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.

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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.

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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.

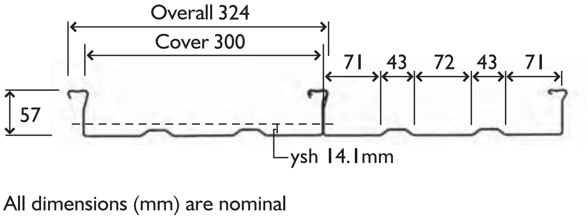
When the Flatdeck sheet is in contact with timber, refer to Section 3.1.3.2 Limitations on Use.

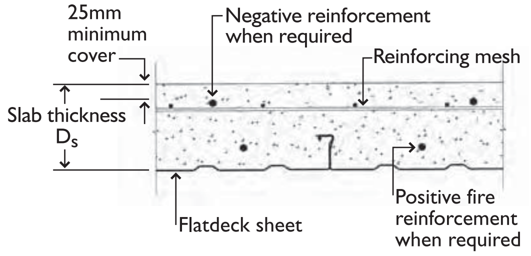
Shear connectors into timber require specific design. These could include galvanised coach screws or reinforcing bar epoxy glued into timber beams and turned into slab.

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.

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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.

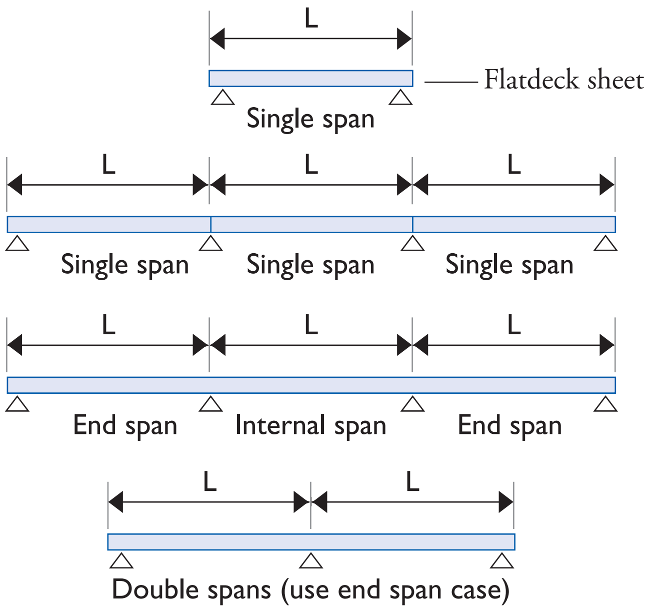
The following notes apply to the formwork tables in this section.

1. D_s is the overall thickness of the slab.
2. Slab weights (G) are based on a wet concrete density of 2400 kg/m³ 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



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

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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 m³/m²	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 m³/m²	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

Continued on next page

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:

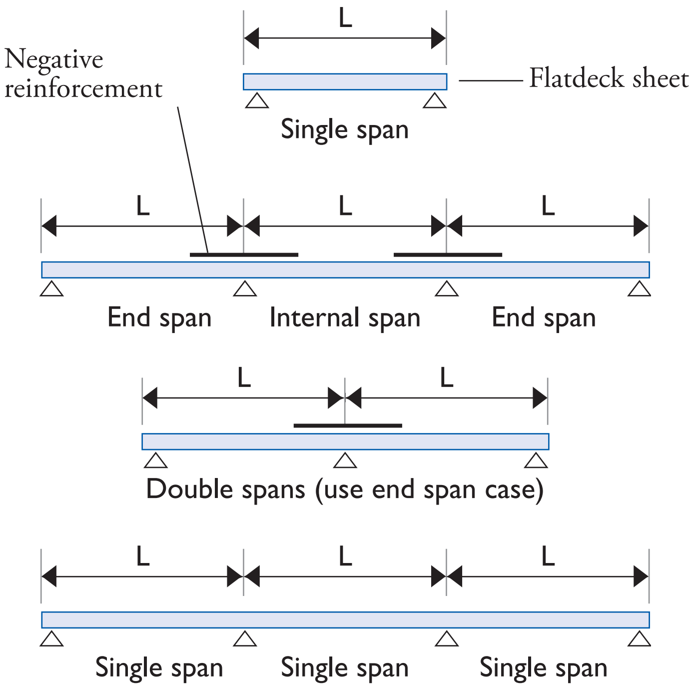
    – – – – Commercial offices, open plan with few small partitions (damping ratio = 0.025)

    ••••••••• 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} 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	7.7	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 (mm^2/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.

