Welcome to the LYSAGHT BONDEK® Design Software User Guide. Our design software will significantly assist a qualified engineer arrive at a solution which speeds the design process for floors and slabs.

BONDEK® works as composite slab saving on concrete and reinforcement costs.

Download your free copy of the software from: 
http://professionals.lysaght.com/products/bondek

BACKGROUND

Our newest release of supporting software and the Design and Construction Manual for BONDEK® Structural Steel Decking incorporates Lysaght’s latest research and development work. Improved design and testing methods have again pushed BONDEK® Structural Steel Decking to the forefront. New formwork tables are optimised for steel frame construction but are also suitable for concrete frame construction and masonry walls.

This User Manual is designed to provide you with basic familiarity about LYSAGHT BONDEK® Design Software to enable you to quickly understand and start using this powerful tool. The software is able to perform major tasks normally performed at a structural consultant’s office. Use LYSAGHT BONDEK® Design and Construction Manual with its set of tables for typical designs. The software will help when input parameters are different from those listed for tables or the user wants to check several different options.

LYSAGHT BONDEK® is a profiled zinc-coated high tensile steel decking for use in the construction of composite floor slabs. It has been successfully used in countless buildings throughout Australia. The profile has been specifically developed for Australian high tensile steels.

It can be used as formwork during construction and as a reinforcement system in composite slabs.

Our increased understanding of composite slabs, together with testing in our NATA-accredited laboratory and leading Australian universities, has paid off with an optimised product, which provides significant cost savings for projects.

The built-in properties of high tensile steel are maximised in the design and fabrication of the deck profiles which result in products with high strength-to-weight ratio. LYSAGHT BONDEK® is currently one of the most popular structural steel decking profiles in Australia for typical applications.

SCOPE

This manual provides information on the design of formwork, propping, composite slabs and design for fire and some information for composite beams.

LYSAGHT BONDEK® Design Software is developed to Australian Standards (AS) whenever possible, Eurocodes have been used when certain design procedures are not available in Australian Standards.

CONDITIONS OF USE

This publication contains technical information on the following grades of LYSAGHT BONDEK®:
- LYSAGHT BONDEK® 0.6mm thickness
- LYSAGHT BONDEK® 0.75mm thickness
- LYSAGHT BONDEK® 0.9mm thickness
- LYSAGHT BONDEK® 1.00mm thickness

Additionally, LYSAGHT BONDEK® Design Software allows you to get quicker and more economical solutions with a range of options. Call Steel Direct on 1800 641 417 to obtain additional copies of the Design and Construction Manual and User Guide to BONDEK® Design Software.

Where we recommend use of third party materials, ensure you check the manufacturer’s requirements. Diagrams are used to explain the requirements of a particular product. Adjacent construction elements of the building that would normally be required in that particular situation are not always shown. Accordingly aspects of a diagram not shown should not be interpreted as meaning these construction or design details are not required. You should check the relevant Codes associated with the construction or design.

WARRANTIES

Our products are engineered to perform according to our specifications only if they are installed according to the recommendations in this manual and our publications. Naturally, if a published warranty is offered for the product, the warranty requires specifiers and installers to exercise due care in how the products are applied and installed and are subject to final use and proper installation. Owners need to maintain the finished work.

PREFACE

LYSAGHT BONDEK® Design Software is a user-friendly Microsoft Excel®-based software for the design of composite concrete slabs with LYSAGHT BONDEK® structural decking. It is suitable for steel frame construction and masonry supports.

It is a tool developed with latest information to assist a competent engineer with the most competent solution.

The software should be used to design composite slabs in conjunction with the LYSAGHT BONDEK® Design & Construction Manual.

www.lysaght.com
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BONDEK® DESIGN SOFTWARE

1.0 Introduction

The software offers following additional design options as compared to tables:

- Two major design options: Design and Design/Check. The first option will perform design with the minimum possible slab thickness; the second one will check the chosen slab thickness and design the rest of the parameters.
- Selection of exposure classifications (A1, A2, B1 and B2).
- 25, 32 and 40 MPa concrete grades.
- Superimposed dead load ($G_{\text{sd}}$) other than 1 kPa.
- Other than office types of imposed loads.
- For negative, positive fire and shrinkage reinforcement, use D500N or D500L.
- User specified bar diameter.
- Specified number of continuous spans (two-span, three-span etc.).
- Degree of control for shrinkage and temperature effects.
- All fire rating periods: 30, 60, 90, 120, 180 and 240 min.
- Variable loads due to weight of stacked materials during construction stage.
- Design with relaxed crack control requirements for flexure.
- Support width.
- User specified concrete cover.

