Metal Decking Specialists

TAB-Deck™ Composite Slabs

SMD.BRO.121.V4

Design Guidance for TAB-Deck™ Composite Slabs using
SMD metal decking reinforced with ArcelorMittal steel fibres

ArcelorMittal

SMD
structural metal decks ltd
Engineers in Steel Decking Systems

Prospect Park, Hurley - 5800m² TR60 with TAB-Deck™

Contents

Introduction

Steel fibre reinforced concrete is a composite material formed by adding steel fibres into the concrete mix prior to pouring on site. The addition of steel fibres turns the normally brittle concrete into a more ductile material with an enhanced post cracking behaviour.

Use of the TAB-Deck™ system can remove the need for traditional mesh reinforcement with all its associated problems of handling, storage and safety. Composite Metal Deck Slabs can be constructed faster and cheaper using the TAB-Deck™ system.

ArcelorMittal Wire Solutions has been one of the leading developers of steel fibre concrete technology for over 30 years. Steel fibres are already widely used for industrial floors constructed on grade or pile supported. Based on this experience, TAB-Deck™ has been developed by ArcelorMittal Wire Solutions in conjunction with Structural Metal Decks Ltd (SMD) for use with their decking profiles.

TAB-Deck™ performance data has been fully assessed and approved by The Steel Construction Institute referred to as SCI in this document.

BCSA

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The increasing popularity of fibre reinforced concrete as a replacement for traditional mesh reinforcement is a welcome technological development.

The TAB-Deck™ solution reduces site handling, storage and associated safety issues making it a positive choice for many contractors. The pre-reinforced nature of steel fibre reinforced concrete adds to the appeal of this new solution by removing one stage of the installation process and thus reducing the overall time required to construct a composite metal deck slab.

SMD Metal Decking with ArcelorMittal TAB-Deck™ System

Advantages of using the TAB-Deck™ system

- Concrete pre-reinforced requiring little or no mesh fixing
- Easily and safely installed in any location
- Faster to install saving time and money
- Removes the need for storing mesh and accessories on site
- No need to lift and handle reinforcing mesh
- No mesh resulting in time and crane hire savings

Crack Control Requirement

The use of ArcelorMittal TAB-Deck™ can meet the crack control design requirements specified by BS5950: Part 4 for composite slabs and therefore removes the need for traditional mesh reinforcement.

Nominal Reinforcement at Intermediate Supports

Continuous composite slabs are typically designed as simply supported with nominal steel fabric reinforcement provided over intermediate supports. The cross section area of reinforcement in a longitudinal direction should be not less than 0.1% of the gross cross-section area of the concrete support. TAB-Deck™ using a dosage rate of 30 kg/m3 of HE 1/50 steel fibres meets this requirement.

Transverse Reinforcement

The cross section area of transverse reinforcement in the form of steel mesh reinforcement should be not less than 0.1% of the cross section area of the concrete above the ribs. TAB-Deck™ meets this requirement.

Concentrated Loads

A line load running parallel to the span should be treated as a series of concentrated loads.

Where there are concentrated point loads or line loads, transverse reinforcement should be placed on or above the profiled steel sheets. It should have a cross section area of not less than 0.2% of the concrete section above the ribs. This transverse reinforcement should be ductile. TAB-Deck™ solutions meet this requirement when used in conjunction with traditional rebar or wire mesh.

For further design advice regarding concentrated loads contact ArcelorMittal Wire Solutions.

Intermediate Supports in Propped Construction or Special Finishes

In situations with a higher risk of cracking such as over intermediate supports for propped construction or where a special floor finish is to be applied, additional reinforcement greater than 0.1% of the gross cross section area of the concrete support will be required. CIRIA Report No 91 and BS 8110-2 give methods to determine the amount of reinforcement required to control cracking due to moisture or thermal movement. Additional guidance is given in Eurocode 4, which specifies more severe reinforcement requirements. Depending on circumstances this can require reinforcement of up to 0.4% of the gross cross section area of the concrete support. TAB-Deck™ can meet this requirement when used in conjunction with traditional rebar or wire mesh.

Situations when additional reinforcement may be required

TAB-Deck™ can be used to replace the traditional mesh reinforcement used for crack control and fire requirements (refer fire tables in this document).

Additional reinforcement may be required in the following situations:

- For continuous slab spans and/or loading conditions, including concentrated loads, which exceed the capacity given by the published fire load / span tables.
- For single span slabs with over 30 minute fire rating, bottom reinforcement bars will normally be required; size and quantity to be determined by the load / span criteria.
- Cantilever slabs should be designed as reinforced concrete with top reinforcement by the structural engineer.
- Trimming reinforcement around square or round holes with an opening greater than 250mm but not exceeding 700mm. Where openings exceed 700mm, additional trimming beams will be required (to be designed and supplied by others).
- For edge composite beams where the distance from the edge of the concrete flange to the nearest row of shear connectors is less than 300mm, transverse U-Bar reinforcement will be required and is to be designed by the structural engineer.
- At Construction / Day Joints within the slab pour adequate continuity reinforcement will be required.

