4	162.9	179.0	179.2	692.3					
7.5	55.7	92.1	95.5	95.7	201.6	69.9	121.6	126.3	126.4	241.6	74.8	113.0	116.6	116.8	344.5	98.6	150.0	154.9	155.1	413.4	101.5	155.6	173.4	173.5	603.1	120.9	187.5	217.8	222.0	933.9
8.0	50.0	85.9	89.5	89.6	177.2	62.6	113.3	118.2	118.4	212.3	68.0	107.6	111.5	111.7	302.7	89.5	142.8	148.1	148.3	363.3	92.1	148.1	167.6	167.7	530.0	108.9	178.3	211.5	216.1	820.8
8.5	45.0	79.7	83.5	83.6	156.9	56.4	105.1	110.1	110.3	188.1	62.2	102.1	106.3	106.5	268.2	81.7	135.6	141.2	141.4	321.8	84.0	140.6	161.6	161.8	469.5	98.0	169.0	204.9	210.0	727.0
9.0	40.7	73.5	77.5	77.7	140.0	51.1	96.8	102.1	102.3	167.7	57.1	96.7	101.1	101.2	239.2	74.5	128.3	134.3	134.5	287.0	76.5	133.0	155.5	155.7	418.8	88.8	159.7	198.2	203.8	648.5
9.5	37.1	67.8	71.6	71.7	125.6	46.6	88.2	93.8	94.0	150.5	52.7	91.2	95.8	96.0	214.7	67.8	121.0	127.3	127.5	257.6	69.7	125.5	149.3	149.5	375.9	80.9	150.4	191.3	197.3	582.0
10.0	33.9	62.8	66.2	66.4	113.4	42.7	80.7	85.7	86.0	135.9	48.7	85.8	90.6	90.8	193.7	62.0	113.8	120.3	120.5	232.5	63.8	117.9	143.0	143.2	339.2	74.1	141.1	184.3	190.7	525.3
10.5	31.2	58.3	61.5	61.7	102.8	39.3	74.2	78.8	79.0	123.2	45.3	80.4	85.4	85.6	175.7	57.0	106.6	113.3	113.6	210.9	58.6	110.5	136.7	136.9	307.7	68.2	131.9	177.3	184.1	476.4
11.0	28.8	54.4	57.3	57.4	93.7	36.3	68.5	72.7	72.8	112.3	41.9	75.1	80.2	80.4	160.1	52.6	99.5	106.4	106.6	192.1	54.1	103.0	130.4	130.6	280.3	63.1	122.9	170.1	177.3	434.1
11.5	26.7	50.3	53.4	53.6	85.7	33.6	63.5	67.3	67.4	102.7	38.8	70.4	75.1	75.3	146.5	48.8	93.2	99.6	99.8	175.8	50.2	96.4	124.1	124.3	256.5	58.5	114.8	163.0	170.5	397.2
12.0	24.8	46.8	49.6	49.7	78.7	31.3	59.1	62.5	62.7	94.3	36.0	66.1	70.6	70.7	134.5	45.3	87.5	93.4	93.7	161.4	46.7	90.4	117.8	118.1	235.5	54.4	106.6	155.8	163.7	364.8
12.5	23.2	43.6	46.2	46.3	72.5	29.2	55.2	58.3	58.4	86.9	33.6	62.2	66.4	66.6	124.0	42.3	82.3	87.9	88.1	148.8	43.5	85.0	111.6	111.9	217.1	50.8	99.3	148.7	156.9	336.2
13.0	21.7	40.8	43.1	43.3	67.1	27.3	51.6	54.5	54.6	80.4	31.4	58.7	62.7	62.8	114.6	39.5	77.5	82.8	83.0	137.6	40.7	80.0	105.3	105.6	200.7	47.6	92.8	141.6	150.0	310.8
13.5						25.6	48.5	51.1	51.2	74.5	29.4	55.6	59.3	59.4	106.3	37.1	72.7	78.2	78.4	127.5	38.2	74.9	99.5	99.7	186.1	44.7	87.0	134.5	143.2	288.2
14.0						24.1	45.6	48.0	48.1	69.3	27.6	52.6	56.1	56.3	98.8	34.9	68.3	73.5	73.6	118.6	35.9	70.4	94.2	94.4	173.0	42.1	81.7	127.4	136.5	268.0
14.5											26.0	50.0	53.3	53.4	92.1	32.9	64.3	69.1	69.3	110.6	33.9	66.2	89.3	89.6	161.3	39.7	76.9	120.7	129.7	249.8
15.0											24.6	47.5	50.6	50.7	86.1	31.0	60.7	65.2	65.3	103.3	32.0	62.4	84.9	85.1	150.7	37.5	72.6	114.6	123.1	233.4
15.5											23.2	45.2	48.2	48.3	80.6	29.3	57.4	61.6	61.7	96.7	30.3	59.0	80.7	80.9	141.2	35.5	68.7	108.3	117.1	218.6
16.0																27.8	54.3	58.3	58.4	90.8	28.7	55.9	76.5	76.7	132.5	33.7	65.1	102.5	111.1	205.2
16.5																26.4	51.5	55.3	55.4	85.4	27.3	53.0	72.5	72.7	124.6	32.0	61.8	97.1	105.4	192.9
17.0																					25.9	50.4	68.8	69.0	117.3	30.5	58.7	92.3	100.0	181.7
17.5																					24.7	47.9	65.5	65.6	110.7	29.1	55.9	87.8	95.2	171.5
18.0																					23.6	45.7	62.4	62.5	104.7	27.7	53.3	83.6	90.6	162.1

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – END SPANS

Axial compression capacities (kN) $f_c N_c$

Span	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
(m)	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0	64.5	78.3	85.3	85.6	506.0	90.4	110.1	120.1	120.6	631.5	78.8	89.6	95.1	95.5	1103.3															
3.5	56.2	73.2	82.2	82.6	371.7	78.7	102.8	115.7	116.2	464.0	72.1	85.7	93.0	93.5	810.6	101.7	121.0	131.3	132.1	1014.6	134.0	159.8	173.6	174.7	1213.1	96.2	109.7	116.3	117.1	1638.0
4.0	48.0	67.7	78.7	79.2	284.6	66.0	94.9	110.7	111.5	355.2	65.1	81.5	90.7	91.3	620.6	91.8	115.1	128.0	129.0	776.8	120.8	151.9	169.2	170.6	928.8	89.2	105.8	114.3	115.3	1254.0
4.5	40.4	62.0	74.9	75.5	224.8	54.2	86.8	105.4	106.2	280.6	58.0	77.1	88.1	88.9	490.3	81.7	108.7	124.4	125.5	613.8	106.8	143.4	164.4	166.0	733.8	81.9	101.6	112.0	113.3	990.8
5.0	34.1	56.2	70.9	71.6	182.1	45.4	78.5	99.7	100.7	227.3	51.0	72.3	85.3	86.3	397.2	71.8	102.0	120.4	121.8	497.1	92.1	134.5	159.1	161.1	594.4	74.5	97.1	109.5	111.1	802.6
5.5	29.0	50.4	66.8	67.6	150.5	38.8	69.7	93.8	94.9	187.9	44.4	67.5	82.3	83.4	328.2	62.3	95.2	116.2	117.8	410.8	78.6	125.3	153.5	155.8	491.2	67.1	92.4	106.8	108.7	663.3
6.0	25.0	44.7	62.5	63.4	126.5	33.6	60.7	87.7	88.9	157.8	39.0	62.6	79.2	80.4	275.8	53.7	88.2	111.8	113.6	345.2	68.0	116.0	147.6	150.1	412.8	59.7	87.5	104.0	106.1	557.3
6.5	21.9	39.6	58.2	59.1	107.7	29.6	53.0	81.4	82.8	134.5	34.7	57.6	75.9	77.3	235.0	47.0	81.2	107.2	109.2	294.1	59.6	106.0	141.4	144.2	351.7	53.0	82.5	101.0	103.4	474.9
7.0	19.3	35.2	53.8	54.8	92.9	26.2	46.8	75.2	76.6	116.0	31.0	52.7	72.6	74.1	202.6	41.5	74.2	102.4	104.6	253.6	52.9	95.6	135.1	138.1	303.2	47.4	77.4	97.8	100.6	409.5
7.5	17.3	31.3	49.5	50.5	80.9	23.5	41.7	68.2	69.9	101.0	27.6	47.9	69.1	70.8	176.5	37.0	67.3	97.5	99.9	220.9	47.3	85.6	128.5	131.8	264.1	42.7	72.3	94.5	97.6	356.7
8.0	15.6	28.0	45.1	46.3	71.1	21.3	37.5	61.3	63.1	88.8	24.7	43.5	65.6	67.4	155.1	33.3	60.9	92.6	95.1	194.2	42.7	76.8	121.9	125.4	232.2	38.7	67.2	91.2	94.6	313.5
8.5	14.1	25.3	41.1	42.2	63.0	19.4	33.9	55.1	56.7	78.6	22.3	39.8	62.1	64.0	137.4	30.2	54.9	87.6	90.3	172.0	38.8	69.4	115.2	118.8	205.6	35.3	62.2	87.7	91.4	277.7
9.0	12.9	22.9	37.7	38.6	56.2	17.7	30.9	49.9	51.3	70.1	20.3	36.5	58.6	60.5	122.5	27.5	49.9	82.6	85.4	153.4	35.3	63.2	108.1	112.3	183.4	32.0	57.2	84.2	88.2	247.7
9.5	11.8	21.0	34.3	35.3	50.4	16.3	28.3	45.4	46.6	62.9	18.6	33.7	55.1	57.1	110.0	25.2	45.5	77.6	80.5	137.7	32.2	57.8	100.5	104.9	164.6	29.2	52.8	80.6	84.9	222.3
10.0	10.9	19.2	31.4	32.2	45.5	15.1	26.1	41.5	42.6	56.8	17.1	31.2	51.6	53.7	99.3	23.3	41.8	72.6	75.6	124.2	29.4	53.2	93.2	97.6	148.6	26.7	48.9	77.0	81.5	200.6
10.5						14.0	24.1	38.1	39.2	51.5	15.8	28.8	48.1	50.3	90.0	21.6	38.5	67.6	70.8	112.7	27.1	49.2	85.9	90.4	134.7	24.5	45.4	73.5	78.2	182.0
11.0						13.0	22.4	35.2	36.1	46.9	14.6	26.6	44.9	47.0	82.0	19.9	35.7	63.0	65.9	102.7	25.0	45.6	79.4	83.4	122.8	22.6	42.3	69.9	74.8	165.8
11.5											13.6	24.6	42.0	43.9	75.0	18.5	33.2	58.4	61.4	93.9	23.1	42.5	73.6	77.2	112.3	20.9	39.6	66.3	71.5	151.7
12.0											12.7	22.9	39.4	41.2	68.9	17.1	30.9	54.3	57.0	86.3	21.5	39.7	68.4	71.7	103.2	19.5	37.1	62.8	68.1	139.3
12.5											11.9	21.4	37.1	38.7	63.5	16.0	28.9	50.6	53.1	79.5	20.0	37.3	63.9	66.8	95.1	18.1	34.9	59.2	64.8	128.4
13.0											11.2	20.1	35.0	36.5	58.7	14.9	27.2	47.3	49.6	73.5	18.7	35.0	59.8	62.4	87.9	17.0	32.6	55.8	61.5	118.7
13.5																14.0	25.6	44.3	46.4	68.2	17.5	33.0	56.1	58.5	81.5	15.9	30.5	52.8	58.1	110.0
14.0																13.1	24.1	41.7	43.6	63.4	16.3	31.2	52.8	54.9	75.8	14.9	28.6	50.0	55.0	102.3
14.5																					15.2	29.6	49.7	51.7	70.6	14.1	26.9	47.4	52.2	95.4
15.0																					14.2	28.0	47.0	48.8	66.0	13.3	25.4	45.0	49.6	89.1
15.5																										12.6	24.0	42.9	47.3	83.5
16.0																										11.9	22.7	40.9	45.1	78.3
16.5																														
17.0																														
17.5																														
18.0																														

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – END SPANS

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 250/15 1B	2B	3B	FR	ØcNex	DHS 250/18 1B	2B	3B	FR	ØcNex	DHS 300/15 1B	2B	3B	FR	ØcNex	DHS 300/18 1B	2B	3B	FR	ØcNex	DHS 350/18 1B	2B	3B	FR	ØcNex	DHS 400/20 1B	2B	3B	FR	ØcNex
3.0																														
3.5																														
4.0	111.1	131.8	142.4	143.7	1446.7	146.7	174.3	188.4	190.3	1733.4	127.7	144.8	153.1	154.6	2471.8															
4.5	102.0	126.6	139.5	141.2	1143.0	134.5	167.4	184.6	187.0	1369.6	120.0	140.5	150.9	152.8	1953.0															
5.0	92.7	121.0	136.4	138.5	925.8	122.0	159.9	180.5	183.4	1109.4	111.9	136.0	148.4	150.7	1581.9	148.2	180.2	196.8	199.9	1898.3	153.0	186.4	203.7	210.7	2769.4					
5.5	83.4	115.2	133.1	135.5	765.1	109.5	152.1	176.0	179.4	916.8	103.6	131.1	145.8	148.5	1307.4	137.2	173.8	193.2	196.9	1568.8	141.5	179.7	200.0	208.3	2288.8					
6.0	74.1	109.1	129.6	132.4	642.9	97.0	143.9	171.3	175.2	770.4	95.2	126.0	142.9	146.1	1098.5	126.0	167.0	189.4	193.8	1318.2	129.9	172.6	196.1	205.7	1923.2	155.8	208.5	237.5	254.0	2978.0
6.5	65.7	102.8	125.8	129.0	547.8	84.4	135.5	166.3	170.8	656.4	86.9	120.6	139.9	143.5	936.0	114.9	159.9	185.4	190.4	1123.2	118.3	165.2	191.8	203.0	1638.7	141.6	199.3	232.3	251.3	2537.5
7.0	58.7	96.4	121.9	125.5	472.3	74.2	127.0	161.1	166.1	566.0	78.6	115.1	136.7	140.8	807.1	103.7	152.6	181.1	186.8	968.5	106.8	157.5	187.4	200.0	1412.9	127.4	189.9	226.8	248.4	2187.9
7.5	52.6	90.0	117.8	121.8	411.5	65.8	118.4	155.6	161.2	493.0	71.0	109.5	133.3	137.9	703.0	93.6	145.1	176.7	183.0	843.7	96.3	149.7	182.7	196.9	1230.8	114.6	180.3	221.0	245.4	1905.9
8.0	47.0	83.6	113.6	118.0	361.6	58.9	109.8	150.0	156.2	433.3	64.6	103.8	129.8	134.9	617.9	84.9	137.5	172.0	179.0	741.5	87.3	141.8	177.9	193.7	1081.8	102.5	170.5	215.0	242.2	1675.1
8.5	42.3	77.3	109.3	114.0	320.3	53.1	101.3	144.2	150.9	383.8	59.0	98.1	126.2	131.8	547.3	77.4	129.8	167.2	174.9	656.8	79.5	133.8	172.8	190.3	958.2	92.3	160.7	208.8	238.8	1483.8
9.0	38.3	71.0	104.9	110.0	285.7	48.1	92.3	138.3	145.6	342.4	54.2	92.4	122.4	128.6	488.2	70.1	122.1	162.2	170.7	585.9	72.0	125.9	167.6	186.7	854.7	83.6	150.9	202.4	235.3	1323.5
9.5	34.9	65.5	100.4	105.9	256.4	43.9	84.0	132.3	140.1	307.3	49.9	86.7	118.6	125.2	438.2	63.8	114.5	157.2	166.3	525.8	65.6	117.9	162.3	183.1	767.1	76.2	141.1	195.8	231.6	1187.9
10.0	31.9	60.6	95.9	101.8	231.4	40.2	76.8	126.3	134.6	277.3	46.2	81.0	114.7	121.8	395.4	58.4	107.0	152.0	161.8	474.5	60.0	110.1	156.9	179.3	692.3	69.8	131.4	189.2	227.8	1072.1
10.5	29.4	56.2	91.4	97.6	209.9	37.0	70.6	120.3	129.0	251.5	42.8	75.4	110.8	118.4	358.7	53.7	99.4	146.7	157.2	430.4	55.2	102.3	151.4	175.4	627.9	64.3	122.0	182.4	223.9	972.4
11.0	27.1	52.1	86.9	93.4	191.2	34.2	65.2	114.2	123.4	229.2	39.4	70.4	106.8	114.8	326.8	49.5	92.8	141.4	152.5	392.2	51.0	95.4	145.9	171.3	572.2	59.4	113.4	175.6	219.8	886.0
11.5	25.1	48.2	82.4	89.2	175.0	31.7	60.3	108.2	117.7	209.7	36.5	65.9	102.7	111.2	299.0	45.9	86.8	136.0	147.7	358.8	47.3	89.2	140.3	167.3	523.5	55.1	105.0	168.7	215.7	810.6
12.0	23.4	44.7	78.0	84.9	160.7	29.5	56.1	102.2	112.1	192.6	33.9	61.9	98.7	107.6	274.6	42.7	81.4	130.6	142.9	329.5	44.0	83.6	134.7	163.1	480.8	51.3	97.5	161.7	211.4	744.5
12.5	21.8	41.7	73.5	80.8	148.1	27.5	52.3	96.1	106.5	177.5	31.6	58.2	94.7	104.0	253.1	39.8	76.2	125.2	138.1	303.7	41.0	78.4	129.1	158.9	443.1	47.9	90.9	154.8	207.1	686.1
13.0	20.4	38.9	69.3	76.6	136.9	25.7	48.9	89.7	100.9	164.1	29.5	54.9	90.6	100.3	234.0	37.3	71.2	119.8	133.2	280.8	38.4	73.2	123.5	154.6	409.6	44.9	85.0	147.9	202.6	634.3
13.5	19.1	36.5	65.4	72.4	127.0	24.1	45.8	84.0	95.1	152.1	27.7	51.9	86.6	96.6	217.0	34.9	66.7	114.5	128.3	260.4	36.0	68.6	117.9	150.3	379.8	42.1	79.7	141.1	198.1	588.2
14.0	18.0	34.3	61.9	68.6	118.0	22.7	43.1	78.8	89.2	141.5	26.0	49.1	82.7	93.0	201.7	32.8	62.6	109.2	123.4	242.1	33.9	64.4	112.4	145.9	353.2	39.7	74.8	134.3	193.5	546.9
14.5	16.9	32.3	58.7	65.0	110.0	21.4	40.6	74.2	83.9	131.9	24.5	46.6	78.6	89.3	188.1	31.0	58.9	103.7	118.6	225.7	31.9	60.6	106.8	141.5	329.3	37.4	70.5	127.4	188.9	509.9
15.0	16.0	30.4	55.7	61.8	102.8	20.2	38.3	69.9	79.1	123.2	23.1	44.3	74.8	85.7	175.7	29.2	55.6	98.6	113.7	210.9	30.2	57.2	101.5	137.1	307.7	35.4	66.6	120.9	184.2	476.4
15.5	15.1	28.8	52.8	58.8	96.3	19.1	36.2	66.1	74.8	115.4	21.9	41.9	71.3	82.1	164.6	27.6	52.5	93.9	108.9	197.5	28.6	54.1	96.6	132.7	288.1	33.5	63.0	115.0	179.5	446.2
16.0	14.3	27.2	50.0	56.0	90.4	18.1	34.3	62.6	70.8	108.3	20.7	39.6	68.0	78.4	154.4	26.2	49.8	89.5	104.0	185.3	27.1	51.2	92.1	128.3	270.4	31.8	59.7	108.9	174.8	418.7
16.5	13.6	25.8	47.4	53.3	85.0	17.1	32.6	59.3	67.1	101.8	19.7	37.5	65.0	75.0	145.2	24.9	47.2	85.5	99.3	174.3	25.7	48.6	87.9	123.9	254.3	30.2	56.6	103.2	170.0	393.7
17.0	12.9	24.6	45.0	50.6	80.0	16.3	31.0	56.4	63.7	95.9	18.7	35.6	62.2	71.7	136.8	23.7	44.8	81.7	95.0	164.2	24.5	46.2	84.0	119.5	239.5	28.8	53.9	98.0	165.3	370.9
17.5						15.5	29.5	53.6	60.6	90.5	17.8	33.9	59.5	68.7	129.1	22.5	42.7	78.2	91.0	154.9	23.3	43.9	80.4	115.1	226.0	27.4	51.3	93.2	160.5	350.0
18.0						14.7	28.1	51.1	57.7	85.6	17.0	32.3	57.1	65.9	122.0	21.5	40.7	74.5	87.2	146.4	22.2	41.9	76.5	110.8	213.6	26.2	48.9	88.8	155.7	330.8

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

Dimond

2.3.8 DHS LOAD SPAN TABLES – INTERNAL SPANS

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 150/12					DHS 150/15					DHS 200/12				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0															
3.5	58.5	75.7	83.5	88.3	728.6	81.9	106.3	117.4	124.3	909.4	73.9	87.5	93.3	97.2	1588.8
4.0	50.6	70.7	80.3	86.4	557.8	70.0	99.2	112.9	121.7	696.3	67.2	83.8	91.0	96.0	1216.4
4.5	42.9	65.4	76.9	84.3	440.7	58.0	91.8	108.1	118.7	550.1	60.4	79.7	88.5	94.7	961.1
5.0	36.5	60.1	73.3	82.1	357.0	48.6	84.1	102.9	115.5	445.6	53.7	75.5	85.7	93.2	778.5
5.5	31.0	54.7	69.5	79.7	295.0	41.5	76.4	97.5	112.1	368.2	47.0	71.0	82.9	91.6	643.4
6.0	26.8	49.3	65.5	77.1	247.9	35.9	68.0	91.9	108.5	309.4	41.3	66.5	79.8	89.9	540.6
6.5	23.4	44.0	61.5	74.4	211.2	31.5	59.7	86.2	104.6	263.6	36.7	61.8	76.6	88.1	460.6
7.0	20.7	39.4	57.5	71.6	182.1	28.0	52.7	80.4	100.6	227.3	32.9	57.2	73.3	86.2	397.2
7.5	18.5	35.3	53.4	68.7	158.6	25.1	46.9	74.6	96.5	198.0	29.5	52.7	70.0	84.2	346.0
8.0	16.6	31.6	49.4	65.7	139.4	22.7	42.1	68.2	92.3	174.0	26.4	48.2	66.5	82.1	304.1
8.5	15.1	28.5	45.4	62.7	123.5	20.6	38.1	61.9	87.9	154.1	23.8	44.0	63.1	80.0	269.3
9.0	13.7	25.8	41.7	59.6	110.1	18.9	34.7	56.2	83.6	137.5	21.7	40.4	59.6	77.7	240.2
9.5	12.6	23.6	38.4	56.6	98.9	17.4	31.7	51.3	79.1	123.4	19.8	37.3	56.2	75.4	215.6
10.0	11.6	21.6	35.4	53.5	89.2	16.1	29.2	47.0	74.7	111.4	18.2	34.6	52.8	73.1	194.6
10.5	10.8	20.0	32.5	50.4	80.9	15.0	27.0	43.3	69.7	101.0	16.8	32.1	49.4	70.7	176.5
11.0	10.0	18.5	30.0	47.4	73.7	13.9	25.1	40.1	64.9	92.0	15.6	29.9	46.1	68.3	160.8
11.5	9.4	17.2	27.8	44.3	67.4	12.9	23.3	37.3	60.1	84.2	14.5	27.7	43.2	65.9	147.1
12.0	8.8	16.0	25.9	41.5	61.9	12.1	21.8	34.8	55.7	77.3	13.5	25.7	40.5	63.4	135.1
12.5	8.2	15.0	24.2	39.0	57.1	11.2	20.5	32.5	51.9	71.3	12.7	24.0	38.2	60.9	124.5
13.0	7.8	14.1	22.6	36.7	52.8	10.4	19.3	30.5	48.4	65.9	11.9	22.5	36.0	58.5	115.1
13.5						9.6	18.2	28.7	45.3	61.1	11.2	21.1	34.0	56.0	106.7
14.0						8.9	17.2	27.1	42.5	56.8	10.5	19.9	32.2	53.6	99.3
14.5											9.9	18.7	30.5	51.2	92.5
15.0											9.3	17.7	28.8	48.7	86.5
15.5											8.8	16.8	27.2	46.4	81.0
16.0											8.4	15.9	25.8	44.2	76.0
16.5											7.9	15.2	24.5	42.2	71.4
17.0															
17.5															
18.0															

Span (m)	DHS 200/15					DHS 200/18					DHS 250/13				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0															
3.5															
4.0															
4.5	85.1	112.5	124.8	133.6	1203.0	111.9	148.5	165.0	176.8	1438.3	84.2	103.9	112.0	118.1	1942.1
5.0	75.5	106.4	121.0	131.6	974.4	97.5	140.4	159.8	174.1	1165.0	77.0	99.9	109.5	116.9	1573.1
5.5	66.1	100.2	116.9	129.4	805.3	83.8	132.0	154.4	171.2	962.8	69.9	95.6	106.8	115.6	1300.1
6.0	57.4	93.7	112.6	127.0	676.7	72.5	123.4	148.6	168.0	809.0	62.8	91.1	104.0	114.2	1092.4
6.5	50.1	87.2	108.1	124.5	576.6	63.5	114.6	142.6	164.6	689.4	55.8	86.5	101.0	112.7	930.8
7.0	44.3	80.6	103.4	121.8	497.1	56.3	105.1	136.3	161.0	594.4	50.0	81.7	97.8	111.1	802.6
7.5	39.5	74.2	98.7	118.9	433.1	50.4	95.5	130.0	157.2	517.8	45.0	76.9	94.5	109.4	699.1
8.0	35.5	67.7	93.8	116.0	380.6	45.4	86.1	123.5	153.3	455.1	40.9	72.1	91.2	107.6	614.5
8.5	32.1	61.7	88.9	112.9	337.1	41.3	77.8	117.0	149.2	403.1	37.3	67.4	87.7	105.7	544.3
9.0	29.3	56.0	84.0	109.8	300.7	37.5	70.7	110.3	145.0	359.5	34.1	62.6	84.2	103.8	485.5
9.5	26.9	51.1	79.1	106.5	269.9	34.1	64.7	102.9	140.7	322.7	31.0	57.9	80.6	101.8	435.7
10.0	24.8	46.8	74.3	103.2	243.6	31.3	59.5	95.7	136.2	291.2	28.3	53.6	77.0	99.7	393.2
10.5	22.9	43.2	69.5	99.8	220.9	28.8	54.9	88.7	131.7	264.1	26.0	49.8	73.5	97.6	356.7
11.0	21.2	39.9	64.8	96.4	201.3	26.5	50.9	82.0	127.1	240.7	24.0	46.5	69.9	95.4	325.0
11.5	19.6	37.1	60.3	93.0	184.2	24.6	47.4	76.1	122.4	220.2	22.3	43.5	66.3	93.1	297.3
12.0	18.2	34.6	56.1	89.5	169.1	22.8	44.3	70.9	117.8	202.2	20.7	40.8	62.8	90.9	273.1
12.5	17.0	32.4	52.3	86.0	155.9	21.3	41.5	66.3	113.0	186.4	19.3	38.3	59.2	88.6	251.7
13.0	15.9	30.4	49.0	82.5	144.1	19.9	39.0	62.1	107.9	172.3	18.0	36.1	55.8	86.2	232.7
13.5	14.9	28.6	46.0	79.0	133.6	18.6	36.8	58.4	102.6	159.8	16.9	34.0	52.8	83.8	215.7
14.0	14.0	26.9	43.3	75.5	124.2	17.4	34.8	55.0	97.4	148.6	15.9	31.9	50.0	81.5	200.6
14.5	13.1	25.5	40.8	72.0	115.8	16.3	32.9	52.0	92.2	138.5	14.9	30.0	47.4	79.1	187.0
15.0	12.4	24.1	38.6	68.5	108.2	15.2	31.2	49.2	87.1	129.4	14.1	28.3	45.0	76.7	174.7
15.5	11.7	22.9	36.5	65.2	101.4	14.2	29.5	46.7	82.2	121.2	13.3	26.7	42.9	74.2	163.6
16.0	11.1	21.8	34.7	62.0	95.1	13.4	27.9	44.4	77.8	113.7	12.6	25.3	40.9	71.8	153.6
16.5	10.5	20.8	33.0	58.7	89.4	12.6	26.5	42.3	73.8	106.9	12.0	24.0	39.0	69.4	144.4
17.0	9.9	19.8	31.4	55.7	84.2	11.8	25.1	40.3	70.1	100.7	11.4	22.8	37.3	67.0	136.0
17.5	9.4	18.9	30.0	53.0	79.5	11.2	23.9	38.5	66.6	95.1	10.8	21.6	35.6	64.7	128.4
18.0	8.9	18.1	28.6	50.4	75.1	10.5	22.8	36.9	63.5	89.8	10.3	20.6	34.1	62.3	121.3

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – INTERNAL SPANS

Axial compression capacities (kN) $f_c N_c$

Span	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
(m)	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0																														
3.5																														
4.0																														
4.5	104.9	129.5	139.5	147.1	2240.4	138.3	171.2	184.6	194.7	2684.5	122.4	142.9	150.9	157.2	3827.9															
5.0	95.9	124.4	136.4	145.6	1814.7	126.3	164.5	180.5	192.8	2174.4	114.7	138.7	148.4	156.1	3100.6															
5.5	86.9	119.1	133.1	144.0	1499.7	114.2	157.3	176.0	190.7	1797.0	106.8	134.3	145.8	154.9	2562.5															
6.0	78.0	113.5	129.6	142.3	1260.2	102.2	149.8	171.3	188.4	1510.0	98.7	129.7	142.9	153.6	2153.2	130.6	171.9	189.4	203.6	2583.8	134.7	177.7	196.1	213.7	3769.5					
6.5	69.3	107.7	125.8	140.4	1073.8	89.7	142.1	166.3	185.9	1286.6	90.6	124.8	139.9	152.2	1834.6	119.8	165.4	185.4	201.8	2201.6	123.5	171.0	191.8	212.2	3211.9					
7.0	61.9-	101.8	121.9	138.4	925.8	78.8	134.2	161.1	183.3	1109.4	82.7	119.8	136.7	150.7	1581.9	109.2	158.7	181.1	199.8	1898.3	112.4	164.0	187.4	210.6	2769.4	134.3	197.9	226.8	258.8	4288.4
7.5	55.7	95.8	117.8	136.3	806.5	69.9	126.1	155.6	180.5	966.4	74.8	114.6	133.3	149.1	1378.0	98.6	151.8	176.7	197.8	1653.6	101.5	156.8	182.7	209.0	2412.4	120.9	189.0	221.0	257.1	3735.6
8.0	50.0	89.8	113.6	134.1	708.8	62.6	118.0	150.0	177.6	849.4	68.0	109.3	129.8	147.4	1211.1	89.5	144.8	172.0	195.6	1453.4	92.1	149.4	177.9	207.2	2120.3	108.9	179.9	215.0	255.4	3283.3
8.5	45.0	83.8	109.3	131.8	627.9	56.4	110.0	144.2	174.5	752.4	62.2	103.9	126.2	145.7	1072.8	81.7	137.6	167.2	193.2	1287.4	84.0	142.0	172.8	205.3	1878.2	98.0	170.7	208.8	253.6	2908.3
9.0	40.7	77.8	104.9	129.4	560.1	51.1	102.0	138.3	171.4	671.1	57.1	98.6	122.4	143.8	956.9	74.5	130.4	162.2	190.8	1148.3	76.5	134.5	167.6	203.3	1675.3	88.8	161.5	202.4	251.6	2594.2
9.5	37.1	71.9	100.4	126.9	502.6	46.6	93.6	132.3	168.1	602.3	52.7	93.2	118.6	141.9	858.9	67.8	123.2	157.2	188.3	1030.6	69.7	127.0	162.3	201.3	1503.6	80.9	152.3	195.8	249.6	2328.3
10.0	33.9	66.5	95.9	124.4	453.6	42.7	85.6	126.3	164.6	543.6	48.7	87.8	114.7	139.9	775.1	62.0	116.0	152.0	185.7	930.1	63.8	119.5	156.9	199.1	1357.0	74.1	143.1	189.2	247.5	2101.3
10.5	31.2	61.8	91.4	121.7	411.5	39.3	78.6	120.3	161.1	493.0	45.3	82.5	110.8	137.8	703.0	57.0	108.9	146.7	182.9	843.7	58.6	112.2	151.4	196.9	1230.8	68.2	134.0	182.4	245.3	1905.9
11.0	28.8	57.6	86.9	119.0	374.9	36.3	72.5	114.2	157.5	449.2	41.9	77.2	106.8	135.7	640.6	52.6	101.8	141.4	180.1	768.7	54.1	104.7	145.9	194.6	1121.5	63.1	124.9	175.6	243.0	1736.6
11.5	26.7	53.7	82.4	116.2	343.0	33.6	67.2	108.2	153.8	411.0	38.8	72.3	102.7	133.5	586.1	48.8	95.2	136.0	177.2	703.3	50.2	98.0	140.3	192.2	1026.1	58.5	116.7	168.7	240.7	1588.8
12.0	24.8	49.8	78.0	113.4	315.0	31.3	62.4	102.2	150.1	377.5	36.0	67.8	98.7	131.3	538.3	45.3	89.3	130.6	174.2	645.9	46.7	91.9	134.7	189.7	942.3	54.4	108.6	161.7	238.2	1459.2
12.5	23.2	46.4	73.5	110.5	290.3	29.2	58.2	96.1	146.2	347.9	33.6	63.9	94.7	128.9	496.1	42.3	84.0	125.2	171.2	595.3	43.5	86.4	129.1	187.2	868.4	50.8	101.2	154.8	235.7	1344.8
13.0	21.7	43.4	69.3	107.6	268.4	27.3	54.4	89.7	142.3	321.6	31.4	60.2	90.6	126.6	458.6	39.5	79.1	119.8	168.1	550.4	40.7	81.4	123.5	184.6	802.9	47.6	94.5	147.9	233.1	1243.3
13.5	20.3	40.6	65.4	104.6	248.9	25.6	51.0	84.0	138.4	298.2	29.4	57.0	86.6	124.2	425.3	37.1	74.3	114.5	164.9	510.3	38.2	76.3	117.9	181.9	744.5	44.7	88.6	141.1	230.4	1152.9
14.0	19.1	38.1	61.9	101.7	231.4	24.1	47.9	78.8	134.4	277.3	27.6	53.9	82.7	121.7	395.4	34.9	69.7	109.2	161.7	474.5	35.9	71.7	112.4	179.2	692.3	42.1	83.2	134.3	227.7	1072.1
14.5	18.0	35.9	58.7	98.7	215.7	22.7	45.1	74.2	130.4	258.5	26.0	51.2	78.6	119.3	368.6	32.9	65.6	103.7	158.4	442.4	33.9	67.4	106.8	176.4	645.4	39.7	78.4	127.4	224.9	999.4
15.0	17.0	33.8	55.7	95.7	201.6	21.4	42.6	69.9	126.4	241.6	24.6	48.6	74.8	116.7	344.5	31.0	61.9	98.6	155.0	413.4	32.0	63.6	101.5	173.5	603.1	37.5	74.0	120.9	222.0	933.9
15.5	16.1	32.0	52.8	92.6	188.8	20.3	40.3	66.1	122.4	226.2	23.2	46.3	71.3	114.2	322.6	29.3	58.5	93.9	151.7	387.1	30.3	60.1	96.6	170.7	564.8	35.5	69.9	115.0	219.1	874.6
16.0	15.2	30.3	50.0	89.6	177.2	19.2	38.1	62.6	118.4	212.3	22.0	44.1	68.0	111.6	302.7	27.8	55.3	89.5	148.3	363.3	28.7	56.9	92.1	167.7	530.0	33.7	66.3	108.9	216.1	820.8
16.5	14.4	28.7	47.4	86.6	166.6	18.2	36.2	59.3	114.3	199.6	20.9	41.8	65.0	109.1	284.7	26.4	52.5	85.5	144.8	341.6	27.3	54.0	87.9	164.8	498.4	32.0	62.9	103.2	213.1	771.8
17.0	13.7	27.3	45.0	83.6	156.9	17.3	34.4	56.4	110.3	188.1	19.8	39.7	62.2	106.5	268.2	25.1	49.9	81.7	141.4	321.8	25.9	51.3	84.0	161.8	469.5	30.5	59.8	98.0	210.0	727.0
17.5	13.1	26.0	42.8	80.6	148.1	16.4	32.7	53.6	106.3	177.5	18.9	37.7	59.5	103.8	253.1	23.9	47.5	78.2	137.9	303.7	24.7	48.8	80.4	158.7	443.1	29.1	56.9	93.2	206.9	686.1
18.0	12.4	24.8	40.7	77.7	140.0	15.7	31.2	51.1	102.3	167.7	18.0	35.9	57.1	101.2	239.2	22.8	45.2	74.5	134.4	287.0	23.6	46.5	76.5	155.7	418.8	27.7	54.3	88.8	203.7	648.5

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – LAPPED END SPAN

Axial compression capacities (kN) $f_c N_c$

Span	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
(m)	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0	64.7	78.4	85.8	86.1	536.2	90.7	110.2	120.8	121.3	669.2	78.9	89.6	95.3	95.8	1169.1															
3.5	56.5	73.3	82.8	83.2	393.9	79.1	102.9	116.6	117.2	491.7	72.2	85.8	93.2	94.0	858.9															
4.0	48.3	67.8	79.5	80.0	301.6	66.6	95.1	111.9	112.6	376.4	65.3	81.6	90.9	91.9	657.6	92.1	115.2	128.3	129.7	823.2	121.3	152.0	169.7	171.6	984.2	89.3	105.9	114.4	115.8	1328.9
4.5	40.7	62.1	75.9	76.5	238.3	54.8	87.0	106.7	107.7	297.4	58.2	77.1	88.4	89.6	519.6	82.1	108.8	124.8	126.5	650.4	107.5	143.6	164.9	167.3	777.6	82.0	101.7	112.1	113.9	1050.0
5.0	34.4	56.3	72.1	72.8	193.0	46.0	78.8	101.3	102.4	240.9	51.3	72.4	85.7	87.1	420.9	72.3	102.2	120.9	123.0	526.8	92.9	134.7	159.8	162.6	629.9	74.6	97.2	109.6	111.8	850.5
5.5	29.3	50.5	68.1	68.9	159.5	39.3	70.0	95.6	96.8	199.1	44.7	67.6	82.8	84.4	347.8	62.8	95.3	116.8	119.2	435.4	79.4	125.5	154.3	157.6	520.5	67.2	92.5	107.0	109.5	702.9
6.0	25.3	44.8	63.9	64.9	134.0	34.1	61.0	89.7	91.1	167.3	39.3	62.7	79.7	81.5	292.2	54.2	88.4	112.5	115.2	365.8	68.8	116.2	148.5	152.2	437.4	59.9	87.6	104.2	107.1	590.6
6.5	22.1	39.7	59.7	60.8	114.2	30.0	53.3	83.7	85.2	142.5	34.9	57.8	76.5	78.6	249.0	47.4	81.4	108.0	111.0	311.7	60.4	106.3	142.5	146.6	372.7	53.1	82.6	101.2	104.5	503.2
7.0	19.6	35.3	55.5	56.6	98.4	26.7	47.0	77.6	79.2	122.9	31.2	52.9	73.2	75.5	214.7	41.9	74.5	103.3	106.6	268.8	53.6	96.0	136.2	140.7	321.3	47.5	77.6	98.0	101.8	433.9
7.5	17.5	31.4	51.3	52.4	85.7	24.0	41.9	71.1	73.0	107.0	27.8	48.1	69.8	72.3	187.0	37.5	67.6	98.5	102.1	234.1	48.0	85.9	129.8	134.7	279.9	42.8	72.5	94.8	99.0	378.0
8.0	15.8	28.1	47.1	48.3	75.4	21.7	37.6	64.4	66.3	94.1	25.0	43.7	66.4	69.0	164.4	33.7	61.1	93.7	97.5	205.8	43.3	77.1	123.4	128.5	246.0	38.8	67.4	91.4	96.0	332.2
8.5	14.3	25.4	43.0	44.2	66.7	19.8	34.1	58.0	59.8	83.3	22.6	39.9	63.0	65.7	145.6	30.6	55.1	88.8	92.8	182.3	39.0	69.7	116.8	122.2	217.9	35.4	62.4	88.0	93.0	294.3
9.0	13.1	23.0	39.4	40.5	59.5	18.2	31.0	52.5	54.1	74.3	20.5	36.7	59.5	62.4	129.9	27.9	50.0	83.9	88.0	162.6	35.4	63.4	110.1	115.8	194.4	32.1	57.4	84.5	89.9	262.5
9.5	12.1	21.1	36.1	37.2	53.4	16.8	28.4	47.8	49.2	66.7	18.8	33.8	56.0	59.1	116.5	25.6	45.7	79.0	83.3	145.9	32.3	58.1	102.7	109.1	174.4	29.3	52.9	81.0	86.8	235.6
10.0	11.1	19.3	33.0	34.0	48.2	15.6	26.2	43.7	45.0	60.2	17.3	31.3	52.6	55.7	105.2	23.5	41.9	74.1	78.5	131.7	29.5	53.4	95.5	101.9	157.4	26.8	49.0	77.4	83.6	212.6
10.5	10.3	17.8	30.3	31.2	43.7	14.5	24.2	40.1	41.3	54.6	16.0	28.9	49.2	52.4	95.4	21.6	38.7	69.2	73.8	119.4	27.2	49.4	88.4	94.9	142.8	24.6	45.5	73.8	80.3	192.8
11.0						13.5	22.5	37.0	38.1	49.7	14.8	26.7	45.9	49.2	86.9	20.0	35.8	64.6	69.1	108.8	25.1	45.8	81.7	87.9	130.1	22.7	42.4	70.3	77.0	175.7
11.5						12.4	21.0	34.3	35.2	45.5	13.8	24.7	43.0	46.0	79.5	18.5	33.3	60.1	64.5	99.5	23.2	42.7	75.8	81.4	119.0	21.0	39.7	66.7	73.8	160.7
12.0											12.9	23.0	40.4	43.1	73.0	17.2	31.1	55.9	60.1	91.4	21.6	39.9	70.6	75.6	109.3	19.5	37.2	63.2	70.5	147.6
12.5											12.1	21.5	38.0	40.6	67.3	16.0	29.1	52.1	56.0	84.2	20.1	37.4	66.0	70.4	100.7	18.2	34.9	59.6	67.3	136.0
13.0											11.3	20.1	35.8	38.2	62.2	15.0	27.3	48.8	52.3	77.9	18.7	35.2	61.8	65.8	93.1	17.0	32.7	56.2	64.0	125.8
13.5											10.6	18.9	33.9	36.1	57.7	14.0	25.7	45.7	48.9	72.2	17.5	33.2	58.1	61.6	86.4	16.0	30.6	53.2	60.8	116.6
14.0																13.2	24.2	43.0	45.9	67.2	16.3	31.4	54.7	57.9	80.3	15.0	28.7	50.3	57.6	108.4
14.5																12.4	22.9	40.6	43.2	62.6	15.2	29.7	51.6	54.5	74.9	14.1	27.0	47.8	54.7	101.1
15.0																					14.2	28.1	48.8	51.4	69.9	13.3	25.5	45.4	52.0	94.5
15.5																					13.3	26.6	46.3	48.6	65.5	12.6	24.1	43.2	49.5	88.5
16.0																					12.5	25.2	43.9	46.0	61.5	11.9	22.8	41.2	47.2	83.0
16.5																										11.3	21.6	39.3	45.0	78.1
17.0																														
17.5																														
18.0																														

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – LAPPED END SPAN

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0																														
3.5																														
4.0	111.3	131.9	142.5	144.3	1533.0	146.9	174.4	188.5	191.0	1836.9	127.8	144.8	153.2	155.1	2619.3															
4.5	102.2	126.7	139.7	141.9	1211.3	134.7	167.5	184.8	187.9	1451.4	120.1	140.6	151.0	153.3	2069.6															
5.0	92.9	121.1	136.6	139.3	981.1	122.2	160.1	180.7	184.5	1175.6	112.0	136.0	148.6	151.4	1676.3															
5.5	83.6	115.3	133.3	136.5	810.8	109.7	152.2	176.3	180.8	971.6	103.8	131.2	145.9	149.2	1385.4	137.4	173.9	193.4	197.9	1662.5	141.7	179.8	200.3	209.1	2425.4					
6.0	74.3	109.2	129.8	133.5	681.3	97.2	144.1	171.6	176.8	816.4	95.4	126.1	143.1	147.0	1164.1	126.2	167.1	189.7	194.9	1396.9	130.1	172.7	196.3	206.7	2038.0					
6.5	65.9	102.9	126.1	130.3	580.5	84.6	135.7	166.6	172.6	695.6	87.1	120.7	140.1	144.5	991.9	115.1	160.0	185.7	191.7	1190.3	118.6	165.3	192.1	204.1	1736.5	141.9	199.5	232.6	252.4	2688.9
7.0	58.9	96.6	122.2	127.0	500.5	74.4	127.2	161.4	168.1	599.8	78.9	115.3	136.9	141.9	855.2	104.0	152.7	181.4	188.3	1026.3	107.1	157.7	187.7	201.3	1497.3	127.7	190.1	227.2	249.7	2318.5
7.5	52.8	90.2	118.1	123.5	436.0	66.0	118.6	156.0	163.4	522.5	71.2	109.7	133.5	139.2	745.0	93.8	145.2	177.0	184.7	894.0	96.5	149.9	183.1	198.4	1304.3	114.9	180.5	221.4	246.8	2019.7
8.0	47.2	83.8	113.9	119.8	383.2	59.1	110.0	150.4	158.6	459.2	64.7	104.0	130.1	136.4	654.8	85.2	137.7	172.4	181.0	785.8	87.6	142.0	178.2	195.3	1146.3	102.8	170.8	215.5	243.7	1775.1
8.5	42.4	77.5	109.6	116.1	339.4	53.2	101.5	144.7	153.6	406.7	59.1	98.2	126.5	133.4	580.0	77.6	130.0	167.6	177.1	696.0	79.8	134.0	173.3	192.0	1015.4	92.5	161.0	209.3	240.5	1572.4
9.0	38.4	71.2	105.3	112.2	302.8	48.3	92.6	138.8	148.5	362.8	54.3	92.5	122.8	130.3	517.4	70.3	122.3	162.7	173.0	620.8	72.2	126.1	168.1	188.7	905.7	83.9	151.1	203.0	237.2	1402.5
9.5	35.0	65.6	100.8	108.3	271.7	44.0	84.2	132.9	143.2	325.6	50.1	86.8	119.0	127.1	464.3	64.0	114.7	157.6	168.8	557.2	65.8	118.2	162.8	185.2	812.9	76.5	141.4	196.5	233.7	1258.8
10.0	32.0	60.7	96.4	104.3	245.2	40.3	77.0	126.9	137.9	293.9	46.3	81.2	115.1	123.9	419.0	58.6	107.2	152.5	164.5	502.9	60.2	110.4	157.5	181.5	733.6	70.1	131.7	189.8	230.1	1136.0
10.5	29.5	56.4	91.9	100.2	222.4	37.1	70.8	120.9	132.5	266.5	42.9	75.6	111.2	120.6	380.1	53.8	99.7	147.3	160.1	456.1	55.4	102.6	152.0	177.8	665.4	64.5	122.3	183.1	226.4	1030.4
11.0	27.2	52.2	87.4	96.1	202.7	34.3	65.3	114.9	127.1	242.9	39.6	70.6	107.2	117.2	346.3	49.7	93.0	142.0	155.6	415.6	51.1	95.6	146.5	174.0	606.3	59.6	113.7	176.3	222.5	938.9
11.5	25.2	48.3	82.9	92.1	185.4	31.8	60.5	108.9	121.6	222.2	36.6	66.1	103.2	113.7	316.8	46.1	87.0	136.6	151.0	380.2	47.4	89.4	140.9	170.1	554.7	55.3	105.3	169.4	218.5	859.0
12.0	23.5	44.9	78.5	88.0	170.3	29.6	56.2	102.9	116.1	204.1	34.0	62.0	99.2	110.2	291.0	42.8	81.5	131.3	146.4	349.2	44.1	83.8	135.4	166.1	509.5	51.5	97.8	162.6	214.5	788.9
12.5	21.9	41.8	74.0	83.9	156.9	27.6	52.4	96.8	110.7	188.1	31.7	58.4	95.2	106.7	268.2	39.9	76.4	125.9	141.7	321.8	41.1	78.6	129.8	162.1	469.5	48.1	91.1	155.7	210.3	727.0
13.0	20.5	39.0	69.8	79.9	145.1	25.8	49.0	90.5	105.3	173.9	29.6	55.1	91.2	103.2	247.9	37.4	71.4	120.5	137.0	297.5	38.5	73.4	124.2	157.9	434.1	45.0	85.2	148.8	206.1	672.2
13.5	19.2	36.6	65.9	75.8	134.5	24.2	46.0	84.7	99.8	161.2	27.8	52.0	87.2	99.6	229.9	35.0	66.9	115.2	132.3	275.9	36.1	68.7	118.7	153.8	402.5	42.3	79.9	142.0	201.8	623.3
14.0	18.0	34.4	62.4	71.8	125.1	22.8	43.2	79.5	94.1	149.9	26.1	49.3	83.2	96.1	213.8	32.9	62.8	109.9	127.5	256.5	34.0	64.6	113.2	149.6	374.3	39.8	75.0	135.2	197.4	579.6
14.5	17.0	32.3	59.2	68.1	116.6	21.4	40.7	74.8	88.5	139.7	24.6	46.7	79.2	92.5	199.3	31.0	59.1	104.5	122.8	239.1	32.0	60.8	107.6	145.3	348.9	37.5	70.7	128.3	192.9	540.3
15.0	16.0	30.5	56.2	64.7	109.0	20.2	38.4	70.5	83.4	130.6	23.2	44.4	75.4	89.0	186.2	29.3	55.7	99.4	118.1	223.5	30.3	57.3	102.2	141.1	326.0	35.5	66.7	121.9	188.5	504.9
15.5	15.2	28.8	53.3	61.6	102.0	19.1	36.3	66.7	78.8	122.3	21.9	42.0	71.8	85.5	174.4	27.7	52.7	94.6	113.4	209.3	28.6	54.2	97.3	136.8	305.3	33.6	63.1	115.9	183.9	472.8
16.0	14.4	27.3	50.4	58.7	95.8	18.1	34.4	63.1	74.6	114.8	20.8	39.7	68.5	82.0	163.7	26.3	49.9	90.2	108.7	196.4	27.2	51.3	92.8	132.5	286.5	31.9	59.8	109.8	179.3	443.7
16.5	13.6	25.9	47.8	56.0	90.0	17.2	32.7	59.8	70.7	107.9	19.7	37.6	65.4	78.4	153.9	25.0	47.3	86.1	104.0	184.7	25.8	48.7	88.6	128.2	269.4	30.3	56.8	104.1	174.8	417.2
17.0	13.0	24.6	45.4	53.3	84.8	16.3	31.0	56.8	67.2	101.6	18.7	35.7	62.6	75.0	145.0	23.7	45.0	82.3	99.4	174.0	24.5	46.3	84.6	124.0	253.8	28.8	54.0	98.9	170.1	393.1
17.5	12.3	23.4	43.1	50.7	80.0	15.5	29.6	54.1	63.9	95.9	17.8	34.0	60.0	71.9	136.8	22.6	42.8	78.8	95.2	164.2	23.4	44.1	81.0	119.7	239.5	27.5	51.4	94.0	165.5	370.9
18.0	11.8	22.3	41.1	48.3	75.7	14.8	28.2	51.5	60.9	90.7	17.0	32.4	57.5	69.0	129.3	21.5	40.8	75.1	91.3	155.2	22.3	42.0	77.2	115.5	226.4	26.3	49.1	89.6	160.9	350.6

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – LAPPED INTERNAL SPANS

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 150/12					DHS 150/15					DHS 200/12					DHS 200/15					DHS 200/18					DHS 250/13				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0																														
3.5																														
4.0	51.1	70.8	80.1	87.4	605.3	70.9	99.5	112.6	123.0	755.5	67.5	83.8	90.7	96.6	1319.9															
4.5	43.4	65.6	76.6	85.5	478.2	59.0	92.1	107.7	120.4	596.9	60.8	79.8	88.2	95.4	1042.8															
5.0	37.1	60.3	73.0	83.5	387.4	49.5	84.5	102.5	117.5	483.5	54.1	75.5	85.4	94.1	844.7	76.2	106.6	120.5	132.9	1057.3	98.7	140.6	159.2	175.8	1264.2	77.3	99.7	108.9	117.6	1706.9
5.5	31.5	54.9	69.1	81.3	320.1	42.3	76.9	97.1	114.5	399.6	47.5	71.1	82.4	92.7	698.1	66.8	100.3	116.3	130.9	873.8	85.1	132.2	153.6	173.2	1044.7	70.1	95.4	106.1	116.5	1410.7
6.0	27.2	49.6	65.2	79.0	269.0	36.7	68.7	91.5	111.2	335.7	41.8	66.5	79.3	91.2	586.6	58.2	93.9	111.9	128.8	734.2	73.7	123.7	147.8	170.4	877.9	63.0	90.9	103.2	115.2	1185.3
6.5	23.8	44.4	61.2	76.6	229.2	32.3	60.5	85.8	107.7	286.1	37.1	62.0	76.1	89.6	499.8	50.9	87.4	107.4	126.5	625.6	64.7	115.0	141.7	167.3	748.0	56.1	86.2	100.1	113.9	1010.0
7.0	21.1	39.7	57.1	74.0	197.6	28.7	53.4	80.0	104.1	246.7	33.2	57.4	72.8	87.9	430.9	45.0	80.9	102.7	124.1	539.4	57.4	105.7	135.4	164.1	645.0	50.2	81.5	96.8	112.5	870.8
7.5	18.9	35.7	53.1	71.4	172.1	25.8	47.6	74.2	100.3	214.9	29.9	52.8	69.4	86.1	375.4	40.1	74.5	97.9	121.6	469.9	51.4	96.2	129.0	160.7	561.8	45.2	76.7	93.4	110.9	758.6
8.0	17.0	31.9	49.1	68.6	151.3	23.4	42.8	67.8	96.4	188.8	26.8	48.3	65.9	84.2	329.9	36.1	68.1	93.0	118.9	413.0	46.1	86.9	122.5	157.2	493.8	41.0	71.8	89.9	109.3	666.7
8.5	15.4	28.8	45.1	65.9	134.0	21.3	38.8	61.6	92.5	167.3	24.2	44.2	62.4	82.2	292.2	32.8	62.2	88.1	116.1	365.8	41.5	78.6	115.9	153.5	437.4	37.4	67.0	86.4	107.7	590.6
9.0	14.1	26.2	41.4	63.0	119.5	19.6	35.4	55.9	88.4	149.2	22.0	40.6	58.9	80.2	260.7	29.9	56.4	83.1	113.3	326.3	37.7	71.5	109.1	149.7	390.1	34.3	62.3	82.8	105.9	526.8
9.5	13.0	23.9	38.2	60.2	107.3	18.1	32.4	51.1	84.3	133.9	20.1	37.5	55.5	78.1	234.0	27.3	51.5	78.2	110.3	292.9	34.3	65.5	101.8	145.7	350.1	31.2	57.6	79.1	104.1	472.8
10.0	12.0	22.0	35.1	57.3	96.8	16.8	29.9	47.0	80.2	120.8	18.5	34.8	52.1	76.0	211.1	25.0	47.3	73.4	107.3	264.3	31.4	60.3	94.6	141.7	316.0	28.5	53.3	75.4	102.3	426.7
10.5	11.1	20.3	32.3	54.4	87.8	15.6	27.7	43.4	76.0	109.6	17.1	32.3	48.6	73.8	191.5	23.0	43.6	68.5	104.2	239.7	28.9	55.7	87.6	137.5	286.6	26.2	49.5	71.7	100.3	387.0
11.0	10.4	18.8	29.9	51.5	80.0	14.6	25.7	40.2	71.5	99.9	15.9	30.1	45.4	71.6	174.5	21.3	40.4	64.0	101.1	218.4	26.7	51.8	81.1	133.3	261.1	24.2	46.2	68.1	98.3	352.6
11.5	9.7	17.5	27.7	48.7	73.2	13.3	24.0	37.4	66.9	91.4	14.8	27.9	42.5	69.3	159.6	19.7	37.6	59.5	97.9	199.8	24.7	48.3	75.4	129.0	238.9	22.4	43.2	64.4	96.3	322.6
12.0	9.1	16.4	25.8	45.8	67.2	12.2	22.5	34.9	62.3	83.9	13.8	26.0	40.0	67.0	146.6	18.3	35.1	55.4	94.6	183.5	23.0	45.1	70.3	124.7	219.4	20.8	40.5	60.9	94.2	296.3
12.5	8.6	15.3	24.1	43.0	61.9	11.3	21.2	32.7	58.0	77.3	12.8	24.3	37.6	64.7	135.1	17.1	32.8	51.7	91.4	169.1	21.4	42.3	65.8	120.3	202.2	19.4	38.1	57.2	92.1	273.1
13.0	8.1	14.4	22.6	40.5	57.3	10.4	19.9	30.8	54.2	71.5	12.0	22.7	35.5	62.4	124.9	16.0	30.8	48.4	88.1	156.4	20.0	39.6	61.7	115.9	187.0	18.1	35.9	54.0	90.0	252.5
13.5	7.7	13.6	21.3	38.2	53.1	9.7	18.8	29.0	50.7	66.3	11.3	21.3	33.6	60.1	115.8	15.0	29.0	45.5	84.8	145.0	18.7	37.1	58.1	111.5	173.4	17.0	33.7	51.0	87.8	234.1
14.0	7.3	12.8	20.0	36.0	49.4	9.0	17.9	27.4	47.6	61.6	10.6	20.1	31.8	57.8	107.7	14.0	27.4	42.8	81.5	134.8	17.5	34.9	54.8	106.4	161.2	16.0	31.7	48.3	85.6	217.7
14.5						8.4	17.0	25.9	44.7	57.4	10.0	19.0	30.1	55.5	100.4	13.2	25.9	40.4	78.2	125.7	16.4	32.8	51.8	101.5	150.3	15.0	29.8	45.8	83.3	202.9
15.0						7.8	16.1	24.6	42.2	53.7	9.4	18.0	28.4	53.2	93.8	12.5	24.6	38.3	75.0	117.4	15.3	31.0	49.2	96.6	140.4	14.2	28.1	43.5	81.1	189.6
15.5											8.9	17.0	26.9	51.0	87.9	11.8	23.3	36.3	71.7	110.0	14.3	29.3	46.6	91.8	131.5	13.4	26.5	41.4	78.9	177.6
16.0											8.4	16.2	25.5	48.7	82.4	11.1	22.1	34.5	68.4	103.2	13.4	27.7	44.1	86.9	123.4	12.7	25.1	39.5	76.6	166.6
16.5											8.0	15.4	24.2	46.5	77.5	10.5	21.0	32.8	65.3	97.0	12.6	26.3	41.8	82.4	116.0	12.1	23.8	37.7	74.3	156.7
17.0											7.6	14.7	23.0	44.5	73.0	10.0	19.9	31.3	62.3	91.4	11.9	25.0	39.8	78.2	109.3	11.5	22.6	36.0	72.1	147.6
17.5											7.2	14.0	22.0	42.6	68.9	9.5	18.9	29.9	59.2	86.3	11.2	23.8	37.8	74.4	103.2	10.9	21.5	34.4	69.8	139.3
18.0																8.9	18.0	28.6	56.4	81.5	10.6	22.6	36.1	70.9	97.5	10.4	20.5	32.8	67.6	131.7

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.8 DHS LOAD SPAN TABLES – LAPPED INTERNAL SPANS

Axial compression capacities (kN) $f_c N_c$

Span (m)	DHS 250/15					DHS 250/18					DHS 300/15					DHS 300/18					DHS 350/18					DHS 400/20				
	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex	1B	2B	3B	FR	ØcNex
3.0																														
3.5																														
4.0																														
4.5																														
5.0																														
5.5	87.2	118.8	132.2	145.1	1627.3	114.6	157.0	174.9	192.1	1949.9	107.0	134.1	145.1	155.7	2780.4															
6.0	78.3	113.2	128.6	143.6	1367.4	102.6	149.5	170.0	190.1	1638.5	99.0	129.5	142.1	154.5	2336.3															
6.5	69.6	107.4	124.7	141.9	1165.1	90.2	141.7	164.8	187.9	1396.1	91.0	124.6	138.9	153.3	1990.7															
7.0	62.2	101.4	120.6	140.2	1004.6	79.2	133.7	159.3	185.6	1203.8	83.0	119.5	135.6	152.0	1716.5	109.6	158.3	179.8	201.5	2059.8	112.9	163.6	185.9	212.0	3005.0					
7.5	56.0	95.4	116.4	138.3	875.1	70.3	125.6	153.7	183.1	1048.6	75.1	114.3	132.1	150.6	1495.2	99.1	151.4	175.1	199.7	1794.3	101.9	156.3	181.1	210.5	2617.7					
8.0	50.2	89.4	112.0	136.3	769.1	62.9	117.5	147.9	180.5	921.6	68.3	109.0	128.5	149.1	1314.2	89.9	144.3	170.3	197.7	1577.0	92.5	148.9	176.1	208.9	2300.7	109.5	179.3	212.8	257.1	3562.6
8.5	45.2	83.4	107.6	134.3	681.3	56.7	109.4	141.9	177.8	816.4	62.4	103.6	124.7	147.5	1164.1	82.1	137.1	165.3	195.7	1396.9	84.4	141.5	170.8	207.3	2038.0	98.5	170.1	206.3	255.5	3155.8
9.0	40.9	77.4	103.1	132.1	607.7	51.4	101.4	135.9	174.9	728.2	57.3	98.2	120.9	145.9	1038.3	74.9	129.9	160.2	193.5	1246.0	77.0	133.9	165.5	205.5	1817.8	89.3	160.8	199.7	253.8	2814.9
9.5	37.3	71.4	98.5	129.9	545.4	46.8	93.0	129.8	171.9	653.5	52.9	92.8	116.9	144.2	931.9	68.1	122.7	154.9	191.2	1118.3	70.1	126.4	160.0	203.7	1631.5	81.4	151.6	193.0	252.0	2526.3
10.0	34.1	66.1	93.9	127.5	492.2	42.9	85.0	123.6	168.8	589.8	49.0	87.4	112.9	142.4	841.1	62.4	115.5	149.6	188.9	1009.3	64.1	118.9	154.5	201.8	1472.4	74.5	142.3	186.1	250.1	2280.0
10.5	31.4	61.4	89.3	125.1	446.5	39.5	78.1	117.4	165.7	535.0	45.5	82.1	108.9	140.5	762.9	57.3	108.3	144.2	186.4	915.4	58.9	111.5	148.8	199.8	1335.5	68.6	133.2	179.2	248.2	2068.0
11.0	29.0	57.2	84.7	122.7	406.8	36.5	72.0	111.2	162.4	487.4	42.1	76.7	104.8	138.6	695.1	52.9	101.1	138.7	183.9	834.1	54.4	104.1	143.1	197.7	1216.9	63.4	124.1	172.1	246.1	1884.3
11.5	26.8	53.3	80.1	120.1	372.2	33.8	66.7	105.0	159.0	446.0	39.0	71.8	100.6	136.6	635.9	49.0	94.6	133.2	181.3	763.1	50.4	97.4	137.4	195.5	1113.4	58.8	116.0	165.1	244.0	1724.0
12.0	25.0	49.5	75.6	117.6	341.8	31.5	62.0	98.9	155.6	409.6	36.2	67.4	96.5	134.6	584.0	45.6	88.8	127.7	178.6	700.9	46.9	91.3	131.6	193.3	1022.5	54.7	107.8	158.0	241.8	1583.3
12.5	23.3	46.1	71.1	114.9	315.0	29.4	57.8	92.4	152.1	377.5	33.8	63.5	92.4	132.5	538.3	42.5	83.5	122.2	175.9	645.9	43.8	85.8	125.9	191.0	942.3	51.1	100.5	150.9	239.6	1459.2
13.0	21.8	43.1	67.0	112.2	291.2	27.5	54.0	86.3	148.5	349.0	31.6	59.9	88.3	130.4	497.6	39.8	78.7	116.7	173.0	597.2	40.9	80.9	120.2	188.7	871.2	47.8	93.9	143.9	237.2	1349.1
13.5	20.4	40.3	63.3	109.5	270.1	25.8	50.6	80.8	144.9	323.6	29.6	56.6	84.2	128.2	461.5	37.3	73.8	111.2	170.2	553.8	38.4	75.8	114.5	186.3	807.9	44.9	88.0	136.9	234.8	1251.0
14.0	19.2	37.9	59.9	106.8	251.1	24.2	47.6	75.8	141.3	300.9	27.8	53.6	80.1	125.9	429.1	35.0	69.2	105.7	167.2	514.9	36.1	71.2	108.8	183.8	751.2	42.3	82.7	129.8	232.4	1163.3
14.5	18.1	35.6	56.7	104.0	234.1	22.8	44.8	71.3	137.6	280.5	26.2	50.9	76.1	123.7	400.0	33.0	65.1	100.3	164.2	480.0	34.1	67.0	103.2	181.3	700.3	39.9	77.8	123.1	229.9	1084.4
15.0	17.1	33.6	53.8	101.2	218.7	21.5	42.3	67.3	133.8	262.1	24.7	48.3	72.4	121.4	373.8	31.2	61.4	95.4	161.2	448.5	32.2	63.2	98.1	178.7	654.4	37.7	73.4	116.9	227.3	1013.3
15.5	16.1	31.8	50.8	98.4	204.9	20.4	40.0	63.6	130.1	245.5	23.3	46.0	68.9	119.0	350.0	29.5	58.1	90.8	158.1	420.1	30.4	59.7	93.4	176.1	612.8	35.7	69.5	110.7	224.7	949.0
16.0	15.3	30.1	48.1	95.6	192.2	19.3	37.9	60.2	126.3	230.4	22.1	43.8	65.8	116.7	328.5	28.0	55.0	86.6	155.0	394.2	28.9	56.5	89.0	173.5	575.1	33.9	65.8	104.7	222.0	890.6
16.5	14.5	28.5	45.6	92.8	180.8	18.3	35.9	57.1	122.5	216.6	21.0	41.5	62.8	114.3	308.9	26.5	52.1	82.6	151.8	370.7	27.4	53.6	85.0	170.8	540.8	32.2	62.5	99.3	219.2	837.4
17.0	13.8	27.1	43.2	89.9	170.3	17.4	34.2	54.2	118.8	204.1	19.9	39.4	60.1	111.9	291.0	25.2	49.5	79.0	148.6	349.2	26.1	51.0	81.2	168.0	509.5	30.6	59.4	94.3	216.4	788.9
17.5	13.1	25.8	41.1	87.1	160.7	16.5	32.5	51.6	115.0	192.6	19.0	37.5	57.6	109.5	274.6	24.0	47.1	75.2	145.4	329.5	24.8	48.5	77.3	165.2	480.8	29.2	56.6	89.7	213.6	744.5
18.0	12.5	24.6	39.2	84.3	151.9	15.8	31.0	49.2	111.2	182.0	18.1	35.7	55.2	107.0	259.5	22.9	44.9	71.6	142.2	311.5	23.7	46.2	73.6	162.4	454.4	27.9	53.9	85.5	210.7	703.7

1. 1B, 2B & 3B: Load Capacity for 1, 2 and 3 rows of bracing. **2.** FR: Load Capacity for fully restrained compression flange. **3.** $f_c N_{ex}$: Elastic buckling capacity about the x-x axis.

2.3.9 DESIGN OF BRACING SYSTEMS

2.3.9.1 INTRODUCTION

Dimond Fastbrace is the preferred bracing system for use with the DHS system for members up to and including DHS 300/18. Continuous bolted channel bracing must be used for DHS 350/18 and DHS 400/20, and it may be used on all other sizes.

We do not recommend the use of brace channel and alternating sag rods as the load capacities for DHS purlins provided in Sections 2.3.7 and 2.3.8 will not necessarily be achieved.

Specific design of the bracing system is required where bracing is used to support additional loads (other than providing rotational and lateral restraint to the purlins), for example sprinkler pipes or ducting. For further advice contact Dimond on 0800 ROOFSPEC.

All purlin configurations outlined in this manual require a minimum of one bracing line per bay to achieve the published loads in the load/span tables. Any variation from use of Dimond bracing or its location may result in lower load capacities and/or greater deflections (as purlins may twist out of plane).

Use of Dimond bracing and its compatibility with the load capacities provided in Sections 2.3.7 and 2.3.8 is subject to the following:

1. The Purlins/Girts are bolted to cleats, and lapped members are connected as detailed in Section 2.3.14.
2. The brace length does not exceed 3.20m. For longer lengths, specific design is required as per Section 2.3.9.2. Shortest available fast brace length is 250mm.

2.3.9.2 METHOD FOR BRACE DESIGN CHECK

The bending moment on each brace channel is determined by:

$M^* = 0.75\ f_b w_{bx} l_b m$ if roofing or cladding attachment provides sufficient restraint to the outside flange

or $M^* = 1.5\ f_b w_{bx} l_b m$ if there is no additional restraint to the outside flange.

Where $f_b w_{bx}$ = Uniformly loaded bending capacities from DHS load span tables

$l_b = l \times h$ where l = purlin span, h = contributing length factor from below

m = distance from shear centre to mid plane of DHS purlin web from below.

M^* must not exceed the brace member capacity M_b given below.

Contributing length factor (h)

Span Type	No. of Brace Lines		
	1	2	3
Single	0.50	0.31	0.25
End	0.50	0.31	0.25
Internal	0.50	0.31	0.25
End Lapped	0.475	0.295	0.24
Internal Lapped	0.45	0.28	0.23

Dimension (m)

DHS Member	m (mm)
150/12	33.2
150/15	32.9
200/12	36.3
200/15	35.9
200/18	35.6
250/13	38.3
250/15	38.1
250/18	37.8
300/15	42.8
300/18	42.6
350/18	41.6
400/20	40.1

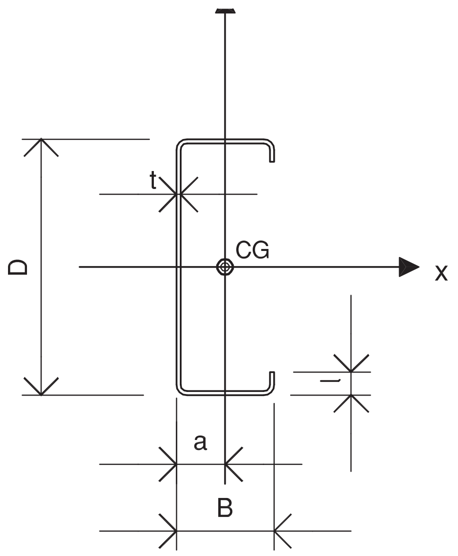
Bracing member moment capacity (M_b)

Maximum Brace Length (m)	less than or equal to 3.2	3.4	3.6	3.8	4.0
M_b (kNm)	0.50	0.48	0.45	0.41	0.38

Notes:

1. For brace lengths less than 3.2m, the brace capacity is limited by cleat connection rather than the brace channel.
2. The moment capacities given above do not apply where additional loads are connected eccentrically to the web of the brace channel. We do not recommend connecting additional loads to the flanges or lips of the brace channel.

2.3.9.3 BRACING CHANNEL SECTION PROPERTIES



Tabulated properties are based on full unreduced sections.

CODE	D x B mm	t mm	Mass kg/m	Weight kN/m	Area mm²	l mm	A mm	I_x ($10^6 mm^4$)	I_y ($10^6 mm^4$)	Z_x ($10^3 mm^3$)	COLUMN PROPERTIES	
											J (mm^4)	I_w ($10^9 mm^6$)
DB 89 / 12	89 x 34	1.15	1.52	0.015	186.3	6	9.17	0.223	0.024	5.002	84.13	0.040

Note: Mass assumes a total coated weight for the zinc coating of 450 g/m²

2.3.10 DESIGN OF CONNECTION SYSTEMS

The following table sets out the bolt connection capacity for the different steel thicknesses used with DHS Purlins when checked for end tearing and bearing. Bolt shear capacities are also included for grade 4.6 and grade 8.8 bolts.

Details of single bolt connection capacities for DHS Purlins and Girts

Bolt dia. (mm)	Failure mode	Steel capacity (kN) for varying steel thicknesses (mm)					Bolt shear fV_{fn} (kN)	
		1.15	1.25	1.45	1.75	1.95	grade 4.6	grade 8.8
12	Tearing fV_f	13.6	14.8	17.2	19.2	21.3		
	Bearing fV_b	12.9	14.0	16.3	18.1	20.2	15.1	31.4
16	Tearing fV_f	13.6	14.8	17.2	19.2	21.3		
	Bearing fV_b	17.2	18.7	21.7	24.2	27.0	28.6	59.3
20	Tearing fV_f	13.6	14.8	17.2	19.2	21.3		
	Bearing fV_b	21.5	23.4	27.1	30.2	33.7	44.6	92.6

Notes:

1. All capacities are in accordance with AS/NZS 4600:1996.
2. Bolts are assumed to comply to AS1111 or AS1252.
3. All connections are assumed to have one washer under each of the bolt head and the nut (or the portal cleat acting as one of the washers).
4. Calculation of tearing capacity assumes a 38mm edge distance.
5. The maximum structural ductility factor used for seismic loads must be less than 1.25.

2.3.11 DESIGN EXAMPLES

2.3.11.1 EXAMPLE: PURLINS, SINGLE AND LAPPED

Loadings
Dead Load, G = 0.12 kPa Live Load, Q = 0.25 kPa Snow Load, S_u = 0.50 kPa
Outward Limit State Wind Loads, W_u = – 0.95 kPa and W_s = – 0.66 kPa
Inward Wind Loading is not significant for this roof.

Building Constraints

Portal Spacing, L_P	= 7.5m	Rafter Length, L_R	= 16.0m (distance from eaves purlin to ridge purlin)
Roof Pitch	= 10 degrees	Roofing Profile	= BB900 x 0.55mm BMT

Critical Design Load Combinations for the Ultimate Limit State (from AS/NZS 1170)

i)	$W^*_{ULS}\downarrow$	=	1.2G + 1.5Q	=	(1.2 x 0.12) + (1.5 x 0.25)	=	0.52 kPa
ii)	$W^*_{ULS}\downarrow$	=	1.2G + S_u + c_cQ	=	1.2 x 0.12 + 0.50 + (0.0 x 0.25)	=	0.64 kPa
iii)	$W^*_{ULS}\uparrow$	=	0.9G + W_u	=	(0.9 x 0.12) + (– 0.95)	=	– 0.84 kPa

Critical Design Load Combinations for the Serviceability Limit State

i)	$W^*_{SLS}\downarrow$	=	L_P/300 under G & c_l Q	=	(0.12 + 0.0 x 0.25) x 300/150	=	0.24 kPa
ii)	$W^*_{SLS}\uparrow$	=	L_P/150 under W_s	=	– 0.66	=	– 0.66 kPa

For i) we have converted the load by a factor of 300/150 in order to compare the load directly with W_s in the DHS load span tables as these are based on span/150.

Optimise Roofing Profile Spans
In this case we have a restricted access roof where the point load requirement limits the intermediate span of the BB900 x 0.55mm BMT profile to 3.0m. End spanning capability of the roofing is reduced to 2.1m, i.e. 70% of the intermediate span. Generally these spans will not 'fit' the rafter length exactly, hence the requirement to optimise.

The optimised roofing profile intermediate span is based on the rafter length and the number of purlins, N_P (assuming at least four) and is given by the term: $L_{RI} = L_{RT} / [N_P – 1.6]$

Try 6 Purlins,	L_{RI} = 16.0/(6 – 1.6)	=	3.64m	No good
Try 8 Purlins,	L_{RI} = 16.0/(8 – 1.6)	=	2.50m	Not controlling
Try 7 Purlins,	L_{RI} = 16.0/(7 – 1.6)	=	2.96m	Intermediate spans and 2.07m edge spans

From this, 7 purlins are required and the purlin spacings may be rationalised to 2.9m intermediate spans and 2.0m spans at the sheet ends.

Continued on next page

2.3.11.1 EXAMPLE: PURLINS, SINGLE AND LAPPED *continued*

1. Single Span Purlin Design

Assuming the top flange of the DHS purlin is restrained by screw-fastened roof sheeting. (If the top flange is not fully restrained then use the load capacity for the 1, 2 or 3 brace case as appropriate to check both uplift and gravity combinations.)

Try DHS 250/18 Purlin

Check design capacities (using those given in the single span DHS load span tables): $W^*_{ULS} \leq f_b W_{bx}$

$W^*_{ULS}\downarrow$	=	2.9 x 0.64	=	1.86 kN/m	< FR, 3.01 kN/m	∴ O.K.
$W^*_{ULS}\uparrow$	=	2.9 x – 0.84	=	– 2.44 kN/m	< 2 Braces, 3.01 kN/m	∴ O.K.

Check deflections

$W^*_{SLS}\uparrow$	=	2.9 x – 0.66	=	–1.91 kN/m	< W_s, 1.94 kN/m	∴ O.K.

Therefore use DHS 250/18 purlins at 2.9m intermediate spacings and 2.0m at sheet ends, with 2 rows of Fastbrace (or standard bolted DB89/12 braces) brace channels per bay.

2. Lapped Span Purlin Design

a) End Bays

Try DHS 200/18 Purlin

Check design capacities (using those given in the lapped end span DHS load span tables):

$W^*_{ULS} \leq f_b W_{bx}$

$W^*_{ULS}\downarrow$	=	2.9 x 0.64	=	1.86 kN/m	< FR, 2.76 kN/m	∴ O.K.
$W^*_{ULS}\uparrow$	=	2.9 x – 0.84	=	– 2.44 kN/m	< 1 Brace, 2.76 kN/m	∴ O.K.

Check deflections

$W^*_{SLS}\uparrow$	=	2.9 x 0.66	=	–1.91 kN/m	< W_s, 2.68 kN/m	∴ O.K.

b) Internal Bays

Try DHS 200/15 Purlin

Check design capacities (using those given in the lapped internal span DHS load span tables):

$W^*_{ULS} \leq f_b W_{bx}$

$W^*_{ULS}\downarrow$	=	2.9 x 0.64	=	1.86 kN/m	< FR, 3.49 kN/m	∴ O.K.
$W^*_{ULS}\uparrow$	=	2.9 x – 0.84	=	– 2.44 kN/m	< 1 Brace, 3.49 kN/m	∴ O.K.

Check deflections

$W^*_{SLS}\uparrow$	=	2.9 x 0.66	=	–1.91 kN/m	< W_s, 4.84 kN/m	∴ O.K.

Therefore use,

End Bays: DHS 200/18 purlins at 2.9m intermediate spacings and 2.0m at sheet ends, with 1 row of Fastbrace (or standard bolted DB89/12 braces) brace channels per bay.

Internal Bays: DHS 200/15 as per the end bay purlin spacings and bracing layout.

In the calculation of wall elements, optimisation follows the same logic as illustrated for roofing with the exception that foot traffic limitations do not apply, leaving the spanning ability of the cladding dependent on face loads caused by wind.

2.3.11.2 DEFLECTION CHARACTERISTICS

a) The W_s loading for a DHS 250/18 purlin on a 9.0m single span is 1.13 kN/m. It is desired to limit the DHS purlin deflection to span/200.

Therefore the serviceable load in the DHS purlin at a deflection of span/200 is expressed as:

$$\frac{1.13 \text{ x } 150}{200} = 0.85 \text{ kN/m}$$

b) The design Linear Load for deflection of a DHS 250/18 on a 9.0m single span has been calculated as 0.94 kN/m.

The relative deflection is shown as, $\frac{0.94 \text{ x span}}{1.13 \text{ x } 150} = \frac{\text{span}}{180}$

The actual deflection is then, $\frac{\text{span}}{180} = \frac{9000 \text{ mm}}{180} = 50\text{mm}$

2.3.11.3 COMBINED BENDING AND COMPRESSION

There are three equations governing the design for combined bending and compression. Assuming there is no minor axis component for flexure, where $N^*/\text{f}_c N_c \leq 0.15$.

Using the purlin example, option 2 for a DHS 200/18 on a 7.5m lapped end span with 1 brace, the DHS purlin is required to resist a 4.0 kN axial load (resulting from wind on the end wall) in addition to the $W^*_{ULS}\uparrow$ load combination. The remaining axial capacity is checked given the known flexural loads:

W_x^*	=	2.44 kN/m	(Design uniformly distributed bending load; $W^*_{ULS}\uparrow$)
$\text{f}_b W_{bx}$	=	2.76 kN/m	(Uniformly loaded bending capacity from load span tables)
N^*	=	4 kN	(Design axial compressive load as calculated)
$\text{f}_c N_c$	=	48.08 kN	(Axial compression capacity from loan/span tables)

Solving for N^*,

$$N^* = \left(1 - \frac{W_x^*}{\text{f}_b W_{bx}}\right) \text{f}_c N_c$$ (solving equation 1 in section 2.3.3)

$$= \left(1 - \frac{2.44}{2.76}\right) .48.08 = 5.57 \text{ kN} > 4.0 \text{ kN} \therefore \text{ O.K.}$$

Check $N^*/\text{f}_c N_c \leq 0.15$ for the above formula to remain valid: 5.57/48.08 = 0.12 $\therefore$ O.K.

If the above formula is not valid, i.e. $N^*/\text{f}_c N_c > 0.15$, then N^* needs to be solved to satisfy whichever of the following equations gives the lowest N^* value.

$$\frac{N^*}{\text{Ý}_c N_c} + \frac{C_{mx} W_x^*}{\text{Ý}_b W_{bx} \text{Ů}_{nx}} \leq 1.0$$ (solving equation 2 in section 2.3.3)

$$N^* = \left(1 - \frac{W_x^*}{\text{f}_b W_{bx}}\right) \text{f}_c N_s$$ (solving equation 3 in section 2.3.3)

2.3.11.4 EXAMPLE: BOLT SIZING

Taking the previous purlin example option 1 where we have a single span DHS 250/18 purlin spaced at 2.9m apart, with 2 rows of bracing.

Critical load combination (ULS) = 0.84 kPa

This converts to design shear force at the supports, V^* = 0.84 x 2.9 x 7.5/2 = 9.14 kN per end connection.

As there are 2 bolts at each end V^* = 9.14/2 = 4.57 kN per bolt.

From the connection capacities given in Section 2.3.10 for 1.75m thickness.

Try 12mm diameter bolts

End tearing	f V_f	=	19.2 kN per bolt	
Bearing	f V_b	=	18.1 kN per bolt	
Bolt shear	f V_{fn}	=	15.1 per grade 4.6 bolt > 4.57	∴ O.K.

2.3.11.5 EXAMPLE: SPECIFIC BRACE DESIGN

Consider a design case with purlin span 10m.
Ultimate uplift design load 1 kPa.
Desired purlin spacing 3.6m on internal spans.

Proposed purlin design
DHS 300/18 on internal lapped spans. 1 row bracing using Fastbrace.
Design load = 1 kPa x 3.6m = 3.6 kN/m
This is less than $f_b w_{bx}$ = 3.85 kN/m from DHS load span tables. ∴ O.K.

Check brace capacity.
From Section 2.3.9.2.
Bending moment on the brace channel.
M* = 0.75 $f_b w_{bx}$ l_b m, assuming screw fixings of the roof sheets will restrain the top flange, where $f_b w_{bx}$ is the purlin capacity. (Note: The designer may choose to use the design load instead of $f_b w_{bx}$, although it is recommended that brace strength is designed to match the purlin capacity.)

In this example, use $f_b w_{bx}$ = 3.85 kN/m.
1_b = 10 x 0.5m (contributing length factor table)
m = 42.6mm (distance from shear centre to mid plane table)
Therefore, M* = 0.75 x 3.85 x 5 x 0.0426
= 0.61 kNm
Brace member moment capacity
M_b= 0.45 kN/m < 0.61 kN/m (bracing member moment capacity table)
Therefore, either reduce purlin spacing or use 2 rows bracing.

Check for 2 rows bracing
l_b = 10 x 0.31 (contributing length factor table)
M* = 0.75 x 3.85 x 3.1 x 0.0426 = 0.38 kN/m < 0.45 kNm. ∴ O.K.

2.3.12 OPTIMISATION

Introduction

Dimond offers a roofing/purlin optimisation service for engineers and specifiers. Given the site variables and design constraints relating to a building, the most cost effective Dimond roofing/purlin combination can be generated.

This service may be used in the conceptual design phase to assist your forward planning and/or at the detailed design phase as you finalise the design. For further information fill out the Optimisation Form in this section or visit our website www.dimond.co.nz and view under the Architects and Specifiers section.

Terms of Use

It is intended that the design engineer check, detail and make amendments as necessary in order to approve the design for construction and to ensure compliance with the relevant codes of practice in relation to building.

Benefits

The roofing/purlin optimisation service has the following benefits:

- Allows a cross-check on design from a reliable, trusted source.
- Provides the most structurally efficient and economical roofing/purlin solution.
- Helps finalise purlin sizes and roof selection early in the design process.
- Reduces risk of unforeseen design issues later in the project, for example step detailing for roof lengths greater than 25m.
- Enables timely coordination of the material availability for the project minimising time delays and programming issues.

2.3.12.1 OPTIMISATION SERVICE FAX FORM

To: Dimond,

Attention: **ROOFING/PURLIN OPTIMISATION SERVICE**

From: .... (Design Engineer)

Company: ....

Telephone: .... Facsimile: ....

Job Name/Location: ....

Code Variables to AS/NZS 1170

Terrain Category: .... Internal Pressure Coefficients: ....

Wind Region: .... Dead Load: ....

Elevation (above sea level): .... Live Load: ....

Misc. Code Multipliers: .... Snow Load: ....

Purlin Deflection Limit and Loading Regime: ....

Geometry

Building Type: Gable ☐ Monoslope ☐ Other (sketch) ☐ Bay Centre Options: ....

Overall Dimensions .... Preferred Purlin Centres Max:............. Min:..............

Roof Pitch: .... Purlin Size Limitation: ....

Ridge Height: .... Roofing Profile Options: ....

Foot Traffic Requirements for Roofing

Service Category	Description	(please tick)
1. Unrestricted-access roof	Expect regular foot traffic to access the roof for maintenance work and able to walk anywhere on the roof. No congregation of foot traffic expected.	☐
2. Restricted-access roof	Expect occasional foot traffic educated to walk only on the purlin lines, in the profile pans, or carefully across two profile ribs. Walkways installed where regular traffic is expected, and "Restricted Access" signs placed at access points.	☐

Sketches and Comments

2.3.13 DHS MATERIAL SPECIFICATION

Dimond Hi-Span Purlins are manufactured by roll forming galvanised steel coil produced to AS 1397:2001.

		Base Metal Thickness, BMT (mm)	Steel Grade	Yield Strength, f_y (MPa)	Standard Zinc Weight, Z (g/m^2)
DHS Purlins and Girts		< 1.5	G500	500	Z 275
		> 1.5	G450	450	Z 275
Tolerances	Depth	+/– 2mm			
	Width	+/– 2mm			
	Hole Centres	+/– 1.5mm			
	Length	+/– 6mm			
	Web/Flange Angle	89-93 degrees			

Z 450 zinc weight coil can be supplied with order lead times of up 12 weeks. Please discuss with Dimond on 0800 775 777.

2.3.14 SHORT FORM SPECIFICATION – DHS PURLINS AND GIRTS

The purlin system will be Dimond DHS **(1)**, manufactured from G450-G500 grade steel with a **(2)** g/m^2 galvanised zinc weight.

The sizes, lengths, span configuration and lap lengths (where required) are as detailed on the drawings.

All hole sizes, hole shapes and positions are as shown on the drawings.

The bracing system is to be **(3)**. The bracing channel size is 89mm x 1.2 thick galvanised with a **(2)** galvanised zinc weight.

All bolts to be **(4)** grade, **(5)** diameter, **(6)** finish.

Choose from

(1) 150/12, 150/15, 200/12, 200/15, 200/18, 250/13, 250/15, 250/18, 300/15, 300/18, 350/18, 400/20

(2) Z 275 or Z 450

(3) Fastbrace or bolted channel bracing

(4) 4.6 or 8.8

(5) 12mm or 16mm

(6) Electro galvanised or hot dip galvanised.