The software is developed as a powerful tool to minimise time and calculations by a consulting engineer to complete the job. However, it is essential for the user to have:

- Good knowledge of structural engineering.
- Familiarity with design of composite concrete slabs.
- Sound knowledge of local regulations and load requirements.

2.0 Getting Started

2.1 COMPUTER REQUIREMENTS

To run LYSAGHT BONDEK® Design Software your computer must have Microsoft Excel® 2000 or a later version, on Windows® platform.

2.2 INSTALLING LYSAGHT BONDEK® DESIGN SOFTWARE

The LYSAGHT BONDEK® Design Software can be downloaded from: http://professionals.lysaght.com/products/bondek


On your hard disc, create a directory (folder) called LYSAGHT BONDEK® Design Software, and place the downloaded files from http://professionals.lysaght.com/products/bondek into the folder. Run the software, in the usual way, by double-clicking on the icons.

Ensure you enable Macros before proceeding with LYSAGHT BONDEK® Design Software. The security settings for Microsoft Excel® shall be set to medium to low level when applicable.
3.0 Software Flowchart for the Design of Continuous Spans

1. Specify parameters in Input dialogue box for End Span
   - Slab thickness known?
     - Yes: Specify parameters in Design/Check dialogue box and click Design
       - The design output is satisfactory (passed) and economical?
         - Yes: Less than five spans
           - Yes: Repeat above procedure for one Interior Span with thicknesses required for End Span using Design/Check dialogue box.
           - No: Repeat above procedure for one Interior Span (Equal Spans) or several Interior Spans.
         - No: Repeat above procedure for one Interior Span with thicknesses required for End Span using Design/Check dialogue box.
       - No: Repeat above procedure for one Interior Span using either of these two options - the same thickness as for End Span, using Design/Check dialogue box - minimum thickness using Design dialogue box.
   - No: Revise input parameters
2. Specify parameters in Design dialogue box and click Design
   - The design output is satisfactory (passed) and economical?
     - Yes: Less than five spans
       - Yes: Repeat above procedure for one Interior Span with thicknesses required for End Span using Design/Check dialogue box.
       - No: Repeat above procedure for one Interior Span (Equal Spans) or several Interior Spans.
     - No: Repeat above procedure for one Interior Span using either of these two options - the same thickness as for End Span, using Design/Check dialogue box - minimum thickness using Design dialogue box.
   - No: Revise input parameters
4.0 LYSAGHT BONDEK® Software Menu

LYSAGHT BONDEK® Design Software Menu options are built into Excel Menu on the top of the screen.

Excel Menu may look different from what is shown below.

There are three additional Menu options:

- Analyse
- Print
- Report

**Figure 1**
Analyse Menu.

**Help**

Analyse Menu has three submenu options:

- Input
- Design
- Design/Check

These options will be described in details in further chapters.

When the software is opened, the Input dialogue box will appear on the screen automatically (see cover page). For the second and consecutive runs, the user shall access the Input dialogue box through Menu.

Print Menu allows the user to print Output/Input information or Report.

**Figure 2**
Print Menu.

**Help**

Report Menu will generate detailed a design report which is described in more detail in Chapter 10.

**Figure 3a**
Report Menu.

It shall be noted that Menu options are available only when LYSAGHT BONDEK® Design Software Excel file is activated.

* For Microsoft Excel® 2007 or later versions, the extra functional tabs described above can be accessed at the Add-ins ribbon.

**Figure 3b**
5.0 Input dialogue box

5.1 GENERAL

Input dialogue box is designed for quick and easy data entry. The user shall normally just choose one of the available options. If required input information is missed or incorrect, the warning message would appear on the screen.

5.2 CONDITIONS OF EXPOSURE

The Exposure Classification shall be specified as required by AS 3600:2009 Clause 4.3

5.3 SPANS

The user may specify Single Spans or Continuous Spans depending on the project.

Increased slab thickness may be required in many instances when continuous slabs are designed as a series of simply supported spans.