SMD Metal Decking with ArcelorMittal TAB-Deck™ System

Guidance for Installing Service Holes in the Composite Slab

When it is necessary to form service holes in the composite slab, the following general guidelines should be followed for openings at right angles to the deck span.

1. Up to 250mm opening, no special treatment is required. Prior to casting the concrete the opening is boxed out. When the slab has cured the deck is then cut using non-percussive methods.

2. Openings greater than 250mm but less than 700mm. Additional reinforcement is required around the opening. The design should generally be in accordance with BS 8110 or Eurocode 2 when forming the hole as described above. Items 1 and 2 relate to isolated single holes and not to a series of holes transverse to the direction of span, holes in groups should be considered as a single overall opening dimension. In both cases 1 and 2 the metal decking should not be cut until the slab has cured.

3. Greater than 700mm. Structural trimming steelwork is required to be designed by the project engineer and supplied by a steelwork fabricator.

These are guidelines only and the project engineer should check particular requirements. SMD and ArcelorMittal Wire Solutions cannot take design responsibility for any additional framing or slab reinforcement for holes or openings.

TAB-Deck™ Steel Fibre Reinforced Concrete

Concrete Mix

The specific mix design will always depend on the local materials available but must follow these basic guidelines:

- Cement – minimum 350kg/m^3 of CEM I or CEM IIIA
- Aggregates – maximum 20mm
- Fines content – minimum 450kg/m^3 of smaller than 200µ including cementitious content
- Water/Cement ratio ≤ 0.50
- Minimum Slump – 70mm (before the addition of steel fibres and super-plasticizer)

ArcelorMittal Wire Solutions can provide advice on individual mix designs and check their suitability for specific projects.

Addition of TAB-Deck™ Fibres to the Concrete Mix

Steel fibres should be added at a rate of 30 kg/m^3 into the mixer truck either at the batching plant or on the job site. Some ready-mix suppliers have suitable facilities for loading the fibres into the mixer at the batching plant. Where these do not exist the fibres can be added at the plant or job site using conveyor belts or "blast" machines.

The steel fibres should be added at a rate of 30-40kg per minute. If using a conveyor belt the fibres should be spread on the belt not heaped to avoid clumps of fibres. The maximum drum rotation should be 12-15 revolutions per minute. The truck mixer should be rotated at full speed for 8-12 minutes after adding the fibres.

Adding steel fibres to the concrete mix will typically reduce the slump of the concrete mix by around 35mm. It is recommended therefore that a Super-Plasticiser be added to the concrete before the addition of the fibres to raise the fibre concrete slump to the required level. This is particularly important when the concrete is to be pumped.

Note: When pumping TAB-Deck™ steel fibre reinforced concrete a minimum 125mm diameter hose should be used.

Installation of TAB-Deck™ Fibre Reinforced Concrete

TAB-Deck™ fibre reinforced concrete should be installed, cured and finished in exactly the same way as plain concrete.

Fire Design of TAB-Deck™ Steel Fibre Reinforced Concrete

The fire resistance of concrete composite slabs reinforced with 30 kg/m^3 of HE 1/50 steel fibres has been investigated by SCI.

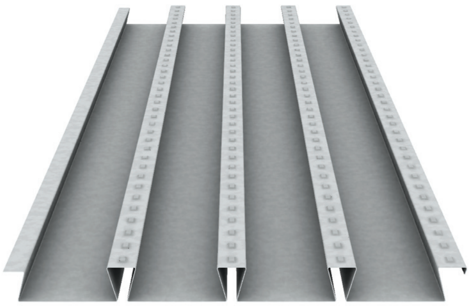
The conclusions drawn with respect to the structural performance of the TR60+, TR80+ and R51 composite deck slabs in fire conditions are based on the results of fire tests carried out by Warringtonfire on behalf of SMD and ArcelorMittal Wire Solutions.

The fire test results have been used to calibrate a structural model developed by SCI. This model was subsequently used to produce fire design tables for composite slabs constructed using SMD TR60+, TR80+ and R51 decking and concrete reinforced with HE 1/50 steel fibres at the same design dosage (30kg/m^3) as that used in the test specimens. Pages 8-10 include fire design tables for resistance periods of 60, 90 and 120 minutes for all SMD composite decking profiles.

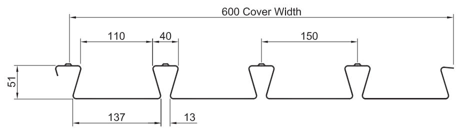
For designs outside the scope of these tables, refer SMD Deck Design Software or contact ArcelorMittal Wire Solutions or Structural Metal Decks Ltd for further design information.

