

LYSAGHT® BONDEK® II

STRUCTURAL STEEL DECKING FOR
COMPOSITE CONCRETE SLABS



Structural Solutions



Roofing & Walling Solutions



House Framing Solutions

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LYSAGHT®

BONDEK® II

Structural Steel Decking for Composite Concrete Slabs



INTRODUCTION

WELCOME TO THE LYSAGHT® BONDEK® II STRUCTURAL STEEL DECKING DESIGN AND CONSTRUCTION MANUAL. WE HAVE SIMPLIFIED THE WORK OF ENGINEERS WITH THIS SINGLE BOOK WHICH REPLACES TWO PREVIOUS PUBLICATIONS. FURTHER, IT WAS DEVELOPED TO LATEST VERSIONS OF RELEVANT BRITISH STANDARDS AND INCLUDES ADVANCED DESIGN OF FORMWORK AND DESIGN FOR FIRE.

BONDEK® II is a profiled steel sheeting widely accepted by the building construction industry to be highly economical, versatile and robust. It has been used to great effect on many major building projects, as well as countless small ones. It can be used as a formwork as well as a reinforcement system for composite concrete slab construction.

This new publication is based on our extensive research conducted on BONDEK® II profiled steel sheeting, so the information is not applicable to other sheeting profiles.

This manual implements several major new technical developments:

- Linear elastic analysis of continuous composite slabs
- Increased unsupported spans of BONDEK® II sheeting at the formwork stage due to inclusion of negative moment region capacities
- Design for reliable control of flexural cracking in support regions; and
- Economical design for fire due to BONDEK® II sheeting being partially effective for fire rating of up to 120 min.

This publication contains complete technical information on the following grades of BONDEK® II:

- BONDEK® II 0.75 mm thickness
- BONDEK® II 1.00 mm thickness
- BONDEK® II 1.20 mm thickness (Includes data for recently introduced 1.2mm).

These developments allow you to make significant improvements compared with the design methods we previously published for slabs using BONDEK® II.

FEATURE AND APPLICATIONS

1.1 SPANNING CAPACITIES

New design rules have been developed for the design of BONDEK® II acting as a BONDEK® II structural formwork for the construction of composite and noncomposite slabs (where BONDEK® II is used as lost formwork). The rules for calculating moment capacities are based on testing performed at BlueScope Lysaght Technology facility at Chester Hill, Sydney Australia.

The data obtained allowed us to include moment capacities in negative regions of the design model in accordance to BS 5950: Part 4: 1994 and reference document in this Standard: Technical Note 116: Design of profiled sheeting as permanent formwork. As a consequence, the span limits that previously applied to BONDEK® II in continuous spans have been increased by up to 12%.

1.2 COMPOSITE ACTION

BONDEK® II has a very high shear-bond capacity. Due to this, BONDEK® II slabs do not normally have limitations on imposed loads on typical spans unlike trapezoidal profiles.

1.3 DESIGN EFFICIENCY

The range of BONDEK® II gauges available (0.75 mm, 1.0 mm and 1.2 mm) allows much closer matching of design requirements and deck performance. BONDEK® II 1.2 mm is not available in the design tables and software. However, the solutions with this BONDEK® II 1.2 thickness may be designed by our Customer Support Centre.

1.4 ECONOMICAL DESIGN FOR FIRE

BONDEK® II sheeting was conservatively treated as ineffective in our previous publications.

Fire tests conducted recently at Victoria University of Technology showed that BONDEK® II has some capacity in fire up to 120 min. Effective area of BONDEK® II is mainly concentrated in top flanges of the profile. Lap joints fully cast in concrete contribute more than dovetail ribs. Fire tests have been conducted to investigate temperatures within concrete body and within BONDEK® II sheeting itself as well as effect of elevated temperatures on shear bond capacity.

BONDEK® II sheeting capacity was included in fire calculations as a result of this research. No additional fire reinforcement may be necessary in many design cases.

1.5 QUICKER TROUBLE-FREE INSTALLATION

The installation of BONDEK® II follows simple, familiar and widely accepted practice. BONDEK® II is available in long lengths so large areas can be quickly and easily covered to form a safe working platform during construction. The bold embossments along the top of the ribs of BONDEK® II enhance safety by reducing the likelihood of workers slipping.

1.6 TECHNICAL SUPPORT

Refer to the back cover for contact details of your local technical support.