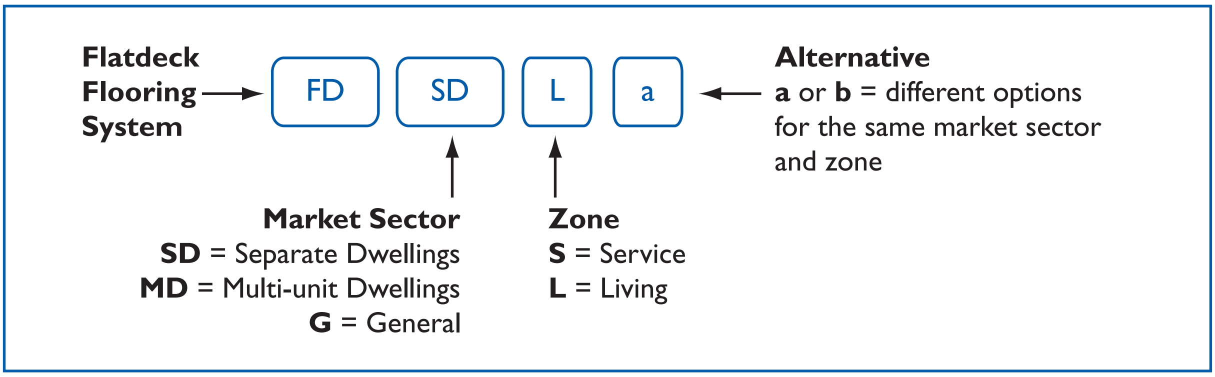
STC and IIC values for the Flatdeck Noise Control System are based upon acoustic opinions and have a margin of error of +/– 2dB for STC and +/– 3dB for IIC.

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 $D_{par} = E_sI_x$

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 x 24)
= 6.33
where E_c = 24 GPa = Modulus of Elasticity for concrete (from NZS 3101)

Therefore $D_{par} = E_sI_x$ = $205 \times 49.2 \times 10^6$
= 10.1×10^9 kNmm^2/m

Static deflection of slab = $\Delta = 5 \times w \times L^4 / (384 \times E_sI_x)$

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,
$\Delta = 5 \times 4.10 \times 5.6^4 \times 10^9/(384 \times 10.1 \times 10^9)$
= 5.2mm

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

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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,

$2 \times 2150 + 2150 = 6450mm$
$\geq$ the required span of 4800mm $\quad \therefore$ 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,

$2 \times 2400 = 4800mm$
$\geq$ the required span of 4800mm $\quad \therefore$ 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	
≥ 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	
≥ 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.

Continued on next page

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 1180mm²/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 ∴ 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* 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,

$M^* = 1.6\ M_Q / b_{eb}$ 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) ∴ 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 $\quad\therefore$ 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 $I_{av} = 9.9 \times 10^6$ mm^4/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

$= 0.015 \times 13.0 \times 3600^3 / (205 \times 10^3 \times 9.9 \times 1406)$
$= 3.2$mm $(L / 1125)$
$\leq$ the limit of $L / 350$ $\quad\therefore$ 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.

Continued on next page

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 $L_{ss}/440$)
≤ 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 $\therefore$ 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

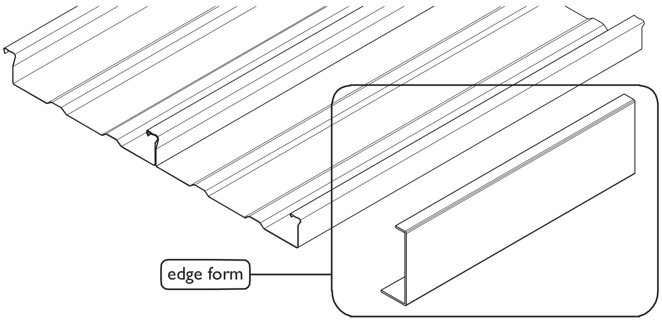
3.4.13.1 EDGE FORM

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.