SMD Products with ArcelorMittal TAB-Deck™

R51 Details and Sectional Properties

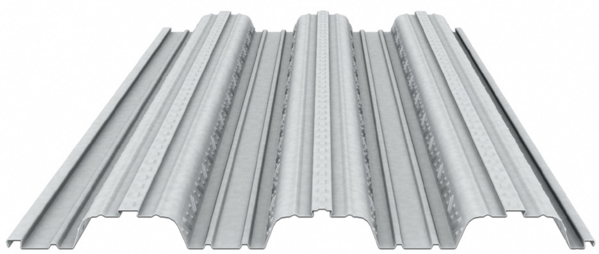


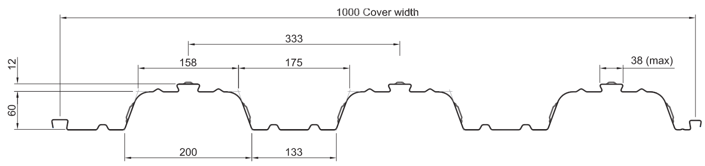
R51 is manufactured from S350 grade steel. This profile is a traditional re-entrant profile and is commonly used on inner city multi-storey projects where the structural zone and storey height is reduced, due to the relatively thin slab depth required to achieve a typical 1 hour fire rating.



TR60+ Details and Sectional Properties

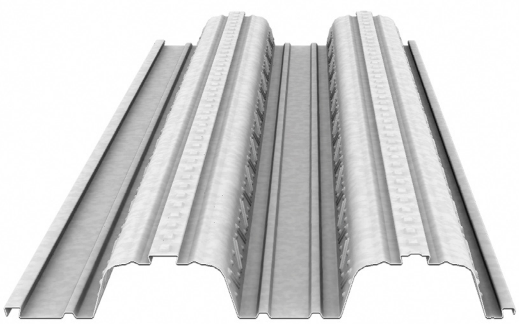
The TR60 profile was SMD's first trapezoidal profile, added to our product range in 1992. Further research and development in recent years has seen our trapezoidal products evolve into the TR+ range. The **TR60+** profile enables un-propped spans in excess of 3.5m and is available in 0.9mm, 1.0mm and 1.2mm gauges in both S350 and S450 grade steel.

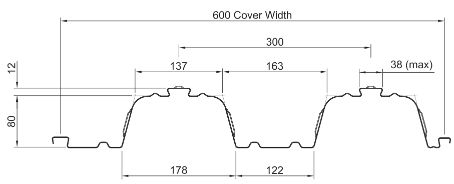




TR80+ Details and Sectional Properties

Initially added to our product range in 2002, the original TR80 has undergone further research and development, evolving to the now revised profile, renamed **TR80+**. This 80mm deep trapezoidal profile is available in 0.9mm, 1.0mm and 1.2mm gauges in both S350 and S450 grade steel.





ArcelorMittal

Technical data sheet
Hooked-end steel fibres

HE 1/50

Dimensions

Wire diameter (d)	1.00 mm (± 0.04 mm)
Fibre length (L)	50.0 mm (+2/-3 mm)
Hook length (l and l')	1 – 4
Hook depth (h and h')	1.80 mm (+1/-0 mm)
Bending angle (a and a')	45° (min. 30°)
Aspect ratio (L/d)	50
Camber of the fibre	max. 5% of l'
Torsion angle of the fibre	< 30°
Number of fibres per kg	3100
Total fibre length per 10 kg	1575 m

Packaging

Recyclable cardboard boxes	
Net weight/box	25 kg
Boxes/palette	48
Weight/palette	1200 kg
The fibres are oriented in one direction	
Palettes are wrapped or welded in a plastic folio	
Available also in big bag of 500 kg	

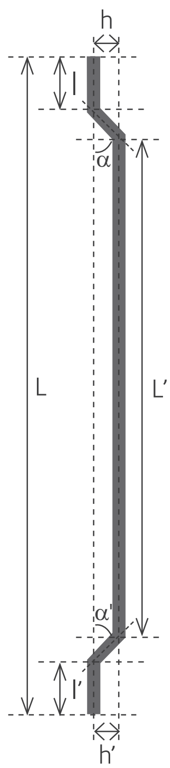
Miscellaneous

The described fibre is in accordance with the following standards:

- EN 14889-1 type 1, cold-drawn wire
- ASTM A820/A820M-04 type I, cold-drawn wire

Material characteristics

- Tensile strength of drawn wire 1100 N/mm²
- Rod wire C4D or C7D according to EN 10016-2



R51

Fire Tables – TAB-Deck™ Fibres

The tables incorporate the following criteria:
C25/30 concrete
Support width of 100mm - Ultimate load factor of 1.0
(The Ultimate load factor may be reduced in some cases, refer BS 5950 Part 8 Table 2)

The composite slab (not necessarily the metal deck) should be continuous over one or more internal supports. Continuity is taken to include all end bay conditions. The total imposed load should include live load, finishes, ceilings and services (all unfactored), but not the self-weight of the slab. For loads and span conditions beyond the scope of these tables refer to SMD Deck Design Software or contact SMD's Technical Department.

Spans shown in red indicate where spans are limited by the fire condition, greater spans may be achievable by addition of bottom reinforcement. Spans shown in blue indicate where spans are limited by the composite/normal stage condition, greater spans my be achievable where shear studs are provided, refer SMD Deck Design Software or contact SMD Technical Department.