SPECIFICATION AND DESIGN

2.1 BONDEK® II COMPOSITE SLABS

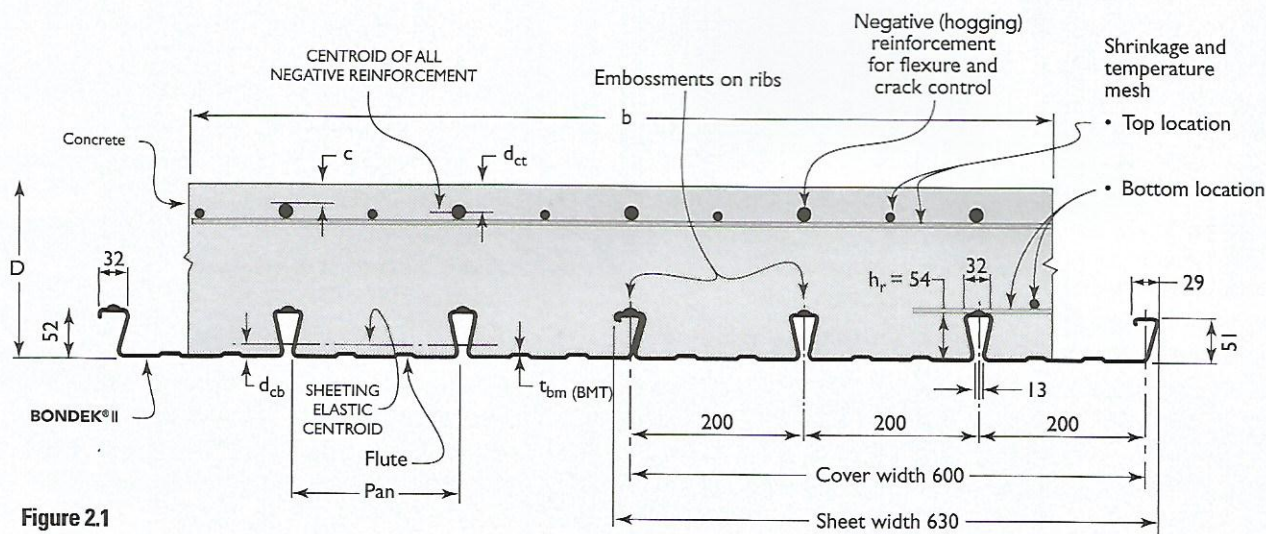


Figure 2.1
BONDEK® II profile dimensions and reinforcement

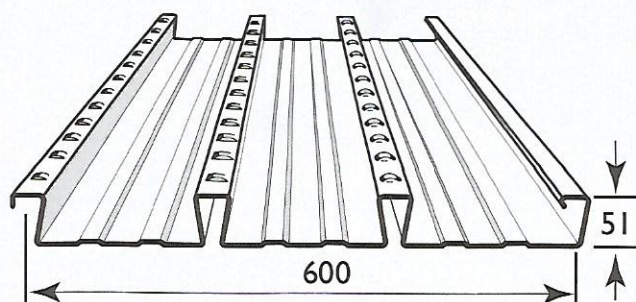


Figure 2.2
BONDEK® II profile and cover width

2.2 BONDEK® II SECTION PROPERTIES

	Thickness BMT mm	Section modulus $Z_x 10^3 \text{ mm}^3/\text{m}$	Cross-sectional area of BONDEK® II $A_{sh} \text{ mm}^2/\text{m}$	Second moment of area $I_x 10^4 \text{ mm}^4/\text{m}$	SelfWeight Kg/m ²
* 1.20 BMT BONDEK® II	1.20	20.03	2014	76.90	16.02
1.00 BMT BONDEK® II	1.00	16.69	1678	64.08	13.60
0.75 BMT BONDEK® II	0.75	12.50	1259	47.98	10.30

Table 1.2

Section properties in Table 1.2 are given for reference only.

* BMT 1.2mm is available upon request.

2.3 SHEETING

BONDEK® II is rolled-formed from hot dipped, zinc-coated, high tensile steel, in base metal thickness (BMT) of 1.2, 1.0 and 0.75mm.

The steel conforms to both AS 1397 and BS EN 10147, and:

- for 1.2 BMT the grade is G500;
- for 1.0 and 0.75 BMT the grade is G550.

The coating is Z275 (275g/m² minimum coating mass) or Z350 (350g/m² minimum coating mass) on both sides. Embossments on the top of flanges provide the mechanical connection between the steel and concrete.

2.4 CONCRETE

All tables have been developed for the C30 concrete with normal density of 2400 kg/m³ (wet density). Other concrete grades are available in the BONDEK® II 2003BS software.

2.5 REINFORCEMENT

Steel reinforcement is necessary to control shrinkage and temperature effects, as flexural negative reinforcement over supports and in some instances for fire engineering purposes. It shall comply with requirements of BS 4449:1997 for bars and with BS 4483:1998 for fabric.

Reinforcement Grade 460B shall be specified.

2.6 SHEAR CONNECTORS

Shear studs for composite beams may be specified with BONDEK® II concrete slabs as required by BS 5950:Part 3: section 3.1 where relevant. Strength reduction factors are not applicable since BONDEK® II forms a solid slab. Shear studs shall not be considered when composite beams are not a design option such as concrete frame buildings or composite slabs supported by masonry walls.

2.7 DESIGN METHODS

There are three ways you can design concrete slabs using BONDEK® II:

- Using the design tables given in this manual.
- Calculate from first principles using relevant British Standards and data from this manual and available through BlueScope Lysaght and Lysaght Technology at Chester Hill, Sydney Australia.
- Run our software. This is also likely to produce more economical design. The software allows input of parameters which are not available in tables such as grades of concrete other than C30.

2.8 FORMWORK DESIGN

The BONDEK® II formwork shall be designed in accordance to BS 5950: Part 4: 1994 and BS 5950: Part 6: 1995 and Technical Note 116: Design of profile sheeting as permanent formwork.

BONDEK® II bending capacities have been confirmed by tests conducted at the Lysaght Technology facility at Chester Hill, Sydney, Australia.

