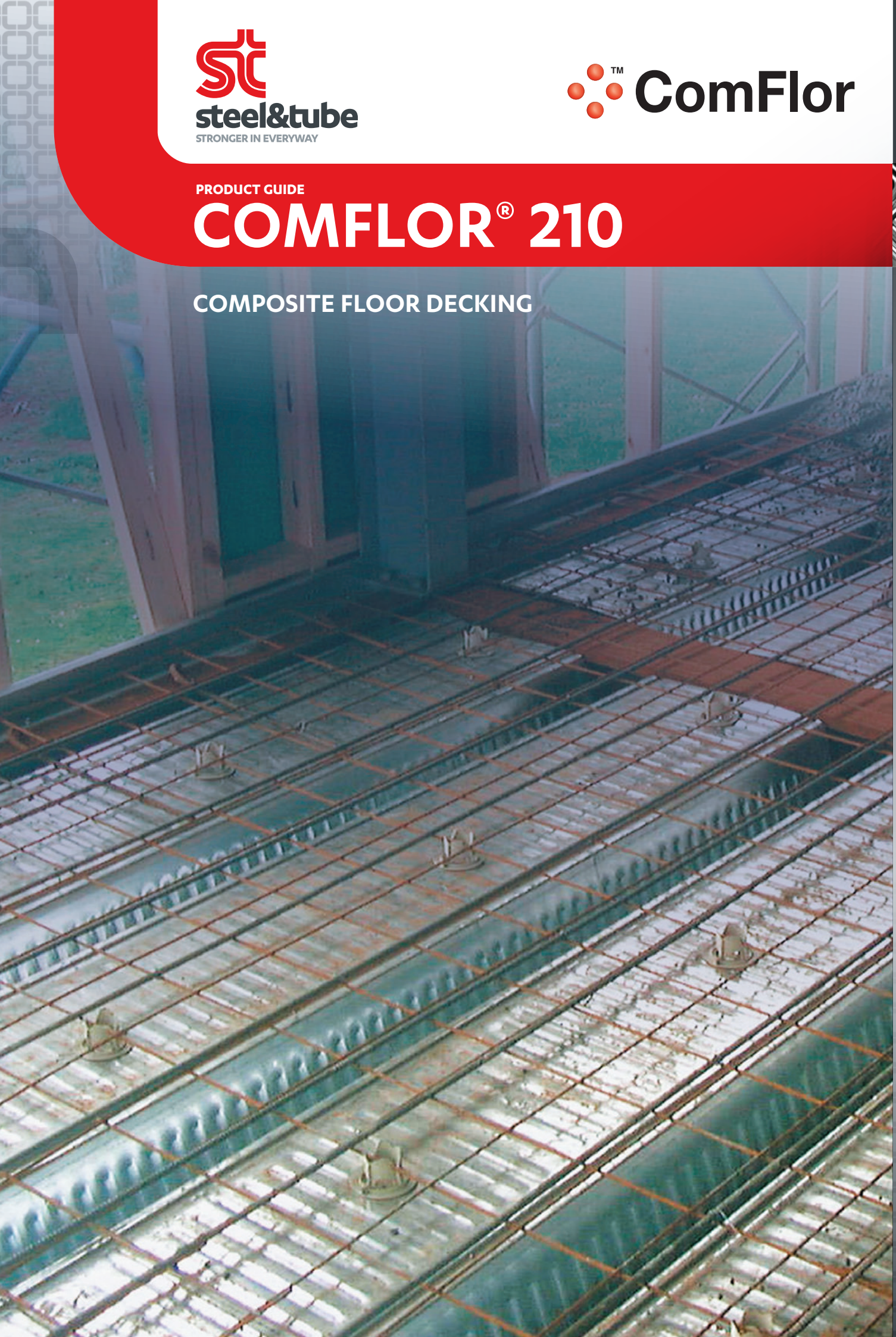
steel&tube
STRONGER IN EVERYWAY

ComFlor™

PRODUCT GUIDE

COMFLOR® 210

COMPOSITE FLOOR DECKING



Photograph:
Canary Wharf Tower, London's Docklands, built with structural steel and stainless steel cladding.

Introduction

Steel & Tube is pleased to provide this ComFlor® Product Guide for your use.

ComFlor, the new generation in composite steel floor decking systems joins Steel & Tube, New Zealand's leading distributor of steel and stainless steel products and services – bringing the world of steel-framed construction closer to you.

Extensive testing has been undertaken in conjunction with the UK-based Steel Construction Institute to ensure ComFlor meets internationally recognised construction standards.

Steel & Tube are applying British research and technology along with New Zealand-made equipment and steel, to manufacture ComFlor right here in New Zealand.

Make ComFlor your first-choice flooring solution for the New Zealand building environment.

To find out more about our range of ComFlor profiles, please visit **www.comflor.co.nz**

To read about Steel & Tube's extensive range of products and solutions sourced and manufactured to international standards, please visit **www.steelandtube.co.nz**

ComFlor® is a registered trade mark used in Australia and New Zealand under licence from Tata Steel UK Limited.

Deep composite floor decks.

Deep Composite Floor decks used in Slimdek construction offer all the benefits of shallow deck composite construction, with some significant additional benefits.

Long span decks

The deck will be designed to span 6m unpropped and up to 9m propped with corresponding reduction in steelwork.

Shallow floor depth

The deck is contained within the beam depth, which produces a “slim floor”. This leads to savings in cladding costs and either helps to reduce the overall building height or enables an extra floor to be added for buildings of 10 storeys plus.

Service integration

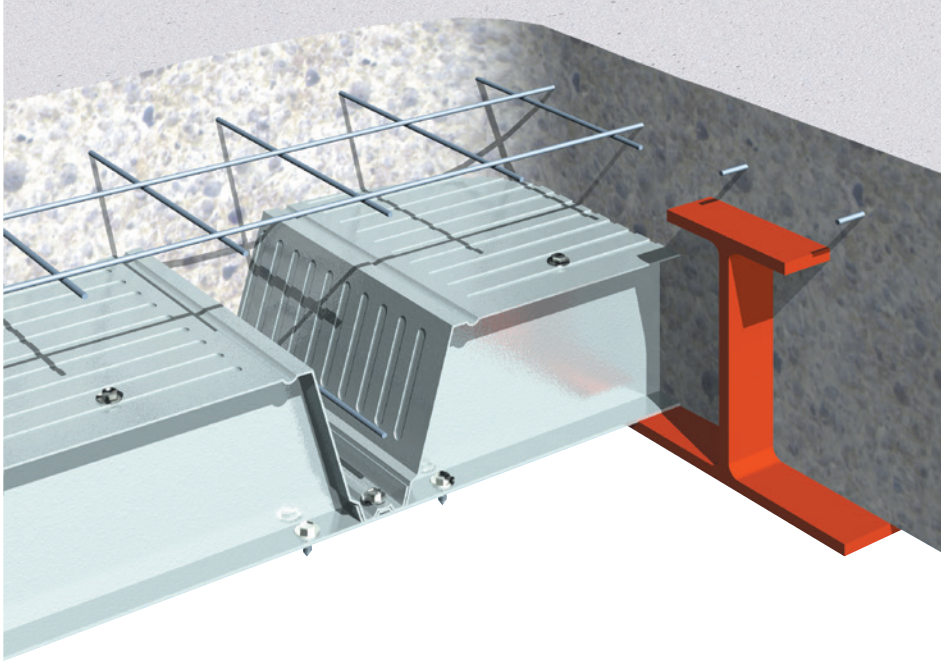
The shape of the deep decks permits services to be installed between the deck ribs, effectively within the slab depth. This leads to further reductions in the floor zone.

Inherent fire resistance

A fire resistance of 60 minutes can be achieved without fire protection to the steelwork or deck.

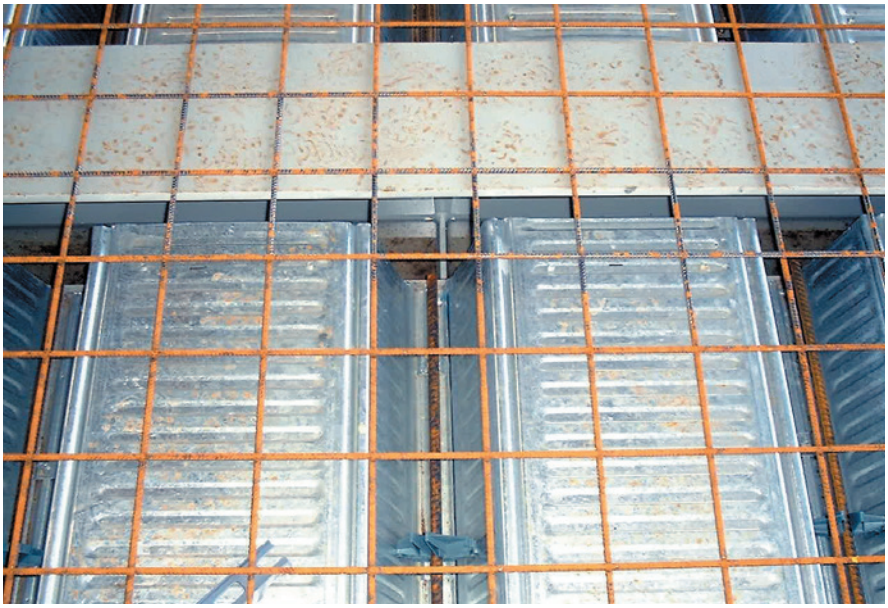
ComFlor® 210

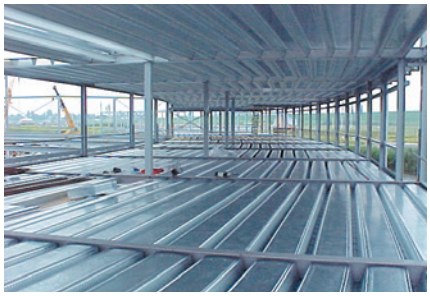
- From the Deep Composite Profile Range

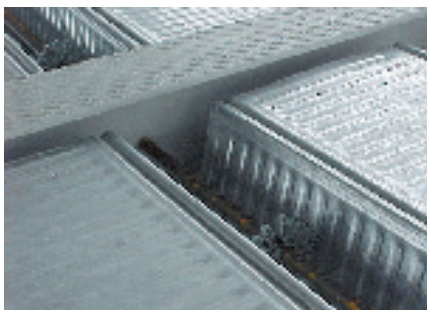


The original SlimFlor long span steel deck, **ComFlor® 210** has the capability to span up to 6 metres in unpropped construction. When used in Slimdek® construction, **ComFlor 210** offers minimal structural depth, fast construction and many other benefits.

- With cross and longitudinal stiffeners, CF210 is structurally efficient and offers excellent composite action with the concrete.
- Simple single bar reinforcement in each trough, combined with anti-crack mesh near the top of the concrete slab gives the composite slab superb structural strength and fire properties.
- The nestable profile shape reduces transport and handling costs.
- Up to 2 hours fire rating with unprotected soffit.

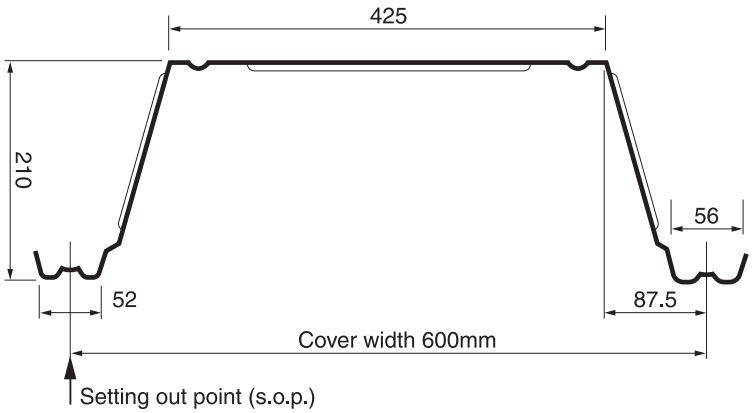






ComFlor® 210 Design information

Full design program available from www.comflor.co.nz



ComFlor 210 Composite Slab - Volume & Weight					
		Weight of Concrete (kN/m²)			
		Normal weight Concrete		Lightweight Concrete	
Slab Depth (mm)	Concrete volume (m³/m²)	Wet	Dry	Wet	Dry
270	0.100	2.36	2.31	1.87	1.77
280	0.110	2.60	2.54	2.05	1.95
290	0.120	2.83	2.77	2.24	2.12
300	0.130	3.07	3.00	2.43	2.30
305	0.135	3.18	3.12	2.52	2.39
310	0.140	3.30	3.23	2.61	2.48
330	0.160	3.77	3.69	2.99	2.83
350	0.180	4.24	4.16	3.36	3.18
375	0.205	4.83	4.73	3.83	3.62
400	0.230	5.42	5.31	4.29	4.07

Volume and weight table notes

1. Deck and beam deflection i.e. ponding is not allowed for in the table.
2. Deck and mesh weight is not included in the weight of concrete figures.
3. Density of concrete is taken as:
   Normal weight (wet) 2400 kg/m²
   Normal weight (dry) 2350 kg/m²
   Lightweight (wet) 1900 kg/m²
   Lightweight (dry) 1800 kg/m²

Section Properties (per metre width)							
						Ultimate Moment Capacity (kNm/m)	
Nominal thickness (mm)	Design thickness (mm)	Profile weight (kN/m²)	Area of steel (mm²/m)	Height to neutral axis (mm)	Moment of inertia (cm⁴/m)	Sagging	Hogging
1.25	1.21	0.16	2009	95.00	816.00	23.20	23.20

Design Notes

Deck material

Zinc coated steel to AS1397 Grade 500, Z275, with a guaranteed minimum yield stress of 500 N/mm². Minimum zinc coating mass is 275 g/m² total including both sides.