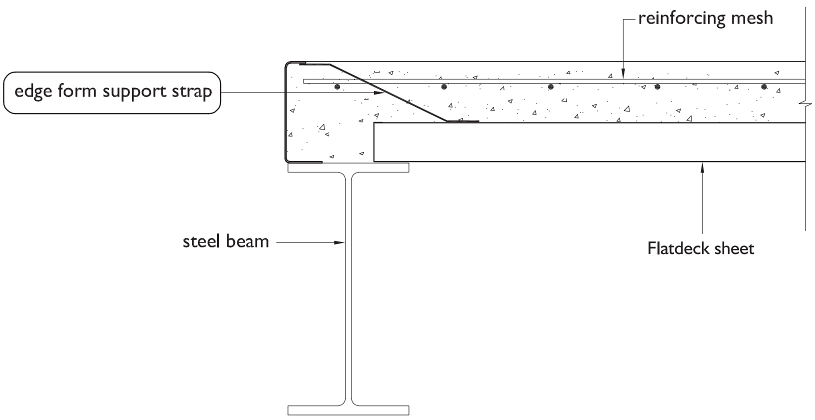
The foot of the edge form is fixed to the structure by self-drilling metal screws or powder actuated fasteners.

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

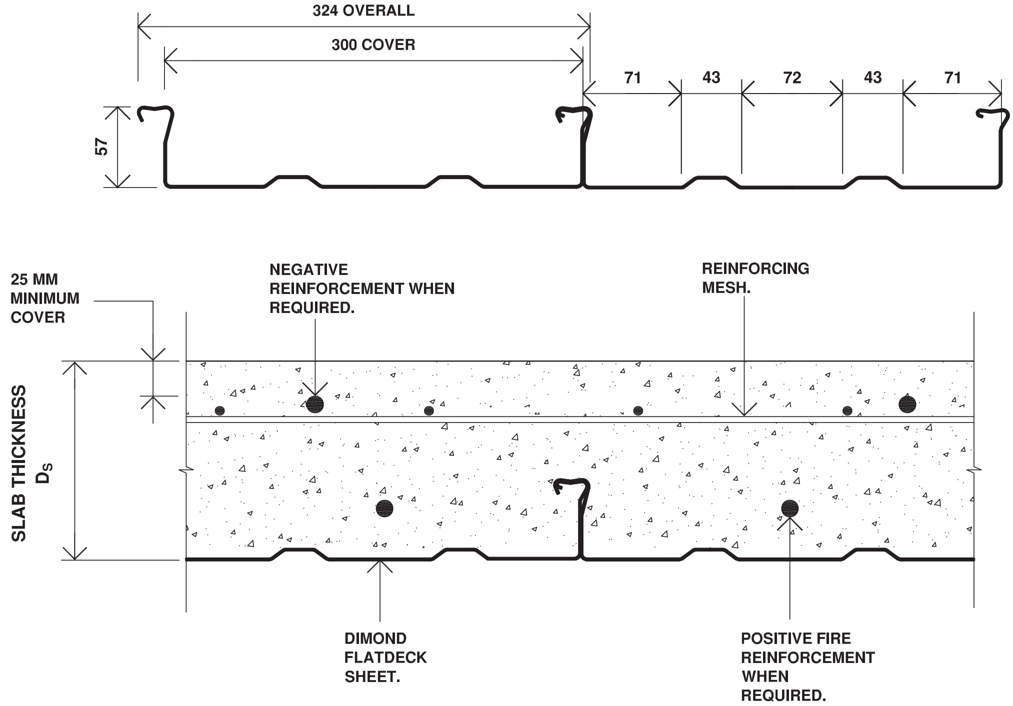
Flatdeck CAD details are shown in this section. For the latest Flatdeck CAD details, please download from the Dimond website **www.dimond.co.nz**. Follow the steps below:

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.