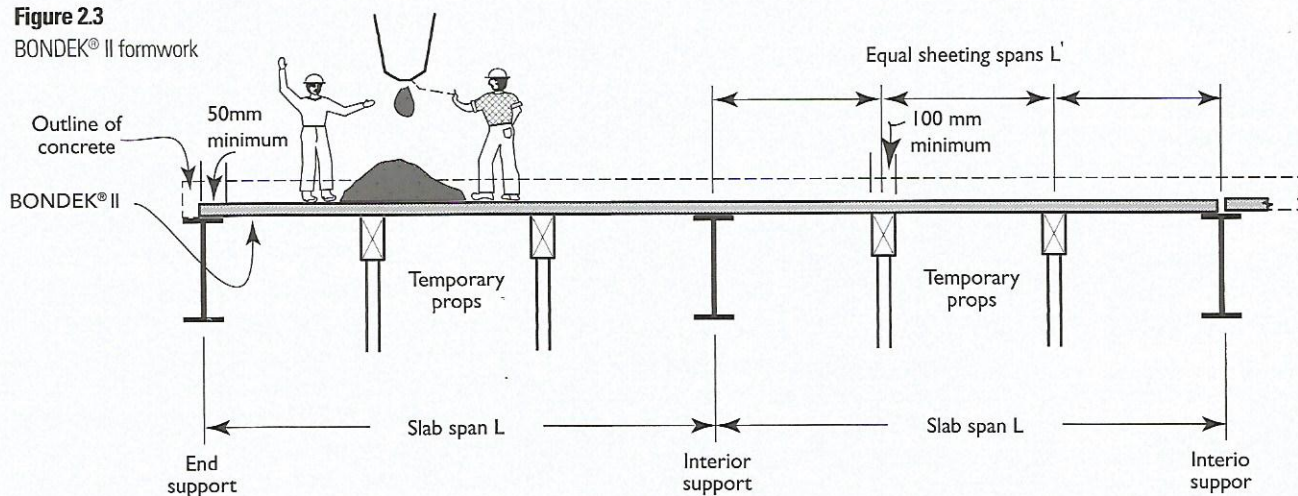
Our design tables can be used to detail BONDEK® II acting as a structural formwork, provided the following conditions are satisfied:

- The support lines extend across the full width of the sheeting and have a minimum bearing of 50 mm at the ends of the sheets when rest on steel or concrete and 70 mm when rest on other materials such as masonry wall.

- The sheets continue within each slab span length without any overlaps or intermediate splicing or jointing longitudinally.
- The sheets are designed as single or continuous span formwork.
- The slab has a uniform cross section.
- The formwork is not used as a restraint to supporting steel beams during construction. When necessary, restraint capacities can be analysed using first principles.
- Separate consideration is given to sides of the sheeting where edges shall be restrained.
- BONDEK® II sheeting ends shall be securely fixed to the supporting structure
- The ratio of the longer slab span to the shorter slab span (L_y/L_x) of any two adjacent spans does not exceed 1.2 (i.e. $L_y/L_x \leq 1.2$).
- The supports are effectively rigid such that their vertical deflections during the construction phase can be ignored in design.
- Maximum construction imposed load is 1.5 kPa, or 4.5/Slab span kPa for slab spans less than 3m. Construction imposed load can be applied on the BONDEK® II formwork or recently formed slabs.
- Maximum imposed storage load on the formwork is 4 kPa. This load shall not be applied on recently formed slabs.
- Imposed construction loads shall not be applied to areas supporting storage loads and vice versa.

Figure 2.3

BONDEK® II formwork



Deflection limits/loading parameters

BS 5950:Part 4: 1994 recommends that the sheeting deflection should not exceed $L/130$ (but $<30\text{mm}$) under its own weight plus the weight of wet concrete (including reinforcement) provided ponding is taken into account. In this publication, deflection limits of $L/130$ is adopted.

Table 1 Factored load combinations for strength and deflection calculations

Construction Stage (See note 1)	Design Case (See note 2)	Sheeting Dead Load Gdp (See Note 3)	Concrete Dead Load Gdp	Imposed Construction Loads Qc	Imposed Storage Loads Qs
Ia	Strength	1.4	-	1.6	-
Ib	Strength	1.4	-	-	1.6
IIa	Strength	1.4	1.4	1.6	-
IIb	Deflection	1.0	1.0	-	-

NOTES:

- 1) Construction Stage 1 is defined as being prior to the placement of concrete, and Stage 2 as during the placement of concrete up until the concrete hardens.
- 2) G_{dc} includes an allowance for concrete ponding and the weight of steel reinforcement.
- 3) Both distributed and line load cases must be considered separately.

2.9 COMPOSITE SLAB DESIGN

The BONDEK® II composite slabs shall be designed in accordance to BS 5950: Part 4: 1994, BS 8110: Part 1: 1997, BS 8110: Part 2: 1985, BS 4449: 1997. AS 3600-2001 may be used where relevant.

The design concept is based on "k" and "m" method. Data about shear-bond capacity have been obtained from full-scale tests and supplementary smallscale slip-block tests. The tables provide with solutions for steel frame or masonry wall types of construction.