Quick reference tables

The quick reference load/span and fire design tables on the following 2 pages are intended for initial design, based on the parameters stated below the tables. The ComFlor calculation suite contained on the CD at the back of this literature provides a full design program.

Please refer to page 22 for help in using the software.

Anti-crack mesh

BS 5950: Part 4 currently recommends that anti-crack mesh should comprise 0.1% of slab area. The Eurocode 4 recommendation is that anti-crack mesh should comprise 0.2% of slab area for unpropped spans and 0.4% of slab area for propped spans. ComFlor in conjunction with the Steel Construction Institute has agreed to modify the requirement with regard to anti-crack mesh, to comply with the Eurocode 4 recommendations. Accordingly, the mesh shown in the quick reference tables complies with EC4 and the design program defaults to these values.
Where EC4 mesh rules are used, the mesh may be reduced midspan - see Design Information on page 10. The reduced BS mesh values may still be used by overriding this default in the design program.

Mesh top cover must be a minimum of 15mm, and a maximum of 30mm. Mesh laps are to be 300mm for A142 mesh and 400mm for A193, A252 & A393 mesh.

Technical services

ComFlor Technical Department offer a comprehensive advisory service on design of composite flooring, which is available to all specifiers and users. Should queries arise which are not covered by this literature or by the design CD, please contact us.

This service is available by contacting ComFlor at comflor@comflor.co.nz or call +64 9 271 1780.

The ComFlor 210 profile is currently an alternative solution as it is outside the scope of AS/NZS 2327, due to not complying with the geometric ratio limit stated in section 2.1.1 (bs/bm = 0.6). Steel & Tube believe that this ratio was implemented to ensure satisfactory performance and simple design procedures for shallow deck profiles under point loads and is not applicable to deep deck profiles such as ComFlor210. The design program available at www.comflor.co.nz currently adopts a more conservative approach to that used for the previous, BS5950 based version. Testing/work is underway to develop a formal compliance pathway. Currently, engineers, architects and building designers will need to consider the alternative solution pathway to building code compliance for this product.

ComFlor® 210 Normal weight concrete - quick reference tables

ComFlor 210 Span table - Normal weight Concrete

Props	Span	Fire Rating	Slab Depth (mm)	Mesh	MAXIMUM SPAN (m) Total Applied Load (kN/m²) 3.5kN/m² Bar Size (mm) 12	16	20	25	5kN/m² 12	16	20	25	10kN/m² 12	16	20	25
No Temporary props	Simple span slab	1 hr	280	A142	4.8	5.4	5.4	5.4	4.3	5.4	5.4	5.4	3.4	4.5	5.4	5.4
			300	A193	4.8	5.2	5.2	5.2	4.4	5.2	5.2	5.2	3.5	4.6	5.2	5.2
			350	A393	4.7	4.7	4.7	4.7	4.5	4.7	4.7	4.7	3.7	4.7	4.7	4.7
		1.5 hr	290	A193	3.7	4.9	5.3	5.3	3.4	4.4	5.3	5.3	2.7	3.5	4.3	5.3
			300	A193	3.7	4.9	5.2	5.2	3.4	4.5	5.2	5.2	2.7	3.6	4.4	5.2
			350	A393	3.8	4.7	4.7	4.7	3.5	4.6	4.7	4.7	2.8	3.8	4.6	4.7
		2 hr	305	A193	2.0	2.7	3.3	4.1	1.8	2.4	3.0	3.7	1.5	1.9	2.4	3.0
			350	A393	2.1	2.7	3.4	4.2	1.9	2.5	3.1	3.8	1.5	2.0	2.5	3.1
			400	A393	2.1	2.7	3.4	4.2	1.9	2.6	3.2	3.9	1.6	2.1	2.6	3.3
1 Line of Temporary props	Simple span slab	1 hr	280	A393	4.9	6.4	7.3	7.3	4.4	5.8	7.2	7.3	3.4	4.5	5.6	6.2
			300	A393	4.9	6.5	6.7	6.7	4.5	5.9	6.7	6.7	3.5	4.7	5.8	6.6
			350	2xA393	5.1	5.6	5.6	5.6	4.6	5.6	5.6	5.6	3.7	4.9	5.6	5.6
		1.5 hr	290	A393	3.7	5.0	6.2	7.0	3.4	4.5	5.5	6.9	2.7	3.5	4.4	5.4
			300	A393	3.8	5.0	6.2	6.7	3.4	4.5	5.6	6.7	2.7	3.6	4.4	5.5
			350	2xA393	3.8	5.1	5.6	5.6	3.5	4.7	5.6	5.6	2.9	3.8	4.7	5.6
		2 hr	305	A393	2.0	2.7	3.3	4.1	1.8	2.4	3.0	3.7	1.5	1.9	2.4	3.0
			350	2xA393	2.1	2.7	3.4	4.2	1.9	2.5	3.1	3.9	1.5	2.0	2.5	3.1
			400	2xA393	2.1	2.8	3.4	4.3	1.9	2.6	3.2	3.9	1.6	2.1	2.6	3.3
	Continuous span slab	1 hr	280	A393	5.7	7.1	7.3	7.3	5.1	6.3	7.3	7.3	4.0	4.9	5.9	6.7
			300	A393	5.8	6.7	6.7	6.7	5.3	6.5	6.7	6.7	4.2	5.1	6.2	6.7
			350	2xA393	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	4.6	5.6	5.6	5.6
		1.5 hr	290	A393	4.3	5.4	6.5	7.0	3.9	4.8	5.8	7.0	3.0	3.8	4.6	5.6
			300	A393	4.4	5.4	6.6	6.7	3.9	4.9	5.9	6.7	3.1	3.9	4.7	5.7
			350	2x A393	4.7	5.6	5.6	5.6	4.3	5.3	5.6	5.6	3.5	4.2	5.1	5.6
		2 hr	305	A393	2.6	3.1	3.7	4.4	2.3	2.8	3.3	4.0	1.9	2.2	2.6	3.2
			350	2xA393	2.8	3.4	3.9	4.6	2.6	3.1	3.6	4.3	2.1	2.5	2.9	3.4
			400	2xA393	3.1	3.6	4.2	4.8	2.9	3.4	3.9	4.5	2.4	2.8	3.2	3.7
2 Lines of Temporary props	Simple span slab	1 hr	280	A393	4.9	6.4	7.6	7.8	4.4	5.8	7.2	7.4	3.4	4.5	5.6	6.2
			300	A393	4.9	6.5	7.7	8.0	4.5	5.9	7.3	7.7	3.5	4.7	5.8	6.6
			350	2xA393	5.0	6.6	8.0	8.3	4.6	6.1	7.6	8.2	3.7	4.9	6.1	7.4
		1.5 hr	290	A393	3.7	5.0	6.2	7.6	3.4	4.5	5.6	6.9	2.7	3.5	4.4	5.4
			300	A393	3.8	5.0	6.2	7.7	3.4	4.5	5.6	6.9	2.7	3.6	4.4	5.5
			350	2x A393	3.8	5.1	6.3	7.8	3.5	4.7	5.8	7.2	2.9	3.8	4.7	5.8
		2 hr	305	A393	2.0	2.7	3.3	4.1	1.8	2.4	3.0	3.7	1.5	1.9	2.4	3.0
			350	2xA393	2.1	2.7	3.4	4.2	1.9	2.5	3.1	3.9	1.5	2.0	2.5	3.1
			400	2xA393	2.1	2.8	3.4	4.3	1.9	2.6	3.2	3.9	1.6	2.1	2.6	3.3
	Continuous span slab	1 hr	280	A393	5.7	7.1	8.0	8.3	5.1	5.3	7.8	7.9	4.0	4.9	5.9	6.7
			300	A393	5.8	7.2	8.3	8.5	5.3	6.5	7.8	8.1	4.2	5.2	6.2	7.1
			350	2xA393	6.2	7.6	8.7	8.7	5.7	7.0	8.6	8.7	4.6	5.6	6.7	7.5
		1.5 hr	290	A393	4.3	5.4	6.5	7.9	3.9	4.8	5.9	7.1	3.0	3.8	4.6	5.6
			300	A393	4.4	5.4	6.6	8.0	3.9	4.9	5.9	7.4	3.1	3.9	4.7	5.2
			350	2x A393	4.7	5.7	6.9	8.3	4.3	5.3	6.3	7.6	3.5	4.3	5.1	5.8
		2 hr	305	A393	2.6	3.1	3.7	4.4	2.3	2.8	3.3	4.0	1.9	2.2	2.6	3.2
			350	2xA393	2.8	3.4	3.9	4.6	2.6	3.1	3.6	4.3	2.1	2.5	2.9	3.4
			400	2xA393	3.1	3.6	4.2	4.9	2.9	3.4	3.9	4.5	2.4	2.8	3.2	3.7

Parameters assumed for quick reference span tables

Mesh See notes on previous page.

Spans Measured centre to centre of supports.

Deck Standard deck material specification (see previous page).

Bearing width The width of the support is assumed to be 200mm.

Prop width Assumed to be 100mm.

Deflection Construction stage L/130 or 30mm (ponding has been taken into account).

Deflection Composite stage L/350.

Concrete grade The concrete is assumed to be Grade 35* with a maximum aggregate size of 20mm. The wet weight of concrete is taken to be normal weight 2400kg/m^3 and lightweight 1900 kg/m^3. The modular ratio is 10 for normal weight and 15 for lightweight concrete.

Construction load Refer to page 9 for details. No allowance is made for heaping of concrete during the casting operation.

*Concrete grade is cube strength. Grade 35 is equivalent to 30 MPa.