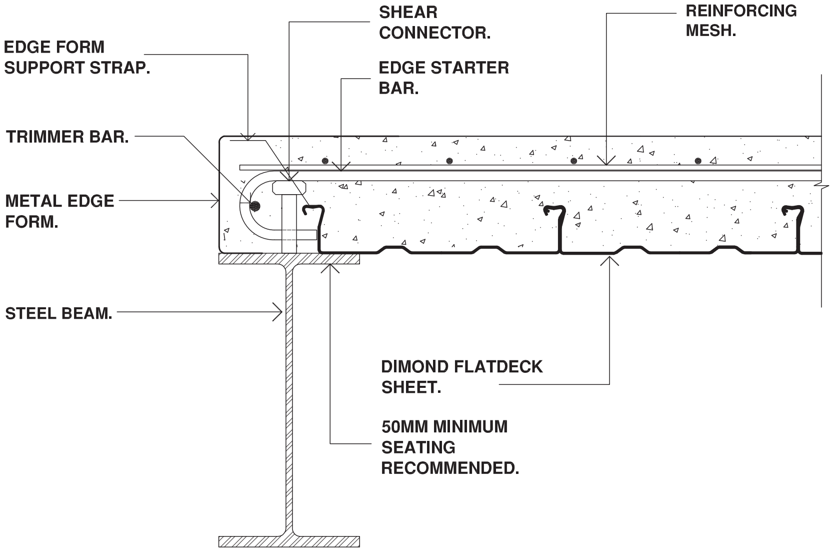
3.4.14 FLATDECK CAD DETAILS

Not to scale



1 – FLATDECK PROFILE

CADREF: 1. flatdeck profile

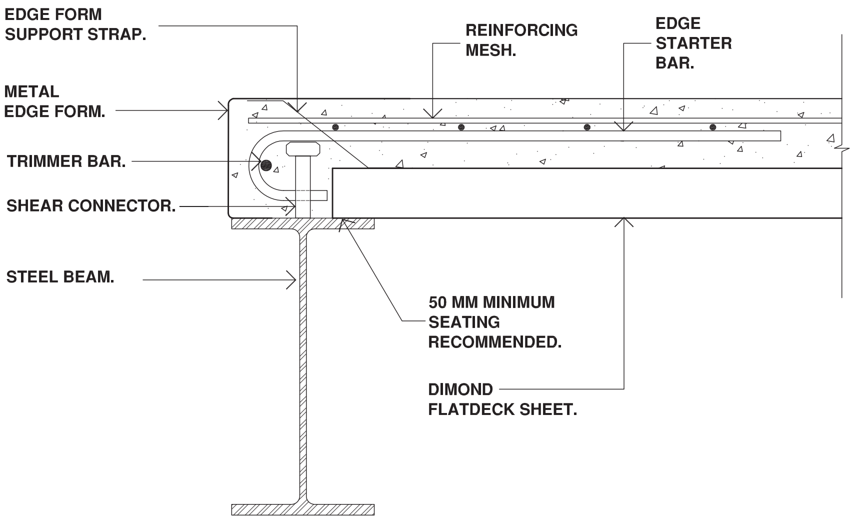


2 – FLATDECK SIDE LAP BEARING ON STEEL BEAM

CADREF: 2. flatdeck side lap bearing on steel beam