If the span is a Continuous one, the user may run the software several times: for End Spans and Interior Spans separately. If the continuous span is a Two spans then there is no option for Interior Spans, both spans are end ones. It shall be noted that Continuous Spans refer here to composite concrete slabs only, LYSAGHT BONDEK® formwork spans are specified in Design and Design/Check dialogue boxes.
End Spans and Interior Spans may be designed with a different thickness to get the most economical design. However, the first Interior Span from the end support shall always have the same thickness as the End Span.

When the slab has less than five spans the user shall run End Spans first using Design Menu option to get the minimum possible slab thickness. Then Interior Spans shall be designed with the slab thickness obtained for End Spans using Design/Check Menu option.

When the slab has five or more spans, the thickness of Interior Spans other than first Interior Span may be specified independently from End Spans.

See flowchart.

The user may specify all spans as equal spans and with maximum **Ratio of longer to shorter adjacent span** of 1.2.

For software options for irregular lay outs with higher ratios of adjacent spans, contact Steel Direct or your local technical sales representative for more information.
5.4 Composite Slab Deflection Limits

The software is developed for Span/250 Composite slab deflection limits due to total load and two options for deflections limits due to imposed loads:

- Span/500 is recommended by AS 3600:2009 Table 2.3.2 for concrete slabs which support brittle partitions like masonry walls, glass doors.
- No limits for slabs not supporting brittle partitions.

5.5 Crack Control for Flexure

Not required option may be used for areas of slabs fully enclosed within a building except for a brief period of weather exposure during construction and where it is assessed that wider cracks can be tolerated - according to AS 3600:2009 Clause 9.4.1. This option will design reinforcement as required for relaxed crack control. Items (a) and (b) of Clause 9.4.1.

5.6 Degree of Control of Shrinkage and Temperature Effects

Refer to AS 3600:2009 Clause 9.4.3 for shrinkage control requirements.
It shall be noted that arid (interior) environment will result in higher shrinkage strains, which in turn may result in deeper slabs.

**5.7 PROPERTIES OF MATERIALS**

The minimum Concrete grade possible depends on **Exposure Classification**. B2 classification will require minimum concrete grade of 40 MPa.

---

**Figure 14**

Concrete grades.

<table>
<thead>
<tr>
<th>Concrete strength (f'_c), MPa</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Negative Bar size, mm</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

**Figure 15**

Negative bar sizes. Positive and fire bar sizes.

<table>
<thead>
<tr>
<th>Negative Bar size, mm</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive and Fire bar size, mm</td>
<td>-</td>
</tr>
<tr>
<td>Cover to Negative Bar, mm</td>
<td>-</td>
</tr>
<tr>
<td>Bondek metal thickness (bmt), mm</td>
<td>10</td>
</tr>
<tr>
<td>Fire Design</td>
<td>12</td>
</tr>
</tbody>
</table>

**Figure 16**

LYSAGHT BONDEK® BMT (base material thickness).

<table>
<thead>
<tr>
<th>Bondek metal thickness (bmt), mm</th>
<th>0.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Design</td>
<td>0.75</td>
</tr>
</tbody>
</table>

| Fire Design | 0.9 |
The software may design composite slabs using: 0.6, 0.75, 0.9 or 1.0 BMT sheets. The user may try 0.6 BMT for the first run. If the design is not economical (props are necessary), next run with increased BMT may be necessary.

5.8 COVER TO NEGATIVE BAR
Users shall specify appropriate covers to ensure that the concrete can be satisfactorily placed and compacted around reinforcement in accordance with the requirements of AS 3600:2009, Clause 17.1.3 and 4.10.

Figure 17
Cover to negative bar.

5.9 FIRE DESIGN
At this stage the user shall specify if the Design for fire is required or not.

The requirements for Fire Reinforcement and its location within the composite concrete slab is given in Section 8 of this manual.

Figure 18
Fire Design.

5.10 SHRINKAGE REINFORCEMENT
This reinforcement is necessary to control cracking due to shrinkage and temperature effects in transverse direction. Shrinkage reinforcement can be specified as mesh or bars.

Users can specify the diameter of reinforcement and spacing for longitudinal bars if the reinforcement grade is D500N.

The detailed definition of Shrinkage reinforcement and its location within the composite concrete slab is given in AS 3600:2009 Clause 9.4.3.