ComFlor® 210 Lightweight concrete - quick reference tables

ComFlor 210 Span table - Lightweight Concrete

Props	Span	Fire Rating	Slab Depth (mm)	Mesh	MAXIMUM SPAN (m) Total Applied Load (kN/m²) 3.5kN/m² Bar Size (mm) 12	16	20	25	5kN/m² Bar Size (mm) 12	16	20	25	10kN/m² Bar Size (mm) 12	16	20	25
No Temporary props	Simple span slab	1 hr	270	A142	5.0	6.0	6.0	6.0	4.5	5.9	6.0	6.0	3.5	4.6	5.6	5.8
			300	A193	5.1	5.6	5.6	5.6	4.6	5.6	5.6	5.6	3.6	4.8	5.6	5.6
			350	A393	5.0	5.0	5.0	5.0	4.8	5.0	5.0	5.0	3.9	5.0	5.0	5.0
		1.5 hr	280	A142	4.3	5.6	5.8	5.8	3.9	5.1	5.8	5.8	3.0	4.0	4.9	5.8
			300	A193	4.4	5.6	5.6	5.6	4.0	5.2	5.6	5.6	3.1	4.1	5.0	5.6
			350	A393	4.5	5.0	5.0	5.0	4.1	5.0	5.0	5.0	3.3	4.3	5.0	5.0
		2 hr	290	A193	3.1	4.1	5.0	5.7	2.8	3.7	4.5	5.6	2.2	2.8	3.5	4.4
			350	A393	3.2	4.2	5.0	5.0	2.9	3.9	4.8	5.0	2.3	3.1	3.8	4.7
			400	A393	3.3	4.3	4.7	4.7	3.0	4.0	4.7	4.7	2.4	3.2	4.0	4.7
1 Line of Temporary props	Simple span slab	1 hr	270	A393	5.1	6.7	7.5	7.7	4.5	6.0	7.0	7.2	3.5	4.6	5.6	5.8
			300	A393	5.2	6.9	7.6	7.6	4.7	6.2	7.4	7.6	3.6	4.8	5.9	6.4
			350	2xA393	5.4	6.4	6.4	6.4	4.9	6.4	6.4	6.4	3.9	5.1	6.4	6.4
		1.5 hr	280	A393	4.4	5.8	7.2	7.8	3.9	5.1	6.4	7.4	3.0	4.0	4.9	6.0
			300	A393	4.4	5.9	7.3	7.6	4.0	5.3	6.5	7.6	3.1	4.1	5.1	6.3
			350	2xA393	4.6	6.0	6.4	6.4	4.1	5.5	6.4	6.4	3.3	4.4	5.4	6.4
		2 hr	290	A393	3.1	4.1	5.1	6.4	2.8	3.8	4.6	5.7	2.2	2.8	3.5	4.4
			350	2xA393	3.2	4.3	5.3	6.4	2.9	3.9	4.8	6.1	2.3	3.1	3.8	4.8
			400	2xA393	3.3	4.4	5.4	5.6	3.0	4.0	5.0	5.6	2.4	3.2	4.0	5.0
	Continuous span slab	1 hr	270	A393	6.0	7.4	7.9	8.1	5.3	6.6	7.4	7.6	4.0	5.0	6.0	6.2
			300	A393	6.3	7.6	7.6	7.6	5.6	6.9	7.6	7.6	4.3	5.4	6.4	6.9
			350	2xA393	6.4	6.4	6.4	6.4	6.1	6.4	6.4	6.4	4.8	5.9	6.4	6.4
		1.5 hr	280	A393	5.1	6.2	7.5	8.2	4.4	5.6	6.7	7.8	3.4	4.3	5.1	6.3
			300	A393	5.1	6.4	7.6	7.6	4.6	5.7	6.9	7.6	3.6	4.4	5.4	6.5
			350	2x A393	5.5	6.4	6.4	6.4	5.0	6.2	6.4	6.4	4.0	4.9	5.8	6.4
		2 hr	290	A393	3.7	4.5	5.5	6.6	3.3	4.0	4.9	5.9	2.5	3.1	3.8	4.6
			350	2xA393	4.0	4.9	5.8	6.4	3.7	4.5	5.3	6.4	2.9	3.5	4.2	5.0
			400	2xA393	4.4	5.2	5.6	5.6	4.0	4.8	5.6	5.6	3.2	3.9	4.6	5.4
2 Lines of Temporary props	Simple span slab	1 hr	270	A393	5.1	6.7	7.5	7.7	4.5	6.0	7.0	7.2	3.5	4.6	5.6	5.8
			300	A393	5.2	6.9	7.9	8.1	4.7	6.2	7.5	7.7	3.6	4.8	5.9	6.4
			350	2xA393	5.4	7.1	8.3	8.5	4.9	6.5	8.0	8.3	3.9	5.1	6.4	7.1
		1.5 hr	280	A393	4.4	5.8	7.2	7.8	3.9	5.1	6.4	7.4	3.0	4.0	4.9	6.0
			300	A393	4.4	5.9	7.3	8.1	4.0	5.3	6.5	7.7	3.1	4.1	5.1	6.3
			350	2x A393	4.6	6.1	7.5	8.5	4.1	5.5	6.8	8.3	3.3	4.4	5.4	6.7
		2 hr	290	A393	3.1	4.1	5.1	6.4	2.8	3.7	4.6	5.7	2.2	2.8	3.5	4.4
			350	2xA393	3.2	4.3	5.3	6.6	2.9	3.9	4.8	6.0	2.3	3.1	3.8	4.8
			400	2xA393	3.3	4.4	5.4	6.8	3.0	4.0	5.0	6.2	2.4	3.2	4.0	5.0
	Continuous span slab	1 hr	270	A393	6.0	7.4	7.9	8.1	5.3	6.6	7.4	7.6	4.0	5.0	6.0	6.2
			300	A393	6.3	7.7	8.3	8.6	5.6	6.9	7.9	8.1	4.3	5.3	6.4	6.9
			350	2xA393	6.7	8.2	8.9	9.2	6.1	7.5	8.5	8.8	4.8	5.9	6.6	7.1
		1.5 hr	280	A393	5.0	6.3	7.6	8.3	4.4	5.6	6.7	7.8	3.4	4.3	5.1	6.3
			300	A393	5.1	6.4	7.7	8.6	4.6	5.7	6.9	8.1	3.6	4.4	5.4	6.5
			350	2x A393	5.5	6.8	8.2	9.2	5.0	6.2	7.4	8.8	4.0	4.9	5.8	7.1
		2 hr	290	A393	3.7	4.5	5.5	6.6	3.3	4.0	4.9	5.9	2.5	3.1	3.8	4.6
			350	2xA393	4.0	4.9	5.8	7.0	3.7	4.5	5.3	6.4	2.9	3.5	4.2	5.0
			400	2xA393	4.4	5.3	6.2	7.4	4.0	4.8	5.7	6.7	3.2	3.9	4.6	5.4

Bar reinforcement End Anchorage for bar reinforcement. All cases require properly anchored L-bars at the supports, except for those boxed in red. Cases boxed in red may have straight bars, with an anchorage length of 70mm from the edge of the support. See Design Notes on page 10 for further information.

One bar is placed in each profile trough, the cover to deck soffit is assumed at 70mm.

Fire The Fire Engineering method (FE) has been used to calculate the reinforcement needed to achieve the fire rating.

The minimum slab thickness indicated in each table for each fire rating satisfies the fire insulation requirements of BS 5950 : Part 8.

Span/depth ratio This is limited to 30 for lightweight concrete and 35 for normal weight concrete.

Deep Composite Floor Decks
-Design information

Deep Composite Floor Decks will be considered where longer span (4m plus) floor slabs are required. When combined with Slimdek® system, deep decks are designed to achieve a very shallow overall structural floor - hence the term Slim Floor Construction.

Deep Composite Floor Decks

Deep Composite Floor Decks will be used in one of these applications:

1 Slimdek system.

2 Long span composite concrete/steel floor deck in composite steel construction.

3 Long span composite concrete/steel floor deck in masonry construction.

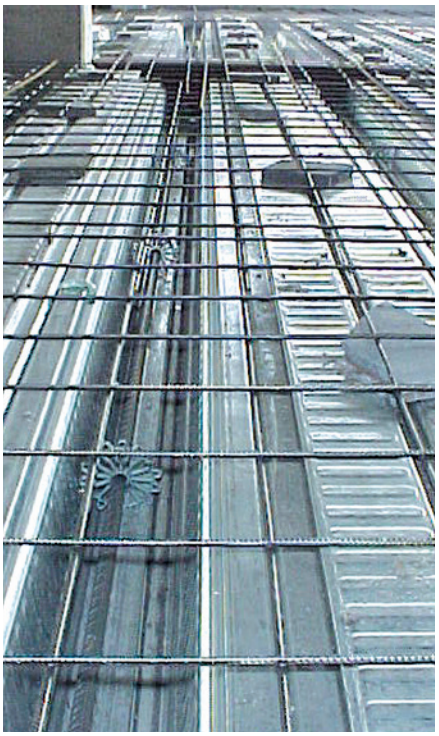
The design considerations relating to the decking are similar for all these applications.

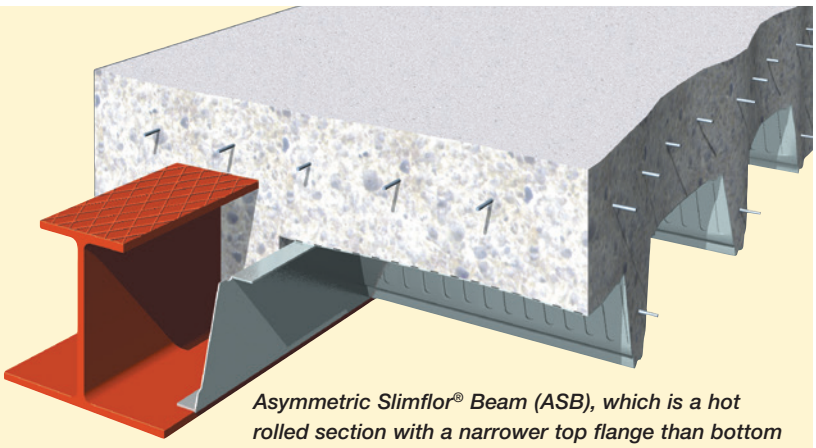
Slimdek® System

The most recent slim floor development produced is the Slimdek® system. This system comprises Asymmetric Slimflor® beams and deep SD225 decking. ComFlor 210 can be subsituted for SD225 decking.

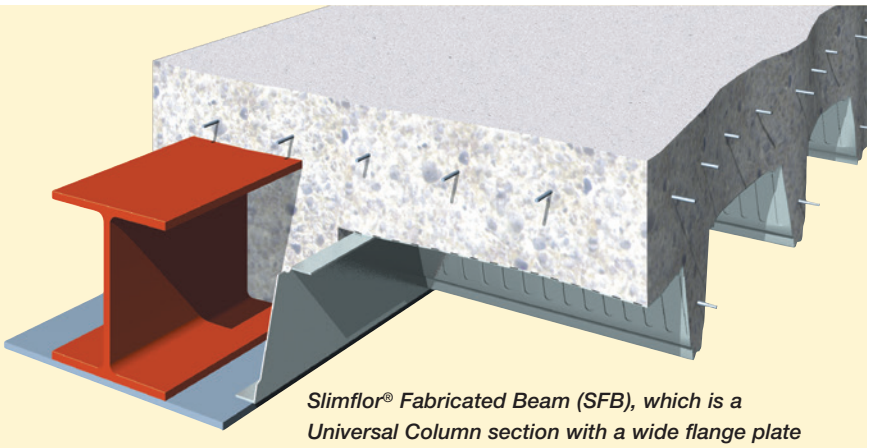
The principle of Slimdek® is that the steel deck (and thus the composite concrete slab) bears on the lower flange of the beam, thus containing the beam within the floor slab.

Three different types of Slimflor® beams are produced:

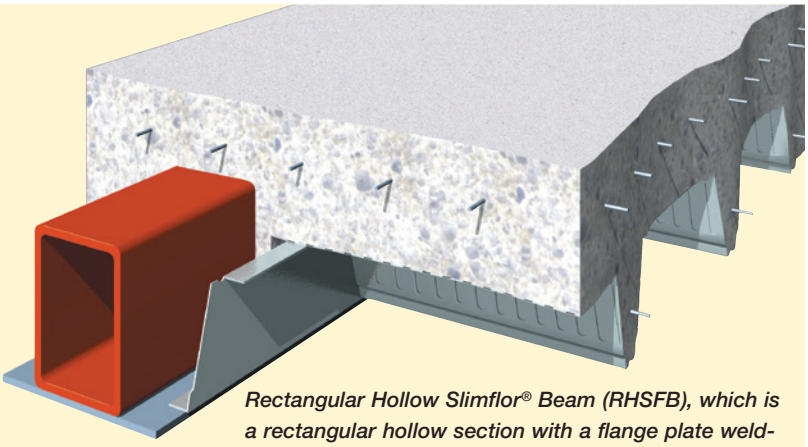




Asymmetric Slimflor® Beam (ASB), which is a hot rolled section with a narrower top flange than bottom flange.



Slimflor® Fabricated Beam (SFB), which is a Universal Column section with a wide flange plate welded to its underside.



Rectangular Hollow Slimflor® Beam (RHSFB), which is a rectangular hollow section with a flange plate welded to its lower face (generally used for edge beams).

Deep Composite Floor Decks
-Design information

Slimdek® Design Procedure

There are two distinct stages for which the elements of the Slimdek® system must be designed. The first is the construction stage, during which the beams and decking support the loads as non-composite sections. The second is the final stage, during which the decking and concrete act together to form composite slabs, as do (generally) the ASBs and slab. SFBs and RHSFBs will act compositely if shear studs have been provided.

The key design points are:

- Consideration of the required spans will allow the depth of the beams to be determined.
- Consideration of the required fire resistance will allow the depth of slab to be determined, as a function of the cover required for the beams and the decking.

Having established these scheme design parameters, detailed design of the beams and slab can be undertaken. The following slab depths should be considered as typical:
280 ASB sections - 290-320mm deep slab
300 ASB sections - 315-340mm deep slab.

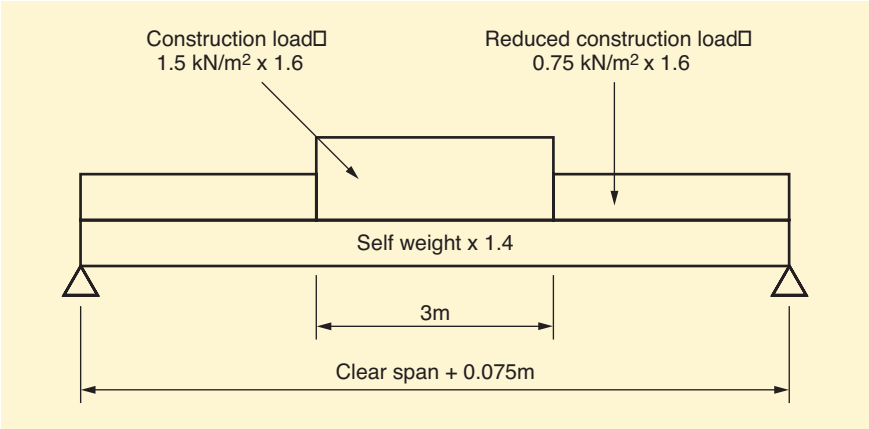
These depths will provide adequate cover to the ASB for it to act compositely with the slab. For SFBs a greater range of slab depths may be considered for a given depth of beam; the slab depth requirement will depend on whether shear studs must be accommodated to make the SFB act compositely.