2.3.15 DHS COMPONENTS

2.3.15.1 FASTBRACE

Product Description
Fastbrace is a lock-in bracing system which uses cleats with specially shaped lock-in tabs attached to each end of a 89 x 12 bracing channel, for use with DHS purlins up to and including DHS 300 series.

Pairs of Fastbrace are fitted from each side of the DHS purlin through prepunched 18mm diameter round bracing holes and are locked together, minimising erection time.

When a line of Fastbrace has been installed, the system provides resistance to restrict lateral movement of the DHS purlin and also supports the purlin flange.

Limitations for Use
The end brace at the first and last bracing points is secured using the standard bolted connection on the outermost cleat end.

To ensure straight alignment of the bracing system, the bracing holes can be offset by 25mm over the last purlin spacing to accommodate a bolted cleat. If this is not achieved, an angle of less than 2 degrees from a straight alignment is created, which in most cases is negligible and acceptable.

At the ridge, the lower bolt position is used to tie the bracing lines each side together using a sag rod.

Where back to back DHS purlins are used, bolted end brace components are required each side.

The durability of zinc coated products is dependent on the environment it will be used in, the grade of the zinc coating and the amount of maintenance that will be carried out over the life of the product. Refer Section 2.1.3 Environments for further guidelines.

Maintenance
Must be carried out in accordance with Section 2.1.6 Maintenance.

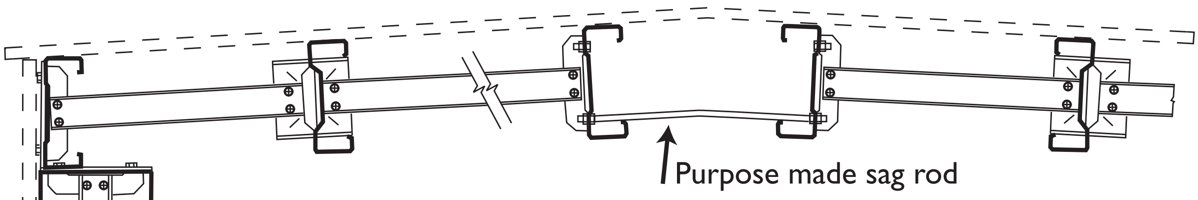
Handling and Storage
The Fastbrace system is delivered to site, usually strapped together, marked in bundles for installing in the same area of the roof structure. Refer to Section 2.6.2 Handling and Storage.

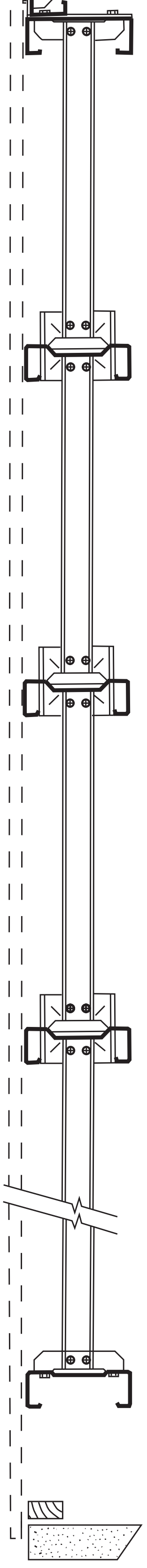
Material Specification

	Base metal thickness (BMT) (mm)	Steel grade	Yield strength f_y (MPa)	Standard zinc weight Z (g/m^2)
Bracing channel	1.15	G250	250	450
End cleats	2.00	G250	250	450

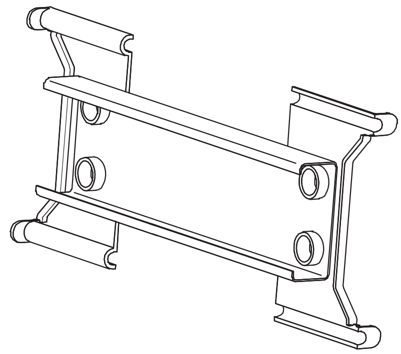
Tolerances:	Length	±	2mm
	Depth	±	1mm
	Width	±	1mm
	Web/flange angle		89 to 93 degrees

2.3.15.1 FASTBRACE *continued*

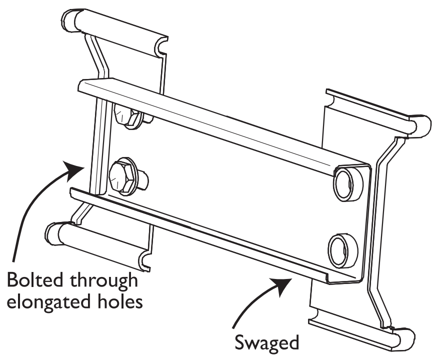




General Arrangement of the Fastbrace System

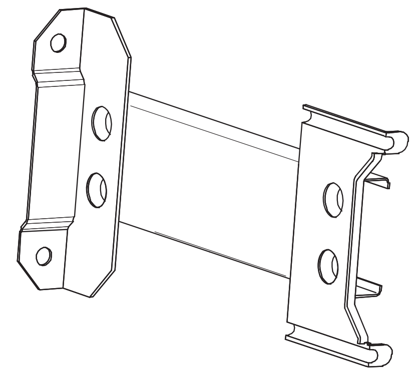


Standard Brace ➔
This is the standard Fastbrace component used almost everywhere in the system. It locks into other standard brace components, adjustable brace components, or end brace components.

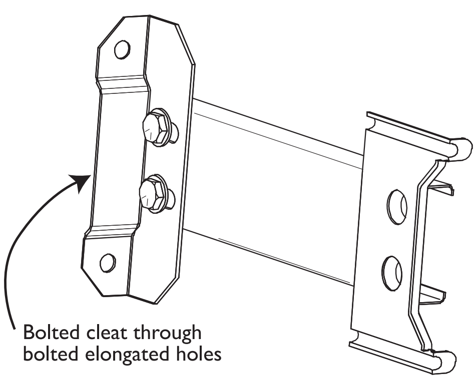


Adjustable Brace
This is the adjustable component in the Fastbrace system and is used where some level of adjustment on the purlin line is required. The purlin is adjusted into line and the 12mm diameter hex flange bolts on the brace tightened. The adjustable brace offers up to 20mm of adjustment.

End Brace ➔
End brace is used at the end of a purlin bracing line, i.e. eaves or ridge, each side of a roof step, or at top and bottom girts on a wall. The end brace locks into either standard or adjustable brace at one end and is twisted between the purlin lips and bolted into position at the other end.



Adjustable End Brace ➔
Where the end purlin spacing is less than 800mm, an adjustable end brace with a bolted end cleat is available, as twisting of the end cleat is not practical. The adjustable cleat can be rotated up to 15 degrees from normal, to accommodate the change in angle from vertical portal to the roof slope of the rafter.



2.3.15.2 BOLTED CHANNEL BRACING

Product Description
The Dimond bolted channel bracing system uses cleats, clinched at each end of a 89 x 12 bracing channel, which are fastened through the DHS purlin with two bolts each end. Bolted channel bracing is used with the full DHS purlin range (DHS 150 to DHS 400 series).

This system uses bolted channel bracing between all purlins in the bracing line. Refer Section 2.3.9.1 for design basis.

At the ridge, the lower hole position is used to tie the bracing lines each side together using a sag rod.

Limitations for Use
The durability of zinc coated products is dependent on the environment it will be used in, the grade of the zinc coating and the amount of maintenance that will be carried out over the life of the product. Refer Section 2.1.3 Environments for further guidelines.

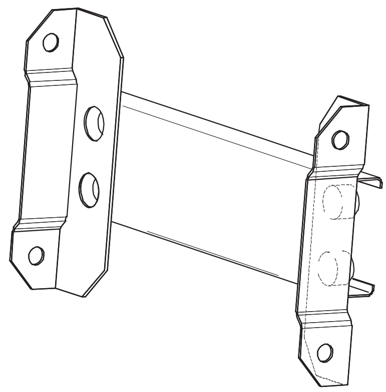
Maintenance
Must be carried out in accordance with Section 2.1.6 Maintenance.

Handling and Storage
The channel bracing system is delivered to site, usually strapped together, marked in bundles for installing in the same area of the roof structure. Refer to Section 2.6.2 Handling and Storage.

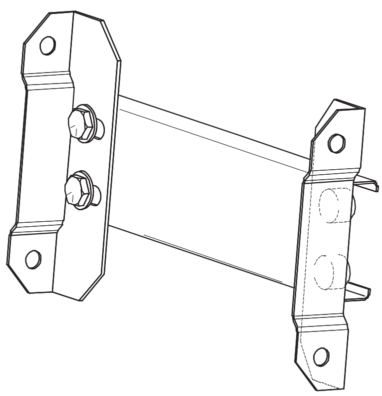
For the material specifications of the bracing refer to Section 2.3.15.1.

Components

Bolted Channel Brace
This is the standard component used in the bolted channel bracing system and is used almost everywhere.



Adjustable Bolted Channel Brace
This is the adjustable component in the bolted channel bracing system and is used where some level of adjustment on the purlin line is required. The purlin is adjusted into line and the 12mm diameter hex flange bolts on the brace tightened. The adjustable brace offers up to 20mm of adjustment.



Dimond

2.3.15.3 PORTAL CLEATS

These are typically supplied by the fabricator or installer and welded on to the portal frame. Cleat thicknesses range from 6mm to 12mm thickness. The hole centres are laid out to suit hole punchings in the DHS purlin, refer to Section 2.3.16.3 Hole Locations for details. The cleat height may need to be increased where an expansion step in the roof is detailed.

2.3.15.4 SAG RODS

Alternating sag rods and channel have been superseded by the use of Fastbrace and the bolted channel bracing as the preferred bracing method. However the rods are still used as a cranked sag rod at the ridge to join each side together. Usually supplied by the steel erectors and fabricators in 12mm diameter engineering round bar grade 250 MPa, galvanised or electroplated finishes, with double nuts and washers each end. Where loads require, 16mm diameter engineering round bar can be used.

2.3.15.5 TIMBER STRIP

Timber strip battens are fitted once the netting is in place to avoid roof insulation squashing down, over the purlin, as the roofing is screwed down.

Usually supplied and fixed on site by the fabricator. However Dimond recommend using an ex 50mm x 50mm timber batten or a depth of batten equal to the thickness of the insulation gauged two sides and treated to H3.1 timber preservation such as boric or LOSP (low, organic solvent preservative). The CCA treatment process should be avoided, due to chemical contact with galvanised surface.

The batten is fixed onto the top flange of the DHS Purlins, once the netting or safety mesh has been laid on the structure. Fixings to be 10g – 16 x 75mm. Countersunk rib head – wingtek. The coating finish is a zinc plated AS 3566 class 2 finish. Longer, other types of fixings may need to be considered when the timber depth is greater than 65mm.

Spacing of the wingteks is dependent on the DHS material thickness it is being fixed into. Refer to the following table.

DHS Purlin BMT (mm)	Max. screw centres (mm)
1.15	250
1.25 to 2.0	300

At these centres, the maximum outward load on the nailing strip is 5.0 kN/m.

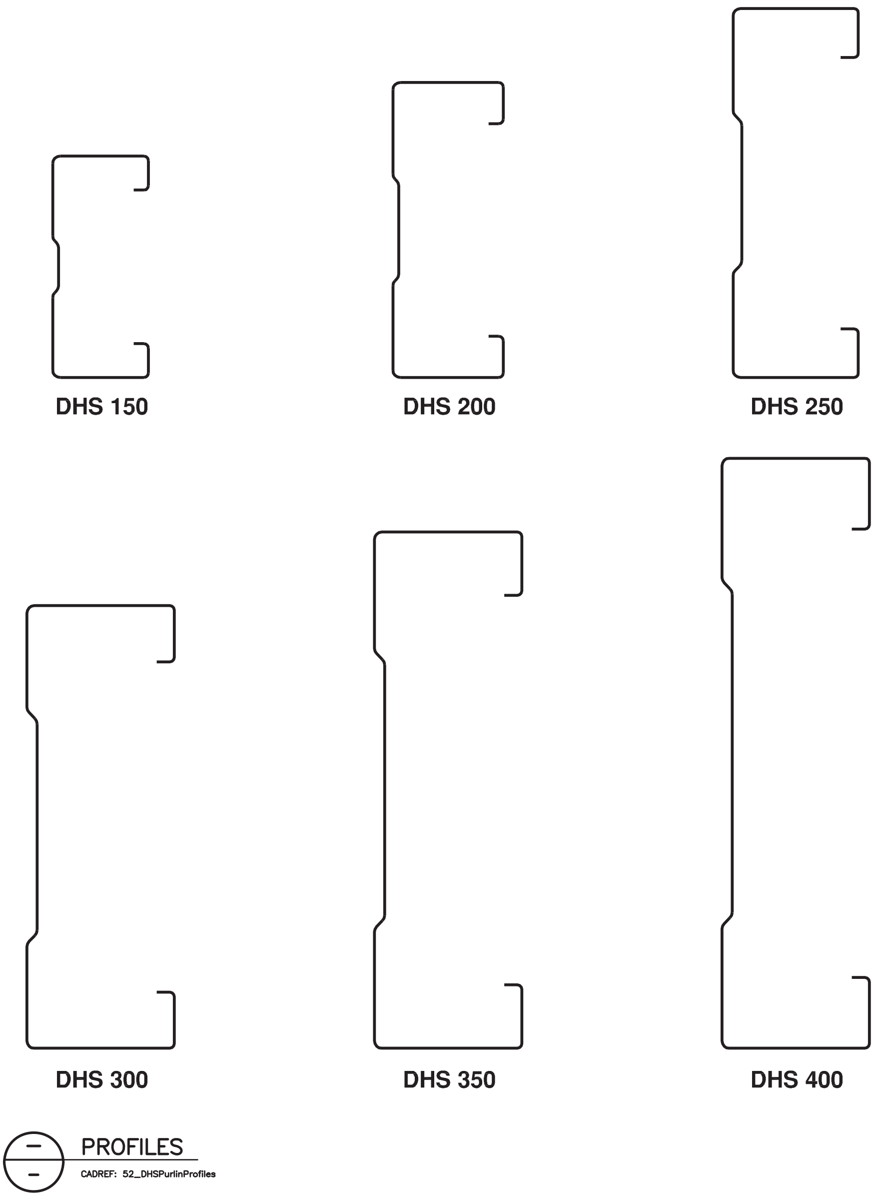
2.3.16 DHS CAD DETAILS

DHS CAD details are shown in this section. For the latest DHS CAD details, please download from the Dimond website **www.dimond.co.nz**. Follow the steps below:

1. Log in to the Architects/Specifiers section.
2. Click on the green "Structural Systems Manual" button.
3. Click on the "Download CAD details" button.
4. Select from product list shown to view CAD details available for that product.

Please note all of these details are to be used as a guide only and are not intended for construction. Specific design details are required to be provided by the design engineer.

2.3.16.1 DHS PROFILES



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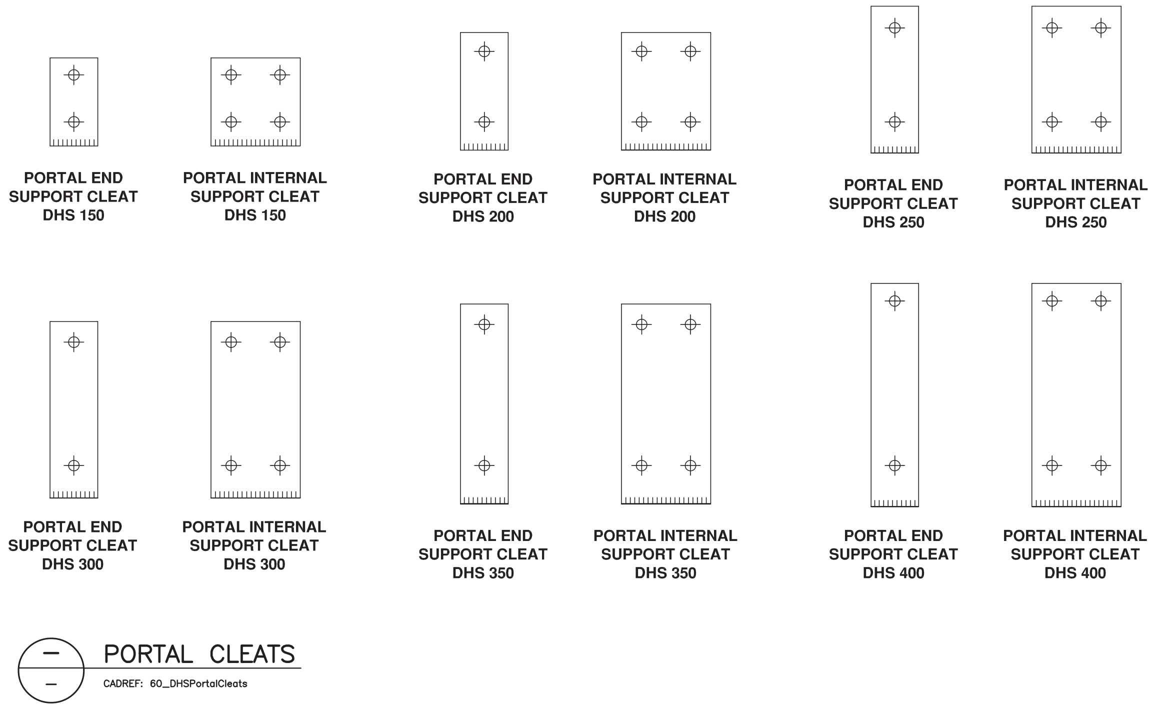
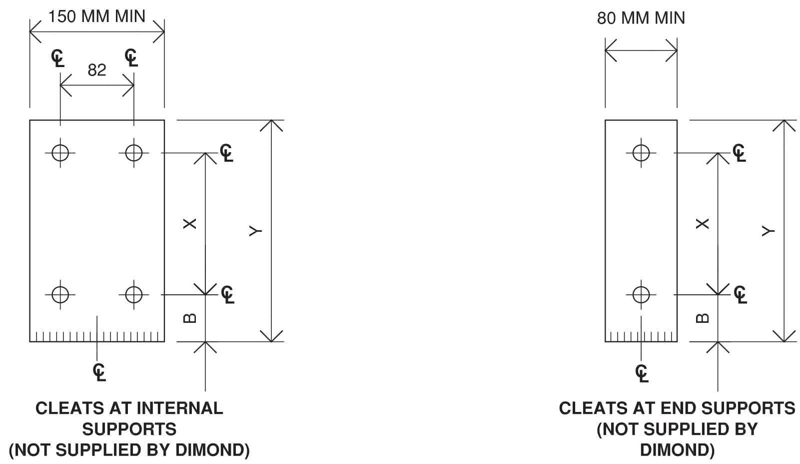
2.3.16 DHS CAD DETAILS *continued*

2.3.16.2 RECOMMENDED DIMENSIONS OF PORTAL CLEATS FOR USE WITH DHS PURLINS & GIRTS





DHS PURLIN	DIMENSIONS B	X	Y
150/12 AND 15	41	80	150
200/12, 15 AND 18	48	120	200
250/13, 15 AND 18	53	160	250
300/15 AND 18	60	200	300
350/18	65	240	340
400/20	70	280	380

CLEAT DIMENSIONS
CADREF: 61_DHSCleatDimensions

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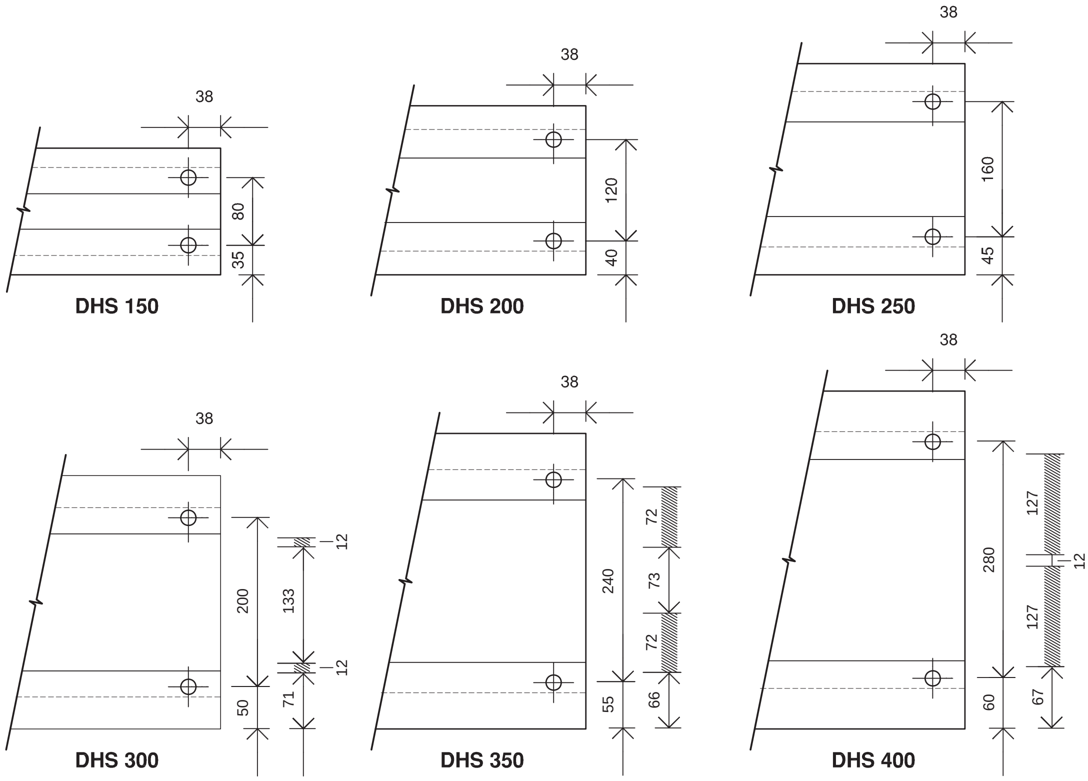
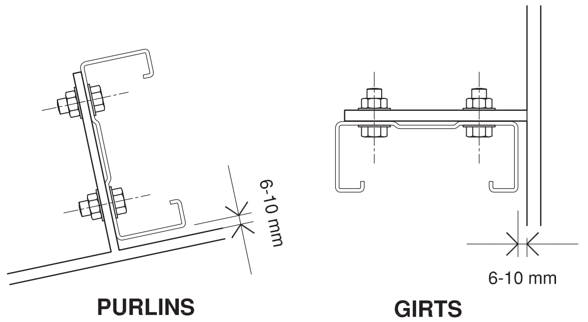
2.3.16 DHS CAD DETAILS *continued*

2.3.16.3 HOLE LOCATIONS

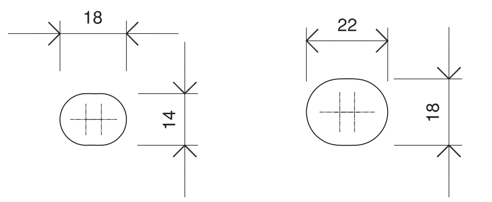


STANDARD HOLE LOCATIONS
CADREF: 62_DHSStandardHoleLocations

Note: Holes cannot be punched in the areas shown as ////////////// in the diagram above.



FASTENING TO CLEATS
CADREF: 64_DHSFasteningtoCleats



ELONGATED HOLES DETAIL
CADREF: 119_DHSElongatedHolesDetail

HOLE SIZES FOR DHS PURLINS & GIRTS

BOLT TYPE	HOLE DIMENSIONS	
	ROUND	ELONGATED
M12	14mm DIAMETER	14mm x 18 mm
M16	18mm DIAMETER	18mm x 22mm

ALL HOLES WILL BE ROUND UNLESS OTHERWISE REQUESTED.

Not to scale.

Note: DHS Purlins are supplied complete with standard pre-punched holes where required for connection at portal cleats, bracing points and laps. Special holes in other locations (flanges and web) may be available upon request. Contact Dimond on 0800 775 777 for details.

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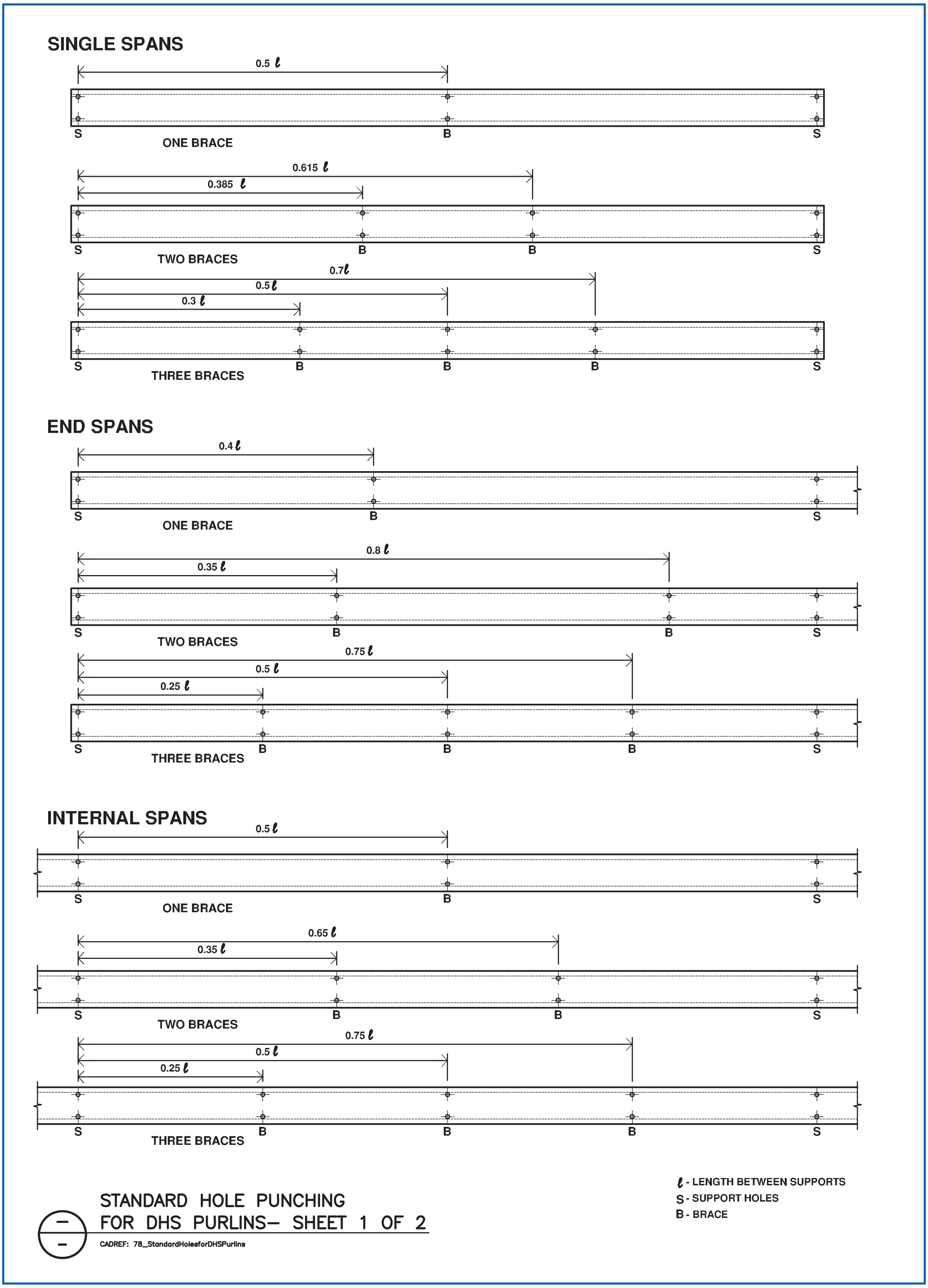
2.3.16 DHS CAD DETAILS *continued*

2.3.16.4 STANDARD HOLE PUNCHING FOR DHS PURLINS



Not to scale.

Note: When using Fastbrace 18mm diameter round holes must be used.

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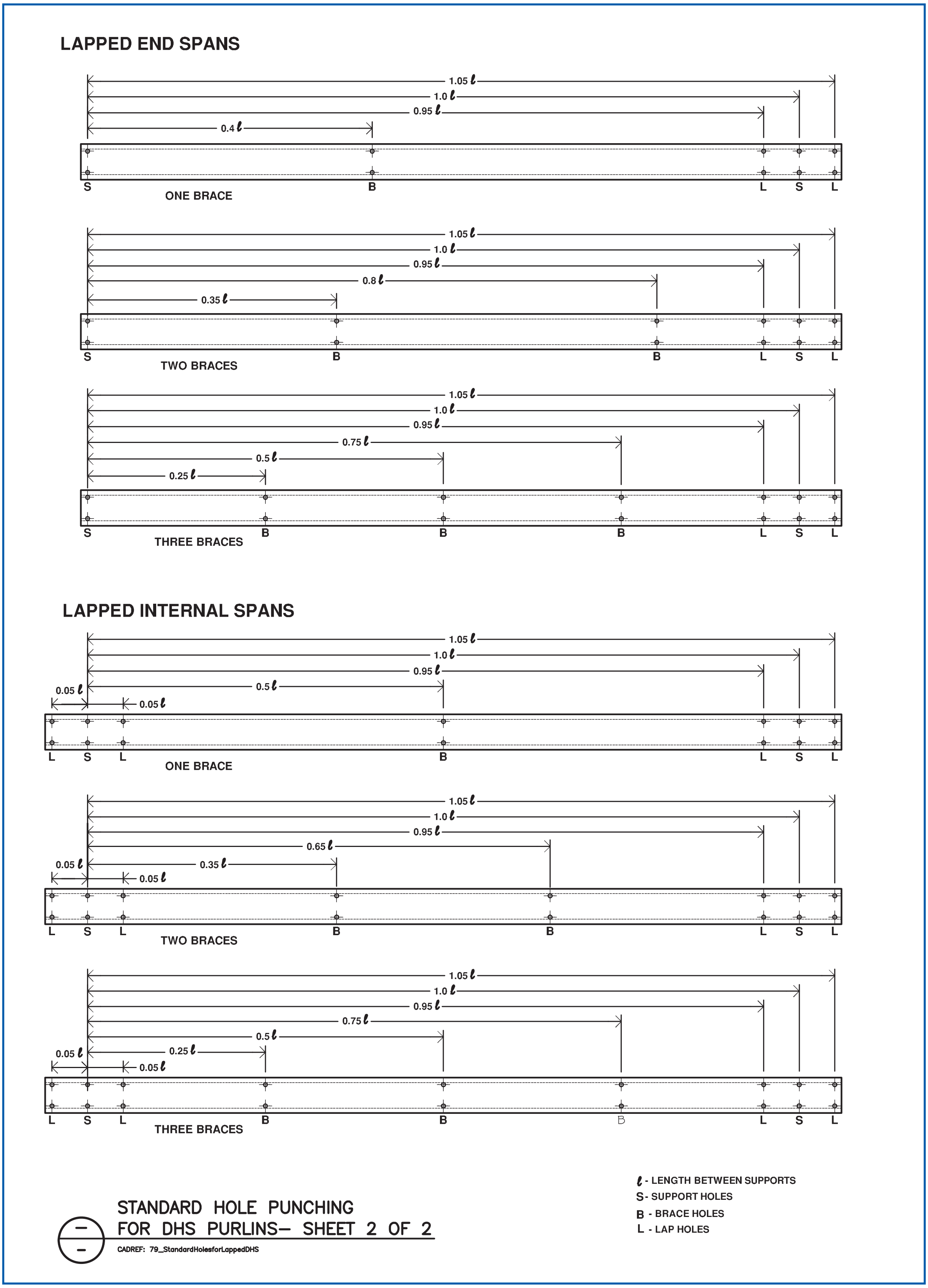
2.3.16 DHS CAD DETAILS *continued*

2.3.16.5 STANDARD HOLE PUNCHING FOR DHS PURLINS



Not to scale.

Note: When using Fastbrace 18mm diameter round holes must be used.

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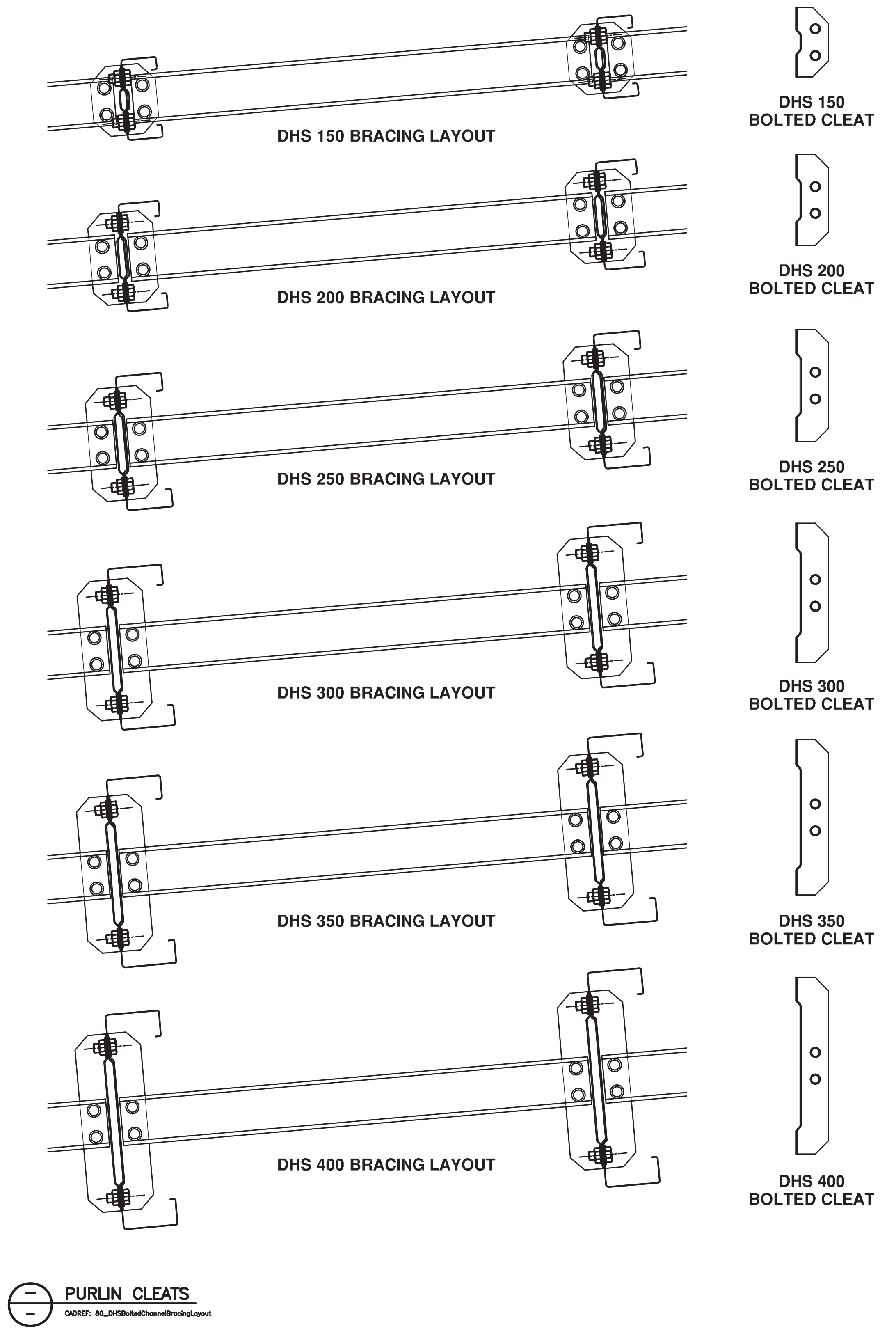
2.3.16 DHS CAD DETAILS *continued*

2.3.16.6 BOLTED CHANNEL BRACING LAYOUT



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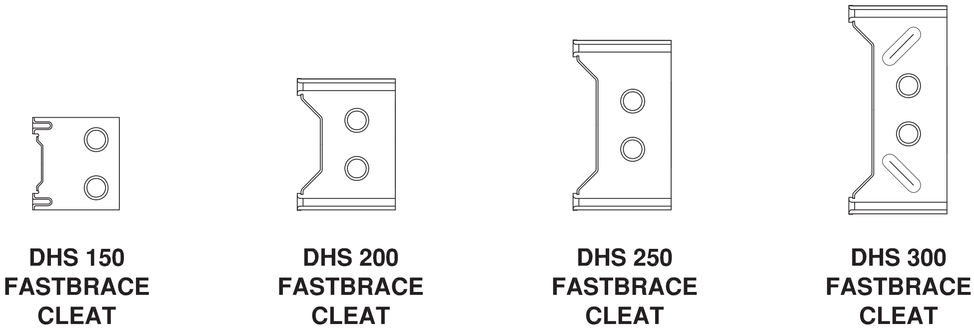
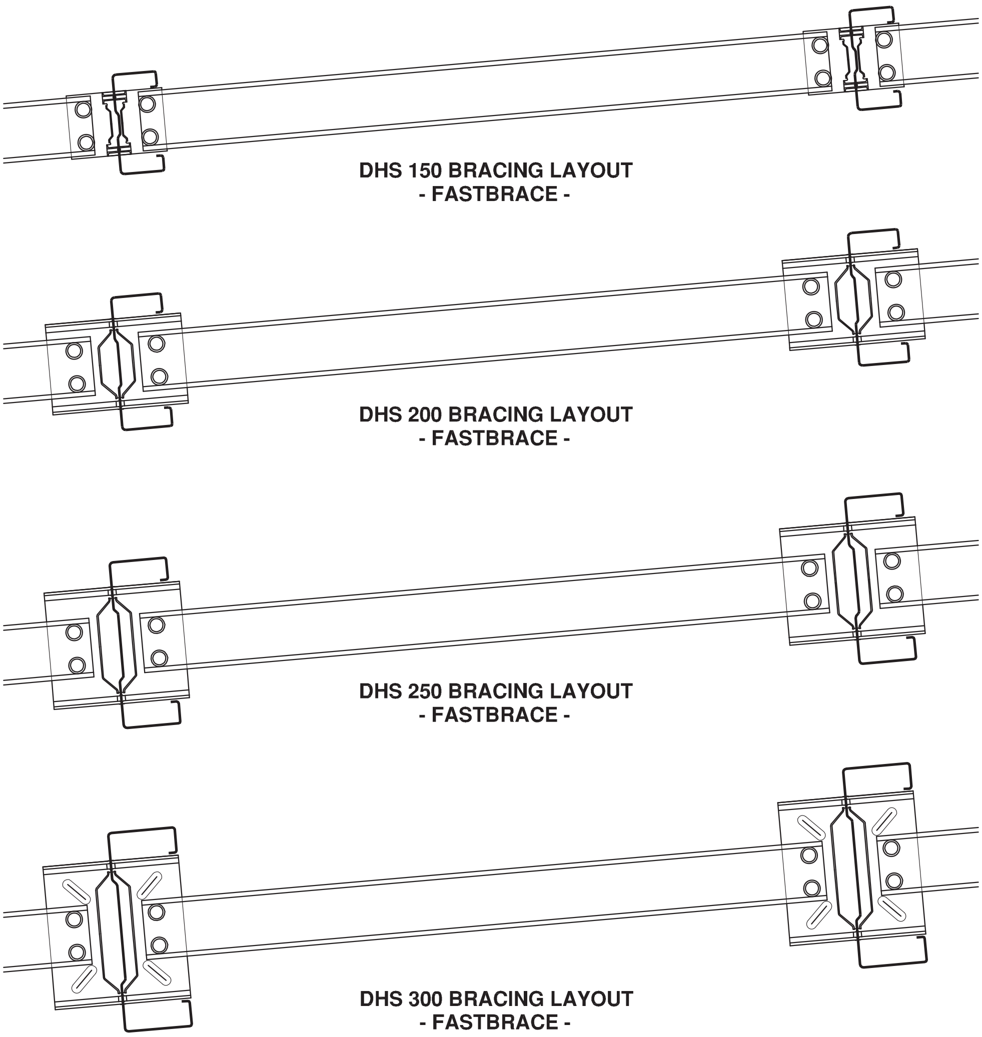
2.3.16 DHS CAD DETAILS *continued*

2.3.16.7 FASTBRACE CLEATS AND BRACING LAYOUT



FASTBRACE PURLIN CLEATS

CADREF: 81_DHSFastBRACECleats



FASTBRACE BRACING LAYOUT

CADREF: 82_DHSFastBRACEBracingLayout

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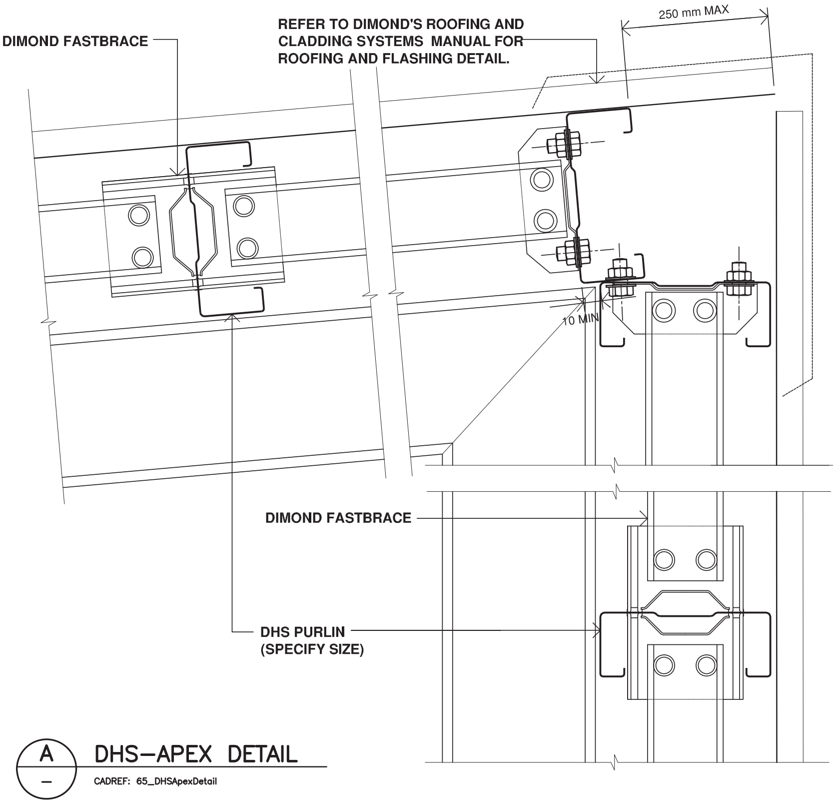
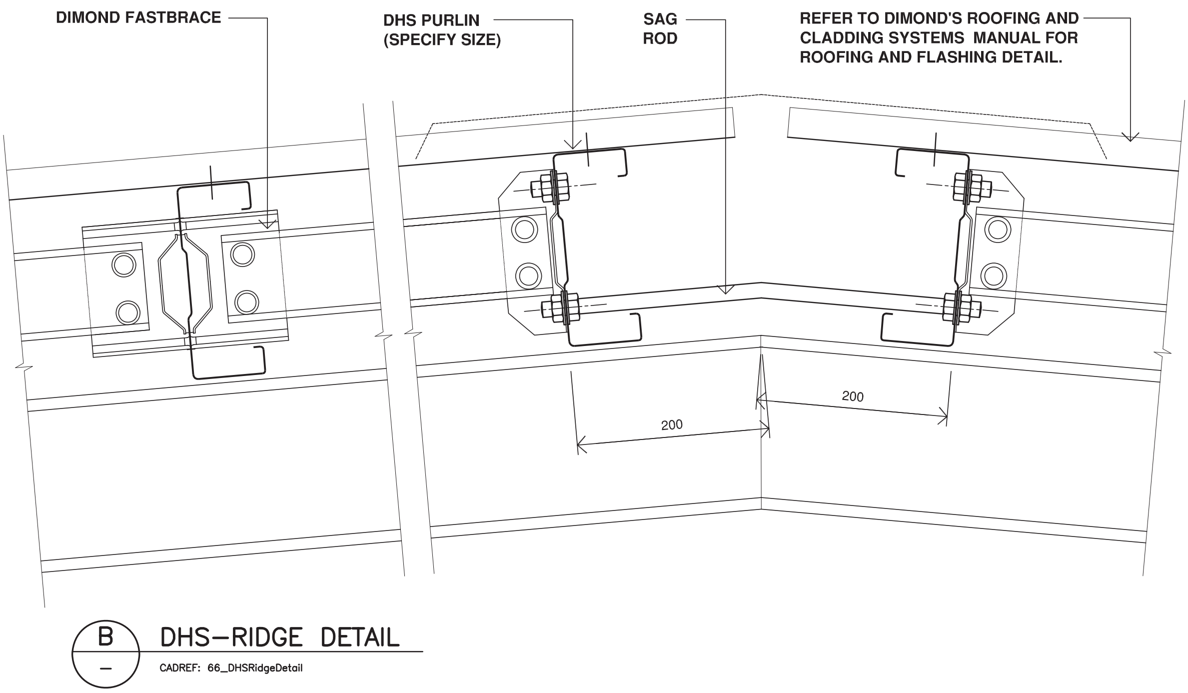
2.3.16 DHS CAD DETAILS *continued*

2.3.16.8 APEX & RIDGE DETAILS





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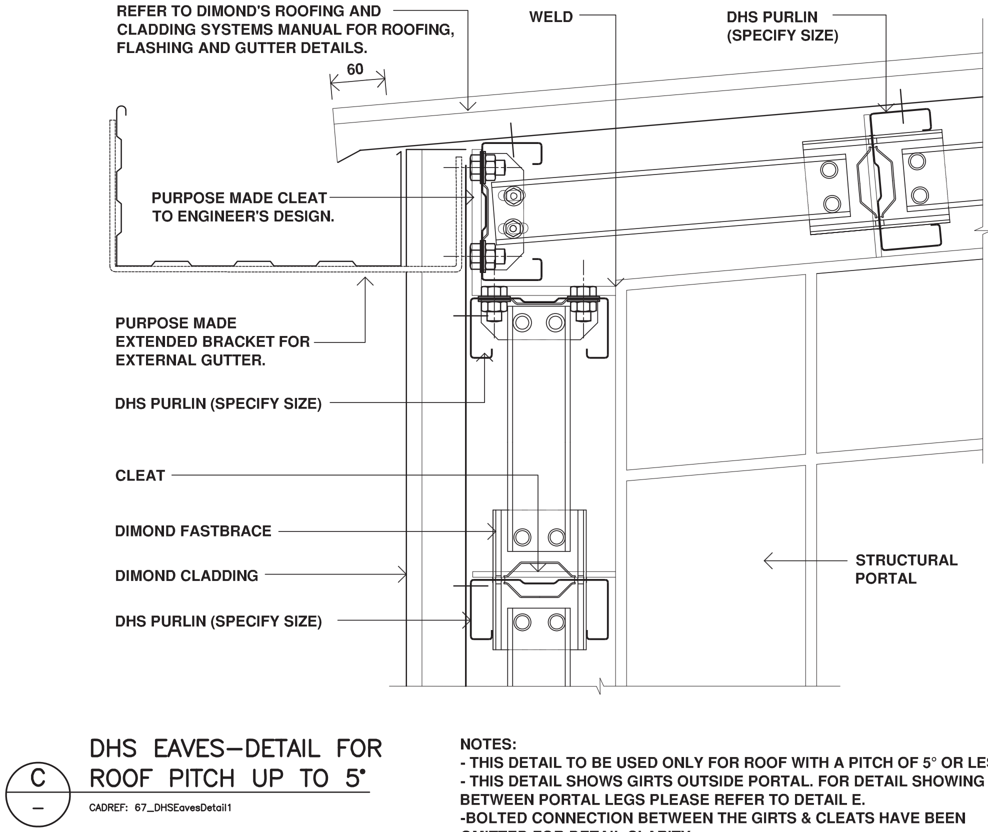
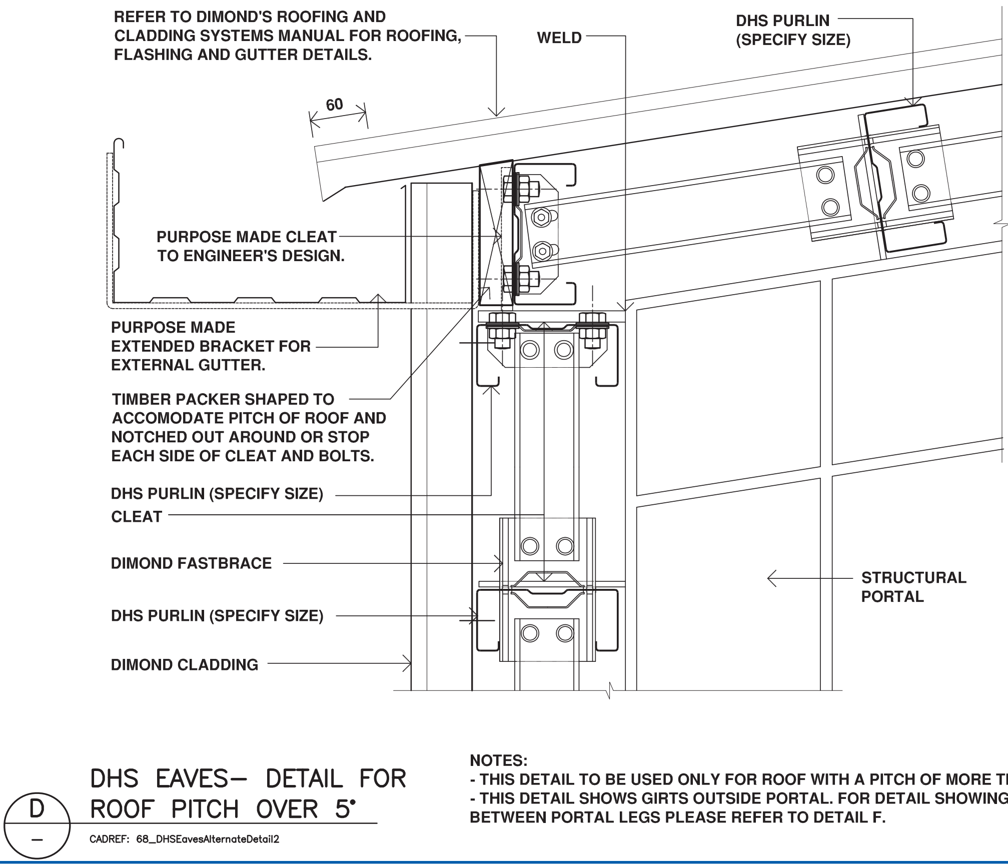
2.3.16 DHS CAD DETAILS *continued*

2.3.16.9 DHS EAVES DETAILS



NOTES:
- THIS DETAIL TO BE USED ONLY FOR ROOF WITH A PITCH OF 5° OR LESS.
- THIS DETAIL SHOWS GIRTS OUTSIDE PORTAL. FOR DETAIL SHOWING GIRTS BETWEEN PORTAL LEGS PLEASE REFER TO DETAIL E.
-BOLTED CONNECTION BETWEEN THE GIRTS & CLEATS HAVE BEEN OMITTED FOR DETAIL CLARITY.



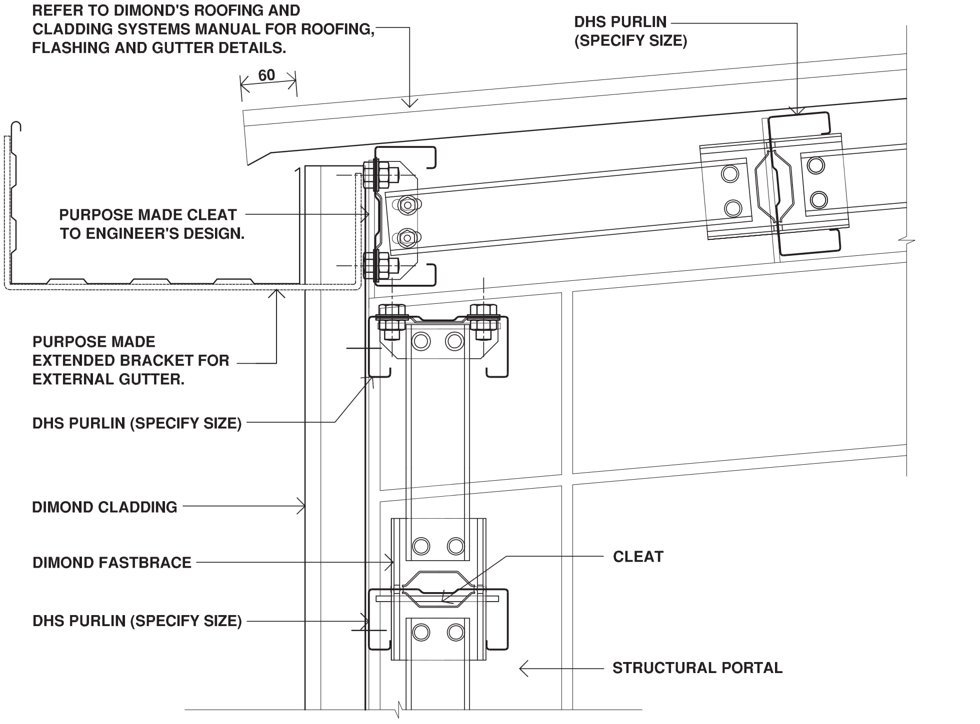
NOTES:
- THIS DETAIL TO BE USED ONLY FOR ROOF WITH A PITCH OF MORE THAN 5°.
- THIS DETAIL SHOWS GIRTS OUTSIDE PORTAL. FOR DETAIL SHOWING GIRTS BETWEEN PORTAL LEGS PLEASE REFER TO DETAIL F.

Not to scale.

Continued on next page

2.3.16 DHS CAD DETAILS *continued*

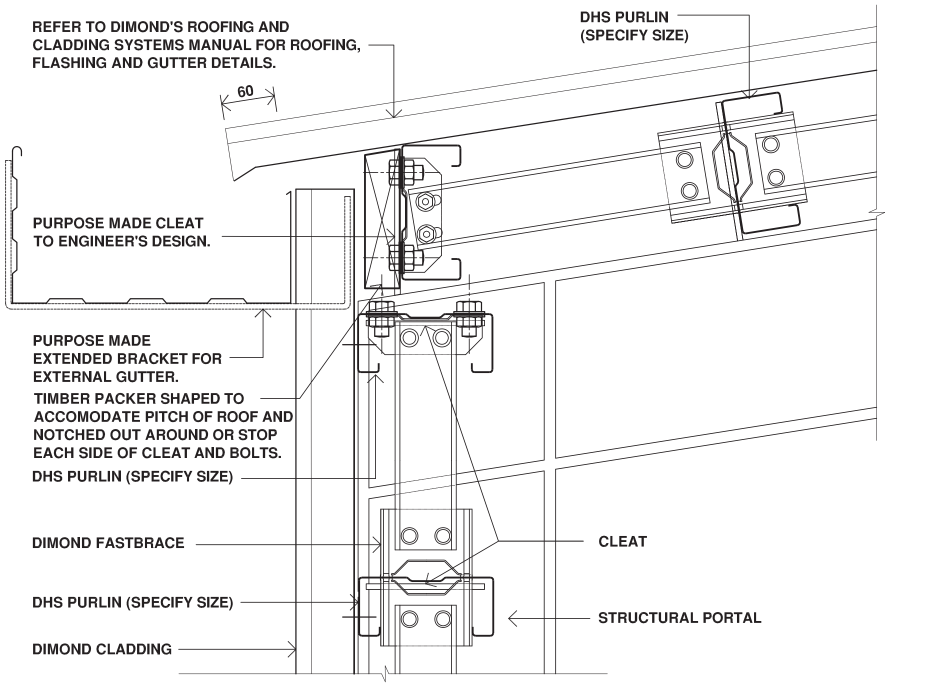
2.3.16.10 DHS EAVES DETAILS 2



E
–
DHS EAVES– DETAIL FOR ROOF PITCH UP TO 5°

CADREF: 69_DHSEavesAlternateDetail1a

NOTES:
- THIS DETAIL TO BE USED ONLY FOR ROOF WITH A PITCH OF 5° OR LESS.
- THIS DETAIL SHOWS GIRTS INSIDE PORTAL. FOR DETAIL SHOWING GIRTS OUTSIDE PORTAL LEGS PLEASE REFER TO DETAIL C.
-BOLTED CONNECTION BETWEEN THE GIRTS & CLEATS HAVE BEEN OMITTED FOR DETAIL CLARITY.



F
–
DHS EAVES– DETAIL FOR ROOF PITCH OVER 5°

CADREF: 70_DHSEavesAlternateDetail2a

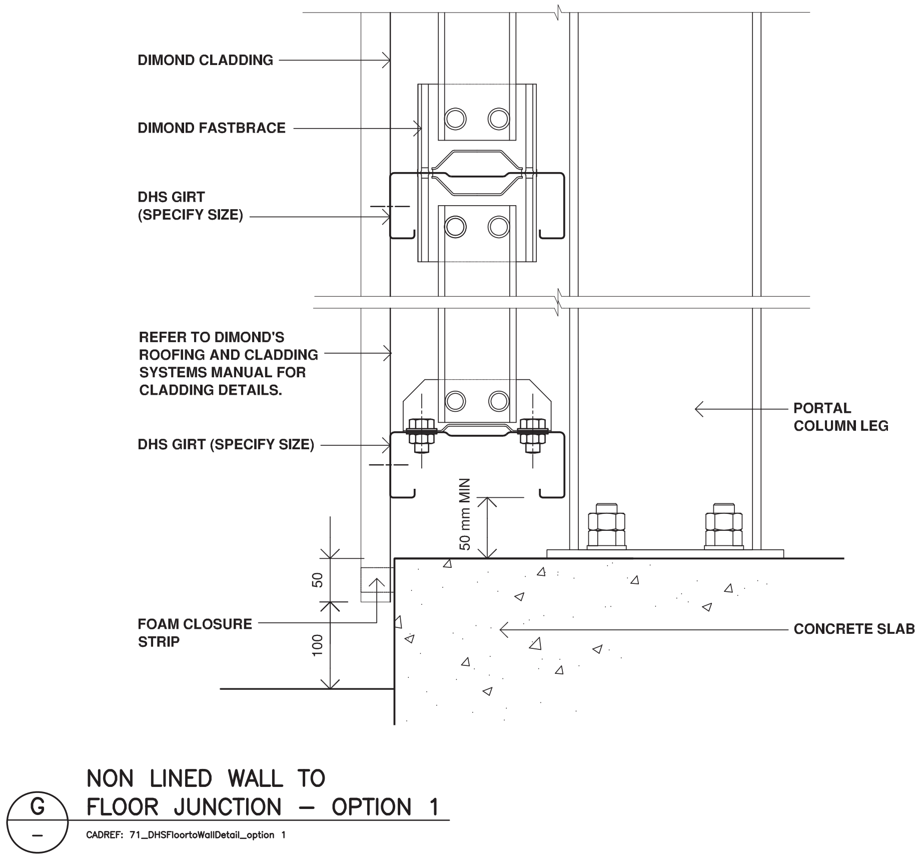
NOTES:
- THIS DETAIL TO BE USED ONLY FOR ROOF WITH A PITCH OF MORE THAN 5°.
- THIS DETAIL SHOWS GIRTS BETWEEN PORTAL LEGS. FOR DETAIL SHOWING GIRTS OUTSIDE PORTAL LEGS PLEASE REFER TO DETAIL D.

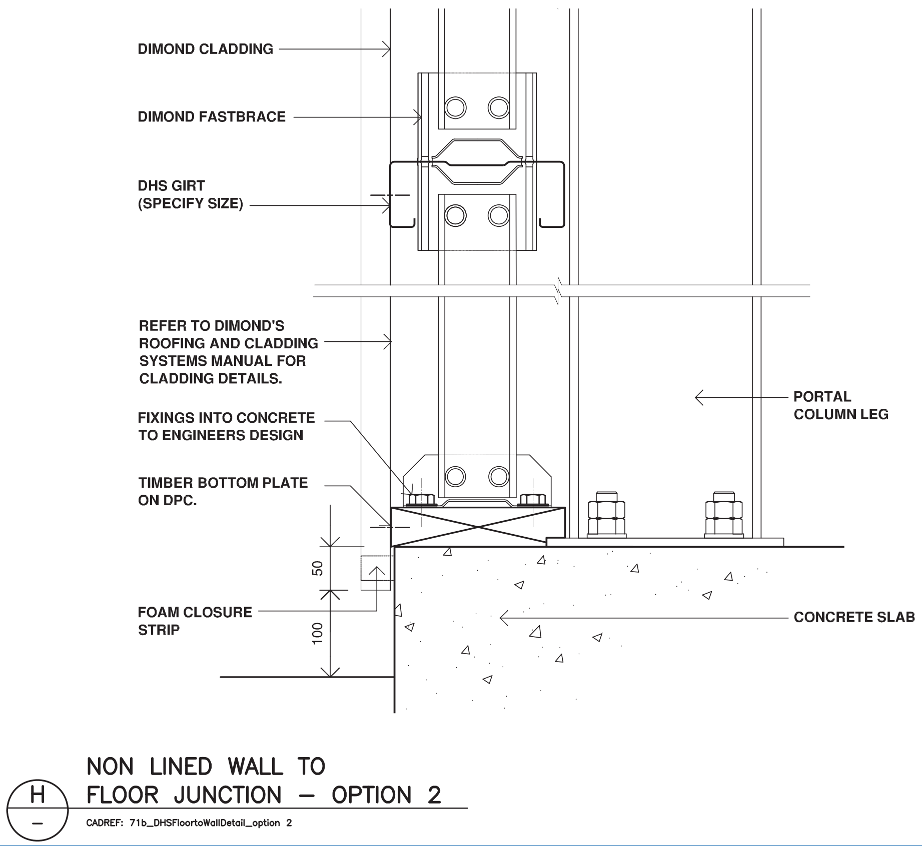
Not to scale.

Continued on next page

2.3.16 DHS CAD DETAILS *continued*

2.3.16.11 FLOOR TO WALL DETAIL





Not to scale.

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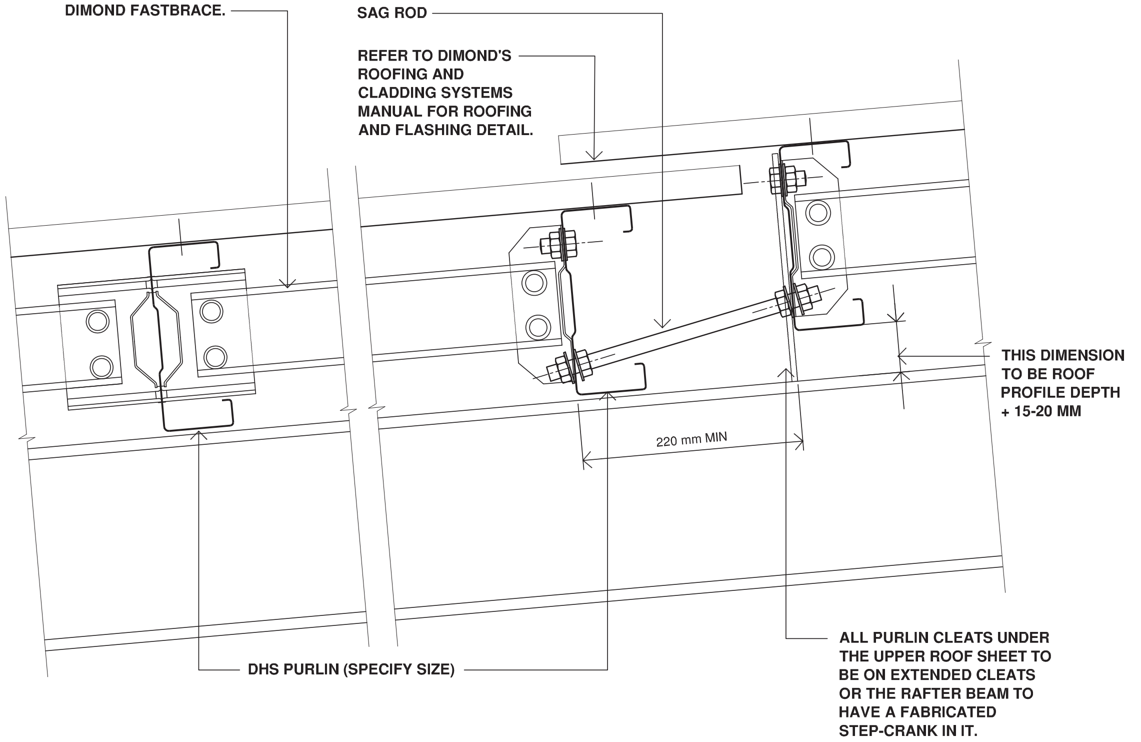
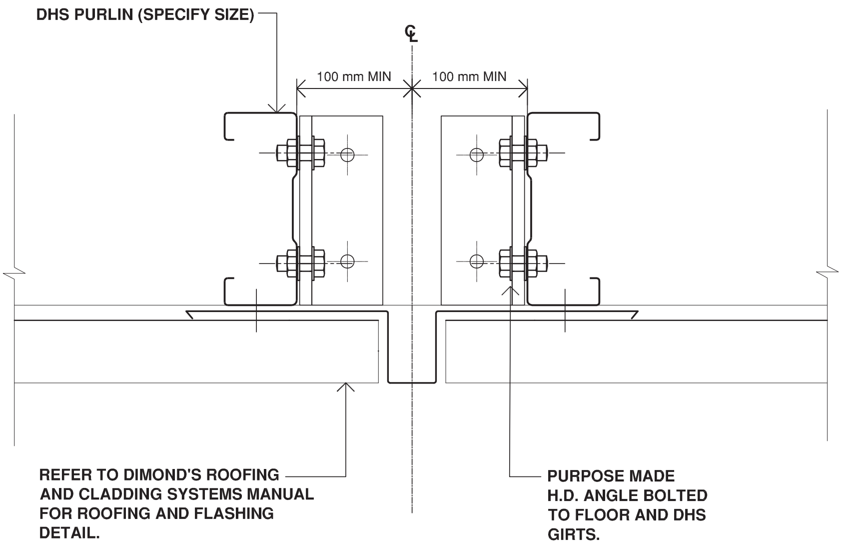
2.3.16 DHS CAD DETAILS *continued*

2.3.16.12 ROOF STEP DETAIL AND HORIZONTAL CLADDING DETAIL



I
–
DHS–STEP IN ROOFING
CADREF: 73_DHSRoofStepDetail



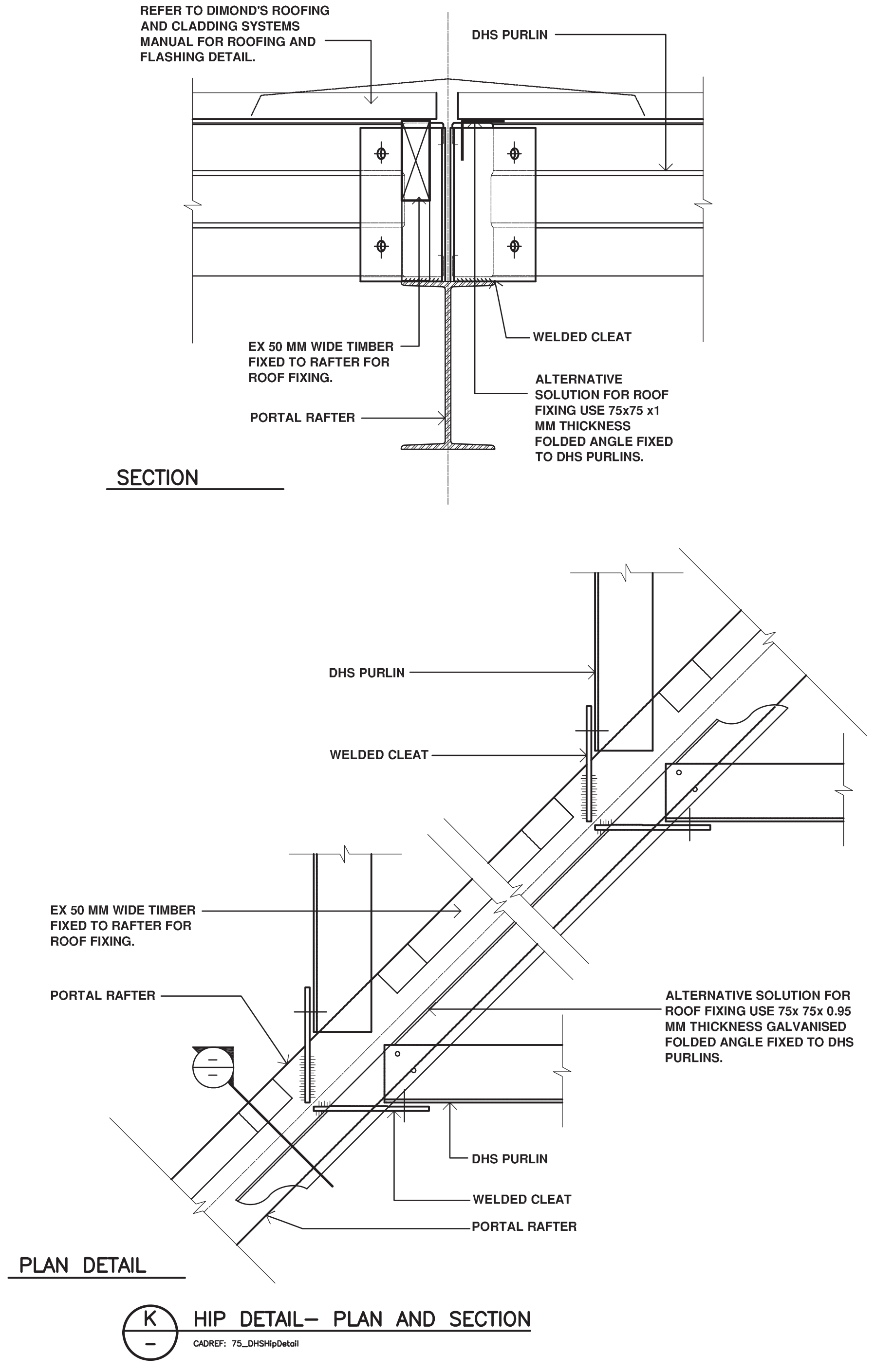
J
–
VERTICAL GIRT LAYOUT FOR HORIZONTAL CLADDING– PLAN DETAIL AT FLOOR LEVEL
CADREF: 74_DHSHorizontalCladdingDetail

Not to scale.

Continued on next page

2.3.16 DHS CAD DETAILS *continued*

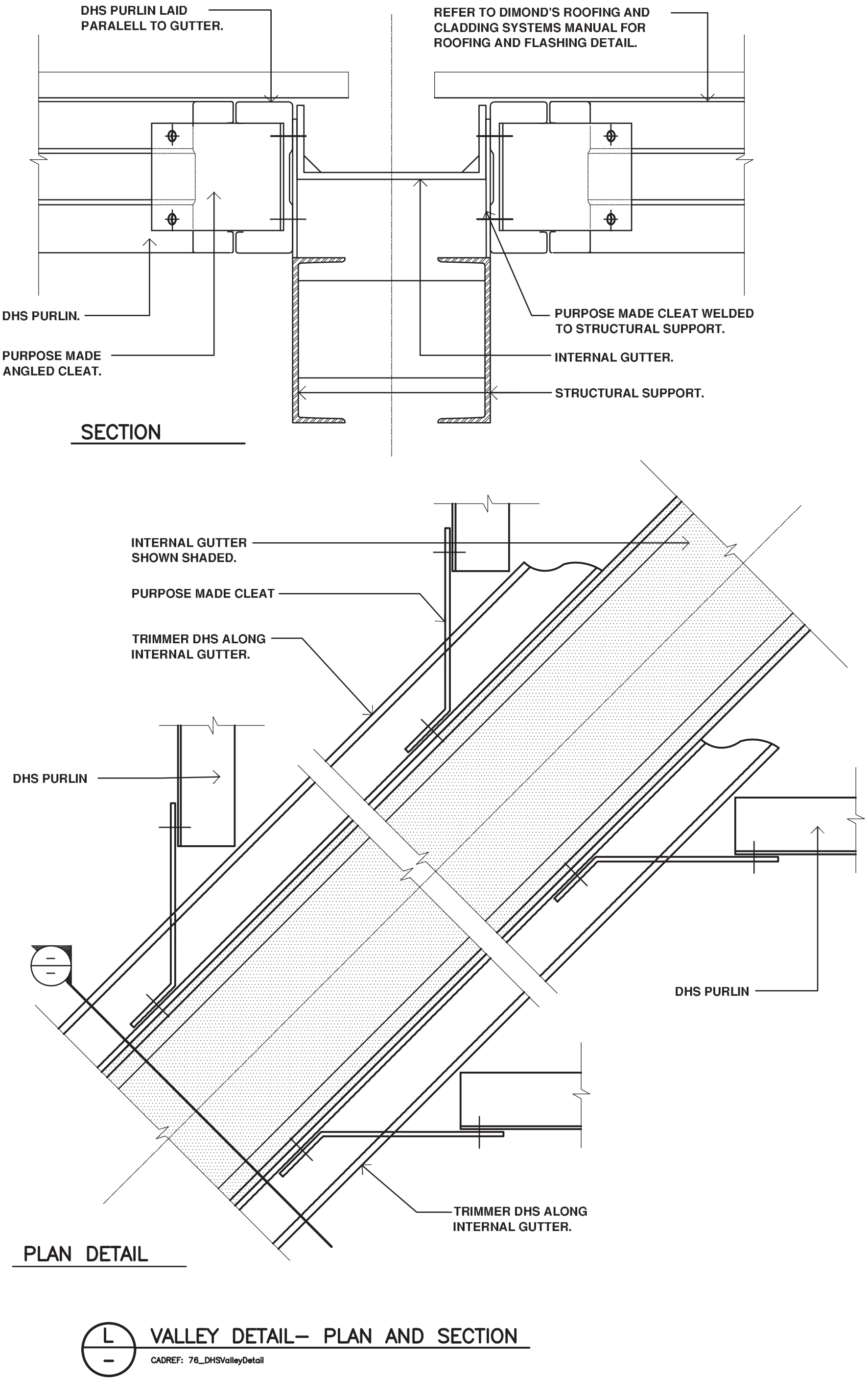
2.3.16.13 HIP DETAIL



Not to scale.

2.3.16 DHS CAD DETAILS *continued*

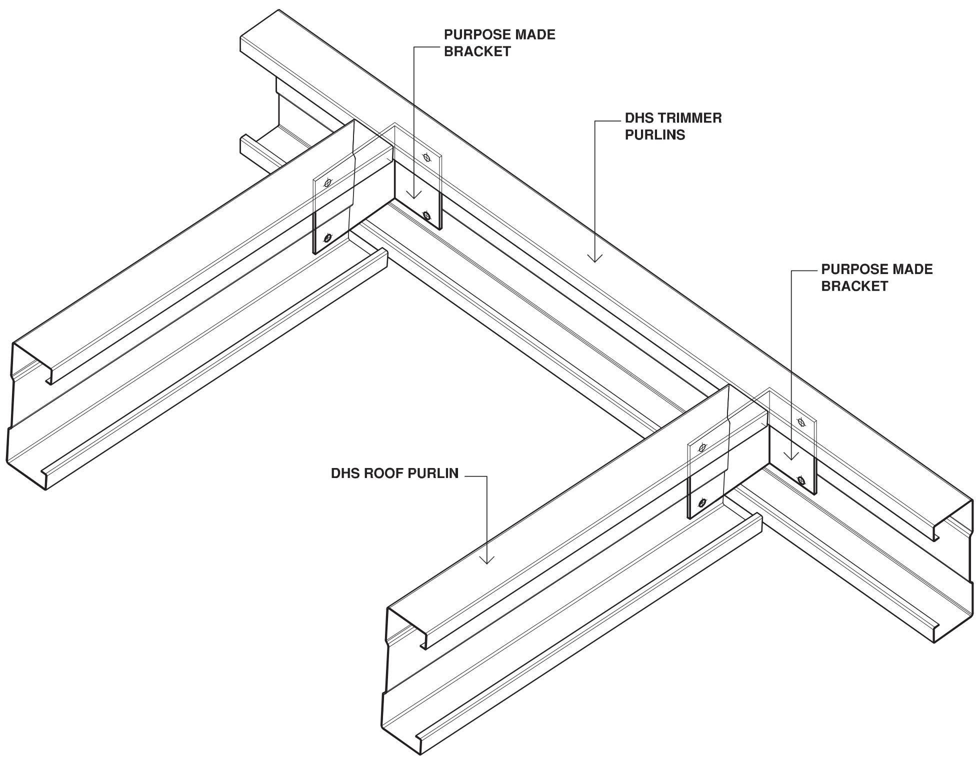
2.3.16.14 VALLEY DETAIL



Not to scale.

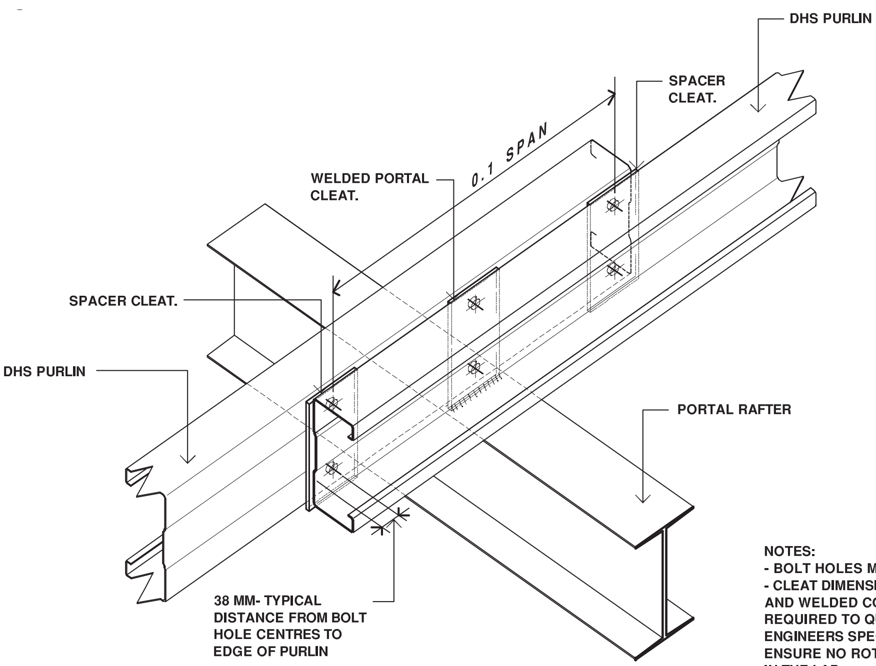
2.3.16 DHS CAD DETAILS *continued*

2.3.16.15 TRIMMER DETAIL AND LAPPED SPAN DETAIL



M – EAVES DETAIL

CADREF: 77_DHSTrimmerDetail



NOTES:
- BOLT HOLES MUST BE ROUND
- CLEAT DIMENSIONS, BOLTS AND WELDED CONNECTION REQUIRED TO QUALIFIED ENGINEERS SPECIFIC DESIGN TO ENSURE NO ROTATION OCCURS IN THE LAP.

* AS A GUIDE: M16 BOLTS WILL BE SUITABLE IN MOST CASES.

N – DHS LAPPED SPAN PORTAL DETAIL

CAD REF: DHS\LAP

Not to scale.

2.4 SPECIFIC DESIGN – TOP NOTCH PURLINS

2.4.1 INTRODUCTION

Dimond Top Notch Purlin Systems have been designed to comply with AS/NZS 4600:1996. Appropriate design limit state load combinations should be determined in accordance with AS/NZS 1170:2002.

Top Notch Purlin Systems are typically used as purlins and girts in farm buildings, light commercial sheds, and garages.

2.4.2 DESIGN CONSIDERATIONS

Data presented in this section is intended for use by structural engineers. Load situations other than uniformly distributed loads will require specific design.

Design capacities in the limit state format have been derived by the application of a capacity factor, f_b = 0.90 for bending.

A design yield stress as outlined in Section 2.4.9 has been used for Top Notch Purlins.

Uniformly loaded bending capacities (kN/m) are given for Top Notch purlins and girts for Inward and Outward cases.

The serviceability linear load, W_s (kN/m), is the load at which the midspan deflection equates to span/150. As deflection is proportional to loading, W_s loads may be factored by the deflection ratio for any deflection within the limit of the linear load capacities.

These tables are intended for use where roofing or cladding provides full restraint to the top flange of the Top Notch purlin or girt. Loads are assumed to be applied about the major axis of symmetry (X-X). Loads for intermediate spans may be calculated by linear interpolation.

The fixing type and size is critical to achieve the outward design loads. Refer Section 2.4.7 Fasteners.

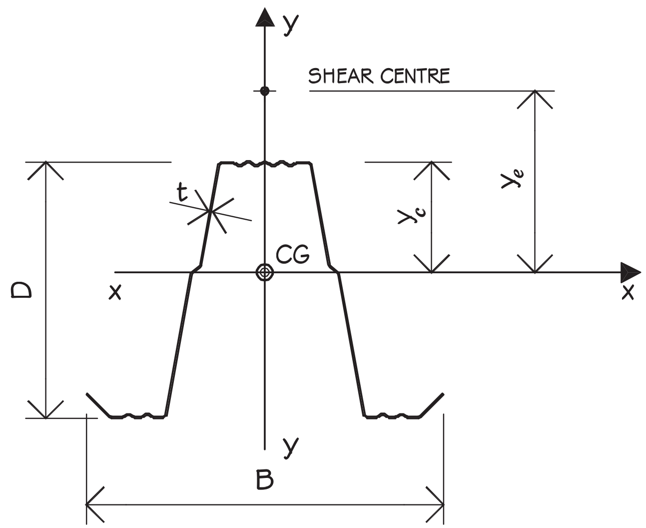
Dimond Top Notch do not require bracing to provide restraint. Therefore the loads are represented as inward and outward cases.

However bracing battens can be screwed transversely along the underside of the purlins to enhance the performance of the Top Notch purlins and are recommended where supports/restraints are further than 30 times the Top Notch depth apart.

Gravity type loads can be assumed to act perpendicular to the roof plane for pitches up to 10 degrees. For pitches greater than 10 degrees, load components about the minor axis of symmetry (Y-Y) should also be considered.

When designing Top Notch to be used as girts, it is assumed cladding and girt gravity loads are taken by a stiff eaves member such as a DHS Purlin.

2.4.3 TOP NOTCH SECTION PROPERTIES



Top Notch Section	Depth D mm	Width B mm	Thickness t mm	Area A mm^2	Mass per unit length kg/m	Second Moment of Area (Full Section) I_x 10^6mm^4	I_y 10^6mm^4	Section Modulus (Full Section) Z_x 10^3mm^3	Z_y 10^3mm^3	Radius of Gyration r_x mm	r_y mm	Centre of Gravity y_c mm	Shear Centre y_e mm	Torsion Constant J mm^4	Warping Constant I_w 10^6mm^6	Monosymmetry Constant b_x mm
60 x 0.75	60	108	0.75	150	1.24	0.077	0.122	2.57	2.26	22.6	28.5	31.5	44.2	28.2	16.0	111
60 x 0.95	60	108	0.95	191	1.56	0.097	0.155	3.23	2.87	22.6	28.5	31.5	44.2	57.3	20.3	111
100 x 0.75	100	163	0.75	248	2.04	0.340	0.450	6.80	5.52	37.0	42.6	55.2	67.4	46.5	238.6	163
100 x 0.95	100	163	0.95	314	2.56	0.430	0.570	8.60	6.99	37.0	42.6	55.2	67.4	94.5	302.2	163
120 x 0.75	120	170	0.75	278	2.28	0.530	0.546	8.83	6.42	43.7	44.3	65.6	82.3	52.1	363.3	190
120 x 0.95	120	170	0.95	352	2.86	0.671	0.691	11.18	8.13	43.6	44.3	65.6	82.3	106.0	460.2	190
150 x 0.95	150	183	0.95	411	3.34	1.166	0.920	15.55	10.05	53.3	47.3	81.0	103.9	123.5	758.4	231
150 x 1.15	150	183	1.15	497	4.02	1.411	1.114	18.81	12.17	53.3	47.3	81.0	103.9	219.1	918.0	231

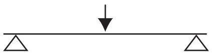
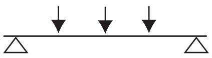
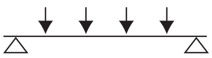
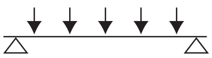
Note: Mass assumes a total coated weight for the standard zinc coating of 275 g/m^2.

2.4.4 CONVERSION FORMULAE FROM POINT LOADS TO EQUIVALENT UNIFORM BENDING LOADS

For Top Notch – Ultimate Strength

Formula $W = F \times \frac{P}{L}$

Where W = Uniform bending load
F = Factor "F" from table below
P = Point load ↓
L = Length of span

Type	Symbol	Factor "F"			
		Simple	End Span	Lapped End	Lapped Internal
One equidistant point load		2	2.25	2.25	2
One eccentric point load		1.5	2	2	1.5
Two equidistant point loads		2.67	3.25	3.25	2.25
Three equidistant point loads		4	4.25	4.25	3.5
Four equidistant point loads		4.8	5.5	5.5	4.25
Five equidistant point loads		6	6.75	6.75	5.5

The formula is only applicable to Top Notch Purlins. Refer to the DHS Purlins Section 2.3.5 for DHS formulae.

The formula assumes all point loads are equal in magnitude.

These factors "F" are an approximation to the pure derivation and are to be used as a guide only.

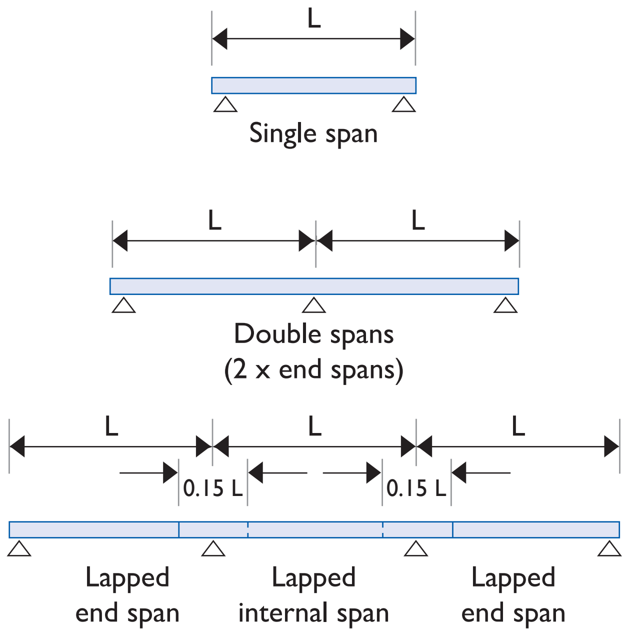
2.4.5 INTRODUCTION TO TOP NOTCH PURLINS CAPACITY TABLES

The capacity tables given in 2.4.6 relate to the following span configurations.

When using Top Notch over more than two spans better performance can be achieved by lapping the sections over the supports.

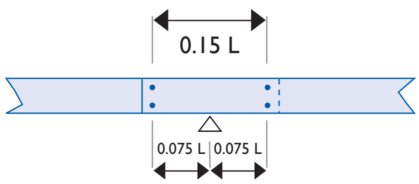
Single span – pinned at both ends.
Lapped end span – pinned at one end and lapped at the other.
Lapped internal span – lapped at both ends.

Note: Use of lapped end span tables with corresponding lapped internal span tables assumes that the end span is within plus 5% or minus 25% of the internal span, otherwise specific design to AS/NZS 4600 is required.



All lap lengths are to be a minimum of 0.15 of the maximum span measured from fixing points each end of the lap, positioned equally each side of the portal rafter. Refer Detail D in Section 2.4.11.