Normal Weight Concrete

Span Type	Fire Rating (hours)	Slab Depth (mm)	Steel Fibre	Maximum Permissible Span (m)											
				0.9mm Gauge				1.0mm Gauge				1.2mm Gauge			
				Total Unfactored Applied Load (kN/m²)											
				3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0
Double Span 	1.0	101	HE 1.0/50	3.23	3.23	3.23	3.18	3.47	3.47	3.47	3.34	3.78	3.78	3.78	3.46
		130	HE 1.0/50	3.05	3.05	3.05	3.05	3.30	3.30	3.30	3.30	3.51	3.51	3.51	3.51
		150	HE 1.0/50	2.89	2.89	2.89	2.89	3.14	3.14	3.14	3.14	3.44	3.44	3.44	3.44
	1.5	110	HE 1.0/50	3.22	3.21	2.82	2.54	3.39	3.34	2.93	2.64	3.69	3.58	3.14	2.83
		130	HE 1.0/50	3.05	3.05	3.05	2.79	3.30	3.30	3.19	2.89	3.51	3.51	3.42	3.10
		150	HE 1.0/50	2.89	2.89	2.89	2.89	3.14	3.14	3.14	3.14	3.44	3.44	3.44	3.35
	2.0	125	HE 1.0/50	3.09	2.95	2.60	2.35	3.33	3.07	2.70	2.44	3.45	3.27	2.88	2.61
		150	HE 1.0/50	2.89	2.89	2.89	2.71	3.14	3.14	3.09	2.81	3.44	3.44	3.28	2.98
		175	HE 1.0/50	2.72	2.72	2.72	2.72	2.98	2.98	2.98	2.98	3.26	3.26	3.26	3.19

Lightweight Concrete

Span Type	Fire Rating (hours)	Slab Depth (mm)	Steel Fibre	Maximum Permissible Span (m)											
				0.9mm Gauge				1.0mm Gauge				1.2mm Gauge			
				Total Unfactored Applied Load (kN/m²)											
				3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0
Double Span 	1.0	101	HE 1.0/50	3.43	3.43	3.39	3.08	3.69	3.69	3.44	3.12	4.02	4.02	3.53	3.21
		130	HE 1.0/50	3.26	3.26	3.26	3.26	3.51	3.51	3.51	3.51	3.76	3.76	3.76	3.76
		150	HE 1.0/50	3.12	3.12	3.12	3.12	3.37	3.37	3.37	3.37	3.68	3.68	3.68	3.68
	1.5	105	HE 1.0/50	3.41	3.19	2.76	2.47	3.65	3.32	2.87	2.57	3.98	3.57	3.09	2.77
		130	HE 1.0/50	3.26	3.26	3.23	2.91	3.51	3.51	3.34	3.01	3.76	3.76	3.56	3.21
		150	HE 1.0/50	3.12	3.12	3.12	3.12	3.37	3.37	3.37	3.27	3.68	3.68	3.68	3.47
	2.0	115	HE 1.0/50	3.33	2.99	2.60	2.33	3.46	3.10	2.70	2.42	3.69	3.31	2.88	2.58
		150	HE 1.0/50	3.12	3.12	3.12	2.86	3.37	3.37	3.27	2.96	3.68	3.68	3.45	3.11
		175	HE 1.0/50	2.97	2.97	2.97	2.97	3.21	3.21	3.21	3.20	3.52	3.52	3.52	3.35

Concrete Volume and Weight

Slab Depth	Volume of Concrete	Weight of Concrete (Normal Weight)		Weight of Concrete (Lightweight)	
mm	m³/m²	Wet (kN/m²)	Dry (kN/m²)	Wet (kN/m²)	Dry (kN/m²)
120	0.111	2.61	2.56	2.07	1.96
130	0.121	2.85	2.79	2.26	2.14
140	0.131	3.08	3.02	2.44	2.31
150	0.141	3.32	3.25	2.63	2.49
175	0.166	3.91	3.83	3.09	2.93
200	0.191	4.50	4.40	3.56	3.37
225	0.216	5.09	4.98	4.03	3.81
250	0.241	5.67	5.56	4.49	4.26

Deflection – This table is based on concrete poured to a constant thickness and does not take account for deflection of the decking or supporting beams (as a guide, to account for the deflection of the decking a concrete volume of span/250 should be added to the figures indicated). Concrete Weight – These tables indicate concrete weight only and do not include the weight of decking or reinforcement. Concrete weights are based on the concrete densities specified in BS5950 Part 4 clause 3.3.3 as follows: Normal Weight Concrete – 2400kg/m³ (wet) and 2350 kg/m³ (dry). Lightweight Concrete – 1900kg/m³ (wet) and 1800 kg/m³ (dry).