Slimdek® Beam Design

The design of the beams in the Slimdek® system is presented in The Slimdek® Manual and Design Software. Further detailed design information is available in The Steel Construction Institute publications: P300 Composite Slabs and Beams Using Steel Decking: Best Practice for Design and Construction, P055 Design of Composite Slabs and Beams with Steel Decking. Please see references section for further information.

Decking Design

In addition to considering the self-weight of the slab, the design of the deep decking should take into account temporary construction loads. These construction loads differ slightly from those that should be considered for shallow decking, because of the considerably greater spans that can be achieved with deep decking.



Loading on deep decking at Construction stage.

Construction Stage Loading

The 1.5 kN/m^2 construction load required by BS 5950-4 should only be applied over the middle 3m of the span, as shown above.

A reduced load of 0.75 kN/m^2 (as specified in EC4) may be applied outside this region, as it would be overly conservative to apply the full load of 1.5kN/m^2 over the entire span. The effect of concrete ponding should be taken into account (by increasing the self weight of the slab) if the deflection under self-weight alone exceeds the lesser of span/180 or 20mm.

If temporary props are used to support the decking during construction, a construction load of 1.5 kN/m2 should be considered as acting over the complete span (between permanent supports). Although a lower value might be justifiable over parts of the span, a constant load should be considered for design simplicity.

Temporary propping (when required)

The spacing of temporary props is governed by the ability of the decking to resist combined bending and shear in the hogging (negative) moment regions over the lines of props. It is recommended that the spacing between the props should be relatively close, so that local loads do not cause damage to the decking (2.5m to 3.5m spacing depending on the slab weight). A 100 mm wide timber bearer should be used to distribute the load at these points.

End Bearing

The end bearing of the sheets should be specified as 50 mm. The flange widths are such that this bearing can be achieved, whilst still allowing the sheets to be dropped vertically into position (i.e. without having to 'thread' them between the top and bottom flanges).

Deep Composite Floor Decks
-Design information

Slab Design

The design of composite slabs using deep decking differs from that for shallow decking in the following ways:

Placing bar reinforcement in the troughs of the decking increases the ultimate load resistance of the slab. The benefit of these bars is considered in both the 'normal' and fire conditions.

The slab depth may need to be chosen not only to satisfy the structural, durability and fire resistance requirements of the slab itself, but also to provide appropriate cover over ASB or Slimflor beams.

The reinforcing bars in the troughs of the decking provide additional tensile area to that provided by the decking, and thus enhance the bending resistance of the composite slab.

Bar diameters range from 8 mm to 32 mm, depending on the span and fire resistance requirements.

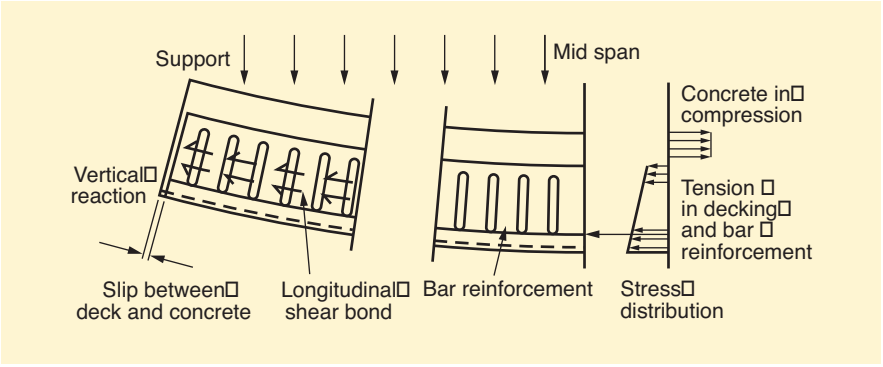
Straight bars may be used to achieve 60 minutes fire resistance (provided that shear stresses are low). In other cases, L bars should be used to provide sufficient end anchorage in fire conditions.

Cracking

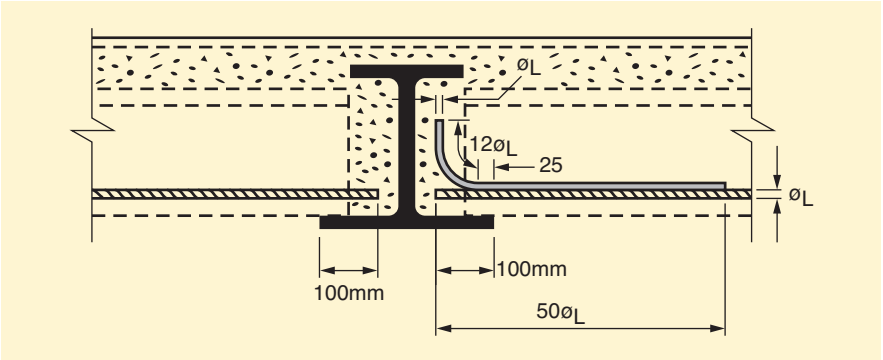
It is normal for some cracking to occur in the slab over the beams. These cracks run parallel with the beams and are not detrimental to the structural behaviour of the slab. They may be controlled by mesh reinforcement provided across the tops of the beams. Guidance on the detailing of reinforcement to control cracking may be found in the Slimdek® manual.

Additional reinforcement may be required to fulfil the following roles:

- Transverse reinforcement adjacent to shear connectors.
- U-bars at composite edge beams.
- Additional crack control reinforcements
- Strengthening around openings.
- Strengthening at positions of concentrated loads.



Action of composite slab with reinforcement in ribs.



Detailing requirements for deep composite slabs (need for L bars depends on level of shear stress).

Fire Resistance

	Concrete thickness above deck	
Fire resistance	NWC	LWC
60min	70mm	60mm
90min	80mm	70mm
120min	95mm	80mm

One of the principal considerations governing the choice of slab depth is the required fire resistance period. Minimum depths are given above as a function of the concrete type and fire resistance required and are based on insulation requirements.

The Fire Engineering Method: The capacity assessment in fire is based on a single or double layer of standard mesh at the top and one bar in each concrete rib. For CF210 or SD 225 decking, the bar is placed at an axis distance, dependent on the fire resistance period. The axis distance must not be less than 70mm. To maximise fire resistance capacity the axis distance needs to be 70, 90 and 120mm (from the soffit of the deck) for 60, 90 and 120 mins. fire resistance, respectively. However where fire resistance is not the limiting factor it may be more effective for the axis distance to be at the minimum.

Reduced Mesh

Where EC4 mesh rules are used, as recommended by The Steel Construction Institute, the full stipulated mesh applies to the slab 1.2m either side of every support. Outside of this, i.e. in the midspan area, the mesh area may be halved (to 0.2% for propped and 0.1% for unpropped construction), provided there are no concentrated loads, openings etc. to be considered. Also the reduced midspan mesh must be checked for adequacy under fire, for the rating required.

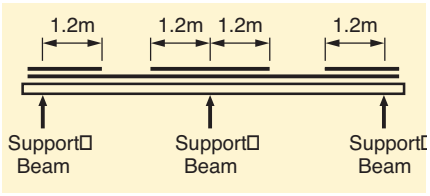


Diagram showing full mesh area over supports

Deep Composite Floor Decks
-Design information

Vibration

The dynamic sensitivity of the composite slab should be checked in accordance with the SCI publication P076: Design guide on the vibration of floors. The natural frequency is calculated using the self-weight of the slab, ceiling and services, screed and 10% imposed loads, representing the permanent loads and the floor self weight.

In the absence of more appropriate information, the natural frequency of the composite slab should not exceed 5Hz for normal office, industrial or domestic usage. For designs using SD225 or CF210 decking, this limit may be reduced to 4Hz if the design has been carried out on the assumption of simple supports at the ends. Conversely, for dance floor type applications or for floors supporting sensitive machinery, the limit may need to be set higher.

In the Slimdek system, consideration should be given to the system frequency of the floor as a whole if the natural frequency of the slab and/or the supporting beam is less than 5Hz.

For design to the Eurocodes, the loads considered for the vibration check are increased using the psi-factor for imposed loads (typically 0.5). The natural frequency limit may be reduced to 4Hz, because of this higher load used in the calculation.

Partial Continuity

Partial continuity for deep decking: Tests have shown that the SD 225 or CF210 composite slabs supported on a steel beam and provided with adequately detailed continuity mesh reinforcement over the steel beam support exhibits a degree of continuity at the support. The beneficial effect of partial continuity at the supports may be taken into account by specifying CONTINUOUS in the Span Type field. When this option is specified, the following assumptions are made by the design software;

- a 20% reduction in the deflections of the composite slab at the normal design stage.
- a 30% reduction in the deflections when assessing the natural frequency of the slab. This is justified by the lower stress levels during vibration.
- stresses in the composite slab in fire conditions are derived from a model which assumes full continuity at one end and a simple support at the other (i.e a propped cantilever condition).

In this case, the amount of mesh reinforcement is increased to a minimum of 0.4% of the cross-sectional area of the concrete topping in order to develop sufficient continuity in the slab.

Note that in all cases, partial continuity is ignored in assessing the capacity of the composite slab at the normal design stage.

Service Attachments

Self-drilling self-tapping screws may be used to attach hangers to the decking after the concrete has been placed.

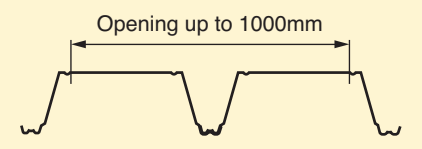
Openings in the Slab

Provision for vertical service openings within the floor slab will necessitate careful design and planning. The following summarises the options that are available to the designer:

Openings up to 300 mm x 300 mm can be accommodated anywhere in the slab over a crest section of the deck, normally without needing additional reinforcement.

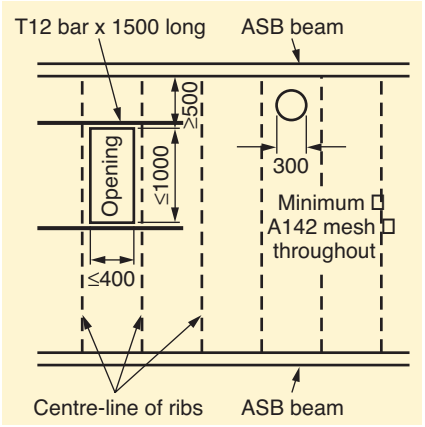
Openings up to 400 mm wide x 1000 mm long may be taken through the crest of the deep decking. Additional reinforcement, which should be designed in accordance with BS 8110, may be required around the opening.

Openings up to 1000 mm wide x 2000 mm long may be accommodated by removing one rib (maximum) of the decking, fixing suitable edge trims and providing additional reinforcement to transfer forces from the discontinuous rib. The slab should be designed as a ribbed slab in accordance with BS 8110, with decking being used as permanent formwork. Guidance may be found in the Slimdek Manual.



Larger openings will generally require trimming by secondary beams.

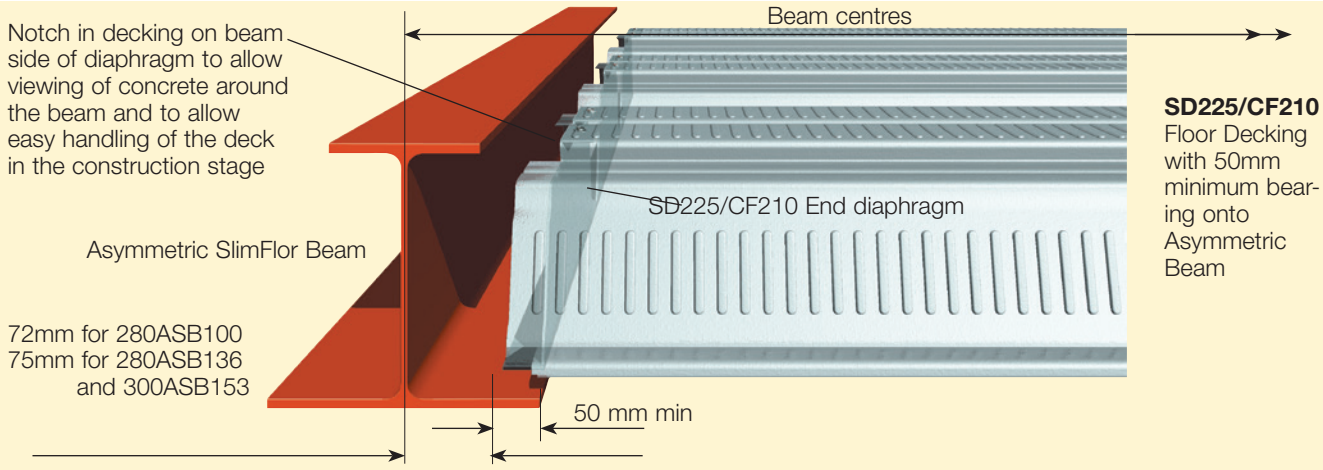
If an opening greater than 300 mm x 300 mm lies within the effective width of slab adjacent to a beam (L/8), the beam should be designed as non-composite. A close grouping of penetrations transverse to the span direction of the decking should be treated as a single large opening.