L = Span length

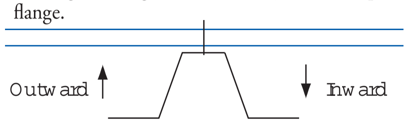


2.4.6 TOP NOTCH PURLINS & GIRTS – SINGLE SPAN

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span	60x0.75			60x0.95			100x0.75			100x0.95			120x0.75			120x0.95			150x0.95			150x1.15		
(m)	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	-Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s
1.00																								
1.25	5.90	4.00	3.59																					
1.50	4.10	2.78	2.08	5.48	3.76	2.75																		
1.75	3.01	2.04	1.31	4.03	2.76	1.73																		
2.00	2.30	1.56	0.88	3.08	2.11	1.16	4.54	3.22	3.90															
2.25	1.82	1.23	0.62	2.44	1.67	0.81	3.59	2.55	2.74	5.37	3.56	3.74												
2.50	1.47	1.00	0.45	1.97	1.35	0.59	2.91	2.06	2.00	4.35	2.88	2.73	3.52	2.46	2.95	5.24	3.68	4.20						
2.75	1.22	0.83	0.34	1.63	1.12	0.45	2.40	1.70	1.50	3.60	2.38	2.05	2.91	2.03	2.22	4.33	3.07	3.15						
3.00				1.37	0.94	0.34	2.02	1.43	1.16	3.02	2.00	1.58	2.45	1.71	1.71	3.64	2.58	2.43	4.57	3.07	3.91			
3.25							1.72	1.22	0.91	2.57	1.70	1.24	2.08	1.45	1.34	3.10	2.19	1.91	3.90	2.70	3.08	5.39	2.83	4.09
3.50							1.48	1.05	0.73	2.22	1.47	0.99	1.80	1.25	1.08	2.68	1.89	1.53	3.36	2.33	2.46	4.65	2.63	3.28
3.75							1.29	0.92	0.59	1.93	1.28	0.81	1.57	1.09	0.87	2.33	1.65	1.24	2.93	2.03	2.00	4.05	2.45	2.66
4.00							1.14	0.81	0.49	1.70	1.13	0.67	1.38	0.96	0.72	2.05	1.45	1.02	2.57	1.78	1.65	3.56	2.30	2.19
4.25							1.01	0.71	0.41	1.51	1.00	0.56	1.22	0.85	0.60	1.81	1.28	0.85	2.28	1.58	1.38	3.15	2.16	1.83
4.50							0.90	0.64	0.34	1.34	0.89	0.47	1.09	0.76	0.51	1.62	1.14	0.72	2.03	1.41	1.16	2.81	2.00	1.54
4.75										1.21	0.80	0.40	0.98	0.68	0.43	1.45	1.03	0.61	1.82	1.26	0.99	2.52	1.79	1.31
5.00										1.09	0.72	0.34	0.88	0.61	0.37	1.31	0.93	0.52	1.65	1.14	0.85	2.28	1.62	1.12
5.25													0.80	0.56	0.32	1.19	0.84	0.45	1.49	1.03	0.73	2.07	1.47	0.97
5.50																1.08	0.77	0.39	1.36	0.94	0.63	1.88	1.34	0.84
5.75																0.99	0.70	0.34	1.25	0.86	0.56	1.72	1.22	0.74
6.00																0.91	0.64	0.30	1.14	0.79	0.49	1.58	1.12	0.65
6.25																			1.05	0.73	0.43	1.46	1.04	0.58
6.50																			0.97	0.67	0.38	1.35	0.96	0.51
6.75																			0.90	0.63	0.34	1.25	0.89	0.46
7.00																			0.84	0.58	0.31	1.16	0.83	0.41
7.25																						1.08	0.77	0.37
7.50																						1.01	0.72	0.33
7.75																						0.95	0.67	0.30
8.00																								
8.25																								
8.50																								
8.75																								
9.00																								
9.25																								
9.50																								
9.75																								
10.00																								

1. W_s = Load at deflection of span/150
2. Outward loads shown are based on the screw fixings and minimum thickness shown in Section 2.4.7 Fasteners.
3. Roofing/cladding assumed to fully restrain top flange.



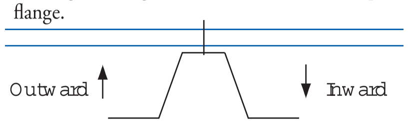
4. Shaded areas of the table relate to spans which will not support a point load of 1.4 kN (refer AS/NZS 1170.1). This assumes no load sharing between purlins.

2.4.6 TOP NOTCH PURLINS & GIRTS – DOUBLE SPAN

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span	60x0.75			60x0.95			100x0.75			100x0.95			120x0.75			120x0.95			150x0.95			150x1.15		
(m)	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	-Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s
1.00																								
1.25	5.90	3.73	7.88																					
1.50	4.10	3.11	4.56	5.48	3.55	5.95																		
1.75	3.01	2.66	2.87	4.03	3.04	3.75																		
2.00	2.30	2.30	1.92	3.08	2.66	2.51																		
2.25	1.82	1.82	1.35	2.44	2.37	1.76	5.09	2.99	5.92															
2.50	1.47	1.47	0.98	1.97	1.97	1.29	4.12	2.69	4.32	5.42	4.03	5.80	4.19	2.94	6.55									
2.75	1.22	1.22	0.74	1.63	1.63	0.97	3.41	2.40	3.24	4.48	3.60	4.35	3.81	2.68	4.92	5.82	4.01	6.73						
3.00	1.02	1.02	0.57	1.37	1.37	0.74	2.85	2.02	2.50	3.77	3.02	3.35	3.41	2.45	3.79	4.89	3.64	5.18	5.60	3.68	8.64			
3.25	0.87	0.87	0.45	1.17	1.17	0.59	2.38	1.72	1.97	3.21	2.57	2.64	2.91	2.08	2.98	4.17	3.10	4.08	5.17	3.40	6.79			
3.50	0.75	0.75	0.36	1.01	1.01	0.47	2.01	1.48	1.57	2.77	2.22	2.11	2.49	1.80	2.39	3.60	2.68	3.26	4.49	3.15	5.44			
3.75				0.88	0.88	0.38	1.71	1.29	1.28	2.39	1.93	1.72	2.13	1.57	1.94	3.13	2.33	2.65	3.82	2.93	4.42	5.35	3.93	5.67
4.00				0.77	0.77	0.31	1.46	1.14	1.05	2.05	1.70	1.42	1.84	1.38	1.60	2.75	2.05	2.19	3.28	2.57	3.64	4.66	3.56	4.67
4.25							1.26	1.01	0.88	1.76	1.51	1.18	1.59	1.22	1.33	2.41	1.81	1.82	2.83	2.28	3.04	4.02	3.15	3.89
4.50							1.09	0.90	0.74	1.52	1.34	0.99	1.39	1.09	1.12	2.10	1.62	1.54	2.45	2.03	2.56	3.48	2.81	3.28
4.75							0.94	0.81	0.63	1.32	1.21	0.85	1.22	0.98	0.95	1.84	1.45	1.31	2.13	1.82	2.18	3.03	2.52	2.79
5.00							0.82	0.73	0.54	1.15	1.09	0.72	1.07	0.88	0.82	1.62	1.31	1.12	1.86	1.65	1.87	2.64	2.28	2.39
5.25							0.72	0.66	0.47	1.00	0.99	0.63	0.94	0.80	0.71	1.43	1.19	0.97	1.62	1.49	1.61	2.31	2.07	2.07
5.50							0.64	0.60	0.41	0.90	0.90	0.54	0.83	0.73	0.62	1.26	1.08	0.84	1.42	1.36	1.40	2.02	1.88	1.80
5.75							0.58	0.55	0.35	0.82	0.82	0.48	0.74	0.67	0.54	1.12	0.99	0.74	1.29	1.25	1.23	1.83	1.72	1.57
6.00							0.54	0.50	0.31	0.76	0.76	0.42	0.65	0.61	0.47	0.99	0.91	0.65	1.19	1.14	1.08	1.68	1.58	1.38
6.25										0.70	0.70	0.37	0.59	0.56	0.42	0.88	0.84	0.57	1.09	1.05	0.96	1.55	1.46	1.22
6.50										0.64	0.64	0.33	0.55	0.52	0.37	0.78	0.78	0.51	1.01	0.97	0.85	1.44	1.35	1.09
6.75													0.51	0.48	0.33	0.73	0.72	0.45	0.94	0.90	0.76	1.33	1.25	0.97
7.00													0.47	0.45	0.30	0.67	0.67	0.41	0.87	0.84	0.68	1.24	1.16	0.87
7.25																0.63	0.62	0.37	0.81	0.78	0.61	1.15	1.08	0.78
7.50																0.59	0.58	0.33	0.76	0.73	0.55	1.08	1.01	0.71
7.75																0.55	0.55	0.30	0.71	0.69	0.50	1.01	0.95	0.64
8.00																			0.67	0.64	0.46	0.95	0.89	0.58
8.25																			0.63	0.60	0.42	0.89	0.84	0.53
8.50																			0.59	0.57	0.38	0.84	0.79	0.49
8.75																			0.56	0.54	0.35	0.79	0.74	0.45
9.00																			0.53	0.51	0.32	0.75	0.70	0.41
9.25																						0.71	0.67	0.38
9.50																						0.67	0.63	0.35
9.75																						0.64	0.60	0.32
10.00																						0.61	0.57	0.30

1. W_s = Load at deflection of span/150
2. Outward loads shown are based on the screw fixings and minimum thickness shown in Section 2.4.7 Fasteners.
3. Roofing/cladding assumed to fully restrain top flange.



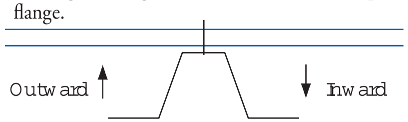
4. Shaded areas of the table relate to spans which will not support a point load of 1.4 kN (refer AS/NZS 1170.1). This assumes no load sharing between purlins.

2.4.6 TOP NOTCH PURLINS & GIRTS – LAPPED END SPAN

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span	60x0.75			60x0.95			100x0.75			100x0.95			120x0.75			120x0.95			150x0.95			150x1.15		
(m)	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	-Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s
1.00																								
1.25																								
1.50	6.00	3.55	4.70																					
1.75	4.34	3.04	2.96	5.88	3.04	3.87																		
2.00	3.19	2.54	1.98	4.33	2.66	2.59																		
2.25	2.40	2.00	1.39	3.26	2.37	1.82	5.84	4.48	5.50															
2.50	1.84	1.62	1.02	2.51	2.13	1.33	4.73	4.26	4.45															
2.75	1.43	1.34	0.76	1.95	1.82	1.00	3.91	3.67	3.34	5.84	3.67	4.49	4.49	4.01	4.42									
3.00	1.13	1.13	0.59	1.53	1.53	0.77	3.28	3.28	2.58	4.91	3.36	3.46	3.97	3.97	3.91	5.92	4.27	5.34						
3.25	0.96	0.96	0.46	1.30	1.30	0.60	2.80	2.80	2.03	4.18	3.10	2.72	3.39	3.39	3.07	5.04	3.40	4.20						
3.50	0.83	0.83	0.37	1.12	1.12	0.48	2.41	2.41	1.62	3.61	2.88	2.18	2.92	2.92	2.46	4.35	3.15	3.37	5.46	3.66	5.23			
3.75				0.98	0.98	0.39	2.10	2.10	1.32	3.14	2.69	1.77	2.54	2.54	2.00	3.79	2.94	2.74	4.76	2.94	4.56			
4.00				0.86	0.86	0.32	1.85	1.85	1.09	2.76	2.52	1.46	2.24	2.24	1.65	3.33	2.76	2.25	4.18	2.76	3.76	5.78	3.68	4.82
4.25							1.64	1.64	0.91	2.45	2.37	1.22	1.98	1.98	1.37	2.95	2.60	1.88	3.70	2.60	3.13	5.12	3.46	4.02
4.50							1.46	1.46	0.76	2.18	2.17	1.02	1.77	1.77	1.16	2.63	2.45	1.58	3.30	2.45	2.64	4.57	3.27	3.38
4.75							1.31	1.31	0.65	1.96	1.95	0.87	1.59	1.59	0.98	2.36	2.32	1.35	2.96	2.32	2.24	4.10	3.10	2.88
5.00							1.18	1.18	0.56	1.77	1.76	0.75	1.43	1.43	0.84	2.13	2.13	1.15	2.68	2.21	1.92	3.70	2.94	2.47
5.25							1.07	1.07	0.48	1.60	1.59	0.65	1.30	1.30	0.73	1.93	1.93	1.00	2.43	2.10	1.66	3.36	2.80	2.13
5.50							0.98	0.98	0.42	1.45	1.45	0.56	1.18	1.18	0.63	1.76	1.76	0.87	2.21	2.01	1.45	3.06	2.68	1.85
5.75							0.89	0.89	0.37	1.33	1.33	0.49	1.08	1.08	0.56	1.61	1.61	0.76	2.02	1.92	1.26	2.80	2.56	1.62
6.00							0.82	0.82	0.32	1.22	1.22	0.43	0.99	0.99	0.49	1.48	1.48	0.67	1.86	1.84	1.11	2.57	2.45	1.43
6.25										1.12	1.12	0.38	0.92	0.92	0.43	1.36	1.36	0.59	1.71	1.71	0.99	2.37	2.36	1.26
6.50										1.04	1.04	0.34	0.85	0.85	0.38	1.26	1.26	0.53	1.58	1.58	0.88	2.19	2.19	1.12
6.75										0.96	0.96	0.30	0.79	0.79	0.34	1.17	1.17	0.47	1.47	1.47	0.78	2.03	2.03	1.00
7.00													0.73	0.73	0.31	1.09	1.09	0.42	1.37	1.37	0.70	1.89	1.89	0.90
7.25																1.01	1.01	0.38	1.27	1.27	0.63	1.76	1.76	0.81
7.50																0.95	0.95	0.34	1.19	1.19	0.57	1.65	1.65	0.73
7.75																0.89	0.89	0.31	1.11	1.11	0.52	1.54	1.54	0.66
8.00																			1.05	1.05	0.47	1.45	1.45	0.60
8.25																			0.98	0.98	0.43	1.36	1.36	0.55
8.50																			0.93	0.93	0.39	1.28	1.28	0.50
8.75																			0.87	0.87	0.36	1.21	1.21	0.46
9.00																			0.83	0.83	0.33	1.14	1.14	0.42
9.25																			0.78	0.78	0.30	1.08	1.08	0.39
9.50																						1.03	1.03	0.36
9.75																						0.97	0.97	0.33
10.00																						0.93	0.93	0.31

1. W_s = Load at deflection of span/150
2. Outward loads shown are based on the screw fixings and minimum thickness shown in Section 2.4.7 Fasteners.
3. Roofing/cladding assumed to fully restrain top flange.



4. Shaded areas of the table relate to spans which will not support a point load of 1.4 kN (refer AS/NZS 1170.1). This assumes no load sharing between purlins.

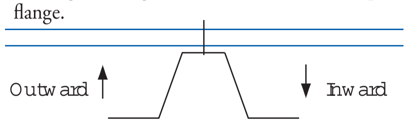
Dimond

2.4.6 TOP NOTCH PURLINS & GIRTS – LAPPED INTERNAL SPAN

Uniformly loaded bending capacities (kN/m) $f_b W_{bx}$

Span	60x0.75			60x0.95			100x0.75			100x0.95			120x0.75			120x0.95			150x0.95			150x1.15		
(m)	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	-Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s	Inward	Outward	W_s
1.00																								
1.25																								
1.50																								
1.75	6.00	3.81	5.38																					
2.00	4.42	3.33	3.61	5.99	3.33	4.71																		
2.25	3.33	2.78	2.53	4.52	2.96	3.31																		
2.50	2.55	2.25	1.85	3.47	2.66	2.41																		
2.75	1.98	1.86	1.39	2.69	2.42	1.81	5.41	4.58	5.41															
3.00	1.56	1.56	1.07	2.11	2.11	1.39	4.54	4.20	4.54															
3.25	1.33	1.33	0.84	1.80	1.80	1.10	3.87	3.87	3.68	5.79	3.88	4.95	4.03	4.03	4.03									
3.50	1.15	1.15	0.67	1.55	1.55	0.88	3.34	3.34	2.95	4.99	3.60	3.96	3.74	3.74	3.96	6.00	3.94	6.00						
3.75	1.00	1.00	0.55	1.35	1.35	0.71	2.91	2.91	2.40	4.35	3.36	3.22	3.50	3.50	3.50	5.24	3.68	4.97	5.60	3.68	5.60			
4.00	0.88	0.88	0.45	1.19	1.19	0.59	2.56	2.56	1.98	3.82	3.15	2.65	3.10	3.10	3.00	4.61	3.45	4.10	5.25	3.45	5.25			
4.25	0.78	0.78	0.38	1.05	1.05	0.49	2.26	2.26	1.65	3.39	2.96	2.21	2.74	2.74	2.50	4.08	3.25	3.42	4.94	3.25	4.94			
4.50				0.94	0.94	0.41	2.02	2.02	1.39	3.02	2.80	1.86	2.45	2.45	2.11	3.64	3.07	2.88	4.57	3.07	4.57			
4.75				0.84	0.84	0.35	1.81	1.81	1.18	2.71	2.65	1.58	2.20	2.20	1.79	3.27	2.91	2.45	4.10	2.91	4.08	5.68	3.87	5.23
5.00				0.76	0.76	0.30	1.64	1.64	1.01	2.45	2.43	1.36	1.98	1.98	1.54	2.95	2.76	2.10	3.70	2.76	3.50	5.13	3.68	4.48
5.25							1.48	1.48	0.87	2.22	2.20	1.17	1.80	1.80	1.33	2.68	2.63	1.81	3.36	2.63	3.02	4.65	3.50	3.87
5.50							1.35	1.35	0.76	2.01	2.01	1.02	1.64	1.64	1.15	2.44	2.44	1.58	3.06	2.51	2.63	4.24	3.35	3.37
5.75							1.24	1.24	0.67	1.84	1.84	0.89	1.50	1.50	1.01	2.23	2.23	1.38	2.80	2.40	2.30	3.88	3.20	2.95
6.00							1.14	1.14	0.59	1.69	1.69	0.79	1.38	1.38	0.89	2.05	2.05	1.21	2.57	2.30	2.02	3.56	3.07	2.59
6.25							1.05	1.05	0.52	1.56	1.56	0.70	1.27	1.27	0.79	1.89	1.89	1.07	2.37	2.21	1.79	3.28	2.94	2.30
6.50							0.97	0.97	0.46	1.44	1.44	0.62	1.17	1.17	0.70	1.75	1.75	0.96	2.19	2.12	1.59	3.03	2.83	2.04
6.75							0.90	0.90	0.41	1.33	1.33	0.55	1.09	1.09	0.62	1.62	1.62	0.85	2.03	2.03	1.42	2.81	2.73	1.82
7.00							0.83	0.83	0.37	1.24	1.24	0.50	1.01	1.01	0.56	1.50	1.50	0.76	1.89	1.89	1.27	2.62	2.62	1.63
7.25							0.78	0.78	0.33	1.16	1.16	0.45	0.94	0.94	0.50	1.40	1.40	0.69	1.76	1.76	1.15	2.44	2.44	1.47
7.50							0.73	0.73	0.30	1.08	1.08	0.40	0.88	0.88	0.45	1.31	1.31	0.62	1.65	1.65	1.04	2.28	2.28	1.33
7.75										1.01	1.01	0.36	0.82	0.82	0.41	1.23	1.23	0.56	1.54	1.54	0.94	2.13	2.13	1.20
8.00										0.95	0.95	0.33	0.77	0.77	0.37	1.15	1.15	0.51	1.45	1.45	0.85	2.00	2.00	1.09
8.25										0.89	0.89	0.30	0.73	0.73	0.34	1.08	1.08	0.47	1.36	1.36	0.78	1.88	1.88	1.00
8.50													0.69	0.69	0.31	1.02	1.02	0.43	1.28	1.28	0.71	1.77	1.77	0.91
8.75																0.96	0.96	0.39	1.21	1.21	0.65	1.67	1.67	0.84
9.00																0.91	0.91	0.36	1.14	1.14	0.60	1.58	1.58	0.77
9.25																0.86	0.86	0.33	1.08	1.08	0.55	1.50	1.50	0.71
9.50																0.82	0.82	0.31	1.03	1.03	0.51	1.42	1.42	0.65
9.75																			0.97	0.97	0.47	1.35	1.35	0.60
10.00																			0.93	0.93	0.44	1.28	1.28	0.56

1. W_s = Load at deflection of span/150
2. Outward loads shown are based on the screw fixings and minimum thickness shown in Section 2.4.7 Fasteners.
3. Roofing/cladding assumed to fully restrain top flange.



4. Shaded areas of the table relate to spans which will not support a point load of 1.4 kN (refer AS/NZS 1170.1). This assumes no load sharing between purlins.

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2.4.7 FASTENERS

In order to achieve the loads shown in the Top Notch design tables, the following size and number of self-drilling screws are required for the support condition and type of material.

FIXINGS

	Support Member			Number of Screws/Screw Gauge Top Notch Purlin Size				
Support Condition	Material	Grade	Min. Thickness (mm)	60x0.75 60x0.95	100x0.75 100x0.95	120x0.75 120x0.95	150x0.95	150x1.15
End	Cold-formed Steel Steel Timber	G450 G300	1.45 3 37*	2/12g 2/12g	2/12g 2/12g	2/14g 2/14g	2/14g 2/14g	2/14g 2/14g
Internal	Cold-formed Steel Steel Timber	G450 G300	1.45 3 37*	4/12g 2/12g	6/12g 4/12g	6/14g 4/14g	6/14g 4/14g	8/14g 6/14g

*Minimum screw embedment into timber support.

Notes to table

- *Cold-formed option* – 2/14g indicates 2 off 14 gauge self-drilling screws fastened into a cold-formed steel (Grade G450) support member of 1.45mm minimum thickness. The same rationale applies where 12 gauge screws are required.
- *Steel/timber option* – 2/12g indicates 2 off 12 gauge self-drilling screws fastened into a Grade 300 hot-rolled steel support member of 3mm minimum thickness or 2 off 12g x 50mm long Type 17 screws fastened into timber to achieve a minimum embedment length of 37mm. The same rationale applies where 14 gauge screws are required.
- Outward loads shall be adjusted to a lower value if less screws or thinner support members are used.
- When the number of specified fixings above cannot be fixed into the Top Notch and/or Top Notch is being installed in cyclonic regions, an additional hold-down strap should be used. Refer detail A in Section 2.4.11 (strap capacity 20 kN).
- Lap end fasteners shall be:
  - 2 screws for the 60 and 100 Top Notch, or
  - 4 screws for the 120 and 150 Top Notch

  positioned at each end. Refer drawing 2.4.11, detail D.
- A minimum distance of 20mm from the fastener to the end of the Top Notch purlin is required.

2.4.8 DESIGN EXAMPLE – TOP NOTCH PURLINS

Selected Loadings

Dead Load, G = 0.12 kPa   Live Load, Q = 0.25 kPa   Snow Load, S_u = 0.5 kPa

Outward Limit State Wind Loads, W_u = –0.95 kPa (ultimate state) and W_s = –0.66 kPa (serviceability state).

Inward Wind Loading is not significant for this roof.

Building Constraints

Portal Spacing, L_P	= 5m	Rafter Length, L_R	= 10.0m (distance from eaves purlin to ridge purlin)
Roof Pitch, a	= 10 degrees	Cladding Profile	= Styleline x 0.40mm BMT

Critical Design Load Combinations for the Ultimate Limit State (AS/NZS 1170.0, clause 4.2)

i)	W^*_{ULS}	=	1.2G + 1.5Q	=	(1.2 x 0.12) + (1.5 x 0.25)	=	0.52 kPa
ii)	W^*_{ULS}	=	1.2G + S_u + c_cQ	=	(1.2 x 0.12) + 0.5 + (0.0 x 0.25)	=	0.64 kPa
iii)	W^*_{ULS}	=	0.9G + W_u	=	(0.9 x 0.12) – 0.95	=	– 0.84 kPa (outward)

Critical Design Load Combinations for the Serviceability Limit State (AS/NZS 1170.0, clause 4.3)

i)	W^*_{SLS}	=	L_P/300 under G + c_1 Q	=	[0.12 + (0.0 x 0.25)] x 300/150	=	0.24 kPa
ii)	W^*_{SLS}	=	L_P/150 under W_s	=	– 0.66	=	– 0.66 kPa (outward)

For i) we have converted the load by a factor of 300/150 in order to compare the load directly with W_s in the Top Notch load span tables as these are based on span/150.

Optimise Roofing Profile Spans

In this case we have a restricted access roof where the point load requirement limits the intermediate span of the Styleline x 0.40mm BMT profile to 1.6m. End spanning capability of the roofing is reduced to 1.1m, i.e. 70% of the intermediate span. Generally these spans will not 'fit' the rafter length exactly, hence the requirement to o ptimise.

The optimised roofing profile intermediate span is based on the rafter length and the number of purlins, N_P (assuming at least four) and is given by $L_{RI} = L_{RT} / [N_P - 1.6]$.

Try 7 Purlins,	L_{RI} = 10.0/(7 – 1.6)	=	1.85m	No good
Try 9 Purlins,	L_{RI} = 10.0/(9 – 1.6)	=	1.35m	Not controlling
Try 8 Purlins,	L_{RI} = 10.0/(8 – 1.6)	=	1.56m	Intermediate spans and 1.26m edge spans

From this, 8 purlins are required and the purlin spacings may be rationalised to 1.6m intermediate spans and 1.0m spans at the sheet ends.

Continued on next page

2.4.8 DESIGN EXAMPLE – TOP NOTCH PURLINS *continued*

Optimise Purlin Size

The Top Notch load span tables assume that the top flange of the Top Notch purlin is continuously restrained by screw fastened roof sheeting. (The tables shall not be used if the top flange is not fully restrained.)

Check design capacities $W^*_{ULS} < f_b W_{bx}$

1. Single Span Purlin Design
a) All Bays (5m span)

Check design capacities (using those given in the simple span Top Notch load span tables):

$W^*_{ULS}\downarrow$	=	1.6 x 0.64	=	1.02 kN/m	c.f 1.31 kN/m for a 120 x 0.95
$W^*_{ULS}\uparrow$	=	1.6 x – 0.84	=	– 1.34 kN/m	c.f 1.62 kN/m for a 150 x 1.15

Check deflections

W^*_{SLS}	=	1.6 x 0.66	=	1.06 kN/m	c.f 1.12 kN/m for a 150 x 1.15

Therefore both wind load outward and deflection govern and a 150 x 1.15 Top Notch purlin is required.

Therefore use,
150 x 1.15 Top Notch purlins single span at 1.6m intermediate spacings and 1.0m at sheet ends.

Typically for multiple bay structures it would be more efficient to use a lapped purlin system as shown below.

2. Lapped Span Purlin Design
a) Check End Bays (5m span)

Check design capacities (using those given in the lapped end span Top Notch load span tables):

$W^*_{ULS}\downarrow$	=	1.6 x 0.64	=	1.02 kN/m	c.f 1.18 kN/m for a 100 x 0.75
$W^*_{ULS}\uparrow$	=	1.6 x – 0.84	=	– 1.34 kN/m	c.f 1.76 kN/m for a 100 x 0.95

Check deflections

W^*_{SLS}	=	1.6 x 0.66	=	1.06 kN/m	c.f 1.15 kN/m for a 120 x 0.95

Therefore wind load deflection governs the end span and a 120 x 0.95 lapped Top Notch is required.

b) Check Internal Bays (5m span)

Check design capacities (using those given in the lapped internal span Top Notch load span tables):

$W^*_{ULS}\downarrow$	=	1.6 x 0.64	=	1.02 kN/m	c.f 1.64 kN/m for a 100 x 0.75
$W^*_{ULS}\uparrow$	=	1.6 x – 0.84	=	– 1.34 kN/m	c.f 1.64 kN/m for a 100 x 0.75

Check deflections

W^*_{SLS}	=	1.6 x 0.66	=	1.06 kN/m	c.f 1.36 kN/m for a 100 x 0.95

Therefore wind load deflection governs the internal span and a 100 x 0.95 lapped Top Notch is required.

Therefore use,
Top Notch 120 x 0.95 lapped purlins at 1.6m intermediate spacings and 1.0m at sheet ends.
(The size is governed by the end bays.)

Typically, Top Notch purlins must have the same depth on all bays and different thicknesses are not mixed when specifying Top Notch purlins for practical reasons.

2.4.8 DESIGN EXAMPLE – TOP NOTCH PURLINS *continued*

3. Lapped Reduced-End Span Purlin Design
The dependable strength characteristics are higher for internal spans on continuously lapped span purlin systems. Therefore typically a reduction in the end bay spacings of 20% to 30% will result in a more efficient purlin optimisation. Try reducing the end bay span by 20% to 4 metres.

a) Check End Bays (4m span)
Check design capacities (using those given in the lapped end span Top Notch load span tables):

$W^*_{ULS}\downarrow$	=	1.6 x 0.64	=	1.02 kN/m	c.f 1.85 kN/m for a 100 x 0.75
$W^*_{ULS}\uparrow$	=	1.6 x – 0.84	=	– 1.34 kN/m	c.f 1.85 kN/m for a 100 x 0.75

Check deflections

W^*_{SLS}	=	1.6 x 0.66	=	1.06 kN/m	c.f 1.09 kN/m for a 100 x 0.75

Therefore all design cases require a 100 x 0.75 lapped Top Notch.

b) Check Internal Bays (5m span)
As for example 2b) above.
A 100 x 0.95 lapped Top Notch is required.

Therefore use,
Top Notch 100 x 0.95 lapped purlins at 1.6m intermediate spacings and 1.0m at sheet ends, on end and internal bays.

The above examples use the same wind load on the end bays and the internal bays. However a more rigorous wind load analysis is likely to have different wind loads on the end and internal bays.

In the calculation of wall elements, optimisation follows the same logic as illustrated above except the wind loading is typically lower on wall elements and the cladding spans (therefore the purlin spacings) are not limited by foot traffic criteria. Typically girts can be spaced approximately 20% further apart than purlins.

2.4.9 MATERIAL SPECIFICATION

Dimond Top Notch are manufactured by roll forming galvanised steel coil produced to AS 1397:2001.

Base Metal Thickness (BMT) (mm)	Steel Grade	Yield Strength f_y (MPa)	Zinc Weight (Z) (g/m^2)
0.75	G550	550	275
0.95	G550	550	275
1.15	G500	500	275

Z 450 zinc weight coil can be supplied with order lead times of up to 12 weeks. Please discuss with Dimond on 0800 775 777.

TOLERANCES

Top Notch Size	Overall Width (mm)	Overall Depth (mm)	Top Web Width (mm)
60	±1	±1	±1
100 120	±2	±2	±1
150	±3	±3	±1

2.4.10 SHORT FORM SPECIFICATION – TOP NOTCH

The light steel section will be Dimond **(1)** Top Notch **(2)** mm BMT to a galvanised zinc weight of **(3)** g/m^2.

The sizes, lengths, span configuration, lap length where required and thickness variations are as shown on the drawing.

Fixings to rafters to be **(4)** **(5)** self-drilling screws.

Choose from

(1) 60, 100, 120, 150

(2) 0.75, 0.95 (and if using the 150) 0.95 or 1.15

(3) 275 or 450

(4) 2 – 12g, 4 – 12g, 6 – 12g, 2 – 14g, 4 – 14g, 6 – 14g or 8 – 14g (Refer Section 2.4.6)

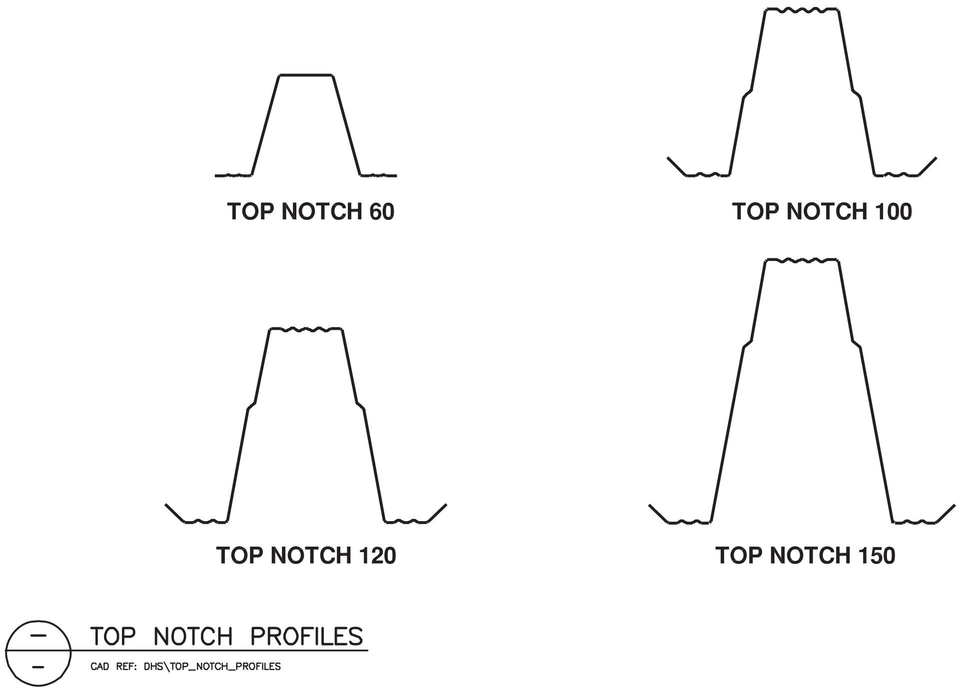
(5) Type 17 self-drilling screw (timber), metal self-drilling screw (steel).

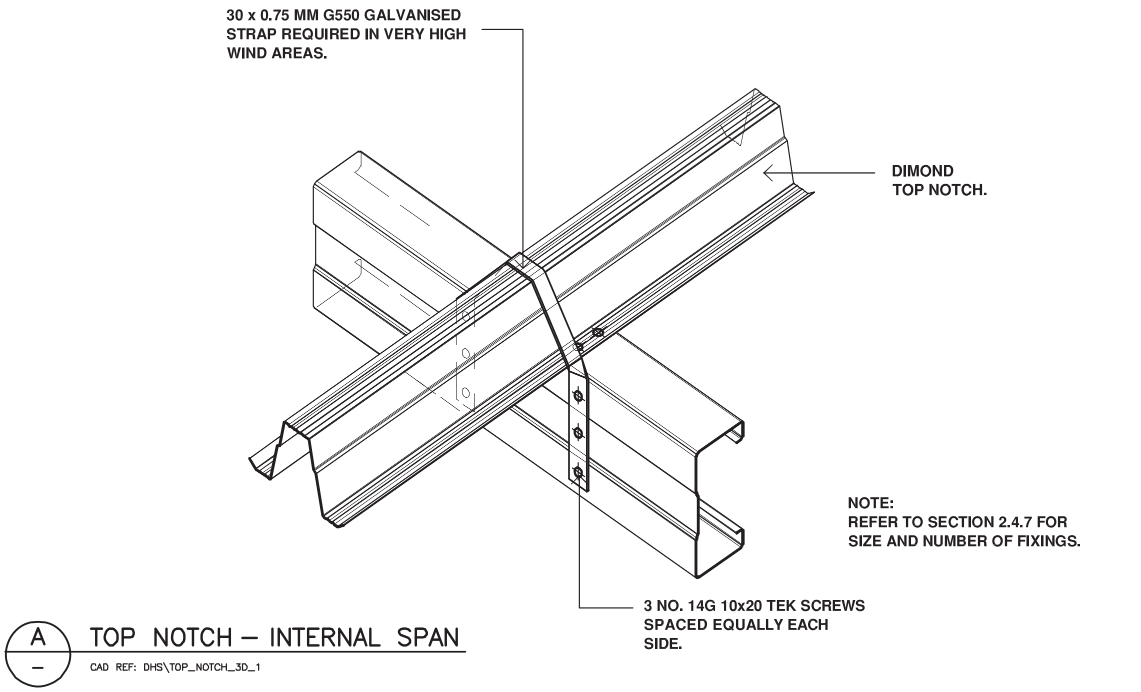
2.4.11 TOP NOTCH CAD DETAILS

Top Notch CAD details are shown in this section. For the latest Top Notch CAD details, please download from the Dimond website **www.dimond.co.nz**. Follow the steps below:

1. Log in to the Architects/Specifiers section.
2. Click on the green "Structural Systems Manual" button.
3. Click on the "Download CAD details" button.
4. Select from product list shown to view CAD details available for that product.

Please note all of these details are to be used as a guide only and are not intended for construction. Specific design details are required to be provided by the design engineer.

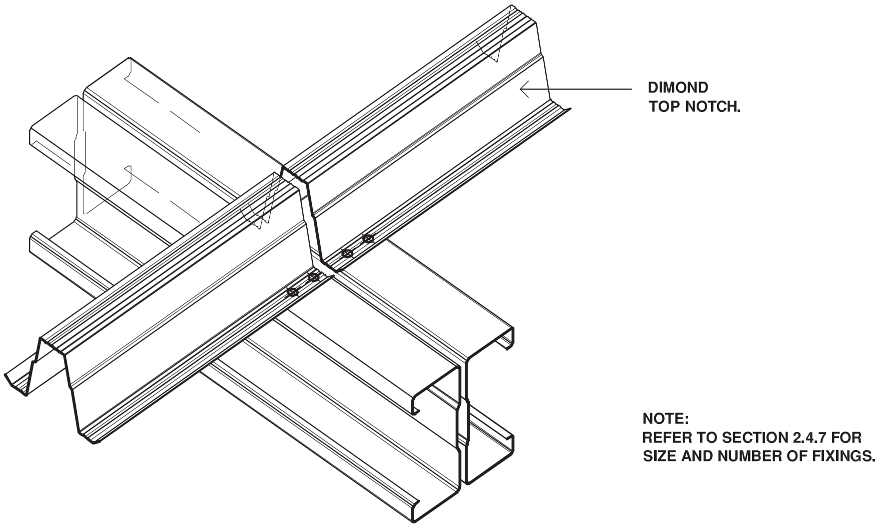




Not to scale.

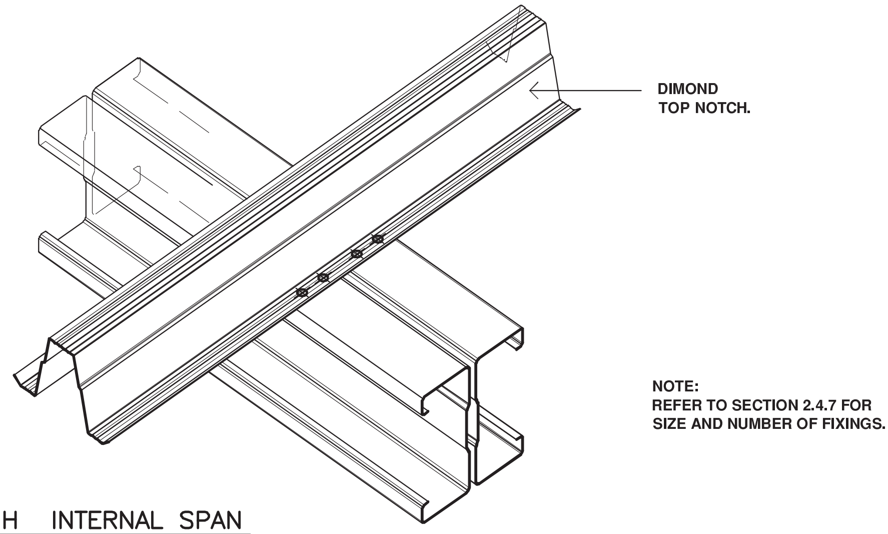
Dimond

2.4.11 TOP NOTCH CAD DETAILS *continued*



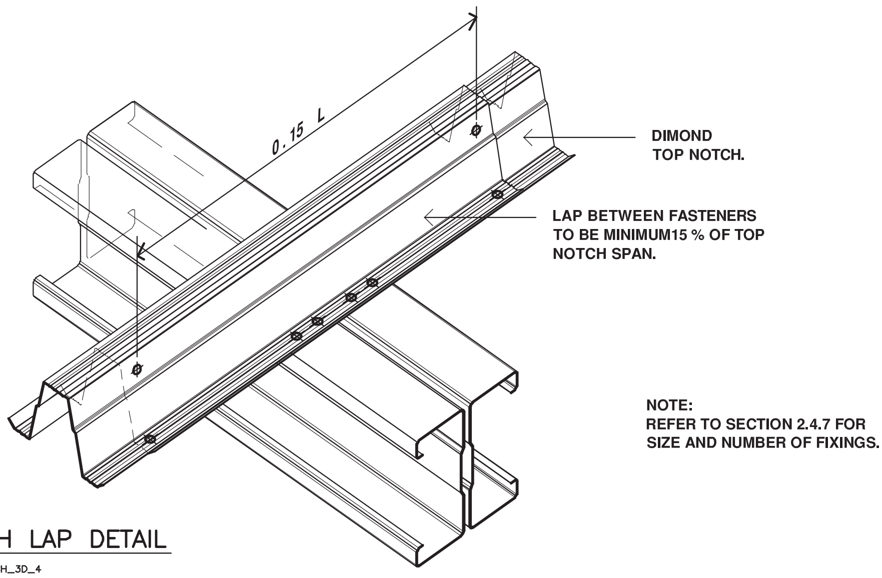
B – TOP NOTCH BUTT OR SINGLE SPAN JOINT

CAD REF: DHS\TOP_NOTCH_3D_2



C – TOP NOTCH INTERNAL SPAN

CAD REF: DHS\TOP_NOTCH_3D_3



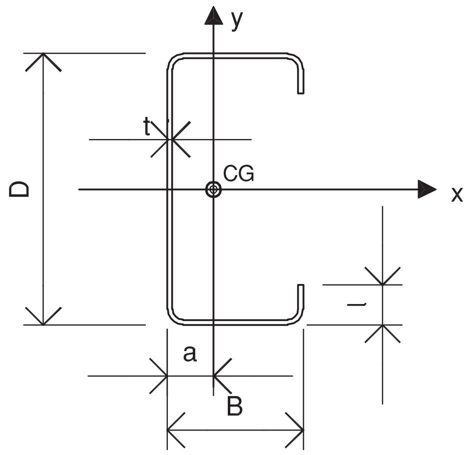
D – TOP NOTCH LAP DETAIL

CAD REF: DHS\TOP_NOTCH_3D_4

Not to scale.

2.5.1 DIMOND 100/19 PURLIN

Dimond manufacture the 100/19 C section which provides economy as a small section purlin or girt. Any limitation placed on the design and use of the Dimond Purlin Systems as detailed in this manual also apply to the Dimond 100/19 Purlin. Sag rods are used as the bracing system for the 100/19 Purlin.



Tabulated properties are based on full unreduced sections.

CODE	D x B mm	t mm	Mass kg/m	Weight kN/m	Area mm²	l mm	a mm	I_{xx} ($10^6 mm^4$)	I_{yy} ($10^6 mm^4$)	Z_{xx} ($10^3 mm^3$)
100 / 19	102 x 51	1.85	3.24	0.032	403	15	17.4	0.668	0.143	13.09

NOTE Mass assumes a total coated weight for the standard zinc coating of 275 g/m.²

Design linear load capacities in kilonewtons per metre of span (kN/m), $\Phi_b w_{bx}$

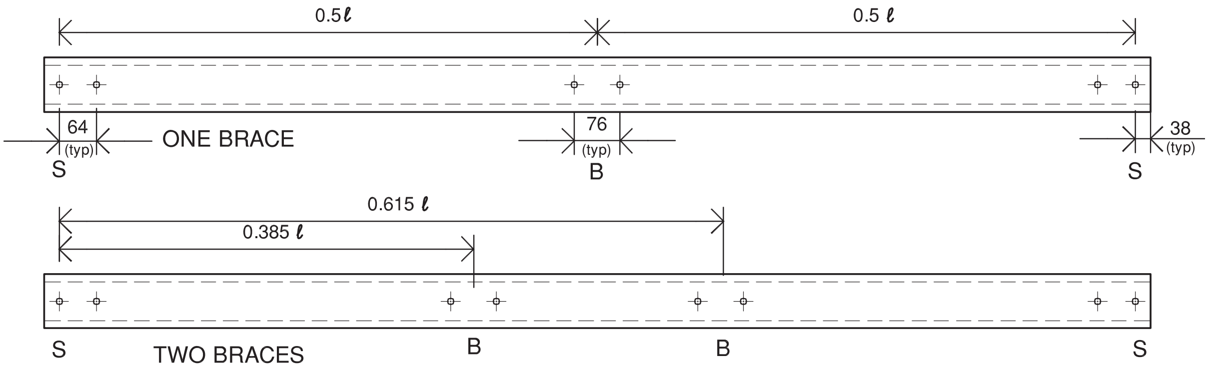
SPAN m	BRACE 1	BRACE 2	FR	W_S
3.0	4.44	4.71	4.71	2.52
3.5	2.91	3.47	3.47	1.58
4.0	1.96	2.66	2.66	1.06
4.5	1.31	2.00	2.10	0.74
5.0	0.90	1.50	1.69	.54
5.5	0.65	1.15	1.40	0.41
6.0	0.47	0.90	1.19	0.31
6.5	0.36	0.68	1.01	0.24
7.0	0.27	0.52	0.87	0.20
7.5		0.42	0.75	0.17
8.0		0.33	0.66	0.13

FR Assumes compression flange fully restrained.

W_S Linear load at a deflection of span / 150.

STANDARD HOLE PUNCHING FOR 100/19 PURLIN

SIMPLE SPANS



ℓ - Length between supports S- Support holes B- Brace

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2.5.2 BOLTS

The grade of bolts used in the design load capacities in this manual are typically grade 4.6. The design engineer will specify grade 8.8 bolts where required.

The load and shear capacity of the bolts are determined and specified by the design engineer using the table in Section 2.3.10 and following the method of the design example in Section 2.3.11.4.

Typical bolt diameters are either M12 or M16. All bolts must be used with washers against the purlin material.

All bolts supplied must comply with AS 1111 for grade 4.6 or AS 1252 for grade 8.8. Bolts should be produced to a quality assurance programme. While Dimond do not supply bolts or washers, we recommend using major suppliers such as Bremic Fasteners or EDL as preferred suppliers.

The following bolt capacities are in accordance with AS/NZS 4600.

Grade 4.6 bolts
Minimum tensile strength = 400 MPa

Grade 8.8 bolts
Minimum tensile strength = 830 MPa

2.5.3 SELF-DRILLING SCREWS

Dimond supply a range of self-drilling Buildex® screws for fixing into both steel or timber.

When fixing into mild steel, a metal tek with a hardened drill point should be chosen.

When fixing into timber, a type 17 self-drilling screw should be used.

The selection guide below is an extract from the Buildex® Product Catalogue and Selection Guide 2001.

Buildex® Metal Teks® – Fixing to Metal

Teks® self-drilling screws have a hardened drill point that will drill and thread in structural steel and mild steel. To choose the correct fastener it is necessary to select one where the length of the drill point is equal to or greater than the total thickness of the material to be drilled, and the table below gives the thickness limitations for each screw. The length should allow three threads beyond the metal being fastened to.

Taptites® require pre-drilled holes into which the fastener will thread.

Selection Guide

Use	Dimensions gauge-threads per inch x length (mm)	Coating/material available	Thickness limitation (mm)
Hex Head fixing to	10-16x16	Climaseal 4	3.5
	12-14x20	Climaseal 4	4.5
steel purlins and girts	12-14x35	Climaseal 4	4.5
	12-14x45	Climaseal 4	4.5
	14-20x22	Climaseal 4	6.4
	14-10x25	Climaseal 4	3.0
	14-10x42	Climaseal 4	3.0
	14-20x65	Climaseal 4	6.4
Hex Head Series 500 Taptites pre-drilled holes into heavy gauge steel	12-24x32	Climaseal 3	12.5
	12-24x50	Climaseal 3	12.5

Continued on next page

2.5.3 SELF-DRILLING SCREWS *continued*

Buildex® Type 17 – Fixing to Timber

Type 17's are self-drilling screws for fixing into timber. To use the correct fastener, the screw length should be chosen to achieve the minimum amount of embedment given in the table below.

Selection Guide

Use	Dimensions gauge-threads per inch x length (mm)	Coating/material available
Hex Head fixing to timber purlins and girts	12-11x45 12-11x50 12-11x65 14-10x50 14-10x65	Climaseal 3 Climaseal 4 Climaseal 4 Climaseal 4 Climaseal 4

Material Grade
Buildex® fasteners are available in a choice of finishes that comply with AS 3566, and are made to a high standard of quality backed by strict inspection and testing procedures endorsed to ISO 9002.

Climaseal 3®
Climaseal coatings use a unique anti-corrosive coating system consisting of three distinct layers which combine to give exceptional corrosion protection:

1. A mechanically deposited zinc alloy coating giving excellent galvanic protection.
2. A chromate conversion coating to passivate the zinc alloy, further inhibiting coating loss.
3. An aluminium filled polyester coating with good all-round corrosion and long-term weathering resistance.

Climaseal 4®
Buildex® Climaseal 4® fasteners meet and exceed the AS 3566 Class 4 specification. Climaseal 4® is a unique coating system comprised of an alloy combination which gives exceptional galvanic protection. The coating thickness exceeds 50 mm, which is twice the thickness of an equivalent Class 3 product.

Climaseal 4® should be used in coastal areas where salt, wind, UV and moisture are prevalent, in tropical zones, in industrial areas subject to acid rain fall-out or drift or in areas of chemical or industrial environments.

It is particularly recommended for use in moderate and severe marine environments.

Continued on next page

2.5.3 SELF-DRILLING SCREWS *continued*

STRENGTH PROPERTIES
Ultimate Average Pullout Loads

Buildex® TEKS® Screws
Fixing to Grade G450

Gauge/TPI	1.0 mm	1.2 mm	1.6 mm	1.9 mm	2.4 mm	3.2 mm
			Purlin Thickness			
12-14	2826N	3174N	4428N	5525N	7620N	11140N
12-24	–	–	3945N	–	7375N	10420N
14-10	3010N	3441N	4594N	6260N	8650N	–

Buildex® Type 17 Screws
Fixing to F5 (F5/JD4 Timber – Radiata Pine)

Screw Type	20 mm	25 mm	30 mm	35 mm	50 mm
			Embedment Depth		
12g	–	–	12-11 x 45 mm Hex 5400N	12-11 x 50 mm Hex 6300N	–
14g	–	–	14-10 x 50 mm Hex 6500N	14-10 x 50 mm Hex 6900N	14-10 x 75 mm Hex 9700N

Fixing to F17 J3 Timber – Seasoned Hardwood

Screw Type	20 mm	25 mm	30 mm	35 mm	50 mm
			Embedment Depth		
12g	–	–	12-11 x 45 mm Hex 6400N	12-11 x 50 mm Hex 7900N	–
14g	–	–	14-10 x 50 mm Hex 7100N	14-10 x 50 mm Hex 9100N	14-10 x 75 mm Hex 13500N

Mechanical Properties

Screw Type	Single Shear Strength	Axial Shear Strength	Torsional Strength
Buildex® TEKS® Screws			
12g	8.8 kN	15.3 kN	13.2 Nm
14g	10.9 kN	19.7 kN	18.5 Nm
Buildex® Type 17 Screws			
12g	8.4 kN	13.9 kN	13.4 Nm
14g	10.2 kN	17.9 kN	18.5 Nm

Note: All values are ultimate averages obtained under laboratory conditions (NATA approved). Appropriate safety factors should be applied for design purposes. These figures apply to Buildex® (BX Head marked) products only.

2.6 INSTALLATION

2.6.1 GENERAL

The fixing of Dimond Purlin Systems is generally carried out by steel fabricators and riggers who are familiar with installation of the Dimond Purlin range.

2.6.2 HANDLING & STORAGE

Correct handling and storage is critical to ensure the Dimond Purlin System is not damaged on site. The following points must be adhered to for maximum product durability and performance over the expected life of the product.

- A visual inspection should be carried out, when delivery is taken on site, of all the material supplied to ensure the product is free from damage and the galvanised coating is in good condition.
- Damaged product resulting in a distorted or buckled section shape must not be installed and should be replaced.
- Site storage must be clear of the ground on dunnage to allow the free movement of air around each bundle. When product is stored on site, it must be kept dry using covers over each product bundle.
- Wear protective gloves when handling the product. Treat all cut edges as sharp.
- Product must always be lifted when moved and not dragged as damage to the galvanised coating will occur.
- Dimond bracing must not be relied upon to act as lifting points during craneage of preassembled sections.

2.6.3 GENERAL FIXING & WORKMANSHIP

- Bundle labels should be checked to ensure the correct size and type is used for the designated area.
- Purlins are placed on the upside of the portal cleat (or at premarked centres for Top Notch), and fixed onto the cleat or rafter.
- Installation of DHS Purlins relies on the correct bolt type, diameter and washer being located through each cleat hole and tightened.
- Washers should be used under the bolt head or nuts against the DHS Purlin.
- Bolts should be tightened using the part turn tightening method, commonly termed snug fit. There are two stages, the first involves bringing the mating surfaces of the joint into effective contact by initially tightening the bolt. The second stage involves marking the bolt and nut relative to each other and then completing a further half turn.
- Self-drilling screws should installed as per engineer's specification (refer Section 2.4.7 Fasteners), and tightened with mechanical drivers set to a preset torque setting. Avoid overtightening as this may damage the galvanised coating.
- Lapped purlins require additional fixings to be installed in the lapped region. Refer detail N in Section 2.3.16.15 for DHS Purlins or detail D in Section 2.4.11 for Top Notch Purlins.
- Additional strapping for Top Notch Purlins may be required as specified by the design engineer.
- The purlin system must not be subject to or installed on spans that are excessive for the loads imposed during construction, or in the serviceable life of the product. All construction loads must have the design engineer's approval, prior to loading.
- All connections including those between the purlin system and primary structural framework must be fully fixed and tightened before any loads are applied. Similarly bracing members must be correctly positioned and fastened prior to installation of the roofing or cladding.
- Gas cutting of holes, or welding of members, or connections are not recommended, as these may cause an unacceptable loss of member strength capacity. In addition gas cutting or welding will remove the galvanised coating locally around the welded area, reducing the product's durability.
- The recommended method for cutting of Top Notch is either by hacksaw or shear cut such as tin snips. If using an abrasive disc blade, care must be taken to ensure the swarf doesn't fall on other products causing rust stains, and the burred cut edge must be cleaned off and primed after cutting.
- DHS Purlins and Top Notch Purlins are not designed for walking on as manufacturing lubricant may still be present on these components. In additional Health and Safety requirements prohibit "walking the purlins". All on-site Health & Safety requirements must be adhered to.
- Roofing and wall cladding sheets can not be installed until the roofing contractor is satisfied that the support structure is complete, sound, and correctly aligned. This includes support around penetrations and openings.
- Curved roofs (whether draped/rolled or crimped) require purlin alignment within ±5mm to minimise the risk of unacceptable finished appearance.
- Hanging of fixtures from the purlin lips, brace channel lips or brace channel flanges is not recommended. All fixtures must be attached to the web of the member they will be connected to and are subject to specific design by the engineer.
- Dimond Purlin Systems are not intended to be used as members to which fall arrest anchor points are attached.

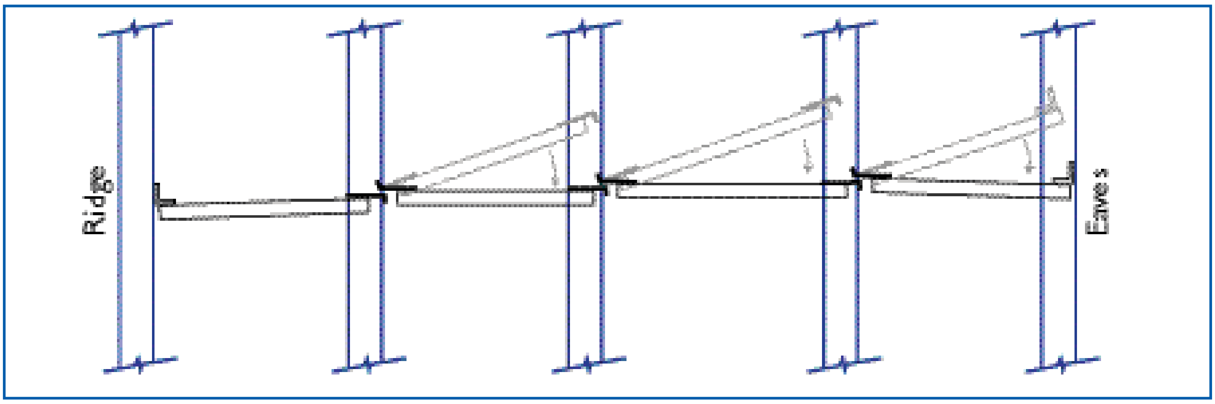
2.6.4 DHS BRACING INSTALLATION

Prior to the purlin system being fully tensioned up and loads applied, the bracing system must be installed.

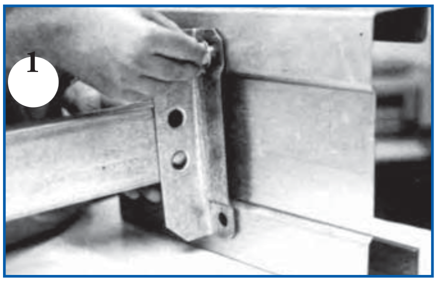
2.6.4.1 FASTBRACE INSTALLATION

Installation of Fastbrace is started from the ridge and works down the roof slope, but the first row of Fastbrace must be bolted off on the top purlin before beginning the next row.

Standard Installation Procedure

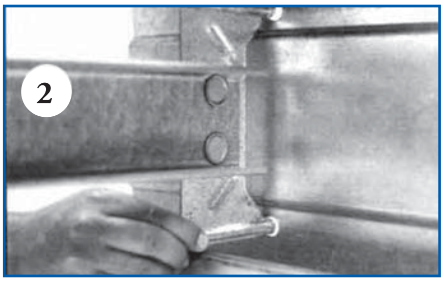


Note: As the eaves and ridge braces are bolted, there is a 25mm offset to the bracing line. This offset can be aligned, refer Section 2.3.15.1 Fastbrace.

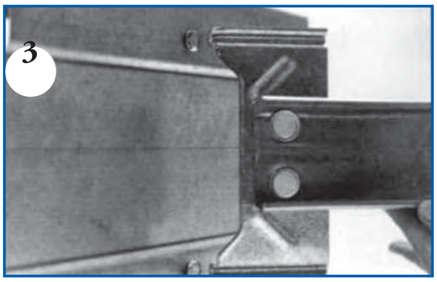


1. The end cleat is bolted to the purlin at the ridge.

It is vital to make sure that the bolted cleat at the ridge is on the left of the brace (looking from the ridge down).

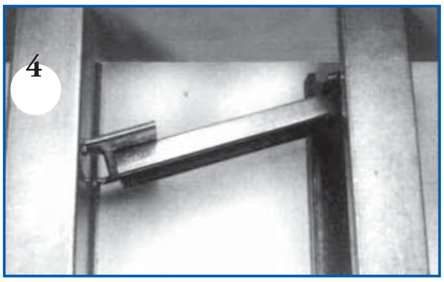


2. The locking tabs at the other end of the brace are then fitted into the second purlin and pushed to the right to lock (looking from the ridge down).



3. The second brace is then held at a 45 degree angle and inserted into the other side of the second purlin. Now rotate the brace until square to the purlin.

Ensure all locking tabs are fitted into the purlin holes.



4. Fit the other end of the brace into the next purlin. Steps 3 and 4 of this process are then repeated until the last cleat is bolted to the eave purlin.

Note that due to the versatility of the system, the process can be started at the ridge or the eaves.

Continued on next page

2.6.4.1 FASTBRACE INSTALLATION *continued*

Adjustable Fastbrace allows up to 20mm adjustment to be made anywhere in the Fastbrace system, simply by installing this adjustable brace and fully tightening two bolts. Further detail is in Section 2.3.15.

Purpose-made cranked sag rods, installed in the lower holes of the DHS ridge purlin at the bracing line, tie each roof plane together at the ridge. These rods should be fitted with washer and double nuts and fully tightened up prior to loading.

Bolted channel bracing relies on placing and tightening one bolt top and bottom through the brace cleat/ purlin assembly. Hence the installation time required for bolted channel bracing is much longer than for Fastbrace.

2.7 REFERENCES USED IN THE PURLIN SYSTEM SECTION

AS 1111.1:2000	Isometric hexagon bolts and screws
AS/NZS 1170:2002	Structural design actions
AS 1252:1996	Bolts – Steel – high strength
AS 1397:2001	Steel sheet and strip – Hot dipped zinc coated or aluminium zinc coated
AS 3566:2002	Self-drilling screws for building and construction industries
AS/NZS 4600:1996	Cold formed steel structures
NZBC	The New Zealand Building Code
ECCS 1983	European recommendation for Steel Construction. The design of profiled sheeting.
S 1108 1997	Dimond Hi-Span Vacuum Rig Tests Centre for Advanced Structural Engineering, The University of Sydney
S 1128 1997	Capacity Tables for Dimond Hi-Span (DHS) Purlins Centre for Advanced Structural Engineering, The University of Sydney

3.0 FLOORING SCOPE & DURABILITY

3.2 FLOORING QUICK REFERENCE GUIDE
Hibond
Flatdeck

3.3 SPECIFIC DESIGN - HIBOND FLOORING
3.3.1 Hibond Desing Considerations
3.3.2 Hibond Design Limitations
3.3.3 Hibond Section Properties
3.3.4 Hibond Formwork Design
3.3.5 Hibond Load Span Tables
3.3.6 Hibond Fire Design
3.3.7 Hibond Noise Control
3.3.8 Hibond Floor Vibration
3.3.9 Hibond Thermal Insulation
3.3.10 Hibond Design Examples
3.3.11 Hibond Specifications
3.3.13 Hibond Components
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3.4 SPECIFIC DESIGN - FLATDECK FLOORING
3.4.1 Flatdeck Design Considerations
3.4.2 Flatdeck Design Limitations
3.4.3 Flatdeck Section Properties
3.4.4 Flatdeck Formwork Design
3.4.5 Flatdeck Load Span Tables
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3.4.14 Flatdeck CAD Details

3.5 FLOORING INSTALLATION
3.5.1 General Installation
3.5.3 Hibond Installation
3.5.4 Flatdeck installation

3.6 FLOORING REFERENCES

For online technical information
visit **www.dimond.co.nz**

Contact the Dimond Technical Team:
0800 ROOF SPEC (0800 766377)
For Design Advice, Technical Assistance, System Specification Help

Contact your Dimond Sales Centre:
0800 DIMOND (0800 346663)
For Sales, Delivery, Availability & Pricing Information

Dimond

3.0 SCOPE OF USE

Dimond Flooring Systems use a roll-formed profiled galvanised steel sheet as a component in reinforced concrete floor systems. The sheet provides both permanent formwork and positive tensile reinforcement in one way reinforced concrete slab construction over concrete block walls, poured concrete beams, steel beams or timber beams, which are subject to environmental limitations referenced to the appropriate grade of material selected.

It is critical to product performance that the loads applied, spans, formwork material thickness and overall slab thickness are designed within the appropriate Limit State Loads and limitations published in this manual.

Before commencing a project using a Dimond Flooring System, the user must refer to the information within this manual and all sections as appropriate, ensuring relevant information is available to the end user. Failure to observe this information may result in a significant reduction in product performance. Dimond accepts no liability whatsoever for products which are used otherwise than in accordance with these recommendations.

The information contained within Flooring Systems is only applicable to Dimond Flooring Systems – it cannot be assumed to apply to similar products from other manufacturers.

USE OUTSIDE THE STATED GUIDELINES

If the need arises to use the Dimond Flooring System outside the limitations and procedures given in this manual or if there exists any doubt on product handling or use, written approval should be obtained from Dimond for the specific project, before the project is commenced.

3.1 DURABILITY

3.1.1 SCOPE

The Dimond Flooring Systems described in this manual are subject to the environments in which they are used and the type of coating used as outlined in detail in this section.

3.1.2 COATING MATERIAL SPECIFICATIONS

Dimond Flooring Systems are manufactured from galvanised coil in grade Z275 i.e. 275 g/m^2 total galvanised zinc coating weight.

Grade Z275 usually requires a three-month lead time from date of order to supply for all thicknesses and quantities. Other grades of zinc coating are available. Please contact Dimond for guidance.

3.1.3 ENVIRONMENTS

3.1.3.1 GENERAL

The durability of galvanised zinc coated products is dependent on:

- The environment it will be installed in.
- The grade or weight of the zinc coating used.
- The degree and extent of the maintenance that will be undertaken over the life of the product.

Performance of galvanised zinc coated flooring products is affected by:

- The cumulative effects of the weather to either the underside surface or moisture ingress of the top surface.
- The amount of dust (which can hold moisture) that settles on the product.
- Any other wind-blown deposits that may settle on the product, promoting corrosion.
- Proximity to the ground in subfloor areas with little or no ventilation.

Condensation or other deposits should be prevented from accumulating on the Dimond Flooring System underside by providing adequate ventilation. A protective barrier must be provided if dampness is possible on the underside of the steel flooring sheet. Refer 3.1.5.

3.1.3.2 LIMITATIONS ON USE

The use of galvanised steel flooring sheet should be avoided:

- In areas where high concentrations of chemicals are combined with a high humidity, unless an appropriate protective coating system is applied to the underside surface and fully maintained for the design life of the structure. In this situation the system remains wet for long periods of time, causing a rapid consumption of the galvanised zinc coating and eventual red rusting of the base metal.
- Where the galvanised surface is being exposed to continuous moisture, without a chance for the surface to dry out, unless an appropriate protective coating system is applied to the underside surface and fully maintained for the design life of the structure. For example, where used as the cover slab of a water tank.
- In or near marine environments, where the prevailing wind carries marine salts, unless an appropriate protective coating system is applied to the underside surface and fully maintained for the design life of the structure.
- In areas surrounding chemical or industrial storage buildings where any chemical attack may lessen the life of the structure or wind-driven chemical fumes may attack the galvanised coating, unless an appropriate protective coating system is applied to the underside surface and fully maintained for the design life of the structure. Please call 0800 Roofspec (0800 766 377) to discuss.
- When in contact with or laid directly on ground.
- When in contact with timber and especially treated timber such as CCA (copper chrome arsenic) without the use of an isolating material such as Malthoid (DPC) between the timber and galvanised steel flooring sheet.
- When used in sub-floor areas with less than 450mm ground clearance.
- When used in sub-floor areas where ventilation does not comply with NZS 3604 Clause 6.14.

Chemical admixtures may only be used with Dimond Flooring Systems if they are compatible with galvanised steel.

Where the top surface of the slab is exposed to moisture, use of the Dimond Flooring System without an appropriate coating system (which is fully maintained for the design life of the structure) and/or adequate crack control to the top surface of the concrete slab should be avoided. Moisture seeping through cracks which are not effectively sealed or which do not have adequate crack control can combine with oxygen to the extent that corrosion of the galvanised steel sheet may occur. For guidance on methods of protection refer to Section 3.1.5 Durability Statement.

3.1.4 NZBC COMPLIANCE

Past history of use of Dimond Flooring Systems indicate that provided the product use and maintenance is in line with the guidelines of this manual, Dimond Flooring Systems can reasonably be expected to meet the performance criteria in Clause B1 Structure and B2 Durability of the New Zealand Building Code for a period of not less than 50 years, provided they are kept free from moisture.

Dimond Flooring Systems designed using the Fire Design Sections 3.3.6 and 3.4.6 of this manual and HERA Reports R4-82 and R4-131 as appropriate will meet the performance criteria in Clauses C3 and C4 of the New Zealand Building Code.

Unless noted otherwise in the Noise Control Sections (3.3.7 and 3.4.7), Dimond Flooring Systems designed using this manual that are stated to achieve Sound Transmission Class (STC) and Impact Insulation Class (IIC) of 55 meet the requirements of the current New Zealand Building Code (NZBC) Clause G6.

Where products used in Dimond Flooring Systems are manufactured by other suppliers, compliance to the NZBC should be checked with that product's manufacturer.

3.1.5 DURABILITY STATEMENT

The use of Dimond Flooring Systems is limited to dry and non corrosive environments. It is the responsibility of the designer to assess the durability requirements of the flooring slab. Consideration must be given to minimum concrete cover of the reinforcement and NZS 3101 provides guidance in this area.

Dimond can, for specific job locations, give advice on the performance of the Dimond galvanised zinc coated flooring system. Call Dimond on 0800 Roofspec.

When using Dimond Flooring Systems in areas as stated in Limitations of Use, achieving the required durability of the system is dependent on adhering to the following:

1. For protection of the galvanised underside surface:
   An application of a suitable paint system to the galvanised surface exposed on the underside of the floor. Specifications for specific locations can be obtained from Ameron Coatings 0800 263 766 or Akzo Nobel Coatings Limited 0800 808 807.
2. Where the top surface requires protection to suppress moisture entering the concrete one of the following methods is needed:
   - Design reinforcement in the slab for "Strong Crack Control" as outlined in HERA Report R4-113 Section 3.3 Control of Cracking and Leaks.
   - Provide the minimum necessary reinforcement in the slab *and* apply a suitable proprietary waterproofing agent (either mixed into the concrete before pouring or sprayed onto the top surface after curing).
   - Provide the minimum necessary reinforcement in the slab *and* apply a proprietary waterproofing membrane.
3. Where the top surface requires protection to prevent moisture entering the concrete one of the following methods is needed:
   - Provide the minimum necessary reinforcement in the slab *and* apply a proprietary waterproofing membrane.
   - Provide reinforcement in the slab for "Strong Crack Control" (outlined in HERA Report R4-113 Section 3.3 Control of Cracking and Leaks) *and* apply a suitable waterproofing agent (either mixed into the concrete before pouring or sprayed onto the top surface after curing).

3.1.6 MAINTENANCE

Dimond Flooring Systems require a minimum degree of maintenance to ensure expected performance is achieved. Careful maintenance can extend the useful life of the Dimond Flooring System.

As a guide the following should be carried out as often as is needed (this could be as often as every three months).

a) Keep surfaces clean and free from continuous contact with moisture, dust and other debris. This includes areas such as exposed undersides, eg decks or subfloors.

b) Any surface cracking exposed to possible water ingress is fully sealed. Similarly ponding of water on exposed top surfaces must be avoided to ensure durability requirements are met.

c) Regular maintenance should include a washdown programme to remove all the accumulated dirt or salt buildup on all the galvanised surfaces with a soft brush and plenty of clean water or by water blasting at 15 MPa (2000 psi).

d) Periodically inspect the Dimond Flooring System. At the first sign of any underside corrosion, the affected areas should be cleaned down, spot primed and then repainted to an appropriate paint manufacturer's recommendations.

Any cases of severe damage or corrosion must be reported to the design engineer.

3.2 PERFORMANCE

3.2.1 GENERAL DESIGN

Dimond Flooring Systems may be used as formwork only or in composite slab applications. Where used as formwork only, the contribution of the steel sheet to the tensile strength of the slab is ignored and tensile reinforcement is provided by additional reinforcing bars placed in the concrete. Where used as a composite slab, the tensile reinforcement is provided by the steel sheet itself.

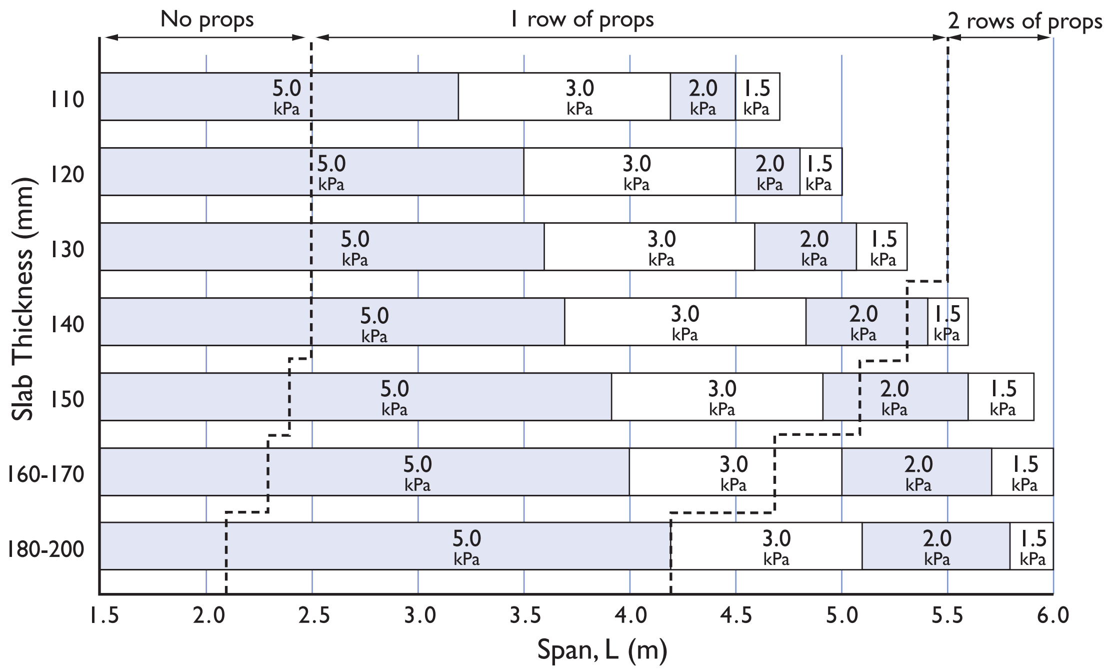
The following charts and tables are based on typical product use and are intended as a quick reference guide only. These must not be used for design purposes or as a substitute for specific design (refer to Sections 3.3 Specific Design – Hibond Flooring and 3.4 Specific Design – Flatdeck Flooring).

There may be specific cases in this section where the spans indicated on the guides will not be achievable, for example no allowance has been made for fire design, acoustics or vibration sensitivity.

3.2.2 HIBOND QUICK REFERENCE GUIDE

1. Values shown are based on 0.75mm Hibond used in single span configuration for the medium term loading condition.
2. The imposed loads (Q) shown in kPa allow for an additional 0.5 kPa as superimposed dead load (SDL) on loads up to 3.0 kPa and 1.0 kPa SDL for Q = 5.0 kPa. Long term loads have been assumed. Span, L (m) shown indicates clear span + 100mm.
3. It is important to place the stated number of temporary propping lines for the selected span prior to Hibond being laid. These span limits should be reduced where minimal soffit deflection is important.
4. Deflection limits used within this table are:
   Formwork: L/180 due to dead load or (slab thickness)/10 to avoid concrete ponding problems.
   Composite Slab: L/350 or 20mm due to superimposed load (where unpropped) or L/250 due to superimposed load plus prop removal.

   The user should satisfy themselves that these limits are adequate for the application considered.



Loading Key:
5.0 kPa Office storage, plant rooms and workshops
3.0 kPa Offices for general use
2.0 kPa Balconies in residential self-contained dwellings
1.5 kPa Residential self-contained dwellings.

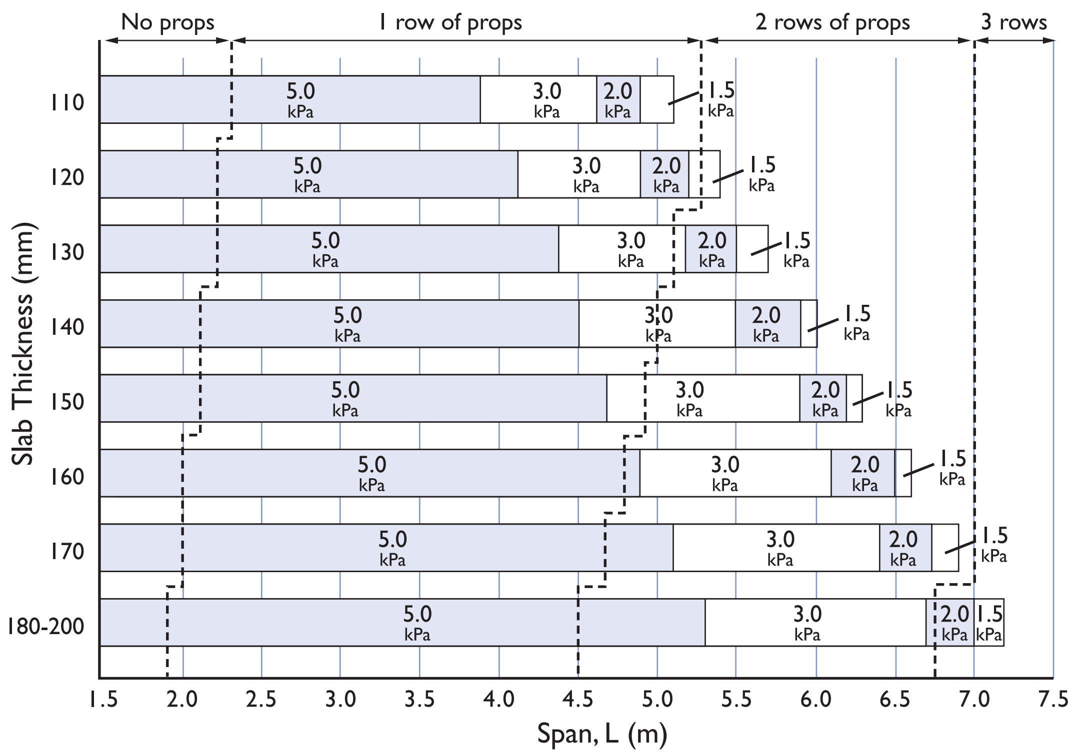
Dimond

3.2 PERFORMANCE *continued*

3.2.3 FLATDECK QUICK REFERENCE GUIDE

1. Values shown are based on 0.75mm Flatdeck used in single span configuration for the medium term loading condition.
2. The imposed loads (Q) shown in kPa allow for an additional 0.5 kPa as superimposed dead load (SDL) on loads up to 3.0 kPa and 1.0 kPa SDL for Q = 5.0 kPa. Long term loads have been assumed. Span, L (m) shown indicates clear span + 100mm.
3. It is important to place the stated number of temporary propping lines for the selected span prior to Flatdeck being laid. These span limits should be reduced where minimal soffit deflection is important.
4. Deflection limits used within this table are:
   Formwork: L/180 due to dead load.
   Composite Slab: L/350 or 20mm due to superimposed load (where unpropped) or L/250 due to superimposed load plus prop removal.

   The user should satisfy themselves that these limits are adequate for the application considered.



Loading Key: 5.0 kPa Office storage, plant rooms and workshops
3.0 kPa Offices for general use
2.0 kPa Balconies in residential self-contained dwellings
1.5 kPa Residential self-contained dwellings.

3.2.4 HIBOND AND FLATDECK NOISE CONTROL FLOOR/CEILING SYSTEMS SUMMARY

System Reference Code	STC	Description of System	Floor Covering Option	IIC
G General	**42**	0.75 or 0.95mm Hibond or Flatdeck. Acoustic performance is based on 120mm overall concrete slab thickness.	Bare slab	23
			15mm strip timber on Bostic Ultraset adhesive	40
			6mm cork flooring	42
			Gerfloor Taralay Comfort Vinyl 3.1mm thick	43
			15mm strip timber on 1mm polyethylene foam	44
			Carpet, nylon or wool 40oz without underlay	66
			Carpet, wool 60oz without underlay	67
			Wool or nylon carpet plus 8mm foam underlay	71
SDL Separate Dwelling Living Zone	**54**	0.75 or 0.95mm Hibond or Flatdeck with 120mm overall slab thickness. USG furring channel at 600mm centres supported by Potters sound isolation clips. 1 x layer of 13mm GIB® standard plasterboard.	Bare slab	39
			15mm strip timber on Bostic Ultraset adhesive	46
			6mm cork flooring	47
			Gerfloor Taralay Comfort Vinyl 3.1mm thick	49
			15mm strip timber on 1mm polyethylene foam	47
			Carpet, nylon or wool 40oz without underlay	60
			Carpet, wool 60oz without underlay	62
			Wool or nylon carpet plus 8mm foam underlay	66
MDLa Multi-Unit Dwelling Living Zone Alternative a	**61**	0.75 or 0.95mm Hibond or Flatdeck with 120mm overall slab thickness. 75mm thick R1.8 Pink Batts insulation blanket (density 9 kg/m³ min). USG furring channel at 600mm centres supported by Potters sound isolation clips. 1 x layer of 13mm GIB® standard plasterboard.	Bare slab	42
			15mm strip timber on Bostic Ultraset adhesive	54
			6mm cork flooring	56
			Gerfloor Taralay Comfort Vinyl 3.1mm thick	56
			15mm strip timber on 1mm polyethylene foam	57
			Carpet, nylon or wool 40oz without underlay	67
			Carpet, wool 60oz without underlay	69
			Wool or nylon carpet plus 8mm foam underlay	73
MDLb Multi-Unit Dwelling Living Zone Alternative b	**59**	0.75 or 0.95mm Hibond or Flatdeck with 120mm overall slab thickness. USG Donn Screwfix suspended ceiling system and furring channel at 600mm centres suspended by wire, supported by either the Dimond hanger tab (for Hibond only) or a masonry suspension anchor for both Hibond and Flatdeck. 1 x layer of 13mm GIB® standard plasterboard.	Bare slab	35
			Ceramic tile on Bostic Ultraset adhesive	51
			15mm strip timber on Bostic Ultraset adhesive	50
			6mm cork flooring	53
			Gerfloor Taralay Comfort Vinyl 3.1mm thick	52
			Carpet, nylon or wool 40oz without underlay	63
			Carpet, wool 60oz without underlay	65
			Wool or nylon carpet plus 8mm foam underlay	69
MDS Multi-Unit Dwelling Service Zone	**61**	0.75 or 0.95mm Hibond or Flatdeck with 120mm overall slab thickness. 75mm thick R1.8 Pink Batts insulation blanket (density 9 kg/m³ min). USG Donn Screwfix suspended ceiling system and furring channel at 600mm centres suspended by wire, supported by either the Dimond hanger tab (for Hibond only) or a masonry suspension anchor for both Hibond and Flatdeck. 1 x layer of 13mm GIB® standard plasterboard.	Bare slab	43
			Ceramic tile on Bostic Ultraset adhesive	55
			15mm strip timber on Bostic Ultraset adhesive	62
			6mm cork flooring	64
			Gerfloor Taralay Comfort Vinyl 3.1mm thick	66
			Carpet, nylon or wool 40oz without underlay	75+
			Carpet, wool 60oz without underlay	75+
			Wool or nylon carpet plus 8mm foam underlay	75+

Note

- Shaded areas above show values of Sound Transmission Class (STC) and Impact Insulation Class (IIC) of 55dB or above.
- For full system description and construction detailing reference must be made to the specification sheets in Section 3.3.7.
- Call Dimond on 0800 Roofspec (0800 766 377) for the sound insulation performance when the slab is greater than 120mm thick.

3.2.5 COST COMPARISON OF DIMOND FLOORING SYSTEMS

As a guide for cost comparison purposes the following table has been calculated for Hibond and Flatdeck composite flooring for various formwork base metal thickness (BMT) and slab thickness.

DIMOND FLOORING	Unit	Auck $	Wgtn $	Chch $	Dun $
0.75mm BMT Hibond composite flooring system,					
110mm thick	m^2	98.00	97.00	94.00	97.00
150mm thick	m^2	107.00	106.00	102.00	106.00
200mm thick	m^2	125.00	123.00	117.00	123.00
0.95mm BMT Hibond composite flooring system,					
110mm thick	m^2	103.00	102.00	100.00	102.00
150mm thick	m^2	113.00	112.00	108.00	112.00
200mm thick	m^2	130.00	128.00	123.00	128.00
0.75mm BMT Flatdeck composite flooring system,					
110mm thick	m^2	102.00	101.00	98.00	101.00
150mm thick	m^2	112.00	110.00	106.00	110.00
200mm thick	m^2	129.00	127.00	121.00	127.00
0.95mm BMT Flatdeck composite flooring system,					
110mm thick	m^2	108.00	107.00	103.00	107.00
150mm thick	m^2	117.00	116.00	111.00	116.00
200mm thick	m^2	135.00	133.00	126.00	133.00

Costs for Hibond and Flatdeck include:

- Propping, placed and stripped
- Dimond steel flooring and accessories, installed inclusive of shear studs
- Edge formwork, installed
- Mesh reinforcing
- 25 MPa concrete, pumped and placed

3.3 SPECIFIC DESIGN – HIBOND FLOORING

3.3.1 INTRODUCTION

The Hibond Flooring System has been designed to comply with BS 5950 using the relevant load combinations therein and the relevant clauses of the New Zealand Building Code. Detailed analysis and comprehensive physical testing have enabled load/span tables to be established using the limit states design philosophy.

Data presented in this manual is intended for use by structural engineers. Use of the Hibond Flooring System in applications other than uniformly distributed loads or outside the scope of this manual will require specific design.

A design yield strength of 550 MPa for 0.75mm base metal thickness (BMT) Hibond and 520 MPa for 0.95mm BMT Hibond has been used.

A minimum 28 day compressive strength of 25 MPa for high grade concrete has been assumed.
A minimum Hibond flooring slab thickness of 110mm has been used in this manual, in accordance with BS 5950.

The self weight of the Hibond Flooring System (including the concrete) has been included in the load tables.

3.3.2 DESIGN CONSIDERATIONS

Formwork

Where Hibond sheet is used as formwork, the trapezoidal shape of the profile provides resistance to wet concrete (G) and construction loads (Q). Maximum formwork spans given in Section 3.3.4.1 Hibond Formwork Tables are based on design checks for bending, web crushing, vertical shear, combined actions and deflection.

Hibond sheets must be laid in one continuous length between permanent supports. Short sheets of Hibond must never be spliced together to achieve the span between temporary or permanent supports.

Composite Slab

Design capacity of the Hibond Flooring System is largely dependent on interaction between the concrete and the Hibond sheet commonly referred to as shear bond. Shear bond is a combination of chemical bond between the concrete and the Hibond sheet and mechanical bond between the concrete and the embossments in the webs of the Hibond sheet. This allows tension forces to be transferred from the concrete into the Hibond sheet.

Capacities for the Ultimate Limit State were derived for positive bending, shear bond, vertical shear and negative bending as appropriate. Each of these values was back substituted into the design combinations for the applied actions using 1.4 (dead load) + 1.6 (superimposed load).

The minimum resulting superimposed load, from all actions (including deflections), was used in the tables.

Appropriate imposed floor actions (Q) should be determined in accordance with AS/NZS 1170.1. All superimposed dead load (G_{SDL}) is then added to the imposed action (Q) to give a design superimposed load (G_{SDL} + Q) expressed in kPa for direct comparison with the tabulated data in Section 3.3.5 Hibond Composite Slab Load Span Tables.

Fire Design

Fire resistance for the Hibond Flooring System may be achieved by several methods. These include placement of additional reinforcement, spray-on insulation retardant, placement of suspended ceilings, and increasing the overall slab thickness. We have considered placement of additional reinforcement in the fire design tables.

This method is based on resistance to collapse (stability), the ability of the Hibond floor slab to prevent flames passing through cracks formed in the slab (integrity) and limiting the temperature increase on the unexposed side of the Hibond floor slab (insulation).

The fire design tables are based on design checks for bending (shear is rarely critical), in accordance with NZS 3101, based on the load combination $G + \psi_{\ell}Q$ for single spans which are effective in fire emergency conditions (where ψ_{ℓ} is the factor for determining quasi-permanent values for long term actions). Full design methodology is provided in HERA Report R4-82.

The fire design tables include a superimposed dead load (G_{SDL}) of 0.5 kPa in order that an imposed action (Q) can be compared directly with the tables in Section 3.3.6 Fire Design Tables.

Continued on next page

3.3.2 DESIGN CONSIDERATIONS *continued*

Additional Reinforcement

Mesh Reinforcement

Mesh reinforcement is placed at minimum cover (according to durability requirements outlined in NZS 3101 Section 3.11) in order to provide:

- Control of cracks caused by shrinkage during curing.
- Nominal continuity reinforcement over supporting members where a floor is designed as a series of simply supported Hibond floor slabs.

For propped construction consideration should be given to increasing nominal continuity reinforcement over supports as crack widths will increase when props are removed. Guidance on crack width tolerances is given in NZS 3101 and HERA Report R4-113.

Consideration should be given to orientating the top bar of the mesh to be parallel to the span of the steel sheet. This will provide the optimum nominal continuity from the mesh.

The following guide features mesh sizes for various slab thicknesses based on the degrees of crack control recommended in AS 3600 in conjunction with the exposure classification, concrete strengths and cover to reinforcing in NZS 3101.

These guidelines do not cover special requirements for reinforcement at locations where the slab is subject to high stresses due to deformation compatability (for example around columns).

Where NZS 3101 requires explicit crack control, this must be specifically determined by the design engineer.