Our design tables and software can be used to design composite slabs with BONDEK® II, provided the following conditions are satisfied:

- It is a common practice to design continuous slabs as a series of single spans. Minimum nominal reinforcement at intermediate supports shall be specified in this case in accordance to BS5950: Part 4: 1994, Clause 6.8. It shall be noted that nominal reinforcement will not prevent formation of wide cracks over supports - requirements of BS8110: Part 1: 1994, Clause 3.5.8 for crack control will not be satisfied. Increased slab thickness may be required in many instances when continuous slabs are designed as a series of simply supported spans.
- The ratio of longer slab span (L_1) to the shorter slab span (L_2) of any two adjacent spans does not exceed 1.2, that is $L_1/L_2 \leq 1.2$.
- The bending moments at the supports are only caused by the action of vertical loads applied to the slab.

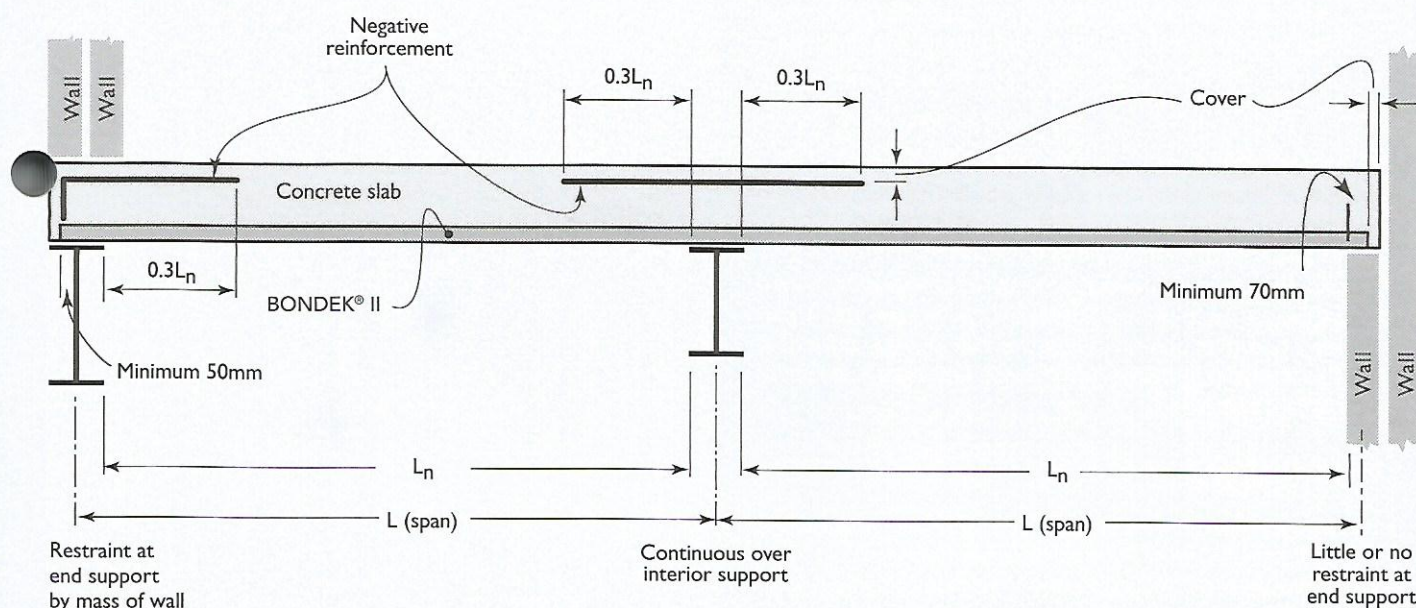


Figure 2.4

BONDEK® II Pattern 1 for conventional (standard) reinforcement

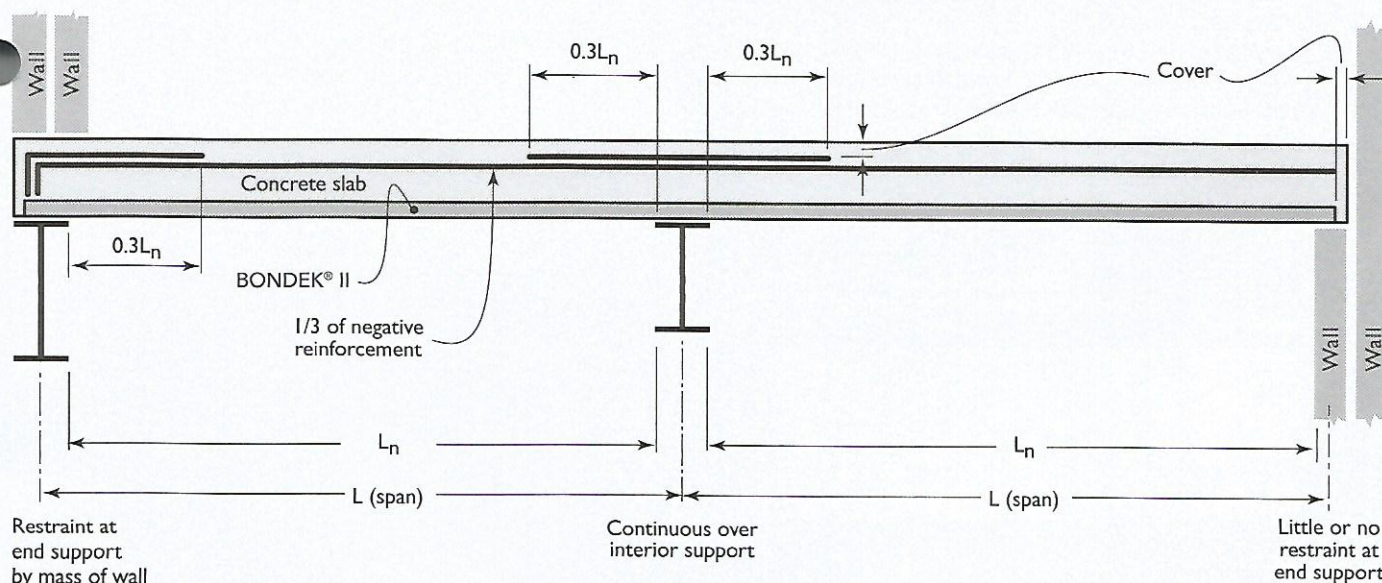


Figure 2.5

BONDEK® II Pattern 2 for conventional reinforcement when imposed load exceeds twice the dead load

- The first interior span shall have the same thickness as the end span.
- The geometry of the steel sheeting profile shall conform to the dimensions and tolerances shown on our production drawings.
Sheeting with embossments of a depth less than that specified on these drawings shall not be used as composites unless the values of "k" and "m" are revised.
- The specified concrete strength grade is in the range C30 to C40 (only C30 is available in tables). The wet concrete density must be 2400 kg/m³ for normal weight concrete. The concrete shall follow the recommendations given in BS 8110.