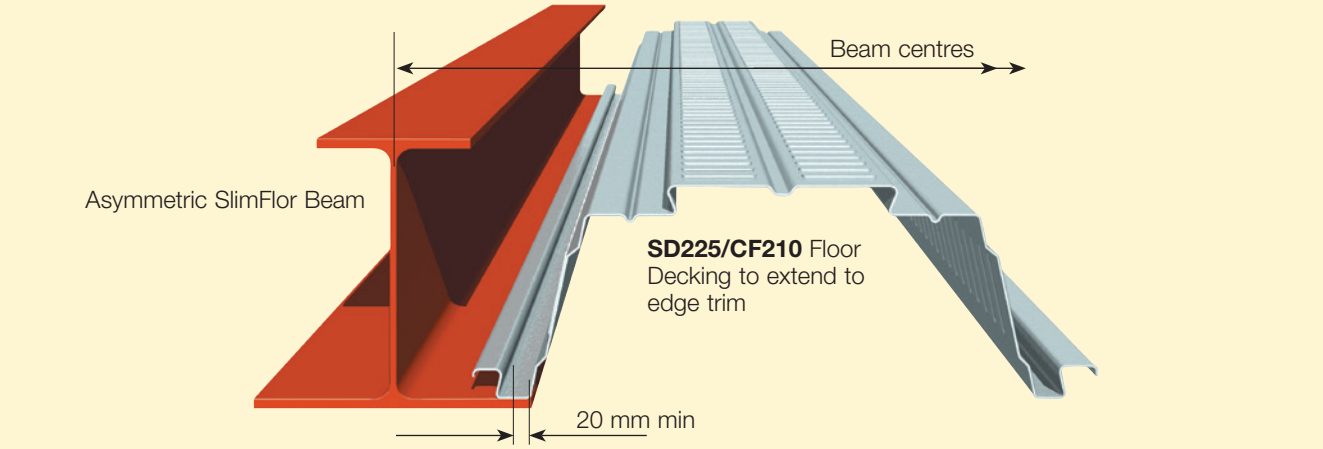
Design of small and medium size openings in the slab