TR60+

Fire Tables – TAB-Deck™ Fibres

The tables incorporate the following criteria:
C25/30 concrete
Support width of 100mm - Ultimate load factor of 1.0
(The Ultimate load factor may be reduced in some cases, refer BS 5950 Part 8 Table 2)

The composite slab (not necessarily the metal deck) should be continuous over one or more internal supports. Continuity is taken to include all end bay conditions. The total imposed load should include live load, finishes, ceilings and services (all unfactored), but not the self-weight of the slab. For loads and span conditions beyond the scope of these tables refer to SMD Deck Design Software or contact SMD's Technical Department.

Spans shown in red indicate where spans are limited by the fire condition, greater spans may be achievable by addition of bottom reinforcement. Spans shown in blue indicate where spans are limited by the composite/normal stage condition, greater spans my be achievable where shear studs are provided, refer SMD Deck Design Software or contact SMD Technical Department.

Normal Weight Concrete

Span Type	Fire Rating (hours)	Slab Depth (mm)	Steel Fibre	Maximum Permissible Span (m) – 0.9mm Gauge – Total Unfactored Applied Load (kN/m²)				1.0mm Gauge				1.2mm Gauge			
				3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0
Double Span 	1.0	130	HE 1.0/50	3.59	3.42	2.99	2.68	3.83	3.54	3.09	2.78	4.19	3.80	3.33	2.99
		150	HE 1.0/50	3.38	3.38	3.30	2.98	3.70	3.70	3.42	3.10	4.12	4.10	3.63	3.28
		200	HE 1.0/50	2.99	2.99	2.99	2.99	3.20	3.20	3.20	3.20	3.78	3.78	3.78	3.78
	1.5	140	HE 1.0/50	3.21	2.90	2.54	2.12	3.29	2.98	2.61	2.18	3.47	3.14	2.75	2.48
		150	HE 1.0/50	3.37	3.06	2.69	2.26	3.46	3.15	2.77	2.50	3.63	3.30	2.90	2.62
		200	HE 1.0/50	2.99	2.99	2.99	2.92	3.20	3.20	3.20	3.20	3.78	3.78	3.63	3.32
	2.0	150	HE 1.0/50	3.21	2.91	2.56	2.14	3.31	3.01	2.64	2.20	3.46	3.14	2.76	2.32
		175	HE 1.0/50	3.17	3.17	2.64	2.40	3.45	3.28	2.71	2.46	3.72	3.42	2.83	2.57
		200	HE 1.0/50	2.99	2.99	2.99	2.79	3.20	3.20	3.20	2.85	3.78	3.78	3.48	2.95

Lightweight Concrete

Span Type	Fire Rating (hours)	Slab Depth (mm)	Steel Fibre	Maximum Permissible Span (m) – 0.9mm Gauge – Total Unfactored Applied Load (kN/m²)				1.0mm Gauge				1.2mm Gauge			
				3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0	3.5	5.0	7.5	10.0
Double Span 	1.0	120	HE 1.0/50	3.81	3.39	2.93	2.61	3.95	3.52	3.03	2.71	4.21	3.76	3.24	2.89
		150	HE 1.0/50	3.64	3.64	3.39	3.05	3.98	3.98	3.52	3.16	4.43	4.32	3.78	3.40
		200	HE 1.0/50	3.25	3.25	3.25	3.25	3.56	3.56	3.56	3.56	4.12	4.12	4.12	4.07
	1.5	130	HE 1.0/50	3.25	2.90	2.51	2.24	3.34	2.98	2.58	2.31	3.54	3.16	2.74	2.45
		150	HE 1.0/50	3.64	3.31	2.88	2.59	3.76	3.39	2.95	2.65	3.92	3.53	3.08	2.76
		200	HE 1.0/50	3.25	3.25	3.25	3.25	3.56	3.56	3.56	3.36	4.12	4.12	3.84	3.49
	2.0	140	HE 1.0/50	3.34	2.99	2.59	2.15	3.42	3.07	2.66	2.20	3.58	3.21	2.78	2.49
		175	HE 1.0/50	3.43	3.43	3.07	2.57	3.75	3.56	3.13	2.62	4.08	3.71	3.26	2.73
		200	HE 1.0/50	3.25	3.25	3.25	3.21	3.56	3.56	3.56	3.26	4.12	4.12	3.71	3.36

Concrete Volume and Weight

Slab Depth	Volume of Concrete	Weight of Concrete (Normal Weight)		Weight of Concrete (Lightweight)	
mm	m³/m²	Wet (kN/m²)	Dry (kN/m²)	Wet (kN/m²)	Dry (kN/m²)
120	0.086	2.02	1.98	1.60	1.52
130	0.096	2.26	2.21	1.79	1.70
140	0.106	2.50	2.44	1.98	1.87
150	0.116	2.73	2.67	2.16	2.05
175	0.141	3.32	3.25	2.63	2.49
200	0.166	3.91	3.83	3.09	2.93
225	0.191	4.50	4.40	3.56	3.37
250	0.216	5.09	4.98	4.03	3.81

Deflection – This table is based on concrete poured to a constant thickness and does not take account for deflection of the decking or supporting beams (as a guide, to account for the deflection of the decking a concrete volume of span/250 should be added to the figures indicated). Concrete Weight – These tables indicate concrete weight only and do not include the weight of decking or reinforcement. Concrete weights are based on the concrete densities specified in BS5950 Part 4 clause 3.3.3 as follows: Normal Weight Concrete – 2400kg/m³ (wet) and 2350 kg/m³ (dry). Lightweight Concrete – 1900kg/m³ (wet) and 1800 kg/m³ (dry).