- Composite action must be assumed to exist between the steel sheeting and the concrete once the concrete in the slab has attained a compressive strength of 20 MPa. Prior to the development of composite action during construction, potential damage to the shear connection must be avoided, and maximum construction imposed loads shall be limited to 1.5 kPa.
- Reinforcement Pattern 2 shall be used when imposed load exceeds twice the dead load.

2.10 DESIGN FOR FIRE

The BONDEK® II composite slabs shall be designed for fire conditions in accordance to BS 5950-8: 1990, BS 476-20: 1987 and BS 476-21: 1987.

Reduction factors are applied to allow for the adverse effect of elevated temperatures on the mechanical properties of concrete and steel. Values of these reduction factors have been derived from fire tests conducted at Victoria University of Technology and extensive finite element analysis of BONDEK® II composite slabs.

Reduced shear bond capacity is also considered for elevated temperatures.

Our tables may be used to detail BONDEK® II composite slabs when the soffit is exposed to fire provided the following conditions are satisfied:

- The composite slab acts as a one-way element spanning in the direction of the sheeting ribs for both room temperature and fire conditions.
- The composite slab has been initially designed and detailed for room temperature conditions in accordance to this manual.
- The fire design load is essentially uniformly distributed and static in nature.
- Adequate detailing of slab jointing, edges, slab holes and cavities (for penetrating, embedded or encased services) to provide the appropriate fire resistance period. Alternatively the local provision of suitable protection (such as fire spray material) will be necessary.
- The fire periods are 30, 60, 90, 120, 180 or 240 min.
- $x_b \geq 30$ mm

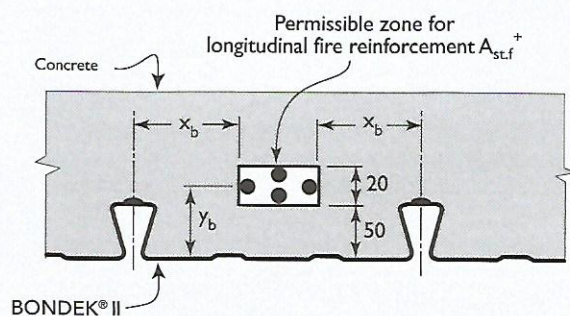
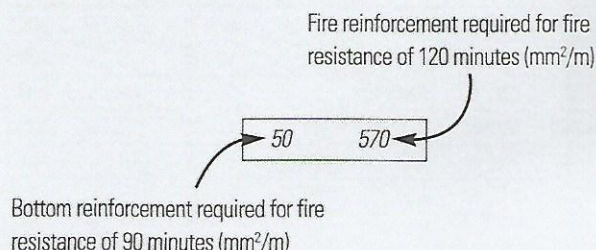


Figure 2.6

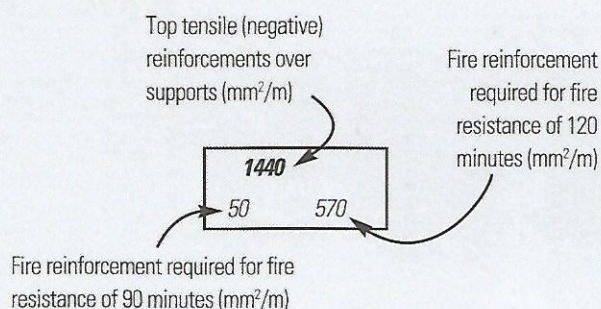
Permissible zone for location of longitudinal fire reinforcement.