Deep Composite Floor Decks
- Construction Details

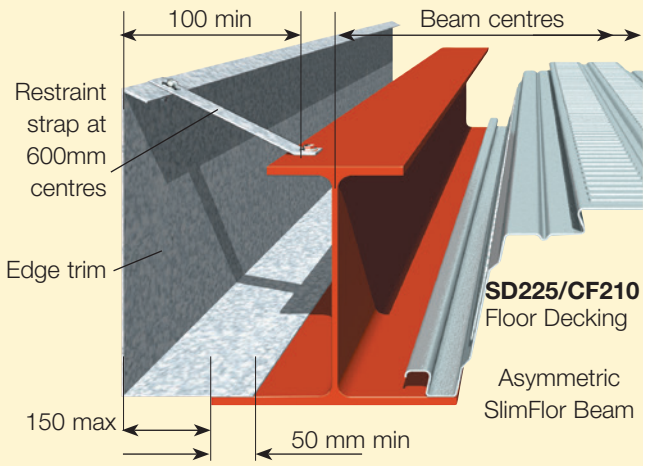
End fixing onto ASB



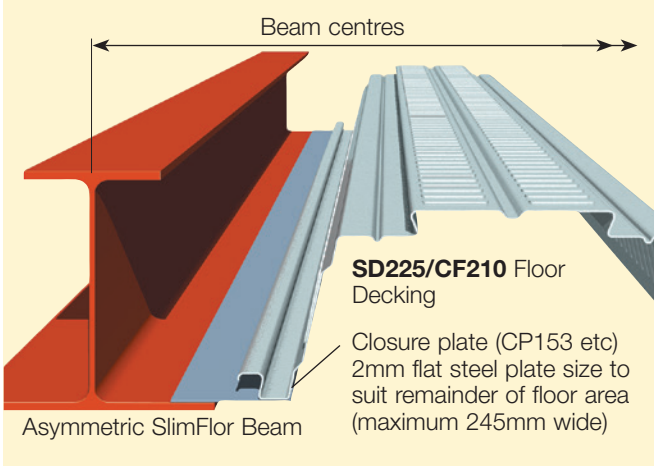
Side fixing onto ASB



Perimeter with trim

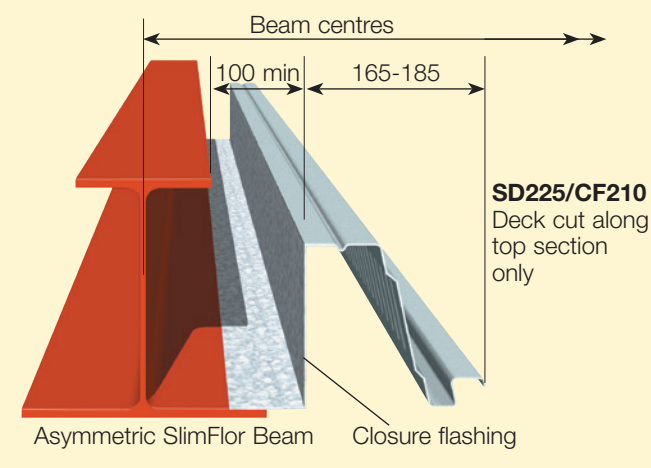


Cut plates

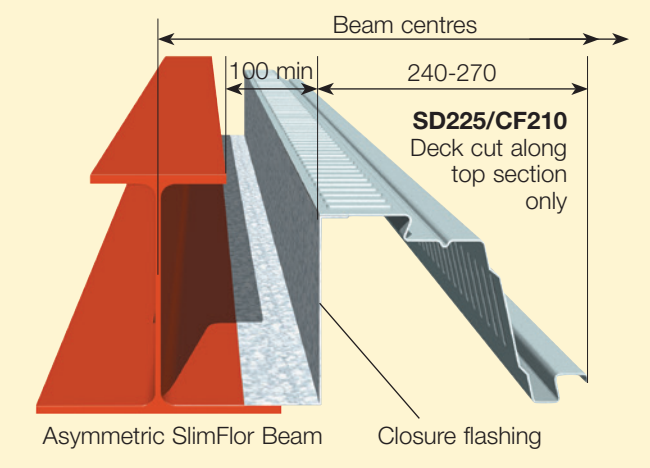


Deep Composite Floor Decks
- Construction Details

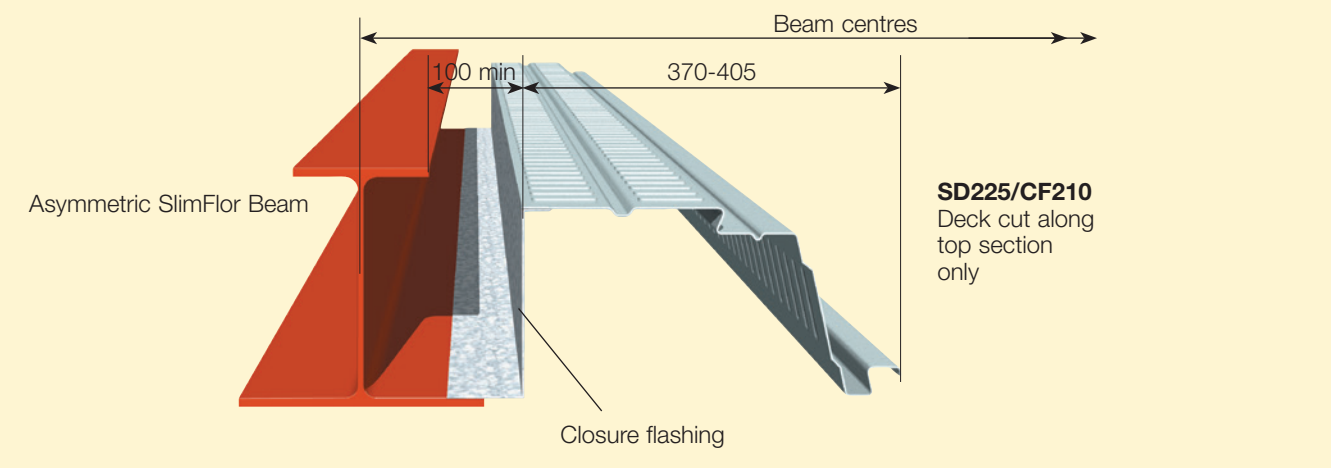
Cut deck - Option 1



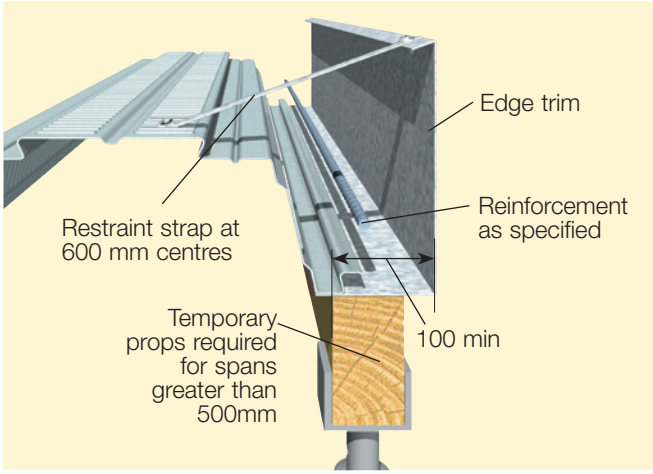
Cut deck - Option 2



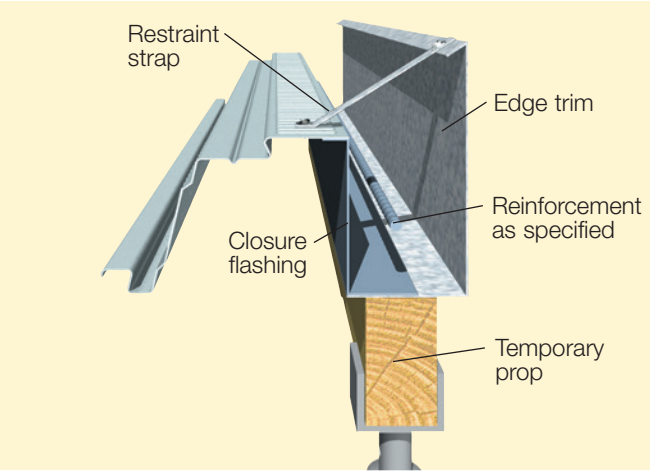
Cut deck - Option 3



Unsupported edge

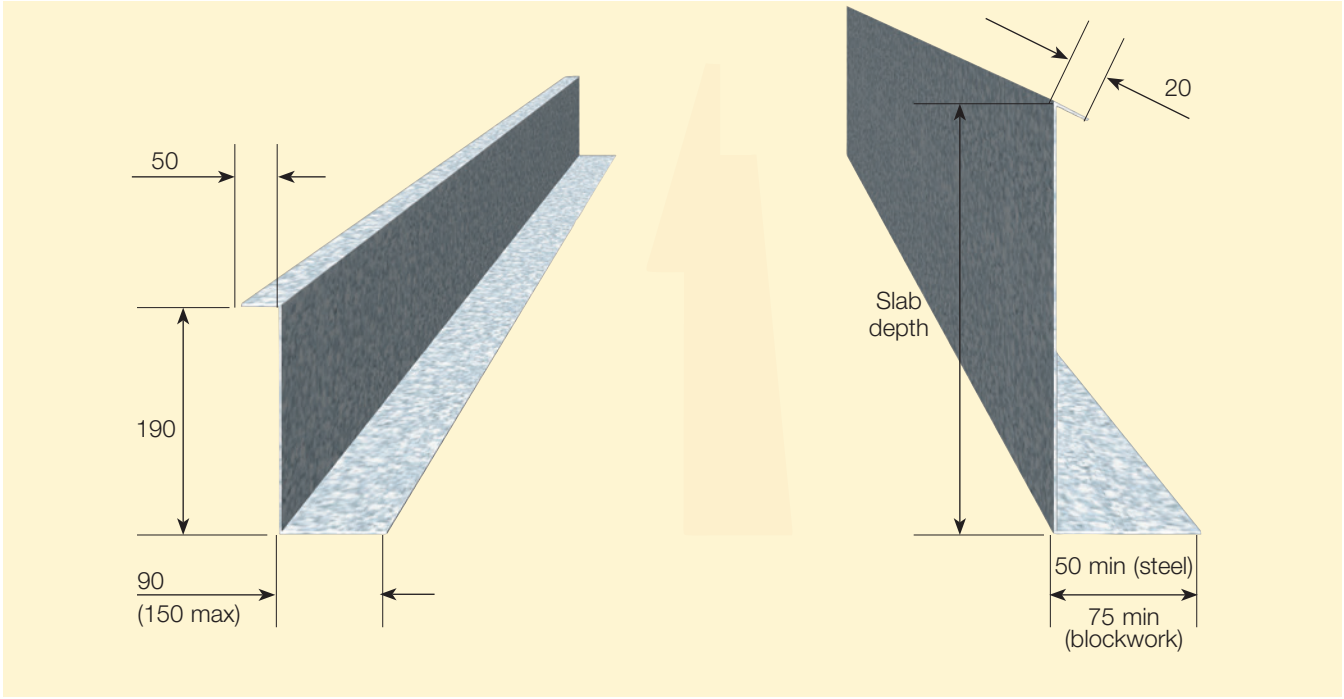


Unsupported edge with closure flashing

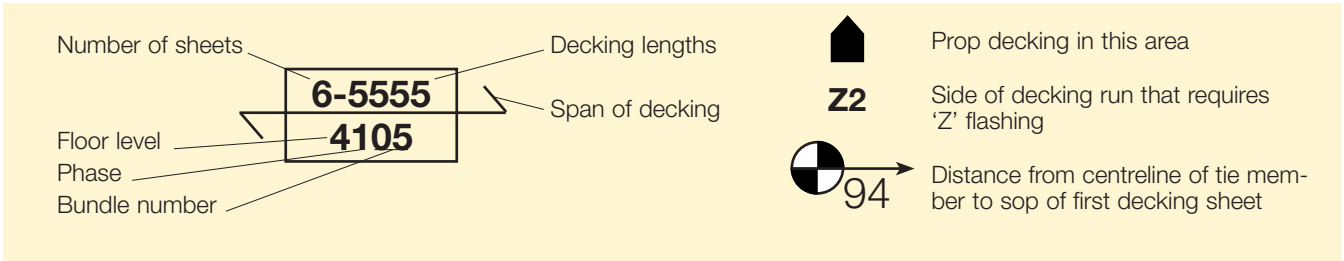


Deep Composite Floor Decks
- Construction Details

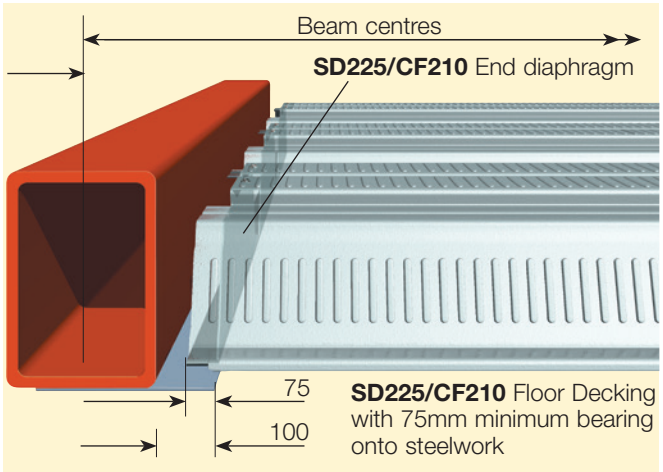
Steel trims



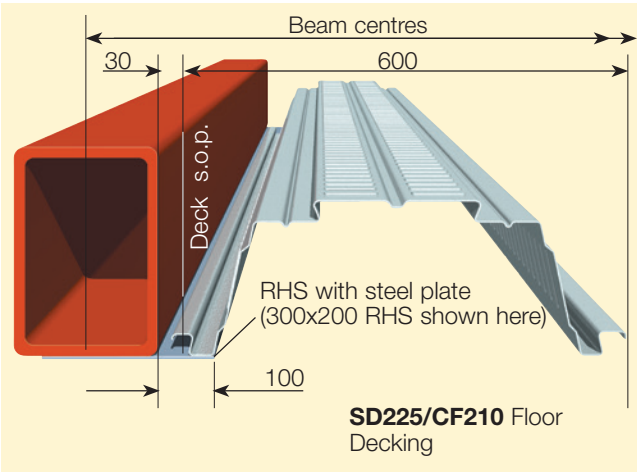
Notations used on deck layout drawing



End fixing onto RHS

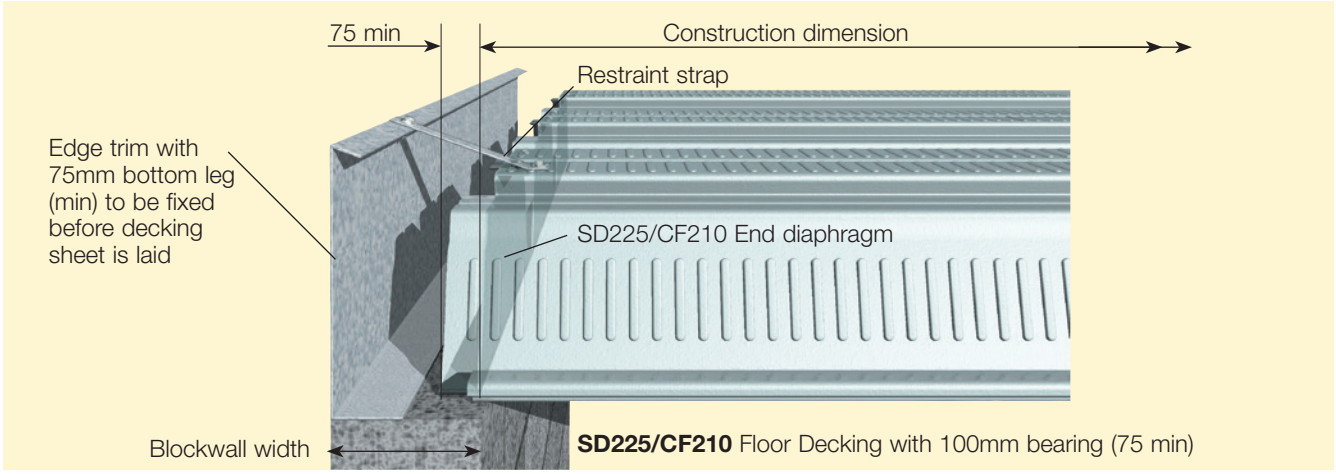


Side fixing onto RHS

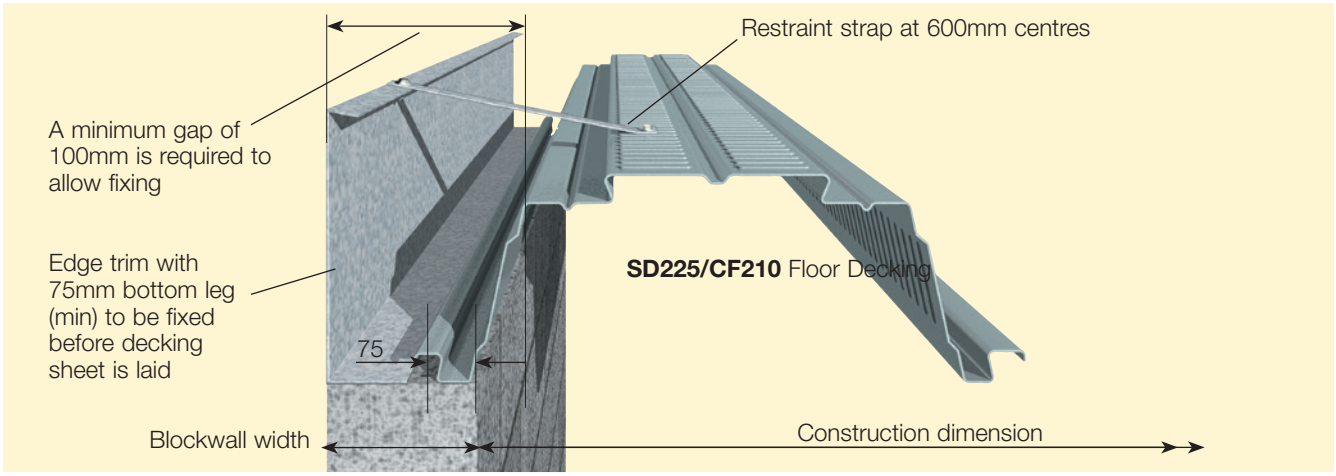


Deep Composite Floor Decks
- Construction Details

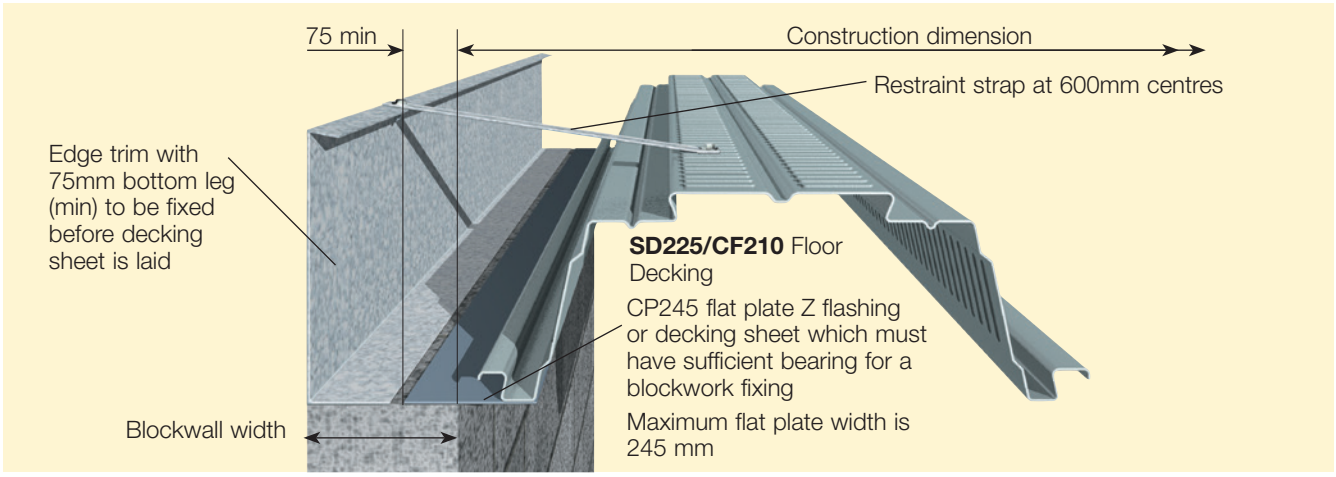
End fixing onto blockwork



Side fixing onto blockwork



Cut Plate on Blockwork



Deep Composite Floor Decks
- Sitework

End Diaphragms

Steel end diaphragms, as manufactured by ComFlor, are essential for both deep deck systems to ensure the structural integrity of the deck. The end diaphragms, are fixed first and are supplied in lengths of 2400 mm, to cover four ComFlor 210 profiles. They are fixed using at least three shot-fired pins for each length; in the Slimdek system the end diaphragms align with the edge of the lower flange of the beam.

Single diaphragms are available with pre-punched service holes in two types. Type 1 has one 160mm diameter hole; Type 2 has one elongated 160mm diameter hole to make opening 320mm wide x 160mm high.

Unpunched single diaphragms are also available. Where the deep deck lands onto a support at a rake, the single diaphragms are used doubled up, and adjusted on site to take up the extra length required due to the fact that the end of the deck is at a raked angle to the support rather than at right angles.

The concrete that the diaphragms entrap around the Asymmetric Slimflor Beam, give the beam its fire rating, therefore the diaphragms must be placed strictly according to specification.

End diaphragm for ComFlor 210

Deck Fixing

The decking sheets are then manually lowered individually onto the beams. In the Slimdek system, the end bearing of the sheets should be 50 mm; the flange widths are such that this can be achieved, whilst still being able to drop the sheets vertically into position (i.e. without having to thread them between the top and bottom flanges).

Once the sheets for the whole bay are in place, they are secured to the beam flanges using heavy duty shot-fired fixings. The required number of main fixings for CF 210 is one main fixing per trough.

Where CF210 deck is being used with Asymmetric SlimFlor Beams, the top flange of the profile must be notched back by 50mm, so that the concrete can be observed passing between the end diaphragm and the beam to allow concrete to flow into the beam.

The crown of the deck sheet is fixed to the top of the diaphragms using one self drilling screw for CF210.

When fixing to other types of supports such as reinforced concrete, or load bearing walls, suitable fixings must be used (one per CF210 trough), as for the steel supports.