1. For composite slabs fully enclosed within a building except during construction (generally exposure classification A1)

AS 3600 Criteria Design Slab Thickness DS (mm)	Minor		Moderate		Strong	
	Non-Ductile	Super Ductile	Non-Ductile	Super Ductile	Non-Ductile	Super Ductile
110	665	SE62	663	SE82	2 x 663	2 x SE82
120	665	SE62	2 x 665	2 x SE62	2 x 663	2 x SE82
130	665	SE62	2 x 665	2 x SE62	HD12 @ 250	HD12 @ 250
140	663	SE82	2 x 663	2 x SE82	HD12 @ 200	HD12 @ 200
150	663	SE82	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
160	663	SE82	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
170	663	SE82	2 x 663	2 x SE82	HD12 @ 150	HD12 @ 150
180	2 x 665	2 x SE62	HD12 @ 250	HD12 @ 250	HD12 @ 150	HD12 @ 150
190	2 x 665	2 x SE62	HD12 @ 200	HD12 @ 200	HD12 @ 100	HD12 @ 100
200	2 x 665	2 x SE62	HD12 @ 200	HD12 @ 200	HD12 @ 100	HD12 @ 100

Note:

a. For nominal continuity reinforcement over supporting members where a floor is designed as a series of simply supported Hibond floor slabs, use the 'minor' column in the table above.

b. Where ductile steel reinforcing bars (eg H16@200) are used the maximum area of longitudinal top steel required is the **greater** of 75% of the area of transverse steel required in the table above or the amount of longitudinal steel required for continuity from the load span tables in Section 3.3.5 or that determined by specific design. Reinforcing bars are Grade 500 to AS/NZS 4671.

c. Super Ductile wire mesh is based on a minimum 500MPa tensile wire.

Continued on next page

3.3.2 DESIGN CONSIDERATIONS *continued*

2. For composite slabs in exposure classification A2 moderate or strong crack control is always required.

Required Slab Thickness (mm)	AS 3600 Criteria Design Slab Thickness DS (mm)	Moderate		Strong	
		Non-Ductile	Super Ductile	Non-Ductile	Super Ductile
120	110	2 x 665	2 x SE62	2 x 663	2 x SE82
130	120	2 x 665	2 x SE62	HD12 @ 250	HD12 @ 250
140	130	2 x 665	2 x SE62	HD12 @ 200	HD12 @ 200
150	140	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
160	150	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
170	160	2 x 663	2 x SE82	HD12 @ 150	HD12 @ 150
180	170	2 x 663	2 x SE82	HD12 @ 150	HD12 @ 150
190	180	HD12 @ 250	HD12 @ 250	HD12 @ 125	HD12 @ 125
200	190	HD12 @ 200	HD12 @ 200	HD12 @ 125	HD12 @ 125
210	200	HD12 @ 200	HD12 @ 200	HD12 @ 100	HD12 @ 100

Note:

a. To illustrate the effect of exposure classification on crack control requirements the slab thickness has been increased by 10mm to meet the minimum cover requirements of NZS 3101. This assumption means that longitudinal top steel requirements over supporting members can be designed using the load span tables in Section 3.3.5, provided that the extra thickness is treated purely as superimposed dead load and the composite slab is designed to the original design slab thickness.

b. Where ductile steel reinforcing bars (eg H16@200) are used the maximum area of longitudinal top steel required is the **greater** of 75% of the area of transverse steel required in the table above or the amount of longitudinal steel required for continuity from the load span tables in Section 3.3.5 or that determined by specific design. Reinforcing bars are Grade 500 to AS/NZS 4671.

3. For composite slabs in exposure classification B1 strong crack control is always required.

Required Slab Thickness (mm)	AS 3600 Criteria Design Slab Thickness DS (mm)	Strong	Strong Ductile
120	110	HD12 @ 250	HD12 @ 250
130	120	HD12 @ 200	HD12 @ 200
140	130	HD12 @ 200	HD12 @ 200
150	140	HD12 @ 175	HD12 @ 175
160	150	HD12 @ 150	HD12 @ 150
170	160	HD12 @ 150	HD12 @ 150
180	170	HD12 @ 125	HD12 @ 125
190	180	HD12 @ 125	HD12 @ 125
200	190	HD12 @ 125	HD12 @ 125
210	200	HD12 @ 100	HD12 @ 100

Note:

a. To illustrate the effect of exposure classification on crack control requirements the slab thickness has been increased by 15mm to meet the minimum cover requirements of NZS 3101. This assumption means that longitudinal top steel requirements over supporting members can be designed using the load span tables in Section 3.3.5, provided that the extra thickness is treated purely as superimposed dead load and the composite slab is designed to the original design slab thickness.

b. Ductile requirements have been provided for this exposure classification to provide the flexibility that longitudinal bars could be used in conjunction with the above for negative steel requirements.

c. Where ductile steel reinforcing bars (eg H16@200) are used the maximum area of longitudinal top steel required is the **greater** of 75% of the area of transverse steel required in the table above or the amount of longitudinal steel required for continuity from the load span tables in Section 3.3.5 or that determined by specific design. Reinforcing bars are Grade 500 to AS/NZS 4671.

d. Composite slabs in exposure classification B2 and C will require a thicker slab than those for B1 above and a higher strength concrete – therefore specific design to NZS 3101 is required.

3.3.2 DESIGN CONSIDERATIONS *continued*

Ductile Reinforcement

Ductile reinforcement (to elongation requirements of BS 4449) may also be required in the following instances:

- To gain full continuity over supporting members in continuous spans (refer Section 3.3.5 Hibond Composite Slab Load Span Tables).
- To increase the fire resistance of the floor slab (refer Section 3.3.6 Fire Design Tables).
- To distribute loads around openings in the floor slab.
- To provide negative reinforcement necessary for floor slabs used as cantilevers (where the contribution of the Hibond sheet is neglected in design).
- Where a point load is not fixed in position and can occur anywhere on the floor slab (for example car parks), placement of transverse reinforcement is required throughout the slab (minimum area as for line loads).
- When used as transverse reinforcement to distribute point loads and line loads; and resist transverse bending in the composite slab as a result of point loads (refer Section 3.3.10 Design Examples). The following two cases need to be considered.

$P_Q \leq 7.5$ kN

For a discrete point load ≤ 7.5 kN it is practical to use 2 – H10 transverse bars over the effective width of the Hibond slab (b_{eb} – refer BS 5950: Part 4 Clause 6.7) centred about the point load.

Where line loads perpendicular to the direction of slab span are present (≤ 7.5 kN/m), transverse reinforcing bars with a minimum cross sectional area of $2(D_s – 55)$ mm^2 per metre of load length (over the effective width of the line load) is required.

This equates to: H10 @ 400mm centres for composite slabs 110-150mm
H12 @ 400mm centres for composite slabs 160-200mm

Line loads running parallel to the span should be treated as a series of discrete point loads.

$P_Q > 7.5$ kN

For a discrete point load > 7.5 kN, transverse reinforcement is required to satisfy the following moment resistance.

$M^*_{trans} = P^* b_{eb} / (15w)$ where $w = L/2 + b_1$ and $w \ngtr L$

Where M^*_{trans} = Factored bending moment in the transverse direction
P^* = Factored concentrated point load
b_{eb} = Effective width of slab
L = Span of composite slab
b_1 = Concentrated load length in direction of slab span

Where line loads perpendicular to the direction of slab span are present (> 7.5 kN/m), P^* is represented as a factored load per metre and b_{eb} is taken as equal to one metre.

Line loads running parallel to the span should be treated as a series of discrete point loads.

This requirement is based on recommendations from the Composite Deck Design Handbook by Heagler RB, Luttrell LD and Easterling WS; published by The Steel Decking Institute, Illinois 1997.

Continued on next page

3.3.2 DESIGN CONSIDERATIONS *continued*

Noise Control
Design guidance on Sound Transmission Class (STC) and Impact Insulation Class (IIC) values for Hibond Flooring Systems has been obtained through physical testing. This is covered in detail in Section 3.3.7 Noise Control.

Floor Vibration
As a guide to designers, the limits expressed in the composite slab design tables represent the maximum span of the Hibond floor slab recommended for in-service floor vibration of an open plan commercial office floor with a low damping ratio (few small partitions) and a residence with higher damping (many full height partitions). Specific design is required to check other types of floor use. This represents the slab response of a person traversing the floor, but does not account for the dynamic response of the supporting structure.

For further information, including a design example, refer Section 3.3.8 Floor Vibration.

Thermal Insulation
Design guidance on thermal resistance (R) values for Hibond floor slabs to NZS 4218 is covered in Section 3.3.9 Thermal Insulation.

In Floor Heating
Where in floor heating is to be used in a Hibond composite slab, consideration should be given to the structural impact of placing heating systems within the compression zone of the floor slab. For example the overall slab thickness could be increased to compensate for any loss of structural integrity caused by the inclusion of in floor heating.

Two systems are commonly available:

- Water, utilising polybutylene tubes up to 20mm outside diameter and spaced as closely as 200mm with minimum 25mm top cover.
- Electrical, utilising wires up to 8mm outside diameter and spaced as closely as 100mm.

Both systems are typically attached directly to the top of the shrinkage mesh, in a pattern determined by the wall layout above the floor in question.

The in floor heating system must not be used to cure the slab as it will cause excessive cracking.

Hibond Design Wizard
Dimond offers the Hibond Design Wizard available as a complimentary CD for engineers and specifiers. (Call 0800 775 777 to order your copy.)

The Hibond Design Wizard is a comprehensive design tool composed of a preliminary design module and a detailed design module. It covers a range of composite designs with Hibond floor slabs and composite secondary/primary beams, providing rapid design solutions and evaluation of alternatives.

The Wizard includes flooring scenarios for unpropped, propped and pre-cambered design along with full strength and serviceability checks and vibration design.

For further design assistance call 0800 Roofspec (0800 766 377).

Although the Hibond Design Wizard is a comprehensive design aid, it is intended that the design engineer check, detail and make amendments as necessary in order to approve the design for construction and to ensure compliance with the relevant codes of practice in relation to building.

Continued on next page

3.3.2 DESIGN CONSIDERATIONS *continued*

Composite Beam Design

The use of the composite beam design concept can result in significant strength and stiffness gains over non-composite beam design. Composite beam design uses shear connectors to interconnect the Hibond floor slab and the beam. Shear connectors are typically 19mm diameter x 100mm long nominal.

The shear connection between the Hibond floor slab and the beam resists slipping at the interface, resulting in an interaction between the two members. This allows compressive forces to develop in the Hibond floor slab and tensile forces to develop in the beam.

The strength achieved in the composite beam is generally dependent on the strength of the shear connection provided between the Hibond floor slab and the beam. It is assumed that the shear connection is ductile.

Three types of construction are commonly used with composite beams.

Unpropped

- Where composite slab, secondary and primary beams are all constructed in an unpropped condition.
- Unpropped construction generally uses larger member sizes. However construction time is minimised, and on this basis unpropped construction is preferred.
- The composite slab is poured to level for unpropped construction.

Propped

- Where secondary and primary beams are propped during construction. The composite slab is usually propped but may also be unpropped.
- Propped construction results in more efficient member sizes. However access to sub-trades is restricted until props have been removed.
- The composite slab is poured to level for propped construction.

Pre-cambered

- Where secondary and/or primary beams are fabricated with a pre-camber. The composite slab is unpropped for this type of construction.
- Pre-cambered construction provides member size efficiency and minimal soffit deflection and is effective on large spans.
- Pre-cambered construction requires the composite slab to be poured to constant thickness.

For further and concise information regarding composite beam construction refer to HERA Report R4-107 Composite Floor Construction Handbook.

3.3.2.1 DESIGN LIMITATIONS

Where Hibond floor slab is greater than 200mm overall thickness, the Hibond sheeting must be used as formwork only and the floor slab designed using additional positive reinforcement.

Cantilevers
Where Hibond sheet is used in cantilever situations, a propping line is required at the sheet ends to ensure a stable working platform is achieved during construction and pouring of the concrete (refer to Section 3.3.4.2 Propping).

As a guide, propping of the Hibond sheet is not required for cantilevers with a clear over-hang of,

300mm for 0.75mm Hibond
400mm for 0.95mm Hibond.

These cantilever spans assume:

- The Hibond sheets are securely fixed to the edge supporting member and the adjacent internal supporting member in accordance with Section 3.3.4.3 Bearing and Fixing Requirements.
- That Hibond edge form at the end of the cantilever is secured with one self-drilling screw (or rivet) per Hibond pan along with edge form support straps as detailed in Section 3.3.13.2 Edge Form Support Strap.

Additional ductile negative reinforcement is required to be designed to support all cantilevered floor slabs.

Pre-Cambering of Hibond Sheet
Pre-cambering of the Hibond sheet will result in less overall deflections of the composite slab. This is achieved by installing props which are higher than the supporting structure.

Caution is required when using pre-cambered Hibond sheet as the concrete must be poured to constant thickness, as flat screeding will result in less than the minimum design slab thickness at mid-span.

In any case the pre-camber must not exceed span/350.

Timber Structure
Hibond is not intended for use on permanent timber supporting beams unless the beams have been specifically engineered to ensure undue deflection due to moisture, long-term creep or shrinkage does not affect the concrete floor performance.

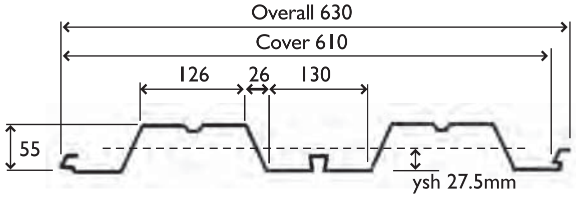
When the Hibond sheet is in contact with timber, refer to Section 3.1.3.2 Limitations on Use.

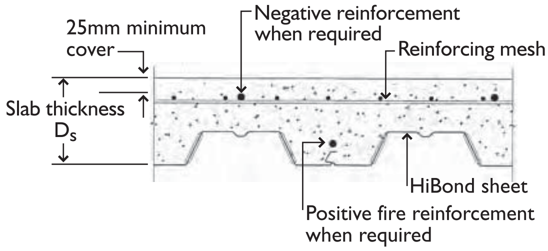
Shear connectors into timber require specific design. These could include galvanised coach screws or reinforcing bar epoxy glued into timber beams and turned into slab.

Two Way Slabs
The Hibond floor slab is made specifically for use in one way slab construction. However, specific design as a two way slab may be carried out to NZS 3101, provided the concrete strength contribution below the Hibond ribs, in the transverse direction, is ignored in the design.

Bridge Structures
Hibond is not intended to be used in bridge structures other than as permanent formwork, unless specifically designed for that purpose.

3.3.3 HIBOND SECTION PROPERTIES





All dimensions (mm) are nominal

HIBOND FORMWORK PROPERTIES (PER METRE WIDTH)

Thickness mm	Weight kN/m	Cross Sectional Area A_p mm^2	Design Strength p_y MPa	Bending Strengths M_c^+ kNm	Bending Strengths M_c^- kNm	Web Crushing Strength P_w, kN End Support	Web Crushing Strength P_w, kN Internal Support
0.75	0.085	1058	550	5.46	6.51	14.52	29.05
0.95	0.108	1340	520	8.93	9.71	21.34	42.68

Thickness mm	Bending/Web Crushing Interaction Equation at Internal Support Limited by:	Shear Strength P_v kN	Second Moment of Area $10^6 mm^4$ Single Span I_s	Second Moment of Area $10^6 mm^4$ Multispan I_m
0.75	$F_w / 29.05 + M^- / 6.51 < 1.43$	45.1	0.493	0.391
0.95	$F_w / 42.68 + M^- / 9.71 < 1.56$	71.6	0.605	0.448

Notes

1. Design strength p_y is 0.84 x ultimate tensile strength.
2. Shear strength values P_v are derived from calculation as per BS 5950.
3. All other values are derived from test results.
4. F_w is the reaction or concentrated load on Hibond rib.
5. M^- is the negative bending moment in the Hibond sheet formwork at the internal support.
6. ysh is the distance from the bottom of the Hibond sheet to the neutral axis.

Continued on next page

3.3.3 HIBOND SECTION PROPERTIES *continued*

0.75mm HIBOND COMPOSITE SLAB PROPERTIES (PER METRE WIDTH)

D_s mm	Weight kN/m	I_g 10^6mm^4 medium	long	Y_g mm medium	long	I_{cr} 10^6mm^4 medium	long	Y_{cr} mm medium	long	I_{av} 10^6mm^4 medium	long
110	1.99	8.9	5.7	49.1	51.9	4.4	3.7	32.6	40.3	6.6	4.7
120	2.22	11.6	7.3	53.9	56.9	5.5	4.7	35.0	43.4	8.6	6.0
130	2.45	14.7	9.3	58.7	61.8	6.8	5.8	37.3	46.4	10.8	7.5
140	2.68	18.5	11.6	63.6	66.7	8.3	7.1	39.5	49.3	13.4	9.3
150	2.91	22.8	14.2	68.4	71.7	10.0	8.5	41.5	52.0	16.4	11.4
160	3.14	27.9	17.3	73.3	76.6	11.8	10.1	43.5	54.6	19.8	13.7
170	3.37	33.6	20.8	78.2	81.6	13.7	11.8	45.4	57.2	23.7	16.3
180	3.60	40.1	24.7	83.1	86.6	15.9	13.7	47.3	59.6	28.0	19.2
190	3.83	47.4	29.1	88.0	91.5	18.2	15.8	49.1	62.0	32.8	22.4
200	4.06	55.6	34.0	93.0	96.5	20.7	18.0	50.8	64.3	38.2	26.0

0.95mm HIBOND COMPOSITE SLAB PROPERTIES (PER METRE WIDTH)

D_s mm	Weight kN/m	I_g 10^6mm^4 medium	long	Y_g mm medium	long	I_{cr} 10^6mm^4 medium	long	Y_{cr} mm medium	long	I_{av} 10^6mm^4 medium	long
110	2.01	9.4	6.1	50.1	53.4	5.2	4.3	35.6	43.6	7.3	5.2
120	2.24	12.1	7.8	54.9	58.4	6.6	5.4	38.3	47.1	9.3	6.6
130	2.47	15.4	9.9	59.8	63.4	8.1	6.8	40.8	50.4	11.8	8.3
140	2.70	19.3	12.3	64.7	68.4	9.9	8.3	43.2	53.6	14.6	10.3
150	2.93	23.8	15.1	69.5	73.4	11.9	9.9	45.6	56.6	17.8	12.5
160	3.16	29.0	18.3	74.5	78.4	14.0	11.8	47.8	59.5	21.5	15.1
170	3.39	34.9	21.9	79.4	83.5	16.4	13.9	49.9	62.4	25.7	17.9
180	3.62	41.6	26.0	84.3	88.5	19.0	16.1	52.0	65.1	30.3	21.1
190	3.86	49.1	30.6	89.2	93.5	21.9	18.6	54.0	67.8	35.5	24.6
200	4.09	57.5	35.8	94.2	98.5	24.9	21.2	56.0	70.4	41.2	28.5

Notes

1. D_s is the overall thickness of the slab.
2. Slab weights are based on a dry concrete density of 2350 kg/m^3 with no allowance for ponding.
3. Section properties are presented in terms of equivalent steel units as follows:
   (a) Medium term superimposed loads are based on ⅔ short term and ⅓ long term load (ie modular ratio = 10) and apply to buildings of normal usage.
   (b) Long term superimposed loads are based on all loads being long term (ie modular ratio = 18) and apply to storage loads and loads which are permanent in nature.
4. I_g is the second moment of area of the gross composite Hibond section.
5. I_{cr} is the second moment of area of the cracked composite Hibond section.
6. I_{av} is the average value of gross (I_g) and cracked (I_{cr}) sections to be used for deflection calculations.
7. Y_g is the distance from top of slab to neutral axis of the composite Hibond slab for gross section.
8. Y_{cr} is the distance from top of slab to neutral axis of the composite Hibond slab for the cracked section.

3.3.4 FORMWORK DESIGN

3.3.4.1 HIBOND FORMWORK TABLES

Maximum formwork spans for slab thicknesses between 110mm and 300mm are provided in the following tables.

The following notes apply to the formwork tables in this section.

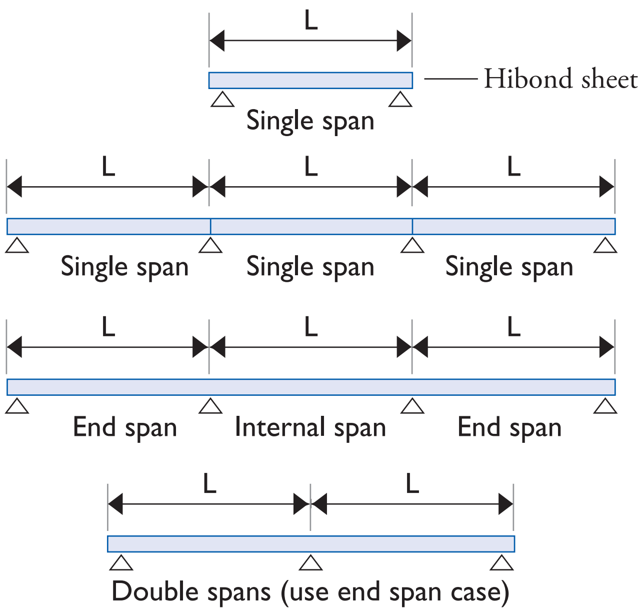
1. D_s is the overall thickness of the slab.
2. Slab weights (G) are based on a wet concrete density of 2400 kg/m^3 with no allowance for ponding.
3. A construction load (Q) taken from BS 5950 is incorporated in these tables. This provides for a minimum of 1.5 kPa and for spans (L) less than 3000mm, 4500/L kPa has been used.
4. L is the maximum span measured centre to centre between permanent or temporary supports.
5. Use of the double or end span tables and internal span tables assumes,
   - All spans have the same slab thickness.
   - The end span is within plus 5% or minus 10% of the internal span and that the end and internal spans are both designed using the appropriate load span table.
   - Double spans are within 10% of each other and the slab design is based on the largest span.
   - Internal spans are within 10% of each other and the slab design is based on the largest internal span.

   Any variations to the above configurations require specific design using the Hibond Formwork Properties table in Section 3.3.3.
6. These tables are based on minimum bearing of Hibond sheet given in Section 3.3.4.3.
7. It should be noted that double or end span capabilities may be less than single spans as the interaction of bending and web crushing create a worse case.
8. Deflection limits incorporated in these tables are as follows:
   a) L/180 maximum due to dead load (G) only.
   b) D_s/10 maximum, to avoid concrete ponding problems.

   These limits are represented in the 'Allow' (allowable) column of the Hibond Formwork Tables. The 5mm limit column should be referred to where soffit deflection is to be reduced.
9. For intermediate values, linear interpolation is permitted.
10. As a guide, formwork deflections of around 15 mm under dead load (G) should be expected within the extent of the tables. Construction loads (Q) will increase deflections.
11. The design span of the formwork relates closely to site installation. If the Hibond sheet is designed as an end span or internal span, the minimum nominal sheet length for construction should be noted clearly in the design documentation to ensure that appropriate sheet lengths are used by the installer to achieve the span type selected. Refer to Section 3.5 Installation.

Typical Formwork Slab Span Configurations

This configuration can only be used where all supports are permanent.



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3.3.4.1 HIBOND FORMWORK TABLES *continued*

0.75mm HIBOND FORMWORK SPAN CAPABILITIES

D_s mm	Slab Weight kPa	Concrete Quantity m³/m²	Maximum Span (L) mm Single		Double or End		Internal	
			Allow.	5mm limit	Allow.	5mm limit	Allow.	5mm limit
110	2.03	0.0825	2500	2050	2800	2450	3150	2950
120	2.26	0.0925	2500	2000	2800	2350	3050	2850
130	2.50	0.1025	2500	1950	2750	2300	2900	2800
140	2.74	0.1125	2500	1900	2650	2250	2750	2700
150	2.97	0.1225	2400	1900	2550	2200	2600	2600
160	3.21	0.1325	2350	1850	2450	2150	2500	2500
170	3.44	0.1425	2300	1800	2350	2150	2400	2400
180	3.68	0.1525	2250	1800	2250	2100	2300	2300
190	3.91	0.1625	2200	1750	2150	2050	2250	2250
200	4.15	0.1725	2150	1750	2100	2050	2150	2150
210	4.38	0.1825	2150	1700	2000	2000	2100	2100
220	4.62	0.1925	2100	1700	1950	1950	2000	2000
230	4.85	0.2025	2050	1650	1900	1900	1950	1950
240	5.09	0.2125	2000	1650	1850	1850	1900	1900
250	5.32	0.2225	2000	1600	1800	1800	1850	1850
260	5.56	0.2325	1950	1600	1750	1750	1800	1800
270	5.79	0.2425	1900	1600	1700	1700	1750	1750
280	6.03	0.2525	1900	1550	1650	1650	1700	1700
290	6.26	0.2625	1850	1550	1600	1600	1650	1650
300	6.50	0.2725	1850	1550	1600	1600	1650	1650

0.95mm HIBOND FORMWORK SPAN CAPABILITIES

D_s mm	Slab Weight kPa	Concrete Quantity m³/m²	Maximum Span (L) mm Single		Double or End		Internal	
			Allow.	5mm limit	Allow.	5mm limit	Allow.	5mm limit
110	2.05	0.0825	2650	2200	2900	2500	3700	3050
120	2.29	0.0925	2650	2100	2850	2450	3650	2950
130	2.52	0.1025	2600	2050	2850	2400	3650	2850
140	2.76	0.1125	2600	2000	2850	2350	3650	2800
150	2.99	0.1225	2600	2000	2850	2300	3600	2750
160	3.23	0.1325	2500	1950	2800	2250	3500	2700
170	3.46	0.1425	2450	1900	2750	2200	3400	2650
180	3.70	0.1525	2400	1850	2700	2150	3300	2600
190	3.93	0.1625	2350	1850	2650	2150	3200	2550
200	4.17	0.1725	2300	1800	2600	2100	3100	2550
210	4.40	0.1825	2300	1800	2550	2100	3050	2500
220	4.64	0.1925	2250	1750	2500	2050	2950	2450
230	4.88	0.2025	2200	1750	2450	2000	2850	2450
240	5.11	0.2125	2150	1750	2400	2000	2800	2400
250	5.35	0.2225	2150	1700	2400	2000	2700	2400
260	5.58	0.2325	2100	1700	2350	1950	2650	2350
270	5.82	0.2425	2100	1650	2300	1950	2600	2350
280	6.05	0.2525	2050	1650	2300	1900	2500	2300
290	6.29	0.2625	2000	1650	2250	1900	2450	2300
300	6.52	0.2725	2000	1600	2250	1900	2400	2250

3.3.4.2 PROPPING

Where spans require propping of the Hibond sheet as shown in 3.3.4.1, adequately braced propping must be installed prior to laying the Hibond sheets and shall be designed to support wet concrete and construction loads. Refer to Section 3.5 Installation for further information.

Propping loads are given below for all slab thicknesses considered in Section 3.3.4.1.

PROPPING LOADS

Thickness mm	Serviceability (Safe) Load	Ultimate (Strength) Load
0.75	17.6 kN/m	25.5 kN/m
0.95	23.5 kN/m	34.3 kN/m

The Hibond sheet must be supported by continuous propping lines parallel to the permanent supports. The minimum width required for bearers is 100mm.

Propping lines must remain in place until:
- The concrete has reached a compressive strength of 20 MPa where construction loads are applied.
- The concrete is fully cured where full design loads are applied.

Refer to NZS 3109 for further details.

3.3.4.3 BEARING AND FIXING REQUIREMENTS

It is the responsibility of the design engineer to determine the bearing and fixing requirements for the Hibond Flooring System specific to each case.

Minimum bearing requirements for different span types are shown below.

The Hibond sheet does not require as much bearing as the composite slab. However the issue of sheet hold down, prior to the placement of the concrete, may determine Hibond bearing requirements.

MINIMUM BEARING REQUIREMENTS

	Bearing of Hibond Slab		Bearing of Hibond Sheet	
	Slab End	Continuous	Sheet End	Continuous
Steel beam	50mm	100mm	30mm	100mm
In situ concrete beam or wall	50mm	100mm	30mm	N/A
Concrete block	70mm	100mm	30mm	N/A

Where steel beams are the main support system, Hibond sheets can be fixed to supports by shear connectors (shear studs) welded through the Hibond sheet (refer also to 3.5 Installation). Shear studs should be placed as close to the middle of each Hibond pan as practicable. Where there is more than one shear stud per pan it is desirable to stagger them diagonally across the width of the beam. Hibond sheets can also be fixed to supports with self-drilling screws or powder-actuated fasteners.

Fixing into the edge of concrete block is not recommended as any breakout of the edge will reduce the effective support.

Where insufficient or inadequate support is available for the Hibond sheet, temporary bearers and props can be used to support the ends. Nails can be driven through the Hibond sheet into timber bearers to provide temporary hold down. Hibond sheets must be continuous when laid over temporary supports.

Where the Hibond sheet is used with tilt slab construction, it is common to fix the Hibond sheet to a steel angle which is bolted to the tilt slab.

While technically a Hibond floor slab does not require support along the edge (edge bearing), it is standard practice to tie the edges of the slab to the support structure. Edge bearing requirements follow that of the end bearing as shown in the minimum bearing requirements table.

Refer to Section 3.5 Installation for further information on:
- Side lap crimping.
- Placement of end caps and edge forms.

3.3.4.4 PENETRATIONS

Penetrations of up to 250mm x 250mm square may be formed as part of the slab construction by formwork or polystyrene infill with the addition of 2 – H12 reinforcing bars laid in each adjacent Hibond sheet pan, the remaining Hibond sheet being cut away after curing.

Penetrations larger than 250mm x 250mm will require additional reinforcement to control cracking and provide structural integrity and may also require independent supporting beams to the design engineer's specific design.

The area of Hibond removed for penetrations must be replaced by an equivalent strength of reinforcement.

If cutting of the Hibond sheet is required prior to pouring the concrete, temporary propping is required to maintain the integrity of the sheet.

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES

Superimposed loads (G_{SDL} + Q) are presented for slab thicknesses between 110mm and 200mm and over a range of spans between 2.0m and 6.0m for single spans. For continuous design, negative reinforcement requirements are presented for double or end spans and internal spans, with an extended range of spans to 7.0m for the latter.

The following Notes apply to the composite slab load span tables in this Section.

1. Span types
   L_{ss} is the clear single span between permanent supports plus 100mm.
   L is the double/end or internal span measured centre to centre between permanent supports.

2. The design superimposed load combination is G_{SDL} + Q and must not be greater than the superimposed loads given in the tables.

3. a) Medium term superimposed loads are based on $^2/_3$ short term and $^1/_3$ long term (i.e. modular ratio = 10) and apply to buildings of normal usage.

   b) Long term superimposed loads are based on all loads being long term (i.e. modular ratio = 18) and apply to storage loads and loads which are permanent in nature.

4. Deflection limits incorporated into these tables are as follows:

   a) L/350 or 20mm maximum due to superimposed load (G_{SDL} + Q).

   b) L/250 maximum due to superimposed load plus prop removal (G + G_{SDL} + Q).

   The designer shall be satisfied that these limits are adequate for the application considered, otherwise additional deflection checks must be made.

5. Propping requirements depend on the Hibond slab thickness and span configuration as formwork. Refer to Section 3.3.4.1 Hibond Formwork Tables to determine formwork span capabilities.

6. The double or end span and internal span tables allow for 10% moment redistribution where negative bending governs (typically thinner slabs on end spans), bounded by the shear bond value where this governs.

7. Some values shown in the double or end span tables are less than corresponding values given in the single span tables. This situation arises as,

   a) Negative bending capacity has been limited to avoid compression failure of the concrete in compression at the internal support.

   b) Shear bond is proportional to vertical shear which is higher for a double span than a single span. Also the shear bond span for an end span must be taken as the full span length using BS5950 Part 4 (when normally the span between points of contraflexure would be used).

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3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES *continued*

8. Use of the double or end span tables and internal span tables assumes,
   - All spans have the same slab thickness.
   - The end span is within plus 5% or minus 10% of the internal span and that the end and internal spans are both designed using the appropriate load span table.
   - Double spans are within 10% of each other and the slab design is based on the largest span.
   - Internal spans are within 10% of each other and the slab design is based on the largest internal span.

   Any variations to the above configurations require specific design.

9. Example: For a 0.75mm Hibond slab of 130mm overall slab thickness on a double span of 3800mm we have the following:

   4.3 H12@200

   where:

4.3	=	Superimposed load kPa
H12@200	=	H12 negative reinforcing (saddle bars) placed at 200mm centres to achieve the superimposed load.

10. Steel areas in the double or end and internal span tables are calculated based on H12 reinforcing bars (12mm diameter grade 500 to AS/NZS 4671) placed at 25mm top cover (A1 exposure classification – NZS 3101). Areas for other bar types, covers and sizes require specific design.

11. Negative reinforcement must be placed on top of the mesh parallel with the Hibond ribs at spacings indicated in the tables for the span and slab thickness considered.

12. Negative reinforcement must extend at least 0.25 of the largest span plus 450mm each side of the centre line of the support.

13. The same negative reinforcing is required for both propped and unpropped construction.

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3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES *continued*

14. Vibration limits expressed as maximum spans in the tables refer to:

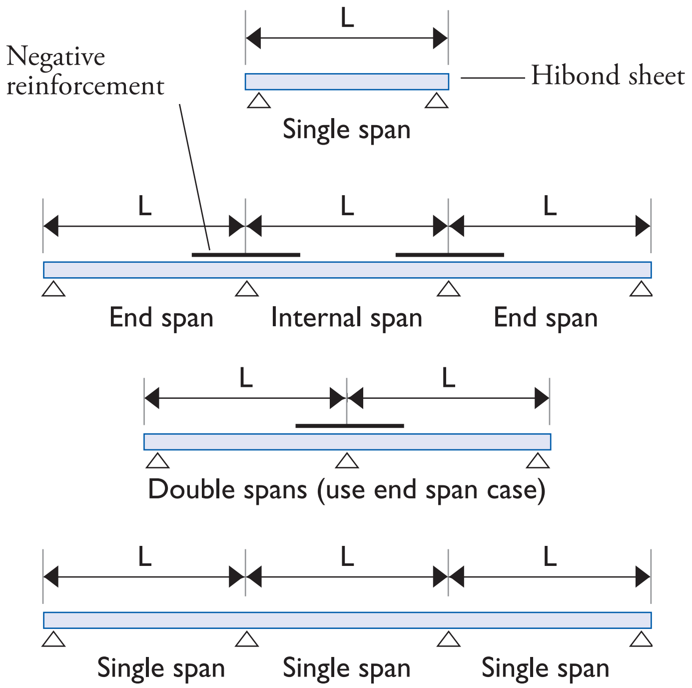
    – – – – Commercial offices, open plan with few small partitions (damping ratio = 0.025)

    ••••••••• Residences with many full height partitions (damping ratio = 0.05)

    Specific design is required for other floor uses. Refer Section 3.3.8 Floor Vibration.

15. For intermediate values, linear interpolation is permitted.

Typical Composite Slab Span Configurations



This configuration requires nominal continuity reinforcement to be placed over the supports as described for a minor degree of crack control for Mesh Reinforcement in Section 3.3.2.

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES continued

0.75mm HIBOND – SINGLE SPANS
Medium term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	16.2	19.6	21.0							
2200	13.3	16.1	17.2	19.3	21.4					
2400	11.2	13.5	14.3	16.0	17.7	19.5	21.4			
2600	9.5	11.4	12.1	13.5	14.9	16.4	17.9	19.4	20.8	
2800	8.2	9.8	10.4	11.5	12.7	13.9	15.1	16.3	17.5	18.8
3000	7.1	8.5	9.0	9.9	10.9	11.9	12.9	13.9	14.8	15.9
3200	6.2	7.4	7.8	8.6	9.4	10.3	11.1	11.9	12.7	13.6
3400	5.5	6.5	6.9	7.5	8.2	8.9	9.6	10.3	10.9	11.6
3600	4.9	5.8	6.1	6.6	7.2	7.8	8.4	8.9	9.5	10.1
3800	4.4	5.2	5.4	5.9	6.4	6.9	7.4	7.8	8.3	8.7
4000	4.0	4.7	4.8	5.3	5.7	6.1	6.5	6.9	7.2	7.6
4200	3.6	4.2	4.3	4.7	5.1	5.4	5.8	6.1	6.3	6.7
4400	2.9	3.8	3.9	4.2	4.5	4.8	5.1	5.4	5.6	5.8
4600	2.3	3.3	3.6	3.8	4.1	4.3	4.6	4.8	5.0	5.1
4800	1.8	2.6	3.2	3.5	3.7	3.9	4.1	4.3	4.4	4.5
5000		2.0	2.9	3.2	3.3	3.5	3.7	3.8	3.9	4.0
5200		1.6	2.3	2.9	3.0	3.2	3.3	3.4	3.5	3.6
5400			1.8	2.6	2.8	2.9	3.0	3.1	3.1	3.1
5600				2.1	2.5	2.6	2.7	2.7	2.8	2.8
5800				1.6	2.3	2.4	2.5	2.5	2.5	2.5
6000					1.8	2.2	2.2	2.2	2.2	2.2

0.75mm HIBOND – SINGLE SPANS
Long term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	16.2	19.6	21.0							
2200	13.3	16.1	17.2	19.3	21.4					
2400	11.2	13.5	14.3	16.0	17.7	19.5	21.4			
2600	9.5	11.4	12.1	13.5	14.9	16.4	17.9	19.4	20.8	
2800	8.2	9.8	10.4	11.5	12.7	13.9	15.1	16.3	17.5	18.8
3000	7.1	8.5	9.0	9.9	10.9	11.9	12.9	13.9	14.8	15.9
3200	6.2	7.4	7.8	8.6	9.4	10.3	11.1	11.9	12.7	13.6
3400	5.4	6.5	6.9	7.5	8.2	8.9	9.6	10.3	10.9	11.6
3600	4.3	5.7	6.1	6.6	7.2	7.8	8.4	8.9	9.5	10.1
3800	3.4	4.6	5.4	5.9	6.4	6.9	7.4	7.8	8.3	8.7
4000	2.6	3.6	4.8	5.3	5.7	6.1	6.5	6.9	7.2	7.6
4200	2.0	2.8	3.9	4.7	5.1	5.4	5.8	6.1	6.3	6.7
4400		2.2	3.1	4.2	4.5	4.8	5.1	5.4	5.6	5.8
4600		1.6	2.4	3.3	4.1	4.3	4.6	4.8	5.0	5.1
4800			1.8	2.6	3.5	3.9	4.1	4.3	4.4	4.5
5000				2.0	2.8	3.5	3.7	3.8	3.9	4.0
5200					2.1	2.9	3.3	3.4	3.5	3.6
5400					1.6	2.3	3.0	3.1	3.1	3.1
5600						1.7	2.4	2.7	2.8	2.8
5800							1.8	2.5	2.5	2.5
6000								2.0	2.2	2.2

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.75mm HIBOND – DOUBLE AND END SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm^2/m width)

	Slab Thickness (D_s) mm									
L (mm)	110	120	130	140	150	160	170	180	190	200
2000	**12.9** H12@300	**15.7** H12@250	**16.8** H12@300	**18.8** H12@250	**21.0** H12@300					
2200	**10.7** H12@250	**12.9** H12@250	**13.8** H12@250	**15.4** H12@250	**17.1** H12@300	**18.9** H12@250	**20.8** H12@250			
2400	**8.9** H12@250	**10.8** H12@250	**11.5** H12@250	**12.8** H12@250	**14.2** H12@250	**15.6** H12@250	**17.1** H12@250	**18.6** H12@250	**20.1** H12@250	
2600	**7.6** H12@250	**9.1** H12@250	**9.7** H12@250	**10.8** H12@250	**11.9** H12@250	**13.1** H12@250	**14.3** H12@250	**15.5** H12@250	**16.7** H12@250	**17.9** H12@250
2800	**6.4** H12@250	**7.8** H12@250	**8.3** H12@250	**9.2** H12@250	**10.1** H12@250	**11.1** H12@250	**12.1** H12@250	**13.0** H12@250	**14.0** H12@250	**15.0** H12@250
3000	**5.3** H12@250	**6.8** H12@200	**7.2** H12@250	**7.9** H12@250	**8.7** H12@250	**9.5** H12@250	**10.3** H12@250	**11.1** H12@250	**11.9** H12@250	**12.7** H12@250
3200	**4.5** H12@250	**5.9** H12@200	**6.2** H12@250	**6.9** H12@250	**7.5** H12@250	**8.2** H12@250	**8.9** H12@250	**9.5** H12@250	**10.2** H12@250	**10.8** H12@250
3400	**3.8** H12@250	**5.0** H12@200	**5.5** H12@200	**6.0** H12@250	**6.6** H12@250	**7.1** H12@250	**7.7** H12@250	**8.2** H12@250	**8.7** H12@250	**9.3** H12@250
3600	**3.2** H12@250	**4.3** H12@200	**4.9** H12@200	**5.3** H12@250	**5.8** H12@250	**6.3** H12@250	**6.7** H12@250	**7.2** H12@250	**7.6** H12@250	**8.0** H12@250
3800	**2.7** H12@250	**3.6** H12@200	**4.3** H12@200	**4.7** H12@200	**5.1** H12@200	**5.5** H12@250	**5.9** H12@250	**6.3** H12@250	**6.6** H12@250	**7.0** H12@250
4000	**2.2** H12@250	**3.1** H12@200	**3.9** H12@200	**4.2** H12@200	**4.5** H12@200	**4.9** H12@200	**5.2** H12@250	**5.5** H12@250	**5.8** H12@250	**6.1** H12@250
4200	**1.9** H12@250	**2.6** H12@200	**3.5** H12@200	**3.8** H12@200	**4.0** H12@200	**4.3** H12@200	**4.6** H12@200	**4.9** H12@250	**5.1** H12@250	**5.3** H12@250
4400		**2.2** H12@200	**3.0** H12@200	**3.4** H12@200	**3.6** H12@200	**3.9** H12@200	**4.1** H12@200	**4.3** H12@200	**4.5** H12@250	**4.7** H12@250
4600		**1.8** H12@200	**2.5** H12@200	**3.1** H12@200	**3.3** H12@200	**3.5** H12@200	**3.7** H12@200	**3.8** H12@200	**4.0** H12@200	**4.1** H12@250
4800			**2.1** H12@200	**2.8** H12@200	**2.9** H12@200	**3.1** H12@200	**3.3** H12@200	**3.4** H12@200	**3.5** H12@200	**3.6** H12@200
5000			**1.8** H12@200	**2.4** H12@200	**2.7** H12@150	**2.8** H12@200	**3.0** H12@200	**3.0** H12@200	**3.1** H12@200	**3.2** H12@200
5200				**2.1** H12@200	**2.4** H12@150	**2.6** H12@200	**2.7** H12@200	**2.7** H12@200	**2.8** H12@200	**2.8** H12@200
5400				**1.8** H12@200	**2.2** H12@150	**2.3** H12@150	**2.4** H12@200	**2.4** H12@200	**2.5** H12@200	**2.5** H12@200
5600					**2.0** H12@150	**2.1** H12@150	**2.2** H12@150	**2.2** H12@200	**2.2** H12@200	**2.2** H12@200
5800					**1.7** H12@150	**1.9** H12@150	**2.0** H12@150	**2.0** H12@150	**2.0** H12@200	**2.0** H12@200
6000						**1.8** H12@150	**1.8** H12@150	**1.8** H12@150	**1.8** H12@200	**1.8** H12@200

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.75mm HIBOND – INTERNAL SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm^2/m width)

	Slab Thickness (D_s) mm									
L (mm)	110	120	130	140	150	160	170	180	190	200
2000	**17.2** H12@250	**22.4** H12@200								
2200	**14.0** H12@250	**18.2** H12@200	**21.6** H12@200							
2400	**11.5** H12@250	**15.1** H12@200	**18.3** H12@200	**20.5** H12@200	**21.3** H12@200	**19.3** H12@200	**19.8** H12@200	**20.3** H12@200		
2600	**9.6** H12@250	**12.6** H12@200	**15.5** H12@200	**16.7** H12@200	**17.2** H12@200	**17.6** H12@200	**18.1** H12@200	**18.5** H12@200	**18.9** H12@200	**19.0** H12@200
2800	**8.1** H12@250	**10.7** H12@200	**13.3** H12@200	**14.8** H12@200	**15.8** H12@200	**16.2** H12@200	**16.6** H12@200	**16.9** H12@200	**17.3** H12@200	**17.6** H12@200
3000	**6.9** H12@250	**9.1** H12@200	**11.4** H12@200	**12.8** H12@200	**14.2** H12@200	**14.9** H12@200	**15.3** H12@200	**15.6** H12@200	**15.9** H12@200	**16.2** H12@200
3200	**5.9** H12@250	**7.8** H12@200	**9.8** H12@200	**11.2** H12@200	**12.3** H12@200	**13.6** H12@200	**14.1** H12@200	**14.4** H12@200	**14.7** H12@200	**15.0** H12@200
3400	**5.1** H12@250	**6.7** H12@200	**8.5** H12@200	**9.8** H12@200	**10.8** H12@200	**11.8** H12@200	**12.9** H12@200	**13.4** H12@200	**13.6** H12@200	**13.9** H12@200
3600	**4.4** H12@250	**5.9** H12@200	**7.4** H12@200	**8.7** H12@200	**9.5** H12@200	**10.4** H12@200	**11.3** H12@200	**12.2** H12@200	**12.7** H12@200	**12.9** H12@200
3800	**3.8** H12@250	**5.1** H12@200	**6.5** H12@200	**7.7** H12@150	**8.4** H12@200	**9.2** H12@200	**10.0** H12@200	**10.8** H12@200	**11.5** H12@200	**12.0** H12@200
4000	**3.3** H12@250	**4.5** H12@200	**5.7** H12@200	**6.9** H12@150	**7.5** H12@200	**8.2** H12@200	**8.9** H12@200	**9.5** H12@200	**10.2** H12@200	**10.8** H12@200
4200	**2.8** H12@250	**3.9** H12@200	**5.0** H12@200	**6.2** H12@150	**6.7** H12@150	**7.3** H12@200	**7.9** H12@200	**8.5** H12@200	**9.0** H12@200	**9.6** H12@200
4400	**2.5** H12@250	**3.4** H12@200	**4.4** H12@200	**5.5** H12@150	**6.1** H12@150	**6.6** H12@200	**7.1** H12@200	**7.6** H12@200	**8.0** H12@200	**8.5** H12@200
4600	**2.1** H12@250	**3.0** H12@200	**3.9** H12@200	**4.8** H12@150	**5.5** H12@150	**5.9** H12@150	**6.4** H12@200	**6.8** H12@200	**7.2** H12@200	**7.6** H12@200
4800	**1.9** H12@250	**2.6** H12@200	**3.4** H12@200	**4.3** H12@150	**5.0** H12@150	**5.4** H12@150	**5.8** H12@150	**6.1** H12@200	**6.4** H12@200	**6.8** H12@200
5000	**1.6** H12@250	**2.3** H12@200	**3.0** H12@200	**3.8** H12@150	**4.5** H12@150	**4.9** H12@150	**5.2** H12@150	**5.5** H12@200	**5.8** H12@200	**6.1** H12@200
5200		**2.0** H12@200	**2.7** H12@200	**3.4** H12@150	**4.1** H12@150	**4.4** H12@150	**4.7** H12@150	**5.0** H12@150	**5.2** H12@200	**5.5** H12@200
5400		**1.8** H12@200	**2.3** H12@200	**3.0** H12@150	**3.8** H12@150	**4.1** H12@150	**4.3** H12@150	**4.5** H12@150	**4.7** H12@200	**4.9** H12@200
5600		**1.5** H12@200	**2.1** H12@200	**2.7** H12@150	**3.3** H12@150	**3.7** H12@150	**3.9** H12@150	**4.1** H12@150	**4.3** H12@200	**4.4** H12@200
5800			**1.8** H12@200	**2.4** H12@150	**3.0** H12@150	**3.4** H12@150	**3.6** H12@150	**3.7** H12@150	**3.9** H12@150	**4.0** H12@200
6000			**1.6** H12@200	**2.1** H12@150	**2.7** H12@150	**3.1** H12@150	**3.3** H12@150	**3.4** H12@150	**3.5** H12@150	**3.6** H12@200
6200				**1.8** H12@150	**2.4** H12@150	**2.9** H12@150	**3.0** H12@150	**3.1** H12@150	**3.2** H12@150	**3.3** H12@150
6400				**1.6** H12@150	**2.1** H12@150	**2.6** H12@150	**2.8** H12@150	**2.8** H12@150	**2.9** H12@150	**3.0** H12@150
6600					**1.9** H12@150	**2.3** H12@150	**2.5** H12@150	**2.6** H12@150	**2.7** H12@150	**2.7** H12@150
6800					**1.6** H12@150	**2.1** H12@150	**2.4** H12@150	**2.4** H12@150	**2.4** H12@150	**2.5** H12@150
7000						**1.8** H12@150	**2.2** H12@150	**2.2** H12@150	**2.2** H12@150	**2.2** H12@150

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES continued

0.95mm HIBOND – SINGLE SPANS
Medium term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	17.8	21.7								
2200	14.7	17.8	19.1	21.4						
2400	12.3	14.9	15.9	17.8	19.8	21.9				
2600	10.5	12.6	13.5	15.0	16.7	18.4	20.1	21.9		
2800	9.0	10.9	11.5	12.8	14.2	15.6	17.1	18.5	19.9	21.4
3000	7.8	9.4	10.0	11.1	12.2	13.4	14.6	15.8	16.9	18.2
3200	6.9	8.2	8.7	9.6	10.6	11.6	12.6	13.6	14.5	15.6
3400	6.1	7.3	7.6	8.4	9.2	10.1	10.9	11.8	12.6	13.4
3600	5.4	6.4	6.8	7.5	8.1	8.9	9.6	10.3	10.9	11.7
3800	4.9	5.8	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2
4000	4.4	5.2	5.4	5.9	6.4	6.9	7.5	7.9	8.4	8.9
4200	4.0	4.7	4.9	5.3	5.7	6.2	6.6	7.0	7.4	7.8
4400	3.3	4.2	4.4	4.8	5.2	5.5	5.9	6.3	6.6	6.9
4600	2.7	3.8	4.0	4.3	4.6	5.0	5.3	5.6	5.8	6.1
4800	2.1	3.0	3.6	3.9	4.2	4.5	4.8	5.0	5.2	5.4
5000	1.6	2.4	3.3	3.6	3.8	4.1	4.3	4.5	4.7	4.8
5200		1.9	2.8	3.3	3.5	3.7	3.9	4.0	4.2	4.3
5400			2.2	3.0	3.2	3.4	3.5	3.6	3.7	3.9
5600			1.7	2.5	2.9	3.1	3.2	3.3	3.4	3.5
5800				2.0	2.7	2.8	2.9	3.0	3.0	3.1
6000				1.5	2.2	2.6	2.7	2.7	2.7	2.8

0.95mm HIBOND – SINGLE SPANS
Long term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	17.8	21.7								
2200	14.7	17.8	19.1	21.4						
2400	12.3	14.9	15.9	17.8	19.8	21.9				
2600	10.5	12.6	13.5	15.0	16.7	18.4	20.1	21.9		
2800	9.0	10.9	11.5	12.8	14.2	15.6	17.1	18.5	19.9	21.4
3000	7.8	9.4	10.0	11.1	12.2	13.4	14.6	15.8	16.9	18.2
3200	6.9	8.2	8.7	9.6	10.6	11.6	12.6	13.6	14.5	15.6
3400	5.9	7.3	7.6	8.4	9.2	10.1	10.9	11.8	12.6	13.4
3600	4.9	6.4	6.8	7.5	8.1	8.9	9.6	10.3	10.9	11.7
3800	3.9	5.3	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2
4000	3.0	4.2	5.4	5.9	6.4	6.9	7.5	7.9	8.4	8.9
4200	2.4	3.3	4.6	5.3	5.7	6.2	6.6	7.0	7.4	7.8
4400	1.8	2.6	3.6	4.8	5.2	5.5	5.9	6.3	6.6	6.9
4600		2.0	2.9	3.9	4.6	5.0	5.3	5.6	5.8	6.1
4800		1.5	2.2	3.1	4.2	4.5	4.8	5.0	5.2	5.4
5000			1.7	2.4	3.3	4.1	4.3	4.5	4.7	4.8
5200				1.9	2.6	3.5	3.9	4.0	4.2	4.3
5400					2.0	2.8	3.5	3.6	3.7	3.9
5600					1.5	2.2	3.0	3.3	3.4	3.5
5800						1.7	2.3	3.0	3.0	3.1
6000							1.8	2.5	2.7	2.8

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.95mm HIBOND – DOUBLE AND END SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm^2/m width)

	Slab Thickness (D_s) mm									
L (mm)	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
2000	**14.2** H12@250	**17.3** H12@200	**18.6** H12@250	**20.9** H12@250						
2200	**11.4** H12@250	**14.3** H12@200	**15.3** H12@250	**17.1** H12@250	**19.1** H12@250	**21.2** H12@250				
2400	**9.3** H12@250	**11.9** H12@200	**12.7** H12@250	**14.3** H12@250	**15.8** H12@250	**17.5** H12@250	**19.2** H12@250	**20.9** H12@250		
2600	**7.7** H12@250	**10.1** H12@200	**10.8** H12@250	**12.0** H12@250	**13.3** H12@250	**14.7** H12@250	**16.1** H12@250	**17.5** H12@250	**18.9** H12@250	**20.0** H12@250
2800	**6.4** H12@250	**8.4** H12@200	**9.2** H12@200	**10.3** H12@250	**11.3** H12@250	**12.5** H12@250	**13.6** H12@250	**14.8** H12@250	**15.9** H12@250	**17.2** H12@250
3000	**5.3** H12@250	**7.1** H12@200	**8.0** H12@200	**8.9** H12@200	**9.8** H12@200	**10.7** H12@200	**11.7** H12@200	**12.6** H12@250	**13.5** H12@250	**14.6** H12@200
3200	**4.5** H12@250	**6.0** H12@200	**7.0** H12@200	**7.7** H12@200	**8.5** H12@200	**9.3** H12@200	**10.1** H12@200	**10.9** H12@200	**11.6** H12@200	**12.5** H12@200
3400	**3.8** H12@250	**5.1** H12@200	**6.1** H12@200	**6.8** H12@200	**7.4** H12@200	**8.1** H12@200	**8.8** H12@200	**9.4** H12@200	**10.0** H12@200	**10.7** H12@200
3600	**3.2** H12@250	**4.3** H12@200	**5.4** H12@200	**6.0** H12@200	**6.5** H12@200	**7.1** H12@200	**7.7** H12@200	**8.2** H12@200	**8.7** H12@200	**9.3** H12@200
3800	**2.7** H12@250	**3.7** H12@200	**4.8** H12@200	**5.3** H12@200	**5.8** H12@200	**6.3** H12@200	**6.7** H12@200	**7.2** H12@200	**7.6** H12@200	**8.1** H12@200
4000	**2.2** H12@250	**3.1** H12@200	**4.1** H12@200	**4.7** H12@200	**5.1** H12@200	**5.6** H12@200	**6.0** H12@200	**6.3** H12@200	**6.7** H12@200	**7.1** H12@200
4200	**1.9** H12@250	**2.6** H12@200	**3.5** H12@200	**4.2** H12@200	**4.6** H12@200	**5.0** H12@200	**5.3** H12@200	**5.6** H12@200	**5.9** H12@200	**6.3** H12@200
4400		**2.2** H12@200	**3.0** H12@200	**3.8** H12@200	**4.1** H12@200	**4.4** H12@200	**4.7** H12@200	**5.0** H12@200	**5.3** H12@200	**5.5** H12@200
4600		**1.9** H12@200	**2.6** H12@200	**3.4** H12@150	**3.7** H12@150	**4.0** H12@200	**4.2** H12@200	**4.5** H12@200	**4.7** H12@200	**4.9** H12@200
4800			**2.2** H12@200	**2.9** H12@150	**3.4** H12@150	**3.6** H12@150	**3.8** H12@200	**4.0** H12@200	**4.2** H12@200	**4.4** H12@200
5000			**1.8** H12@200	**2.5** H12@150	**3.1** H12@150	**3.3** H12@150	**3.4** H12@200	**3.6** H12@200	**3.7** H12@200	**3.9** H12@200
5200				**2.1** H12@150	**2.8** H12@150	**3.0** H12@150	**3.1** H12@150	**3.2** H12@200	**3.3** H12@200	**3.5** H12@200
5400				**1.8** H12@150	**2.4** H12@150	**2.7** H12@150	**2.8** H12@150	**2.9** H12@150	**3.0** H12@200	**3.1** H12@200
5600					**2.1** H12@150	**2.5** H12@150	**2.6** H12@150	**2.6** H12@150	**2.7** H12@150	**2.8** H12@200
5800					**1.7** H12@150	**2.2** H12@150	**2.3** H12@150	**2.4** H12@150	**2.4** H12@150	**2.5** H12@150
6000						**2.0** H12@150	**2.1** H12@150	**2.2** H12@150	**2.2** H12@150	**2.2** H12@150

3.3.5 HIBOND COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.95mm HIBOND – INTERNAL SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm²/m width)

	Slab Thickness (D_s) mm									
L (mm)	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
2000	**17.2** H12@250	**22.4** H12@200								
2200	**14.0** H12@250	**18.2** H12@200	**23.0** H12@200							
2400	**11.5** H12@250	**15.1** H12@200	**19.1** H12@200	**22.8** H12@150						
2600	**9.6** H12@250	**12.6** H12@200	**16.0** H12@200	**19.3** H12@150	**21.5** H12@150					
2800	**8.1** H12@250	**10.7** H12@200	**13.6** H12@200	**16.5** H12@150	**18.4** H12@150	**19.4** H12@200	**19.9** H12@200	**20.3** H12@200		
3000	**6.9** H12@250	**9.1** H12@200	**11.6** H12@200	**14.1** H12@150	**15.8** H12@150	**17.5** H12@150	**18.3** H12@150	**18.7** H12@200	**19.1** H12@200	**19.5** H12@200
3200	**5.9** H12@250	**7.8** H12@200	**10.0** H12@200	**12.2** H12@150	**13.8** H12@150	**15.2** H12@150	**16.7** H12@150	**17.4** H12@150	**17.7** H12@200	**18.0** H12@200
3400	**5.1** H12@250	**6.7** H12@200	**8.7** H12@200	**10.6** H12@150	**12.1** H12@150	**13.3** H12@150	**14.6** H12@150	**15.8** H12@150	**16.5** H12@150	**16.8** H12@200
3600	**4.4** H12@250	**5.9** H12@200	**7.6** H12@200	**9.3** H12@150	**10.7** H12@150	**11.7** H12@150	**12.8** H12@150	**13.9** H12@150	**14.9** H12@150	**15.6** H12@150
3800	**3.8** H12@250	**5.1** H12@200	**6.6** H12@200	**8.1** H12@150	**9.5** H12@150	**10.4** H12@150	**11.3** H12@150	**12.2** H12@150	**13.1** H12@150	**14.1** H12@150
4000	**3.3** H12@250	**4.5** H12@200	**5.8** H12@200	**7.2** H12@150	**8.5** H12@150	**9.3** H12@150	**10.1** H12@150	**10.8** H12@150	**11.6** H12@150	**12.5** H12@150
4200	**2.8** H12@250	**3.9** H12@200	**5.1** H12@200	**6.3** H12@150	**7.6** H12@150	**8.3** H12@150	**9.0** H12@150	**9.7** H12@150	**10.3** H12@150	**11.1** H12@150
4400	**2.5** H12@250	**3.4** H12@200	**4.5** H12@200	**5.6** H12@150	**6.8** H12@150	**7.5** H12@150	**8.1** H12@150	**8.7** H12@150	**9.2** H12@150	**9.9** H12@150
4600	**2.1** H12@250	**3.0** H12@200	**4.0** H12@200	**5.0** H12@150	**6.0** H12@150	**6.7** H12@150	**7.3** H12@150	**7.8** H12@150	**8.3** H12@150	**8.8** H12@150
4800	**1.9** H12@250	**2.6** H12@200	**3.5** H12@200	**4.4** H12@150	**5.4** H12@150	**6.1** H12@150	**6.6** H12@150	**7.0** H12@150	**7.4** H12@150	**7.9** H12@150
5000	**1.6** H12@250	**2.3** H12@200	**3.1** H12@200	**3.9** H12@150	**4.8** H12@150	**5.6** H12@150	**6.0** H12@150	**6.3** H12@150	**6.7** H12@150	**7.1** H12@150
5200		**2.0** H12@200	**2.7** H12@200	**3.5** H12@150	**4.3** H12@150	**5.1** H12@150	**5.4** H12@150	**5.8** H12@150	**6.1** H12@150	**6.4** H12@150
5400		**1.8** H12@200	**2.4** H12@200	**3.1** H12@150	**3.8** H12@150	**4.6** H12@150	**5.0** H12@150	**5.2** H12@150	**5.5** H12@150	**5.8** H12@150
5600		**1.5** H12@200	**2.1** H12@200	**2.7** H12@150	**3.4** H12@150	**4.2** H12@150	**4.5** H12@150	**4.8** H12@150	**5.0** H12@150	**5.3** H12@150
5800			**1.9** H12@200	**2.4** H12@150	**3.1** H12@150	**3.8** H12@150	**4.2** H12@150	**4.4** H12@150	**4.6** H12@150	**4.8** H12@150
6000			**1.6** H12@200	**2.2** H12@150	**2.7** H12@150	**3.4** H12@150	**3.8** H12@150	**4.0** H12@150	**4.2** H12@150	**4.4** H12@150
6200				**1.9** H12@150	**2.4** H12@150	**3.0** H12@150	**3.5** H12@150	**3.7** H12@150	**3.8** H12@150	**4.0** H12@150
6400				**1.7** H12@150	**2.2** H12@150	**2.7** H12@150	**3.2** H12@150	**3.4** H12@150	**3.5** H12@150	**3.6** H12@150
6600					**1.9** H12@150	**2.4** H12@150	**3.0** H12@150	**3.1** H12@150	**3.2** H12@150	**3.3** H12@150
6800					**1.7** H12@150	**2.1** H12@150	**2.7** H12@150	**2.9** H12@150	**2.9** H12@150	**3.0** H12@150
7000						**1.9** H12@150	**2.4** H12@150	**2.6** H12@150	**2.7** H12@150	**2.8** H12@150

3.3.6 FIRE DESIGN TABLES

INTRODUCTION

Fire resistance ratings are given for slab thicknesses between 110mm and 160mm, plus 180mm and 200mm slabs, for single spans between 2.0m and 6.0m with live loads of 3 kPa to 5 kPa.

Fire resistance ratings can also be adjusted for loads of 1.5 kPa and 2.5 kPa, refer Note 5 below.

The following notes apply to the Hibond flooring fire design tables in this section.

1. The fire resistance ratings tabulated are equivalent times in minutes of exposure to the standard fire test (NZS/BS 476) that satisfy the criteria for insulation, integrity and stability based on simply supported spans. Fire resistance ratings shown in ***bold italics*** are limited by insulation criteria. The beneficial effects of continuous spans and/or negative reinforcement at supports may be accounted for by specific design.
2. L is the span measured centre to centre between permanent supports.
3. Spans of up to 4.0m do not require any supplementary fire reinforcing steel to achieve a Fire Resistance Rating (FRR) of up to 30 minutes. Spans greater than 4.0m **require** supplementary fire reinforcing steel as outlined in the following tables.
4. The fire resistance ratings given are based on the following conditions. If design conditions differ from the following, specific design will be required.
   - The minimum cover to the fire reinforcement is 25mm to the bottom of the profile and 40mm to the side of the rib.
   - A superimposed dead load (G_{SDL}) of 0.5 kPa has been included. Where G_{SDL} is greater than 0.5 kPa specific design to HERA Report R4-82 is required.
   - The self weight of the Hibond slab is based on a concrete density of 2350 kg/m^3 and an allowance of 5% for concrete ponding during construction.
   - The long term live load factor (AS 1170.0) used for 5 kPa live load is 0.6. For all other live loads 0.4 has been used.
   - Specified concrete strength, f'_c = 25 MPa and Type A aggregate.
   - Reinforcement is grade 500 to AS/NZS 4671 and is assumed to be continuous over the length of the clear span.
   - Design moment capacity of the concrete slab is calculated in accordance with NZS 3101 and any contribution from the Hibond steel is neglected.
5. Live loads less than 3 kPa.
   - For a live load of 2.5 kPa, increase FRR by 4 minutes for the corresponding live load, span and slab thickness published for the 3 kPa live load, provided that the fire resistance rating is not limited by insulation criteria.
   - For a live load of 1.5 kPa, increase FRR by 10 minutes for the corresponding live load, span and slab thickness published for the 3 kPa live load, provided that the fire resistance rating is not limited by insulation criteria.
6. For intermediate values linear interpolation is permitted provided that the two values are within the extent of the tables. For example, interpolation can be used to derive the fire resistance ratings for 170mm and 190mm overall slab thicknesses. No interpolation is permitted between 30 minutes and the tabulated values – in this case the next greater steel content given in the fire design tables must be used.
7. Fire resistance ratings have been provided for spans up to where a value of G_{SDL} + Q = 1.5 kPa can be achieved from the Load Span tables in Section 3.3.5. Therefore these fire resistance rating tables must be used in conjunction with Section 3.3.5 Hibond Composite Slab Load Span Tables as satisfaction of fire resistance rating does not always ensure the load capacity and deflection criteria are met.

Continued on next page

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm														
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800
110	3	H10 every 3rd pan	***71***	69	57	46											
		H12 every 3rd pan				***71***	61	51									
		H12 every 2nd pan							***71***	62	53	46					
		H16 every 3rd pan								***71***	66	57	50				
		H16 every 2nd pan												***71***	65	58	52
		H12 every pan													***71***	67	60
		H16 every pan															***71***
	4	H10 every 3rd pan	***71***	62	50												
		H12 every 3rd pan			***71***	64	54	44									
		H12 every 2nd pan						***71***	63	54	46						
		H16 every 3rd pan							***71***	67	58	50					
		H16 every 2nd pan											***71***	64	57	51	
		H12 every pan												***71***	66	59	53
		H16 every pan															***71***
	5	H10 every 3rd pan	55														
		H12 every 3rd pan	***71***	68	55	44											
		H12 every 2nd pan				***71***	62	52									
		H16 every 3rd pan					***71***	64	54	45							
		H16 every 2nd pan								***71***	66	58	50				
		H12 every pan									***71***	66	58	51	45		
		H16 every pan														***71***	***71***

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200
120	3	H10 every 3rd pan	***86***	73	61	50													
		H12 every 3rd pan			***86***	76	65	55	46										
		H12 every 2nd pan					***86***	84	75	66	57	50							
		H16 every 3rd pan							***86***	79	70	62	54	47					
		H16 every 2nd pan										***86***	84	77	70	63	56	50	
		H12 every pan											***86***	85	78	71	65	59	53
		H16 every pan																	***86***
	4	H10 every 3rd pan	80	67	54	43													
		H12 every 3rd pan		***86***	81	69	58	48											
		H12 every 2nd pan					***86***	77	68	59	51								
		H16 every 3rd pan						***86***	81	72	63	55	48						
		H16 every 2nd pan									***86***	85	77	70	63	56	49		
		H12 every pan										***86***	85	78	71	64	58	52	46
		H16 every pan																	***86***
	5	H10 every 3rd pan	61	47															
		H12 every 3rd pan	***86***	73	61	49													
		H12 every 2nd pan			***86***	78	67	57	48										
		H16 every 3rd pan				***86***	81	70	60	51									
		H16 every 2nd pan							***86***	81	72	64	56	49					
		H12 every pan								***86***	80	72	64	57	50	44			
		H16 every pan														***86***	79	73	66

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																	
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400
130	3	H10 every 3rd pan	90	77	64	53														
		H12 every 3rd pan	***105***	103	91	79	68	58	49											
		H12 every 2nd pan				***105***	97	88	78	69	61	53								
		H16 every 3rd pan					***105***	101	92	83	74	66	58	51						
		H16 every 2nd pan								***105***	104	96	88	81	74	67	60	54	48	
		H12 every pan									***105***	102	95	88	81	75	68	62	57	51
		H16 every pan																***105***	99	94
	4	H10 every 3rd pan	84	70	58	47														
		H12 every 3rd pan	***105***	97	84	73	62	52												
		H12 every 2nd pan			***105***	101	91	81	72	63	55	47								
		H16 every 3rd pan					***105***	95	85	76	67	59	52							
		H16 every 2nd pan								***105***	97	89	82	74	67	60	54	48		
		H12 every pan								***105***	104	96	89	82	75	68	62	56	50	45
		H16 every pan															***105***	99	93	87
	5	H10 every 3rd pan	65	52																
		H12 every 3rd pan	92	78	65	54														
		H12 every 2nd pan		***105***	94	83	72	62	53	44										
		H16 every 3rd pan			***105***	97	86	75	65	56	48									
		H16 every 2nd pan						***105***	95	86	78	69	62	54	47					
		H12 every pan						***105***	102	93	85	77	69	62	55	49				
		H16 every pan												***105***	98	91	85	78	72	66

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																			
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800
140	3	H10 every 3rd pan	93	79	67	56	46															
		H12 every 3rd pan	118	105	94	82	71	61	52	44												
		H12 every 2nd pan		***125***	120	110	100	90	81	72	64	56	49									
		H16 every 3rd pan			***125***	123	114	104	95	86	77	69	61	54	47							
		H16 every 2nd pan						***125***	122	115	107	99	92	84	77	70	64	58	52	46		
		H12 every pan							***125***	119	112	105	98	91	84	78	72	65	60	54	49	44
		H16 every pan													***125***	120	114	108	103	97	92	86
	4	H10 every 3rd pan	87	73	61	50																
		H12 every 3rd pan	112	100	88	76	65	55	46													
		H12 every 2nd pan		***125***	115	104	94	84	75	66	58	50										
		H16 every 3rd pan			***125***	118	108	98	89	80	71	63	55	48								
		H16 every 2nd pan						***125***	117	109	101	93	85	78	71	64	57	51	46			
		H12 every pan						***125***	121	114	107	99	92	85	78	72	65	59	53	48		
		H16 every pan												***125***	120	114	108	102	96	91	85	80
	5	H10 every 3rd pan	69	56	44																	
		H12 every 3rd pan	96	82	70	58	48															
		H12 every 2nd pan	122	110	98	87	76	66	57	48												
		H16 every 3rd pan	***125***	123	112	101	90	80	70	61	52											
		H16 every 2nd pan				***125***	118	109	100	91	82	74	66	59	52	45						
		H12 every pan				***125***	123	114	106	97	89	81	74	67	60	53	47					
		H16 every pan									***125***	123	116	109	103	96	90	83	77	71	65	60

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																				
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000
150	3	H10 every 3rd pan	95	82	69	58	48																
		H12 every 3rd pan	≥120	108	96	85	74	64	55	46													
		H12 every 2nd pan			≥120	112	102	93	84	75	66	59	51	45									
		H16 every 3rd pan				≥120	116	107	98	89	80	72	64	57	50								
		H16 every 2nd pan							≥120	117	109	102	94	87	80	73	67	60	55	49			
		H12 every pan								≥120	114	107	100	94	87	80	74	68	62	57	52	47	
		H16 every pan														≥120	116	111	105	100	94	89	84
	4	H10 every 3rd pan	90	76	64	52																	
		H12 every 3rd pan	115	102	90	79	68	58	49														
		H12 every 2nd pan		≥120	117	107	97	87	78	69	61	53	46										
		H16 every 3rd pan				≥120	111	101	92	83	74	66	58	51									
		H16 every 2nd pan							≥120	112	104	96	88	81	74	67	61	54	49				
		H12 every pan							≥120	117	109	102	95	88	81	75	68	62	56	51	46		
		H16 every pan													≥120	117	111	105	100	94	88	83	78
	5	H10 every 3rd pan	73	59	47																		
		H12 every 3rd pan	99	86	73	62	51																
		H12 every 2nd pan	≥120	113	102	91	80	70	60	52	44												
		H16 every 3rd pan		≥120	116	105	94	84	74	65	56	48											
		H16 every 2nd pan					≥120	113	104	95	86	78	70	63	56	49							
		H12 every pan					≥120	117	109	101	93	85	78	70	63	57	51	45					
		H16 every pan										≥120	119	113	106	100	94	88	81	76	70	64	59

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																				
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000
160	3	H10 every 3rd pan	97	84	71	60	50																
		H12 every 3rd pan	≥120	110	98	87	76	66	57	48													
		H12 every 2nd pan			≥120	114	104	95	86	77	69	61	53	47									
		H16 every 3rd pan				≥120	118	109	100	91	83	74	67	59	52	46							
		H16 every 2nd pan							≥120	119	112	104	97	89	82	76	69	63	57	51	46		
		H12 every pan								≥120	116	109	103	96	89	83	77	70	65	59	54	49	44
		H16 every pan														≥120	119	113	108	102	97	92	87
	4	H10 every 3rd pan	92	78	66	55	45																
		H12 every 3rd pan	117	105	93	81	71	60	51														
		H12 every 2nd pan		≥120	119	109	99	90	80	71	63	55	48										
		H16 every 3rd pan				≥120	113	104	94	85	77	69	61	54	47								
		H16 every 2nd pan							≥120	114	106	99	91	84	77	70	63	57	51	46			
		H12 every pan							≥120	119	111	104	97	90	84	77	71	65	59	54	48		
		H16 every pan													≥120	119	114	108	102	97	91	86	81
	5	H10 every 3rd pan	76	62	50																		
		H12 every 3rd pan	102	89	76	65	54	45															
		H12 every 2nd pan	≥120	116	105	94	83	73	64	55	47												
		H16 every 3rd pan		≥120	118	108	97	87	77	68	60	52											
		H16 every 2nd pan					≥120	116	107	98	90	82	74	66	59	46							
		H12 every pan						≥120	112	104	96	88	81	74	67	60	54	48					
		H16 every pan											≥120	116	110	103	97	91	85	79	74	68	63

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																				
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000
180	3	H10 every 3rd pan	100	87	75	64	53	44															
		H12 every 3rd pan	≥120	113	101	90	80	70	60	52	44												
		H12 every 2nd pan			≥120	117	108	99	90	81	72	65	57	50	44								
		H16 every 3rd pan					≥120	113	104	95	87	78	71	63	56	50							
		H16 every 2nd pan								≥120	115	108	101	93	87	80	73	67	61	56	50		
		H12 every pan								≥120	119	113	106	99	93	87	80	74	68	63	58	53	48
		H16 every pan															≥120	117	112	106	101	96	91
	4	H10 every 3rd pan	96	82	70	59	48																
		H12 every 3rd pan	≥120	108	97	85	75	65	55	47													
		H12 every 2nd pan			≥120	113	103	94	85	76	67	60	52	45									
		H16 every 3rd pan				≥120	117	108	99	90	81	73	65	58	51								
		H16 every 2nd pan							≥120	118	110	103	96	88	81	75	68	62	56	50	45		
		H12 every pan								≥120	115	108	101	95	88	82	75	69	63	58	53	48	
		H16 every pan														≥120	118	112	107	101	96	91	86
	5	H10 every 3rd pan	81	67	55	44																	
		H12 every 3rd pan	107	94	82	70	59	50															
		H12 every 2nd pan		≥120	110	99	89	79	69	60	52	45											
		H16 every 3rd pan			≥120	113	103	93	83	74	65	57	50										
		H16 every 2nd pan						≥120	112	104	95	87	80	72	65	58	52	46					
		H12 every pan						≥120	117	109	101	94	87	79	73	66	60	54	48				
		H16 every pan												≥120	115	109	103	97	91	86	80	75	69

3.3.6 FIRE DESIGN TABLES *continued*

0.75mm AND 0.95mm HIBOND COMPOSITE SLAB – FIRE RESISTANCE RATINGS (minutes)

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF HIBOND SLAB (L) mm																				
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000
200	3	H10 every 3rd pan	103	90	78	66	56	46															
		H12 every 3rd pan	≥120	115	104	93	83	73	63	55	47												
		H12 every 2nd pan				≥120	110	101	92	84	75	67	60	53	47								
		H16 every 3rd pan					≥120	115	107	98	90	82	74	66	59	53	47						
		H16 every 2nd pan								≥120	118	111	104	96	90	86	77	70	64	59	53	48	
		H12 every pan									≥120	115	109	102	96	89	83	77	72	66	61	56	51
		H16 every pan																≥120	114	109	104	99	94
	4	H10 every 3rd pan	99	85	73	62	51																
		H12 every 3rd pan	≥120	111	100	89	78	68	59	50													
		H12 every 2nd pan			≥120	116	106	97	88	79	71	63	55	49									
		H16 every 3rd pan					≥120	111	102	93	85	77	69	62	55	48							
		H16 every 2nd pan								≥120	114	106	99	92	85	78	72	66	60	54	49		
		H12 every pan								≥120	118	111	104	98	91	85	79	73	67	61	56	51	46
		H16 every pan															≥120	115	110	105	100	94	89
	5	H10 every 3rd pan	85	72	59	48																	
		H12 every 3rd pan	111	98	86	75	64	54	45														
		H12 every 2nd pan		≥120	113	103	93	83	74	65	56	49											
		H16 every 3rd pan			≥120	117	107	97	88	79	70	62	54	47									
		H16 every 2nd pan						≥120	116	108	100	92	84	77	70	63	57	51	45				
		H12 every pan							≥120	113	105	98	91	84	77	71	64	58	53	47			
		H16 every pan												≥120	119	113	108	102	96	90	85	80	74

3.3.7 NOISE CONTROL

3.3.7.1 SCOPE

This section provides guidelines for specifiers and constructors who require noise control systems for residential applications such as separate multi-unit dwellings or single dwellings, commercial applications such as retail spaces, offices and institutional buildings. It is not intended that these guidelines replace the need for specialist acoustic design to meet the specified sound insulation performance for the building.

A Hibond Noise Control System consists of a Hibond concrete slab with a selected USG ceiling system, GIB® standard plasterboard ceiling linings, selected floor coverings and the specific inclusion of a cavity absorber. It must be noted that the floor covering is an essential aspect of the performance of the system.

The information in this section is based on laboratory testing carried out by the University of Auckland, Acoustics Testing Service. The test data was analysed and acoustic opinions provided where required.

Acoustic opinions for the Hibond Noise Control System are contained in Report Rp002 R00_2006476 by Marshall Day Acoustics Limited. This report is available on request for use as a producer statement supporting an alternative solution to the New Zealand Building Code.

The systems set out in this publication provide the stated sound transmission loss performances under laboratory conditions or by opinion. However in practical applications on site there is a significant element of subjectivity to interpreting noise levels within rooms. No matter how low a sound level might be, if it is intrusive upon a person's privacy, then it is likely to cause annoyance. No practical system can guarantee complete sound insulation and completely satisfy everyone.

For more specific information about the fundamentals of sound, its propagation, noise control and detailing, reference should be made to the HERA Acoustic Guide, *HERA Report R4-121*.

3.3.7.2 FACTORS AFFECTING NOISE CONTROL

Layout Planning

A complete noise control solution is a synthesis of detailing and planning. Hibond Noise Control specifications only provide details of the floor/ceiling system components. The following recommendations will help ensure better noise control is achieved.

- Avoid positioning continuous steel beams under non-carpeted floors.
- Avoid positioning services in ceiling spaces of habitable rooms.
- Non-carpeted service areas should be placed adjacent to each other (vertically and horizontally).
- Locate noise sensitive bedrooms away from noise emission areas such as plant rooms, toilets etc.

Flanking

Overall noise control performance of the building is dependent on the surrounding structure having the same or greater performance than the Hibond Noise Control System. Special care in both design and construction must be taken at expansion joints, service penetrations and the junctions of Hibond floor/ceilings to walls and structural members to ensure that flanking transmission does not unduly degrade the sound insulation performance.

Continued on next page

3.3.7.2 FACTORS AFFECTING NOISE CONTROL *continued*

Substitution

Do not substitute! Hibond Noise Control Systems are not generic. It is most important that only the specified components are used when installing Hibond Noise Control Systems. Otherwise, the system performance may not meet the published ratings and may fail to meet customer satisfaction.

Substitution is not in accordance with Hibond Flooring System recommendations and is undertaken at the risk of the owner, specifier and builder.

For the Hibond Flooring System components, refer Section 3.3.13 Hibond Components.

For components supplied by other manufacturers including additional information on specifications, performance, installation, supply and costing etc, refer to manufacturers and distributors' information.

Various	Floor coverings (refer descriptions in Section 3.3.7.4 System Specifications)
USG (09 636 3680)	Strongback Channel (DJ38 or DJ75) Furring Strap (FS37) Furring Channel (FC37) Perimeter Channel (PC24)
Potter Interior Systems Ltd (0800 768 837)	Sound Isolation Clip (ST001) 2.5mm diameter galvanised wire Masonry suspension anchor (for wire attachment to composite slab)
Tasman Insulation (0800 802 287)	Fibreglass Insulation Blanket (density 9 kg/m^3 minimum) Kawool (density 96 kg/m^3)
Winstone Wallboards Ltd (0800 100 442)	13mm GIB® standard plasterboard
Bostik New Zealand Ltd (04 567 5119)	Bostik Ultraset Adhesive

Quality Control

When designing or building Hibond Noise Control Systems, strict attention to the specification, construction and workmanship is required. If the system is not constructed to the recommended details, sound insulation performance will be significantly degraded.

A documented process for checking materials and workmanship should be implemented as part of design and construction. It is recommended that in any multi-unit building at an early stage of the contract, a demonstration apartment be finished to second fix with door and ceilings in place and the airborne and impact sound performance tested and a pass achieved before the completion of any subsequent units.

In order to eliminate "weak spots", the Hibond Noise Control System must be fully completed for a particular room, including floor coverings, junctions of floor coverings to partitions, ceiling cavities, suspension systems, ceiling linings, light fittings and junctions of the Hibond Flooring System with walls or steel beams and partitions. Failure to observe these requirements will render the systems ineffective.

Continued on next page

3.3.7.2 FACTORS AFFECTING NOISE CONTROL *continued*

Laboratory versus Site Testing
All Sound Transmission Class (STC) and Impact Insulation Class (IIC) values for Hibond Noise Control Systems in this publication are from test reports and corresponding acoustic opinions. The laboratory tested constructions replicate site installations as closely as practicable. However laboratory testing does not address sound flanking paths at the floor/ceiling to wall junctions, which can reduce the sound insulation performance.

It is prudent to allow a 5 point reduction for Field Sound Transmission Class (FSTC) and Field Impact Insulation Class (FIIC) when compared to laboratory test results. This reduced performance is reflected in the lesser requirement of FSTC 50 and FIIC 50 for field testing verification in NZBC Clause G6.

The test frequency range was between 100 and 4000 Hertz. Tests were carried out in accordance with vertification method G6/VM1 including both the ASTM standards and the corresponding ISO 140 requirements.

Impact sound insulation testing was carried out for the Hibond Flooring System and indicative IIC values for various floor coverings are listed in the appropriate system specification (refer 3.3.7.4). A carpet or sufficiently resilient floor covering to achieve FIIC 50 (minimum) is required throughout the serviceable life of the building, where carpet or resilient floor covering is specified as part of the system.

The term ***indicative*** refers to a difference from the test arrangement in *ISO140/VI-1978(E) Laboratory measurements of impact sound insulation of floors, clause 5.2 Test specimen setout.* This clause prescribes a sample size of not less than 10 square metres with edge conditions as similar as possible to normal construction practice. The tested samples of floor coverings were approximately 600x600mm with free edges.

Building Services
Downlights and flush-mounted lighting boxes must be acoustically tested and approved as suitable for the specific application in order to ensure that the sound insulation performances are not compromised. All ceiling penetrations have the potential to reduce performance. Plumbing pipe work installed using bends with generous radii, smooth bores and tapered joints will reduce the generation of plumbing noise caused by turbulence. The transfer of plumbing noise may be reduced by isolating elements such as the use of resilient pipe clips and heavy pipe wraps. Plumbing systems designed to prevent excessive pressure, water hammer, splashing, thermal movement of pipes, aeration or appliance noise will complement Hibond Noise Control Systems by reducing the noise generated by these installations.

Continued on next page

3.3.7.3 SYSTEM SELECTION

Selecting a System
When selecting a Hibond Noise Control System the following questions should be considered.

1. The Market Sector and Zone, which best describes the situation.
2. Is code compliance necessary?
3. What will the occupants find satisfactory?

If code compliance is necessary, then a system with a STC and IIC rating of at least 55 must be selected.

If code compliance is not required for the floor ceiling, then occupant satisfaction must be assessed and the performance specified accordingly.

It should be noted that code compliance may not constitute satisfaction. The building code should be treated as a minimum standard. Many people will not be satisfied by a system that merely satisfies NZBC Clause G6 (STC and IIC 55). For this reason Hibond Noise Control Systems offer the option of many differently performing systems including those which considerably exceed building code requirements.

The following guide shows relative perception of loudness and sound insulation performance:

- 1dB increase in insulation = very difficult to perceive change in sound level.
- 3dB increase in insulation = just perceivable change in sound level.
- 5dB increase in insulation = clearly noticeable decrease in sound level.
- 10dB increase in insulation = sound heard through construction is approximately half as loud.
- 20dB increase in insulation = sound heard through construction is approximately quarter as loud.
- The addition of an extra layer of 13mm GIB® standard plasterboard could increase the system performance by 3 STC points and 2 IIC points.

Some STC and IIC values in this document are based upon acoustic opinions and have a margin of error of +/– 2dB for STC and +/– 3dB for IIC.

Call Dimond on 0800 Roofspec (0800 766 377) for further information on sound insulation performance for composite slabs other than 120mm overall thickness.

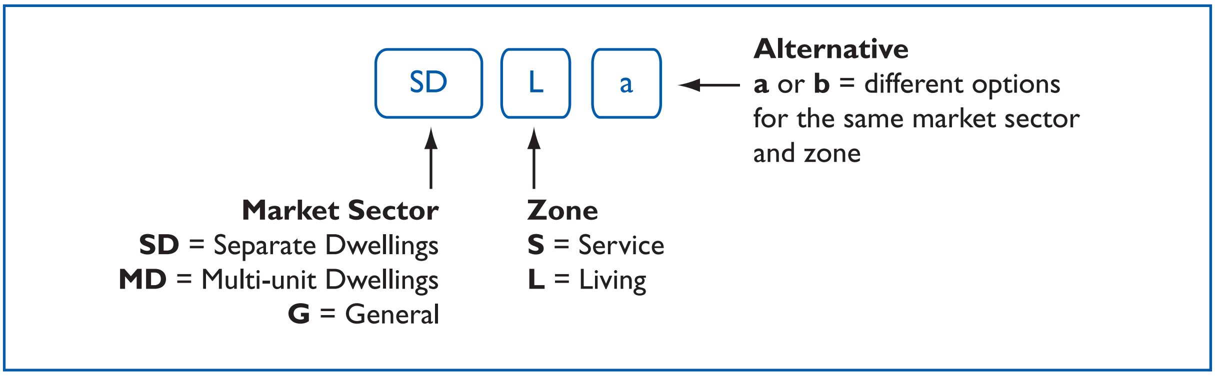
Continued on next page

3.3.7.3 SYSTEM SELECTION *continued*

System Specification Reference

Reference codes for each system are marked on the top right hand corner of each system specification. The intent of the specification reference is to allow designers to include a single unique code on a contract drawing. It is a quick concise means of identifying a system comprised of a number of subsystems and components. These codes are:

System reference example: SDLa



The system specification codes contain certain items which have the following particular meanings:

General: Use of Hibond in non-specific applications including garages, retail spaces without ceilings and other spaces without ceiling linings.

Separate Dwelling: A typical New Zealand house which is a single dwelling on a section and isolated from other buildings.

Multi-unit Dwelling: A residential occupancy in a multi-unit building requiring compliance with NZBC Clause G6.

Living Zone: Habitable rooms such as kitchens, bedrooms, lounge, dining room and study.

Service Zone: Non-habitable rooms such as laundries, bathrooms, showers and toilets.