DESIGN TABLES

KEY - Single Spans



KEY - Continuous Spans



Notes:

1. Areas without cells mean that a design solution is not possible.
2. Single spans do not require top tensile reinforcement, relevant cells are not shown.
3. All spans are centre to centre.
4. A dash (-) means no fire reinforcement is necessary.
5. N/A means a design solution with this particular fire rating is not possible.
6. Top tensile/negative reinforcement includes longitudinal wires of shrinkage mesh, if any, and additional bars.

3.1 USE OF DESIGN TABLES

The design parameters specific for each table are given on the top of tables:

- Spans: single, continuous end or interior.
- Thickness of the slab.

The rest of parameters are common for all tables and listed below:

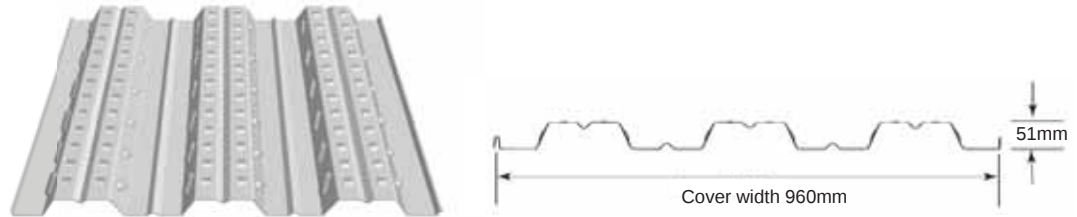
- More than four spans for continuous spans
- Concrete grade: C30.
- Type of construction: steel-frame or masonry wall construction.
- Density of wet concrete: 2400 kg/m³.
- BONDEK® II used as a structural deck with thickness 0.75 & 1.0mm BMT
- Formwork deflections limit: L/130.
- Maximum storage imposed loads on formwork: 4 kPa.
- Minimum 100 mm width of permanent supports.
- Mild conditions of exposure.
- Composite slab deflection limits: L/250 for total loads and L/350 for imposed loads.
- Indoor conditions for creep and shrinkage.
- Ratio of longer adjacent span to shorter does not exceed 1.2.
- Degree of redistribution of negative reinforcement is 10%.
- For crack control of slabs in flexure over supports limits the crack width to 0.3mm.
- Maximum 10 mm diameter reinforcing bars.
- Office type of imposed loads: 25% of imposed loads are permanent.
- 1 kPa of superimposed dead load.
- Reinforcement: 460B grade in accordance to BS 4449:1997 for bars and BS 4483:1998 for fabric.
- 0.8 factor for imposed loads for fire conditions.
- 90 and 120 min. fire resistance levels for single and continuous spans
- Location of negative reinforcement as shown on Fig. 2.1
- Location of fire reinforcement as shown on Fig. 2.6

The background of the entire page features faint, light blue architectural drawings, including floor plans and circular technical diagrams. A large, close-up photograph of the LYSAGHT SMARTDEK steel decking profile is positioned diagonally across the center-left. The decking is made of dark, textured metal with a series of raised, rounded ribs and small circular indentations. The lighting highlights the metallic texture and the geometric pattern of the profile.

LYSAGHT

LYSAGHT® SMARTDEK®

An Appealing Steel
Decking Profile with
Broader Span

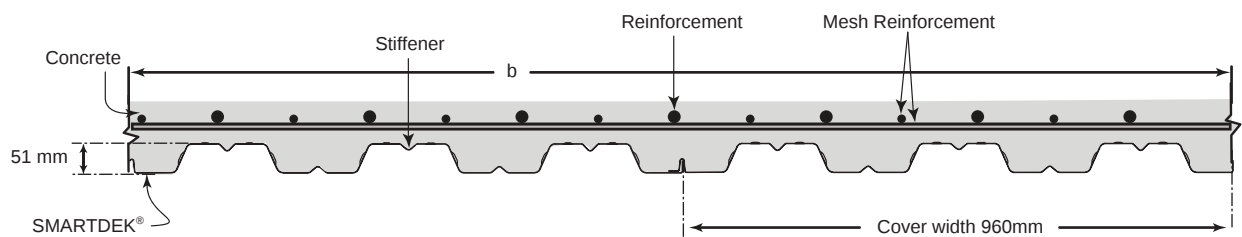
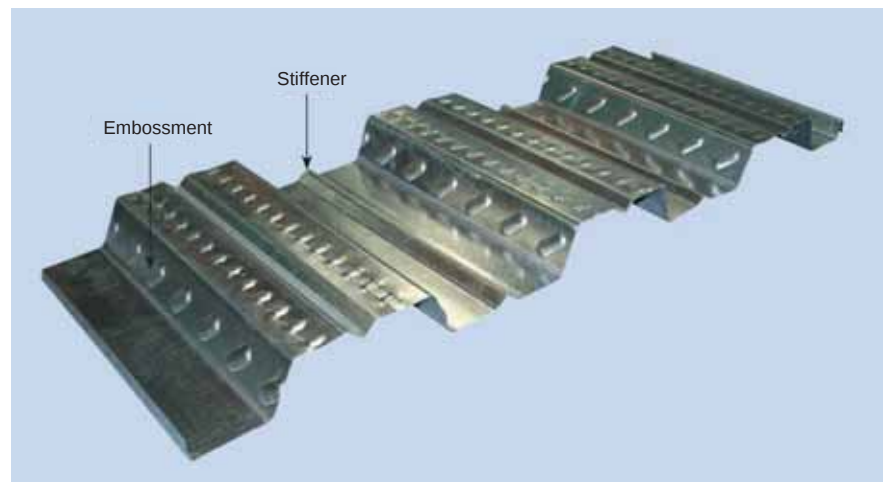


LYSAGHT® SMARTDEK® is an innovative high strength zinc-coated steel decking system designed for use in the construction of composite floor slabs. It is suitable for typical application as it provides widest cover per weight of steel and minimizes the requirement for reinforcement. It acts as a permanent formwork for a composite concrete slab, which in its assembled state can be used as a working platform as well as a formwork to support wet concrete, construction materials and trades. When the concrete hardens, it acts as the bottom tensile reinforcement provided composite slab design is taken into consideration.