TR80+

Fire Tables – TAB-Deck™ Fibres

The tables incorporate the following criteria:
C25/30 concrete
Support width of 100mm - Ultimate load factor of 1.0
(The Ultimate load factor may be reduced in some cases, refer BS 5950 Part 8 Table 2)

The composite slab (not necessarily the metal deck) should be continuous over one or more internal supports. Continuity is taken to include all end bay conditions. The total imposed load should include live load, finishes, ceilings and services (all unfactored), but not the self-weight of the slab. For loads and span conditions beyond the scope of these tables refer to SMD Deck Design Software or contact SMD's Technical Department.

Spans shown in red indicate where spans are limited by the fire condition, greater spans may be achievable by addition of bottom reinforcement. Spans shown in blue indicate where spans are limited by the composite/normal stage condition, greater spans my be achievable where shear studs are provided, refer SMD Deck Design Software or contact SMD Technical Department.

Normal Weight Concrete

Span Type	Fire Rating (hours)	Slab Depth (mm)	Steel Fibre	Maximum Permissible Span (m) – Total Unfactored Applied Load (kN/m²): 0.9mm Gauge 3.5	0.9mm Gauge 5.0	0.9mm Gauge 7.5	0.9mm Gauge 10.0	1.0mm Gauge 3.5	1.0mm Gauge 5.0	1.0mm Gauge 7.5	1.0mm Gauge 10.0	1.2mm Gauge 3.5	1.2mm Gauge 5.0	1.2mm Gauge 7.5	1.2mm Gauge 10.0
Double Span	1.0	140	HE 1.0/50	4.35	3.93	3.43	3.09	4.50	4.07	3.56	3.20	4.84	4.39	3.84	3.45
		160	HE 1.0/50	4.19	4.18	3.68	3.33	4.49	4.35	3.84	3.47	5.02	4.66	4.12	3.72
		200	HE 1.0/50	3.78	3.78	3.78	3.78	4.13	4.13	4.13	4.03	4.63	4.63	4.63	4.31
	1.5	150	HE 1.0/50	3.57	3.23	2.82	2.54	3.72	3.37	2.94	2.65	3.98	3.60	3.15	2.84
		175	HE 1.0/50	3.88	3.54	3.13	2.63	3.99	3.64	3.22	2.71	4.22	3.85	3.40	3.08
		200	HE 1.0/50	3.78	3.78	3.54	3.22	4.13	4.07	3.63	3.31	4.63	4.27	3.81	3.47
	2.0	160	HE 1.0/50	3.58	3.24	2.85	2.38	3.69	3.35	2.94	2.46	3.91	3.55	3.12	2.62
		175	HE 1.0/50	3.68	3.35	2.96	2.50	3.79	3.46	3.05	2.58	4.02	3.67	3.24	2.73
		200	HE 1.0/50	3.78	3.78	3.41	2.88	4.13	3.92	3.50	2.96	4.45	4.10	3.66	3.33

Lightweight Concrete

Span Type	Fire Rating (hours)	Slab Depth (mm)	Steel Fibre	Maximum Permissible Span (m) – Total Unfactored Applied Load (kN/m²): 0.9mm Gauge 3.5	0.9mm Gauge 5.0	0.9mm Gauge 7.5	0.9mm Gauge 10.0	1.0mm Gauge 3.5	1.0mm Gauge 5.0	1.0mm Gauge 7.5	1.0mm Gauge 10.0	1.2mm Gauge 3.5	1.2mm Gauge 5.0	1.2mm Gauge 7.5	1.2mm Gauge 10.0
Double Span	1.0	140	HE 1.0/50	4.54	4.07	3.52	3.15	4.71	4.22	3.65	3.27	5.05	4.53	3.93	3.51
		160	HE 1.0/50	4.51	4.38	3.82	3.43	4.76	4.51	3.94	3.54	5.34	4.84	4.23	3.80
		200	HE 1.0/50	4.10	4.10	4.10	4.03	4.48	4.48	4.48	4.13	4.98	4.98	4.86	4.41
	1.5	150	HE 1.0/50	3.78	3.39	2.94	2.63	3.92	3.51	3.05	2.73	4.17	3.73	3.24	2.90
		175	HE 1.0/50	4.09	3.70	3.23	2.77	4.21	3.80	3.33	2.85	4.44	4.01	3.51	3.16
		200	HE 1.0/50	4.10	4.10	3.79	3.43	4.48	4.39	3.88	3.51	4.98	4.59	4.06	3.67
	2.0	160	HE 1.0/50	3.83	3.44	2.99	2.53	3.97	3.57	3.10	2.60	4.24	3.81	3.32	2.98
		180	HE 1.0/50	4.22	3.82	3.35	2.80	4.33	3.92	3.44	2.88	4.55	4.12	3.61	3.25
		200	HE 1.0/50	4.10	4.10	3.63	3.28	4.48	4.22	3.72	3.36	4.83	4.41	3.89	3.52