3.3.7.4 SYSTEM SPECIFICATIONS

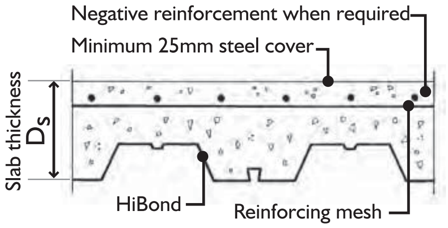
HIBOND (OR FLATDECK) FLOOR FOR GENERAL MARKET

System Specification Reference
G

Airborne Sound Insulation
STC 42
Sound Transmission Class

Acoustic Opinion No.
Rp002 R00_2006476
Hibond Test ID Nos.
T601/T609

Typical Section



Description

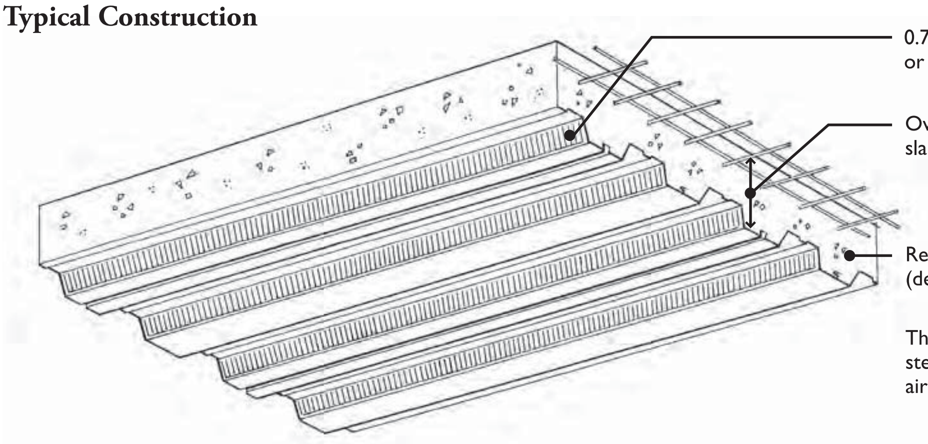
0.75 or 0.95mm Hibond or Flatdeck steel sheeting, with overall slab thickness as indicated below.

Sound Transmission Class (STC)

STC	Description of System	Test ID or Opinion No.
40	0.75 or 0.95mm Hibond with 110mm overall thickness	Rp002 R00_2006476
42	0.75 or 0.95mm Hibond with 120mm overall thickness	T601T1
44	0.75 or 0.95mm Hibond with 130mm overall thickness	Rp002 R00_2006476
44	0.75 or 0.95mm Hibond with 140mm overall thickness	Rp002 R00_2006476
46	0.75 or 0.95mm Hibond with 150mm overall thickness	Rp002 R00_2006476
47	0.75 or 0.95mm Hibond with 160mm overall thickness	Rp002 R00_2006476
48	0.75 or 0.95mm Hibond with 170mm overall thickness	Rp002 R00_2006476
49	0.75 or 0.95mm Hibond with 180mm overall thickness	Rp002 R00_2006476
50	0.75 or 0.95mm Hibond with 190mm overall thickness	Rp002 R00_2006476
51	0.75 or 0.95mm Hibond with 200mm overall thickness	Rp002 R00_2006476

Note: This system does not comply with the requirements of the NZBC Clause G6 for airborne sound insulation (STC).

Typical Construction



Impact Insulation Class (IIC)
for various floor coverings on a slab with an overall slab thickness (D_s) of 120mm

IIC	Floor Covering Option	Hibond Test ID
23	Bare slab	T609-15
40	15mm strip timber on Bostic Ultraset adhesive	T609-57
42	6mm cork flooring	T609-13
43	Gerfloor Taralay Comfort Vinyl 3.1mm thick	T601-3
44	15mm strip timber on 1mm polyethylene foam	T609-44
66	Carpet, nylon or wool 40oz without underlay	Rp002 R00_2006476
67	Carpet, wool 60oz without underlay	Rp002 R00_2006476
71	Wool or nylon carpet plus 8mm foam underlay	Rp002 R00_2006476

Notes

1. The acoustic opinion has a margin of error of +/- 3 IIC points. IIC tests other than for bare slab are indicative with a margin for error of +/- 3 IIC points. Refer Section 3.3.7.2 Factors Affecting Noise Control: Laboratory versus Site Testing.
2. This system can not comply with NZBC Clause G6 for impact insulation class where IIC values shown are less than 55.
3. A quality assurance process must be implemented for all floor coverings.
4. In service zones, the performance requirement of NZBC Clause E3 – Internal Moisture must be properly considered and fully detailed.
5. Bostik Ultraset adhesive to be placed with a two layer application to achieve a dry film thickness not less than 1.9mm. All other adhesives to be thin layer applications in accordance with the manufacturers' instructions.

3.3.7.4 SYSTEM SPECIFICATIONS *continued*

HIBOND (OR FLATDECK) FLOOR/CEILING FOR SEPARATE DWELLING IN LIVING ZONE

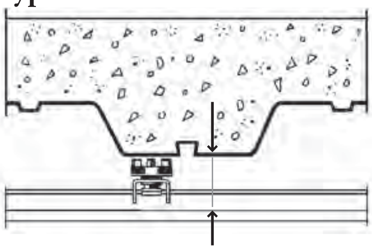
System Specification Reference
SDL

Airborne Sound Insulation
STC 54
Sound Transmission Class

Acoustic Opinion No.
Rp002 R00_2006476
Hibond Test ID Nos.
T609-19

Note this system does not comply with the requirements of the NZBC Clause G6 for airborne sound insulation (STC).

Typical Section



40mm (minimum) for Hibond
80mm (minimum) for Flatdeck

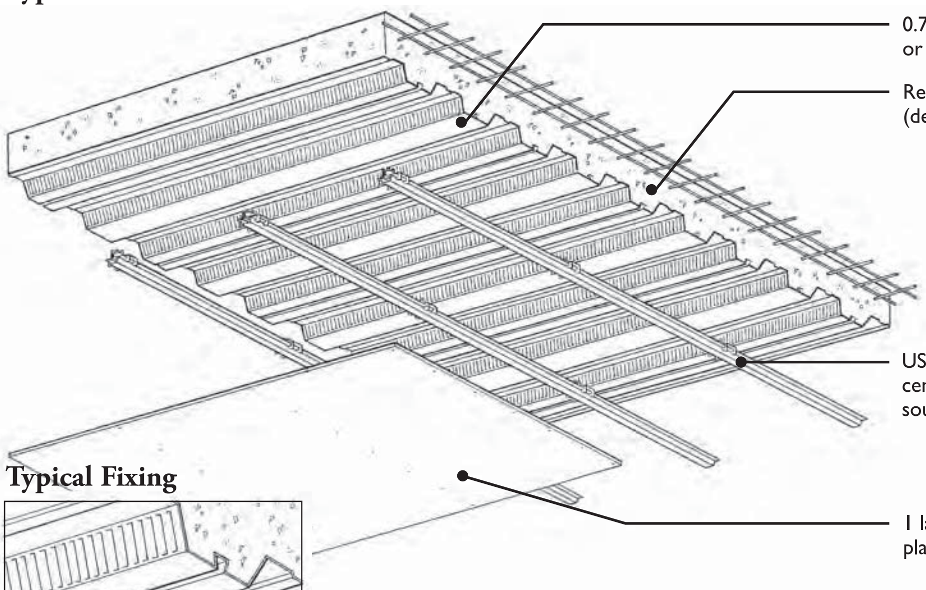
Description

0.75 or 0.95mm Hibond or Flatdeck steel sheeting with 120mm overall thickness concrete slab. Potters Direct Fix Clip ceiling system with Potters sound isolation clips. USG furring channel at 600mm centres (max). 1 layer of 13mm GIB® standard plasterboard.

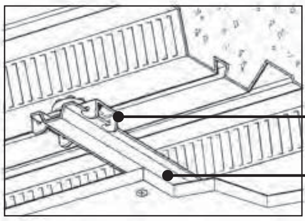
Increased Performance

The addition of an extra layer of 13mm GIB® standard plasterboard could increase STC rating by 3 points and IIC rating by 2 points.

Typical Construction



Typical Fixing



The junction between the plasterboard ceiling and walls must be airtight.

Impact Insulation Class (IIC)
for various floor coverings on a slab with an overall slab thickness (D_S) of 120mm

IIC	Floor Covering Option	Hibond Test ID or Opinion No.
39	Bare slab	Rp002 R00_2006476
46	15mm strip timber on Bostic Ultraset adhesive	Rp002 R00_2006476
47	6mm cork flooring	Rp002 R00_2006476
49	Gerfloor Taralay Comfort Vinyl 3.1mm thick	Rp002 R00_2006476
47	15mm strip timber on 1mm polyethylene foam	Rp002 R00_2006476
60	Carpet, nylon or wool 40oz without underlay	Rp002 R00_2006476
62	Carpet, wool 60oz without underlay	Rp002 R00_2006476
66	Wool or nylon carpet plus 8mm foam underlay	Rp002 R00_2006476

Notes
1. The acoustic opinion has a margin of error of +/- 3 IIC points.
2. This system can not comply with NZBC Clause G6 for impact insulation class where IIC values shown are less than 55.
3. A quality assurance process must be implemented for all floor coverings.
4. In service zones, the performance requirement of NZBC Clause E3 – Internal Moisture must be properly considered and fully detailed.
5. Bostik Ultraset adhesive to be placed with a two layer application to achieve a dry film thickness not less than 1.9mm. All other adhesives to be thin layer applications in accordance with the manufacturers' instructions.

3.3.7.4 SYSTEM SPECIFICATIONS *continued*

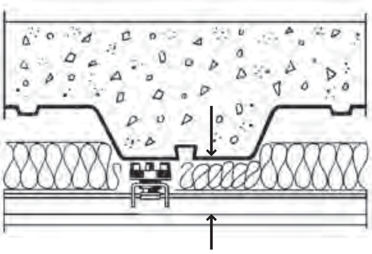
System Specification Reference
MDLa

Airborne Sound Insulation
STC 61
Sound Transmission Class

Acoustic Opinion No.
Rp002 R00_2006476
Hibond Test ID Nos.
T609-18

HIBOND (OR FLATDECK) FLOOR/CEILING FOR MULTI-UNIT DWELLING IN LIVING ZONE – Alternative a

Typical Section



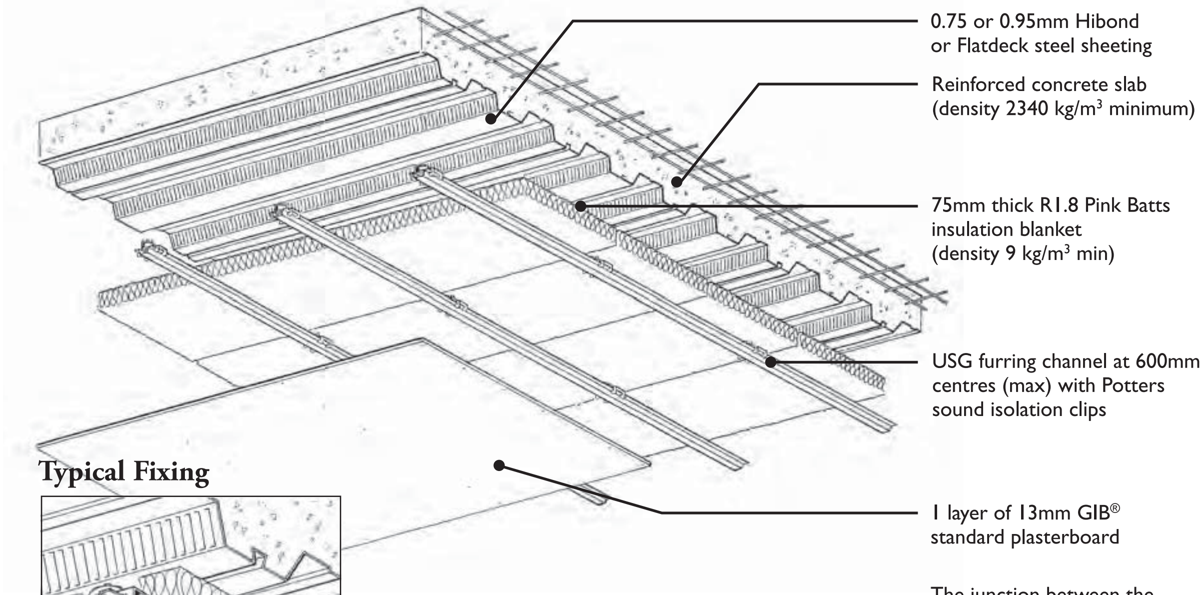
Description

0.75 or 0.95mm Hibond or Flatdeck steel sheeting with 120mm overall thickness concrete slab. 75mm thick R1.8 Pink Batts insulation blanket (density 9kg/m^3 min). Potters Direct Fix Clip ceiling system with Potters sound isolation clips. USG furring channel at 600mm centres (max). 1 layer of 13mm GIB® standard plasterboard.

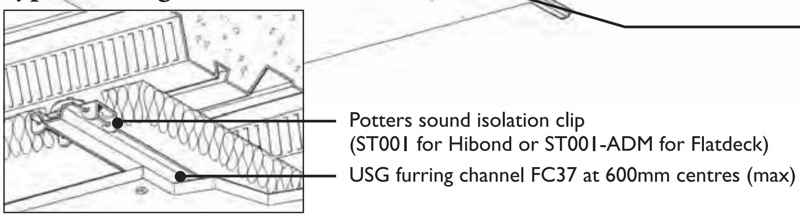
Increased Performance

The addition of an extra layer of 13mm GIB® standard plasterboard could increase STC rating by 3 points and IIC rating by 2 points.

Typical Construction



Typical Fixing



The junction between the plasterboard ceiling and walls must be airtight.

Impact Insulation Class (IIC)
for various floor coverings on a slab with an overall slab thickness (D_s) of 120mm

IIC	Floor Covering Option	Hibond Test ID or Opinion No.
42	Bare slab	Rp002 R00_2006476
54	15mm strip timber on Bostic Ultraset adhesive	Rp002 R00_2006476
56	6mm cork flooring	Rp002 R00_2006476
56	Gerfloor Taralay Comfort Vinyl 3.1mm thick	Rp002 R00_2006476
57	15mm strip timber on 1mm polyethylene foam	Rp002 R00_2006476
67	Carpet, nylon or wool 40oz without underlay	Rp002 R00_2006476
69	Carpet, wool 60oz without underlay	Rp002 R00_2006476
73	Wool or nylon carpet plus 8mm foam underlay	Rp002 R00_2006476

Notes

1. The acoustic opinion has a margin of error of +/- 3 IIC points.
2. This system can not comply with NZBC Clause G6 for impact insulation class where IIC values shown are less than 55.
3. A quality assurance process must be implemented for all floor coverings.
4. In service zones, the performance requirement of NZBC Clause E3 – Internal Moisture must be properly considered and fully detailed.
5. Bostik Ultraset adhesive to be placed with a two layer application to achieve a dry film thickness not less than 1.9mm. All other adhesives to be thin layer applications in accordance with the manufacturers' instructions.

3.3.7.4 SYSTEM SPECIFICATIONS *continued*

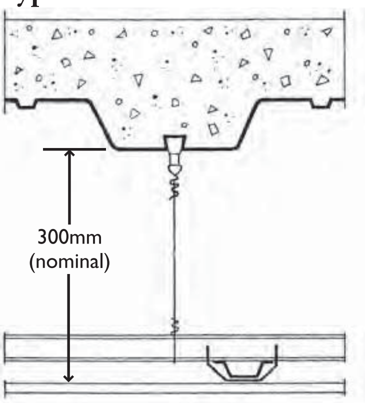
HIBOND (OR FLATDECK) FLOOR/CEILING FOR MULTI-UNIT DWELLING IN LIVING ZONE – Alternative b

System Specification Reference
MDLb

Airborne Sound Insulation
STC 59
Sound Transmission Class

Acoustic Opinion No.
Rp002 R00_2006476
Hibond Test ID Nos.
T609-22

Typical Section



Description

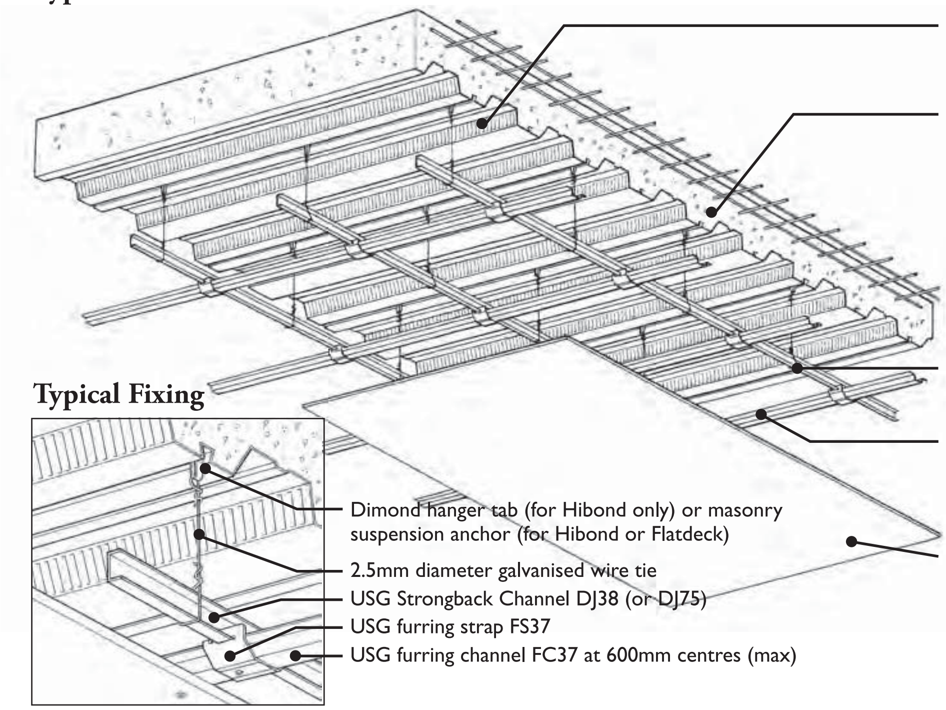
0.75 or 0.95mm Hibond or Flatdeck steel sheeting with 120mm overall thickness concrete slab. USG Donn Screw Fix suspended ceiling system. USG furring channel at 600mm centres (max). 1 layer of 13mm GIB® standard plasterboard.

Increased Performance

The addition of an extra layer of 13mm GIB® standard plasterboard could increase STC rating by 3 points and IIC rating by 2 points.

Typical Construction

Typical Fixing



The junction between the plasterboard ceiling and walls must be airtight.

Impact Insulation Class (IIC)
for various floor coverings on a slab with an overall slab thickness (D_S) of 120mm

IIC	Floor Covering Option	Hibond Test ID or Opinion No.
35	Bare slab	Rp002 R00_2006476
51	Ceramic tile on Bostic Ultraset adhesive	Rp002 R00_2006476
50	15mm strip timber on Bostic Ultraset adhesive	Rp002 R00_2006476
52	6mm cork flooring	Rp002 R00_2006476
52	Gerfloor Taralay Comfort Vinyl 3.1mm thick	Rp002 R00_2006476
63	Carpet, nylon or wool 40oz without underlay	Rp002 R00_2006476
65	Carpet, wool 60oz without underlay	Rp002 R00_2006476
69	Wool or nylon carpet plus 8mm foam underlay	Rp002 R00_2006476

Notes

1. The acoustic opinion has a margin of error of +/- 3 IIC points.
2. This system can not comply with NZBC Clause G6 for impact insulation class where IIC values shown are less than 55.
3. A quality assurance process must be implemented for all floor coverings.
4. In service zones, the performance requirement of NZBC Clause E3 – Internal Moisture must be properly considered and fully detailed.
5. Bostik Ultraset adhesive to be placed with a two layer application to achieve a dry film thickness not less than 1.9mm. All other adhesives to be thin layer applications in accordance with the manufacturers' instructions.

3.3.7.4 SYSTEM SPECIFICATIONS *continued*

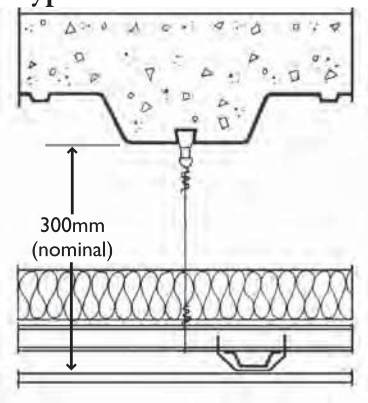
HIBOND (OR FLATDECK) FLOOR/CEILING FOR MULTI-UNIT DWELLING IN SERVICE ZONE

System Specification Reference
MDS

Airborne Sound Insulation
STC 61
Sound Transmission Class

Acoustic Opinion No.
Rp002 R00_2006476
Hibond Test ID Nos.
T609-23

Typical Section



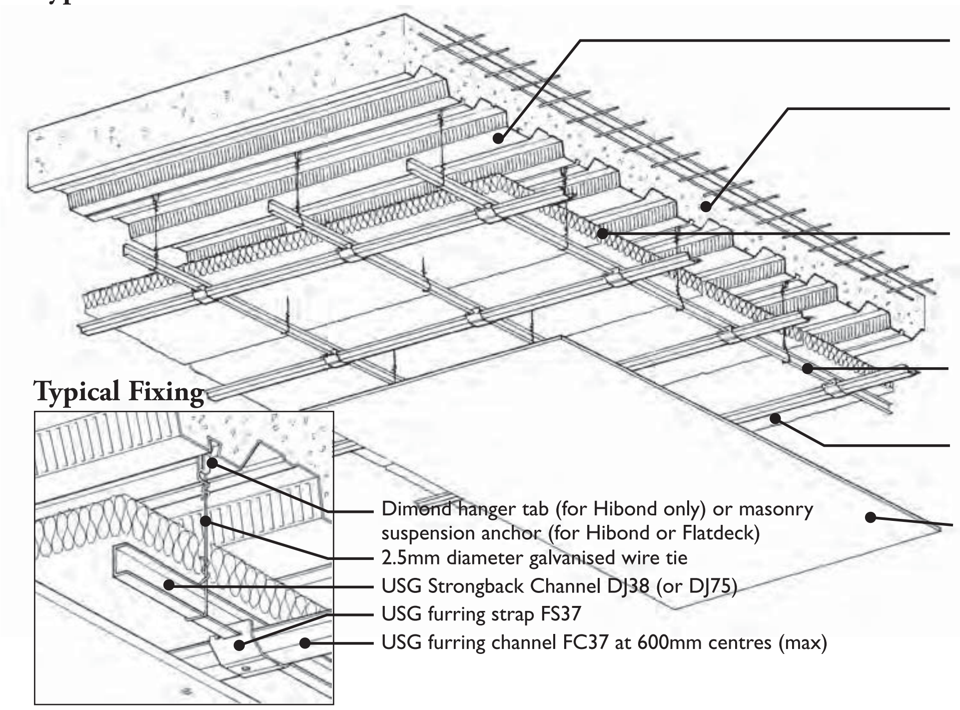
Description

0.75 or 0.95mm Hibond or Flatdeck steel sheeting with 120mm overall thickness concrete slab. 75mm thick R1.8 Pink Batts insulation blanket (density 9 kg/m³ min). USG Donn Screw Fix suspended ceiling system. USG furring channel at 600mm centres (max). 1 layer of 13mm GIB® standard plasterboard.

Increased Performance

The addition of an extra layer of 13mm GIB® standard plasterboard could increase STC rating by 3 points and IIC rating by 2 points.

Typical Construction



The junction between the plasterboard ceiling and walls must be airtight.

Typical Fixing

Impact Insulation Class (IIC)
for various floor coverings on a slab with an overall slab thickness (D_s) of 120mm

IIC	Floor Covering Option	Hibond Test ID or Opinion No.
43	Bare slab	Rp002 R00_2006476
55	Ceramic tile on Bostic Ultraset adhesive	Rp002 R00_2006476
62	15mm strip timber on Bostic Ultraset adhesive	Rp002 R00_2006476
64	6mm cork flooring	Rp002 R00_2006476
66	Gerfloor Taralay Comfort Vinyl 3.1mm thick	Rp002 R00_2006476
75+	Carpet, nylon or wool 40oz without underlay	Rp002 R00_2006476
75+	Carpet, wool 60oz without underlay	Rp002 R00_2006476
75+	Wool or nylon carpet plus 8mm foam underlay	Rp002 R00_2006476

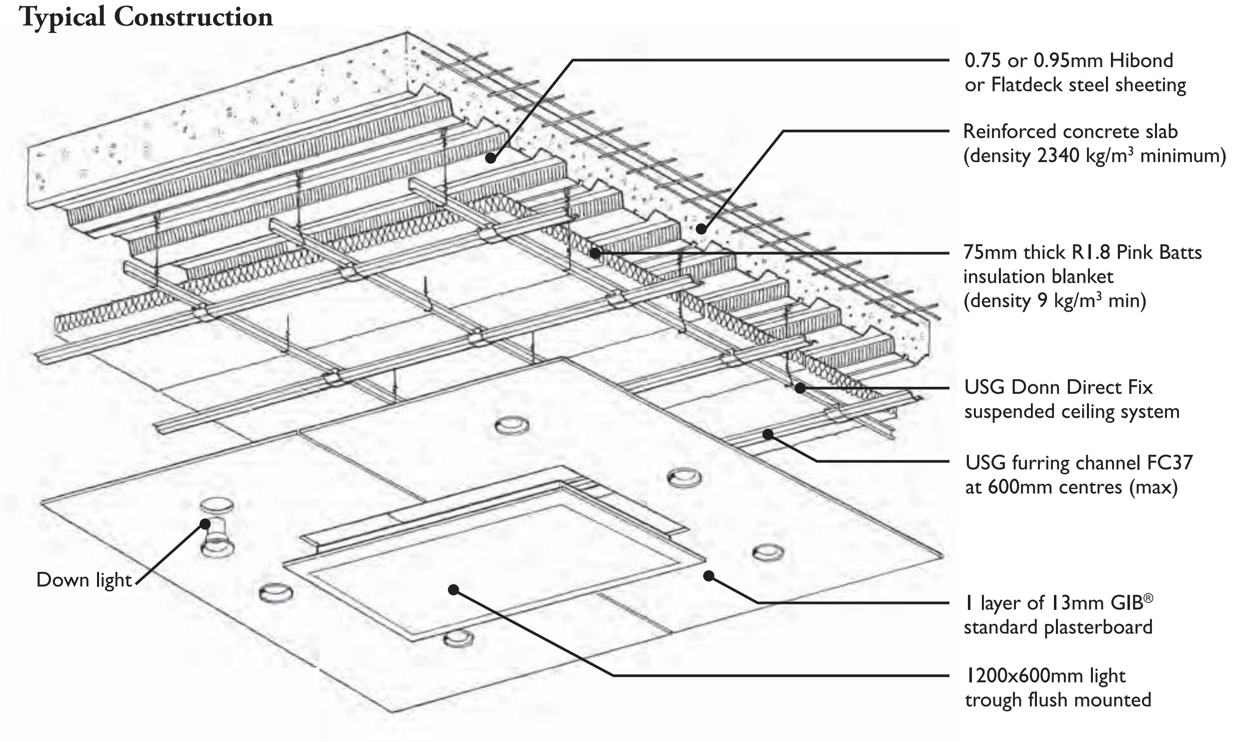
Notes
1. The acoustic opinion has a margin of error of +/- 3 IIC points.
2. This system can not comply with NZBC Clause G6 for impact insulation class where IIC values shown are less than 55.
3. A quality assurance process must be implemented for all floor coverings.
4. In service zones, the performance requirement of NZBC Clause E3 – Internal Moisture must be properly considered and fully detailed.
5. Bostik Ultraset adhesive to be placed with a two layer application to achieve a dry film thickness not less than 1.9mm. All other adhesives to be thin layer applications in accordance with the manufacturers' instructions.

3.3.7.4 SYSTEM SPECIFICATIONS *continued*

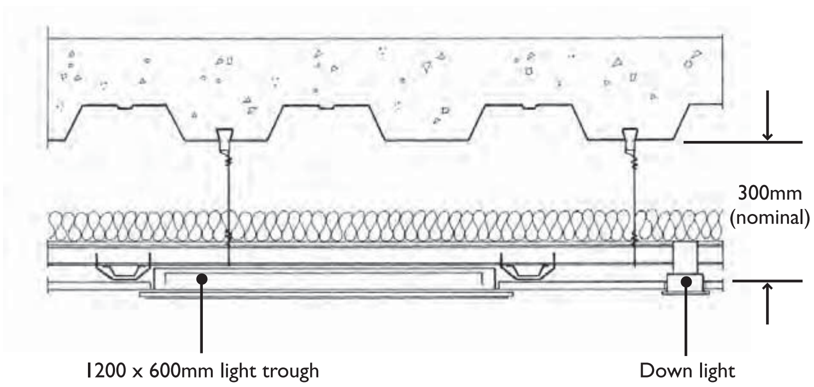
LIGHT FITTING PENETRATIONS IN CEILING LININGS

The light fittings shown below reduce the sound insulation performance of the floor/ceiling system. For each of the Hibond or Flatdeck floor/ceiling systems MDLb and MDS the impact sound insulation is reduced by a minimum of 1 IIC point and the airborne sound insulation is reduced by a minimum of 2 STC points.

Typical Construction



Typical Section



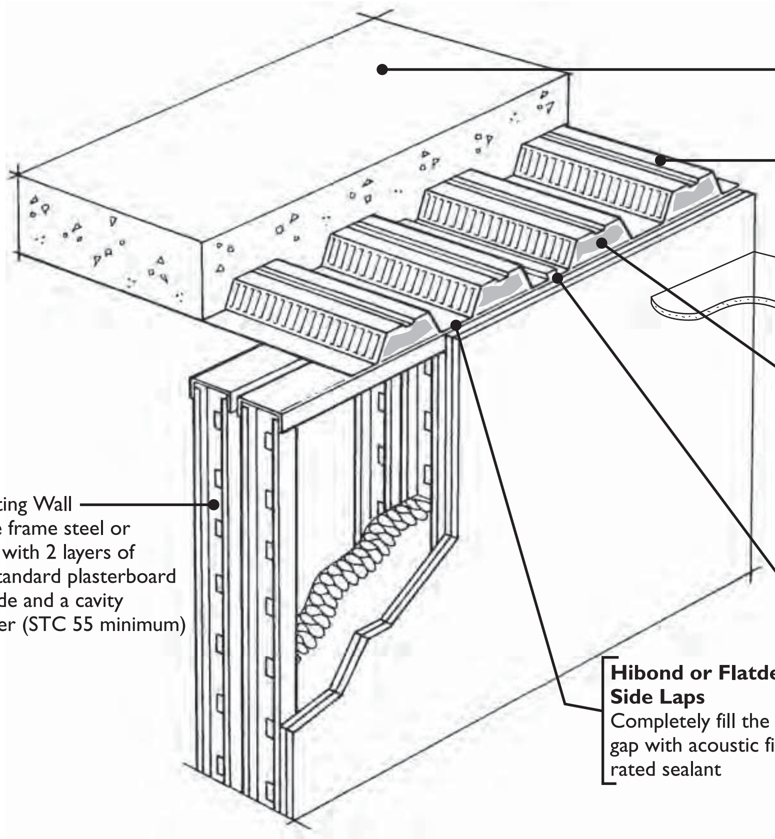
Notes

1. Downlights and light trough penetrations through the ceiling are permissible in Hibond or Flatdeck Flooring Systems MDLb and MDS (illustrated) but not permitted in SDL and MDLa.
2. The illustration represents the extent of light fitting penetrations per $10m^2$ of ceiling lining. If the extent of light fitting penetrations exceeds the proportion illustrated, the sound insulation performance of the Hibond or Flatdeck system may be reduced.
3. The junction between the plasterboard ceiling and walls must be airtight.

3.3.7.4 SYSTEM SPECIFICATIONS *continued*

TOP OF INTER-TENANCY SEPARATING WALL TO UNDERSIDE OF HIBOND OR FLATDECK FLOOR SLAB

This detail provides guidance on how to complete the voids between the top of the wall and the underside of the Hibond or Flatdeck Flooring System.



Notes

1. This construction detail only applies to separating walls with a STC of 55dB or more. For light single stud walls with one layer of plasterboard each side, the top track/plate must be spaced off from and not connected (isolated) to the slab soffit.
2. This construction detail requires a suspended ceiling with one layer of 13mm GIB® standard plasterboard as a ceiling lining. The junction between the plasterboard ceiling and the walls must be airtight.
3. With **Hibond**, if there is no suspended ceiling both layers of 13mm GIB® standard plasterboard wall lining each side must be scribed around the ribs and sealed airtight with an acoustic fire rated sealant. The mineral fibre Kaowool (density 96 kg/m^3) is required to fill the void above the wall and between the Hibond steel sheeting ribs.
4. With **Flatdeck**, if there is no suspended ceiling, the small voids and side laps must be sealed airtight as described in the detail above.

3.3.7.5 CONSTRUCTION DETAILS FROM HERA ACOUSTIC GUIDE

The following construction details are a complete reproduction of the appendix: Recommended construction details from the HERA Acoustic Guide HERA Report R4-121.

SYSTEM PERFORMANCE [A.1]

General [A.1.1]
The following details are designed to be cost effective solutions to common detailing needs for good acoustic performance in steel framed buildings with concrete floor slabs. These solutions, if fully implemented, without substitution of specified products or rearrangement or alteration, will ensure that the use of structural steel framing does not adversely affect the acoustic performance of the building system.

No matter what transmission loss is being sought the steel isolation details shown herein apply. They cover 11 areas within steel framed buildings where acoustic detailing is most important, including areas not involving a structural steel member.

Details 3, 4, 8, 9, 10 and 11 require any structural steel member within an apartment to be inside a framing system that does not contact the steel. While this is slightly more expensive to provide than simply fixing the framing for the lining directly to the steel, it is required for acoustic isolation to any specified level. There is an additional benefit, however, in that it also makes the linings a more effective radiation barrier in the event of a severe fire, even though these linings do not carry a specified fire resistance rating. This will raise the damage threshold of the steel frame in fire and will typically mean that no additional passive fire protection will be required to the beam or the column member. The cost saving from eliminating the need for this passive material will be greater than the increased cost of acoustically isolating the linings from the steel section.

Explanation of notes on performance [A.1.2]
In each case the objective/intent of the detail is provided so that the designer can identify the essential components of the construction and their relationship to one another. In this way any change that might compromise that intent can be avoided. It will become self evident that every detail acoustically isolates particular components from each other. Often this will be isolating the steel structure or the floor slab from the linings.

Details 3, 4, 5, 8, 9, 10 and 11 in the following section contain the note:

- The steel member does not reduce the acoustic performance of the building system when this detail is used.

Where details carry this note, the objective/intent is to ensure that the presence of the structural steel member does not adversely affect the impact and airborne sound insulation performance of the building system. Furthermore, transmission of building noise from services will be reduced.

It is essential to implement a detailed acoustic design to meet the specified sound insulation performance (NZBC minimum or better quality). The following details form part of this acoustic design.

Continued on next page

3.3.7.5 CONSTRUCTION DETAILS FROM HERA ACOUSTIC GUIDE *continued*

Notes on floor/ceiling performance [A.1.3]
These details are designed to give isolation sufficient to achieve the impact sound insulation provisions of the New Zealand Building Code when used in conjunction with a floor/ceiling system that achieves the airborne sound insulation provisions of the New Zealand Building Code. The concrete slab thickness and concrete density in these details is either determined by testing or must comply with G6/AS1. For concrete and composite concrete on steel deck slab systems not in G6/AS1, consult the manufacturer or an acoustic specialist.

(Note that most proprietary concrete floor systems have never been laboratory tested for airborne or impact sound insulation.)

Verification methods [A.1.4]
Any floor covering that does not comply with that shown in the following details must have a preconstruction sample tested on site for impact insulation performance in accordance with verification method G6/VM1.

Overall system [A.1.5]
The overall system including the ceiling system, structure and building fabric performs to provide impact sound insulation and not just the upper floor covering.

CHECKLIST OF CONSTRUCTION DETAILS [A.2]

- Quality assurance procedures must be implemented to make sure that the system is built exactly as specified.
- All structural steel beams must be isolated from ceiling and wall lining systems.
- All structural steel columns must be isolated from wall lining systems.
- Ceiling suspension systems must not be rigid systems; they must be USG Donn Screw fix suspended ceiling systems.
- A fibreglass or polyester bulk fibre sound absorber must be placed in the ceiling cavity beneath all hard tiled floor surfaces.
- Consider layout of rooms and if practical do not locate tiled floor surfaced rooms over or adjacent to habitable rooms.
- It is advantageous to have a building layout to provide dissimilar room volumes and shape on either side of an inter-tenancy wall or floor.
- Service ducts must be insulated against sound and vibration.
- Isolating brackets must be used for service pipework.
- Sprinkler pipes must use resilient supports and not be connected rigidly to the structural steel beams within ceiling cavities.
- Airconditioning return air grilles must not compromise the performance of the inter-tenancy wall or floor/ceiling system.

(The following details 1-11 incorporate these requirements where they are applicable.)

ACKNOWLEDGEMENT [A.3]
The principal author of these details is Ken McGunnigle of Prendos Limited.

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3.3.7.5 CONSTRUCTION DETAILS FROM HERA ACOUSTIC GUIDE *continued*

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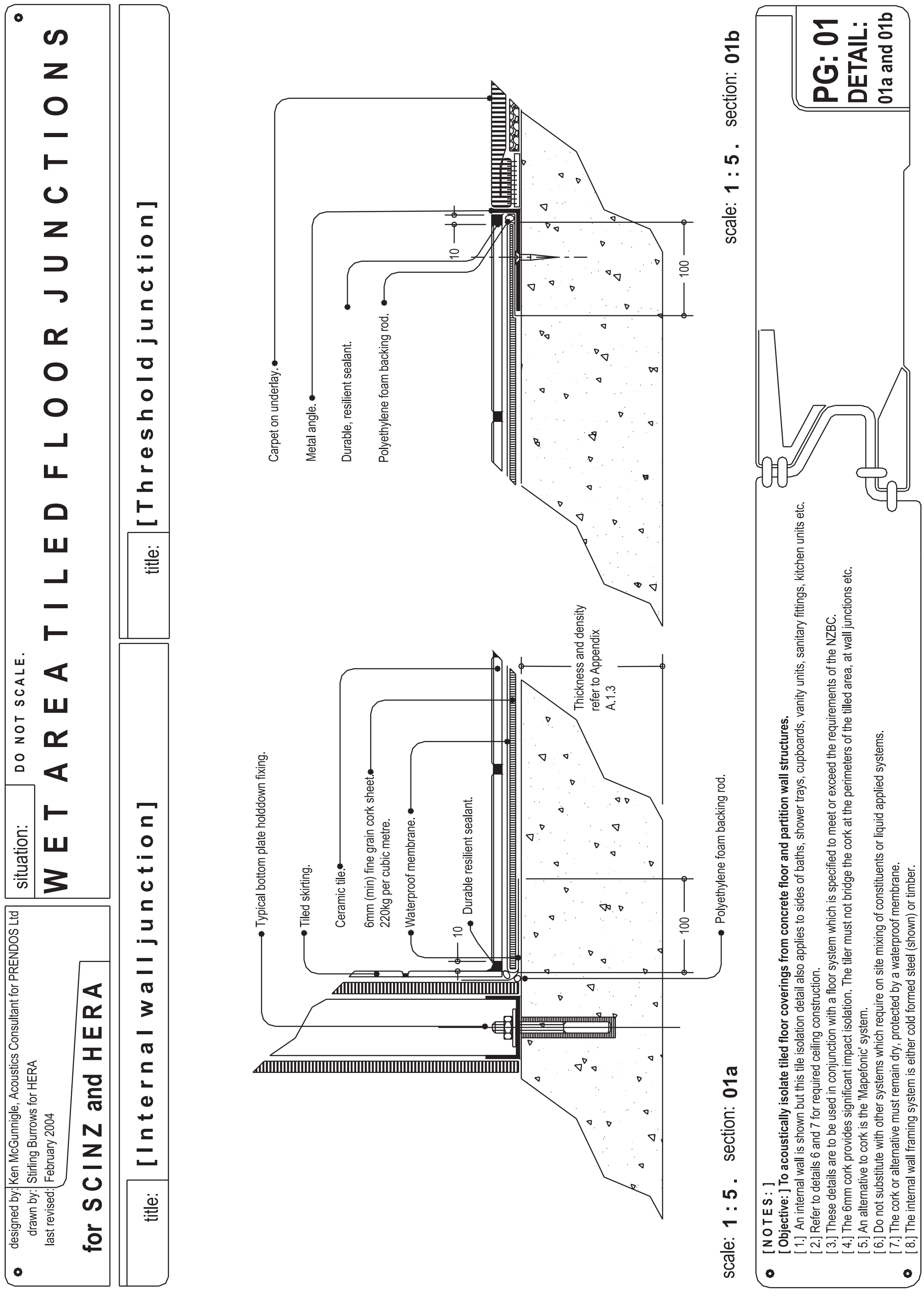

3.3.7.5 CONSTRUCTION DETAILS FROM HERA ACOUSTIC GUIDE *continued*

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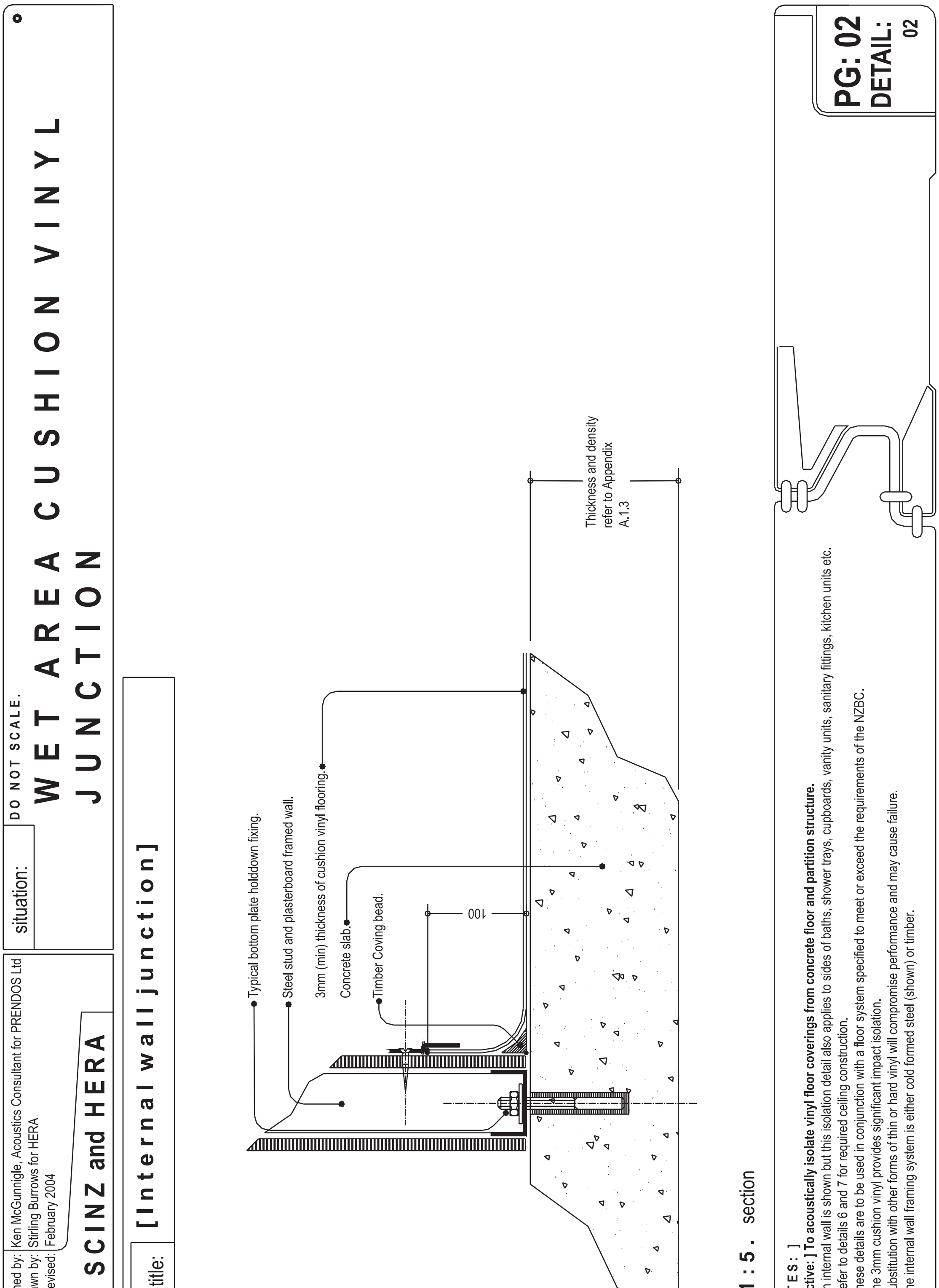

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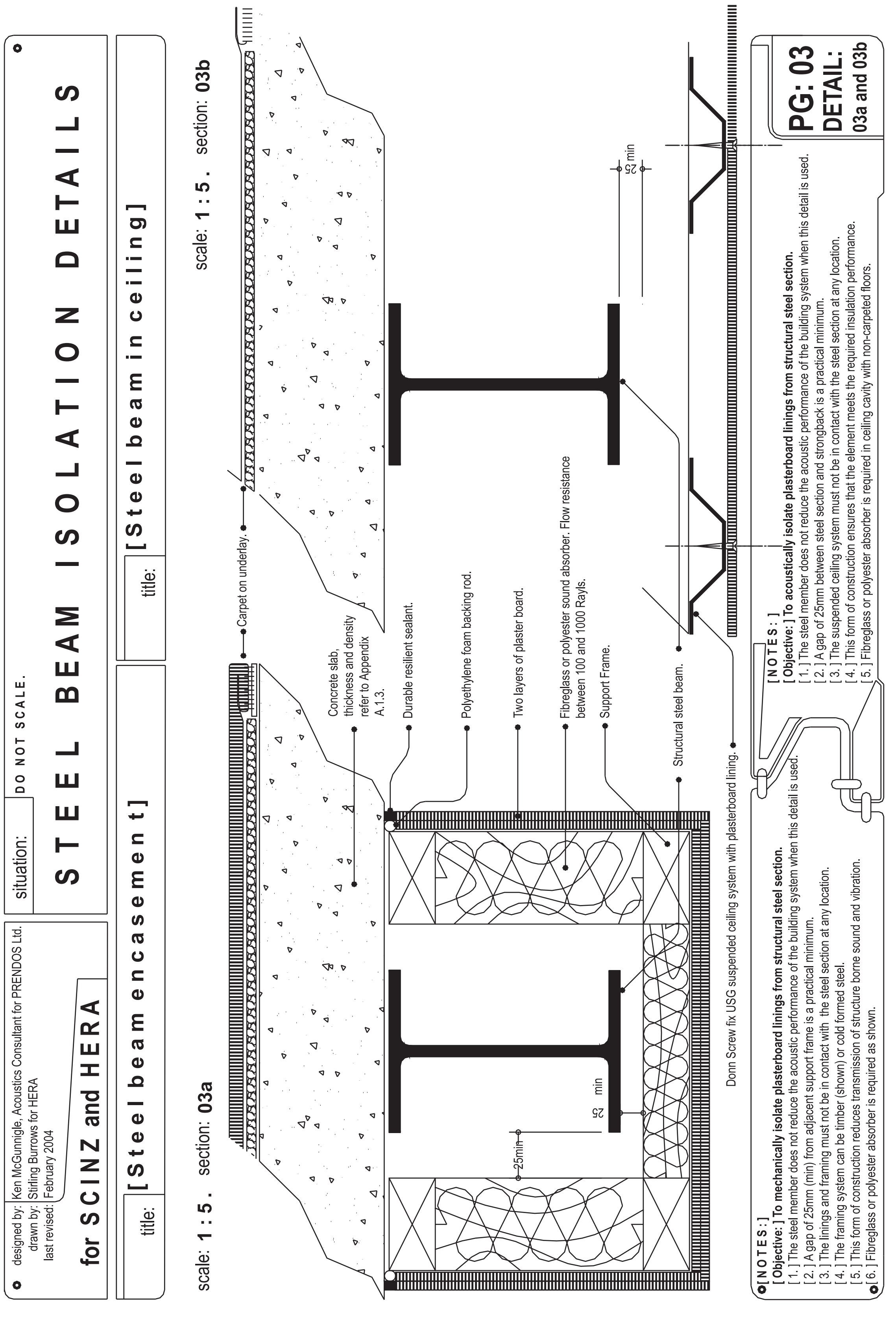

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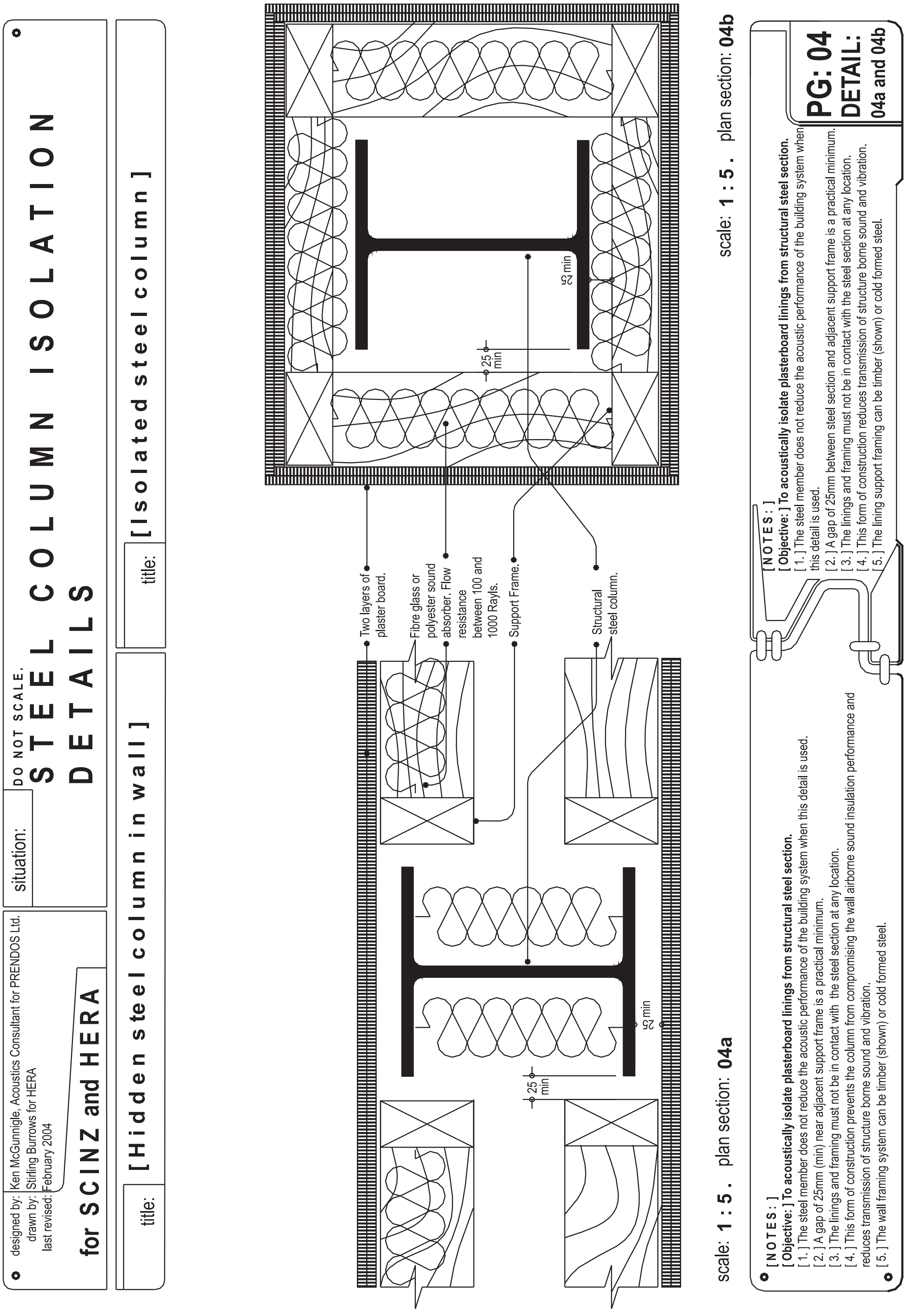

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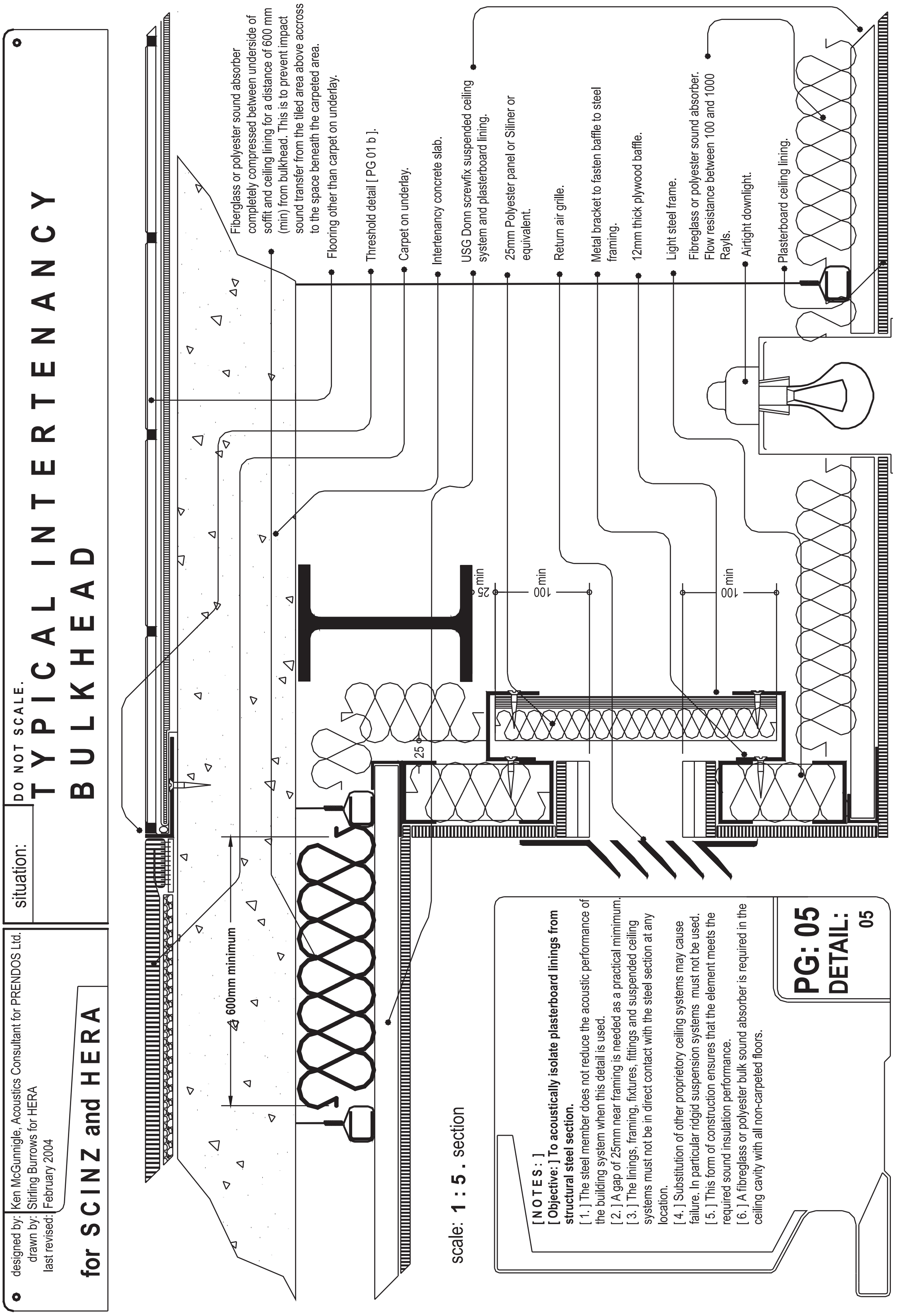

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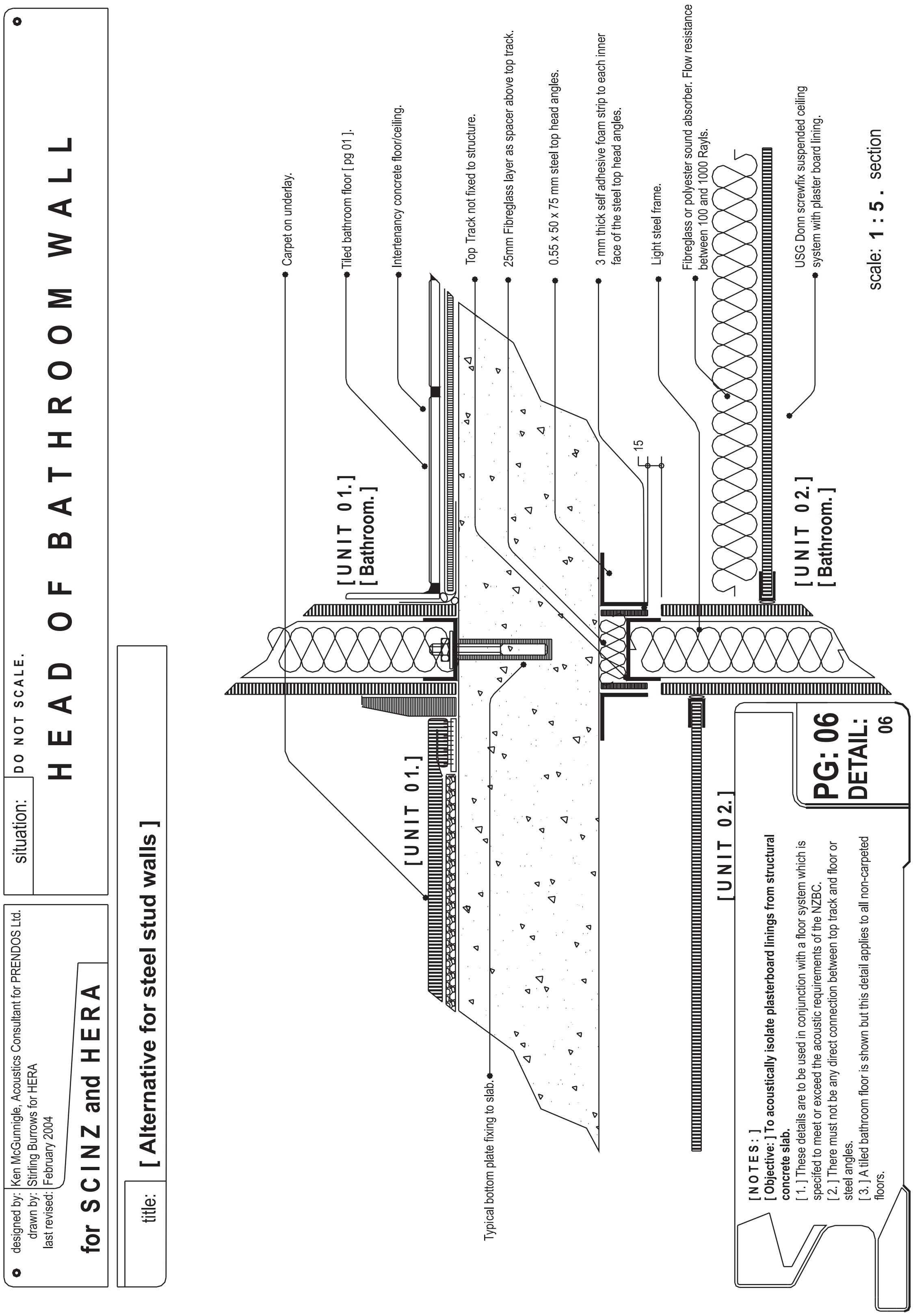

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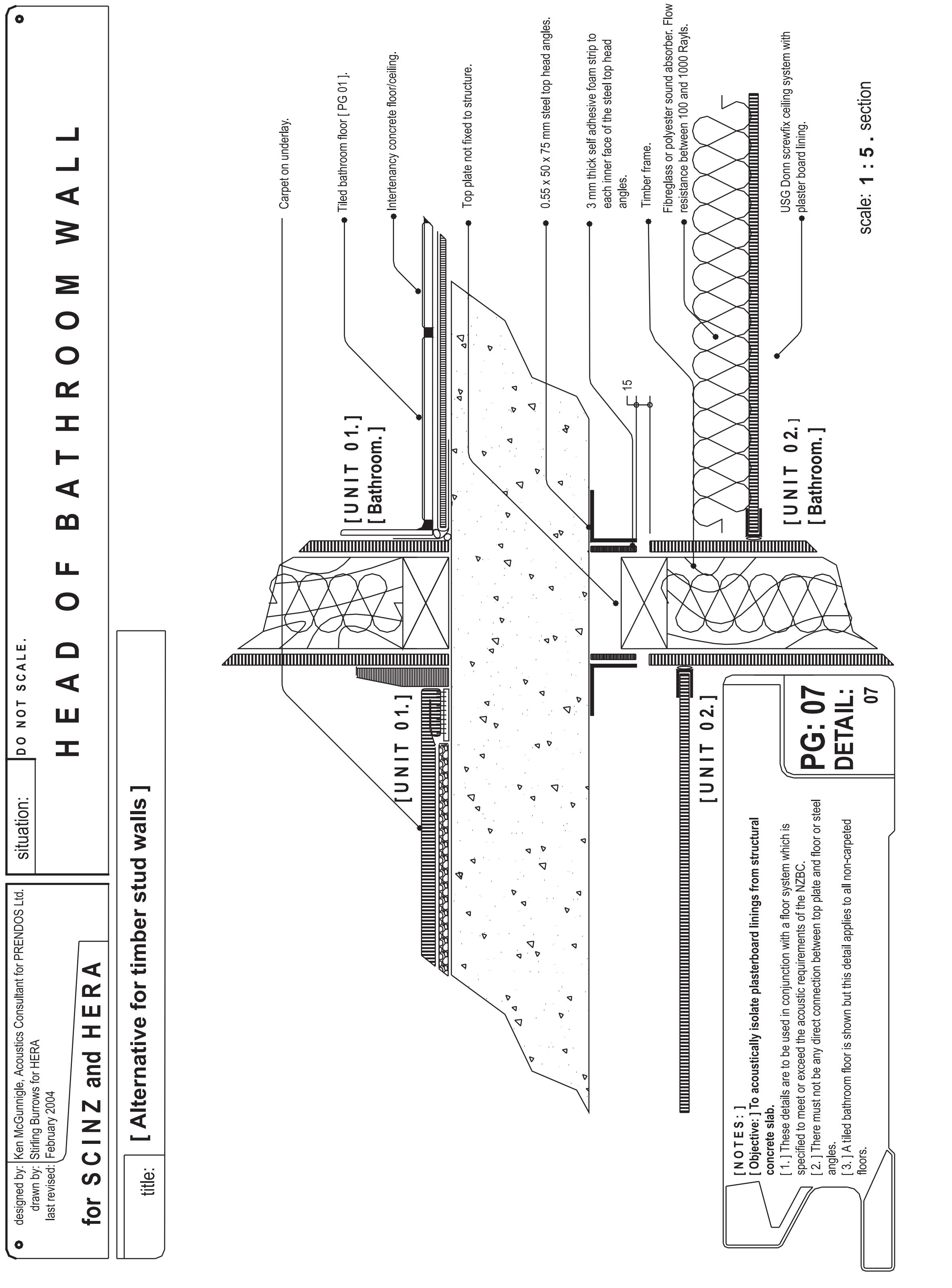

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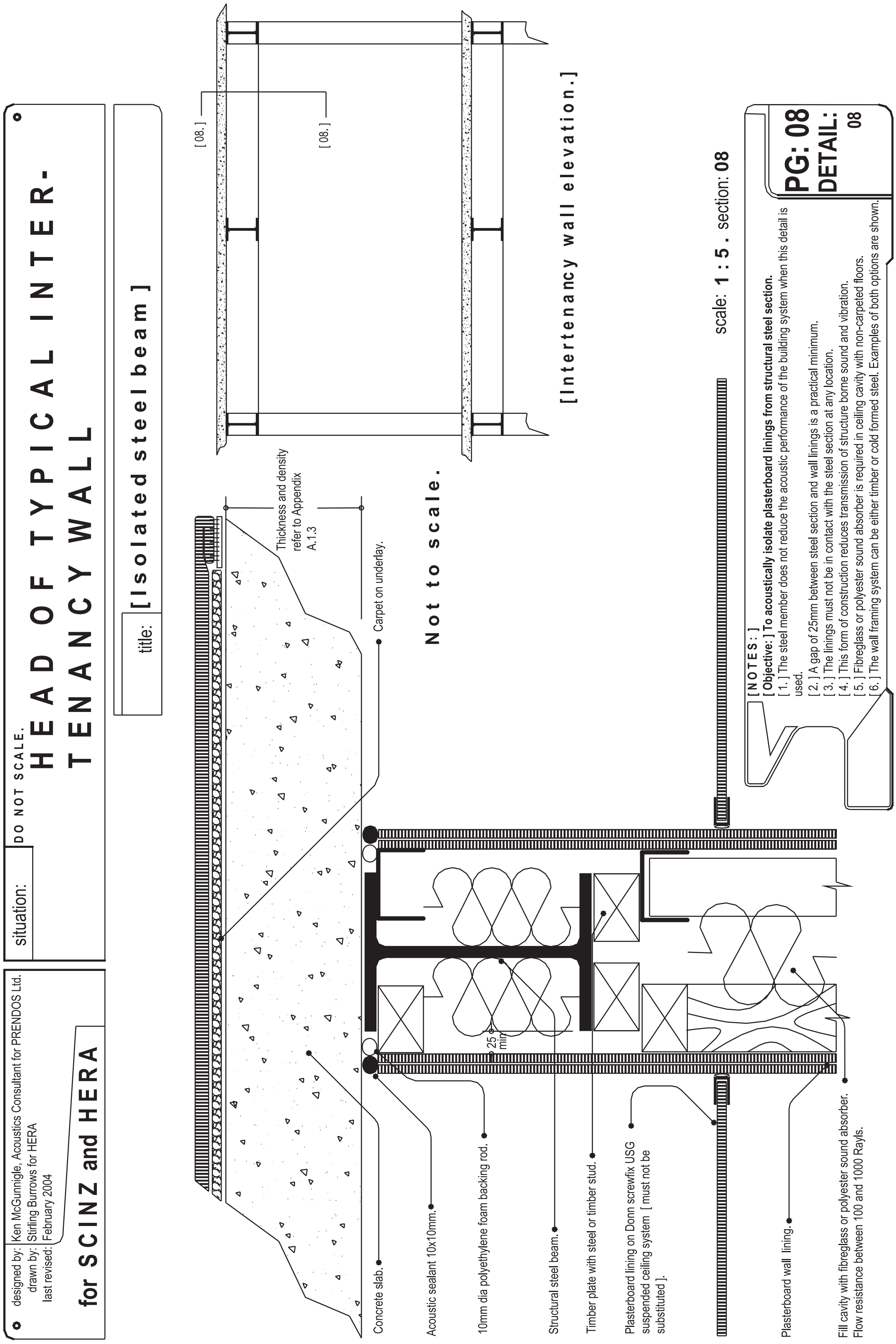

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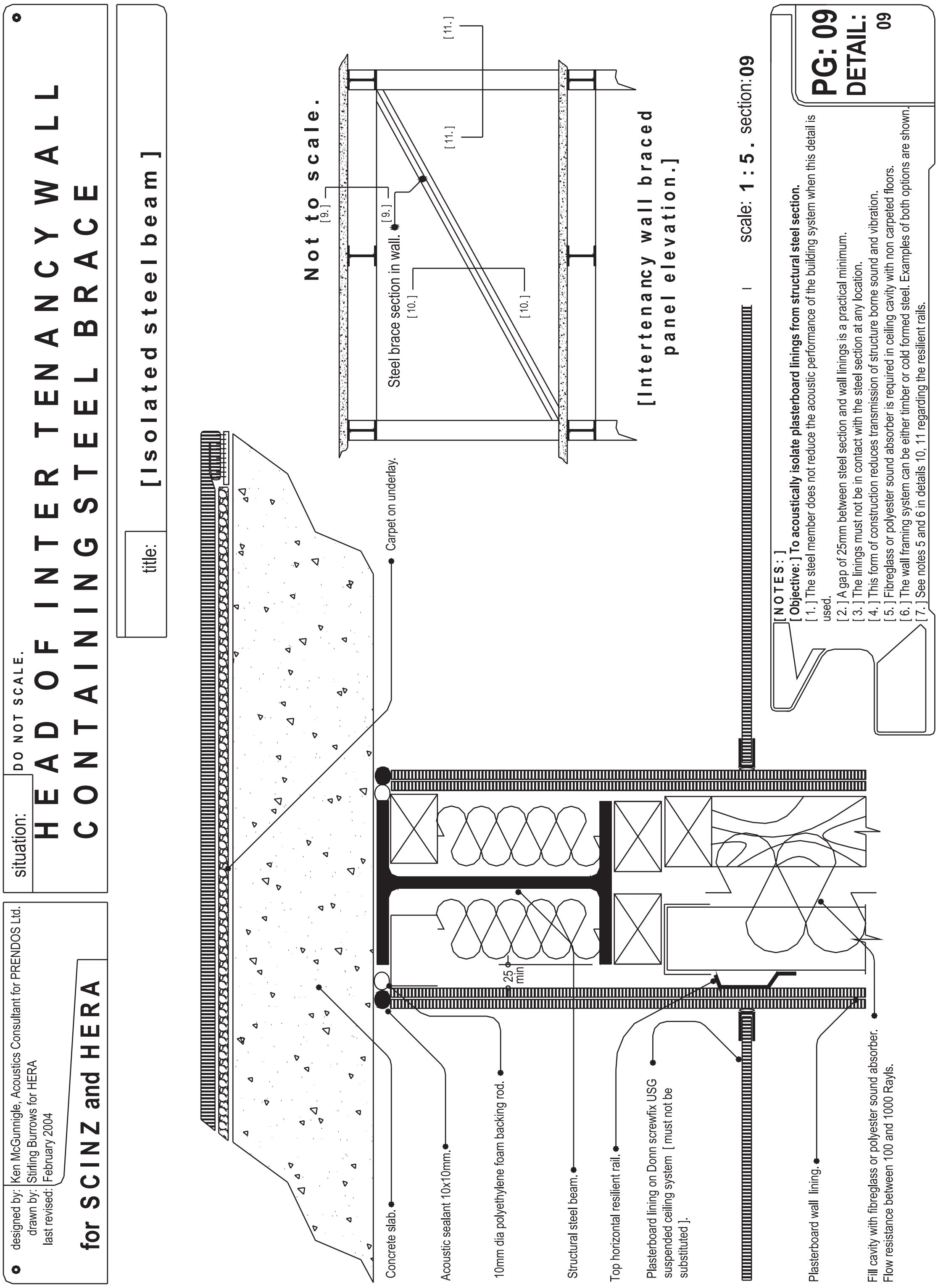

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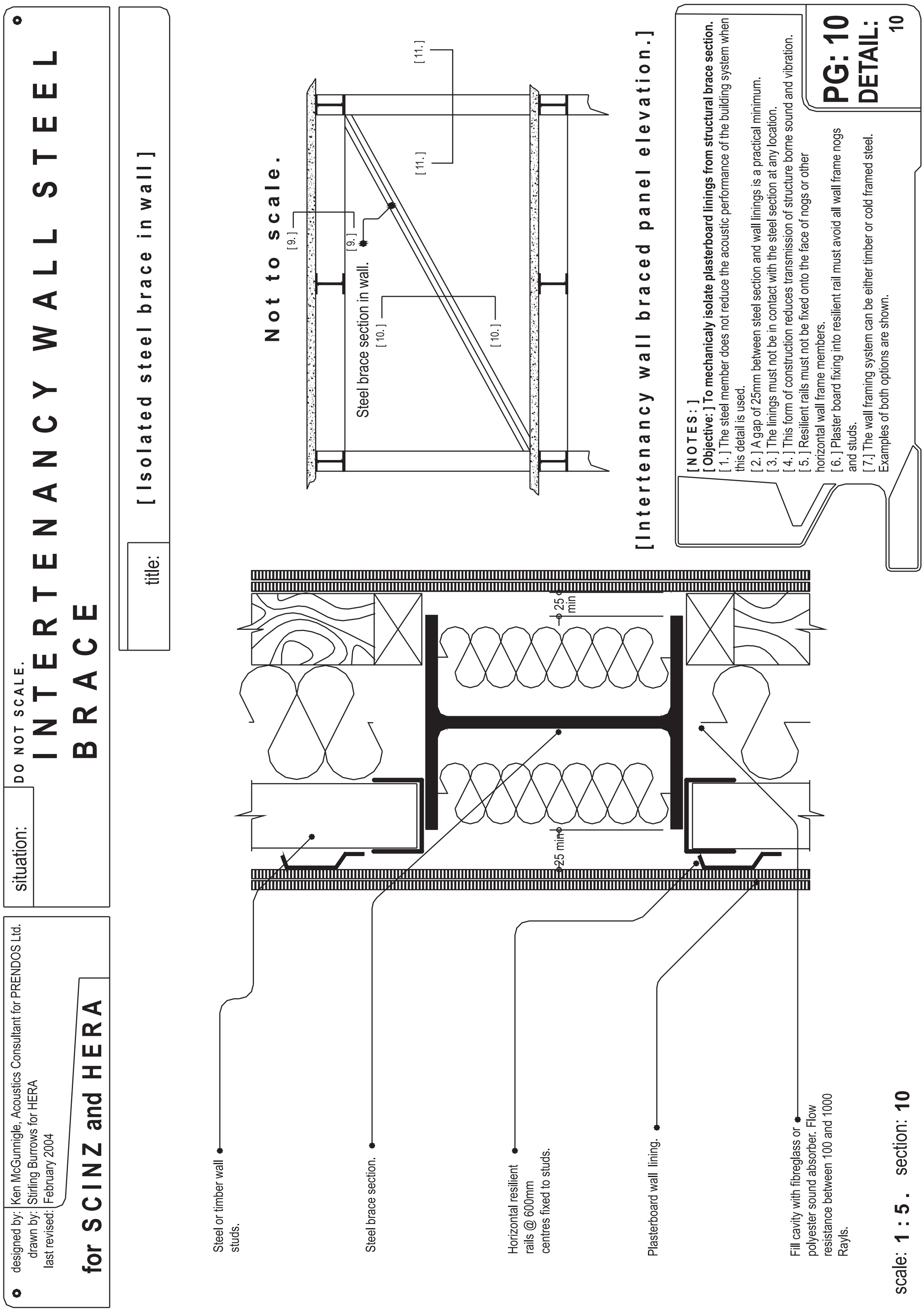

3.3.7.5 CONSTRUCTION DETAILS FROM HERA ACOUSTIC GUIDE *continued*

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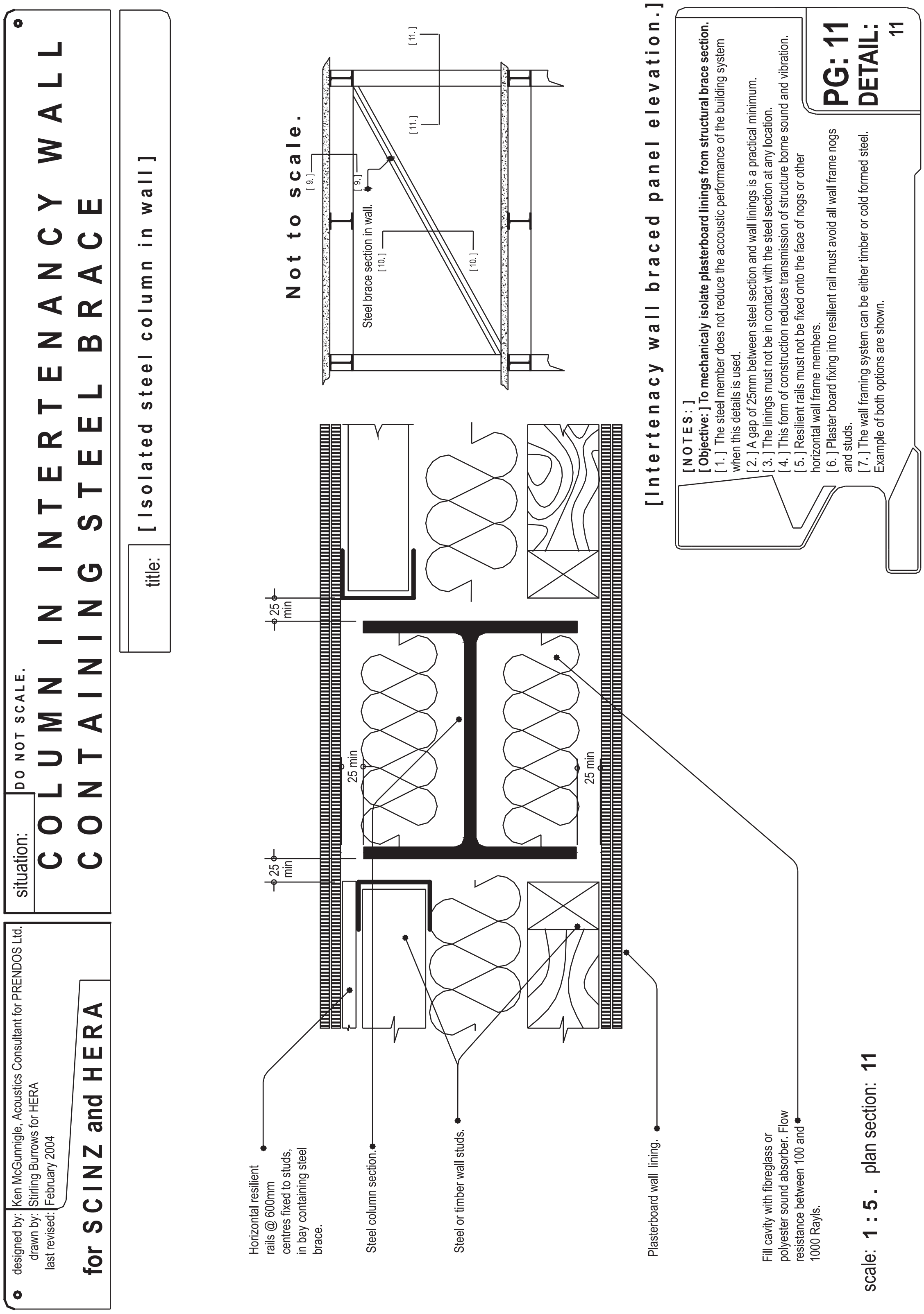
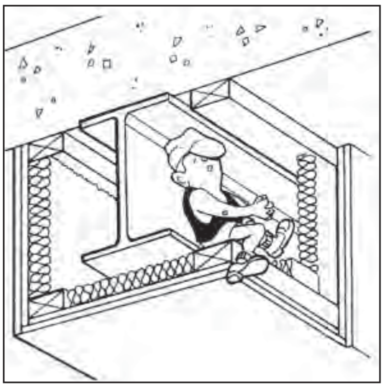
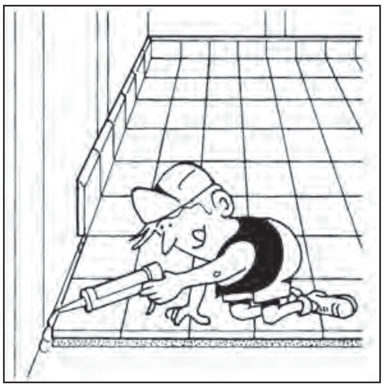


Dimond

3.3.7.6 NOISE CONTROL DO'S & DON'TS

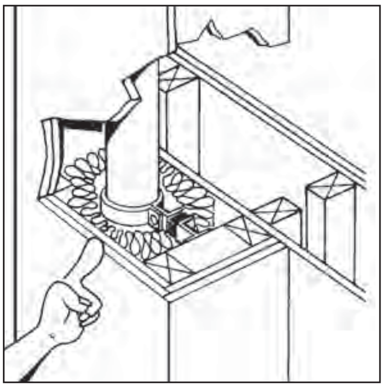


DO isolate steel beams.

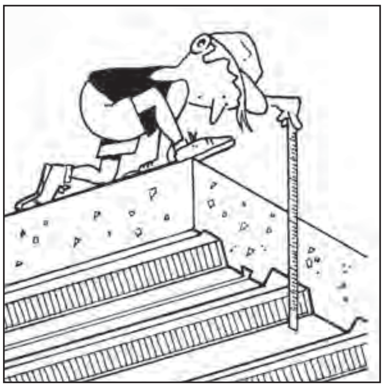


DO isolate tiles from floors and walls.

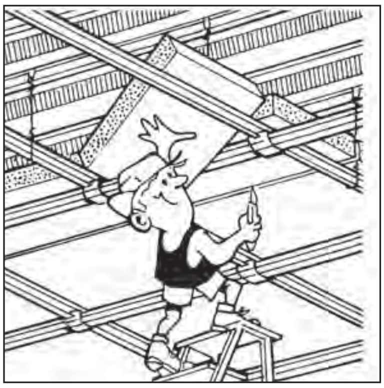
DO read the Hibond manual before you start.



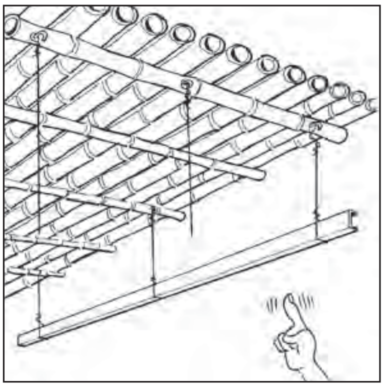
DO isolate pipes and services such as toilet waste.



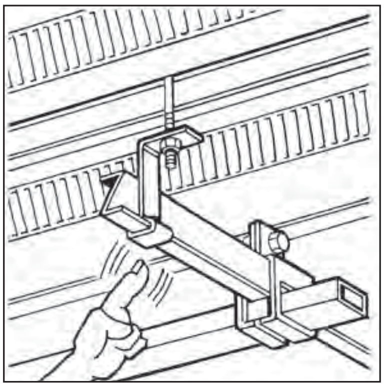
DO ensure correct concrete thickness and quality assurance.



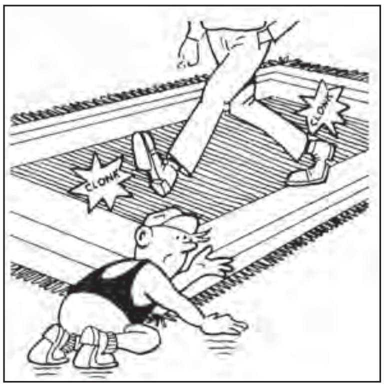
DON'T substitute polystyrene blocks as alternative sound infill.



DON'T substitute other structural products for Hibond.



DON'T use anything other than USG or Potters suspended ceiling components.



DON'T use floor coverings that haven't been tested.

3.3.7.7 GLOSSARY OF ACOUSTIC TERMS

Absorption: The ability of a material to dissipate sound energy.

Acoustic: Concerned with the sense of hearing and includes both reverberant and transmitted sound energy.

Airborne Sound: Sound energy transmitted through the air.

dB: The abbreviation for the sound pressure level measurement decibel. A decibel is a tenth of the logarithmic ratio Bel.

Flanking: The situation whereby sound energy is transmitted around a sound insulated wall or floor/ceiling.

IIC: The abbreviation for "Impact Insulation Class". A single figure descriptor for the structure borne insulation capability of a wall or floor/ceiling.

Structure Borne Sound: Sound energy transmitted through a solid, e.g. the building structure or service pipes.

ISO: The abbreviation for The International Organisation for Standardisation. The name has its origins in the Greek word "isos" meaning equal.

Noise: Subjective sound, merely heard, usually unwanted, contains listener information and may be annoying.

Reverberation: The continuation of sound reflections in a space after the sound source has ceased.

Sound: An audible air vibration from a source which is detected by the sense of hearing.

STC: The abbreviation for "Sound Transmission Class", a single figure descriptor for the continuous airborne sound insulation capability of a wall or floor/ceiling over the speech frequency range. In general the higher the STC the better the performance. The third octave range used is 125 to 4000 Hz.

Subjectivity: Related to interpretation of acoustic input by the brain and the auditory sense organ rather than to direct physical phenomena.

Transmission Loss: The difference in the reverberant sound pressure levels between source and receiving rooms on opposite sides of a wall or floor/ceiling.

3.3.8 FLOOR VIBRATION

It is important to note that the subject of floor vibration is complicated in nature. It is not a precise science and assessment of parameters such as floor damping ratio, ambient floor loads and possible future uses of the floor can be highly subjective in reality – what is acceptable for one occupant may not be acceptable for another.

All structures may be subject to vibration from human activity or mechanical oscillation, with increasing thresholds of acceptance from floors used in operating rooms through offices/residences to shopping malls/dance halls and floors used for group rhythmic activities.

Resonance occurs when the frequency of the dynamic loadings on the floor approaches the natural frequency of vibration of the floor system. The effect of resonance may result in damage to finishes and structure alike and therefore it must be considered in the assessment of floor vibration. The natural frequency of Hibond floor slabs will typically fall within the 4 to 12 Hz frequency range.

Design for walking vibration considers the control of peak floor accelerations through damping provided by the floor panel along with the floor panel mass and stiffness. Design for rhythmic vibration considers control of peak floor accelerations by increasing the natural frequency of the floor to more than 20% above the driving frequency of the activity along with controlling higher mode effects using the floor panel mass and damping.

For a detailed explanation of floor vibration, reference should be made to HERA Report R4-141 and HERA Report R4-113 Session 3.4.

The best way to illustrate the design process for floor vibration is by example using the procedures outlined in HERA Report R4-141 and HSSS2000 (HERA Steel Structures Seminar 2000).

A vibration check is required for a 0.75mm Hibond floor to satisfy the criteria for vibration due to walking. The Hibond floor will support an open plan office with only low damping available from demountable partitions. It has a single span, L, between blockwork walls of 5m and an overall thickness of 150mm.

This example covers the vibration characteristics of the composite floor slab only. It assumes the floor spans between rigid supports such as concrete or block walls. If the slab is supported on flexible supports such as steel beams then a further vibration check needs to be made for the combined slab/beam system using, for example, the Hibond Design Wizard (refer Section 3.3.2 Design Considerations) or the HERA NZFI-Vib2 programme (refer HERA Report R4-141). However the vibration check that follows provides a method of checking whether the slab itself is adequate. Note that the first indication that the floor selected may be vibration sensitive can be seen from the dashed line on the Hibond Composite Slab Load Span Tables in Section 3.3.5.

Continued on next page

3.3.8 FLOOR VIBRATION *continued*

In order to assess the vibration criteria of the slab we need to know its natural frequency of vibration and its peak acceleration under a constant walking force. The *natural floor frequency* is assessed from the static deflection of the floor under ambient load conditions, which requires the longitudinal floor stiffness to be calculated.

Longitudinal floor stiffness $D_{par} = E_s I_x$

where E_s = Young's modulus for steel = 205 GPa
I_x = gross transformed second moment of area of slab in the direction of span
= 34×10^6 mm^4/m
calculated from first principles using steel/concrete dynamic
modular ratio n = $E_s/(1.35E_c)$ (Refer HSSS2000)
= 205 / (1.35 x 24)
= 6.3
where E_c = 24 GPa = Modulus of Elasticity for concrete (from NZS 3101)

Therefore $D_{par} = E_s I_x$ = $205 \times 34 \times 10^6$
= 6.97×10^9 kNmm^2/m

Static deflection of slab = $\Delta = 5 \times w \times L^4 / (384 \times E_s I_x)$

Total static UDL, w = 0.35 + 0.2 + 2.91 = 3.46 kN/m

where 0.35 = ambient live load (Refer HERA Report R4-141 Table 5)
0.2 = ambient superimposed dead load (Refer HERA Report R4-141 Table 5)
2.91 = dead load slab excluding ponding of wet concrete (Refer Section 3.3.3 Hibond Section Properties)

therefore, midspan deflection under this UDL,
$\Delta = 5 \times 3.46 \times 5^4 \times 10^9/(384 \times 6.97 \times 10^9)$
= 4.0mm

Natural floor frequency, $f_n = 0.18 \times (g/\Delta)^{0.5}$ (Refer HSSS2000)
where g = acceleration due to gravity = 9810mm/sec^2
= $0.18 \times (9810/4.0)^{0.5}$
= 8.9 Hz < 9 Hz so no minimum stiffness check required

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3.3.8 FLOOR VIBRATION *continued*

To calculate the *peak acceleration* of the floor under a constant walking force we must calculate the effective weight of the floor that is being vibrated by first estimating the effective floor panel width,

$B = C \times [D_{perp}/D_{par}]^{0.25} \times L$ (Refer HSSS2000)

where D_{par} = 6.97×10^9 kNmm²/m as before
D_{perp} = transverse floor stiffness = $E_s I_y$
C = transverse flexural continuity factor
I_y = transformed tranverse second moment area based on concrete cover only

therefore, $I_y = 1000 \times (150 - 55)^3 / 12 / 6.3$
$= 11.34 \times 10^6$ mm^4/m

and $D_{perp} = 205 \times 11.34 \times 10^6$
$= 2.32 \times 10^9$ kNmm^2/m

Using C = transverse flexural continuity factor = 2.0, based on transverse continuity,

then $B = C \times [D_{perp}/D_{par}]^{0.25} \times L$
$= 2.0 \times [2.32/6.97]^{0.25} \times L$
$= 1.52 \times L$

B must be less than L or the actual transverse width available. Therefore use B = L = 5.0m.