If rectangular mesh (RL) is specified it shall be oriented such as more steel is spanning in transverse (perpendicular to sheeting) direction.
5.11 LOADING PARAMETERS

Superimposed dead load ($G_{sdl}$) is a load of permanent nature in addition to self weight of composite concrete slabs.

$\psi_s$ and $\psi_l$ are factors for Live (Imposed) Loads. Live Load itself shall be entered in Design or Design/Check dialogue boxes which are described in next Chapters.

Refer to AS 1170.0 : 2002 for more information.

Figure 20
Superimposed dead load.

Figure 21
$\psi$, load factor.

Figure 22
Stacked materials.

This is the weight of Storage loads as specified in AS 3610:1995, Clause 4.4.2.4 during construction stage before concrete is placed. The value of the Storage Load is 4 kPa. A 1 kPa option is available.

If load is less than 4 kPa is specified, it shall be clearly shown on formwork documentation and controlled on construction site.
6.0 Design dialogue box

6.1 GENERAL

When the user entered all necessary parameters in the Input dialogue box, the next step would be to click Design or Design/Check button at the bottom of the Input dialogue box. This will open one or another dialogue box. The Design option is used when the user wants to design the slab to the very minimum slab thickness. Design/Check option shall be used when the possible slab thickness is known. (User controlled - See flowchart.)

![Design dialogue box](image)

**Figure 23** Design dialogue box.

6.2 SLAB SPAN

The user shall type in the span length. It shall be centre-to-centre span, see Chapter 8 of this Guide for more details. The range of possible spans is from 1.4 to 6.0m.

![Slab span](image)

**Figure 24** Slab span.

6.3 FORMWORK DEFLECTION LIMITS

Formwork deflection limits shall be specified as required by AS 3610:1995 and AS 2327.1. Span/240 (visual quality important) deflection limit is recommended for slabs in which good general alignment is required. It is suitable for a Class 3 or 4 surface finish.

L/130 (visual quality not important) deflection limit is suitable for Class 5 surface finish.

![Formwork deflection limits](image)

**Figure 25** Formwork deflection limits.
6.4 SUPPORT WIDTH
This is a width of a supporting structure – steel beams. It is important to enter correct value – it may result in smaller BMT of the LYSAGHT BONDEK® formwork.

Figure 26
Support width.

<table>
<thead>
<tr>
<th>Support width, mm</th>
<th>175</th>
<th>100</th>
<th>125</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formwork sheets continue over number of spans</td>
<td>Two spans</td>
<td>175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moment redistribution in composite slabs</td>
<td>200</td>
<td>250</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

6.5 LIVE LOAD
Live Load \( (Q) \) shall be specified as required by AS 1170.1-2002.

Figure 27
Live load.

<table>
<thead>
<tr>
<th>Loading Parameters</th>
<th>2</th>
<th>1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Load ( (Q) ), kPa</td>
<td>2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design/Check Option</th>
<th>3.5</th>
<th>3</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab thickness ( (\text{dys}) ), mm</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Design/Check Option</td>
<td>7.5</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

6.6 FIRE DESIGN
The user may specify Fire-resistance periods of 30, 60, 90, 120, 180 and 240 minutes as defined by AS 3600:2009 Section 5.

Figure 28
Fire design.

<table>
<thead>
<tr>
<th>Fire-resistance period, min</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire reinforcement option</td>
<td>Fire Detail 1</td>
</tr>
<tr>
<td>Loading Parameters</td>
<td>120</td>
</tr>
<tr>
<td>Live Load ( (Q) ), kPa</td>
<td>180</td>
</tr>
</tbody>
</table>

Figure 29
Fire reinforcement option.

<table>
<thead>
<tr>
<th>Fire reinforcement option</th>
<th>Fire Detail 1 (Top)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Parameters</td>
<td>Fire Detail 2 (Bottom)</td>
</tr>
</tbody>
</table>
7.0 Design/Check dialogue box

7.1 GENERAL
When the user has entered all necessary parameters in the Input dialogue box, the next step would be to click Design or Design/Check button at the bottom of the Input dialogue box. This will open one or another dialogue box. The Design option is used when the user wants to design the slab to the very minimum slab thickness. Design/Check option shall be used when the slab thickness is known (user controlled). It may be in a case when the architect specified the slab thickness for other than structural reasons or Interior spans shall be designed to the slab thickness as required for End spans – see Chapter 5.3 of this Guide and the flowchart.