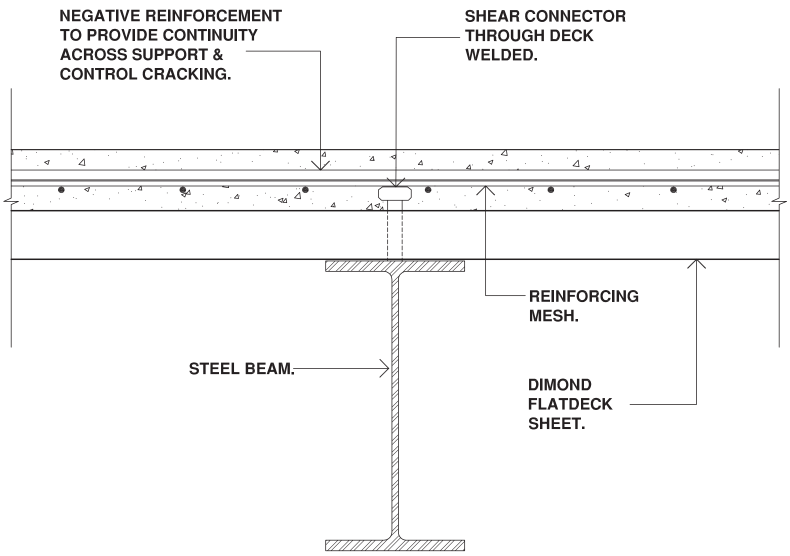
3.4.14 FLATDECK CAD DETAILS *continued*

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*

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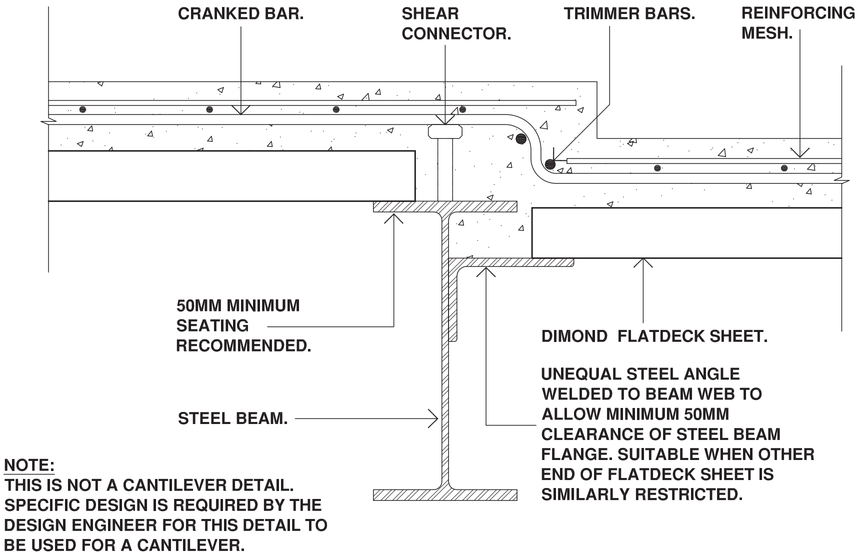
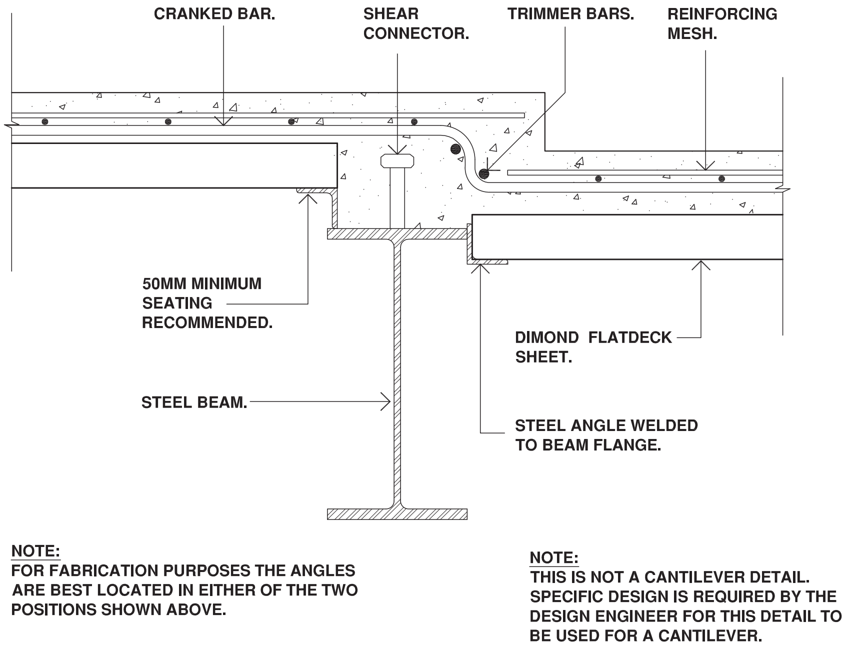