Now calculate effective floor panel weight, W = wBL (Refer HSSS2000)
= 3.46 x 5.0 x 5.0
= 86.5 kN

Estimated peak acceleration ratio, a_p (expressed as a % of g)
$= P_0 \times e^{-0.35 f_n} / (\beta x W)$ (Refer HSSS2000)

where P_0 = constant walking force = 0.29 kN (From HERA Report R4-141 Table 4)
β = floor damping ratio = 0.025 (From HERA Report R4-141 Table 4)

Therefore $a_p = P_0 \times e^{-0.35 f_n} / (\beta x W)$
$= (0.29 \times e^{-0.35 \times 8.9}) / (0.025 \times 86.5)$
= 0.60 %g

The values we have for f_n and a_p must now be compared with the acceptable criteria of graph line C shown in Figure 1 of HERA Report R4-141. If the point plotted on this graph from these two values is below the line C then vibration criteria are acceptable. Alternatively, we can interpret acceptable peak acceleration, a_0 from the graph line (already expressed as a % of g) as follows:

for natural frequency f_n between 4 and 8 Hz: $a_0 < 0.5$ %g
for natural frequency $f_n > 8$ Hz, the equation of the line is $\log a_0 < \log f_n - 1.2041$

In this case $f_n = 8.9$ Hz > 8
therefore $\log a_0 = \log 8.9 - 1.2041$
which gives $a_0 = 0.56$ %g.

$a_p > a_0$ therefore the slab is unsatisfactory for vibration, and either a shorter span, thicker floor or greater damping must be used.

For example, if the damping is improved by providing more small demountable, uniformly distributed partitions then the damping ratio β can be increased:

Thus if $\beta = 0.03$,
then $a_p = 0.29 \times e^{-0.35 \times 8.9} / (0.03 \times 86.5)$
= 0.50 %g
$< a_0 = 0.56$ %g and floor can be considered acceptable for vibration.

3.3.9 THERMAL INSULATION

For Hibond floors to comply with the requirements of NZS 4218 using the method of calculation described in NZS 4214, it is generally necessary to add some form of insulation to the floor system. The table below indicates the thermal resistance (R value) that can be expected from the Hibond floor slab.

Hibond Floor Slab (Note 1)		Inside Surface	Outside Surface R Value (m^2 °C/W)		Perimeter (Note 2)	Total R Value (m^2 °C/W)	
Thickness (mm)	R Value (m^2 °C/W)	R Value (m^2 °C/W)	Exposed	Enclosed Perimeter	R Value (m^2 °C/W)	Exposed	Enclosed Perimeter
110	0.04	0.15	0.08	0.16	0.12	0.27	0.47
150	0.06	0.15	0.08	0.16	0.12	0.29	0.49
200	0.08	0.15	0.08	0.16	0.12	0.31	0.51

Note 1: The R value is for the floor slab only, excluding any top surface covering.

Note 2: The perimeter R value is based on a 150mm hollow concrete block wall with 1 in 3 cores filled, and 10% of the wall area as open ventilation.

Compliance with NZS 4218 generally requires a floor R value of 1.3m^2 °C/W excluding the top surface floor covering. The additional R value necessary is usually achieved by treating the underside of the Hibond with a suitable insulation material. Expanded polystyrene (EPS) is recommended, with the following R values:

40mm EPS: R = 1.1m^2 °C/W
30mm EPS: R = 0.8m^2 °C/W

For inter-tenancy floors, or for second storey floors where energy conservation in a room is desired, a sensible objective is to achieve an R value of 1.9m^2 °C/W for the floor-ceiling construction. As a general guide, the additional insulation can be achieved with a combination of enclosed air space between the ceiling and the Hibond, and insulation blanket.

Typical R values are:

Enclosed ceiling air space:	R = 0.3m^2 °C/W for heat flow up.
50mm insulation blanket:	R = 1.0m^2 °C/W
75mm insulation blanket:	R = 1.5m^2 °C/W
100mm insulation blanket:	R = 2.0m^2 °C/W

Example
Using a 110mm overall thickness slab, over an enclosed subfloor perimeter to achieve required 1.3m^2 °C/W.

R value of 110mm Hibond floor	= 0.47
Add 40mm EPS	
R value	= 1.10
Total R value	= 1.57m^2 °C/W > 1.3 ∴ O.K.

3.3.10 DESIGN EXAMPLES

3.3.10.1 EXAMPLE: FORMWORK

A 250mm overall thickness slab is required to span 4800mm c/c between permanent supports using the Hibond sheet as permanent formwork only. Two alternatives are available in design.

a) Using 0.75mm Hibond from Section 3.3.4.1, select the formwork span capabilities for a 250mm overall thickness slab, i.e.

single	2000mm
double or end	1800mm
internal	1850mm

Using two rows of props, there are two end spans and one internal span. The maximum span of Hibond in this configuration is,

1850 + 2 x 1800 = 5450mm
≥ the required span of 4800mm ∴ O.K.

Therefore 0.75mm Hibond with two rows of props at third points may be considered.

b) Using 0.95mm Hibond from Section 3.3.4.1, select the formwork span capabilities for a 250mm overall thickness slab, i.e.

single	2150mm
double or end	2400mm
internal	2700mm

Using one row of props, there are two end spans only. The maximum span of Hibond in this configuration is,

2 x 2400 = 4800mm
≥ the required span of 4800mm ∴ O.K.

Therefore 0.95mm Hibond with one row of props at midspan may also be considered.

Continued on next page

3.3.10 DESIGN EXAMPLES *continued*

3.3.10.2 EXAMPLE: RESIDENTIAL AND POINT LOADS

A suspended slab in a residential dwelling is required to achieve a double span of 2 x 3600mm in each of the living and garage areas.

Living area loading,

live load, Q	1.5 kPa
superimposed dead load, G_{SDL}	0.3 kPa
design superimposed load, $G_{SDL} + Q$	1.8 kPa

Garage loading,

	live load, Q	2.5 kPa
or	point live load, P_Q	13.0 kN

Living Area Floor

From Section 3.3.5, select the double or end span superimposed load and negative reinforcement for a 0.75mm Hibond slab of 110mm overall thickness, with one row of props at midspan. This gives,

$$\text{superimposed load} = 3.2 \text{ kPa}$$
$$\geq G_{SDL} + Q = 1.8 \text{ kPa} \quad \therefore \text{ O.K.}$$

Minimum mesh requirement throughout the Hibond slab from Section 3.3.2 Additional Reinforcement assuming a minor degree of crack control is one layer of 665 mesh at minimum cover.

From Section 3.3.5 0.75mm Hibond – Double and End Spans, the area of negative reinforcement required over the internal support is H12 bars at 250mm c/c.

Length of reinforcement required is 3600 / 4 + 450 = 1350mm each side of the support centre line.

For the living area floor use a 0.75mm Hibond slab of 110mm overall thickness with one row of props at midspan. A 665 mesh is required throughout the slab plus H12 x 2700mm longitudinal top reinforcement at 250mm c/c, laid atop the mesh at minimum cover, over the internal support.

Garage Floor

From Section 3.3.5, select the double or end span superimposed load and negative reinforcement for a 0.75mm Hibond slab of 110mm overall thickness, with one row of props at midspan. This gives,

$$\text{superimposed load} = 3.2 \text{ kPa}$$
$$\geq G_{SDL} + Q = 2.5 \text{ kPa} \quad \therefore \text{ O.K.}$$

Minimum mesh requirement throughout the Hibond slab from Section 3.3.2 Additional Reinforcement assuming a minor degree of crack control is one layer of 665 mesh at minimum cover.

From Section 3.3.5 0.75mm Hibond – Double and End Spans, the area of negative reinforcement required over the internal support is H12 bars at 250 m c/c.

Length of reinforcement required = 3600 / 4 + 450 = 1350mm each side of the support centre line.

Continued on next page

3.3.10 DESIGN EXAMPLES *(3.3.10.2 continued)*

For the 13.0 kN point load, detailed checks are required using BS 5950: Part 4 Section 6. Please note that this point load check method is only valid for spans between 2.0m and 5.0m, due to the use of empirically derived formulae.

Vertical Shear: The critical load position occurs when the edge of the 13 kN point load is at a distance d_s from the edge of the support. Given a load width, b_o of 300mm, the effective load width is,

b_m = effective load width
= $b_o + 2 (D_s - 55)$ where D_s is the overall depth of Hibond composite slab
= 300 + 2 x (110 – 55) = 410mm b_o is the width of the concentrated load
ds = 110 – 27.5 = 82.5mm

The distance between the centre lines of the point load and nearer support (*a*), given a support width of, say, 150mm is,

a = $b_o / 2 + d_s$ + support width / 2 where d_s is the distance from the top of the Hibond
= 150 + 82.5 + 75 = 307mm composite slab to the centroid of the Hibond sheet

Assuming the load is centred at least $b_{er} / 2$ from the slab edge, the effective width of resisting Hibond slab is,

b_{er} = effective width of the slab in shear
= $b_m + a (1 - a / L)$
= 410 + 307 x (1 – 307 / 3600)
= 690mm

Applied shear at 307mm from the central support per 690mm width is,

V* = design shear force for strength
= 1.4 G (0.625 L – 307) + 1.6 P_Q (2L – aL/(L – a)) / (2L) where P_Q is the point live load
= 1.4 x 1.99 x 10^{-6} x 690 x 1940 + 1.6 x 13.0 (2 x 3600 – 307 x 3600/(3600 – 307))/(2 x 3600)
= 23.5 kN / 690mm

Design concrete shear stress (V_c) from BS 8110 may be calculated using specified cube compressive strength of concrete, f_{cu} of 1.25 specified compressive strength of concrete, f'_c = 31.25 MPa and A_p of 1058mm^2/m from formwork properties table, Section 3.3.3 Hibond Section Properties,

V_c = $0.632 (f_{cu} A_p / 250 d_s)^{0.333} (400 / d_s)^{0.25}$
= $0.632 \times (1.60)^{0.333} \times (4.85)^{0.25}$
= 1.10 MPa

Vertical shear capacity (V_v),

V_v = $156 d_s v_c$
= 156 x 82.5 x 1.10 x 10^{-3} = 14.1 kN/rib
= 14.1 x 690 / 305 = 31.9 kN/690mm
≥ V* = 23.5 kN/690mm ∴ O.K.

Continued on next page

3.3.10 DESIGN EXAMPLES *(3.3.10.2 continued)*

Punching Shear: Assuming the load is centred at least $b_m/2$ from the slab edge, the critical perimeter (u) for the Hibond slab is,

$u = 4\{b_o + (D_s - 55) + d_s\}$
$= 4 \times (300 + 55 + 82.5) = 1750\text{mm}$

Applied shear over critical perimeter area is,

$V^* = 1.4\ G + 1.6\ P_Q$
$= 1.4 \times 438^2 \times 1.99 \times 10^{-6} + 1.6 \times 13.0$
$= 21.3\ \text{kN}$

Punching shear capacity (V_p),

$V_p = u\ (D_s - 55)\ v_c$
$= 1750 \times 55 \times 1.10 \times 10^{-3} = 106\ \text{kN}$
$\geq V^* = 21.3\ \text{kN}$ ∴ O.K.

Shear Bond: It is assumed in this calculation that the slab is fixed to the supports on at least three sides. An empirical formula is used to convert the point live load (P_Q) into a superimposed load.

Hence $G_{SDL} + Q$ equates to,

$$\frac{P_Q\ (19000 - 3\ L)}{0.00743\ (-0.393\ L^2 + 3200\ L - 3.52 \times 10^6)}$$

$G_{SDL} + Q = 13.0 \times 8200\ /\ (0.00743 \times 2.91 \times 10^6)$
$= 4.9\ \text{kPa}$

Section 3.3.5 0.75mm Hibond – Single Spans Medium term superimposed loads table is then used for all span conditions for shear bond calculations (i.e. single spans, double or end spans, internal spans) to compare empirically derived $G_{SDL} + Q$ to available superimposed load,

superimposed load = 4.9 kPa
$\geq G_{SDL} + Q = 4.9$ kPa ∴ O.K.

Negative Bending: Assuming the load is centred at least $b_{eb}\ /\ 2$ from the slab edge, the effective width of resisting Hibond slab (b_{eb}) is,

$b_{eb} = b_m + 2\ a\ (1 - a\ /\ L)$ *single spans*
or $b_{eb} = b_m + 1.333\ a\ (1 - a\ /\ L)$ *continuous*

Maximum bending occurs when the point load is at midspan. Thus the effective width is,

$b_{eb} = 410 + 1.333 \times 1800 \times (1 - 0.5)$
$= 1610\text{mm}$

The applied bending moment for strength (M*) over the internal support due to the point load is,

$M^* = 1.6\ M_Q\ /\ b_{eb}$ where M_Q is the design live load moment
$= 1.6 \times 0.094 \times 3600 \times 13.0\ /\ 1610$
$= 4.37\ \text{kNm/m}$

This is converted into an equivalent superimposed load,

$G_{SDL} + Q = 4.37 \times 10^6\ /\ (0.063 \times 1.6 \times 3600^2)$
$= 3.3\ \text{kPa}$
> 3.2 kPa (from Section 3.3.5 0.75mm Hibond
Composite Slab Load Span Tables Double and End Spans) ∴ No good

Therefore garage slab must be increased to 120mm as,

4.3 kPa > 3.3 kPa ∴ O.K

Negative bending is generally critical for point loads on thin slabs over continuous spans.

Continued on next page

3.3.10 DESIGN EXAMPLES *(3.3.10.2 continued)*

Positive Bending: Using an empirical formula to convert the point live load into a superimposed load,

$$G_{SDL} + Q = \frac{1000\ P_Q}{(0.00247\ L^2 - 14.65\ L + 27100)}$$

$$= 13000 / 6371 = 2.04 \text{ kPa}$$

Section 3.3.5 0.75mm Hibond – Single Spans Medium term superimposed loads is then used for all span conditions for positive bending calculations (i.e. single spans, double or end spans, internal spans) to compare empirically derived $G_{SDL} + Q$ to available superimposed load for the 120mm Hibond composite slab,

superimposed load = 5.8 kPa
$\geq G_{SDL} + Q = 2.04$ kPa ∴ O.K.

Positive bending is rarely critical.

Deflection: It is assumed the 13.0 kN point load is of short term duration and deflection is not likely to cause damage to finishes. However to illustrate the methodology, using b_{eb} in bending and $I_{av} = 8.6 \times 10^6$ mm^4/m from Section 3.3.3 (medium term), the imposed deflection under the point load at midspan (δ_p) is,

$\delta_p = 0.015\ P_Q\ L^3 / E_s\ 1$ where E_s is the Modulus of Elasticity of the Hibond sheet and I is the second moment of area

$= 0.015 \times 13.0 \times 3600^3 / (205 \times 10^3 \times 8.6 \times 1610)$
$= 3.2$mm (L / 1125)
$\leq$ the limit of L / 350 ∴ O.K.

In summary, for the garage floor use a 0.75mm Hibond slab of 120mm overall thickness with one row of props at midspan. A 665 mesh is required throughout the slab plus H12 x 2700mm longitudinal top reinforcement at 200mm c/c, laid atop the mesh at minimum cover, over the internal support. It would be sensible to adopt this configuration over the living area floor also, for practicality.

Transverse Reinforcement: In this example as $P_Q > 7.5$ kN (13.0 kN), ductile transverse reinforcement is required to be provided to satisfy the following moment resistance.

$M^*_{trans} = P^*\ b_{eb} / (15w)$ where $w = L/2 + b_1$ and $w \not> L$

Where M^*_{trans} = Factored bending moment in the transverse direction
P^* = Factored concentrated point load
b_{eb} = Effective width of slab
L = Span of composite slab
b_1 = Concentrated load length in direction of slab span

This requirement is based on recommendations from the Steel Decking Institute, Illinois, to resist transverse bending in the composite slab as a result of the concentrated load.

Continued on next page

3.3.10 DESIGN EXAMPLES *continued*

3.3.10.3 EXAMPLE: INSTITUTIONAL BUILDING DEFLECTION

A heavy equipment floor in a hospital is required to form a single span of 4800mm given a long term superimposed load of 3.5 kPa.

Using Section 3.3.5 0.75mm Hibond – Single Spans long term superimposed loads table, select the single span superimposed load for a 0.75mm Hibond slab of 150mm overall thickness, with one row of props at midspan (Section 3.3.4.1). This gives,

superimposed load = 3.5 kPa
$\geq G_{SDL} + Q$ = 3.5 kPa ∴ O.K.

This configuration borders the region of the table where vibration becomes critical (with a minimum damping ratio of 0.025; commercial offices, open plan with few small partitions) and the equipment is likely to be vibration sensitive. Therefore resonance checks are required using specific design.

Alternatively, the slab thickness may be increased for the purposes of this example to, say, 180mm using 0.75mm Hibond with two rows of props at third points, or 180mm using 0.95mm Hibond with one row of props at midspan. This would provide better dampening to the floor, however the equipment is likely to be vibration sensitive and therefore a detailed vibration analysis of the floor would be required by the design engineer.

Deflection of the floor is to be minimised by reducing the allowable limit from $L_{ss}/250$ to $L_{ss}/400$.
For this limit, deflection is made up of two components. Dead load deflection from prop removal is (for one or two props),

$5\ G\ L_{ss}^4\ /\ (384\ E_s\ I)$

and the superimposed load deflection is,

$5\ (G_{SDL} + Q)\ L_{ss}^4\ /\ (384\ E_s\ I)$

For the 0.95mm Hibond slab of 180mm overall thickness, refer Section 3.3.3 Hibond Section Properties for long term superimposed loads,

G = 3.62 kPa, $I_{av} = 21.1 \times 10^6$ mm^4/m

Hence $G + (G_{SDL} + Q)$ = 3.62 + 3.5 = 7.12 kPa

and δ_{G+Q} = Combined dead and superimposed load deflection at midspan
= $5 \times 7.12 \times 4800^4 / (384 \times 205 \times 10^9 \times 21.1)$
= 11mm (or $L_{ss}/435$)
$\leq$ the limit of $L_{ss}/400$ ∴ O.K.

For a 0.75mm Hibond slab of 190mm overall thickness Section 3.3.3 Hibond Section Properties gives (for long term superimposed loads),

G = 3.83 kPa, $I_{av} = 22.4 \times 10^6$ mm^4/m

Hence $G + (G_{SDL} + Q)$ = 3.83 + 3.5 = 7.33 kPa

and δ_{G+Q} = $5 \times 7.33 \times 4800^4 / (384 \times 205 \times 10^9 \times 22.4)$
= 11mm (or $L_{ss}/435$)
$\leq$ the limit of $L_{ss}/400$ ∴ O.K.

Therefore, use a 0.75mm Hibond slab of 190mm overall thickness with two rows of props at third points and, assuming a minor degree of crack control is required, use 662 mesh at minimum cover throughout, *or* a 0.95mm Hibond slab of 180mm overall thickness with one row of props at midspan and, assuming a minor degree of crack control is required, use 662 mesh at minimum cover throughout.

Continued on next page

3.3.10 DESIGN EXAMPLES *continued*

3.3.10.4 EXAMPLE: COMMERCIAL OFFICE FIRE RESISTANCE

A banking chamber floor is required over continuous spans of 2600mm c/c with a fire resistance rating of 49 minutes.

Office loading (medium term),

live load, Q	4.0 kPa
superimposed dead load, G_{SDL}	0.5 kPa
design superimposed load, G_{SDL} + Q	4.5 kPa

In terms of structural ability, Section 3.3.5 gives medium term superimposed loads well in excess of 4.5 kPa over a 2600mm span for a Hibond slab of 120mm overall thickness.

If the floor is designed as a series of single spans, nominal continuity reinforcement is required over the internal supports. From Section 3.3.5 Hibond – Single Spans Medium term superimposed loads, a 0.75mm Hibond slab with one row of props at midspan (from Section 3.3.4.1) may be used, or an unpropped (from Section 3.3.4.1) 0.95mm Hibond slab may also be used. Assuming a minor degree of crack control and to provide nominal continuity reinforcement over the internal supports, from Section 3.3.2 Additional Reinforcement, 665 mesh is required at minimum cover over the entire floor area.

This configuration may lead to unsightly cracking of the slab and therefore longitudinal steel at minimum cover over the supports and a moderate or strong degree of crack control could be considered.

As an alternative, the floor may be designed as a continuous slab by providing full continuity reinforcement over the internal supports.

End Spans
From Section 3.3.5 0.95mm Hibond – Double and End Spans, the area of negative reinforcement required over the first internal support is H12 bars at 200mm c/c.

The length of reinforcement required is 2600 / 4 + 450 = 1100mm each side of the support centre line.

Internal Spans
From Section 3.3.5 0.95mm Hibond – Internal Spans, the area of negative reinforcement required over the other internal supports is H12 bars at 200mm c/c.

The length of reinforcement required is 2600 / 4 + 450 = 1100mm each side of the support centre line.

The fire resistance rating (FRR) is checked from Section 3.3.6 Fire Design Tables, for a 0.75mm Hibond slab of 120mm overall thickness using H12 reinforcement every third Hibond pan. This gives,

FRR = 69 minutes
≥ the required 49 minutes ∴ O.K.

Therefore, use an unpropped 0.95mm Hibond slab of 120mm overall thickness with H12 longitudinal bottom reinforcement every third pan at 25mm bottom cover and 40mm cover to the side of the Hibond rib. In terms of top steel, 665 mesh is required throughout the slab plus H12 x 2200mm longitudinal top reinforcement at 200mm c/c over all internal supports, laid atop the mesh at minimum cover.

Continued on next page

3.3.10 DESIGN EXAMPLES *(3.3.10.4 continued)*

Detailed calculation of the fire resistance rating for the preceding example.

Insulation Criteria: The minimum effective thickness for 49 minutes is 66mm for Type A aggregate, using HERA Report R4-82 Section 5. The effective thickness (h_e) for the 120mm Hibond composite slab is,

$h_e = h_1 + 0.5\,h_2\,\{(l_1 + l_2) / (l_1 + l_3)\}$

where h_1 is the depth of concrete above the top of Hibond (D_s – 55), h_2 is the depth of Hibond sheet (55mm) and l_1, l_2 and l_3 are profile dimensions of the Hibond sheet

$= 65 + 27.5\,\{(182 + 130) / (182 + 126)\}$
$= 93\text{mm}$
$\geq$ the minimum of 66mm ∴ O.K.

Stability and Integrity Criteria: For the Hibond composite slab, integrity criteria are satisfied if the stability requirements are met. It is assumed the Hibond slab acts as a series of single spans in the calculation of stability. The load combination is $G + \psi_\ell Q$ under fire emergency conditions (clause 4.2.4 AS/NZS 1170.0). This gives,

w = uniformly distributed load
$= G + G_{SDL} + \psi_\ell Q$
$= (2.24 \times 1.05 + 0.5) + 0.4 \times 4.0 = 4.45$ kPa
5% ponding applied to self weight, G

producing a design bending moment,

$M^* = w\,L^2 / 8$
$= 4.45 \times 2600^2 \times 10^{-6} / 8$
$= 3.76$ kNm/m width of Hibond slab

The required fire resistance rating is greater than 30 minutes, therefore any contribution to the moment capacity of the slab from the Hibond steel is neglected, and supplementary "fire" reinforcement is provided. The slab moment capacity is calculated using a strength reduction factor of $\phi = 1.0$ and the effective yield stress is based on the temperature of the reinforcement (refer NZS 3101).

Consider H12 reinforcement (f_y = 500 MPa) placed every third pan (A_s = 123mm²/m width) at 25mm bottom cover and 40mm cover to the side of the Hibond rib. Using HERA Report R4-82 Section 6,

$u_1 = 46\text{mm},\ u_2 = 98\text{mm},\ u_3 = 31\text{mm}$

where u_1, u_2 and u_3 are the position of reinforcement bars

$u_1 + u_2 = 144 \leq 5\,u_3 = 155$ ∴ O.K.
u_1 or u_2 = 46 or 98 $\leq 4\,u_3 = 124$ ∴ O.K.

and,

$\gamma = 1 / (1 / 46^{0.5} + 1 / 98^{0.5} + 1 / 31^{0.5})$
$= 2.34$

where γ is the coefficient used to calculate temperature of the reinforcing bars

Continued on next page

3.3.10 DESIGN EXAMPLES *(3.3.10.4 continued)*

The temperature in the reinforcement (u_s) at 30 minutes is given by,

$u_s = 900 - 350\, g = 81^oC$

and at 60 minutes,

$u_s = 1175 - 350\, g = 356^oC$

For a fire resistance of 49 minutes the temperature by linear interpolation is,

$u_s = 81 + 19 / 30 \times (356 - 81) = 255^oC$

The effective yield stress of the reinforcement for $250^oC < u_s \leq 720^oC$ is,

$f_{yru} = f_y \{(720 - T) / 470\}$ where f_{yru} is the yield strength of elevated temperature and f_y is the lower characteristic yield strength of non-prestressed reinforcement

$= 500 \times \{(720 - 255) / 470\} = 494$ MPa

Hence the moment capacity of the slab for reinforcement (R_{Tu}) at an elevated temperature is,

$R_{Tu} = A_s f_{yru} = 123 \times 494 \times 10^{-3} = 60.7$ kN/m

Where A_s = Area of non-prestressed tension reinforcement
= 113 / (3 x 0.305) = 123mm^2/m width (= H12 every 3rd Hibond pan)

and,

where a is the depth of equivalent rectangular stress block
b is the width of concrete compression face
d is the distance from extreme compression fibre to the centroid of the non pre-stressed tension reinforcement

$a = R_{Tu} / (0.85 f'_c b)$
$= 60.7 \times 10^3 / (0.85 \times 25 \times 1000) = 2.8$mm

$d = 120 - 31 = 89$mm

Hence internal lever arm between centroids of compression and tension resultant forces (jd) is,

$jd = d - 0.5\, a = 87.6$mm

and,

where M_n is the nominal flexural strength of the section

$\Phi M_n = 1.0 \times 60.7 \times 10^{-3} \times 87.6 = 5.32$ kNm/m
$\geq M^* = 3.76$ kNm/m width ∴ O.K.

Hence H12 reinforcement every third Hibond pan will achieve a fire resistance rating of greater than 49 minutes for insulation, instability and integrity.

3.3.11 MATERIAL SPECIFICATION

Dimond Hibond and accessories are manufactured from galvanised steel coil produced to AS 1397:2001.

	Thickness BMT mm	Steel Grade MPa	Min. Zinc Weight g/m^2
Hibond sheeting	0.75 & 0.95	G550	Z 275
End cap	0.55	G250	Z 275
Closure strip	0.55	G250	Z 275
Edge form	1.15	G250	Z 275
Hanger tab	1.55	G250	Z 275

BMT – Base Metal Thickness

Tolerances
Length -0mm +10mm
Sheet cover width -1mm +5mm
Maximum manufactured length of Hibond sheet 18m.

3.3.12 SHORT FORM SPECIFICATION – HIBOND FLOORING

The flooring system will be Dimond **(1)** mm Hibond manufactured from G550 grade steel, with a 275 g/m^2 galvanised zinc weight. The minimum nominal sheet length to be used in construction shall be .... m, in accordance with the design formwork spans.

Edge forms and end caps should be used in accordance with Dimond recommendations.

Specify concrete thickness, and number of rows of propping during construction.

Mesh and any additional reinforcement bar size and spacing should be referred to the design engineer's drawings.

Choose from:

(1) 0.75, 0.95

3.3.13 HIBOND COMPONENTS

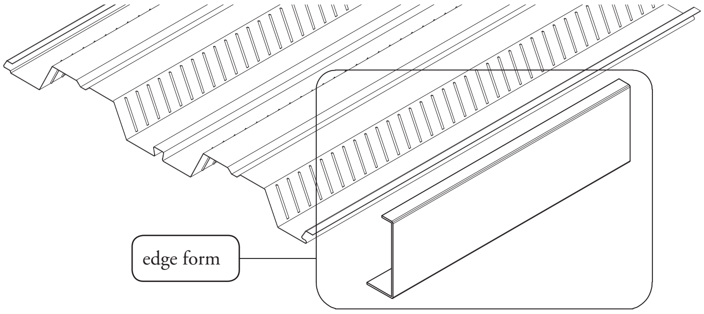
3.3.13.1 EDGE FORM

Manufactured from 1.15mm Base Metal Thickness (BMT) galvanised steel in 6m lengths, providing an edge to screed the concrete to the correct slab thickness.

Standard sizes are from 110mm to 200mm in 10mm height increments.

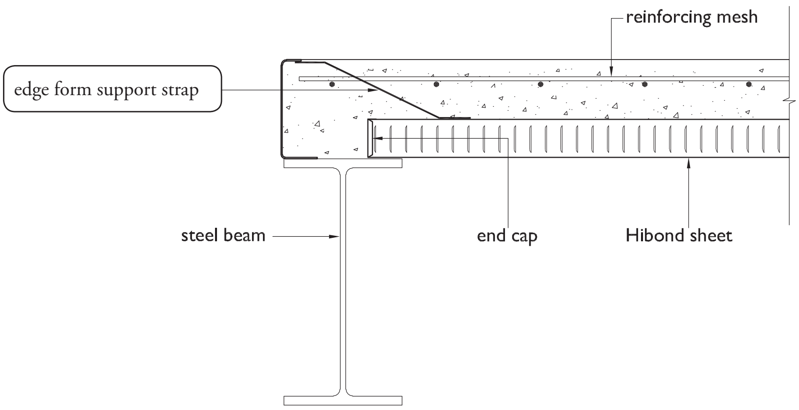
The foot of the edge form is fixed to the structure by self-drilling metal screws or powder actuated fasteners.

The Hibond sheeting may sit on this foot and be fixed to the edge form by rivets or self-drilling metal screws.



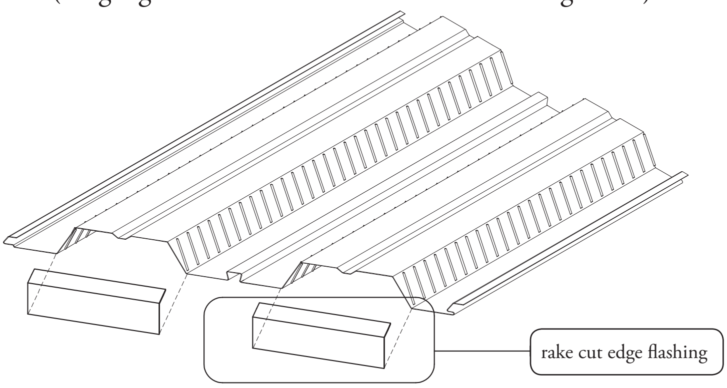
3.3.13.2 EDGE FORM SUPPORT STRAP

The top edge is restrained from outward movement (when the concrete is being placed) by a specifically designed 30 x 0.55mm galvanised metal edge form support strap, which is fixed to the Hibond or structure. The straps are normally at 600mm centres.



3.3.13.3 RAKE CUT EDGE FLASHINGS

Manufactured from 0.55mm BMT galvanised steel in 55mm x 30mm x 3m lengths which are cut to suit on site (as shown). Rake cut edge flashings are used in place of end caps to close off the end of Hibond sheets when they are cut on an angle or curve. These are cut to length then fixed to the Hibond sheet with 1 fastener per rib (10 gauge – 16 x 16mm hex head self-drilling screw).



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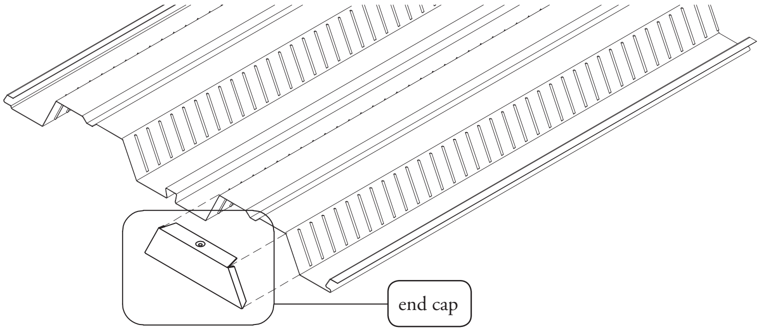
3.3.13 HIBOND COMPONENTS *continued*

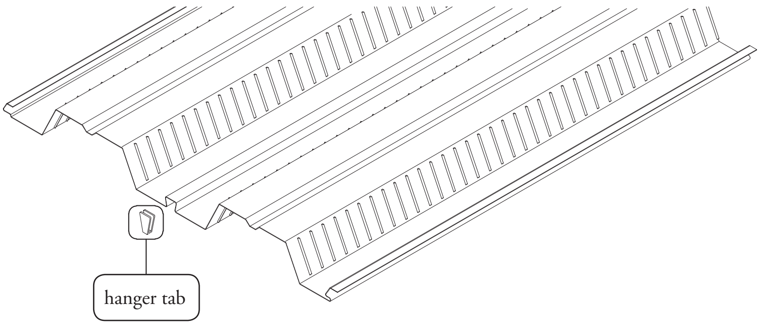
3.3.13.4 END CAPS

Manufactured from 0.55mm BMT galvanised steel, end caps are used to blank off the ribs (to prevent concrete leakage) at the end of each Hibond sheet, or where openings are created in the deck. The cap should be secured to the Hibond by 10 gauge – 16 x16mm hex head self-drilling screws.



3.3.13.5 HANGER TABS

Manufactured from 1.55mm BMT galvanised steel, the tabs provide a suspension point for ceiling systems, pipework, ducting or electrical trays onto the underside of the Hibond sheet. The hanger tab is attached by inserting it into, and parallel to the dovetail groove running down the centre of each Hibond sheet. It is then rotated through 90° and sits down in the groove. The serviceability (safe) load for a standard hanger is 1.25 kN.



3.3.14 HIBOND CAD DETAILS

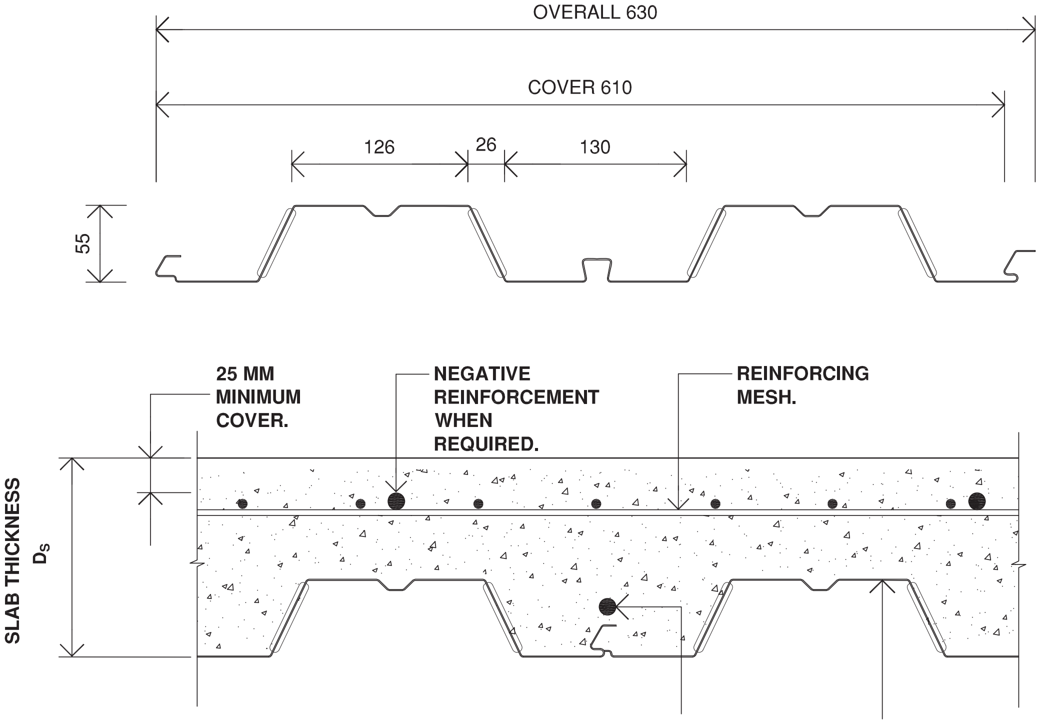
Hibond CAD details are shown in this section. For the latest Hibond CAD details, please download from the Dimond website **www.dimond.co.nz**. Follow the steps below:

1. Log in to the Architects/Specifiers section.
2. Click on the green "Structural Systems Manual" button.
3. Click on the "Download CAD details" button.
4. Select from product list shown to view CAD details available for that product.

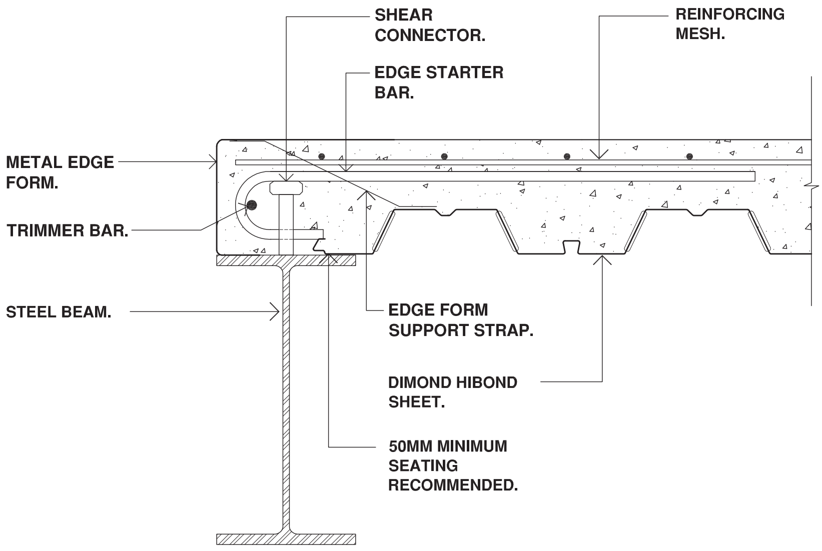
Please note all of these details are to be used as a guide only and are not intended for construction. Specific design details are required to be provided by the design engineer.

3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



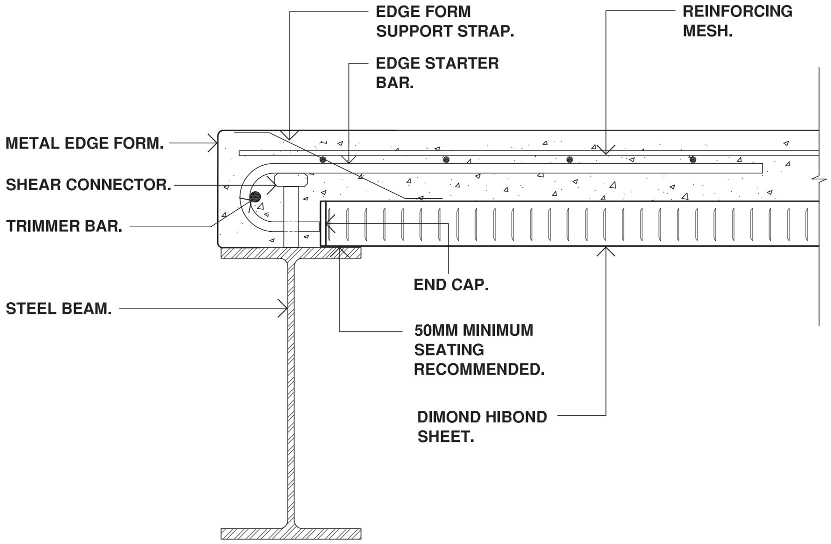
1 HIBOND PROFILE
CADREF: 1. hibond profile



2 HIBOND SIDE LAP BEARING ON STEEL BEAM
CADREF: 2.hibond side lap bearing on steel beam

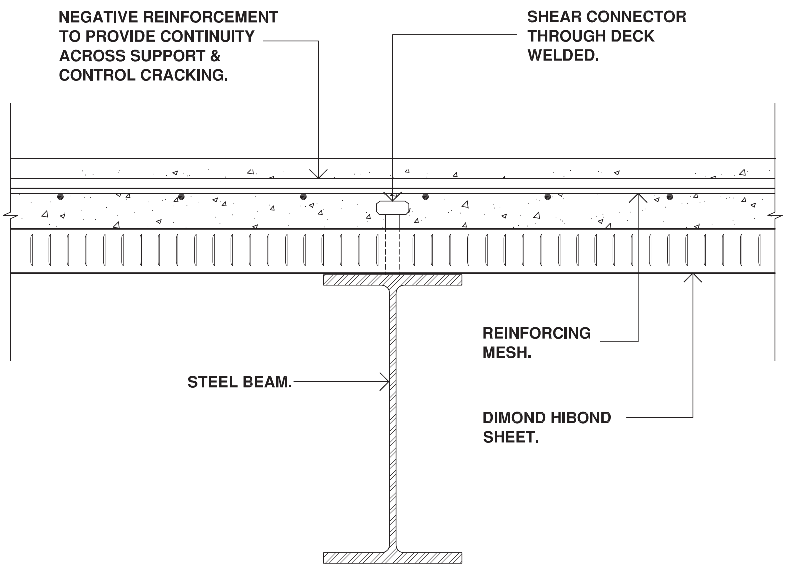
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



3 – HIBOND END BEARING ON STEEL BEAM

CADREF: 3.hibond end bearing on steel beam

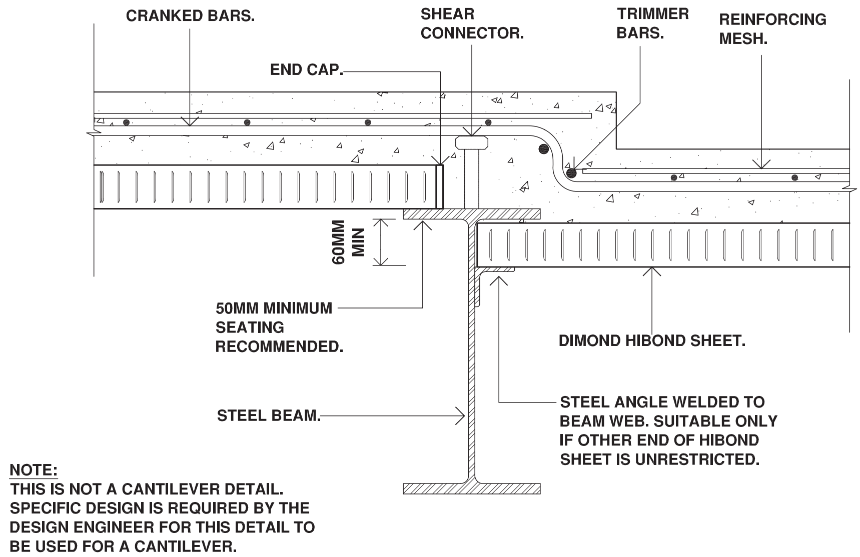


4 – HIBOND INTERNAL BEARING ON STEEL BEAM

CADREF: 4.hibond internal bearing on steel beam

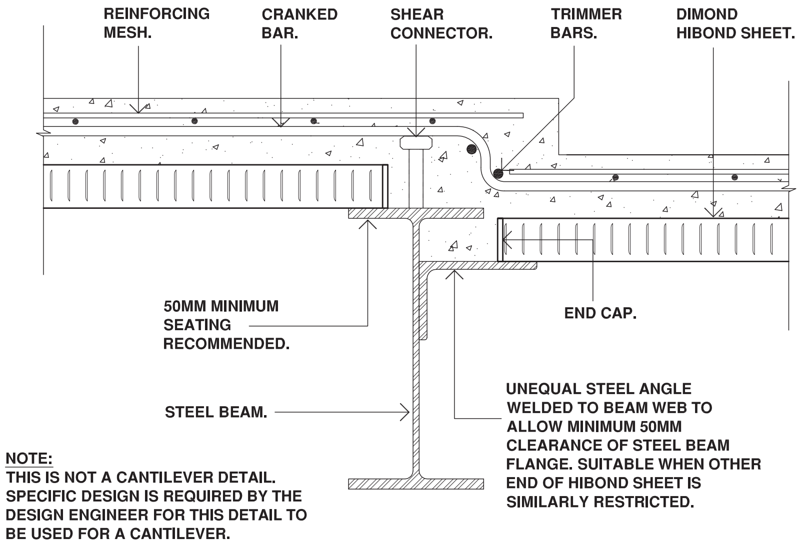
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



5 — HIBOND INTERNAL STEP DOWN ON STEEL BEAM – OPTION 1

CADREF: 5. hibond step down on steel beam – option 1

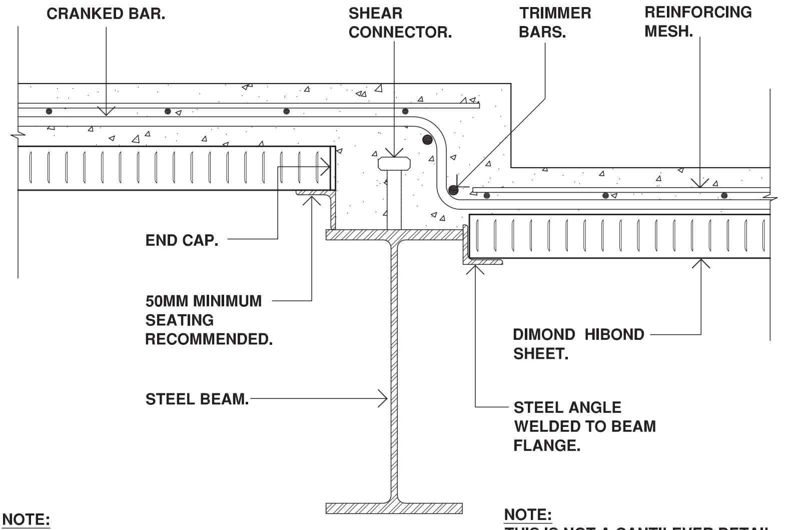


6 — HIBOND INTERNAL STEP DOWN ON STEEL BEAM – OPTION 2

CADREF: 6.hibond step down on steel beam – option 2

3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



NOTE:
FOR FABRICATION PURPOSES THE ANGLES ARE BEST LOCATED IN EITHER OF THE TWO POSITIONS SHOWN ABOVE.

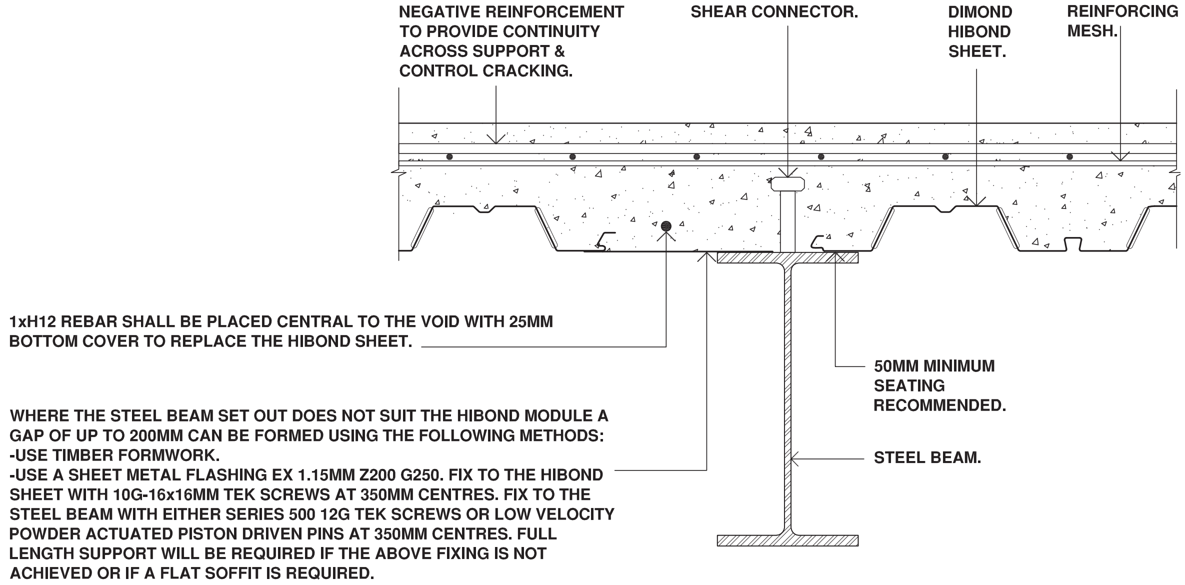
NOTE:
THIS IS NOT A CANTILEVER DETAIL. SPECIFIC DESIGN IS REQUIRED BY THE DESIGN ENGINEER FOR THIS DETAIL TO BE USED FOR A CANTILEVER.

7 / – HIBOND INTERNAL STEP DOWN ON STEEL BEAM – OPTION 3

CADREF: 7.hibond step down on steel beam – option 3

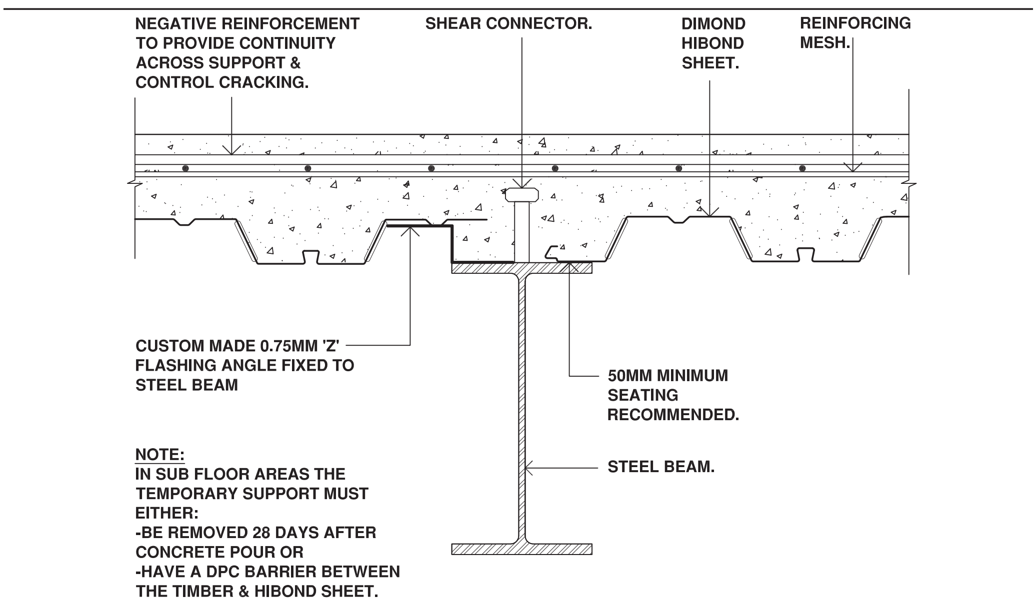
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



8 — HIBOND SIDE LAP BEARING ON STEEL BEAM – OPTION 1

CADREF: 8.hibond side lap bearing on steel beam – option 1

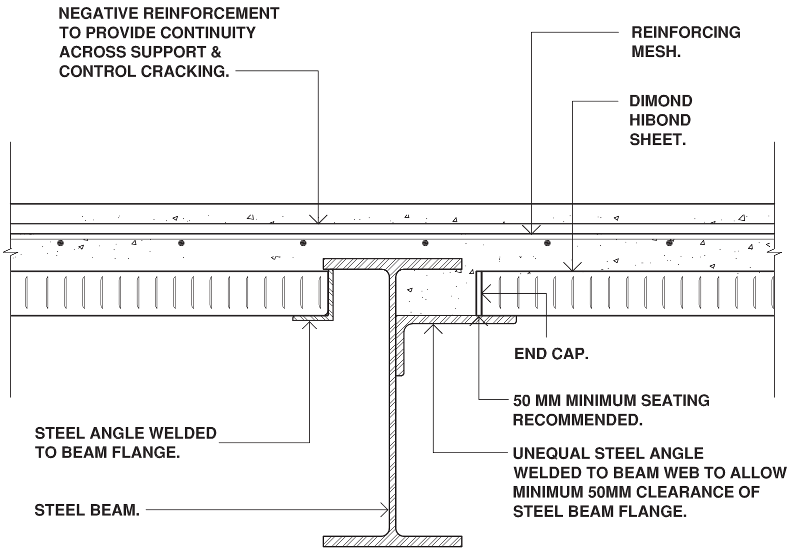


9 — HIBOND SIDE LAP BEARING ON STEEL BEAM – OPTION 2

CADREF: 9.hibond side lap bearing on steel beam – option 2

3.3.14 HIBOND CAD DETAILS *continued*

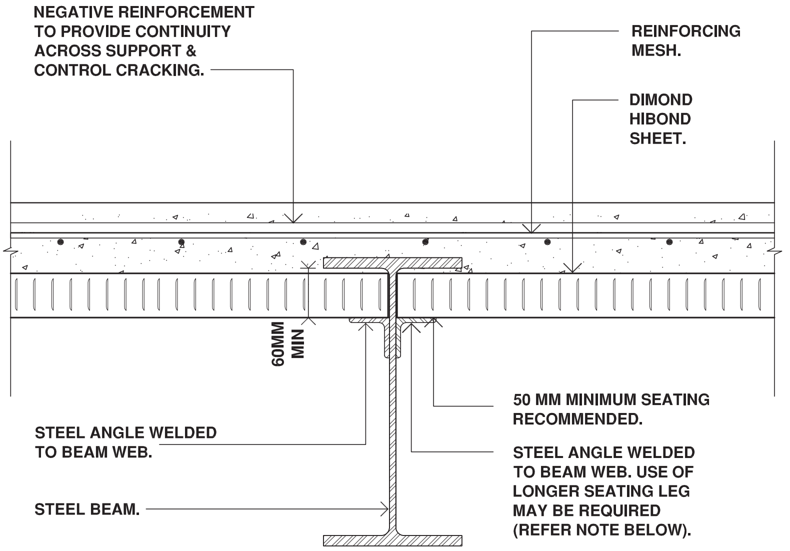
Not to scale



NOTE:
-THIS DETAIL CONTAINS TWO OPTIONS (SHOWN EACH SIDE OF THE BEAM) TO ACHIEVE AN INTERNAL SET DOWN.
-THIS DETAIL IS SUITABLE WHEN THE OTHER END OF THE HIBOND SHEET IS SIMILARLY RESTRICTED.
-FOR FABRICATION PURPOSES THE EQUAL ANGLE IS BEST LOCATED AS SHOWN.
-THE COST BENEFITS OF COMPOSITE BEAM ACTION AND ADDITIONAL FIRE RATING OF THE BEAM SHOULD BE CONSIDERED TO OFFSET THE INITIAL EXPENSE OF THE UNEQUAL ANGLE OPTION SHOWN IN THIS DETAIL.

10 – HIBOND INTERNAL SET DOWN ON STEEL BEAM – OPTION 1

CADREF: 10.hibond internal set down on steel beam – option 1



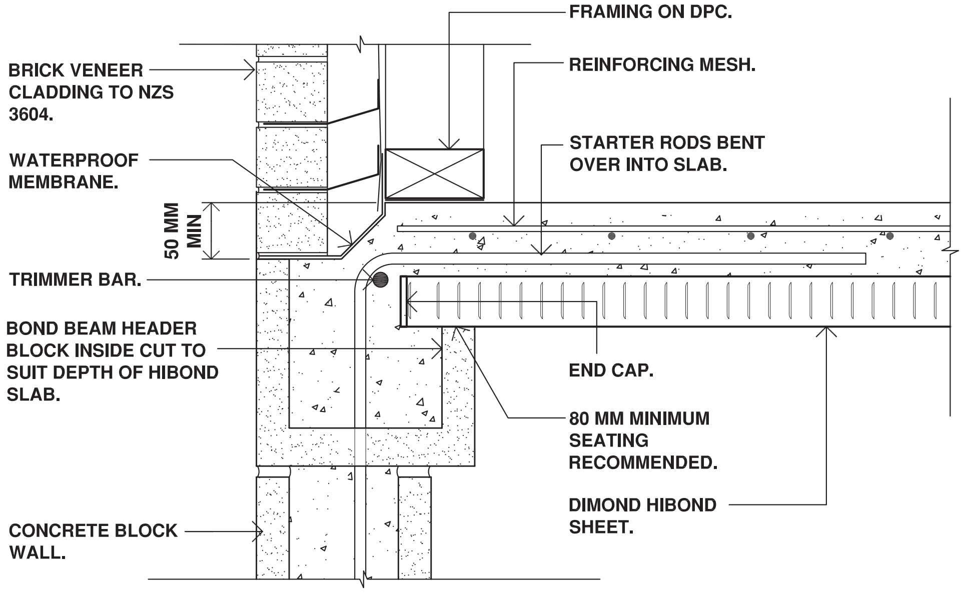
NOTE:
-THIS DETAIL IS SUITABLE ONLY IF THE OTHER END OF THE HIBOND SHEET IS UNRESTRICTED.

11 – HIBOND INTERNAL SET DOWN ON STEEL BEAM – OPTION 2

CADREF: 11.hibond internal set down on steel beam – option 2

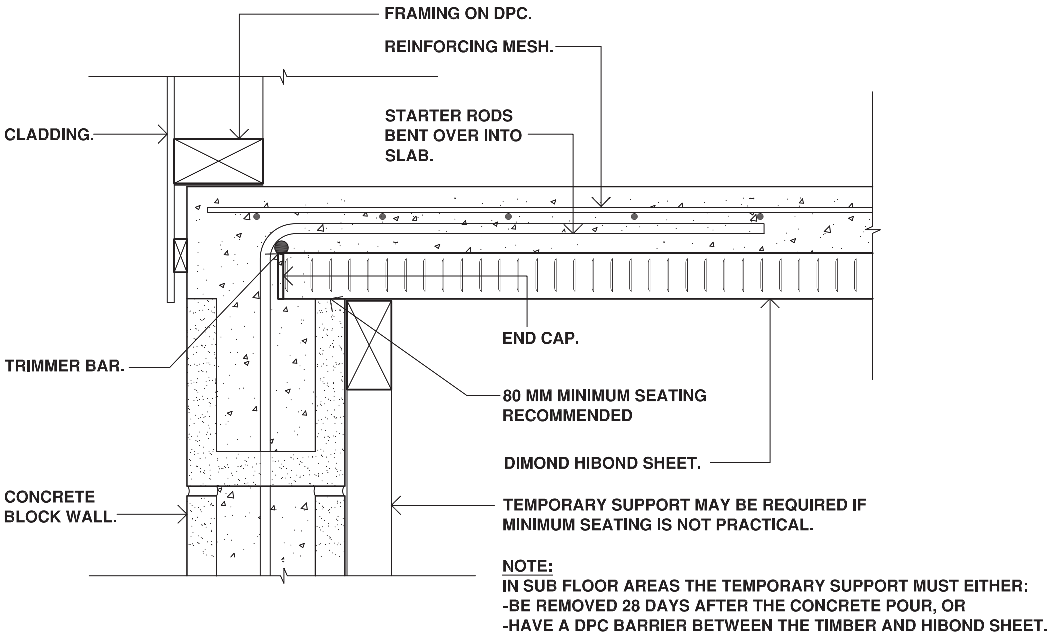
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



12 – HIBOND ON MASONRY BLOCK WITH BRICK VENEER

CADREF: 12.hibond on masonry block with brick veneer

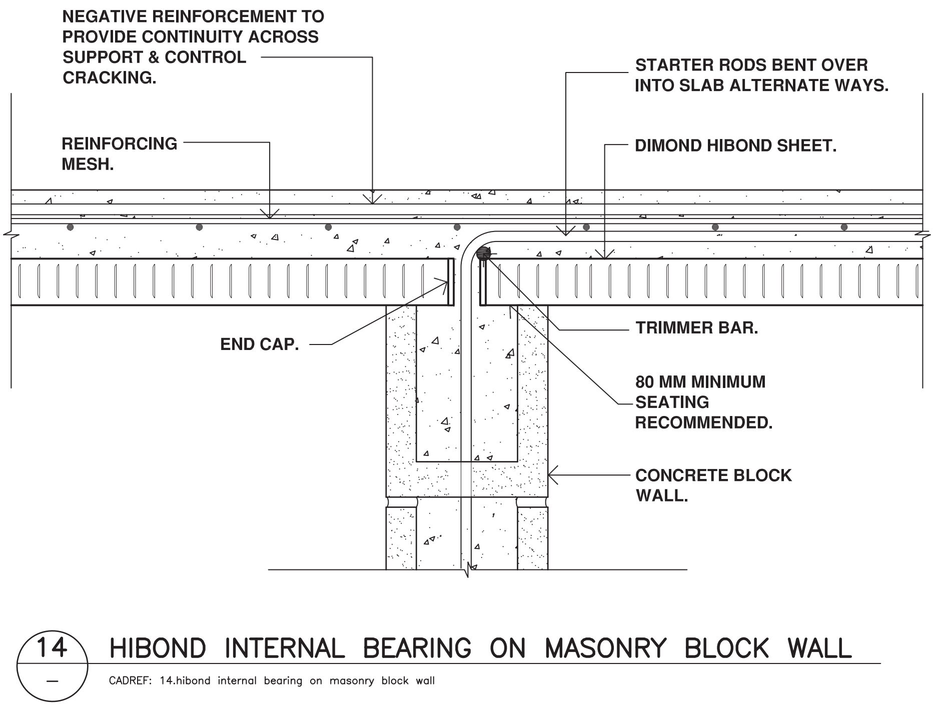


13 – HIBOND ON MASONRY BLOCK WITH TIMBER WALL

CADREF: 13.hibond on masonry block with timber wall

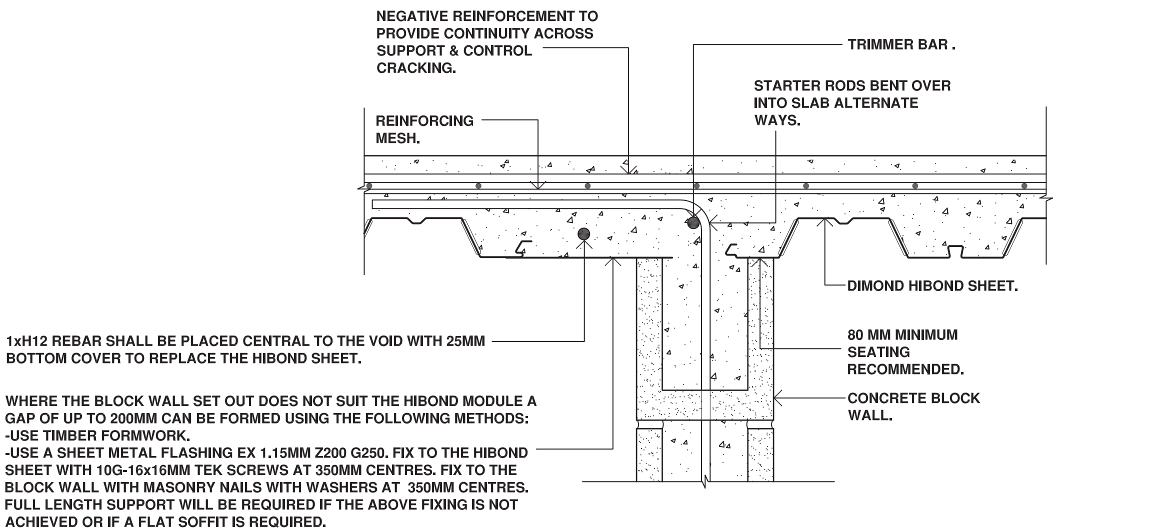
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



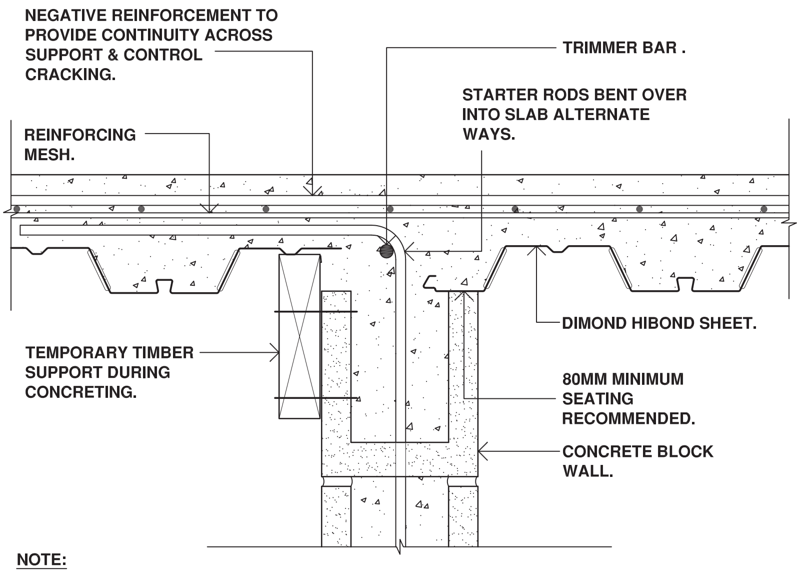
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



15 — HIBOND SIDE LAP BEARING ON MASONRY BLOCK WALL – OPTION 1

CADREF: 15.hibond side lap bearing on masonry block wall



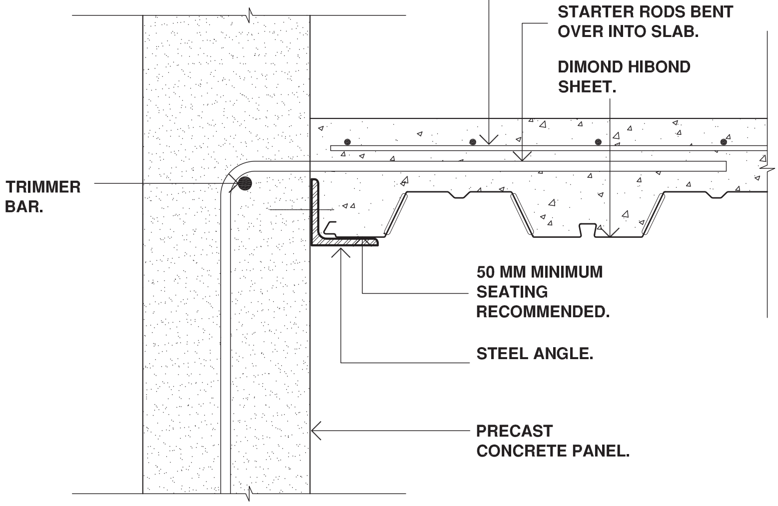
NOTE:
IN SUB FLOOR AREAS THE TEMPORARY SUPPORT MUST EITHER:
-BE REMOVED 28 DAYS AFTER CONCRETE POUR, OR
-HAVE A DPC BARRIER BETWEEN THE TIMBER AND HIBOND SHEET.

16 — HIBOND SIDE LAP BEARING ON MASONRY BLOCK WALL – OPTION 2

CADREF: 16.hibond side lap bearing on masonry block wall

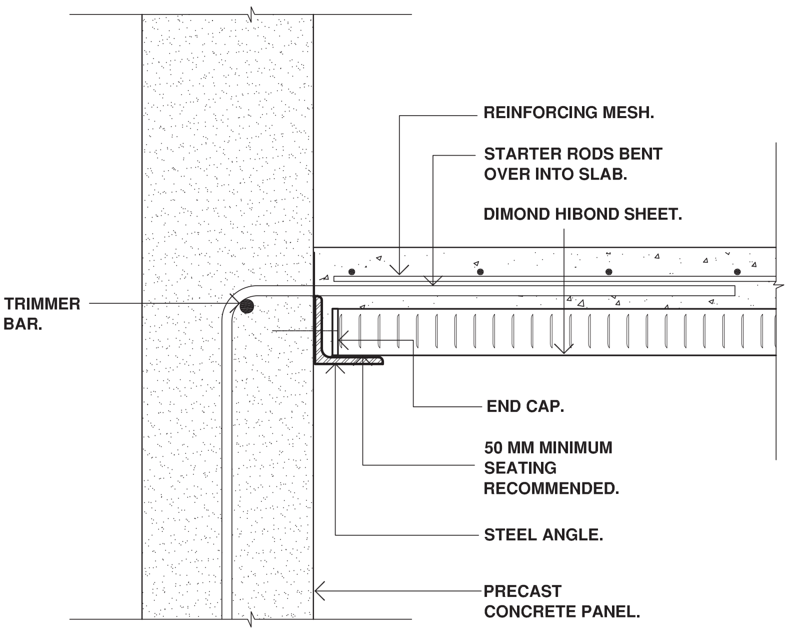
3.3.14 HIBOND CAD DETAILS *continued*

Not to scale



17 – HIBOND SIDE LAP BEARING ON TILT SLAB

CADREF: 17.hibond side lap bearing on tilt slab



18 – HIBOND END BEARING ON TILT SLAB

CADREF: 18.hibond end bearing on tilt slab

3.4 SPECIFIC DESIGN – FLATDECK FLOORING

3.4.1 INTRODUCTION

The Flatdeck Flooring System has been designed to comply with AS/NZ 4600 for formwork strength, AS 3600 for composite slab strength and BS 5950 for formwork and composite sab deflections, using the relevant load combinations therein and the relevant clauses of the New Zealand Building Code. Finite element analysis and physical testing have enabled load/span tables to be established using the limit states design philosophy.

Data presented in this manual is intended for use by structural engineers. Use of the Flatdeck Flooring System in applications other than uniformly distributed loads or outside the scope of this manual will require specific design.

A design yield strength of 550 MPa for 0.75mm and 0.95mm base metal thickness (BMT) Flatdeck has been used.

A minimum 28 day compressive strength of 25 MPa for high grade concrete has been assumed.
A minimum Flatdeck flooring slab thickness of 110mm has been used in this manual, in accordance with BS 5950.

The self weight of the Flatdeck Flooring System (including the concrete) has been included in the load tables.

3.4.2 DESIGN CONSIDERATIONS

Formwork

Where Flatdeck sheet is used as formwork, the profile provides resistance to wet concrete (G) and construction loads (Q). Maximum formwork spans given in Section 3.4.4.1 Flatdeck Formwork Tables are based on design checks for bending, web crushing, vertical shear, combined actions and deflection.

Flatdeck sheets must be laid in one continuous length between permanent supports. Short sheets of Flatdeck must never be spliced together to achieve the span between temporary or permanent supports.

Composite Slab

Design capacity of the Flatdeck Flooring System is largely dependent on interaction between the concrete and the Flatdeck sheet commonly referred to as shear bond. Shear bond is a combination of chemical bond between the concrete and the Flatdeck sheet and mechanical bond between the concrete and the vertical ribs of the Flatdeck sheet. This allows tension forces to be transferred from the concrete into the Flatdeck sheet.

Capacities for the Ultimate Limit State were derived for positive bending, shear bond, vertical shear and negative bending as appropriate. Each of these values was back substituted into the design combinations for the applied actions using 1.2 (dead load) + 1.5 (superimposed load).

The minimum resulting superimposed load, from all actions (including deflections), was used in the tables.

Appropriate imposed floor actions (Q) should be determined in accordance with AS/NZS 1170.1. All superimposed dead load (G_{SDL}) is then added to the imposed action (Q) to give a design superimposed load (G_{SDL} + Q) expressed in kPa for direct comparison with the tabulated data in Section 3.4.5 Flatdeck Composite Slab Load Span Tables.

Fire Design

Fire resistance for the Flatdeck Flooring System may be achieved by several methods. These include placement of additional reinforcement, spray-on insulation retardant, placement of suspended ceilings, and increasing the overall slab thickness. We have considered placement of additional reinforcement in the fire design tables.

This method is based on resistance to collapse (stability), the ability of the Flatdeck floor slab to prevent flames passing through cracks formed in the slab (integrity) and limiting the temperature increase on the unexposed side of the Flatdeck floor slab (insulation).

The fire design tables are based on design checks for bending (shear is rarely critical), in accordance with NZS 3101, based on the load combination $G + \psi_\ell Q$ for single spans which are effective in fire emergency conditions (where ψ_ℓ is the factor for determining quasi-permanent values for long term actions). Full design methodology is provided in HERA Report R4-82, except that for Flatdeck the contribution of that portion of the steel decking rib that is embedded into the slab and therefore shielded from direct exposure to the fire, is calculated by determining the temperature due to conduction of heat from the exposed pan of the decking.

The rib element is subdivided into 10 elements and the temperature of each element is determined using the method from HERA Report R4-131 Slab Panel Method (3rd edition). The strength at elevated temperature (yield strength as function of temperature) is also determined in accordance with this report. The contribution of each element to the overall moment capacity of the slab is calculated in accordance with normal reinforced concrete design procedures.

The fire design tables include a superimposed dead load (G_{SDL}) of 0.5 kPa in order that an imposed action (Q) can be compared directly with the tables in Section 3.4.6 Fire Design Tables.

Continued on next page

3.4.2 DESIGN CONSIDERATIONS *continued*

Additional Reinforcement

Mesh Reinforcement

Mesh reinforcement is placed at minimum cover (according to durability requirements outlined in NZS 3101 Section 3.11) in order to provide:

- Control of cracks caused by shrinkage during curing.
- Nominal continuity reinforcement over supporting members where a floor is designed as a series of simply supported Flatdeck floor slabs.

For propped construction consideration should be given to increasing nominal continuity reinforcement over supports as crack widths will increase when props are removed. Guidance on crack width tolerances is given in NZS 3101 and HERA Report R4-113.

Consideration should be given to orientating the top bar of the mesh to be parallel to the span of the steel sheet. This will provide the optimum nominal continuity from the mesh.

The following guide features mesh sizes for various slab thicknesses based on the degrees of crack control recommended in AS 3600 in conjunction with the exposure classification, concrete strengths and cover to reinforcing in NZS 3101.

These guidelines do not cover special requirements for reinforcement at locations where the slab is subject to high stresses due to deformation compatability (for example around columns).

Where NZS 3101 requires explicit crack control, this must be specifically determined by the design engineer.

1. For composite slabs fully enclosed within a building except during construction (generally exposure classification A1)

AS 3600 Criteria Design Slab Thickness DS (mm)	Minor		Moderate		Strong	
	Non-Ductile	Super Ductile	Non-Ductile	Super Ductile	Non-Ductile	Super Ductile
110	665	SE62	663	SE82	2 x 663	2 x SE82
120	665	SE62	2 x 665	2 x SE62	2 x 663	2 x SE82
130	665	SE62	2 x 665	2 x SE62	HD12 @ 250	HD12 @ 250
140	663	SE82	2 x 663	2 x SE82	HD12 @ 200	HD12 @ 200
150	663	SE82	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
160	663	SE82	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
170	663	SE82	2 x 663	2 x SE82	HD12 @ 150	HD12 @ 150
180	2 x 665	2 x SE62	HD12 @ 250	HD12 @ 250	HD12 @ 150	HD12 @ 150
190	2 x 665	2 x SE62	HD12 @ 200	HD12 @ 200	HD12 @ 100	HD12 @ 100
200	2 x 665	2 x SE62	HD12 @ 200	HD12 @ 200	HD12 @ 100	HD12 @ 100

Note:

a. For nominal continuity reinforcement over supporting members where a floor is designed as a series of simply supported Flatdeck floor slabs, use the 'minor' column in the table above.

b. Where ductile steel reinforcing bars (eg H16@200) are used the maximum area of longitudinal top steel required is the **greater** of 75% of the area of transverse steel required in the table above or the amount of longitudinal steel required for continuity from the load span tables in Section 3.4.5 or that determined by specific design. Reinforcing bars are Grade 500 to AS/NZS 4671.

c. Super Ductile wire mesh is based on a minimum 500MPa tensile wire.

Continued on next page

3.4.2 DESIGN CONSIDERATIONS *continued*

2. For composite slabs in exposure classification A2 moderate or strong crack control is always required.

Required Slab Thickness (mm)	AS 3600 Criteria Design Slab Thickness DS (mm)	Moderate		Strong	
		Non-Ductile	Super Ductile	Non-Ductile	Super Ductile
120	110	2 x 665	2 x SE62	2 x 663	2 x SE82
130	120	2 x 665	2 x SE62	HD12 @ 250	HD12 @ 250
140	130	2 x 665	2 x SE62	HD12 @ 200	HD12 @ 200
150	140	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
160	150	2 x 663	2 x SE82	HD12 @ 175	HD12 @ 175
170	160	2 x 663	2 x SE82	HD12 @ 150	HD12 @ 150
180	170	2 x 663	2 x SE82	HD12 @ 150	HD12 @ 150
190	180	HD12 @ 250	HD12 @ 250	HD12 @ 125	HD12 @ 125
200	190	HD12 @ 200	HD12 @ 200	HD12 @ 125	HD12 @ 125
210	200	HD12 @ 200	HD12 @ 200	HD12 @ 100	HD12 @ 100

Note:

a. To illustrate the effect of exposure classification on crack control requirements the slab thickness has been increased by 10mm to meet the minimum cover requirements of NZS 3101. This assumption means that longitudinal top steel requirements over supporting members can be designed using the load span tables in Section 3.4.5, provided that the extra thickness is treated purely as superimposed dead load and the composite slab is designed to the original design slab thickness.

b. Where ductile steel reinforcing bars (eg H16@200) are used the maximum area of longitudinal top steel required is the **greater** of 75% of the area of transverse steel required in the table above or the amount of longitudinal steel required for continuity from the load span tables in Section 3.4.5 or that determined by specific design. Reinforcing bars are Grade 500 to AS/NZS 4671.

3. For composite slabs in exposure classification B1 strong crack control is always required.

Required Slab Thickness (mm)	AS 3600 Criteria Design Slab Thickness DS (mm)	Strong	Strong Ductile
120	110	HD12 @ 250	HD12 @ 250
130	120	HD12 @ 200	HD12 @ 200
140	130	HD12 @ 200	HD12 @ 200
150	140	HD12 @ 175	HD12 @ 175
160	150	HD12 @ 150	HD12 @ 150
170	160	HD12 @ 150	HD12 @ 150
180	170	HD12 @ 125	HD12 @ 125
190	180	HD12 @ 125	HD12 @ 125
200	190	HD12 @ 125	HD12 @ 125
210	200	HD12 @ 100	HD12 @ 100

Note:

a. To illustrate the effect of exposure classification on crack control requirements the slab thickness has been increased by 15mm to meet the minimum cover requirements of NZS 3101. This assumption means that longitudinal top steel requirements over supporting members can be designed using the load span tables in Section 3.4.5, provided that the extra thickness is treated purely as superimposed dead load and the composite slab is designed to the original design slab thickness.

b. Ductile requirements have been provided for this exposure classification to provide the flexibility that longitudinal bars could be used in conjunction with the above for negative steel requirements.

c. Where ductile steel reinforcing bars (eg H16@200) are used the maximum area of longitudinal top steel required is the **greater** of 75% of the area of transverse steel required in the table above or the amount of longitudinal steel required for continuity from the load span tables in Section 3.4.5 or that determined by specific design. Reinforcing bars are Grade 500 to AS/NZS 4671.

d. Composite slabs in exposure classification B2 and C will require a thicker slab than those for B1 above and a higher strength concrete – therefore specific design to NZS 3101 is required.

3.4.2 DESIGN CONSIDERATIONS *continued*

Ductile Reinforcement

Ductile reinforcement (to elongation requirements of BS 4449) may also be required in the following instances:

- To gain full continuity over supporting members in continuous spans (refer Section 3.4.5 Flatdeck Composite Slab Load Span Tables).
- To increase the fire resistance of the floor slab (refer Section 3.4.6 Fire Design Tables).
- To distribute loads around openings in the floor slab.
- To provide negative reinforcement necessary for floor slabs used as cantilevers (where the contribution of the Flatdeck sheet is neglected in design).
- Where a point load is not fixed in position and can occur anywhere on the floor slab (for example car parks), placement of transverse reinforcement is required throughout the slab (minimum area as for line loads).
- When used as transverse reinforcement to distribute point loads and line loads; and resist transverse bending in the composite slab as a result of point loads (refer Section 3.4.10 Design Examples). The following two cases need to be considered.

$P_Q \leq 7.5$ kN

For a discrete point load ≤ 7.5 kN it is practical to use 2 – H10 transverse bars over the effective width of the Flatdeck slab (b_{eb} – refer BS 5950: Part 4 Clause 6.7) centred about the point load.

Where line loads perpendicular to the direction of slab span are present (≤ 7.5 kN/m), transverse reinforcing bars with a minimum cross sectional area of $2(D_s - 55)$ mm^2 per metre of load length (over the effective width of the line load) is required.

This equates to: H10 @ 400mm centres for composite slabs 110-150mm
H12 @ 400mm centres for composite slabs 160-200mm

Line loads running parallel to the span should be treated as a series of discrete point loads.

$P_Q > 7.5$ kN

For a discrete point load > 7.5 kN, transverse reinforcement is required to satisfy the following moment resistance.

$M^*_{trans} = P^* b_{eb} / (15w)$ where $w = L/2 + b_1$ and $w \not> L$

Where
M^*_{trans} = Factored bending moment in the transverse direction
P^* = Factored concentrated point load
b_{eb} = Effective width of slab
L = Span of composite slab
b_1 = Concentrated load length in direction of slab span

Where line loads perpendicular to the direction of slab span are present (> 7.5 kN/m), P^* is represented as a factored load per metre and b_{eb} is taken as equal to one metre.

Line loads running parallel to the span should be treated as a series of discrete point loads.

This requirement is based on recommendations from the Composite Deck Design Handbook by Heagler RB, Luttrell LD and Easterling WS; published by The Steel Decking Institute, Illinois 1997.

Continued on next page

3.4.2 DESIGN CONSIDERATIONS *continued*

Noise Control
Design guidance on Sound Transmission Class (STC) and Impact Insulation Class (IIC) values for Flatdeck Flooring Systems has been obtained by professional acoustic opinion. This is covered in detail in Section 3.4.7 Noise Control.

Floor Vibration
As a guide to designers, the limits expressed in the composite slab design tables represent the maximum span of the Flatdeck floor slab recommended for in-service floor vibration of an open plan commercial office floor with a low damping ratio (few small partitions) and a residence with higher damping (many full height partitions). Specific design is required to check other types of floor use. This represents the slab response of a person traversing the floor, but does not account for the dynamic response of the supporting structure.

For further information, including a design example, refer Section 3.4.8 Floor Vibration.

Thermal Insulation
Design guidance on thermal resistance (R) values for Flatdeck floor slabs to NZS 4218 is covered in Section 3.4.9 Thermal Insulation.

In Floor Heating
Where in floor heating is to be used in a Flatdeck composite slab, consideration should be given to the structural impact of placing heating systems within the compression zone of the floor slab. For example the overall slab thickness could be increased to compensate for any loss of structural integrity caused by the inclusion of in floor heating.

Two systems are commonly available:

- Water, utilising polybutylene tubes up to 20mm outside diameter and spaced as closely as 200mm with minimum 25mm top cover.
- Electrical, utilising wire up to 8mm outside diameter and spaced as closely as 100mm.

Both systems are typically attached directly to the top of the shrinkage mesh, in a pattern determined by the wall layout above the floor in question.

The in floor heating system must not be used to cure the slab as it will cause excessive cracking.

Continued on next page

3.4.2 DESIGN CONSIDERATIONS *continued*

Composite Beam Design

The use of the composite beam design concept can result in significant strength and stiffness gains over non-composite beam design. Composite beam design uses shear connectors to interconnect the Flatdeck floor slab and the beam. Shear connectors are typically 19mm diameter x 100mm long nominal.

The shear connection between the Flatdeck floor slab and the beam resists slipping at the interface, resulting in an interaction between the two members. This allows compressive forces to develop in the Flatdeck floor slab and tensile forces to develop in the beam.

The strength achieved in the composite beam is generally dependent on the strength of the shear connection provided between the Flatdeck floor slab and the beam. It is assumed that the shear connection is ductile.

Three types of construction are commonly used with composite beams.

Unpropped

- Where composite slab, secondary and primary beams are all constructed in an unpropped condition.
- Unpropped construction generally uses larger member sizes and construction time is minimised, and on this basis unpropped construction is preferred.
- The composite slab is poured to level for unpropped construction.

Propped

- Where secondary and primary beams are propped during construction. The composite slab is usually propped but may also be unpropped.
- Propped construction results in more efficient member sizes. However access to sub-trades is restricted until props have been removed.
- The composite slab is poured to level for propped construction.

Pre-cambered

- Where secondary and/or primary beams are fabricated with a pre-camber. The composite slab is unpropped for this type of construction.
- Pre-cambered construction provides member size efficiency and minimal soffit deflection and is effective on large spans.
- Pre-cambered construction requires the composite slab to be poured to constant thickness.

For further and concise information regarding composite beam construction refer to HERA Report R4-107 Composite Floor Construction Handbook.

3.4.2.1 DESIGN LIMITATIONS

Where Flatdeck floor slab is greater than 200mm overall thickness, the Flatdeck sheeting must be used as formwork only and the floor slab designed using additional positive reinforcement.

Cantilevers

Where Flatdeck sheet is used in cantilever situations, a propping line is required at the sheet ends to ensure a stable working platform is achieved during construction and pouring of the concrete (refer to Section 3.4.4.2 Propping).

As a guide, propping of the Flatdeck sheet is not required for cantilevers with a clear over-hang of,

300mm for 0.75mm Flatdeck
400mm for 0.95mm Flatdeck.

These cantilever spans assume:

- The Flatdeck sheets are securely fixed to the edge supporting member and the adjacent internal supporting member in accordance with Section 3.4.4.3 Bearing and Fixing Requirements.
- That Flatdeck edge form at the end of the cantilever is secured with one self-drilling screw (or rivet) per Flatdeck pan along with edge form support straps as detailed in Section 3.4.13.2 Edge Form Support Strap.

Additional ductile negative reinforcement is required to be designed to support all cantilevered floor slabs.

Pre-Cambering of Flatdeck Sheet

Pre-cambering of the Flatdeck sheet may be achieved using raised propping lines in cases where the underside of the Flatdeck floor slab requires minimal deflection. For example, propped Flatdeck sheet on a large span will deflect further when the props are removed.

Caution is required when using pre-cambered Flatdeck sheet as the concrete must be poured to constant thickness, as flat screeding will result in less than the minimum design slab thickness at mid-span.

In any case the pre-camber must not exceed span/350.

Timber Structure

Flatdeck is not intended for use on permanent timber supporting beams unless the beams have been specifically engineered to ensure undue deflection due to moisture, long-term creep or shrinkage does not affect the concrete floor performance.

When the Flatdeck sheet is in contact with timber, refer to Section 3.1.3.2 Limitations on Use.

Shear connectors into timber require specific design. These could include galvanised coach screws or reinforcing bar epoxy glued into timber beams and turned into slab.

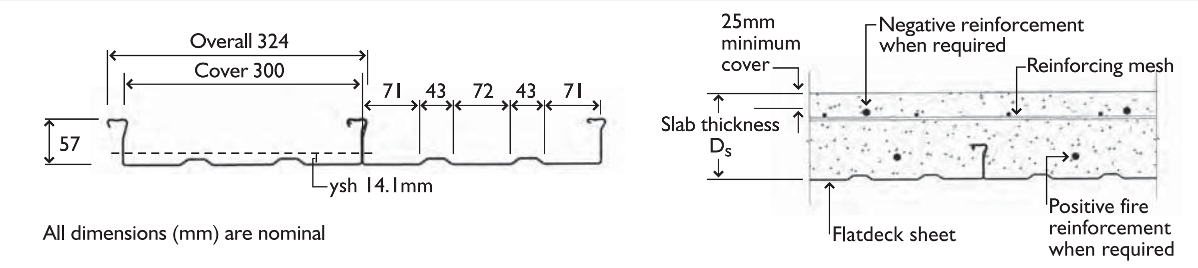
Two Way Slabs

The Flatdeck floor slab is made specifically for use in one way slab construction. However, specific design as a two way slab may be carried out to NZS 3101, provided the concrete strength contribution below the Flatdeck ribs, in the transverse direction, is ignored in the design.