This Dialogue box has the same options as Design dialogue box with an addition of Slab thickness option.

Figure 30
Design & Design/Check Options.

Figure 31
Design/Check dialogue box.

Figure 32
Slab thickness.

7.2 SLAB THICKNESS
The slab thickness may vary from 95 to 250mm. The user shall type in the necessary slab thicknesses. Slabs thicknesses of more than 250mm are considered as not practical. Contact Steel Direct or your local technical sales representative to design slabs with more than 250mm thickness. (Contact details are on back cover.)
8.0 Results window

8.1 GENERAL
The Results window will appear on the screen automatically when the user clicks the Design or Design/Check buttons on the relevant Dialogue box. Alternatively, the window may be opened by clicking on the Results worksheet at the bottom of the Excel window.

The window shows the design summary (Design Output) and the list of entered parameters in Input, Design or Design/Check dialogue boxes (Input parameters).

### Figure 33
Results window.

---

**Bondek Typical**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Notation</th>
<th>Single</th>
<th>End</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td>slab thickness</td>
<td>D (mm)</td>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top (negative) reinforcement over supports</td>
<td>As (mm²)</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pattern of negative reinforcement</td>
<td></td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete cover</td>
<td>C (mm)</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transverse (shrinkage/temperature effects) reinforcement, additional for DS50N, total for DS500N</td>
<td>Amin (mm²)</td>
<td>220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire reinforcement (additional to shrinkage and negative reinforcement)</td>
<td>Aver (mm²)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom tensile (positive) reinforcement (additional to Bondek sheathing)</td>
<td>A+min (mm²)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of temporary props</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Input parameters**

<table>
<thead>
<tr>
<th>Type of Buildings</th>
<th>Steel Frame</th>
<th>Negative Reinforcement Diameter</th>
<th>Negative Reinforcement Grade</th>
<th>D500N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span Configuration</td>
<td>Single Spans</td>
<td>D.0.05</td>
<td>Negative Reinforcement Grade</td>
<td>D500N</td>
</tr>
<tr>
<td>Continuous Spans</td>
<td>A1</td>
<td>D.0.05</td>
<td>Negative Reinforcement Grade</td>
<td>D500N</td>
</tr>
<tr>
<td>Exposure Classification</td>
<td>UL S</td>
<td>D.0.05</td>
<td>Negative Reinforcement Grade</td>
<td>D500N</td>
</tr>
<tr>
<td>Deflection Limits of Composites Slabs</td>
<td>Total &lt;250</td>
<td>Bonded sheathing</td>
<td>0.75 mm</td>
<td></td>
</tr>
<tr>
<td>L, mm</td>
<td>2800</td>
<td>Bonded sheathing</td>
<td>0.75 mm</td>
<td></td>
</tr>
<tr>
<td>Formwork Deflection Limits</td>
<td>Visual quality not important</td>
<td>Bonded sheathing</td>
<td>0.75 mm</td>
<td></td>
</tr>
<tr>
<td>Formwork sheets continue</td>
<td>Two spans</td>
<td>Shear strength</td>
<td>0.75 mm</td>
<td></td>
</tr>
<tr>
<td>Crack control for shrinkage and temperature effects</td>
<td>Minor</td>
<td>Fire Engineering</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>Crack control for flexure</td>
<td>320 kPa</td>
<td>Fire Resistance Periods</td>
<td>60 min</td>
<td></td>
</tr>
<tr>
<td>Shrinkage Reinforcement Grade</td>
<td>D500N</td>
<td>Fire Reinforcement Options</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>Mesh or transverse bar diameter, mm</td>
<td>N12</td>
<td>Positive and Fire Reinforcement</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>Mesh meshed bar diameter, mm</td>
<td>N10</td>
<td>Fire Reinforcement Options</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>Mesh meshed bar diameter, mm</td>
<td>300</td>
<td>Environment for shrinkage</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Mesh meshed bar spacing, mm</td>
<td>175</td>
<td>Support width, mm</td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>
The reinforcement types in the Design Output table is explained in the following Figures:

**Figure 34**
Typical slab cross section showing common terms.

**Figure 35**
Pattern 1 for conventional reinforcement.

**Figure 36**
Pattern 2 for conventional reinforcement when imposed load exceeds twice the dead load.
1. Positive/bottom - Fire detail 2 reinforcement shall be placed within permissible zone as shown on Figure 39. Recommended bottom location of fire reinforcement is chosen for practical reasons (to place fire bars on transverse bars). See Figure 39. Lower location of fire bars with cover down to 20mm from soffit may give more economical results. Consult your local Technical Sales Representative for the most economical design.