5 – FLATDECK INTERNAL STEP DOWN ON STEEL BEAM – OPTION 1

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*

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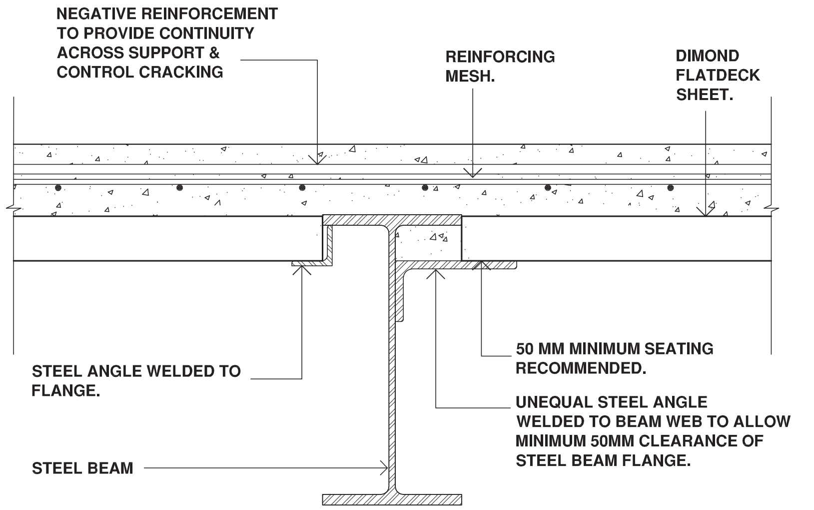
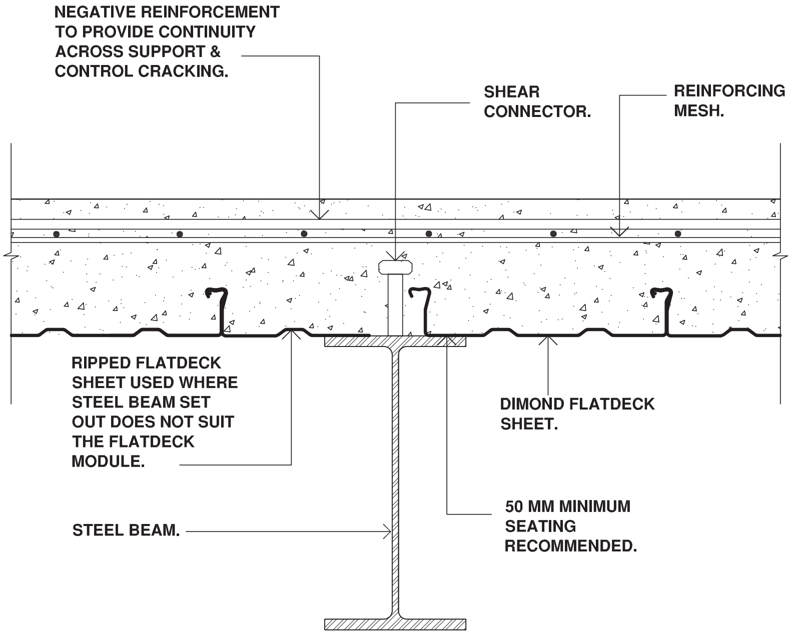


NOTE:
-THIS DETAIL CONTAINS TWO OPTIONS (SHOWN EACH SIDE OF THE BEAM) TO ACHIEVE AN INTERNAL SET DOWN.
-DUE TO THE NECESSITY TO ROTATE FLATDECK DURING INSTALLATION IT IS NOT PRACTICAL TO LOCATE THE FLATDECK SHEET DIRECTLY UNDER THE FLANGE.
-FOR FABRICATION PURPOSES THE EQUAL ANGLE IS BEST LOCATED AS 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*

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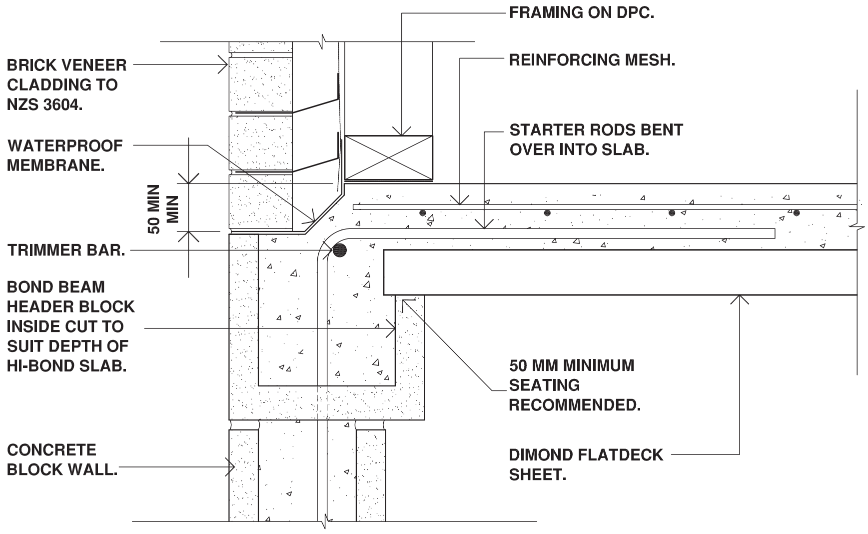
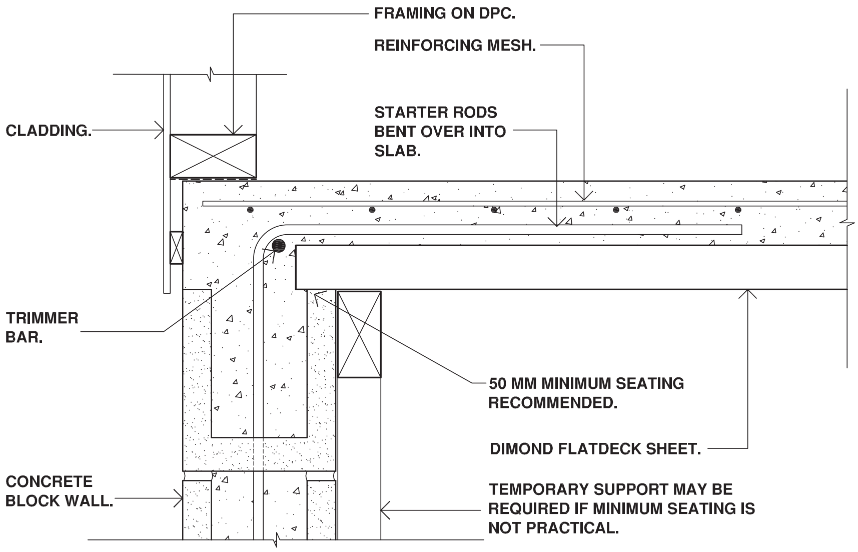