Bridge Structures

Flatdeck is not intended to be used in bridge structures other than as permanent formwork, unless specifically designed for that purpose.

3.4.3 FLATDECK SECTION PROPERTIES



FLATDECK FORMWORK PROPERTIES (PER METRE WIDTH)

Thickness mm	Weight kN/m	Cross Sectional Area A_p mm^2	Design Strength p_y MPa	Bending Strengths M_c^+ kNm	Bending Strengths M_c^- kNm
0.75	0.094	1180	550	4.2	2.73
0.95	0.118	1495	550	5.10	3.61
Thickness mm	**Shear Strength P_v kN**	**Second Moment of Area 10^6mm^4 Single Span $1\ x^{+ve}$**	**Second Moment of Area 10^6mm^4 Multispan $1\ x^{-ve}$**	**Web Crushing Strength P_w kN End Support**	**Web Crushing Strength P_w kN Internal Support**
0.75	95.1	0.503	0.369	68.3	90.5
0.95	123.6	0.670	0.502	95.0	126.5

Notes

1. Design strength p_y is 0.84 x ultimate tensile strength.
2. ysh is the distance from the bottom of the Flatdeck sheet to the neutral axis.

Continued on next page

3.4.3 FLATDECK SECTION PROPERTIES *continued*

0.75mm FLATDECK COMPOSITE SLAB PROPERTIES (PER METRE WIDTH)

D_s mm	Weight kN/m	I_g 10^6mm^4 medium	I_g 10^6mm^4 long	Y_g mm medium	Y_g mm long	I_{cr} 10^6mm^4 medium	I_{cr} 10^6mm^4 long	Y_{cr} mm medium	Y_{cr} mm long	I_{av} 10^6mm^4 medium	I_{av} 10^6mm^4 long
110	2.63	13.4	8.3	59.0	61.7	6.3	5.3	37.4	46.2	9.9	6.8
120	2.86	17.2	10.6	64.2	67.0	7.8	6.6	39.8	49.3	12.5	8.6
130	3.09	21.6	13.3	69.3	72.2	9.5	8.0	42.0	52.3	15.6	10.7
140	3.32	26.8	16.4	74.4	77.4	11.4	9.6	44.2	55.2	19.1	13.0
150	3.55	32.7	20.0	79.5	82.6	13.4	11.4	46.3	57.9	23.1	15.7
160	3.78	39.5	24.0	84.6	87.8	15.6	13.3	48.3	60.6	27.6	18.7
170	4.01	47.1	28.6	89.7	93.0	18.1	15.4	50.2	63.2	32.6	22.0
180	4.24	55.6	33.7	94.7	98.1	20.7	17.8	52.1	65.7	38.1	25.7
190	4.47	65.0	39.3	99.8	103.2	23.5	20.2	54.0	68.1	44.3	29.8
200	4.70	75.5	45.5	104.8	108.3	26.5	22.9	55.8	70.5	51.0	34.2

0.95mm FLATDECK COMPOSITE SLAB PROPERTIES (PER METRE WIDTH)

D_s mm	Weight kN/m	I_g 10^6mm^4 medium	I_g 10^6mm^4 long	Y_g mm medium	Y_g mm long	I_{cr} 10^6mm^4 medium	I_{cr} 10^6mm^4 long	Y_{cr} mm medium	Y_{cr} mm long	I_{av} 10^6mm^4 medium	I_{av} 10^6mm^4 long
110	2.65	14.0	8.8	59.9	63.1	7.5	6.1	40.8	50.0	10.7	7.5
120	2.88	17.9	11.2	65.1	68.5	9.3	7.6	43.5	53.4	13.6	9.4
130	3.12	22.5	14.0	70.3	73.8	11.3	9.3	46.0	56.8	16.6	11.7
140	3.35	27.8	17.3	75.5	79.1	13.5	11.2	48.4	59.9	20.6	14.3
150	3.58	33.9	21.0	80.6	84.4	16.0	13.3	50.8	63.0	24.9	17.2
160	3.81	40.8	25.2	85.7	89.6	18.7	15.6	53.0	66.0	29.7	20.4
170	4.04	48.6	29.9	90.8	94.8	21.6	18.1	55.2	68.9	35.1	24.0
180	4.27	57.3	35.2	95.9	100.0	24.8	20.9	57.3	71.6	41.0	28.0
190	4.50	67.0	41.1	101.0	105.1	28.2	23.9	59.4	74.4	47.6	32.5
200	4.73	77.7	47.5	106.0	110.3	31.8	27.0	61.4	77.0	54.7	37.3

Notes

1. D_s is the overall thickness of the slab.
2. Slab weights are based on a dry concrete density of 2350 kg/m^3 with no allowance for ponding.
3. Section properties are presented in terms of equivalent steel units as follows:
   (a) Medium term superimposed loads are based on ⅔ short term and ⅓ long term load (ie modular ratio = 10) and apply to buildings of normal usage.
   (b) Long term superimposed loads are based on all loads being long term (ie modular ratio = 18) and apply to storage loads and loads which are permanent in nature.
4. I_g is the second moment of area of the gross composite Flatdeck section.
5. I_{cr} is the second moment of area of the cracked composite Flatdeck section.
6. I_{av} is the average value of gross (I_g) and cracked (I_{cr}) sections to be used for deflection calculations.
7. Y_g is the distance from top of slab to neutral axis of the composite Flatdeck slab for gross section.
8. Y_{cr} is the distance from top of slab to neutral axis of the composite Flatdeck slab for the cracked section.

3.4.4 FORMWORK DESIGN

3.4.4.1 FLATDECK FORMWORK TABLES

Maximum formwork spans for slab thicknesses between 110mm and 300mm are provided in the following tables.

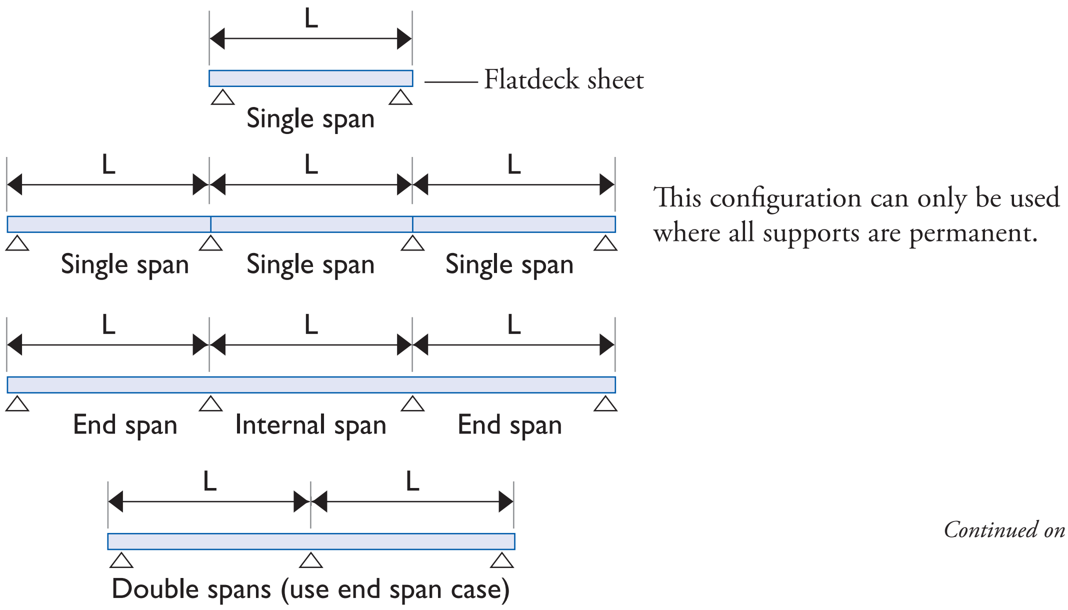
The following notes apply to the formwork tables in this section.

1. D_s is the overall thickness of the slab.
2. Slab weights (G) are based on a wet concrete density of 2400 kg/m^3 with no allowance for ponding.
3. A construction load (Q) of 1.5 kPa is incorporated in these tables.
4. L is the maximum span measured centre to centre between permanent or temporary supports.
5. Use of the double or end span tables and internal span tables assumes,
   - All spans have the same slab thickness.
   - The end span is within plus 5% or minus 10% of the internal span and that the end and internal spans are both designed using the appropriate load span table.
   - Double spans are within 10% of each other and the slab design is based on the largest span.
   - Internal spans are within 10% of each other and the slab design is based on the largest internal span.

   Any variations to the above configurations require specific design using the Flatdeck Formwork Properties table in Section 3.4.3.
6. These tables are based on minimum bearing of Flatdeck sheet given in Section 3.4.4.3.
7. Deflection limits incorporated in these tables are L/180 maximum due to dead load (G) only.

   These limits are represented in the 'Allow' (allowable) column of the Flatdeck Formwork Tables. The 5mm limit should be referred to where soffit deflection is to be reduced.
8. For intermediate values, linear interpolation is permitted.
9. As a guide, formwork deflections of around 15mm under dead load (G) should be expected within the extent of the tables. Construction loads (Q) will increase deflections.
10. The design span of the formwork relates closely to site installation. If the Flatdeck sheet is designed as an end span or internal span, the minimum nominal sheet length for construction should be noted clearly in the design documentation to ensure that appropriate sheet lengths are used by the installer to achieve the span type selected. Refer to Section 3.5 Installation.

Typical Formwork Slab Span Configurations



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3.4.4.1 FLATDECK FORMWORK TABLES *continued*

0.75mm FLATDECK FORMWORK SPAN CAPABILITIES

D_s mm	Slab Weight kPa	Concrete Quantity m^3/m^2	Maximum Span (L) mm Single		Double or End		Internal	
			Allow.	5mm limit	Allow.	5mm limit	Allow.	5mm limit
110	2.68	0.11	2300	1950	2700	2200	2700	2050
120	2.92	0.12	2200	1900	2650	2150	2650	2000
130	3.15	0.13	2200	1900	2550	2100	2550	2000
140	3.39	0.14	2150	1850	2500	2050	2500	1950
150	3.63	0.15	2100	1800	2450	2050	2450	1900
160	3.86	0.16	2050	1800	2400	2000	2400	1900
170	4.10	0.17	2000	1750	2350	2000	2350	1850
180	4.33	0.18	2000	1750	2350	1950	2300	1850
190	4.57	0.19	1950	1700	2300	1900	2300	1800
200	4.80	0.20	1900	1700	2250	1900	2250	1800
210	5.04	0.21	1900	1700	2200	1900	2200	1750
220	5.27	0.22	1850	1650	2200	1850	2150	1750
230	5.51	0.23	1850	1650	2150	1850	2150	1750
240	5.74	0.24	1800	1650	2100	1800	2100	1700
250	5.98	0.25	1800	1600	2100	1800	2100	1700
260	6.22	0.26	1750	1600	2050	1800	2050	1700
270	6.45	0.27	1750	1600	2000	1750	2000	1650
280	6.69	0.28	1700	1600	2000	1750	2000	1650
290	6.92	0.29	1700	1550	1950	1750	1950	1650
300	7.16	0.30	1650	1550	1950	1750	1950	1650

0.95mm FLATDECK FORMWORK SPAN CAPABILITIES

D_s mm	Slab Weight kPa	Concrete Quantity m^3/m^2	Maximum Span (L) mm Single		Double or End		Internal	
			Allow.	5mm limit	Allow.	5mm limit	Allow.	5mm limit
110	2.71	0.11	2500	2050	3000	2350	2950	2200
120	2.94	0.12	2450	2000	2900	2300	2900	2150
130	3.18	0.13	2400	2000	2850	2250	2850	2150
140	3.41	0.14	2350	1950	2800	2250	2800	2100
150	3.65	0.15	2300	1900	2750	2200	2700	2050
160	3.89	0.16	2250	1900	2700	2150	2650	2050
170	4.12	0.17	2200	1850	2650	2150	2600	2000
180	4.36	0.18	2150	1850	2600	2100	2550	2000
190	4.59	0.19	2150	1800	2550	2050	2550	1950
200	4.83	0.20	2100	1800	2500	2050	2500	1950
210	5.06	0.21	2050	1800	2450	2000	2450	1900
220	5.30	0.22	2050	1750	2400	2000	2400	1900
230	5.53	0.23	2000	1750	2400	2000	2350	1850
240	5.77	0.24	2000	1750	2350	1950	2350	1850
250	6.00	0.25	1950	1700	2300	1950	2300	1850
260	6.24	0.26	1900	1700	2250	1900	2250	1800
270	6.47	0.27	1900	1700	2250	1900	2250	1800
280	6.71	0.28	1850	1650	2200	1900	2200	1800
290	6.95	0.29	1850	1650	2200	1850	2200	1750
300	7.18	0.30	1850	1650	2150	1850	2150	1750

3.4.4.2 PROPPING

Where spans require propping of the Flatdeck sheet as shown in 3.4.4.1, adequately braced propping must be installed prior to laying the Flatdeck sheets and shall be designed to support wet concrete and construction loads. Refer to Section 3.5 Installation for further information.

Propping loads are given below for all slab thicknesses considered in Section 3.4.4.1.

PROPPING LOADS

Thickness mm	Serviceability (Safe) Load	Ultimate (Strength) Load
0.75	21.1 kN/m	26.4 kN/m
0.95	23.4 kN/m	29.2 kN/m

The Flatdeck sheet must be supported by continuous propping lines parallel to the permanent supports. The minimum width required for bearers is 100mm.

Propping lines must remain in place until:

- The concrete has reached a compressive strength of 20 MPa where construction loads are applied.
- The concrete is fully cured where full design loads are applied.

Refer to NZS 3109 for further details.

3.4.4.3 BEARING AND FIXING REQUIREMENTS

It is the responsibility of the design engineer to determine the bearing and fixing requirements for the Flatdeck Flooring System specific to each case.

Minimum bearing requirements for different span types are shown below.

The Flatdeck sheet does not require as much bearing as the composite slab. However the issue of sheet hold down, prior to the placement of the concrete, may determine Flatdeck bearing requirements.

MINIMUM BEARING REQUIREMENTS

	Bearing of Flatdeck Slab		Bearing of Flatdeck Sheet	
	Slab End	Continuous	Sheet End	Continuous
Steel beam	50mm	100mm	30mm	100mm
In situ concrete beam or wall	50mm	100mm	30mm	N/A
Concrete block	70mm	100mm	30mm	N/A

Where steel beams are the main support system, Flatdeck sheets can be fixed to supports by shear connectors (shear studs) welded through the Flatdeck sheet (refer also to 3.5 Installation). Flatdeck sheets can also be fixed to supports with self-drilling screws or powder-actuated fasteners.

Fixing into the edge of concrete block is not recommended as any breakout of the edge will reduce the effective support.

Where insufficient or inadequate support is available for the Flatdeck sheet, temporary bearers and props can be used to support the ends. Nails can be driven through the Flatdeck sheet into timber bearers to provide temporary hold down. Flatdeck sheets must be continuous when laid over temporary supports.

Where the Flatdeck sheet is used with tilt slab construction, it is common to fix the Flatdeck sheet to a steel angle which is bolted to the tilt slab.

While technically a Flatdeck floor slab does not require support along the edge (edge bearing), it is standard practice to tie the edges of the slab to the support structure. Edge bearing requirements follow that of the end bearing as shown in the minimum bearing requirements table.

3.4.4.4 PENETRATIONS

Penetrations of up to 250mm x 250mm square may be formed as part of the slab construction by formwork or polystyrene infill with the addition of 2 – H12 reinforcing bars laid in each adjacent Flatdeck sheet pan, the remaining Flatdeck sheet being cut away after curing.

Penetrations larger than 250mm x 250mm will require additional reinforcement to control cracking and provide structural integrity and may also require independent supporting beams to the design engineer's specific design.

The area of Flatdeck removed for penetrations must be replaced by an equivalent strength of reinforcement.

If cutting of the Flatdeck sheet is required prior to pouring the concrete, temporary propping is required to maintain the integrity of the sheet.

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES

Superimposed loads (G_{SDL} + Q) are presented for slab thicknesses between 110mm and 200mm and over a range of spans between 2.0m and 7.2m for all span configurations. For continuous design, negative reinforcement requirements are presented for double or end spans and internal spans.

The following Notes apply to the composite slab load span tables in this Section.

1. Span types
   L_{ss} is the clear single span between permanent supports plus 100mm.
   L is the double/end or internal span measured centre to centre between permanent supports.

2. The design superimposed load combination is G_{SDL} + Q and must not be greater than the superimposed loads given in the tables.

3. a) Medium term superimposed loads are based on 2/3 short term and 1/3 long term (i.e. modular ratio = 10) and apply to buildings of normal usage.

   b) Long term superimposed loads are based on all loads being long term (i.e. modular ratio = 18) and apply to storage loads and loads which are permanent in nature.

4. Deflection limits incorporated into these tables are as follows:

   a) L/350 or 20mm maximum due to superimposed load (G_{SDL} + Q).

   b) L/250 maximum due to superimposed load plus prop removal (G + G_{SDL} + Q).

   The designer shall be satisfied that these limits are adequate for the application considered, otherwise additional deflection checks must be made.

5. Propping requirements depend on the Flatdeck slab thickness and span configuration as formwork. Refer to Section 3.4.4.1 Flatdeck Formwork Tables to determine formwork span capabilities.

6. Use of the double or end span tables and internal span tables assumes,

   - All spans have the same slab thickness.
   - The end span is within plus 5% or minus 10% of the internal span and that the end and internal spans are both designed using the appropriate load span table.
   - Double spans are within 10% of each other and the slab design is based on the largest span.
   - Internal spans are within 10% of each other and the slab design is based on the largest internal span.

   Any variation to the above configurations requires specific design.

7. Example: For a 0.75mm Flatdeck slab of 130mm overall slab thickness on a double span of 3800mm we have the following:

8.9 H16@200

   where:

8.9	=	Superimposed load kPa
H16@200	=	H16 negative reinforcing (saddle bars) placed at 200mm centres to achieve the superimposed load

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3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES *continued*

8. Steel areas in the double or end and internal span tables are calculated based on H16 reinforcing bars (i.e. 16mm diameter grade 500 to AS/NZS 4671) placed at 25mm top cover (A1 exposure classification – NZS 3101). Areas for other bar types, covers and sizes require specific design.

9. Negative reinforcement must be placed on top of the mesh parallel with the Flatdeck ribs at spacings indicated in the tables for the span and slab thickness considered.

10. Negative reinforcement must extend at least 0.25 of the largest span plus 450mm each side of the centre line of the support.

11. The same negative reinforcing is required for both propped and unpropped construction.

12. Vibration limits expressed as maximum spans in the tables refer to:

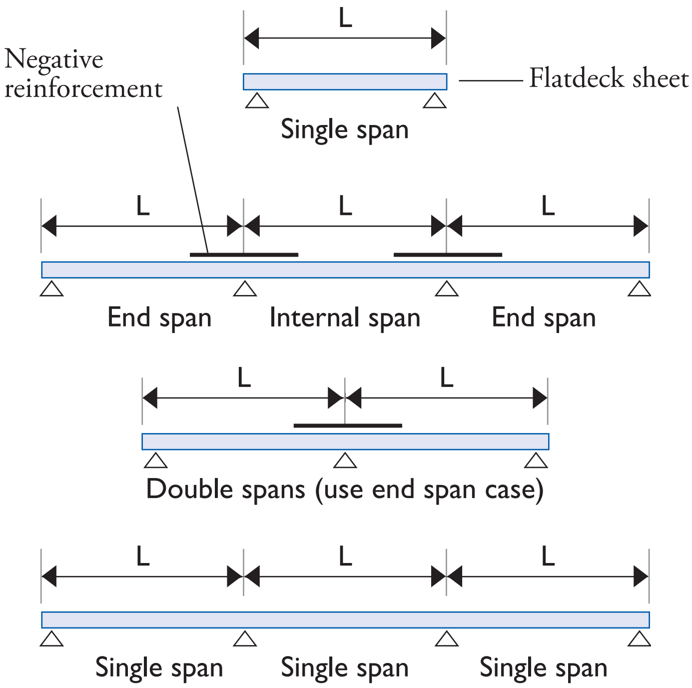
    – – – – Commercial offices, open plan with few small partitions (damping ratio = 0.025)

    ········· Residences with many full height partitions (damping ratio = 0.05)

    Specific design is required for other floor uses. Refer Section 3.4.8 Floor Vibration.

13. For intermediate values, linear interpolation is permitted.

Typical Composite Slab Span Configurations



This configuration requires nominal continuity reinforcement to be placed over the supports as described for a minor degree of crack control for Mesh Reinforcement in Section 3.4.2.

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES continued

0.75mm FLATDECK – SINGLE SPANS
Medium term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	18.6	20.3	21.8	–	–	–	–	–	–	–
2200	16.0	17.3	18.8	20.3	21.8	–	–	–	–	–
2400	13.9	15.2	16.4	17.7	19.0	20.3	21.6	–	–	–
2600	12.2	13.4	14.4	15.6	16.7	17.8	19.0	20.2	21.3	–
2800	10.9	11.8	12.8	13.8	14.8	15.8	16.9	17.9	18.9	20.0
3000	9.7	10.6	11.5	12.4	13.3	14.2	15.1	16.0	17.0	17.9
3200	8.8	9.5	10.3	11.1	11.9	12.8	13.6	14.4	15.3	16.1
3400	7.9	8.6	9.3	10.1	10.8	11.6	12.3	13.1	13.8	14.6
3600	7.1	7.8	8.5	9.2	9.8	10.5	11.2	11.9	12.6	13.3
3800	6.5	7.1	7.8	8.3	9.0	9.6	10.2	10.9	11.5	12.1
4000	5.9	6.5	7.1	7.6	8.2	8.8	9.4	9.9	10.5	11.1
4200	5.4	5.9	6.5	7.0	7.5	8.1	8.6	9.1	9.7	10.2
4400	4.6	5.4	6.0	6.4	6.9	7.4	7.9	8.4	8.9	9.4
4600	3.7	5.0	5.5	5.9	6.4	6.8	7.3	7.7	8.3	8.8
4800	2.9	4.2	5.1	5.4	5.9	6.3	6.8	7.3	7.7	8.1
5000	2.3	3.4	4.6	5.0	5.5	5.9	6.3	6.7	7.1	7.5
5200	1.7	2.7	3.8	4.7	5.1	5.5	5.9	6.2	6.6	7.0
5400	–	2.1	3.1	4.4	4.7	5.1	5.4	5.8	6.1	6.5
5600	–	1.6	2.4	3.4	4.4	4.7	5.0	5.4	5.7	6.0
5800	–	–	1.9	2.8	4.1	4.4	4.7	5.0	5.3	5.6
6000	–	–	–	2.2	3.1	4.1	4.4	4.6	4.9	5.2
6200	–	–	–	1.7	2.5	3.4	4.1	4.4	4.6	4.9
6400	–	–	–	–	1.9	2.8	3.7	4.0	4.3	4.6
6600	–	–	–	–	–	2.2	3.0	3.7	4.1	4.3
6800	–	–	–	–	–	1.7	2.4	3.3	3.8	4.1
7000	–	–	–	–	–	–	1.9	2.7	3.5	3.7
7200	–	–	–	–	–	–	–	2.1	2.9	3.5

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES continued

0.75mm FLATDECK – SINGLE SPANS
Long term superimposed loads (kPa)

L_{ss}	Slab thickness (D_s) mm									
mm	110	120	130	140	150	160	170	180	190	200
2000	18.6	20.3	21.8	–	–	–	–	–	–	–
2200	16.0	17.3	18.8	20.3	21.8	–	–	–	–	–
2400	13.9	15.2	16.4	17.7	19.0	20.3	21.6	–	–	–
2600	12.2	13.4	14.4	15.6	16.7	17.8	19.0	20.2	21.3	–
2800	10.9	11.8	12.8	13.8	14.8	15.8	16.9	17.9	18.9	20.0
3000	9.7	10.6	11.5	12.4	13.3	14.2	15.1	16.0	17.0	17.9
3200	8.8	9.5	10.3	11.1	11.9	12.8	13.6	14.4	15.3	16.1
3400	7.7	8.6	9.3	10.1	10.8	11.6	12.3	13.1	13.8	14.6
3600	6.5	7.8	8.5	9.2	9.8	10.5	11.2	11.9	12.6	13.3
3800	5.1	6.9	7.8	8.3	9.0	9.6	10.2	10.9	11.5	12.1
4000	4.0	5.5	7.1	7.6	8.2	8.8	9.4	9.9	10.5	11.1
4200	3.1	4.4	5.9	7.0	7.5	8.1	8.6	9.1	9.7	10.2
4400	2.3	3.4	4.7	6.2	6.9	7.4	7.9	8.4	8.9	9.4
4600	1.7	2.6	3.7	5.0	6.5	6.8	7.3	7.7	8.3	8.8
4800	–	1.9	2.9	4.0	5.3	6.3	6.8	7.3	7.7	8.1
5000	–	–	2.2	3.2	4.3	5.5	6.3	6.7	7.1	7.5
5200	–	–	1.6	2.4	3.4	4.5	5.8	6.2	6.6	7.0
5400	–	–	–	1.8	2.6	3.6	4.7	5.8	6.1	6.5
5600	–	–	–	–	2.0	2.8	3.8	4.9	5.7	6.0
5800	–	–	–	–	–	2.2	3.0	4.0	5.0	5.6
6000	–	–	–	–	–	1.6	2.3	3.2	4.1	5.2
6200	–	–	–	–	–	–	1.7	2.5	3.3	4.2
6400	–	–	–	–	–	–	–	1.8	2.6	3.4
6600	–	–	–	–	–	–	–	–	2.0	2.7
6800	–	–	–	–	–	–	–	–	–	2.1
7000	–	–	–	–	–	–	–	–	–	1.5
7200	–	–	–	–	–	–	–	–	–	–

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.75mm FLATDECK – DOUBLE AND END SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm^2/m width)

	Slab Thickness (D_s) mm									
L (mm)	110	120	130	140	150	160	170	180	190	200
2000	**21.1** H16@300	**22.9** H16@300								
2200	**18.1** H16@250	**19.7** H16@300	**21.2** H16@300	**22.9** H16@300						
2400	**15.8** H16@250	**17.2** H16@250	**18.5** H16@300	**19.9** H16@300	**21.4** H16@300	**22.8** H16@300				
2600	**13.9** H16@250	**15.1** H16@250	**16.3** H16@250	**17.6** H16@300	**18.8** H16@300	**20.1** H16@300	**21.3** H16@300			
2800	**12.4** H16@250	**13.4** H16@250	**14.5** H16@250	**15.6** H16@250	**16.7** H16@300	**17.8** H16@300	**18.9** H16@300	**20.1** H16@300	**21.3** H16@300	**22.0** H16@300
3000	**11.1** H16@200	**12.1** H16@250	**13.0** H16@250	**14.0** H16@250	**15.0** H16@250	**16.0** H16@250	**17.0** H16@300	**18.1** H16@300	**19.1** H16@300	**20.2** H16@300
3200	**10.0** H16@200	**10.9** H16@200	**11.8** H16@250	**12.7** H16@250	**13.6** H16@250	**14.5** H16@250	**15.4** H16@200	**16.3** H16@250	**17.3** H16@250	**18.2** H16@250
3400	**8.6** H16@200	**9.9** H16@200	**10.7** H16@200	**11.5** H16@250	**12.3** H16@250	**13.2** H16@250	**14.0** H16@200	**14.8** H16@250	**15.7** H16@250	**16.5** H16@250
3600	**7.1** H16@200	**9.0** H16@200	**9.7** H16@200	**10.5** H16@200	**11.3** H16@200	**12.0** H16@250	**12.8** H16@200	**13.5** H16@250	**14.3** H16@250	**15.1** H16@250
3800	**5.8** H16@200	**7.5** H16@200	**8.9** H16@200	**9.6** H16@200	**10.3** H16@200	**11.0** H16@200	**11.7** H16@200	**12.4** H16@250	**13.1** H16@250	**13.8** H16@250
4000	**4.8** H16@200	**6.3** H16@200	**7.9** H16@200	**8.9** H16@200	**9.5** H16@200	**10.1** H16@200	**10.8** H16@200	**11.4** H16@200	**12.1** H16@200	**12.7** H16@200
4200	**3.9** H16@200	**5.2** H16@200	**6.6** H16@200	**8.2** H16@200	**8.7** H16@200	**9.3** H16@200	**9.9** H16@200	**10.5** H16@200	**11.2** H16@200	**11.8** H16@200
4400	**3.1** H16@200	**4.3** H16@200	**5.5** H16@200	**6.9** H16@200	**8.1** H16@200	**8.6** H16@200	**9.2** H16@200	**9.8** H16@200	**10.3** H16@200	**10.9** H16@200
4600	**2.5** H16@200	**3.5** H16@200	**4.6** H16@200	**5.8** H16@200	**7.2** H16@200	**8.0** H16@200	**8.5** H16@200	**9.1** H16@200	**9.7** H16@200	**10.2** H16@200
4800	**1.9** H16@200	**2.8** H16@200	**3.7** H16@200	**4.8** H16@200	**6.1** H16@200	**7.4** H16@200	**8.0** H16@200	**8.5** H16@200	**9.0** H16@200	**9.5** H16@200
5000	**1.4** H16@200	**2.2** H16@200	**3.0** H16@200	**4.0** H16@200	**5.3** H16@200	**6.5** H16@200	**7.4** H16@200	**7.9** H16@200	**8.4** H16@200	**8.9** H16@200
5200		**1.6** H16@200	**2.4** H16@200	**3.5** H16@200	**4.4** H16@200	**5.5** H16@200	**6.6** H16@200	**7.2** H16@200	**7.8** H16@200	**8.3** H16@200
5400			**2.1** H16@200	**2.8** H16@200	**3.7** H16@200	**4.7** H16@200	**5.7** H16@200	**6.4** H16@200	**6.9** H16@200	**7.5** H16@200
5600			**1.6** H16@200	**2.3** H16@200	**3.0** H16@200	**3.9** H16@200	**4.8** H16@200	**5.7** H16@200	**6.1** H16@200	**7.3** H16@100
5800				**1.8** H16@200	**2.5** H16@200	**3.2** H16@200	**4.1** H16@200	**5.0** H16@200	**5.5** H16@200	**6.8** H16@100
6000					**1.9** H16@200	**2.6** H16@200	**3.9** H16@100	**4.2** H16@200	**4.8** H16@200	**6.4** H16@100
6200						**2.1** H16@200	**3.2** H16@100	**3.5** H16@200	**4.3** H16@200	**5.9** H16@100
6400						**1.5** H16@200	**2.6** H16@100	**3.3** H16@100	**3.6** H16@200	**5.2** H16@100
6600							**2.0** H16@100	**2.7** H16@100	**3.7** H16@100	**4.5** H16@100
6800							**1.7** H16@100	**2.4** H16@100	**3.1** H16@100	**3.8** H16@100
7000								**1.8** H16@100	**2.5** H16@100	**3.2** H16@100
7200									**2.0** H16@100	**2.6** H16@100

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.75mm FLATDECK – INTERNAL SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm²/m width)

	Slab Thickness (D_s) mm									
L (mm)	110	120	130	140	150	160	170	180	190	200
2000	**20.0** H16@300	**21.7** H16@300	**23.4** H16@300							
2200	**17.1** H16@300	**18.6** H16@300	**20.1** H16@300	**21.6** H16@300	**23.1** H16@300					
2400	**15.0** H16@300	**16.2** H16@300	**17.5** H16@300	**18.8** H16@300	**20.2** H16@300	**21.4** H16@300	**22.8** H16@300			
2600	**13.2** H16@300	**14.3** H16@300	**15.4** H16@300	**16.6** H16@300	**17.7** H16@300	**18.9** H16@300	**20.1** H16@300	**21.3** H16@300	**22.6** H16@300	
2800	**11.6** H16@250	**12.7** H16@300	**13.7** H16@300	**14.7** H16@300	**15.8** H16@300	**16.8** H16@300	**17.9** H16@300	**19.0** H16@300	**20.1** H16@300	**21.2** H16@300
3000	**10.5** H16@250	**11.3** H16@250	**12.3** H16@300	**13.2** H16@300	**14.1** H16@300	**15.1** H16@300	**16.0** H16@300	**17.0** H16@300	**18.0** H16@300	**19.1** H16@300
3200	**9.4** H16@250	**10.2** H16@250	**11.1** H16@250	**11.9** H16@300	**12.8** H16@300	**13.6** H16@300	**14.5** H16@300	**15.4** H16@300	**16.3** H16@300	**17.2** H16@300
3400	**8.3** H16@250	**9.3** H16@250	**10.1** H16@250	**10.8** H16@250	**11.6** H16@300	**12.4** H16@300	**13.2** H16@300	**14.0** H16@300	**14.8** H16@300	**15.6** H16@300
3600	**6.4** H16@200	**8.3** H16@250	**9.2** H16@250	**9.9** H16@250	**10.6** H16@250	**11.3** H16@250	**12.0** H16@300	**12.8** H16@300	**13.5** H16@300	**14.3** H16@300
3800	**5.2** H16@200	**6.8** H16@200	**8.4** H16@250	**9.1** H16@250	**9.7** H16@250	**10.4** H16@250	**11.0** H16@250	**11.7** H16@250	**12.4** H16@300	**13.1** H16@300
4000	**4.2** H16@200	**5.6** H16@200	**7.2** H16@200	**8.3** H16@250	**8.9** H16@250	**9.5** H16@250	**10.1** H16@250	**10.8** H16@250	**11.4** H16@250	**12.0** H16@250
4200	**3.4** H16@200	**4.6** H16@200	**5.9** H16@200	**7.4** H16@200	**8.2** H16@250	**8.8** H16@250	**9.4** H16@250	**9.9** H16@250	**10.5** H16@250	**11.1** H16@250
4400	**2.7** H16@200	**3.7** H16@200	**4.9** H16@200	**6.2** H16@200	**7.6** H16@200	**8.1** H16@250	**8.7** H16@250	**9.2** H16@250	**9.7** H16@250	**10.3** H16@250
4600	**2.1** H16@200	**2.9** H16@200	**4.0** H16@200	**5.1** H16@200	**6.4** H16@200	**7.5** H16@200	**8.0** H16@250	**8.5** H16@250	**9.1** H16@250	**9.6** H16@250
4800	**1.5** H16@200	**2.3** H16@200	**3.2** H16@200	**4.2** H16@200	**5.3** H16@200	**6.6** H16@200	**7.5** H16@200	**8.0** H16@200	**8.5** H16@200	**8.9** H16@250
5000		**1.7** H16@200	**2.5** H16@200	**3.4** H16@200	**4.6** H16@200	**5.7** H16@200	**7.0** H16@200	**7.5** H16@200	**7.9** H16@200	**8.3** H16@200
5200			**1.8** H16@200	**2.9** H16@200	**3.8** H16@200	**4.8** H16@200	**5.9** H16@200	**7.0** H16@200	**7.4** H16@200	**7.8** H16@200
5400			**1.5** H16@200	**2.3** H16@200	**3.1** H16@200	**4.0** H16@200	**5.5** H16@100	**6.0** H16@200	**6.9** H16@200	**7.3** H16@200
5600				**1.7** H16@200	**2.5** H16@200	**3.2** H16@200	**4.6** H16@100	**5.6** H16@100	**6.1** H16@200	**6.8** H16@200
5800					**1.8** H16@200	**2.6** H16@200	**3.8** H16@100	**4.7** H16@100	**5.8** H16@100	**6.2** H16@200
6000						**2.0** H16@200	**3.1** H16@100	**3.9** H16@100	**4.9** H16@100	**5.9** H16@100
6200							**2.5** H16@100	**3.2** H16@100	**4.1** H16@100	**5.0** H16@100
6400							**1.8** H16@100	**2.6** H16@100	**3.3** H16@100	**4.3** H16@100
6600								**1.9** H16@100	**2.6** H16@100	**3.6** H16@100
6800								**1.5** H16@100	**2.2** H16@100	**3.0** H16@100
7000									**1.6** H16@100	**2.3** H16@100
7200										**1.7** H16@100

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES continued

0.95mm FLATDECK – SINGLE SPANS
Medium term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	19.8	21.5	23.1	–	–	–	–	–	–	–
2200	16.9	18.4	19.8	21.2	22.7	–	–	–	–	–
2400	14.6	15.9	17.1	18.6	19.8	21.1	22.4	–	–	–
2600	13.0	14.1	15.2	16.3	17.4	18.6	19.7	20.9	22.1	–
2800	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.6	19.6	20.6
3000	10.3	11.2	12.0	12.9	13.9	14.8	15.7	16.6	17.5	18.5
3200	9.2	10.0	10.8	11.7	12.5	13.3	14.1	14.9	15.8	16.6
3400	8.3	9.1	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.1
3600	7.5	8.2	8.9	9.6	10.3	10.9	11.6	12.3	13.0	13.7
3800	6.9	7.5	8.1	8.7	9.4	10.0	10.6	11.2	11.9	12.5
4000	6.3	6.8	7.4	8.0	8.6	9.2	9.7	10.3	10.9	11.5
4200	5.7	6.3	6.8	7.3	7.9	8.4	8.9	9.5	10.0	10.5
4400	5.2	5.8	6.2	6.7	7.2	7.7	8.2	8.7	9.2	9.7
4600	4.2	5.3	5.7	6.2	6.7	7.1	7.6	8.0	8.5	9.0
4800	3.4	4.8	5.3	5.7	6.1	6.6	7.0	7.4	7.9	8.3
5000	2.7	3.9	4.9	5.3	5.7	6.1	6.5	6.9	7.3	7.8
5200	2.1	3.1	4.4	4.9	5.2	5.6	6.0	6.5	6.8	7.2
5400	1.6	2.5	3.6	4.5	4.8	5.2	5.7	6.0	6.4	6.7
5600	–	1.9	2.9	4.0	4.6	4.9	5.3	5.6	5.9	6.2
5800	–	–	2.3	3.3	4.3	4.6	4.9	5.2	5.5	5.8
6000	–	–	1.7	2.6	3.6	4.3	4.5	4.8	5.1	5.4
6200	–	–	–	2.1	3.0	4.0	4.2	4.5	4.8	5.0
6400	–	–	–	1.6	2.4	3.3	3.9	4.2	4.4	4.7
6600	–	–	–	–	1.8	2.6	3.6	3.9	4.1	4.4
6800	–	–	–	–	–	2.1	2.9	3.6	3.8	4.1
7000	–	–	–	–	–	1.6	2.3	3.2	3.6	3.8
7200	–	–	–	–	–	–	1.8	2.6	3.4	3.6

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES continued

0.95mm FLATDECK – SINGLE SPANS
Long term superimposed loads (kPa)

L_{ss} mm	Slab thickness (D_s) mm 110	120	130	140	150	160	170	180	190	200
2000	19.8	21.5	23.1	–	–	–	–	–	–	–
2200	16.9	18.4	19.8	21.2	22.7	–	–	–	–	–
2400	14.6	15.9	17.1	18.6	19.8	21.1	22.4	–	–	–
2600	13.0	14.1	15.2	16.3	17.4	18.6	19.7	20.9	22.1	–
2800	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.6	19.6	20.6
3000	10.3	11.2	12.0	12.9	13.9	14.8	15.7	16.6	17.5	18.5
3200	9.2	10.0	10.8	11.7	12.5	13.3	14.1	14.9	15.8	16.6
3400	8.3	9.1	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.1
3600	7.2	8.2	8.9	9.6	10.3	10.9	11.6	12.3	13.0	13.7
3800	5.9	7.5	8.1	8.7	9.4	10.0	10.6	11.2	11.9	12.5
4000	4.7	6.3	7.4	8.0	8.6	9.2	9.7	10.3	10.9	11.5
4200	3.7	5.1	6.8	7.3	7.9	8.4	8.9	9.5	10.0	10.5
4400	2.8	4.0	5.5	6.7	7.2	7.7	8.2	8.7	9.2	9.7
4600	2.1	3.2	4.4	5.8	6.7	7.1	7.6	8.0	8.5	9.0
4800	1.6	2.4	3.5	4.7	6.1	6.6	7.0	7.4	7.9	8.3
5000	–	1.8	2.7	3.8	5.0	6.1	6.5	6.9	7.3	7.8
5200	–	–	2.1	3.0	4.1	5.3	6.0	6.5	6.8	7.2
5400	–	–	1.5	2.3	3.2	4.3	5.5	6.0	6.4	6.7
5600	–	–	–	1.7	2.5	3.5	4.5	5.6	5.9	6.2
5800	–	–	–	–	1.9	2.7	3.7	4.7	5.5	5.8
6000	–	–	–	–	–	2.1	2.9	3.9	4.9	5.4
6200	–	–	–	–	–	1.5	2.3	3.1	4.0	5.0
6400	–	–	–	–	–	–	1.7	2.4	3.2	4.2
6600	–	–	–	–	–	–	–	1.8	2.6	3.4
6800	–	–	–	–	–	–	–	–	1.9	2.7
7000	–	–	–	–	–	–	–	–	–	2.1
7200	–	–	–	–	–	–	–	–	–	1.5

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.95mm FLATDECK – DOUBLE AND END SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm^2/m width)

	Slab Thickness (D_s) mm									
L (mm)	110	120	130	140	150	160	170	180	190	200
2000	**22.6** H16@250	**24.4** H16@300								
2200	**19.3** H16@250	**20.8** H16@250	**22.4** H16@300							
2400	**16.7** H16@250	**18.1** H16@250	**19.5** H16@250	**21.0** H16@300	**22.4** H16@300					
2600	**14.8** H16@200	**16.0** H16@250	**17.2** H16@250	**18.4** H16@250	**19.7** H16@300	**21.0** H16@300	**22.2** H16@300			
2800	**13.1** H16@200	**14.2** H16@250	**15.3** H16@250	**16.4** H16@250	**17.5** H16@250	**18.5** H16@300	**19.8** H16@300	**20.9** H16@300	**22.1** H16@300	
3000	**11.8** H16@200	**12.7** H16@200	**13.7** H16@250	**14.7** H16@250	**15.7** H16@250	**16.7** H16@250	**17.7** H16@250	**18.7** H16@250	**19.8** H16@250	**20.8** H16@300
3200	**10.6** H16@200	**11.5** H16@200	**12.4** H16@200	**13.3** H16@250	**14.2** H16@250	**15.1** H16@250	**16.0** H16@250	**16.9** H16@250	**17.8** H16@250	**18.8** H16@250
3400	**9.3** H16@200	**10.4** H16@200	**11.2** H16@200	**12.0** H16@200	**12.9** H16@200	**13.7** H16@250	**14.5** H16@250	**15.4** H16@250	**16.2** H16@250	**17.1** H16@250
3600	**7.7** H16@200	**9.5** H16@200	**10.2** H16@200	**11.0** H16@200	**11.7** H16@200	**12.5** H16@200	**13.3** H16@250	**14.1** H16@250	**14.8** H16@250	**15.6** H16@250
3800	**6.3** H16@200	**8.2** H16@200	**9.4** H16@200	**10.1** H16@200	**10.8** H16@200	**11.5** H16@200	**12.2** H16@200	**12.9** H16@200	**13.6** H16@250	**14.3** H16@250
4000	**5.2** H16@200	**6.8** H16@200	**8.6** H16@200	**9.3** H16@200	**9.9** H16@200	**10.6** H16@200	**11.2** H16@200	**11.8** H16@200	**12.5** H16@200	**13.2** H16@200
4200	**4.3** H16@200	**5.7** H16@200	**7.2** H16@200	**8.5** H16@200	**9.1** H16@200	**9.7** H16@200	**10.3** H16@200	**10.9** H16@200	**11.5** H16@200	**12.2** H16@200
4400	**3.5** H16@200	**4.7** H16@200	**6.0** H16@200	**7.6** H16@200	**8.5** H16@200	**9.0** H16@200	**9.6** H16@200	**10.1** H16@200	**10.7** H16@200	**11.3** H16@200
4600	**2.8** H16@200	**3.9** H16@200	**5.0** H16@200	**6.4** H16@200	**7.6** H16@200	**8.4** H16@200	**8.9** H16@200	**9.4** H16@200	**9.9** H16@200	**10.5** H16@200
4800	**2.2** H16@200	**3.1** H16@200	**4.2** H16@200	**5.3** H16@200	**6.7** H16@200	**7.5** H16@200	**8.2** H16@200	**8.7** H16@200	**9.2** H16@200	**9.7** H16@200
5000	**1.7** H16@200	**2.5** H16@200	**3.4** H16@200	**4.4** H16@200	**5.6** H16@200	**6.6** H16@200	**7.3** H16@200	**7.9** H16@200	**8.6** H16@200	**9.2** H16@200
5200		**2.0** H16@200	**2.8** H16@200	**3.7** H16@200	**4.7** H16@200	**5.8** H16@200	**6.4** H16@200	**7.1** H16@200	**7.7** H16@200	**8.3** H16@200
5400			**2.2** H16@200	**3.0** H16@200	**3.9** H16@200	**4.9** H16@200	**5.8** H16@200	**6.4** H16@200	**6.9** H16@200	**7.4** H16@200
5600			**1.6** H16@200	**2.4** H16@200	**3.4** H16@200	**4.3** H16@200	**5.2** H16@200	**5.6** H16@200	**6.1** H16@200	**7.5** H16@100
5800				**2.1** H16@200	**2.8** H16@200	**3.6** H16@200	**4.5** H16@200	**5.0** H16@200	**5.5** H16@200	**7.1** H16@100
6000				**1.6** H16@200	**2.3** H16@200	**3.0** H16@200	**3.8** H16@200	**4.4** H16@200	**4.8** H16@200	**6.6** H16@100
6200					**1.7** H16@200	**2.4** H16@200	**3.6** H16@100	**3.9** H16@200	**4.3** H16@200	**6.2** H16@100
6400						**1.9** H16@200	**3.0** H16@100	**3.8** H16@100	**3.8** H16@200	**5.6** H16@100
6600							**2.4** H16@100	**3.2** H16@100	**3.9** H16@100	**4.8** H16@100
6800							**1.9** H16@100	**2.6** H16@100	**3.3** H16@100	**4.1** H16@100
7000								**2.0** H16@100	**2.7** H16@100	**3.4** H16@100
7200									**2.4** H16@100	**3.0** H16@100

3.4.5 FLATDECK COMPOSITE SLAB LOAD SPAN TABLES *continued*

0.95mm FLATDECK – INTERNAL SPANS

Medium and Long Term Superimposed Loads (kPa) and Negative Reinforcement (mm²/m width)

	Slab Thickness (D_s) mm									
L (mm)	110	120	130	140	150	160	170	180	190	200
2000	**21.3** H16@300	**23.0** H16@300								
2200	**18.2** H16@300	**19.7** H16@300	**21.2** H16@300	**22.6** H16@300						
2400	**15.7** H16@300	**17.0** H16@300	**18.5** H16@300	**19.8** H16@300	**21.1** H16@300	**22.4** H16@300				
2600	**14.0** H16@250	**15.1** H16@300	**16.2** H16@300	**17.4** H16@300	**18.6** H16@300	**19.8** H16@300	**21.0** H16@300	**22.1** H16@300		
2800	**12.4** H16@250	**13.4** H16@250	**14.5** H16@300	**15.5** H16@300	**16.6** H16@300	**17.6** H16@300	**18.6** H16@300	**19.7** H16@300	**20.8** H16@300	**21.9** H16@300
3000	**11.1** H16@250	**12.0** H16@250	**12.9** H16@250	**13.9** H16@300	**14.9** H16@300	**15.7** H16@300	**16.7** H16@300	**17.7** H16@300	**18.6** H16@300	**19.6** H16@300
3200	**10.0** H16@250	**10.8** H16@250	**11.6** H16@250	**12.5** H16@250	**13.3** H16@300	**14.2** H16@300	**15.1** H16@300	**16.0** H16@300	**16.8** H16@300	**17.8** H16@300
3400	**8.5** H16@200	**9.8** H16@250	**10.6** H16@250	**11.4** H16@250	**12.2** H16@250	**12.9** H16@250	**13.7** H16@300	**14.5** H16@300	**15.3** H16@300	**16.1** H16@300
3600	**6.9** H16@200	**8.9** H16@200	**9.7** H16@250	**10.4** H16@250	**11.1** H16@250	**11.8** H16@250	**12.5** H16@250	**13.3** H16@250	**14.0** H16@300	**14.7** H16@300
3800	**5.7** H16@200	**7.4** H16@200	**8.8** H16@200	**9.5** H16@250	**10.2** H16@250	**10.8** H16@250	**11.5** H16@250	**12.2** H16@250	**12.8** H16@250	**13.5** H16@250
4000	**4.6** H16@200	**6.1** H16@200	**7.8** H16@200	**8.7** H16@200	**9.3** H16@250	**10.0** H16@250	**10.6** H16@250	**11.2** H16@250	**11.8** H16@250	**12.4** H16@250
4200	**3.7** H16@200	**5.0** H16@200	**6.5** H16@200	**8.0** H16@200	**8.6** H16@200	**9.2** H16@250	**9.7** H16@250	**10.3** H16@250	**10.9** H16@250	**11.4** H16@250
4400	**3.0** H16@200	**4.1** H16@200	**5.3** H16@200	**6.8** H16@200	**8.0** H16@200	**8.5** H16@200	**9.0** H16@250	**9.5** H16@250	**10.1** H16@250	**10.6** H16@250
4600	**2.3** H16@200	**3.3** H16@200	**4.4** H16@200	**5.6** H16@200	**7.0** H16@200	**7.9** H16@200	**8.3** H16@200	**8.8** H16@200	**9.3** H16@250	**9.8** H16@250
4800	**1.8** H16@200	**2.6** H16@200	**3.6** H16@200	**4.6** H16@200	**5.9** H16@200	**7.2** H16@200	**7.8** H16@200	**8.2** H16@200	**8.7** H16@200	**9.1** H16@200
5000		**2.0** H16@200	**2.8** H16@200	**3.8** H16@200	**4.9** H16@200	**6.1** H16@200	**7.2** H16@200	**7.6** H16@200	**8.1** H16@200	**8.6** H16@200
5200			**2.2** H16@200	**3.0** H16@200	**4.0** H16@200	**5.0** H16@200	**6.2** H16@200	**7.2** H16@200	**7.6** H16@200	**8.0** H16@200
5400			**1.6** H16@200	**2.4** H16@200	**3.2** H16@200	**4.1** H16@200	**5.4** H16@200	**6.6** H16@200	**7.1** H16@200	**7.5** H16@200
5600				**1.7** H16@200	**2.8** H16@200	**3.6** H16@200	**4.6** H16@200	**5.6** H16@200	**6.7** H16@200	**7.0** H16@200
5800					**2.2** H16@200	**3.0** H16@200	**3.8** H16@200	**4.7** H16@200	**6.3** H16@100	**6.6** H16@200
6000					**1.6** H16@200	**2.4** H16@200	**3.5** H16@100	**3.9** H16@200	**5.4** H16@100	**6.2** H16@100
6200						**1.7** H16@200	**2.9** H16@100	**3.7** H16@100	**4.5** H16@100	**5.8** H16@100
6400						**1.1** H16@200	**2.2** H16@100	**3.0** H16@100	**3.8** H16@100	**4.6** H16@100
6600							**1.6** H16@100	**2.3** H16@100	**3.1** H16@100	**3.9** H16@100
6800								**1.7** H16@100	**2.4** H16@100	**3.2** H16@100
7000									**1.7** H16@100	**2.4** H16@100
7200										**2.1** H16@100

3.4.6 FIRE DESIGN TABLES

INTRODUCTION

Fire resistance ratings are given for slab thicknesses between 110mm and 160mm, plus 180mm and 200mm slabs, for single spans between 2.0m and 7.2m with live loads of 3 kPa to 5 kPa.

Fire resistance ratings can also be adjusted for loads of 1.5 kPa and 2.5 kPa, refer Note 4 below.

The following notes apply to the Flatdeck flooring fire design tables in this section.

1. The fire resistance ratings tabulated are equivalent times in minutes of exposure to the standard fire test (NZS/BS 476) that satisfy the criteria for insulation, integrity and stability based on simply supported spans. Fire resistance ratings shown in ***bold italics*** are limited by insulation criteria. The beneficial effects of continuous spans and/or negative reinforcement at supports may be accounted for by specific design.
2. L is the span measured centre to centre between permanent supports.
3. The fire resistance ratings given are based on the following conditions. If design conditions differ from the following, specific design will be required.
   - The minimum cover to the fire reinforcement is 25mm to the bottom of the profile.
   - A superimposed dead load (G_{SDL}) of 0.5 kPa has been included. Where G_{SDL} is greater than 0.5 kPa specific design to HERA Report R4-82 is required.
   - The self weight of the Flatdeck slab is based on a concrete density of 2350 kg/m^3 and an allowance of 5% for concrete ponding during construction.
   - The long term live load factor (AS 1170.0) used for 5 kPa live load is 0.6. For all other live loads 0.4 has been used.
   - Specified concrete strength, f'_c = 25 MPa and Type A aggregate.
   - Reinforcement is grade 500 to AS/NZS 4671 and is assumed to be continuous over the length of the clear span.
   - Design moment capacity of the concrete slab is calculated in accordance with NZS 3101.
   - Contribution to fire resistance from the Flatdeck steel decking has been included as noted in Section 3.4.2 Design Considerations.
4. Live loads less than 3 kPa.
   - For a live load of 2.5 kPa, increase FRR by 4 minutes for the corresponding live load, span and slab thickness published for the 3 kPa live load, provided that the fire resistance rating is not limited by insulation criteria.
   - For a live load of 1.5 kPa, increase FRR by 12 minutes for the corresponding live load, span and slab thickness published for the 3 kPa live load, provided that the fire resistance rating is not limited by insulation criteria.
5. For intermediate values linear interpolation is permitted provided that the two values are within the extent of the tables. For example, interpolation can be used to derive the fire resistance ratings for 170mm and 190mm overall slab thicknesses.
6. Fire resistance ratings have been provided for spans up to where a value of G_{SDL} + Q = 1.5 kPa can be achieved from the Load Span tables in Section 3.4.5. Therefore these fire resistance rating tables must be used in conjunction with Section 3.4.5 Flatdeck Composite Slab Load Span Tables as satisfaction of fire resistance rating does not always ensure the load capacity and deflection criteria are met.

Continued on next page

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200
110	3	no additional reinforcing										***120***	114	104	93	82	71	58	
		H10 every 3rd pan												***120***	116	108	97	88	78
		H12 every 3rd pan													***120***	117	108	98	88
		H12 every 2nd pan															***120***	112	102
		H16 every 3rd pan																***120***	112
		H16 every 2nd pan																	***120***
	4	no additional reinforcing									***120***	116	105	94	83	71	57		
		H10 every 3rd pan											***120***	117	108	97	87	77	
		H12 every 3rd pan												***120***	117	108	97	87	77
		H12 every 2nd pan														***120***	111	102	92
		H16 every 3rd pan															***120***	111	101
		H16 every 2nd pan																	***120***
	5	no additional reinforcing							***120***	113	100	88	75	60					
		H10 every 3rd pan									***120***	112	100	89	77				
		H12 every 3rd pan										***120***	110	99	88	76			
		H12 every 2nd pan											***120***	113	102	91	80		
		H16 every 3rd pan												***120***	112	101	90		
		H16 every 2nd pan														***120***	111	101	90
		H12 every pan														***120***	115	105	95
		H16 every pan																	***120***

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																	
			2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600
120	3	no additional reinforcing										≥120	114	105	94	83	72	60		
		H10 every 3rd pan												≥120	117	108	99	89	80	
		H12 every 3rd pan													≥120	117	109	99	90	81
		H12 every 2nd pan															≥120	113	104	95
		H16 every 3rd pan																≥120	114	105
		H16 every 2nd pan																		≥120
	4	no additional reinforcing									≥120	116	106	95	84	73	59			
		H10 every 3rd pan											≥120	118	109	99	89	79		
		H12 every 3rd pan												≥120	118	109	99	89	78	
		H12 every 2nd pan														≥120	113	104	94	85
		H16 every 3rd pan															≥120	113	104	95
		H16 every 2nd pan																	≥120	116
	5	no additional reinforcing							≥120	113	101	89	76	62						
		H10 every 3rd pan									≥120	113	102	90	79					
		H12 every 3rd pan										≥120	112	101	90	79				
		H12 every 2nd pan											≥120	114	104	94	83			
		H16 every 3rd pan												≥120	114	103	93			
		H16 every 2nd pan														≥120	114	105	95	85
		H12 every pan														≥120	118	108	99	89
		H16 every pan																		≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																			
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800
130	3	no additional reinforcing												≥120	113	104	93	83	72	59		
		H10 every 3rd pan														≥120	116	108	98	89	80	
		H12 every 3rd pan															≥120	117	109	99	90	81
		H12 every 2nd pan																	≥120	113	105	96
		H16 every 3rd pan																		≥120	114	106
		H16 every 2nd pan																				≥120
		H12 every pan																				
	4	no additional reinforcing											≥120	115	105	94	83	72	59			
		H10 every 3rd pan													≥120	117	108	99	89	79		
		H12 every 3rd pan														≥120	117	109	99	90	80	
		H12 every 2nd pan																≥120	113	104	95	86
		H16 every 3rd pan																	≥120	114	105	96
		H16 every 2nd pan																			≥120	117
		H12 every pan																				≥120
	5	no additional reinforcing									≥120	112	100	88	75	62						
		H10 every 3rd pan											≥120	112	101	91	80					
		H12 every 3rd pan												≥120	111	101	90	80				
		H12 every 2nd pan													≥120	114	105	95	85			
		H16 every 3rd pan														≥120	114	105	94	84		
		H16 every 2nd pan																≥120	116	107	97	88
		H12 every pan																≥120	119	110	101	92
		H16 every pan																				≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200
140	3	no additional reinforcing												≥120	111	101	91	81	70	57			
		H10 every 3rd pan														≥120	115	106	97	88	79		
		H12 every 3rd pan															≥120	116	108	98	89	81	
		H12 every 2nd pan																	≥120	112	104	95	87
		H16 every 3rd pan																		≥120	114	106	96
		H16 every 2nd pan																				≥120	118
		H12 every pan																					≥120
		H16 every pan																					
	4	no additional reinforcing											≥120	112	103	92	81	70	57				
		H10 every 3rd pan													≥120	115	107	97	88	78			
		H12 every 3rd pan														≥120	116	108	98	89	80		
		H12 every 2nd pan																≥120	112	104	95	86	77
		H16 every 3rd pan																	≥120	113	105	96	87
		H16 every 2nd pan																			≥120	117	109
		H12 every pan																				≥120	112
		H16 every pan																					≥120
	5	no additional reinforcing								≥120	119	109	98	86	74	60							
		H10 every 3rd pan											≥120	111	100	89	79						
		H12 every 3rd pan												≥120	110	100	90	79					
		H12 every 2nd pan													≥120	113	104	94	84				
		H16 every 3rd pan														≥120	114	104	94	85			
		H16 every 2nd pan																≥120	116	107	98	89	
		H12 every pan																	≥120	110	102	93	84
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400
150	3	no additional reinforcing											≥120	117	108	98	88	78	67				
		H10 every 3rd pan														≥120	112	104	95	86	77		
		H12 every 3rd pan															≥120	113	105	96	88	79	
		H12 every 2nd pan																≥120	118	110	102	94	86
		H16 every 3rd pan																		≥120	112	104	96
		H16 every 2nd pan																				≥120	117
		H12 every pan																					≥120
	4	no additional reinforcing										≥120	119	110	100	89	79	67					
		H10 every 3rd pan													≥120	113	105	95	86	76			
		H12 every 3rd pan														≥120	114	106	96	88	78		
		H12 every 2nd pan															≥120	118	110	102	93	85	76
		H16 every 3rd pan																	≥120	112	104	95	86
		H16 every 2nd pan																			≥120	116	109
		H12 every pan																			≥120	119	112
		H16 every pan																					≥120
	5	no additional reinforcing								≥120	116	106	95	83	71	56							
		H10 every 3rd pan										≥120	118	108	98	88	77						
		H12 every 3rd pan											≥120	117	108	98	88	78					
		H12 every 2nd pan													≥120	112	103	94	84				
		H16 every 3rd pan														≥120	112	103	94	84			
		H16 every 2nd pan																≥120	115	107	98	89	
		H12 every pan																≥120	118	110	101	93	84
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800
160	3	no additional reinforcing										≥120	113	104	94	85	74	62					
		H10 every 3rd pan												≥120	117	110	101	92	83	74			
		H12 every 3rd pan													≥120	118	111	103	94	85	77		
		H12 every 2nd pan															≥120	116	108	100	92	84	76
		H16 every 3rd pan																≥120	118	110	102	94	86
		H16 every 2nd pan																			≥120	116	108
		H12 every pan																			≥120	118	111
		H16 every pan																					≥120
	4	no additional reinforcing									≥120	115	106	96	86	75	63						
		H10 every 3rd pan											≥120	118	110	102	92	83	74				
		H12 every 3rd pan												≥120	119	111	103	94	85	76			
		H12 every 2nd pan														≥120	116	108	100	91	83		
		H16 every 3rd pan															≥120	118	110	102	93	85	
		H16 every 2nd pan																		≥120	115	108	99
		H12 every pan																		≥120	117	110	103
		H16 every pan																					≥120
	5	no additional reinforcing							≥120	113	102	91	79	67									
		H10 every 3rd pan									≥120	114	105	95	85	74							
		H12 every 3rd pan										≥120	115	106	96	86	76						
		H12 every 2nd pan											≥120	118	110	100	91	82					
		H16 every 3rd pan												≥120	119	111	101	92	83				
		H16 every 2nd pan															≥120	114	106	97	88		
		H12 every pan															≥120	116	109	100	92	84	76
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800	7000	7200
180	3	no additional reinforcing									≥120	113	105	95	85	75	64						
		H10 every 3rd pan											≥120	118	110	102	93	85	76				
		H12 every 3rd pan												≥120	119	112	104	95	87	79			
		H12 every 2nd pan														≥120	117	110	102	94	86	78	
		H16 every 3rd pan															≥120	119	112	104	96	89	
		H16 every 2nd pan																		≥120	118	111	104
		H12 every pan																			≥120	113	107
		H16 every pan																					≥120
	4	no additional reinforcing								≥120	115	107	97	87	77	65							
		H10 every 3rd pan										≥120	119	111	103	94	85	76					
		H12 every 3rd pan												≥120	113	105	96	87	79				
		H12 every 2nd pan													≥120	117	110	102	94	86	78		
		H16 every 3rd pan															≥120	112	104	96	88		
		H16 every 2nd pan																	≥120	117	110	103	95
		H12 every pan																		≥120	113	106	99
		H16 every pan																					≥120
	5	no additional reinforcing						≥120	114	104	93	82	70	55									
		H10 every 3rd pan								≥120	116	107	98	88	78								
		H12 every 3rd pan									≥120	116	108	98	88	79							
		H12 every 2nd pan											≥120	112	104	95	86	77					
		H16 every 3rd pan												≥120	113	104	96	87					
		H16 every 2nd pan														≥120	117	110	101	93	85		
		H12 every pan															≥120	112	105	97	89	81	
		H16 every pan																				≥120	119

3.4.6 FIRE DESIGN TABLES *continued*

0.75mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800	7000	7200
200	3	no additional reinforcing										≥120	112	103	94	84	74	63					
		H10 every 3rd pan												≥120	117	110	101	93	84	76			
		H12 every 3rd pan													≥120	118	111	103	95	87	79		
		H12 every 2nd pan															≥120	116	109	102	94	86	79
		H16 every 3rd pan																≥120	119	112	105	97	89
		H16 every 2nd pan																			≥120	118	112
		H12 every pan																				≥120	114
		H16 every pan																					≥120
	4	no additional reinforcing									≥120	114	106	96	86	76	65						
		H10 every 3rd pan											≥120	118	111	103	94	85	76				
		H12 every 3rd pan													≥120	112	105	96	88	79			
		H12 every 2nd pan														≥120	117	110	102	94	86	79	
		H16 every 3rd pan																≥120	112	105	97	89	
		H16 every 2nd pan																		≥120	118	111	104
		H12 every pan																			≥120	114	107
		H16 every pan																					≥120
	5	no additional reinforcing							≥120	113	103	93	82	70	56								
		H10 every 3rd pan									≥120	116	108	98	88	79							
		H12 every 3rd pan										≥120	116	108	99	90	81						
		H12 every 2nd pan												≥120	113	105	96	87	79				
		H16 every 3rd pan													≥120	115	107	98	89				
		H16 every 2nd pan															≥120	119	111	104	96	88	
		H12 every pan																≥120	114	107	99	91	84
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																	
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400
110	3	no additional reinforcing												***120***	117	108	98	89	79	68
		H10 every 3rd pan														***120***	117	109	99	90
		H12 every 3rd pan															***120***	116	108	98
		H12 every 2nd pan																***120***	118	110
		H16 every 3rd pan																	***120***	118
		H16 every 2nd pan																		***120***
	4	no additional reinforcing											***120***	118	109	98	88	78	67	
		H10 every 3rd pan													***120***	117	108	98	89	79
		H12 every 3rd pan														***120***	116	107	97	88
		H12 every 2nd pan															***120***	118	109	100
		H16 every 3rd pan																***120***	117	108
		H16 every 2nd pan																		***120***
	5	no additional reinforcing									***120***	113	101	90	78	66				
		H10 every 3rd pan										***120***	119	110	99	88	77			
		H12 every 3rd pan											***120***	117	107	96	86	75		
		H12 every 2nd pan												***120***	118	108	98	88	78	
		H16 every 3rd pan													***120***	116	106	95	85	
		H16 every 2nd pan															***120***	114	104	94
		H12 every pan															***120***	117	108	98
		H16 every pan																		***120***

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																	
			2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600
120	3	no additional reinforcing												≥120	118	110	100	91	81	71
		H10 every 3rd pan														≥120	118	111	102	93
		H12 every 3rd pan															≥120	118	110	101
		H12 every 2nd pan																	≥120	113
		H16 every 3rd pan																		≥120
		H16 every 2nd pan																		
	4	no additional reinforcing											≥120	119	110	100	91	81	70	58
		H10 every 3rd pan													≥120	118	110	101	92	83
		H12 every 3rd pan														≥120	118	109	100	91
		H12 every 2nd pan																≥120	112	103
		H16 every 3rd pan																	≥120	112
		H16 every 2nd pan																		≥120
	5	no additional reinforcing									≥120	114	104	92	81	69				
		H10 every 3rd pan											≥120	112	101	91	81			
		H12 every 3rd pan											≥120	119	110	99	89	79		
		H12 every 2nd pan													≥120	111	101	92	82	
		H16 every 3rd pan													≥120	119	110	100	90	
		H16 every 2nd pan															≥120	118	109	99
		H12 every pan																≥120	112	103
		H16 every pan																		≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000
130	3	no additional reinforcing														≥120	118	110	101	91	82	72	61
		H10 every 3rd pan																≥120	119	111	103	94	85
		H12 every 3rd pan																	≥120	118	111	102	94
		H12 every 2nd pan																			≥120	114	106
		H16 every 3rd pan																				≥120	114
		H16 every 2nd pan																					≥120
	4	no additional reinforcing													≥120	119	110	101	91	81	71	59	
		H10 every 3rd pan															≥120	119	111	102	93	84	75
		H12 every 3rd pan																≥120	118	110	101	93	84
		H12 every 2nd pan																		≥120	113	105	96
		H16 every 3rd pan																			≥120	113	105
		H16 every 2nd pan																					≥120
	5	no additional reinforcing											≥120	114	104	93	82	71	57				
		H10 every 3rd pan													≥120	112	102	92	82	72			
		H12 every 3rd pan														≥120	111	101	91	81			
		H12 every 2nd pan															≥120	112	103	94	84		
		H16 every 3rd pan																≥120	112	102	93	83	
		H16 every 2nd pan																		≥120	112	103	93
		H12 every pan																		≥120	114	106	97
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400
140	3	no additional reinforcing													≥120	117	109	100	91	81	72	61	
		H10 every 3rd pan															≥120	118	110	102	94	85	77
		H12 every 3rd pan																≥120	118	110	102	94	86
		H12 every 2nd pan																	≥120	121	113	106	98
		H16 every 3rd pan																			≥120	114	107
		H16 every 2nd pan																					≥120
		H12 every pan																					
		H16 every pan																					
	4	no additional reinforcing												≥120	118	109	100	91	81	71	59		
		H10 every 3rd pan														≥120	118	110	102	93	84	75	
		H12 every 3rd pan															≥120	118	110	101	93	84	76
		H12 every 2nd pan																	≥120	113	105	97	89
		H16 every 3rd pan																		≥120	113	105	97
		H16 every 2nd pan																				≥120	116
		H12 every pan																				≥120	118
		H16 every pan																					≥120
	5	no additional reinforcing										≥120	113	103	92	82	70	57					
		H10 every 3rd pan												≥120	112	102	92	83	73				
		H12 every 3rd pan												≥120	119	110	101	91	82				
		H12 every 2nd pan														≥120	112	104	94	85	76		
		H16 every 3rd pan															≥120	112	103	94	85		
		H16 every 2nd pan																	≥120	113	104	95	87
		H12 every pan																	≥120	115	107	99	90
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600
150	3	no additional reinforcing													≥120	115	107	98	89	80	70	59	
		H10 every 3rd pan															≥120	116	109	101	92	84	76
		H12 every 3rd pan																≥120	116	109	101	93	85
		H12 every 2nd pan																		≥120	112	105	97
		H16 every 3rd pan																			≥120	113	106
		H16 every 2nd pan																					≥120
	4	no additional reinforcing												≥120	116	108	98	89	80	69	57		
		H10 every 3rd pan														≥120	117	109	100	92	83	74	
		H12 every 3rd pan															≥120	116	109	101	92	84	75
		H12 every 2nd pan																≥120	119	112	104	96	88
		H16 every 3rd pan																		≥120	113	105	97
		H16 every 2nd pan																				≥120	115
		H12 every pan																				≥120	118
		H16 every pan																					≥120
	5	no additional reinforcing										≥120	111	101	91	80	69	55					
		H10 every 3rd pan											≥120	119	110	101	91	82	72				
		H12 every 3rd pan												≥120	118	109	100	91	81				
		H12 every 2nd pan														≥120	112	103	94	85	76		
		H16 every 3rd pan															≥120	112	103	94	85		
		H16 every 2nd pan																	≥120	113	105	96	88
		H12 every pan																	≥120	115	107	99	91
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800	7000
160	3	no additional reinforcing												≥120	113	105	95	87	77	68	55		
		H10 every 3rd pan														≥120	114	107	99	90	82	74	
		H12 every 3rd pan															≥120	114	108	99	91	83	75
		H12 every 2nd pan																≥120	118	111	104	96	88
		H16 every 3rd pan																	≥120	119	112	105	97
		H16 every 2nd pan																				≥120	116
		H12 every pan																				≥120	118
		H16 every pan																					≥120
	4	no additional reinforcing											≥120	113	105	96	87	77	67				
		H10 every 3rd pan													≥120	114	107	98	90	81	73		
		H12 every 3rd pan														≥120	115	107	99	91	82		
		H12 every 2nd pan															≥120	118	110	103	95	87	79
		H16 every 3rd pan																≥120	118	111	104	96	88
		H16 every 2nd pan																			≥120	114	108
		H12 every pan																			≥120	117	110
		H16 every pan																					≥120
	5	no additional reinforcing								≥120	117	109	99	88	78	67							
		H10 every 3rd pan										≥120	117	109	99	90	80						
		H12 every 3rd pan											≥120	116	108	99	89	80					
		H12 every 2nd pan												≥120	118	110	102	93	84	76			
		H16 every 3rd pan													≥120	118	110	102	93	84			
		H16 every 2nd pan																≥120	112	104	96	88	
		H12 every pan																≥120	114	107	99	91	83
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800	7000	7200
180	3	no additional reinforcing												≥120	114	106	97	89	80	70	59		
		H10 every 3rd pan														≥120	116	109	101	93	85	77	
		H12 every 3rd pan															≥120	116	109	102	94	86	79
		H12 every 2nd pan																	≥120	113	106	99	91
		H16 every 3rd pan																		≥120	114	108	100
		H16 every 2nd pan																				≥120	118
		H12 every pan																					≥120
	4	no additional reinforcing											≥120	115	107	98	89	80	70	59			
		H10 every 3rd pan													≥120	116	109	101	93	85	76		
		H12 every 3rd pan														≥120	116	110	102	94	86	78	
		H12 every 2nd pan																≥120	113	106	98	91	83
		H16 every 3rd pan																	≥120	114	107	100	92
		H16 every 2nd pan																			≥120	118	111
		H12 every pan																				≥120	113
		H16 every pan																					≥120
	5	no additional reinforcing								≥120	119	111	102	92	82	71	59						
		H10 every 3rd pan										≥120	119	111	103	93	84	75					
		H12 every 3rd pan											≥120	119	111	102	93	85	76				
		H12 every 2nd pan													≥120	113	106	97	89	81			
		H16 every 3rd pan														≥120	114	106	98	90			
		H16 every 2nd pan																≥120	116	109	101	93	86
		H12 every pan																≥120	118	111	104	96	89
		H16 every pan																					≥120

3.4.6 FIRE DESIGN TABLES *continued*

0.95mm FLATDECK FLOOR SLAB – FIRE RESISTANCE RATINGS (minutes) FOR GRADE 500 REINFORCING STEEL

SLAB THICKNESS D_s (mm)	Q kPa	FIRE REINFORCING STEEL	SPAN OF FLATDECK SLAB (L) mm																				
			3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800	7000	7200
200	3	no additional reinforcing													≥120	113	106	97	89	80	71	60	
		H10 every 3rd pan															≥120	116	109	101	93	86	78
		H12 every 3rd pan																≥120	116	110	102	95	87
		H12 every 2nd pan																		≥120	113	107	100
		H16 every 3rd pan																			≥120	115	109
		H16 every 2nd pan																					≥120
	4	no additional reinforcing												≥120	114	107	98	90	81	71	60		
		H10 every 3rd pan														≥120	116	110	102	94	86	78	
		H12 every 3rd pan															≥120	117	110	103	95	87	79
		H12 every 2nd pan																	≥120	114	107	100	92
		H16 every 3rd pan																		≥120	115	109	101
		H16 every 2nd pan																				≥120	119
		H12 every pan																					≥120
	5	no additional reinforcing									≥120	119	111	102	93	83	73	61					
		H10 every 3rd pan												≥120	112	104	95	87	78				
		H12 every 3rd pan												≥120	119	112	104	96	87	79			
		H12 every 2nd pan														≥120	115	108	100	91	83	75	
		H16 every 3rd pan															≥120	116	109	101	92	84	
		H16 every 2nd pan																	≥120	118	112	104	97
		H12 every pan																		≥120	114	107	100
		H16 every pan																					≥120

3.4.7 NOISE CONTROL

3.4.7.1 SCOPE

This section provides guidelines for specifiers and constructors who require noise control systems for residential applications such as separate multi-unit dwellings or single dwellings, commercial applications such as retail spaces, offices and institutional buildings. It is not intended that these guidelines replace the need for specialist acoustic design to meet the specified sound insulation performance for the building.

A Flatdeck Noise Control System consists of a Flatdeck concrete slab with a selected USG ceiling system, GIB® standard plasterboard ceiling linings, selected floor coverings and the specific inclusion of a cavity absorber. It must be noted that the floor covering is an essential aspect of the performance of the system. This section must be read in conjunction with Section 3.3.7 Noise Control.

Information for the Flatdeck Noise Control System is based on acoustic opinions using laboratory testing of Hibond carried out by the University of Auckland, Acoustics Testing Service. For system specification including STC and IIC values for Flatdeck, please refer to the Hibond Noise Control System in Section 3.3.7 of this manual.

The Hibond Noise Control System specifications give at least the same STC and IIC values for the same overall slab thickness and system configuration as Flatdeck. For specific information regarding the Flatdeck Noise Control System contact Dimond on 0800 Roofspec (0800 766 377).

Acoustic opinions for the Flatdeck Noise Control System are contained in report Rp001 R00_2006476 by Marshall Day Acoustics Limited. This report is available on request for use as a producer statement supporting an alternative solution to the New Zealand Building Code.

The systems set out in this publication provide the stated sound transmission loss performances by opinion. However in practical applications on site there is a significant element of subjectivity to interpreting noise levels within rooms. No matter how low a sound level might be, if it is intrusive upon a person's privacy, then it is likely to cause annoyance. No practical system can guarantee complete sound insulation and completely satisfy everyone.

For more specific information about the fundamentals of sound, its propagation, noise control and detailing, reference should be made to the HERA Acoustic Guide, *HERA Report R4-121*.

3.4.7.2 FACTORS AFFECTING NOISE CONTROL

Layout Planning
A complete noise control solution is a synthesis of detailing and planning. Flatdeck Noise Control specifications only provide details of the floor/ceiling system components. The following recommendations will help ensure better noise control is achieved.

- Avoid positioning continuous steel beams under non-carpeted floors.
- Avoid positioning services in ceiling spaces of habitable rooms.
- Non-carpeted service areas should be placed adjacent to each other (vertically and horizontally).
- Locate noise sensitive bedrooms away from noise emission areas such as plant rooms, toilets etc.

Flanking
Overall noise control performance of the building is dependent on the surrounding structure having the same or greater performance than the Flatdeck Noise Control System. Special care in both design and construction must be taken at expansion joints, service penetrations and the junctions of Flatdeck floor/ceilings to walls and structural members to ensure that flanking transmission does not unduly degrade the sound insulation performance.

Continued on next page

3.4.7.2 FACTORS AFFECTING NOISE CONTROL *continued*

Substitution

Do not substitute! Flatdeck Noise Control Systems are not generic. It is most important that only the specified components are used when installing Flatdeck Noise Control Systems. Otherwise, the system performance may not meet the published ratings and may fail to meet customer satisfaction.

Substitution is not in accordance with Flatdeck Flooring System recommendations and is undertaken at the risk of the owner, specifier and builder.

For the Flatdeck Flooring System components, refer Section 3.4.13 Flatdeck Components.

For components supplied by other manufacturers including additional information on specifications, performance, installation, supply and costing etc, refer to manufacturers and distributors' information.

Various	Floor coverings (refer descriptions in Section 3.3.7.4 System Specifications)
USG (09 636 3680)	Strongback Channel (DJ38 or DJ75) Furring Strap (FS37) Furring Channel (FC37) Perimeter Channel (PC24)
Potter Interior Systems Ltd (0800 768 837)	Sound Isolation Clip (ST001-ADM) 2.5mm diameter galvanised wire Masonry suspension anchor (for wire attachment to composite slab)
Tasman Insulation (0800 802 287)	Fibreglass Insulation Blanket (density 9 kg/m^3 minimum)
Winstone Wallboards Ltd (0800 100 442)	13mm GIB® standard plasterboard
Bostik New Zealand Ltd (04 567 5119)	Bostik Ultraset Adhesive

Quality Control

When designing or building Flatdeck Noise Control Systems, strict attention to the specification, construction and workmanship is required. If the system is not constructed to the recommended details, sound insulation performance will be significantly degraded.

A documented process for checking materials and workmanship should be implemented as part of design and construction. It is recommended that in any multi-unit building at an early stage of the contract, a demonstration apartment be finished to second fix with door and ceilings in place and the airborne and impact sound performance tested and a pass achieved before the completion of any subsequent units.

In order to eliminate "weak spots", the Flatdeck Noise Control System must be fully completed for a particular room, including floor coverings, junctions of floor coverings to partitions, ceiling cavities, suspension systems, ceiling linings, light fittings and junctions of the Flatdeck Flooring System with walls or steel beams and partitions. Failure to observe these requirements will render the systems ineffective.

Continued on next page

3.4.7.2 FACTORS AFFECTING NOISE CONTROL *continued*

Building Services

Downlights and flush-mounted lighting boxes must be acoustically tested and approved as suitable for the specific application in order to ensure that the sound insulation performances are not compromised. All ceiling penetrations have the potential to reduce performance. Plumbing pipe work installed using bends with generous radii, smooth bores and tapered joints will reduce the generation of plumbing noise caused by turbulence. The transfer of plumbing noise may be reduced by isolating elements such as the use of resilient pipe clips and heavy pipe wraps. Plumbing systems designed to prevent excessive pressure, water hammer, splashing, thermal movement of pipes, aeration or appliance noise will complement Flatdeck Noise Control Systems by reducing the noise generated by these installations.

3.4.7.3 SYSTEM SELECTION

Selecting a System

When selecting a Flatdeck Noise Control System the following questions should be considered.

1. The Market Sector and Zone, which best describes the situation.
2. Is code compliance necessary?
3. What will the occupants find satisfactory?

If code compliance is necessary, then a system with a STC and IIC rating of at least 55 must be selected.

If code compliance is not required for the floor ceiling, then occupant satisfaction must be assessed and the performance specified accordingly.

It should be noted that code compliance may not constitute satisfaction. The building code should be treated as a minimum standard. Many people will not be satisfied by a system that merely satisfies NZBC Clause G6 (STC and IIC 55). For this reason Flatdeck Noise Control Systems offer the option of many differently performing systems including those which considerably exceed building code requirements.

The following guide shows relative perception of loudness and sound insulation performance:

- 1dB increase in insulation = very difficult to perceive change in sound level.
- 3dB increase in insulation = just perceivable change in sound level.
- 5dB increase in insulation = clearly noticeable decrease in sound level.
- 10dB increase in insulation = sound heard through construction is approximately half as loud.
- 20dB increase in insulation = sound heard through construction is approximately quarter as loud.
- The addition of an extra layer of 13 mm GIB® standard plasterboard could increase the system performance by 3 STC points and 2 IIC points.

STC and IIC values for the Flatdeck Noise Control System are based upon acoustic opinions and have a margin of error of +/– 2dB for STC and +/– 3dB for IIC.

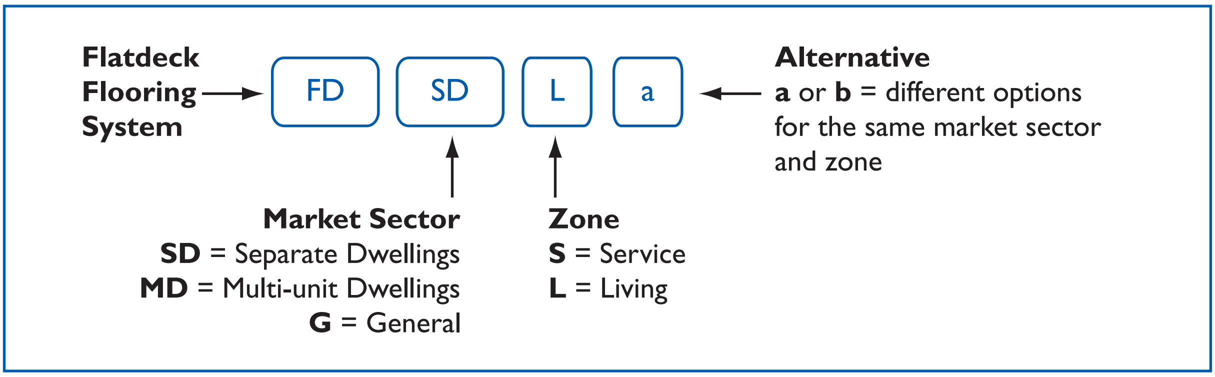
Call Dimond on 0800 Roofspec (0800 766 377) for further information on sound insulation performance for composite slabs other than 120mm overall thickness.

3.4.7.3 SYSTEM SELECTION *continued*

System Specification Reference

Reference codes for each system are marked on the top right hand corner of each system specification. The intent of the specification reference is to allow designers to include a single unique code on a contract drawing. It is a quick concise means of identifying a system comprised of a number of subsystems and components. These codes are:

System reference example: FDSDLa



The system specification codes contain certain items which have the following particular meanings:

General: Use of Flatdeck in non-specific applications including garages, retail spaces without ceilings and other spaces without ceiling linings.

Separate Dwelling: A typical New Zealand house which is a single dwelling on a section and isolated from other buildings.

Multi-unit Dwelling: A residential occupancy in a multi-unit building requiring compliance with NZBC Clause G6.

Living Zone: Habitable rooms such as kitchens, bedrooms, lounge, dining room and study.

Service Zone: Non-habitable rooms such as laundries, bathrooms, showers and toilets.

3.4.7.4 GLOSSARY OF ACOUSTIC TERMS

Absorption: The ability of a material to dissipate sound energy.

Acoustic: Concerned with the sense of hearing and includes both reverberant and transmitted sound energy.

Airborne Sound: Sound energy transmitted through the air.

dB: The abbreviation for the sound pressure level measurement decibel. A decibel is a tenth of the logarithmic ratio Bel.

Flanking: The situation whereby sound energy is transmitted around a sound insulated wall or floor/ceiling.

IIC: The abbreviation for "Impact Insulation Class". A single figure descriptor for the structure borne insulation capability of a wall or floor/ceiling.

Structure Borne Sound: Sound energy transmitted through a solid, e.g. the building structure or service pipes.

ISO: The abbreviation for The International Organisation for Standardisation. The name has its origins in the Greek word "isos" meaning equal.

Noise: Subjective sound, merely heard, usually unwanted, contains listener information and may be annoying.

Reverberation: The continuation of sound reflections in a space after the sound source has ceased.

Sound: An audible air vibration from a source which is detected by the sense of hearing.

STC: The abbreviation for "Sound Transmission Class", a single figure descriptor for the continuous airborne sound insulation capability of a wall or floor/ceiling over the speech frequency range. In general the higher the STC the better the performance. The third octave range used is 125 to 4000 Hz.

Subjectivity: Related to interpretation of acoustic input by the brain and the auditory sense organ rather than to direct physical phenomena.

Transmission Loss: The difference in the reverberant sound pressure levels between source and receiving rooms on opposite sides of a wall or floor/ceiling.

3.4.8 FLOOR VIBRATION

It is important to note that the subject of floor vibration is complicated in nature. It is not a precise science and assessment of parameters such as floor damping ratio, ambient floor loads and possible future uses of the floor can be highly subjective in reality – what is acceptable for one occupant may not be acceptable for another.

All structures may be subject to vibration from human activity or mechanical oscillation, with increasing thresholds of acceptance from floors used in operating rooms through offices/residences to shopping malls/dance halls and floors used for group rhythmic activities.

Resonance occurs when the frequency of the dynamic loadings on the floor approaches the natural frequency of vibration of the floor system. The effect of resonance may result in damage to finishes and structure alike and therefore it must be considered in the assessment of floor vibration. The natural frequency of Flatdeck floor slabs will typically fall within the 4 to 12 Hz frequency range.

Design for walking vibration considers the control of peak floor accelerations through damping provided by the floor panel along with the floor panel mass and stiffness. Design for rhythmic vibration considers control of peak floor accelerations by increasing the natural frequency of the floor to more than 20% above the driving frequency of the activity along with controlling higher mode effects using the floor panel mass and damping.

For a detailed explanation of floor vibration, reference should be made to HERA Report R4-141 and HERA Report R4-113 Session 3.4.

The best way to illustrate the design process for floor vibration is by example using the procedures outlined in HERA Report R4-141 and HSSS2000 (HERA Steel Structures Seminar 2000).

A vibration check is required for a 0.75mm Flatdeck floor to satisfy the criteria for vibration due to walking. The Flatdeck floor will support an open plan office with only low damping available from demountable partitions. It has a single span, L, between blockwork walls of 5.6m and an overall thickness of 150mm.

This example covers the vibration characteristics of the composite floor slab only. It assumes the floor spans between rigid supports such as concrete or block walls. If the slab is supported on flexible supports such as steel beams then a further vibration check needs to be made for the combined slab/beam system – refer HERA Report R4-141. However the vibration check that follows provides a method of checking whether the slab itself is adequate. Note that the first indication that the floor selected may be vibration sensitive can be seen from the dashed line on the Flatdeck Composite Slab Load Span Tables in Section 3.4.5.