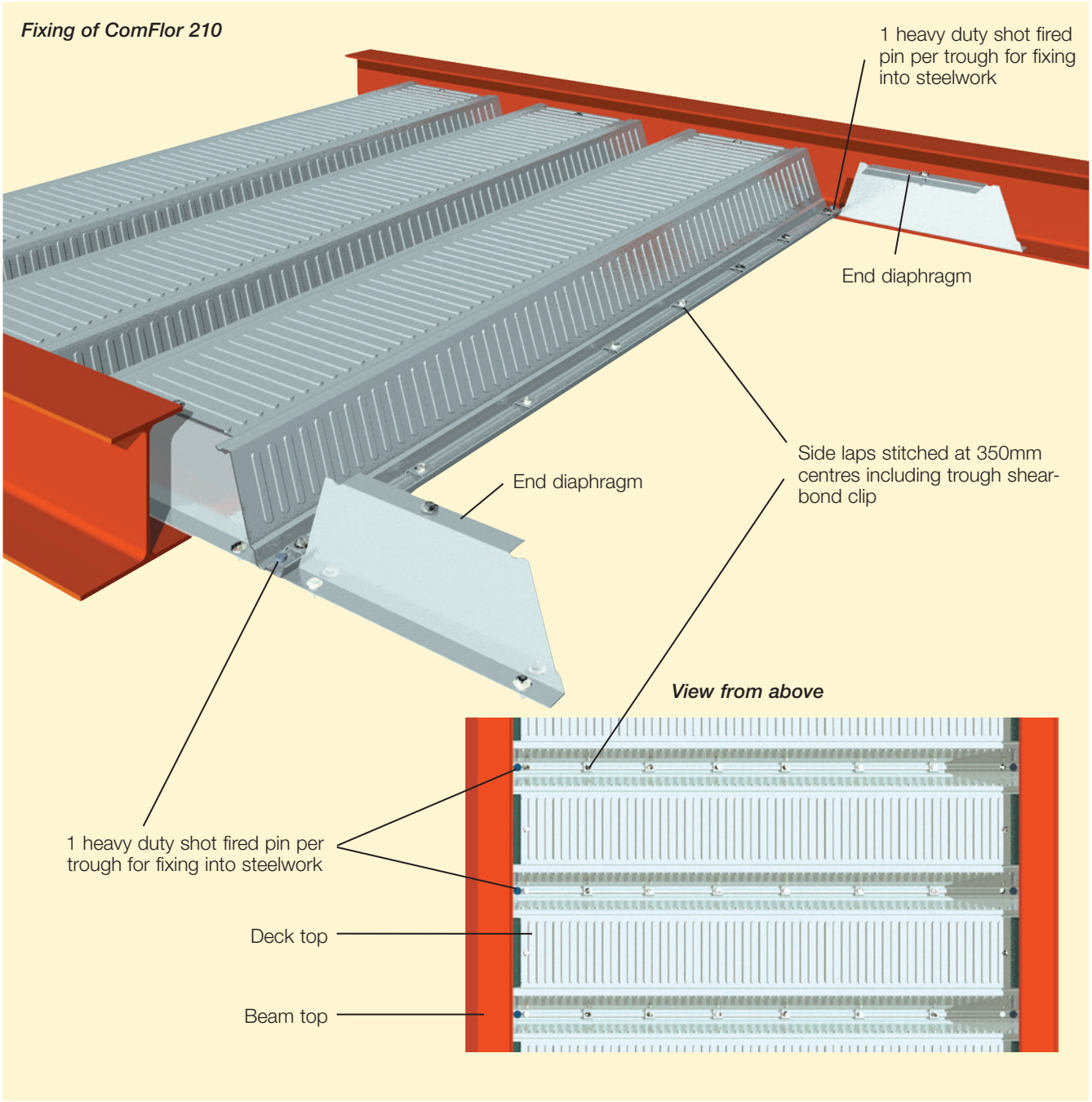
FIXING INFORMATION FOR DEEP DECKING

To Steel	Heavy duty powder actuated fixings - Hilti ENP2 - 21 L15 nail/or equivalent
	Self-drilling screws. To steel up to 11mm thick - SFS SD14 - 5.5 x 32 / EJOT HS 38 or equivalent. To steel up to 17mm thick SFS TDC-T-6.3 x 38 or equivalent
To Masonry or Concrete	Pre drill hole - use self tapping fixing suitable for masonry/ concrete - SFS TB-T range / EJOT 4H32 or equivalent
To side laps or closures etc.	Self drilling stitching screw typically SFS SL range / EJOT SF25 or equivalent

FIXING SPACINGS

	ComFlor 210
End fixing	1 per trough
Side laps	1 fixing with shear clip at 350mm c/c
Side fixing onto support	1 fixing at 600mm c/c

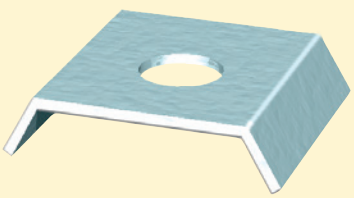
Deep Composite Floor Decks
- Sitework



Side Laps

Where the first and last sheet lands on a support, the edge of the sheet must be fixed to the support at 600mm centres.

CF210 side laps are to be stitched at 350mm centres with 5.5mm diameter self drilling screw, the location is marked by a hole in the overlap tail. Every side lap fastener must fix and locate a trough shear connector clip into position. The clip is partly responsible for the composite action of the decking and must not be omitted.



ComFlor 210 shear clip

Deep Composite Floor Decks
- Sitework

Edge Details

The steelwork must be stable and adequately restrained with support for the deck around columns and openings. ComFlor 210 decking can be easily cut, and fitted, to accommodate columns and other awkward shapes. Where there is no supporting steelwork, brackets fixed to the column will have to be used for local support to the deck.

Light steel edge trim is used to form the edges of the slab and to infill where the 600 mm profile of the deck does not align with the parallel supports. Supplied in 3m lengths as standard, and offered in thickness of 1.2 mm to 2.0 mm, the edge trims are fixed to the perimeter steel beams, using the same shot fired fasteners that secure the deck. The upper leg is strapped to the crown of the profile, to prevent buckling during the concrete pouring operation.

Cantilevers

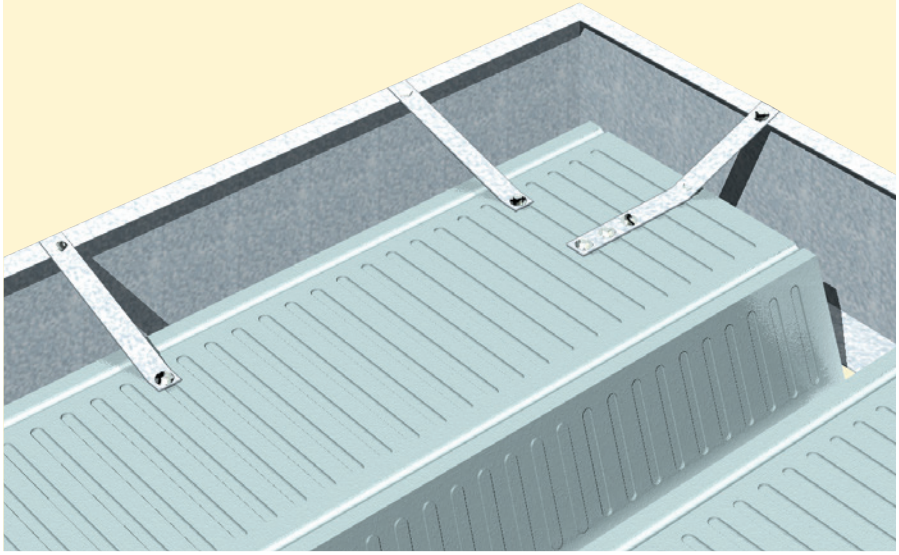
ComFlor 210 can be Cantilevered in its length up to 500 mm during construction. When Cantilevers are required perpendicular to the span of the profile, stub beams or some similar type of support has to be supplied. In both cases, the Cantilever must be assessed, for the final stage, in accordance with BS8110 Part 1, to determine whether additional reinforcement is required.

Reinforcement

The decking forms a part of the slab reinforcement, with the remainder being supplied by a bar in each trough of the decking and a mesh placed near to the top of the slab. Reinforcement should be fixed in accordance with the requirements of the Structural Designer. Normally, circular plastic spacers are used to position the bars 70 mm from the base of the trough. This distance can increase to 90 or 120 mm (respectively) when 90 or 120 minutes fire resistance are required. There may be additional mesh or bar requirements to fix adjacent to the supports or edge beams, or above beams for crack control purposes.

Any shear studs that are required (to make SFBs or RHSFBs composite) may be welded to these sections during fabrication, because they do not interfere with the decking.

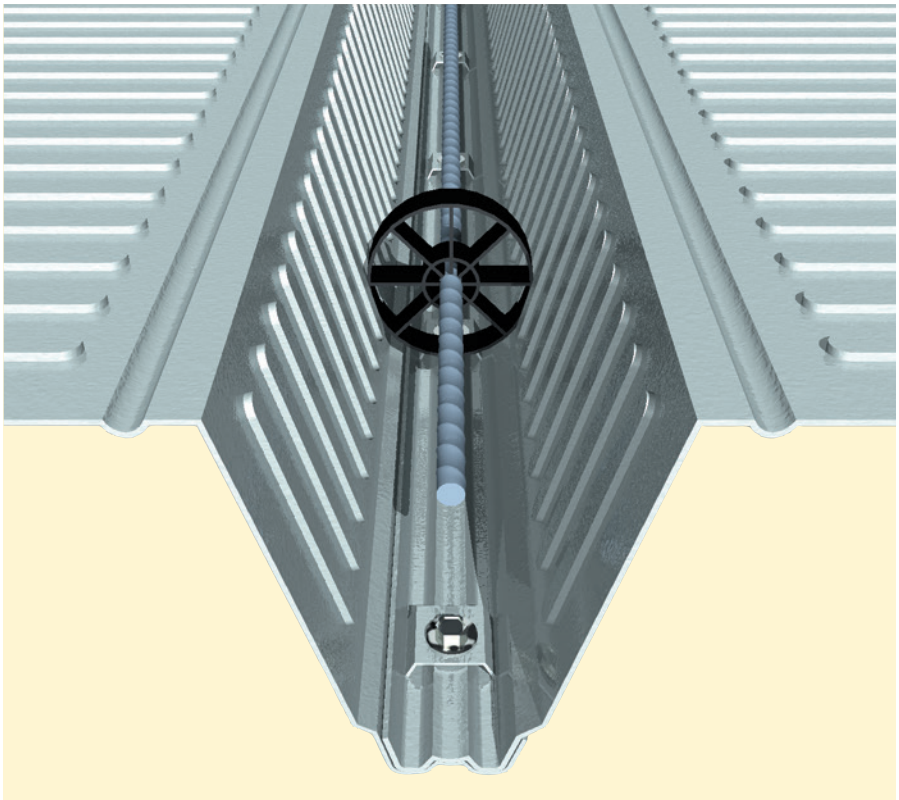
Fit restraint straps at 600mm c/c to prevent any bowing of edge trim.



Edge trims selector

Edge trim depth (mm)	Maximum Cantilever (mm)	
	Galv. Steel Edge trim thickness (mm)	
	1.6	2.0
270	100	135
300	0	100
350	x	0
400	x	0

x = not recommended



Deep Composite Floor Decks
- Sitework

Temporary Props

In instances when the design spans exceed the construction stage capacity of the decking, it is necessary to support the weight of the wet concrete and construction loads, by using additional temporary supports. The supports should offer a continuous bearing of at least 100 mm width to the underside of the deck. Where temporary supports are used it is important that: The timbers and supports are of adequate strength. The props are placed at mid-span, or at third span, as required. The propping structure is not to be removed until the concrete has achieved 75% of its design strength. The horizontal bearer timbers must be at least 100mm wide and should be propped at no more than 1m centres. Sometimes the specification may call for 150mm wide bearers.

TEMPORARY PROPS
Timber Bearer Guide (deep decks)
All to be min. 100mm wide

Slab Depth (mm)	Bearer Depth (mm)
280	150
320	200
360	250

Penetrations

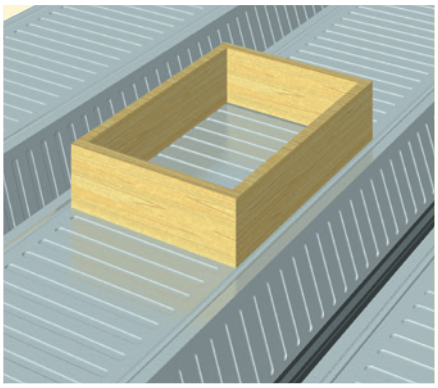
Openings should be made through the wide crown of the profile. The openings should be boxed out prior to the pouring of the concrete, and the metal of the deck only cut once the concrete has achieved 75% of its design strength.

Casting Concrete

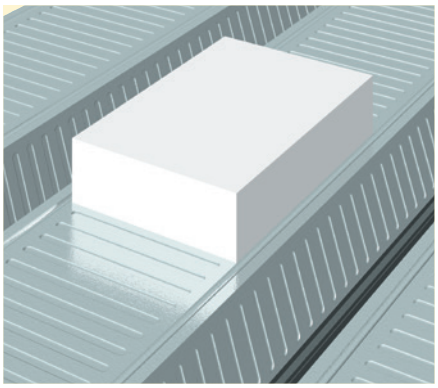
All grease, dirt and debris, which could have an adverse effect upon the performance of the cured slab, must be cleared before the application of the concrete can commence. The deck may have some lubricant from the roll forming process on its surface. This does not have to be removed. Care should be taken during the application of the concrete, to avoid heaping, and the close working of unnecessarily large number of operatives.