9 – FLATDECK ON MASONRY BLOCK WITH BRICK VENEER

CADREF: 9. flatdeck on masonry block with brick veneer



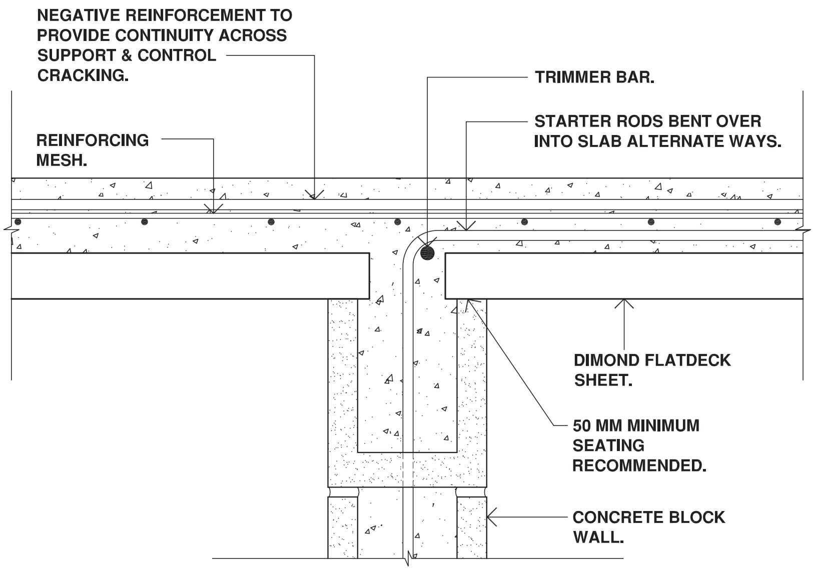
NOTE:
IN SUB FLOOR AREAS THE TEMPORARY SUPPORT MUST EITHER:
-BE REMOVED 28 DAYS AFTER CONCRETE POUR, OR
-HAVE A DPC BARRIER BETWEEN THE TIMBER AND FLATDECK SHEET.