Designed to Perfection

LYSAGHT® SMARTDEK® is an innovative “W” profile structural steel decking system. It brings greater economy and design freedom as it is precision engineered and provides ease of use as well as safety. SMARTDEK® system has excellent spanning capacities that ensure greater strength and less deflection.

SMARTDEK® panel has a rib depth of 51mm and provides an effective cover width of 960mm. Embossments at the top of the flange provide excellent mechanical interlocking between steel and concrete. In the assembled state, the profile comprises of intermediate male and female ribs for every interlocking side-lap joint.



Scan for online resources

MATERIAL SPECIFICATION & SECTION PROPERTIES

Thickness (BMT) (mm)	Self-Weight (kg/m ²)	Full Cross-Sectional Area (mm ² /m)	Zinc Coating (g/m ²) *	Steel Grade (MPa) **	Inertia Moment Lx ³ (mm ² /m)	Section Modules Zx ¹ (mm ² /m)
0.75	7.84	953.0	275	550	438,645.11	16,217.18
1.00	10.34	1269.7	275	550	526,562.50	19,479.17
1.20	12.33	1523.9	275	550	701,979.17	25,958.33

Note:

The steel conforms to AS1397 and BS EN 10147

* Nominal coating thickness

** Minimum yield strength of steel

BENEFITS OF LYSAGHT® SMARTDEK® SYSTEM

Features	Benefits	
	Technical	Commercial
G550 Steel Grade	Increase free span	Less support
	Stiffer profile no indentation after support removed	Saving cost for formwork
3mm Embossment	Better composite action	Optimize reinforcement design
	Able to receive high intensity of loading without additional bottom reinforcement	
	Enhance design for fire capacity	Optimize overall design
960mm Effective Width	Fit with most column grid, no waste	Saving cost for material waste
		Less on site cutting needed, improve safety
MEGAFLOOR Software	Ultimate tool to design decking as formwork, composite and fire.	Fast in designing composite slab.
		Less resource for planning the usage of SMARTDEK®

Smart Software

MEGAFLOOR structural decking software for the design of composite slabs with SMARTDEK® profile will be available to assist engineers and consultants in deriving an optimal solution.

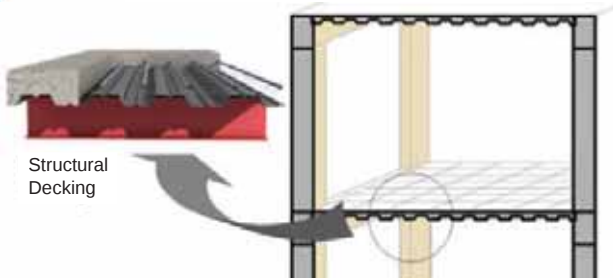
Smart Construction

SMARTDEK® system provides a safe working platform that is fast and easy to set up and therefore minimizes multi-storey construction time. Faster construction time allows optimization on construction schedule delivering faster value to the developers.

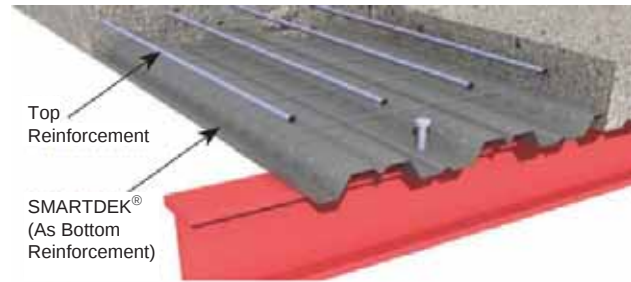
Smart Application

Besides its application in composite floors in multi-storey buildings and commercial establishments, it is extensively used for Mezzanine applications. Corrosion resistant coating makes it the best solution for typical applications like parking sheds, where SMARTDEK® system provides better appearance to exposed ceilings.

SMARTDEK® acts as an integral structural element



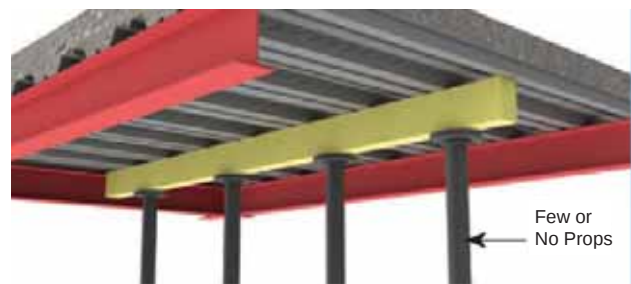
SMARTDEK® acts as bottom tensile reinforcement – Steel saving



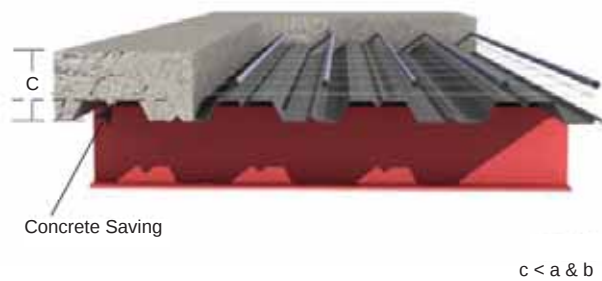
Embossments provide mechanical interlock between steel and concrete.