Concrete Volume and Weight

Slab Depth	Volume of Concrete	Weight of Concrete (Normal Weight)		Weight of Concrete (Lightweight)	
mm	m³/m²	Wet (kN/m²)	Dry (kN/m²)	Wet (kN/m²)	Dry (kN/m²)
140	0.096	2.26	2.21	1.79	1.70
150	0.106	2.50	2.44	1.98	1.87
160	0.116	2.73	2.67	2.16	2.05
170	0.126	2.97	2.90	2.35	2.22
180	0.136	3.20	3.14	2.53	2.40
200	0.156	3.67	3.60	2.91	2.75
225	0.181	4.26	4.17	3.37	3.20
250	0.206	4.85	4.75	3.84	3.64

Deflection – This table is based on concrete poured to a constant thickness and does not take account for deflection of the decking or supporting beams (as a guide, to account for the deflection of the decking a concrete volume of span/250 should be added to the figures indicated). Concrete Weight – These tables indicate concrete weight only and do not include the weight of decking or reinforcement. Concrete weights are based on the concrete densities specified in BS5950 Part 4 clause 3.3.3 as follows: Normal Weight Concrete – 2400kg/m³ (wet) and 2350 kg/m³ (dry). Lightweight Concrete – 1900kg/m³ (wet) and 1800 kg/m³ (dry).

Composite Beam Design with TAB-Deck™ Steel Fibre Reinforced Concrete

Shear Stud Connectors

From a number of shear stud push tests it has been demonstrated that the resistance of thru deck welded shear studs was similar in specimens using concrete reinforced with a dosage of 30 kg/m^3 of Arcelormittal Wire Solutions HE 1/50 fibres (TAB-Deck™), when compared to identical specimens using conventional mesh reinforcement. The presence of fibres resulted in a significant enhancement to the ductility, for single and pairs of studs.

Longitudinal Shear

Testing has shown that in composite beam applications, the longitudinal shear resistance of floor slabs reinforced with 30 kg/m^3 of HE 1/50 fibres is, in most cases, sufficient so as not to require provision of additional transverse reinforcement. For example, a dosage of 30 kg/m^3 of HE 1/50 fibres was sufficient to provide a longitudinal shear resistance equivalent to an A393 mesh in a 150mm solid slab with f_{cu} = 30N/mm^2. When 30 kg/m^3 of HE 1/50 fibres are used in combination with conventional reinforcement, it may be possible to gain enhancement compared to cases when bars are embedded within plain concrete.

Design Rules

When profiled steel sheeting is oriented with the ribs parallel to the longitudinal axis of the beam (i.e. at primary beam positions) the longitudinal shear resistance may not be sufficient when the concrete is only reinforced with 30 kg/m^3 of steel fibres. In such cases, supplementary transverse reinforcement in the form of conventional bars should be provided. Although the tests undertaken so far indicate that an enhancement of approximately 10% can be achieved when fibres are used in combination with conventional reinforcement bars, there is insufficient data at this time to allow improved design equations to be developed. As a consequence of this, when supplementary reinforcement bars are provided, the fibres should be ignored and the design carried out according to the requirements given in Eurocode 4, 6.2.4 or Clause 5.6 of BS5950-3: 1990.

Eurocode 4

For design in accordance with Eurocode 4, the following equation should be used when normal weight concrete slab is reinforced with 30 kg/m^3 of steel fibres.

$$F_d = \frac{\nu f_{ck}}{2} \Delta_x h_f \frac{1}{\gamma_M} + \nu_{pd}$$

$$\text{but } 20 \text{ N/mm}^2 \leq f_{ck} \leq 30 \text{N/mm}^2$$

Where h_f is the effective thickness of the concrete flange, Δ_x is the length under consideration (half the distance between the point of zero moment and maximum moment, ie. 1/4 span for a simply supported beam with UDL), f_{ck} is the characteristic compressive cylinder strength of concrete, γ_M is the partial factor of safety (= 1.5), ν is the strength reduction factor for concrete cracked in shear

$$= 0.38\left[1 - \frac{f_{ck}}{250}\right]$$

and ν_{pd} is the contribution of the profiled steel sheeting if applicable, calculated according to BS EN 1994-1-1 clause 6.6.6.4.

BS5950-3: 1990

For design in accordance with BS5950-3: 1990, the following equation should be used when a normal weight concrete slab is reinforced with 30 kg/m^3 of TAB-Deck™ fibres.

$$\nu_r = 2.7 A_{cv} + \nu_p$$

$$\text{but } 30 \text{ N/mm}^2 \leq f_{cu} \leq 45 \text{N/mm}^2$$

Where A_{cv} is the mean cross-sectional area per unit length of the beam of the concrete shear surface under consideration and ν_p is the contribution of the profiled steel sheeting, if applicable, calculated to Clause 5.6.4 of BS5950-3: 1990.