10 – FLATDECK ON MASONRY BLOCK WITH TIMBER WALL

CADREF: 10.flatdeck on masonry block with timber wall

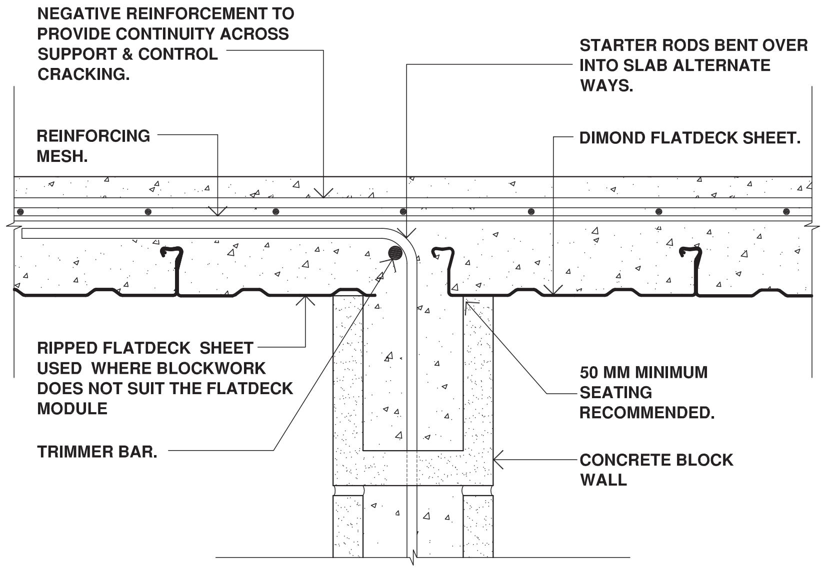
3.4.14 FLATDECK CAD DETAILS *continued*

Not to scale



11 — FLATDECK INTERNAL BEARING ON MASONRY BLOCK WALL

CADREF: 11. flatdeck internal bearing on masonry block wall

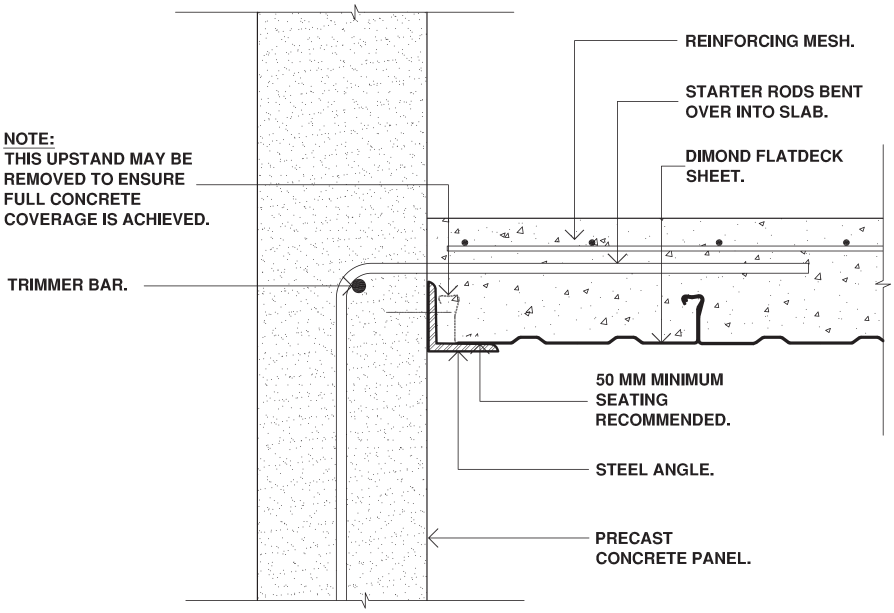


12 — FLATDECK SIDE LAP BEARING ON MASONRY BLOCK WALL

CADREF: 12. flatdeck side lap bearing on masonry block wall

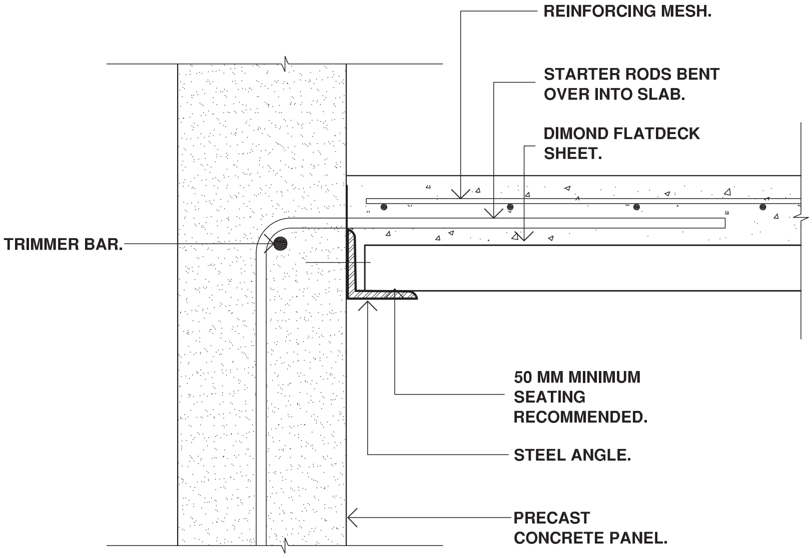
3.4.14 FLATDECK CAD DETAILS *continued*

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