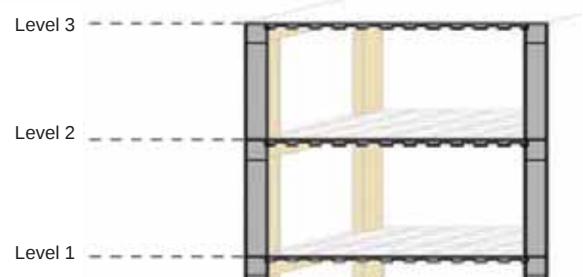
High tensile steel (G550) provides large unpropped spans



Concrete saving makes construction economical.



SMARTDEK® application delivers faster value to developers.



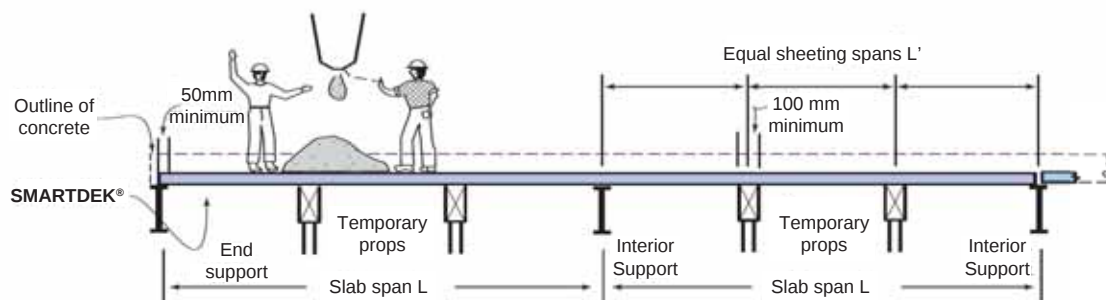
Span Type		Single			Continuous End			Continuous Interior				
												
Slab Thickness (mm)	BMT	0.7	1.0	1.2		0.7	1.0	1.2		0.7	1.0	1.2
	100	2380	2740	2800		2640	3410	3200		2640	3280	3200
	110	2310	2650	2780		2550	3320	3110		2550	3170	3110
	120	2230	2570	2700		2470	3230	3020		2470	3070	3020
	130	2170	2500	2620		2400	3150	2930		2400	2990	2930
	140	2110	2430	2560		2330	3080	2850		2330	2900	2850
	150	2060	2370	2500		2270	3000	2770		2270	2800	2770
	160	2010	2330	2440		2210	2930	2700		2210	2710	2700
	170	1960	2260	2390		2160	2850	2640		2140	2630	2640
	180	1920	2230	2340		2110	2790	2580		2080	2550	2580
	200	1840	2150	2180		2030	2670	2470		1870	2300	2470

- * Allowable span based on No Prop condition.
- * Deflection based on L/130, wet concrete density of 24kN/m³.
- * Maximum construction-imposed load is 1.5kPa.

Formwork Design – Design for Strength

The SMARTDEK® formwork shall be designed in accordance with BS 5950: Part 4: 1994 and BS 5950: Part 6: 1995 and Technical Note 116: Design of profile sheeting as permanent formwork.

SMARTDEK® bending capacities have been confirmed by tests conducted as Lysaght Technology Laboratory at Chester Hill, Sydney, Australia



LYSAGHT® SMARTDEK® formwork (double span) with two rows of propping

Tested to Extreme Conditions

SMARTDEK® panels have been subjected to rigorous tests such as slip block test, formwork tests including shear and bearing, full scale slab test, composite slab cycle test, fire rating test, formwork-air pressure test, formwork-four-point load test and concentrated load test. These tests are carried out in the labs of LYSAGHT® Technology Laboratory in Chester Hill, Sydney, Australia, to ensure maximum performance and quality of our decking profiles.



Formwork - Point Load



Formwork - Air Pressure Test



Composite - Slip Block Test



Fire Test - Victoria University

Quality Assurance

The LYSAGHT® brand name is synonymous with quality and performance. As with all other LYSAGHT® products, SMARTDEK® steel sheets comply with major design standards adopted across Asia. Manufactured using high tensile steel, it is optimally configured and uses advanced design and construction method.

Note: All the product images used in this brochure are for reference purposes only and do not reflect the actual configuration of the product. Kindly note that the product images are indicative and for illustration purposes only. Lysaght reserves the right to make any change to product images without prior notice. For accurate and up-to-date information, seek advice from Lysaght representative.

REFERENCES



TRX Exchange 106, Kuala Lumpur



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Ministry of Religious Affairs
Office Tower at Jakarta



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