Unsupported Edges

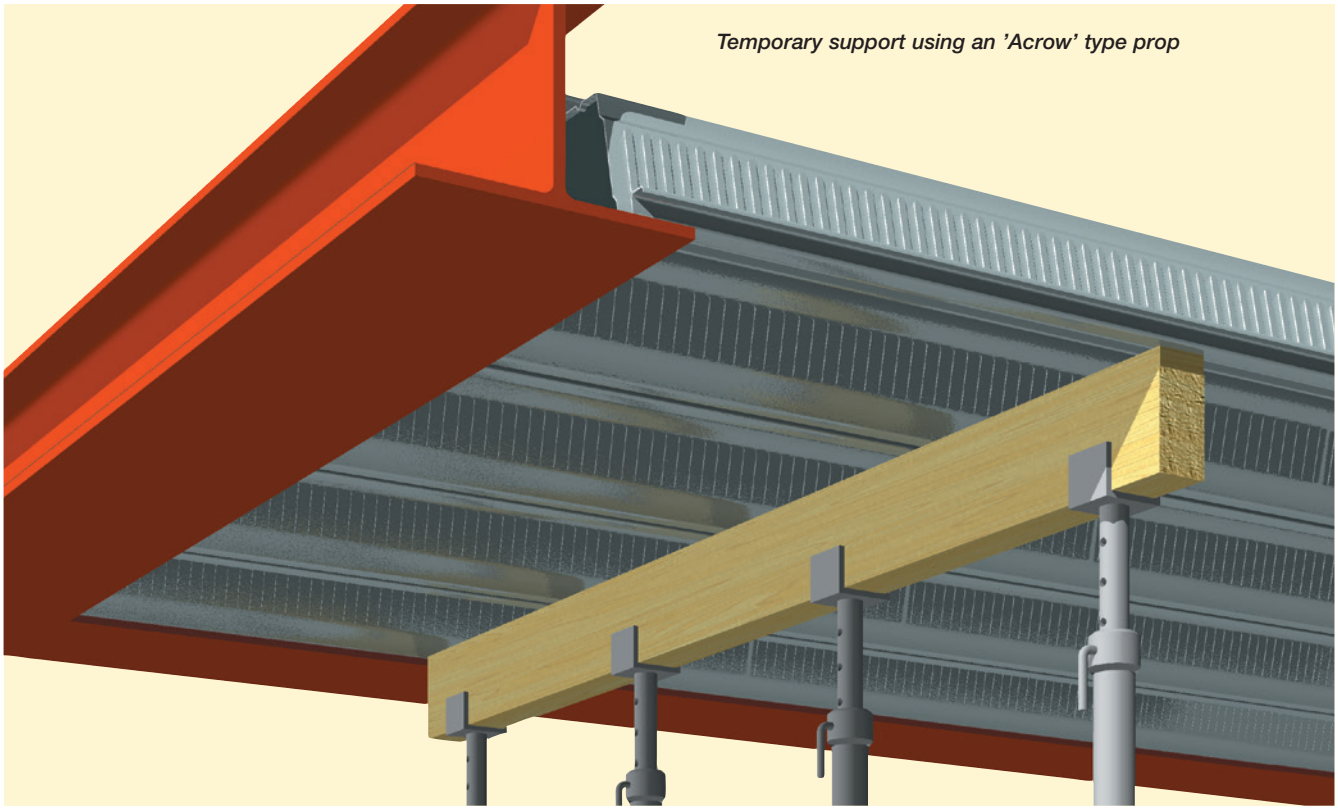
All unsupported edges must be propped, and may require additional reinforcement.



Timber shutter for opening



Dense polystyrene block for opening



Temporary support using an 'Acrow' type prop

Transport & Handling

Information of particular interest to Composite Flooring Contractors is given below.

Receiving Decking

ComFlor 210 Decking is packed into bundles of up to 30 sheets, and the sheets are secured with metal banding. Each bundle is 650mm wide (the overall width of a single sheet) by 450 mm high, and may weigh up to 2.5 tonnes, depending on sheet length (average weight is about 1.5 tonnes). Loads are normally delivered by articulated lorries approximately 16 m long with a maximum gross weight of up to 40 tonnes, and a turning circle of approximately 19 m.
The Main Contractor should ensure that there is suitable access and appropriate standing and off-loading areas.

Each bundle has an identification tag. The information on each tag should be checked by operatives from the decking contractor (or, if they are not on site, the Main Contractor) immediately upon arrival. In particular, the stated sheet thickness should be checked against the requirement specified on the contract drawings, and a visual inspection should be made to ensure that there is no damage.

Lifting Bundles

The bundles should be lifted from the lorry. Bundles should never be off-loaded by tipping, dragging, dropping or other improvised means.

Care is needed when lifting the decking bundles; protected chain slings are recommended. Unprotected chain slings can damage the bundle during lifting; when synthetic slings are used there is a risk of the severing them on the edges of the decking sheets.

If timber packers are used, they should be secured to the bundle before lifting so that when the slings are released they do not fall to the ground (with potentially disastrous results). Bundles must never be lifted using the metal banding.

Positioning the Decking

The support steelwork should be prepared to receive the decking before lifting the bundles onto it. The top surface of the underlying beams should be reasonably clean.

The identification tags should be used to ensure that bundles are positioned on the frame at the correct floor level, and in the nominated bay shown on the deck layout drawing. The bundles should be positioned such that the interlocking side laps are on the same side. This will enable the decking to be laid progressively without the need to turn the sheets. The bundles should also be positioned in the correct span orientation, and not at 90^{o} to it. Care should be taken to ensure that the bundles are not upside down.

Placement of Decking

The breaking open of bundles and installation of decking should only begin if all the sheets can be positioned and secured. This will require sufficient time and suitable weather. The decking layout drawing should also be checked to ensure that any temporary supports that need to be in position prior to deck laying are in place.

Access for installation will normally be achieved using ladders connected to the steel frame. Once they have started laying out the sheets, the erectors will create their own working platform by securely fixing the decking as they progress.

The laying of sheets should begin at the locations indicated on the decking layout drawings. These would normally be at the corner of the building at each level; to reduce the number of ‘leading edges’, i.e. unprotected edges, where the decking is being laid. When the bundles have been properly positioned, as noted above, there should be no need to turn the sheets manually, and there should be no doubt which way up the sheet should be fixed.

Individual sheets should be slid into place and, where possible, fixed to the steelwork before moving onto the next sheet.

This will minimise the risk of an accident occurring as a result of movement of a sheet when it is being used as a platform. (However, for setting-out purposes, it may be necessary to lay out an entire bay using a minimum number of temporary’ fixings before fully securing the sheets later).

Sheets should be positioned to provide a minimum bearing of 50 mm on the steel support beams. The ends of adjacent sheets should be butted together. A gap of up to 5 mm is generally considered not to allow excessive seepage, but, if necessary, the ends of the sheets may be taped together. When end gaps are greater than 5 mm, it is normally sufficient to seal them with an expanding foam filler. The longitudinal edges should be overlapped, to minimise concrete seepage.

Cutting Sheets

Where necessary, sheets may be cut using a grinder or a nibbler. However, field cutting should be kept to a minimum and should only be necessary where a column or other obstruction interrupts the decking. Gaps adjacent to the webs of columns should be filled in with off-cuts or thin strips of steel. Decking sheets shown as continuous on the decking layout drawing should never be cut into more than one length. Also, sheets should never be severed at the location of a temporary support, and the decking should never be fastened to a temporary support.

As the work progresses, unwanted scraps and off-cuts should be disposed of in a skip placed alongside the appropriate level of working. The skip should be positioned carefully over a support beam to avoid overloading the decking. If a skip is not available, scraps should be gathered for collection by the Main Contractor as soon as is possible. Partially used bundles should be secured, to avoid individual sheets moving in strong winds.

References - Health & Safety

British Standards

The design guidance given in this brochure and on the attached software complies, where relevant, with the following Standards.

Composite Floor Deck

1. BS 5950: Part 4 1994. Structural use of steelwork in building: Code of practice for design of composite slabs with profiled steel sheeting.

Composite Steel Beams

2. BS 5950: Part 3: 1990. Design in composite construction: Section 3.1: 1990. Code of practice for design of simple and continuous composite beams.

Profiled Steel Deck

3. BS 5950: Part 6 1995. Structural use of steelwork in building: Code of practice for design of light gauge profiled steel sheeting.

Fire Resistance

4. BS 5950: Part 8 1990. Structural use of steelwork in building: Code of practice for fire resistant design.

Concrete

5. BS 8110: Part 1: 1997 Structural use of concrete: Code of practice for design and construction.
6. BS 8110: Part 2: 1985 Structural use of concrete: Code of practice for special circumstances.

Reinforcement

7. BS 4483: 1998 Specification for steel fabric for the reinforcement of concrete.
8. BS4449:1997 Specification for carbon steel bars for the reinforcement of concrete.

Eurocode 4

9. ENV 1993 - 1 - 3: Design of steel structures. Supplementary rules for cold formed thin gauge members and sheeting.
10. ENV 1994 - 1 - 1: Design of Composite steel and concrete structures. General rules for building.
11. ENV 1994 - 1 - 2: Design of composite steel and concrete structures. Structural fire design.
12. SCI - P - 076 : Design guide on the vibration of floors.
    SCI in association with CIRIA (1989).

Health & Safety

Handling Hazards

Zinc coated steel decking should be handled with care; it may be delivered with soluble protective layer of oil, which can cause contamination to lacerated skin. Decking will have sharp edges and corners. Adequate gloves and protective clothing should be worn when handling decking.

Eye Hazards

Eye protectors conforming to the specification in BS 2092:1987 should always be worn, when breaking the strapping around bundles because the sudden release of tension creates a risk to eyes.
Particles of metal also create eye hazards when cutting steel, and eye protection should be worn, during this activity.

Noise Hazards

Noise may be hazardous whilst handling or cutting decking, shot firing, etc, adequate ear defenders should be worn.

Respiratory Hazards

Fumes containing oxides of iron and zinc are produced during welding or flame cutting and if inhaled these may cause metal fume fever; this is a short-lasting condition with symptoms similar to those of influenza. In conditions of exposure to such hazards, the use of respiratory equipment is recommended.

Explosives and Fumes

When using shot fired fixings explosives and fumes may create a hazard.

Occupational Exposure Limits

Limits for iron and zinc oxides are 5g/m≥ (8 hours TWA) and 10mg/m≤ (10 minutes TWA). (OE recommendation)

Summary of Protective Measures

Wear adequate gloves and protective clothing and safety goggles.
Ensure adequate ventilation and use personal protective equipment.
Follow instructions for safe handling, use, disposal and control of cartridges issued by equipment supplier.
Ensure adequate ventilation and / or use personal respiratory protective equipment.
Use appropriate ear defenders or earplugs.

General Safety Points

Follow the good practice outlined here and in SCI publications.

- Always fix deck securely before using as a working platform.
- Steel end diaphragms, as manufactured by ComFlor, are essential for both deep deck systems to ensure the structural integrity of the deck.
- Rigorously employ all personal safety measures such as hard hats, protective clothing.
- Rigorously employ all site safety measures such as safety lines, edge protection, properly tied ladders.
- **Don't** leave any unfixed decking sheets.
- **Don't** heap concrete or drop from any height.
- **Don't** put heavy loads on unprotected deck.
- **Don't** place props on uncured concrete.
- **Don't** cut holes/voids in the deck prior to concreting.

Composite Floor Design Disc

Use of the CD

The Composite Floor Design disc is available. If it is missing, ComFlor will send or email a replacement version free of charge. Please also refer to www.comflor.co.nz. This website brings together a vast amount of product and design information for specifiers. Please note that the software will be updated from time to time without prior notice.

The disc is for use on Windows based PCs and does not Auto-start. Place CD in drive, click Start - Run - Browse. When in CD drive, double click ComFlor folder - setup. The software must be installed, i.e. will not run directly from the CD; it requires less than 2MB of disc space once installed.

The ComFlor software was developed by the Steel Construction Institute for ComFlor.

Use of the design program

Choose BS5950 or Eurocodes.
All the variables start with a default value, however check or input new variables on both Datasheet1 and Datasheet2. When satisfied click analyse to run the calculations.

Job details may be entered for a formal printout.

It is not necessary to put in shear connectors (shear studs) for the composite slab design (shear connectors are used primarily for the benefit of the beam not the slab). However if shear connectors are to be used, then the design software allows end anchorage to be accounted for which in some cases will improve the load capacity of the composite slab.

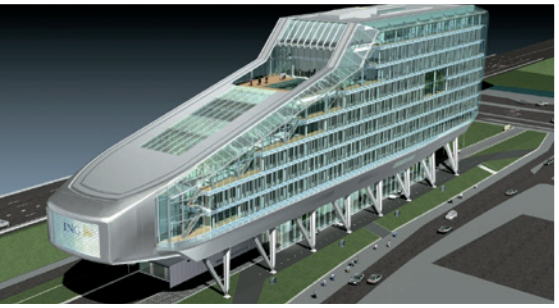
Before accepting a particular design as satisfactory, it is highly advisable to print out the calculations and check that all the input parameters are correct.

Design criteria and methods

The design program has been produced by the Steel Construction Institute on behalf of ComFlor.

Help function on disc.

The Help function on the design program contains all the detailed information that is used to produce the calculations.



Hoofdkantoor ING Amsterdam;
ASB – ComFlor 100/210

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