The design resistance given in this equation is equivalent to that provided by an A393 mesh in a solid slab with f_{cu} = 30 N/mm^2. Further comparisons of longitudinal shear resistance for each profile at different slab depths using TAB-Deck™ at a dosage of 30kg/m^3 compared to conventional mesh fabric can be found on page 15. These tables are in accordence with the above equation for BS5950-3 1990 based upon 0.9mm gauge S350 grade decking, 500N/mm^2 grade reinforcement and 30N/mm^2 Normal Weight Concrete.

Composite Beam Design with TAB-Deck™ Steel Fibre Reinforced Concrete

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Notes

† Secondary beam with continuous decking perpendicular to the longitudinal axis of the beam (with deck contribution vp)
‡ Primary beam with decking parallel to the longitudinal axis of the beam (no deck contribution)

Slab Depth	Concrete Cross Section	A142		A193		A252		A393		TAB-Deck™ Fibre Concrete (30 kg/m³)	
mm	mm²	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)
100	91000	432.6	93.8	450.5	111.7	471.1	132.3	520.5	181.7	546.7	132.3
110	101000	441.6	102.8	459.5	120.7	480.1	141.3	529.5	190.7	573.7	159.3
120	111000	450.6	111.8	468.5	129.7	489.1	150.3	538.5	199.7	600.7	186.3
130	121000	459.6	120.8	477.5	138.7	498.1	159.3	547.5	208.7	627.7	213.3
140	131000	468.6	129.8	486.5	147.7	507.1	168.3	556.5	217.7	654.7	240.3
150	141000	477.6	138.8	495.5	156.7	516.1	177.3	565.5	226.7	681.7	267.3
160	151000	486.6	147.8	504.5	165.7	525.1	186.3	574.5	235.7	708.7	294.3
170	161000	495.6	156.8	513.5	174.7	534.1	195.3	583.5	244.7	735.7	321.3
180	171000	504.6	165.8	522.5	183.7	543.1	204.3	592.5	253.7	762.7	348.3
190	18100	513.6	174.8	531.5	192.7	552.1	213.3	601.5	262.7	789.7	375.3
200	191000	522.6	183.8	540.5	201.7	561.1	222.3	610.5	271.7	816.7	402.3

TR60+

Notes

† Secondary beam with continuous decking perpendicular to the longitudinal axis of the beam (with deck contribution vp)
‡ Primary beam with decking parallel to the longitudinal axis of the beam (no deck contribution)

Slab Depth	Concrete Cross Section	A142		A193		A252		A393		TAB-Deck™ Fibre Concrete (30 kg/m³)	
mm	mm²	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)
120	86000	428.1	103.7	446.0	121.6	466.6	142.2	516.0	191.6	533.2	162.0
130	96000	437.1	112.7	455.0	130.6	475.6	151.2	525.0	200.6	560.2	189.0
140	106000	446.1	121.7	464.0	139.6	484.6	160.2	534.0	209.6	587.2	216.0
150	116000	455.1	130.7	473.0	148.6	493.6	169.2	543.0	218.6	614.2	243.0
160	126000	464.1	139.7	482.0	157.6	502.6	178.2	552.0	227.6	641.2	270.0
170	136000	473.1	148.7	491.0	166.6	511.6	187.2	561.0	236.6	668.2	297.0
180	146000	482.1	157.7	500.0	175.6	520.6	196.2	570.0	245.6	695.2	324.0
190	156000	491.1	166.7	509.0	184.6	529.6	205.2	579.0	254.6	722.2	351.0
200	166000	500.1	175.7	518.0	193.6	538.6	214.2	588.0	263.6	749.2	378.0

TR80+

Notes

† Secondary beam with continuous decking perpendicular to the longitudinal axis of the beam (with deck contribution vp)
‡ Primary beam with decking parallel to the longitudinal axis of the beam (no deck contribution)

Slab Depth	Concrete Cross Section	A142		A193		A252		A393		TAB-Deck™ Fibre Concrete (30 kg/m³)	
mm	mm²	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)	Vr † (N/mm²)	Vr ‡ (N/mm²)
130	86000	428.1	94.7	446.0	112.6	466.6	133.2	516.0	182.6	533.2	135.0
140	96000	437.1	103.7	455.0	121.6	475.6	142.2	525.0	191.6	560.2	162.0
150	106000	446.1	112.7	464.0	130.6	484.6	151.2	534.0	200.6	587.2	189.0
160	116000	455.1	121.7	473.0	139.6	493.6	160.2	543.0	209.6	614.2	216.0
170	126000	464.1	130.7	482.0	148.6	502.6	169.2	552.0	218.6	641.2	243.0
180	136000	473.1	139.7	491.0	157.6	511.6	178.2	561.0	227.6	668.2	270.0
190	146000	482.1	148.7	500.0	166.6	520.6	187.2	570.0	236.6	695.2	297.0
200	156000	491.1	157.7	509.0	175.6	529.6	196.2	579.0	245.6	722.2	324.0

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