Continued on next page

3.4.8 FLOOR VIBRATION *continued*

In order to assess the vibration criteria of the slab we need to know its natural frequency of vibration and its peak acceleration under a constant walking force. The *natural floor frequency* is assessed from the static deflection of the floor under ambient load conditions, which requires the longitudinal floor stiffness to be calculated.

Longitudinal floor stiffness $D_{par} = E_s I_x$

where E_s = Young's modulus for steel = 205 GPa

I_x = gross transformed second moment of area of slab in the direction of span = 49.2×10^6 mm^4/m

calculated from first principles using steel/concrete dynamic

modular ratio $n = E_s/(1.35E_c)$ (Refer HSSS2000)

$= 205 / (1.35 \times 24)$

$= 6.33$

where E_c = 24 GPa = Modulus of Elasticity for concrete (from NZS 3101)

Therefore $D_{par} = E_s I_x = 205 \times 49.2 \times 10^6$

$= 10.1 \times 10^9$ kNmm^2/m

Static deflection of slab = $\Delta = 5 \times w \times L^4 / (384 \times E_s I_x)$

Total static UDL, $w = 0.35 + 0.2 + 3.55 = 4.10$ kN/m

where 0.35 = ambient live load (Refer HERA Report R4-141 Table 5)

0.2 = ambient superimposed dead load (Refer HERA Report R4-141 Table 5)

3.55 = dead load slab excluding ponding of wet concrete (Refer Section 3.4.3 Flatdeck Section Properties)

therefore, midspan deflection under this UDL,

$\Delta = 5 \times 4.10 \times 5.6^4 \times 10^9/(384 \times 10.1 \times 10^9)$

$= 5.2$mm

Natural floor frequency, $f_n = 0.18 \times (g/\Delta)^{0.5}$ (Refer HSSS2000)

where g = acceleration due to gravity = 9810mm/sec^2

$= 0.18 \times (9810/5.2)^{0.5}$

$= 7.8$ Hz < 9 Hz so no minimum stiffness check required

Continued on next page

3.4.8 FLOOR VIBRATION *continued*

To calculate the *peak acceleration* of the floor under a constant walking force we must calculate the effective weight of the floor that is being vibrated by first estimating the effective floor panel width,

$B = C \times [D_{perp}/D_{par}]^{0.25} \times L$ (Refer HSSS2000)

where D_{par} = 10.1×10^9 kNmm²/m as before

D_{perp} = transverse floor stiffness = $E_s I_y$

C = transverse flexural continuity factor

I_y = transformed tranverse second moment area based on concrete cover only

therefore, $I_y = 1000 \times (150 - 57)^3 / 12 / 6.33$

$= 10.6 \times 10^6$ mm⁴/m

and $D_{perp} = 205 \times 10.6 \times 10^6$

$= 2.17 \times 10^9$ kNmm²/m

Using C = transverse flexural continuity factor = 2.0, based on transverse continuity,

then $B = C \times [D_{perp}/D_{par}]^{0.25} \times L$

$= 2.0 \times [2.17/10.1]^{0.25} \times L$

$= 1.36 \times L$

B must be less than L or the actual transverse width available. Therefore use B = L = 5.6m.

Now calculate effective floor panel weight, W $= wBL$ (Refer HSSS2000)

$= 4.10 \times 5.6 \times 5.6$

$= 128.6$ kN

Estimated peak acceleration ratio, a_p (expressed as a % of g)

$= P_0 \times e^{-0.35 f_n} / (\beta x W)$ (Refer HSSS2000)

where P_0 = constant walking force = 0.29 kN (From HERA Report R4-141 Table 4)

β = floor damping ratio = 0.025 (From HERA Report R4-141 Table 4)

Therefore $a_p = P_0 \times e^{-0.35 f_n} / (\beta x W)$

$= (0.29 \times e^{-0.35 \times 7.8}) / (0.025 \times 128.6)$

$= 0.59$ %g

The values we have for f_n and a_p must now be compared with the acceptable criteria of graph line C shown in Figure 1 of HERA Report R4-141. If the point plotted on this graph from these two values is below the line C then vibration criteria are acceptable. Alternatively, we can interpret acceptable peak acceleration, a_0 from the graph line (already expressed as a % of g) as follows:

for natural frequency f_n between 4 and 8 Hz: $a_0 < 0.5$ %g

for natural frequency $f_n > 8$ Hz, the equation of the line is $\log a_0 < \log f_n - 1.2041$

In this case $f_n = 7.8$ Hz < 8

therefore $a_0 = 0.5$ %g.

$a_p > a_0$ therefore the slab is unsatisfactory for vibration, and either a shorter span, thicker floor or greater damping must be used.

For example, if the damping is improved by providing many full height partitions then the damping ratio β can be increased:

Thus if $\beta = 0.05$,

then $a_p = (0.29 \times e^{-0.35 \times 7.8}) / (0.05 \times 128.6)$

$= 0.29$ %g

$< a_0 = 0.5$ %g and floor can be considered acceptable for vibration.

3.4.9 THERMAL INSULATION

For Flatdeck floors to comply with the requirements of NZS 4218 using the method of calculation described in NZS 4214, it is generally necessary to add some form of insulation to the floor system. The table below indicates the thermal resistance (R value) that can be expected from the Flatdeck floor slab.

Flatdeck Floor Slab (Note 1)		Inside Surface	Outside Surface R Value (m^2 °C/W)		Perimeter (Note 2)	Total R Value (m^2 °C/W)	
Thickness (mm)	R Value (m^2 °C/W)	R Value (m^2 °C/W)	Exposed	Enclosed Perimeter	R Value (m^2 °C/W)	Exposed	Enclosed Perimeter
110	0.06	0.15	0.08	0.16	0.12	0.29	0.49
150	0.09	0.15	0.08	0.16	0.12	0.32	0.52
200	0.13	0.15	0.08	0.16	0.12	0.36	0.56

Note 1: The R value is for the floor slab only, excluding any top surface covering.

Note 2: The perimeter R value is based on a 150mm hollow concrete block wall with 1 in 3 cores filled, and 10% of the wall area as open ventilation.

Compliance with NZS 4218 generally requires a floor R value of 1.3m^2 °C/W excluding the top surface floor covering. The additional R value necessary is usually achieved by treating the underside of the Flatdeck with a suitable insulation material. Expanded polystyrene (EPS) is recommended, with the following R values:

40mm EPS: R = 1.1m^2 °C/W
30mm EPS: R = 0.8m^2 °C/W

For inter-tenancy floors, or for second storey floors where energy conservation in a room is desired, a sensible objective is to achieve an R value of 1.9m^2 °C/W for the floor-ceiling construction. As a general guide, the additional insulation can be achieved with a combination of enclosed air space between the ceiling and the Flatdeck, and insulation blanket.

Typical R values are:

Enclosed ceiling air space: R = 0.3m^2 °C/W for heat flow up.
50mm insulation blanket: R = 1.0m^2 °C/W
75mm insulation blanket: R = 1.5m^2 °C/W
100mm insulation blanket: R = 2.0m^2 °C/W

Example
Using a 110mm overall thickness slab, over an enclosed subfloor perimeter to achieve required 1.3m^2 °C/W.

R value of 110mm Flatdeck floor = 0.49
Add 40mm EPS
R value = 1.10
Total R value = 1.59m^2 °C/W > 1.3 ∴ O.K.

3.4.10 DESIGN EXAMPLES

3.4.10.1 EXAMPLE: FORMWORK

A 230mm overall thickness slab is required to span 4800mm c/c between permanent supports using the Flatdeck sheet as permanent formwork only. Two alternatives are available in design.

a) Using 0.75mm Flatdeck from Section 3.4.4.1, select the formwork span capabilities for a 230mm overall thickness slab, i.e.

single	1850mm
double or end	2150mm
internal	2150mm

Using two rows of props, there are two end spans and one internal span. The maximum span of Flatdeck in this configuration is,

$2 \times 2150 + 2150 = 6450$mm
$\geq$ the required span of 4800mm $\therefore$ O.K.

Therefore 0.75mm Flatdeck with two rows of props at third points may be considered.

b) Using 0.95mm Flatdeck from Section 3.4.4.1, select the formwork span capabilities for a 230mm overall thickness slab, i.e.

single	2000mm
double or end	2400mm
internal	2350mm

Using one row of props, there are two end spans only. The maximum span of Flatdeck in this configuration is,

$2 \times 2400 = 4800$mm
$\geq$ the required span of 4800mm $\therefore$ O.K.

Therefore 0.95mm Flatdeck with one row of props at midspan may also be considered.

Continued on next page

3.4.10 DESIGN EXAMPLES *continued*

3.4.10.2 EXAMPLE: RESIDENTIAL AND POINT LOADS

A suspended slab in a residential dwelling is required to achieve a double span of 2 x 3600mm in each of the living and garage areas.

Living area loading,

live load, Q	1.5 kPa
superimposed dead load, G_{SDL}	0.3 kPa
design superimposed load, $G_{SDL} + Q$	1.8 kPa

Garage loading,

	live load, Q	2.5 kPa
or	point live load, P_Q	13.0 kN

Living Area Floor
From Section 3.4.5, select the double or end span superimposed load and negative reinforcement for a 0.75mm Flatdeck slab of 110mm overall thickness, with one row of props at midspan. This gives,

superimposed load = 7.1 kPa
$\geq G_{SDL} + Q =$ 1.8 kPa ∴ O.K.

Minimum mesh requirement throughout the Flatdeck slab from Section 3.4.2 Additional Reinforcement assuming a minor degree of crack control is one layer of 665 mesh at minimum cover.

From Section 3.4.5 0.75mm Flatdeck – Double and End Spans, the area of negative reinforcement required over the internal support is H16 bars at 200mm c/c.

Length of reinforcement required is 3600 / 4 + 450 = 1350mm each side of the support centre line.

For the living area floor use a 0.75mm Flatdeck slab of 110mm overall thickness with one row of props at midspan. A 665 mesh is required throughout the slab plus H16 x 2700mm longitudinal top reinforcement at 200mm c/c, laid atop the mesh at minimum cover, over the internal support.

Garage Floor
From Section 3.4.5, select the double or end span superimposed load and negative reinforcement for a 0.75mm Flatdeck slab of 110mm overall thickness, with one row of props at midspan. This gives,

superimposed load = 7.1 kPa
$\geq G_{SDL} + Q =$ 2.5 kPa ∴ O.K.

Minimum mesh requirement throughout the Flatdeck slab from Section 3.4.2 Additional Reinforcement assuming a minor degree of crack control is one layer of 665 mesh at minimum cover.

From Section 3.4.5 0.75mm Flatdeck – Double and End Spans, the area of negative reinforcement required over the internal support is H16 bars at 200mm c/c.

Length of reinforcement required is 3600 / 4 + 450 = 1350mm each side of the support centre line.

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3.4.10 DESIGN EXAMPLES *(3.4.10.2 continued)*

For the 13.0 kN point load, detailed checks are required using BS 5950: Part 4 Section 6. Please note that this point load check method is only valid for spans between 2.0m and 5.0m, due to the use of empirically derived formulae.

Vertical Shear: The critical load position occurs when the edge of the 13 kN point load is at a distance d_s from the edge of the support. Given a load width, b_o of 100mm, the effective load width is,

b_m = effective load width
= $b_o + 2 (D_s – 57)$ where D_s is the overall depth of Flatdeck composite slab
= 100 + 2 x (110 – 57) = 206mm b_o is the width of the concentrated load
d_s = 110 – 14 = 96mm

The distance between the centre lines of the point load and nearer support (*a*), given a support width of, say, 150mm is,

a = b_o / 2 + d_s + support width / 2 where d_s is the distance from the top of the Flatdeck
= 50 + 96 + 75 = 221mm composite slab to the centroid of the Flatdeck sheet

Assuming the load is centred at least b_{er} / 2 from the slab edge, the effective width of resisting Flatdeck slab is,

b_{er} = effective width of the slab in shear
= $b_m + a (1 – a / L)$
= 206 + 221 x (1 – 221 / 3600)
= 413mm

Applied shear at 221mm from the central support per 413mm width is,

V* = design shear force for strength
= 1.4 G (0.625 L – 221) + 1.6 P_Q (2L – aL/(L – a)) / (2L) where P_Q is the point live load
= 1.4 x 2.64 x 10^{-6} x 413 x 2029 + 1.6 x 13.0 (2 x 3600 – 221 x 3600/(3600 – 221)) / (2 x 3600)
= 23.2 kN/413mm

Design concrete shear stress (V_c) from BS 8110 may be calculated using specified cube compressive strength of concrete, f_{cu} of 1.25 specified compressive strength of concrete, f'_c = 31.25 MPa and A_p of 1180mm^2/m from formwork properties table, Section 3.4.3 Flatdeck Section Properties,

V_c = $0.632 (f_{cu} A_p / 250 d_s)^{0.333} (400 / d_s)^{0.25}$
= $0.632 \times (1.54)^{0.333} \times (4.17)^{0.25}$
= 1.04 MPa

Vertical shear capacity (V_v),

V_v = $300 d_s v_c$
= 300 x 96 x 1.04 x 10^{-3} = 30.0 kN/trough
= 30.0 x 413 / 300 = 41.3 kN/413mm
≥ V* = 23.2 kN/413mm ∴ O.K.

Continued on next page

3.4.10 DESIGN EXAMPLES *(3.4.10.2 continued)*

Punching Shear: Assuming the load is centred at least $b_m/2$ from the slab edge, the critical perimeter (u) for the Flatdeck slab is,

$$u = 4\{b_o + (D_s - 57) + d_s\}$$
$$= 4 \times (100 + 53 + 96) = 996\text{mm}$$

Applied shear over critical perimeter area is,

$$V^* = 1.4\,G + 1.6\,P_Q$$
$$= 1.4 \times 249^2 \times 2.63 \times 10^{-6} + 1.6 \times 13.0$$
$$= 21.0\text{ kN}$$

Punching shear capacity (V_p),

$$V_p = u\,(D_s - 57)\,v_c$$
$$= 996 \times 53 \times 1.04 \times 10^{-3} = 54.9\text{ kN}$$
$$\geq V^* = 21.0\text{ kN} \qquad \therefore \text{O.K.}$$

Shear Bond: It is assumed in this calculation that the slab is fixed to the supports on at least three sides. An empirical formula is used to convert the point live load (P_Q) into a superimposed load.

Hence $G_{SDL} + Q$ equates to,

$$\frac{P_Q\,(15000 - L^{1.1})\,L}{14\,(-\,0.16\,L^2 + 3200\,L - 3.52 \times 10^6)}$$
$$= 13 \times 24.61 \times 10^6 / (14 \times 5.93 \times 10^6)$$
$$= 3.85\text{ kPa}$$

Section 3.4.5 0.75mm Flatdeck – Single Spans Medium term superimposed loads table is then used for all span conditions for shear bond calculations (i.e. single spans, double or end spans, internal spans) to compare empirically derived $G_{SDL} + Q$ to available superimposed load,

superimposed load = 7.1 kPa
$= G_{SDL} + Q = 3.85$ kPa $\qquad \therefore$ O.K.

Negative Bending: Assuming the load is centred at least $b_{eb} / 2$ from the slab edge, the effective width of resisting Flatdeck slab (b_{eb}) is,

$b_{eb} = b_m + 2\,a\,(1 - a / L)$ *single spans* $\qquad$ where a = span/2
or $b_{eb} = b_m + 1.333\,a\,(1 - a / L)$ *continuous*

Maximum bending occurs when the point load is at midspan. Thus the effective width is,

$$b_{eb} = 206 + 1.333 \times 1800 \times (1 - 0.5)$$
$$= 1406\text{mm}$$

The applied bending moment for strength (M*) over the internal support due to the point load is,

$M^* = 1.6\,M_Q / b_{eb}$ $\qquad$ where M_Q is the design live load moment
$= 1.6 \times 0.094 \times 3600 \times 13 / 1406$
$= 5.0$ kNm/m

This is converted into an equivalent superimposed load,

$G_{SDL} + Q = 5.0 \times 10^6 / (0.063 \times 1.6 \times 3600^2)$
$= 3.8$ kPa
≤ 7.1 kPa (from Section 3.4.5, 0.75mm Flatdeck Composite Slab Load Span Tables Double and End Spans) $\therefore$ O.K.

Continued on next page

3.4.10 DESIGN EXAMPLES *(3.4.10.2 continued)*

Positive Bending: Using an empirical formula to convert the point live load into a superimposed load,

$$G_{SDL} + Q = \frac{1000\ P_Q}{(0.00247\ L^2 - 14.65\ L + 27100)}$$

$$= 13000\ /\ 6371 = 2.04\ \text{kPa}$$

Section 3.4.5 0.75mm Flatdeck – Single Spans Medium term superimposed loads is then used for all span conditions for positive bending calculations (i.e. single spans, double or end spans, internal spans) to compare empirically derived $G_{SDL} + Q$ to available superimposed load,

superimposed load = 7.1 kPa
$\geq G_{SDL} + Q = 2.04$ kPa ∴ O.K.

Positive bending is rarely critical.

Deflection: It is assumed the 13.0 kN point load is of short term duration and deflection is not likely to cause damage to finishes. However to illustrate the methodology, using b_{eb} in bending and $I_{av} = 9.9 \times 10^6\ \text{mm}^4/\text{m}$ from Section 3.4.3 (medium term), the imposed deflection under the point load at midspan (δ_p) is,

$\delta_p = 0.015\ P_Q\ L^3\ /\ E_s\ 1$ where E_s is the Modulus of Elasticity of the Flatdeck sheet and I is the second moment of area

$= 0.015 \times 13.0 \times 3600^3\ /\ (205 \times 10^3 \times 9.9 \times 1406)$
$= 3.2\text{mm}\ (L\ /\ 1125)$
$\leq$ the limit of $L\ /\ 350$ ∴ O.K.

In summary, for the garage floor use a 0.75mm Flatdeck slab of 110mm overall thickness with one row of props at midspan. A 665 mesh is required throughout the slab plus H16 x 2700mm longitudinal top reinforcement at 200mm c/c, laid atop the mesh at minimum cover, over the internal support.

Transverse Reinforcement: In this example as $P_Q > 7.5$ kN (13.0 kN), transverse reinforcement is required to be provided to satisfy the following moment resistance.

$M^*_{trans} = P^*\ b_{eb}\ /\ (15w)$ where $w = L/2 + b_1$ and $w \ngtr L$

Where M^*_{trans} = Factored bending moment in the transverse direction
P^* = Factored concentrated point load
b_{eb} = Effective width of slab
L = Span of composite slab
b_1 = Concentrated load length in direction of slab span

This requirement is based on recommendations from the Steel Decking Institute, Illinois, to resist transverse bending in the composite slab as a result of the concentrated load.

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3.4.10 DESIGN EXAMPLES *continued*

3.4.10.3 EXAMPLE: INSTITUTIONAL BUILDING DEFLECTION

A heavy equipment floor in a hospital is required to form a single span of 5200mm given a long term superimposed load of 4.0 kPa.

Using Section 3.4.5 0.75mm Flatdeck – Single Spans Long term superimposed loads table, select the single span superimposed load for a 0.75mm Flatdeck slab of 160mm overall thickness, with two rows of props at midspan (Section 3.4.4.1). This gives,

superimposed load = 4.5 kPa
$\geq G_{SDL} + Q = 4.0$ kPa ∴ O.K.

Although this configuration lies in the region of the table where vibration is not critical with a minimum damping ratio of 0.025 (commercial offices, open plan with few small partitions), the equipment is likely to be vibration sensitive and therefore a detailed vibration analysis of the floor would be required by the design engineer.

Deflection of the floor is to be minimised by reducing the allowable limit from $L_{ss}/250$ to $L_{ss}/400$. For this limit, deflection is made up of two components. Dead load deflection from prop removal is (for one or two props),

$5\ G\ L_{ss}^4 / (384\ E_s\ I)$

and the superimposed load deflection is,

$5\ (G_{SDL} + Q)\ L_{ss}^4 / (384\ E_s\ I)$

For the 0.75mm Flatdeck slab of 160mm overall thickness, refer Section 3.4.3 Flatdeck Section Properties for long term superimposed loads,

$G = 3.78$ kPa, $I_{av} = 18.7 \times 10^6$ mm^4/m

Hence $G + (G_{SDL} + Q) = 3.78 + 4.0 = 7.78$ kPa

and δ_{G+Q} = Combined dead and superimposed load deflection at midspan
$= 5 \times 7.78 \times 5200^4 / (384 \times 205 \times 10^9 \times 18.7)$
= 19.3mm (or $L_{ss}/269$)
$>$ the limit of $L_{ss}/400$ ∴ No good

The deflection of the 0.75mm Flatdeck slab of 160mm overall thickness is greater than the limit of $L_{ss}/400$, therefore a greater slab thickness is required.

Try a 0.75mm Flatdeck slab of 200mm overall thickness Section 3.4.3 Flatdeck Section Properties gives (for long term superimposed loads),

$G = 4.7$ kPa, $I_{av} = 34.2 \times 10^6$ mm^4/m

Hence $G + (G_{SDL} + Q) = 4.7 + 4.0 = 8.7$ kPa

and $\delta_{G+Q} = 5 \times 8.7 \times 5200^4 / (384 \times 205 \times 10^9 \times 34.2)$
= 11.8mm (or $L_{ss}/440$)
$\leq$ the limit of $L_{ss}/400$ ∴ O.K.

Therefore, use a 0.75mm Flatdeck slab of 200mm overall thickness with two rows of props at third points and, assuming a minor degree of crack control, use 662 mesh at minimum cover throughout.

Continued on next page

3.4.10 DESIGN EXAMPLES *continued*

3.4.10.4 EXAMPLE: COMMERCIAL OFFICE FIRE RESISTANCE

A banking chamber floor is required over continuous spans of 3000mm c/c with a fire resistance rating of 60 minutes.

Office loading (medium term),

live load, Q	4.0 kPa
superimposed dead load, G_{SDL}	0.5 kPa
design superimposed load, G_{SDL} + Q	4.5 kPa

In terms of structural ability, Section 3.4.5 gives a medium term superimposed load well in excess of 4.5 kPa for a 3000mm span with a Flatdeck slab of 120mm overall thickness.

If the floor is designed as a series of single spans, nominal continuity reinforcement is required over the internal supports. From Section 3.4.5 Flatdeck – Single Spans Medium term superimposed loads, a 0.75mm Flatdeck slab with one row of props at midspan (from Section 3.4.4.1) may be used. Assuming a minor degree of crack control and to provide nominal continuity reinforcement over the internal supports, from Section 3.4.2 Additional Reinforcement, 665 mesh is required at minimum cover over the entire floor area.

This configuration may lead to unsightly cracking of the slab and therefore longitudinal steel at minimum cover over the supports and a moderate or strong degree of crack control may be considered.

As an alternative, the floor may be designed as a continuous slab by providing full continuity reinforcement over the internal supports.

End Spans
From Section 3.4.5 0.75mm Flatdeck – Double and End Spans, the area of negative reinforcement required over the first internal support is H16 bars at 250mm c/c.

Length of reinforcement required is 3000 / 4 + 450 = 1200mm each side of the support centre line.

Internal Spans
From Section 3.4.5 0.75mm Flatdeck – Internal Spans, the area of negative reinforcement required over the other internal supports is H16 bars at 250mm c/c.

Length of reinforcement required is 3000 / 4 + 450 = 1200mm each side of the support centre line.

The fire resistance rating (FRR) is checked from Section 3.4.6 Fire Design Tables. For a 0.75mm Flatdeck slab of 120mm overall thickness with live load Q = 4.0 kPa (0.5 kPa superimposed dead load is assumed in the Fire Design tables) and 3000mm span the FRR for various fire reinforcing steel configurations can be checked.

The beneficial effect of the Flatdeck ribs encased in concrete is taken into consideration when calculating the Fire Resistance Ratings of the Flatdeck composite slab.

Using Flatdeck and no additional reinforcing this gives

FRR $\geq$ 120 minutes
$\geq$ the required 60 minutes $\quad\therefore$ O.K.

Therefore use a 0.75mm Flatdeck slab of 120mm overall thickness with one row of props at midspan – no additional bottom reinforcement is required to achieve the required Fire Resistance Rating. In terms of top steel, 665 mesh is required throughout the slab plus H16 x 2400mm longitudinal top reinforcement at 250mm c/c over all internal supports, laid atop the mesh at minimum cover.

A detailed methodology of the fire resistance calculation is given in the Hibond design examples in Section 3.3.10.4 Example: Commercial Office Fire Resistance.

Continued on next page

3.4.10 DESIGN EXAMPLES *(3.4.10.4 continued)*

This method uses HERA Report R4-82 to satisfy Insulation, Stability and Integrity criteria, except that for Flatdeck the contribution of that portion of the steel decking rib that is embedded into the slab and therefore shielded from direct exposure to the fire, is calculated by determining the temperature due to conduction of heat from the exposed pan of the decking.

The rib element is subdivided into 10 elements and the temperature of each element is determined using the method from HERA Report R4-131 Slab Panel Method (3rd edition). The strength at elevated temperature (yield strength as function of temperature) is also determined in accordance with this report. The contribution of each element to the overall moment capacity of the slab is calculated in accordance with normal reinforced concrete design procedures.

3.4.11 MATERIAL SPECIFICATION

Dimond Flatdeck and accessories are manufactured from galvanised steel coil produced to AS 1397:2001.

	Thickness BMT mm	Steel Grade MPa	Min. Zinc Weight g/m^2
Flatdeck sheeting	0.75 & 0.95	G550	Z 275
Edge form	1.15	G250	Z 275

BMT – Base Metal Thickness

Tolerances
Length -0mm +10mm
Sheet cover width -1mm +5mm
Maximum manufactured length of Flatdeck sheet 18m.

3.4.12 SHORT FORM SPECIFICATION – FLATDECK FLOORING

The flooring system will be Dimond **(1)** mm Flatdeck manufactured from G550 grade steel, with a 275 g/m^2 galvanised zinc weight. The minimum nominal sheet length to be used in construction shall be .... m, in accordance with the design formwork spans.

Edge forms should be used in accordance with Dimond recommendations.

Specify concrete thickness, and number of rows of propping during construction.

Mesh and any additional reinforcement bar size and spacing should be referred to the design engineer's drawings.

Choose from:

(1) 0.75, 0.95

3.4.13 FLATDECK COMPONENTS

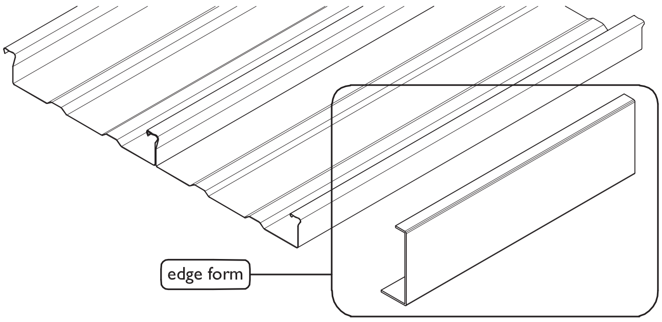
3.4.13.1 EDGE FORM

Manufactured from 1.15mm Base Metal Thickness (BMT) galvanised steel in 6m lengths, providing an edge to screed the concrete to the correct slab thickness.

Standard sizes are from 110mm to 200mm in 10mm height increments.

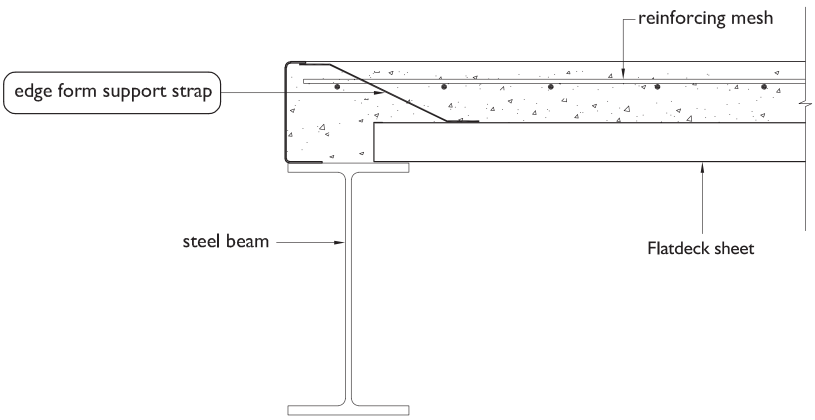
The foot of the edge form is fixed to the structure by self-drilling metal screws or powder actuated fasteners.

The Flatdeck sheeting may sit on this foot and be fixed to the edge form by rivets or self-drilling metal screws.



3.4.13.2 EDGE FORM SUPPORT STRAP

The top edge is restrained from outward movement (when the concrete is being placed) by a specifically designed 30 x 0.55mm galvanised metal edge form support strap, which is fixed to the Flatdeck or structure. The straps are normally at 600mm centres.



3.4.14 FLATDECK CAD DETAILS

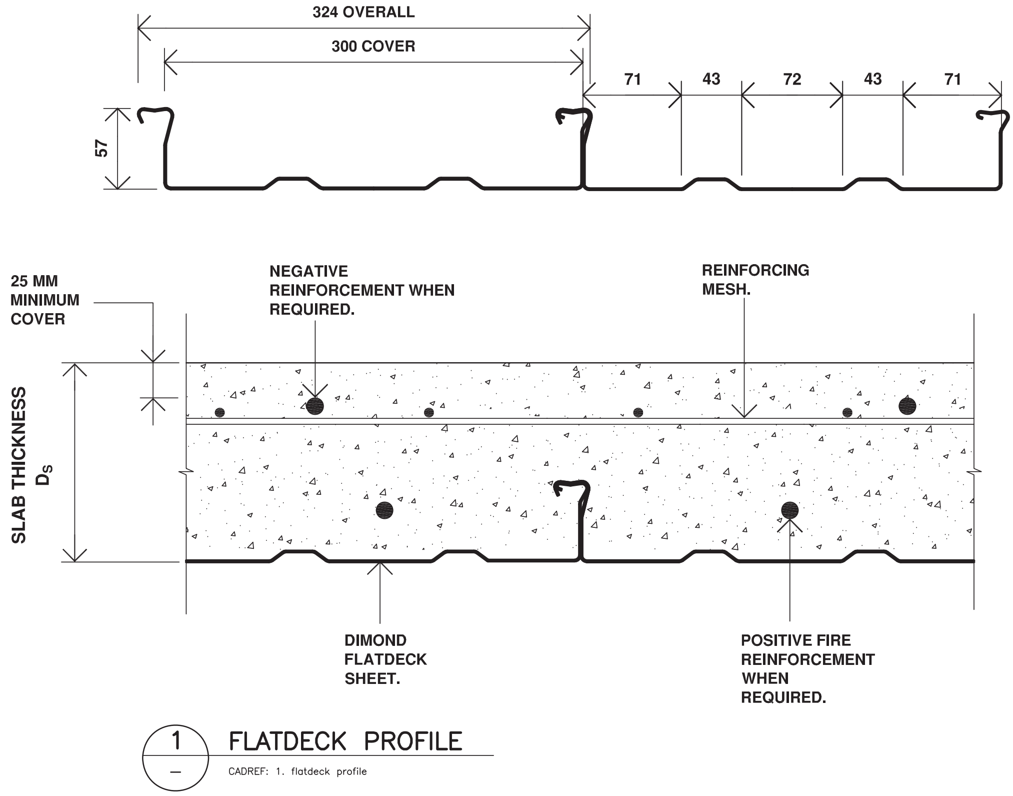
Flatdeck CAD details are shown in this section. For the latest Flatdeck CAD details, please download from the Dimond website **www.dimond.co.nz**. Follow the steps below:

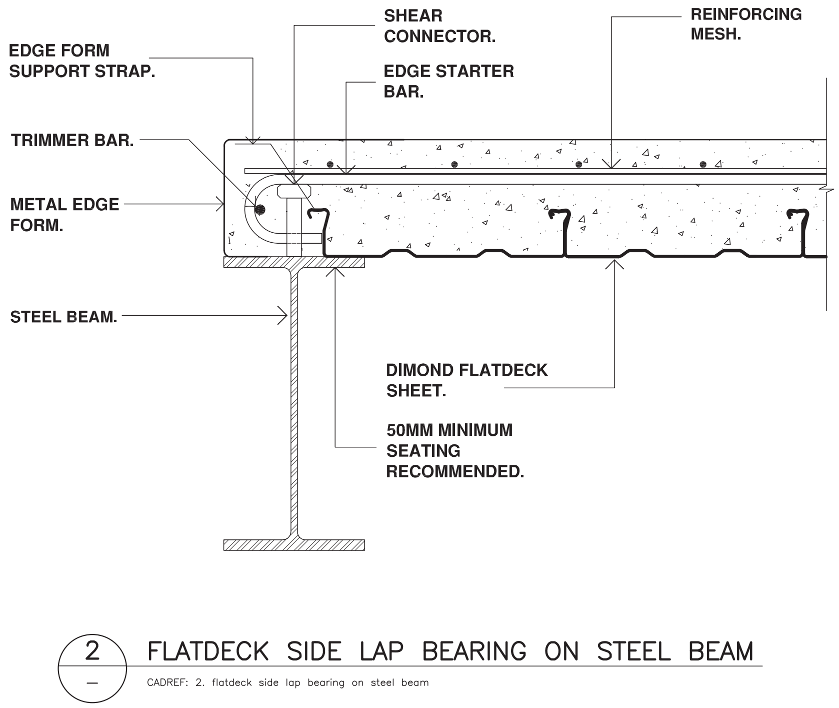
1. Log in to the Architects/Specifiers section.
2. Click on the green "Structural Systems Manual" button.
3. Click on the "Download CAD details" button.
4. Select from product list shown to view CAD details available for that product.

Please note all of these details are to be used as a guide only and are not intended for construction. Specific design details are required to be provided by the design engineer.

3.4.14 FLATDECK CAD DETAILS

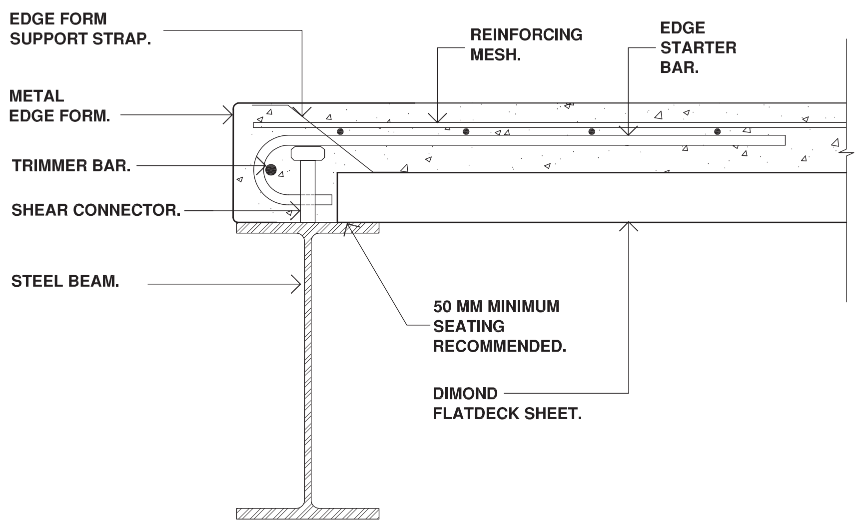
Not to scale





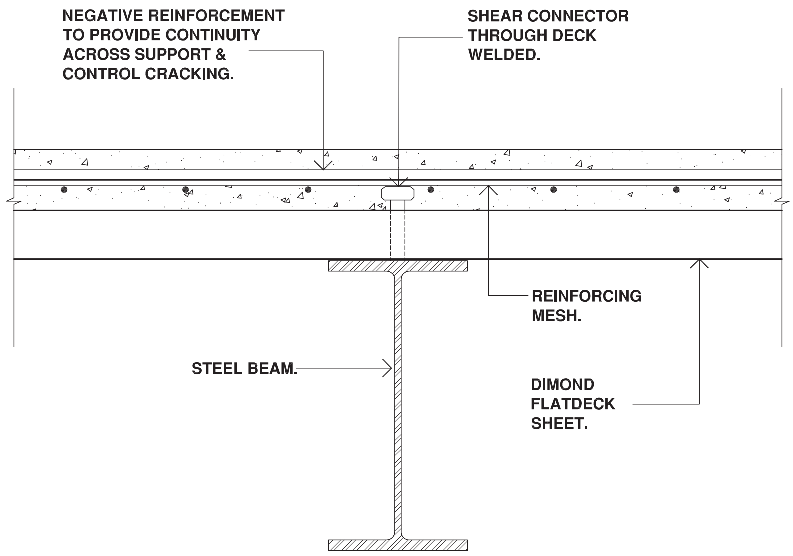
3.4.14 FLATDECK CAD DETAILS *continued*

Not to scale



3 — FLATDECK END BEARING ON STEEL BEAM

CADREF: 3. flatdeck end bearing on steel beam

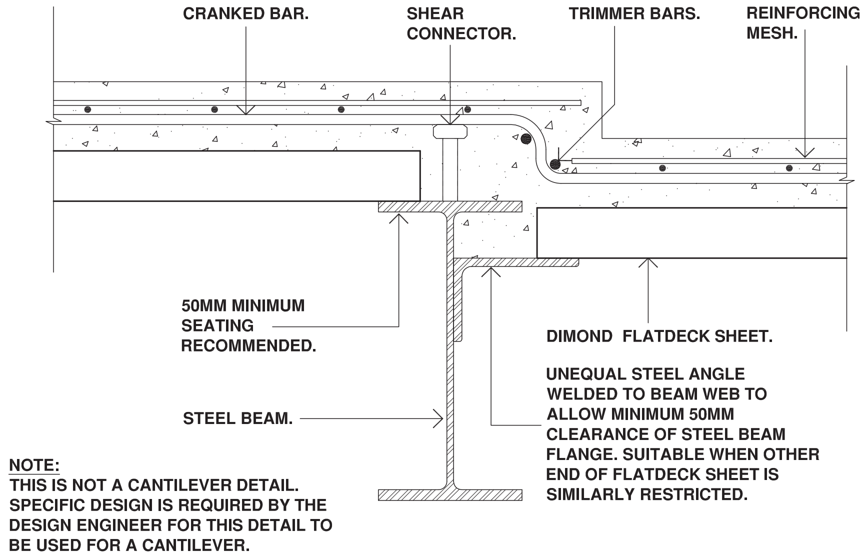


4 — FLATDECK INTERNAL BEARING ON STEEL BEAM

CADREF: 4 .flatdeck internal bearing on steel beam

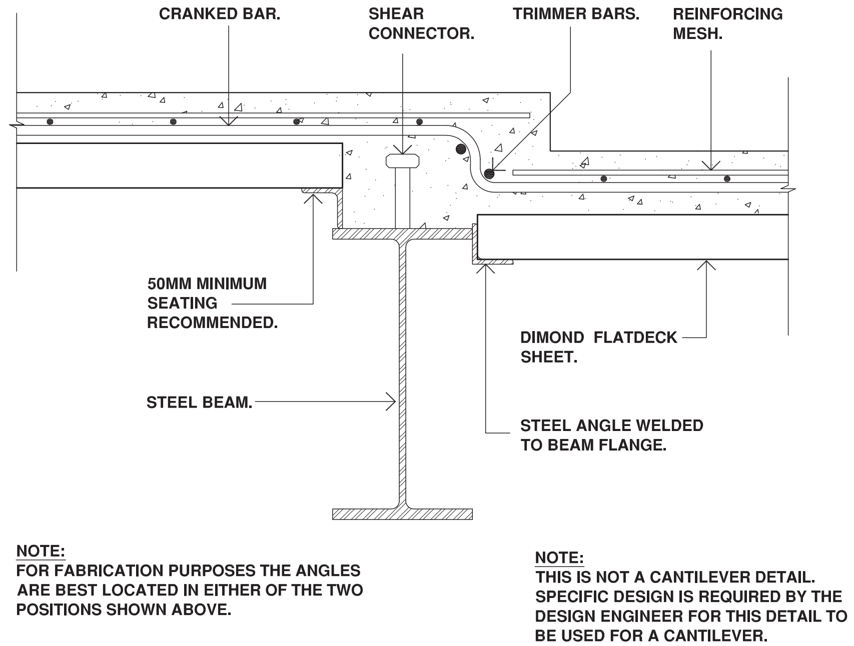
3.4.14 FLATDECK CAD DETAILS *continued*

Not to scale



5 — FLATDECK INTERNAL STEP DOWN ON STEEL BEAM – OPTION 1

CADREF: 5. flatdeck internal step down on steel beam.option 1

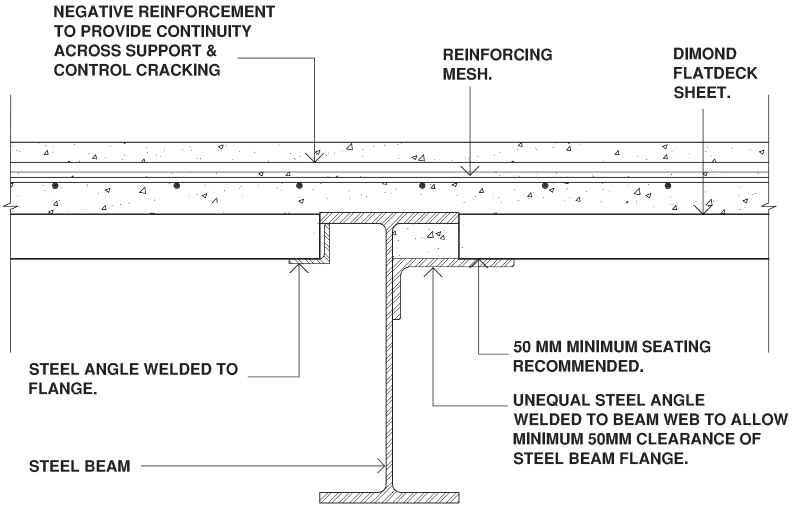


6 — FLATDECK INTERNAL STEP DOWN ON STEEL BEAM – OPTION 2

CADREF: 6. flatdeck internal step down on steel beam.option 2

3.4.14 FLATDECK CAD DETAILS *continued*

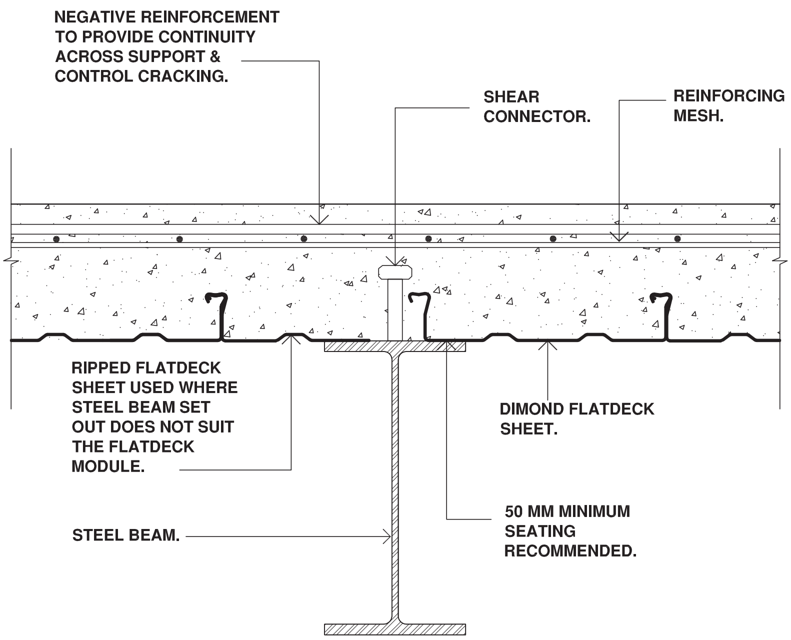
Not to scale



NOTE:
-THIS DETAIL CONTAINS TWO OPTIONS (SHOWN EACH SIDE OF THE BEAM) TO ACHIEVE AN INTERNAL SET DOWN.
-DUE TO THE NECESSITY TO ROTATE FLATDECK DURING INSTALLATION IT IS NOT PRACTICAL TO LOCATE THE FLATDECK SHEET DIRECTLY UNDER THE FLANGE.
-FOR FABRICATION PURPOSES THE EQUAL ANGLE IS BEST LOCATED AS SHOWN.
-THE COST BENEFITS OF COMPOSITE BEAM ACTION AND ADDITIONAL FIRE RATING OF THE BEAM SHOULD BE CONSIDERED TO OFFSET THE INITIAL EXPENSE OF THE UNEQUAL ANGLE OPTION SHOWN IN THIS DETAIL.

7 – FLATDECK INTERNAL SET DOWN ON STEEL BEAM

CADREF: 7. flatdeck internal setdown on steel beam

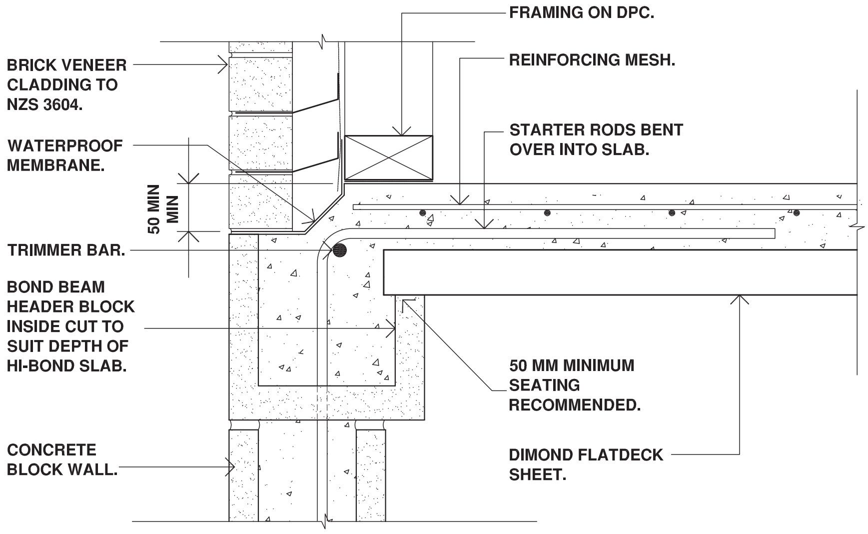


8 – FLATDECK SIDELAP BEARING ON STEEL BEAM

CADREF: 8. flatdeck sidelap on steel beam

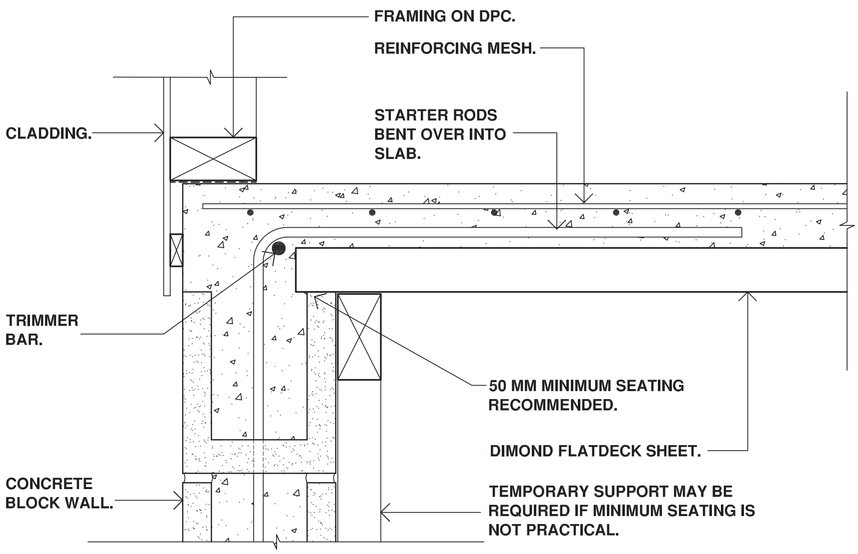
3.4.14 FLATDECK CAD DETAILS *continued*

Not to scale



9 – FLATDECK ON MASONRY BLOCK WITH BRICK VENEER

CADREF: 9. flatdeck on masonry block with brick veneer



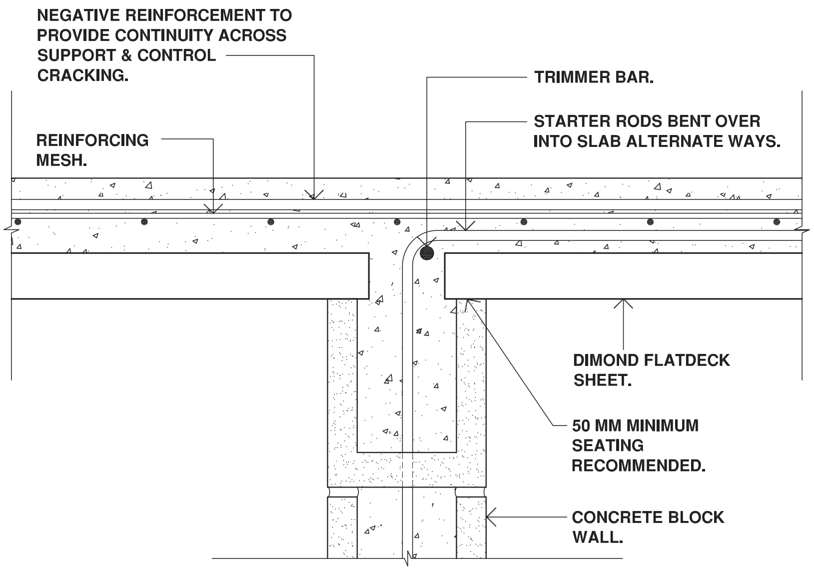
NOTE:
IN SUB FLOOR AREAS THE TEMPORARY SUPPORT MUST EITHER:
-BE REMOVED 28 DAYS AFTER CONCRETE POUR, OR
-HAVE A DPC BARRIER BETWEEN THE TIMBER AND FLATDECK SHEET.

10 – FLATDECK ON MASONRY BLOCK WITH TIMBER WALL

CADREF: 10.flatdeck on masonry block with timber wall

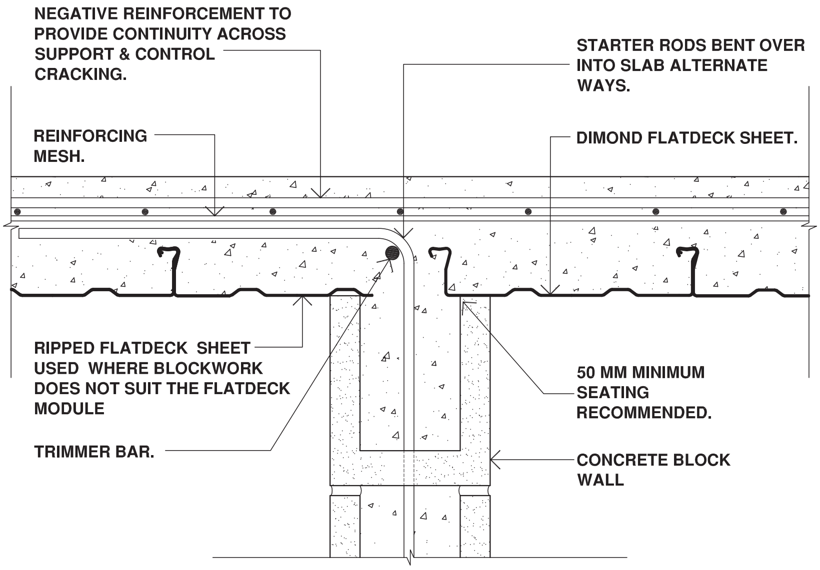
3.4.14 FLATDECK CAD DETAILS *continued*

Not to scale



11 — FLATDECK INTERNAL BEARING ON MASONRY BLOCK WALL

CADREF: 11. flatdeck internal bearing on masonry block wall

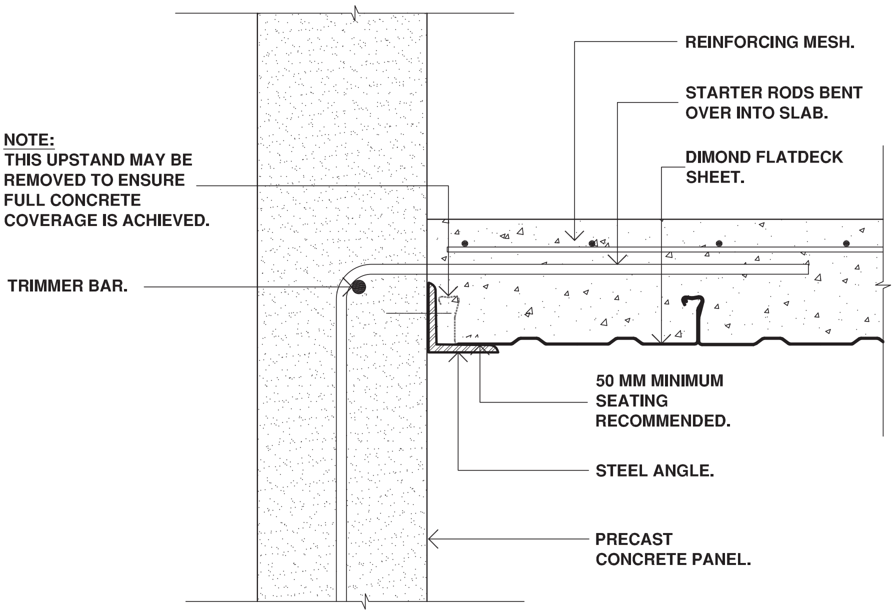


12 — FLATDECK SIDE LAP BEARING ON MASONRY BLOCK WALL

CADREF: 12. flatdeck side lap bearing on masonry block wall

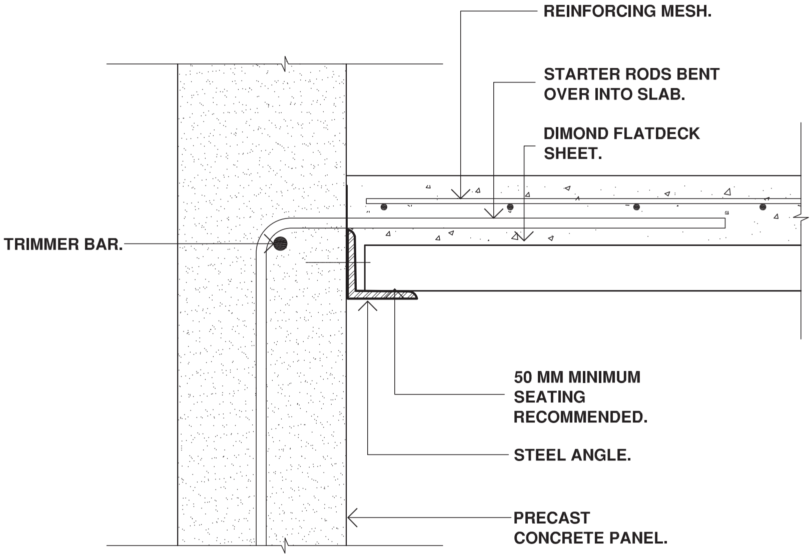
3.4.14 FLATDECK CAD DETAILS *continued*

Not to scale



13 – FLATDECK SIDE LAP BEARING ON TILT SLAB

CADREF: 13. flatdeck side lap bearing on tilt slab



14 – FLATDECK END BEARING ON TILT SLAB

CADREF: 14. flatdeck end bearing on tilt slab

3.5 DIMOND FLOORING INSTALLATION

3.5.1 GENERAL

The placing and fixing of Dimond Flooring Systems is carried out by specialist flooring installers, who lay the flooring sheets and weld shear connectors through into the supporting beams using specialised equipment.

For a list of recommended installers of Dimond flooring systems in your area, please contact your local Dimond Sales Centre.

Dimond flooring installation can also be carried out by construction companies and builders. In this case connectors are either pre-welded to steel beams in the fabricator's workshop or welded on-site.

On site through deck welded shear connectors using the longest practical sheet lengths is the preferred method based on efficiency gains in both design and construction.

3.5.2 HANDLING AND STORAGE

Correct handling and storage is critical to ensure the Dimond Flooring System is not damaged on site. The following points must be adhered to for maximum product durability and performance over the expected life of the product.

- A visual inspection should be carried out, when delivery is taken on site, of all the material supplied to ensure the product is free from damage and the galvanised coating is in good condition.
- Damaged product resulting in a distorted or buckled section shape must not be installed and must be replaced.
- Site storage must be clear of the ground on dunnage to allow the free movement of air around each bundle. When product is stored on site, it must be kept dry using covers over each product bundle.
- Wear protective gloves when handling the product. Treat all cut edges as sharp.
- Product must always be lifted when moved and not dragged as damage to the galvanised coating will occur.
- For practical on-site handling, a sheet length of 13m can be handled by two people. Longer sheet lengths can be manufactured. Refer Sections 3.3.11 and 3.4.11 Material Specification.
- Bundle labels should be checked to ensure the correct lengths are placed in the designated area.
- Where there are multiple bundles in the same area, care should be taken that all bundles are orientated the same way. This will ensure that male and female side laps fit together correctly avoiding the need to rotate sheets.
- Where the underside appearance of the Dimond flooring is important (e.g. Dimond flooring used as an exposed ceiling), care should be taken during the construction phase to minimise damage or deflections to the underside. Self-drilling screws should be used in place of crimping where underside appearance is important.
- When ordering Dimond flooring, it is critical that sheet lengths match the type of span designed for. For example for an unpropped 0.75mm Hibond slab of 120mm overall thickness with beams laid out at 2.80m centres, a minimum sheet length of approximately 5.60m is required to achieve a double span. (If 2.80m sheet lengths are used, the Hibond formwork will fail. For a Hibond slab of 120mm overall thickness, a single span of 2.50m is the maximum achievable without propping.)

3.5.3 HIBOND INSTALLATION

Propping

- Temporary propping must be placed in position prior to placement of the Hibond sheet to provide a safe and solid working platform during the construction phase. Section 3.3.4.1 Hibond Formwork Tables gives the maximum spans for different slab thicknesses and span conditions. As a practical maximum, propping lines should be placed not more than 2.0m apart (for up to 180mm overall slab thickness).
- Bearers and props must consist of either Machine Stress Graded MSG8 timber for load-bearing situations or structural steel sections sized for the construction loads (refer Section 3.3.4.2 Propping) by the design engineer.
- A continuous 100mm x 50mm strap fixed to the studs at mid-height attached at one end to a permanent wall is required to avoid buckling of the studs during the concrete pour.
- Propping lines must have a solid foundation and be cross braced or held in position by nailing through the Hibond sheet into the bearer.
- Bearers used must be a minimum dimension of 100mm x 100mm (2 -100mm x 50mm on edge nailed together), fully supporting all Hibond sheets.
- Vertical propping varies depending on the slab thickness and maximum height of the propping system.

Slab thicknesses up to 180mm

- Up to 2.4m maximum height use 100mm x 50mm vertical props at 600mm centres.
- From 2.4m to 2.7m maximum height use 100mm x 50mm vertical props at 450mm centres.
- From 2.7m to 3.0m maximum height use 100mm x 100mm (2 - 100mm x 50mm nailed together) at 600mm centres.

Slab thicknesses from 180mm to 300mm

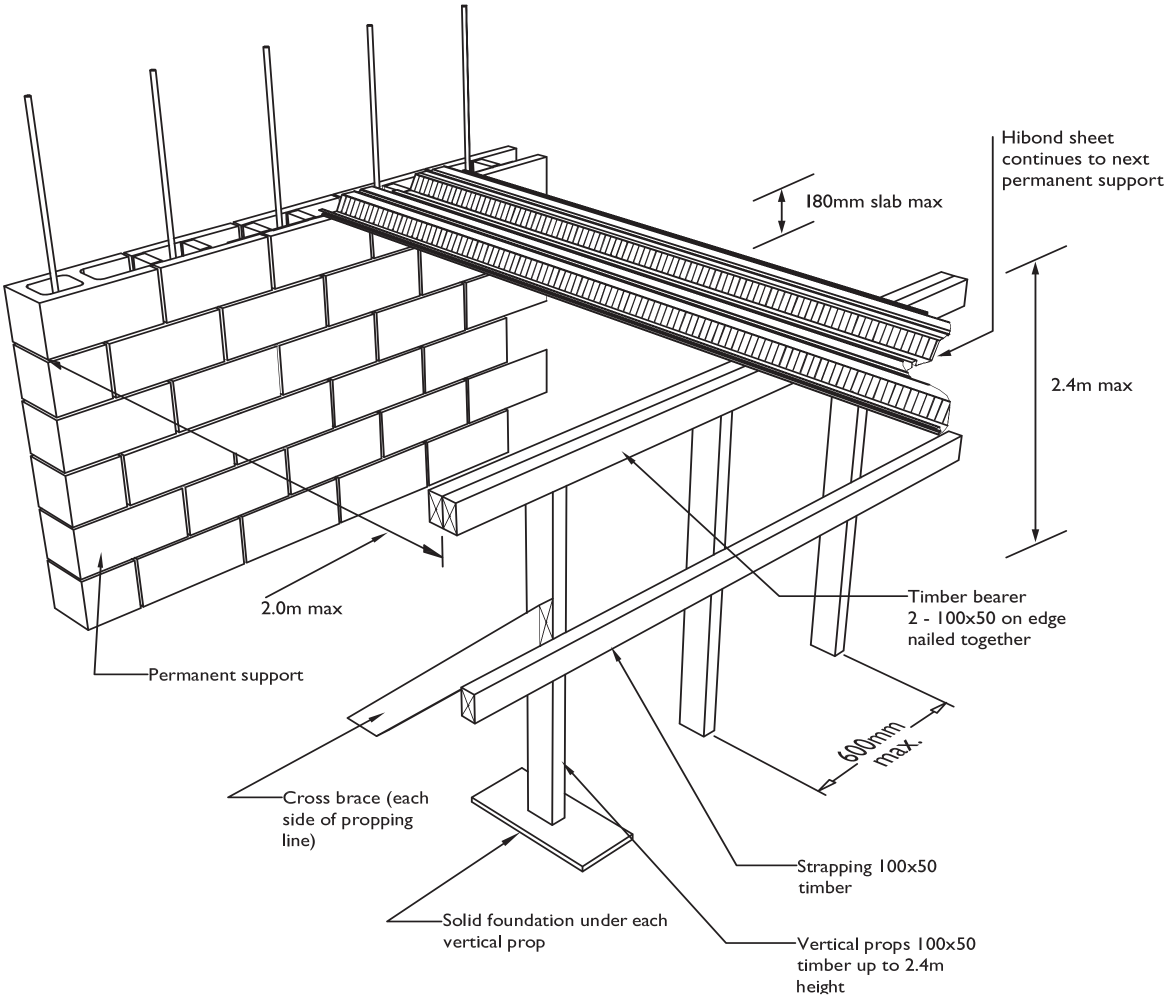
- Up to 2.7m maximum height use 100mm x 50mm vertical props at 450mm centres.
- From 2.7m to 3.0m maximum height use 100mm x 100mm (2 - 100mm x 50mm nailed together) at 600mm centres.

All other slab thicknesses and propping systems require specific design by the design engineer.

Continued on next page

3.5.3 HIBOND INSTALLATION *continued*

- If cutting of the Hibond sheet is required when forming penetrations, temporary propping is required around the opening to maintain the integrity of the sheet during the concrete pour. The area of Hibond removed for penetrations must be replaced by an equivalent strength of reinforcing to the design engineer's specification.
- Penetrations greater than 250mm x 250mm require specific design by the design engineer.



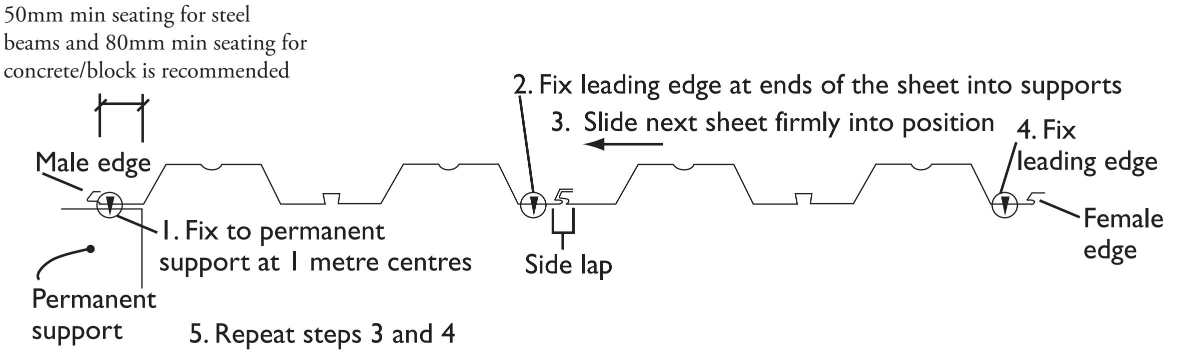
Note: The diagram above is representative of a propping system with propping lines placed not more than 2.0m apart, for a Hibond slab up to 180mm overall thickness with a maximum propping height of 2.4m.

Continued on next page

3.5.3 HIBOND INSTALLATION *continued*

Laying

- Hibond sheets must be laid in one continuous length between permanent supports. Short sheets of Hibond must never be spliced together to achieve the span between temporary or permanent supports.
- Hibond end caps are fitted at sheet ends to avoid concrete leakage. Fit the end caps after the Hibond sheets have been laid and fixed in place. Self-drilling screws are used to secure end caps in position via a pre-punched locating hole.
- The minimum Hibond sheet bearing (or seating) onto permanent structure is 30mm. However for steel beams 50mm minimum bearing is recommended, and for concrete/block 80mm minimum bearing is recommended.
- Align the first Hibond sheet with the male edge of the side lap sitting on the permanent support. This will ensure the side laps fit correctly together. Apply hold down fixings and lay Hibond sheets in the sequence shown.



5. Repeat steps 3 and 4
6. Crimp or screw side laps as shown in Side Lap Stitching section

Note: Where the Hibond sheet is continuous over multiple steel beams consideration should be given to additional fixings to avoid issues due to wind uplift.
Care should be taken with location of fixings to ensure these do not clash with shear stud locations.

- Where supports are steel beams, shear connectors are welded through the Hibond sheets onto the steel beam beneath. Where this is required the top flange of the beam must be unpainted or have the paint stripped clean. Where shear connectors are pre-welded to beams, these must be located in line with the bottom pan of the Hibond sheet (305mm centre to centre) in order to gain the required shear capacity.
- Where fixing into solid filled concrete block (especially when using powder actuated drive pins), edge breakout of the block can be avoided by increasing the Hibond sheet bearing (or seating) and fixing into the grout.
- Where tilt slab construction is being used, the Hibond sheets are fixed to a steel angle bolted onto the tilt slab (minimum 50mm seating leg).
- When laying over timber supports, the Hibond sheet must be separated from the timber using Malthoid (DPC) or similar. Galvanised nails must be used to hold down Hibond sheets during installation. Permanent shear connectors require specific design by the engineer.

Continued on next page

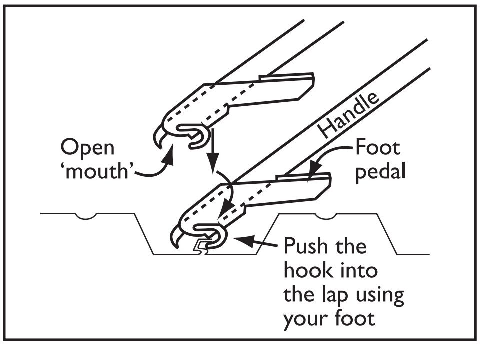
3.5.3 HIBOND INSTALLATION *continued*

- Periodic checks should be made on large runs to ensure the sheets are parallel and true to the first sheet. Stretching of the Hibond sheet to increase coverage must be avoided.
- Where on-site cutting of the Hibond sheet is necessary, use a metal-cutting power saw or angle grinder. After cutting, all swarf or metal filings must be cleaned off the sheet surface (recommended at the end of each day's work) to avoid corrosion.
- For indicative Hibond CAD details refer to Section 3.3.14.

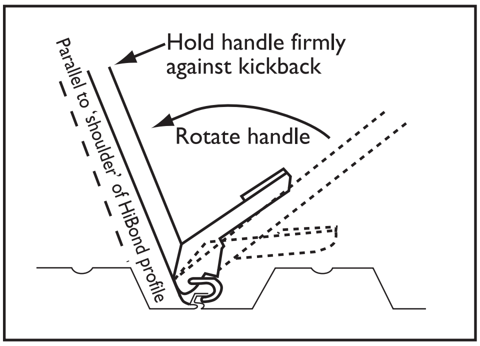
Side Lap Stitching

- Self-drilling screws are the preferred method for side lap stitching of Hibond sheets. As a practical guide, use 10g - 16 x 16mm self-drilling screws at maximum of 600mm centres.
- As an alternative Hibond sheet side laps can be crimped together at a maximum of 350mm centres along the full lap length, using the specialised crimping tool. Call your local representative on 0800 DIMOND (346 663) to arrange a crimping tool.
- Crimping is carried out using the following method:

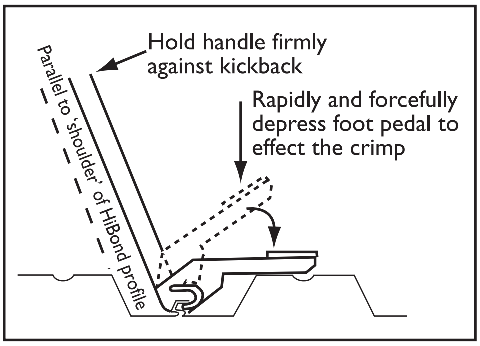
1. Hook tool into sheet



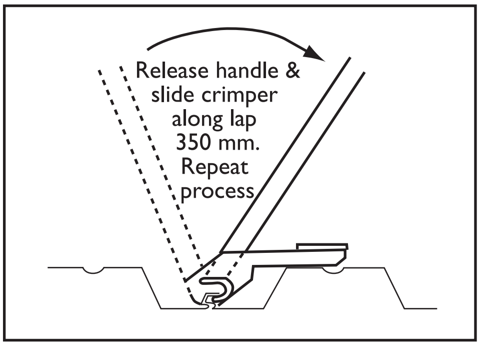
2. Rotate handle



3. Depress foot pedal



4. Release handle



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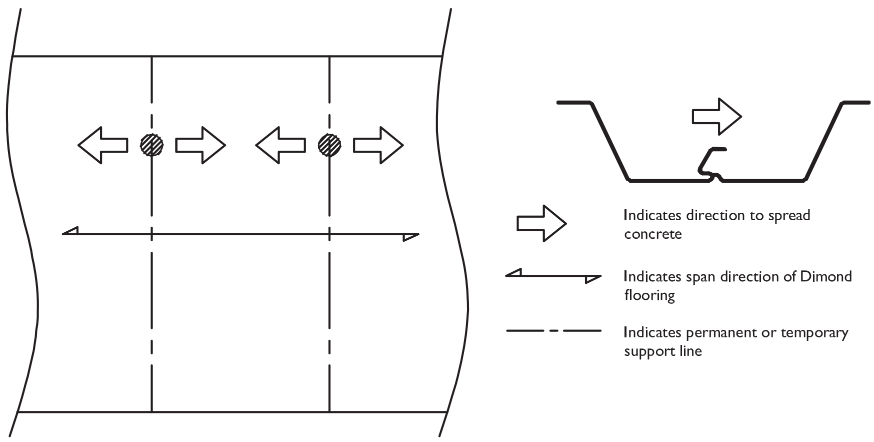
3.5.3 HIBOND INSTALLATION *continued*

Other Considerations

- Where required, Edge Form and Closure Strip (rake edge flashing) are used to contain concrete during the pour. Refer to Section 3.3.13 Hibond Components for details.
- Mesh and/or additional reinforcing must be placed in accordance with the design engineer's specifications to ensure minimum top cover. Refer to Section 3.3.2 Design Considerations: Additional Reinforcement. The reinforcing mesh shall be orientated so the top bar runs in the same direction as the steel sheet.
- Consideration should be given to laying planks as walkways to minimise localised loading of the Hibond sheet by foot traffic or equipment.

Concrete Placement

- Avoid dumping of wet concrete in a heap and when using a concrete pump, ensure the height of the discharge nozzle is not more than 300mm above the top of the Hibond sheet. This will avoid overloading of the Hibond sheet causing buckling and/or opening of the side laps.
- Begin the pour over a beam or propping line (shown as ▨ in the diagram below) to minimise deflections. Spread the wet concrete away from the beams and into the span. Work wet concrete across the Hibond sheet towards the underlapping sheet to keep the side laps tightly closed, as illustrated.
- It is recommended that concrete placers do not crowd together during the pouring sequence, but maintain a one square metre "zone" to avoid overloading the Hibond sheet.



- The use of a concrete vibrator will help eliminate air voids and ensure full contact between the Hibond sheet and the concrete.
- Where the Hibond sheet underside is visible, concrete leakage on the underside must be washed off once concrete placement is complete and before the concrete slurry dries off.
- Temporary propping and formwork should not be removed until the concrete strength has reached 20 MPa, or if this can not be established, 28 days full cure.

3.5.4 FLATDECK INSTALLATION

Propping

- Temporary propping must be placed in position prior to placement of the Flatdeck sheet to provide a safe and solid working platform during the construction phase. Section 3.4.4.1 Flatdeck Formwork Tables gives the maximum spans for different slab thicknesses and span conditions. As a practical maximum, propping lines should be placed not more than 2.0m apart (for up to 180mm overall slab thickness).
- Bearers and props must consist of either Machine Stress Graded MSG8 timber for load-bearing situations or structural steel sections sized for the construction loads (refer Section 3.4.4.2 Propping) by the design engineer.
- A continuous 100mm x 50mm strap fixed to the studs at mid-height attached at one end to a permanent wall is required to avoid buckling of the studs during the concrete pour.
- Propping lines must have a solid foundation and be cross braced or held in position by nailing through the Flatdeck sheet into the bearer.
- Bearers used must be a minimum dimension of 100mm x 100mm (2 -100mm x 50mm on edge nailed together), fully supporting all Flatdeck sheets.
- Vertical propping varies depending on the slab thickness and maximum height of the propping system.

  Slab thicknesses up to 180mm

  - Up to 2.4m maximum height use 100mm x 50mm vertical props at 600mm centres.
  - From 2.4m to 2.7m maximum height use 100mm x 50mm vertical props at 450mm centres.
  - From 2.7m to 3.0m maximum height use 100mm x 100mm (2 - 100mm x 50mm nailed together) at 600mm centres.

  Slab thicknesses from 180mm to 300mm

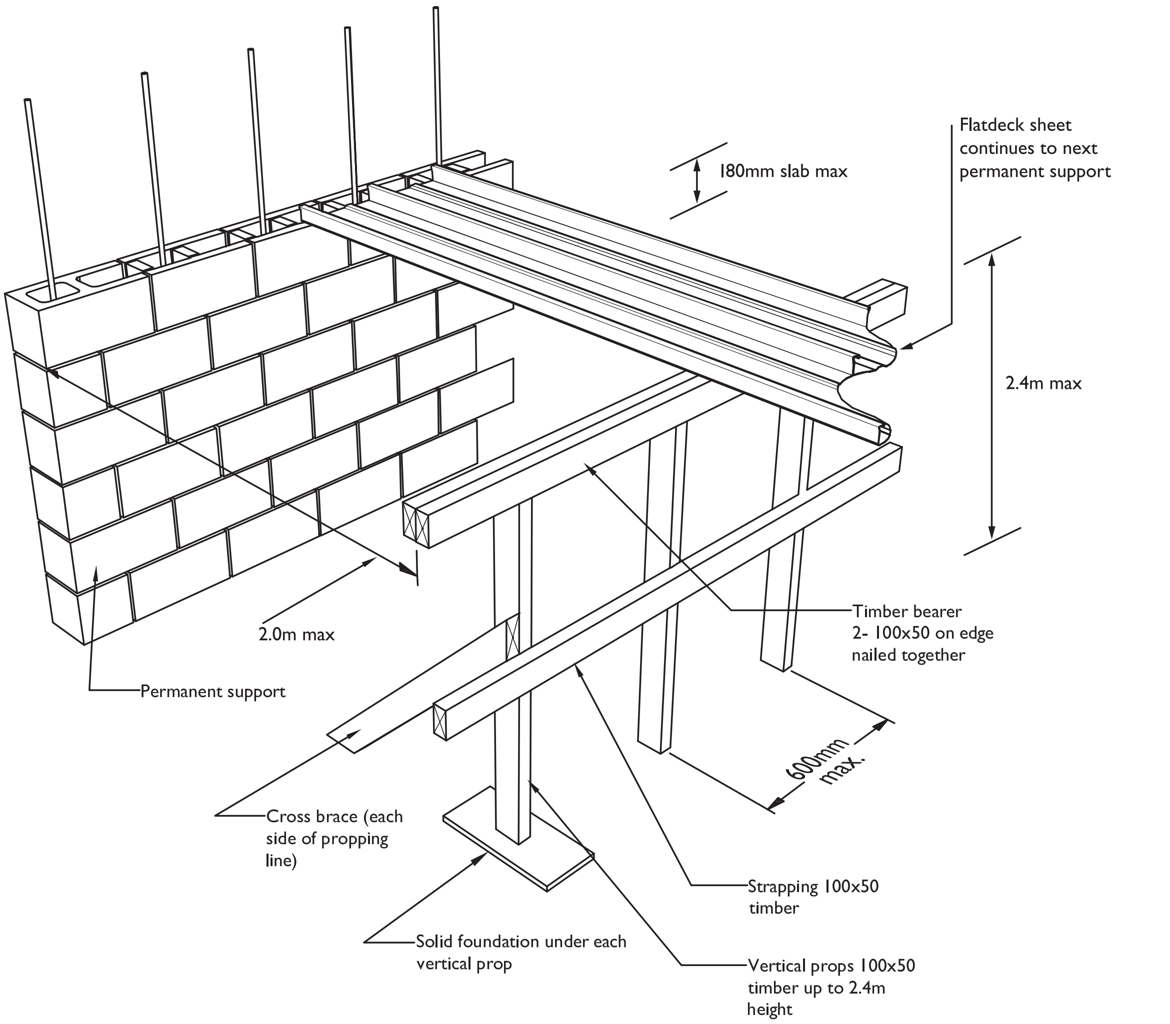
  - Up to 2.7m maximum height use 100mm x 50mm vertical props at 450mm centres.
  - From 2.7m to 3.0m maximum height use 100mm x 100mm (2 - 100mm x 50mm nailed together) at 600mm centres.

  All other slab thicknesses and propping systems require specific design by the design engineer.

Continued on next page

3.5.4 FLATDECK INSTALLATION *continued*

- If cutting of the Flatdeck sheet is required when forming penetrations, temporary propping is required around the opening to maintain the integrity of the sheet during the concrete pour. The area of Flatdeck removed for penetrations must be replaced by an equivalent strength of reinforcing to the design engineer's specification.
- Penetrations greater than 250mm x 250mm require specific design by the design engineer.



Note: The diagram above is representative of a propping system with propping lines placed not more than 2.0m apart for a Flatdeck slab up to 180mm overall thickness with a maximum propping height of 2.4m.

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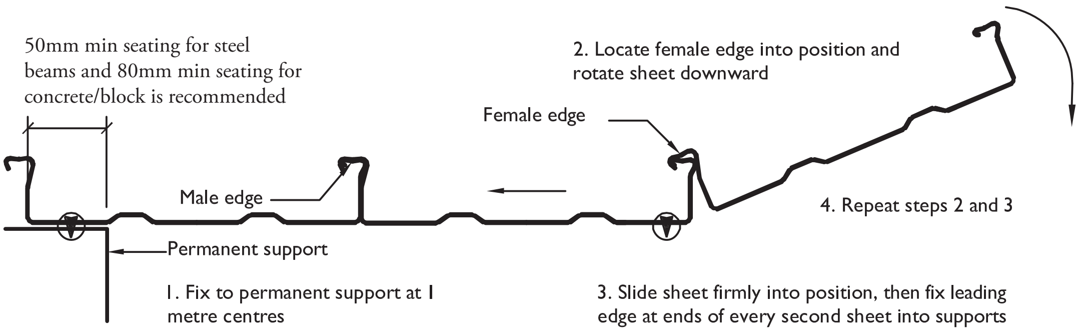
3.5.4 FLATDECK INSTALLATION *continued*

Laying

- Flatdeck sheets must be laid in one continuous length between permanent supports. Short sheets of Flatdeck must never be spliced together to achieve the span between temporary or permanent supports.
- The minimum Flatdeck sheet bearing (or seating) onto permanent structure is 30mm. However for steel supports 50mm minimum bearing is recommended, and for concrete/block 80mm minimum bearing is recommended.
- Align the first Flatdeck sheet with the female edge of the side lap sitting on the permanent support. Apply hold down fixings and lay Flatdeck sheets in the sequence shown.



Note: Where the Flatdeck sheet is continuous over multiple steel beams, additional fixing may be required to avoid issues due to wind uplift.
Care should be taken with location of fixings to ensure these do not clash with shear stud locations.
Use of self-drilling screws is recommended to control deflections and maintain the integrity of the side lap. As a practical guide, use 10g – 16 x 16mm self-drilling screws midspan between permanent supports and temporary propping lines.

- Where supports are steel beams, shear connectors are welded through the Flatdeck sheets onto the steel beam beneath. Where this is required the top flange of the beam must be unpainted or have the paint stripped clean. Where shear connectors are pre-welded to beams, these must be located in line with the bottom pan of the Flatdeck sheet (300mm centre to centre) in order to gain the required shear capacity.
- Where fixing into solid filled concrete block (especially when using powder actuated drive pins), edge breakout of the block can be avoided by increasing the Flatdeck sheet bearing (or seating) and fixing into the grout.
- Where tilt slab construction is being used, the Flatdeck sheets are fixed to a steel angle bolted onto the tilt slab (minimum 50mm seating leg).
- When laying over timber supports, the Flatdeck sheet must be separated from the timber using Malthoid (DPC) or similar. Galvanised nails must be used to hold down Flatdeck sheets during installation. Permanent shear connectors require specific design by the engineer.
- Periodic checks should be made on large runs to ensure the sheets are parallel and true to the first sheet. Stretching of the Flatdeck sheet to increase coverage must be avoided.
- Where on-site cutting of the Flatdeck sheet is necessary, use a metal-cutting power saw or angle grinder. After cutting, all swarf or metal filings must be cleaned off the sheet surface (recommended at the end of each day's work) to avoid corrosion.

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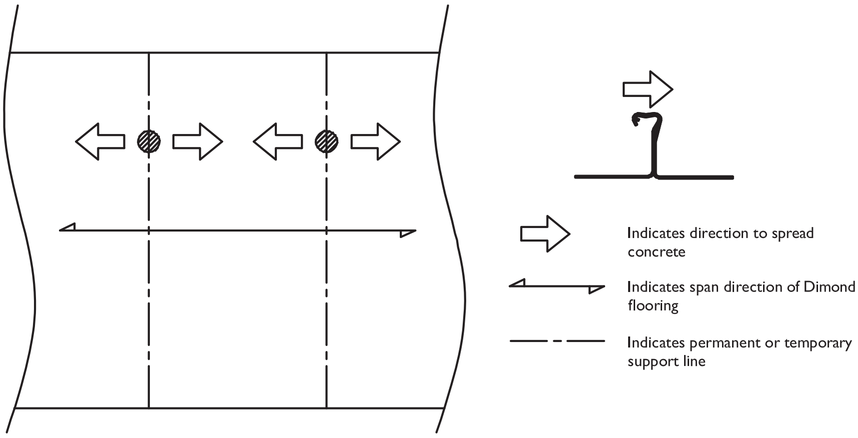
3.5.4 FLATDECK INSTALLATION *continued*

Other Considerations

- Where required, Edge Form is used to contain concrete during the pour. Refer to Section 3.4.13 Flatdeck Components for details.
- Mesh and/or additional reinforcing must be placed in accordance with the design engineer's specifications to ensure minimum top cover. Refer to Section 3.4.2 Design Considerations: Additional Reinforcement. The reinforcing mesh shall be orientated so the top bar runs in the same direction as the steel sheet.
- Consideration should be given to laying planks as walkways to minimise localised loading of the Flatdeck sheet by foot traffic or equipment.
- For indicative Flatdeck CAD details refer to Section 3.4.14.

Concrete Placement

- Avoid dumping of wet concrete in a heap and when using a concrete pump, ensure the height of the discharge nozzle is not more than 300mm above the top of the Flatdeck sheet. This will avoid overloading of the Flatdeck sheet causing buckling and/or opening of the side laps.
- Begin the pour over a beam or propping line (shown as ▨ in the diagram below) to minimise deflections. Spread the wet concrete away from the beams and into the span. Work wet concrete across the Flatdeck sheet towards the underlapping sheet to keep the side laps tightly closed, as illustrated.
- It is recommended that concrete placers do not crowd together during the pouring sequence, but maintain a one square metre "zone" to avoid overloading the Flatdeck sheet.



- The use of a concrete vibrator will help eliminate air voids and ensure full contact between the Flatdeck sheet and the concrete.
- Where the Flatdeck sheet underside is visible, concrete leakage on the underside must be washed off once concrete placement is complete and before the concrete slurry dries off.
- Temporary propping and formwork should not be removed until the concrete strength has reached 20 MPa, or if this can not be established, 28 days full cure.

3.6 REFERENCES USED IN THE FLOORING SYSTEMS SECTION

AS/NZS 1397:2001	Steel Sheet and Strip – Hot Dipped, Zinc Coated or Aluminium/Zinc Coated
AS 3600:2001	Concrete Structures
AS/NZS 4600:1996	Cold-formed Steel Structures
AS/NZS 4671:2001	Steel Reinforcing Materials
AS/NZS 1170:2002	Structural Design Actions
BS 4449:1997	Specification for Carbon Steel Bars for the Reinforcement of Concrete
BS 5950:	Structural Use of Steelwork in Building
Part 3: 1990	Code of practice for design of simple and continuous composite beams
Part 4: 1994	Code of practice for design of composite slabs with profiled steel sheeting
Part 6: 1995	Code of practice for design of light gauge profiled steel sheeting
BS 8110:	Structural Use of Concrete
Part 1: 1985	Code of practice for design and construction
BRANZ Draft Report	Guide to Serviceability Limit State Criteria for New Zealand Buildings, Sept 1995
BRANZ Study Report SR 35	Dynamic Characteristics of New Zealand Heavy Floors, 1991
Chien EYL & Ritchie JK	Design and Construction of Composite Floor Systems – Canadian Institute of Steel Construction, 1984 (ISBN 0-88811-056-1)
Heagler RB, Luttrell LD, Easterling WS	Composite Deck Design Handbook, Steel Decking Institute, Illinois, 1997
HERA Report R4-82	Calculation of the Design Fire Resistance of Composite Concrete Slabs with Profiled Steel Sheet Under Fire Emergency Conditions
HERA Report R4-107	Composite Floor Construction Handbook
HERA Report R4-112	Report and User Manual for NZF1_Vib1 Programme (Analysis of floor vibration)
HERA Report R4-113	Notes Prepared for a Seminar on Composite Design and Construction
HERA Report R4-121	Acoustic Guide
HERA Report R4-131	Design of Composite Steel Floor Systems for Severe Fires Incorporating SPM0306 Software
HSSS2000	HERA Steel Structures Seminar 2000: Floor Vibrations Serviceability Design (contained in Appendix A3.4 of HERA Report R4-113)
Rp001 R00_2006476	Opinion on Flatdeck Concrete Floor Slab Constructions – Marshall Day Acoustics Limited
Rp002 R00_2006476	Opinion on Hibond Concrete Floor Slab Constructions – Marshall Day Acoustics Limited
NZBC	The New Zealand Building Code
NZS 3101:2006	Concrete Structures
NZS 3109:1997	Concrete Construction
NZS 3422:1975	Specification for Welded Fabric of Drawn Steel Wire for Concrete Reinforcement
NZS 4203:1992	General Structural Design and Design Loadings for Buildings

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3.6 REFERENCES USED IN THE FLOORING SYSTEMS SECTION *continued*

NZS 4214:1977	Methods of determining the total thermal resistances of parts of buildings
NZS 4218:1996	Energy Efficiency – Housing and small building envelope
NZS/BS 476:	Fire Tests on Building Materials and Structures
Part 20: 1987	Method for determination of the fire resistance of elements of construction (general principles)
Part 21: 1987	Methods for determination of the fire resistance of loadbearing elements of construction
Part 22: 1987	Methods for determination of the fire resistance of non-loadbearing elements of construction