2. Positive tensile reinforcement is given as extra area to fire reinforcement (Fire detail 2) and may be placed outside the permissible zone. Alternatively, fire bars (Fire detail 2) may be specified with increased diameter to satisfy requirements for positive tensile reinforcement.
9.0 Warning messages

SLAB CANNOT BE DESIGNED TO SPECIFIED THICKNESS

This message means that the minimum possible slab thickness shall be more than specified by the user using Design/Check option. The user may:

- Increase slab thickness specified using Design/Check option
- Reduce minimum required slab thickness by:
  - Increasing concrete grade
  - Decreasing Tensile and Compression reinforcement bar size
  - Increasing slab deflection limit to L/250

All input parameters shall be checked if adequate.

SLAB THICKNESS SHALL BE WITHIN 95MM TO 250MM

This means that slab thickness entered is not correct.

250mm is considered as the maximum practical slab thickness.

Contact Steel Direct if you still want to design deeper slabs.

THIS MEANS THAT THE SLAB SPAN ENTERED IS OUTSIDE ALLOWED LIMITS.

TENSILE & COMPRESSION REINFORCEMENT BAR SIZE HAVE NOT BEEN ENTERED

Self explanatory.
FIRE REINFORCEMENT BAR SIZE HAS NOT BEEN ENTERED
Self explanatory.

SPECIFY CORRECT NUMBER OF SPANS FOR CONTINUOUS SLABS
This message may appear when the user designs first continuous span as an end double span and then tries to design interior span (as double span). The interior span shall be specified for continuous slabs with three or more spans.

1 KPA STACKED MATERIALS LOAD SHALL BE CLEARLY SPECIFIED ON FORMWORK DOCUMENTATION. CONTINUE?
The user may choose Yes and continue with the design. However, 1 kPa load shall be clearly specified on design documentation and controlled on a construction site.

TRANSVERSE BAR SIZE HAS NOT BEEN ENTERED
Self explanatory.

SPECIFIED COVER IS LESS THAN REQUIRED FOR CHOSEN EXPOSURE CLASSIFICATION
Self explanatory. User may choose Yes and continue the design. However, the design is not according to the AS 3600:2009 as the cover is less than specified.
10.0 Report - Sample Pages

Bondek

Job Name: Bondek Typical

INPUT PARAMETERS:

Type of building: Steel frames
Span configuration: End Spans
Continuous spans: Two spans up to 1.2
Ratio of shorter to longer spans: Dc 175
Slab thickness: Dc 175
Density of concrete: $\rho_c$ kg/m$^3$ 2400
Concrete grade: 32MPa
Concrete slab span, centre to centre: L mm 2900
Exposure classification: A1

Reinforcement (negative, positive, fire) grade: D500N
Reinforcing (positive, fire) bar diameter: mm 12
Reinforcing negative bar diameter: mm 12
Deflection limits of composite slabs: Total <L/250

Degree of control for shrinkage and temperature effects: Minor
Shrinkage mesh grade: D500L
Mesh or transverse bar diameter: SL102
Mesh longitudinal bar diameter: mm -
Mesh longitudinal bar spacing: mm -
Concrete cover: mm 20

Slab acting compositely with steel beams or used as diaphragm: NO
Environment for shrinkage strains: Arid (interior)
Formwork sheets continue over number of spans: Two spans
Formwork deflection limit: Visual quality not important

Bondek base metal thickness: t mm 0.75
Permanent support width: mm 175

Superimposed dead load: Gsup kPa 1
Live Load: Q kPa 1.5
Load factor: $\psi_s$ 0.7
Load factor: $\psi_l$ 0.4
Construction loads due to to weight of stacked materials: M kPa 4

Fire resistance level: FRL min 60 min

Load factor for imposed loads during fire: Fire Detail 1 (Top)
Full crack control for flexure is required: YES
Formwork design

| Number of temporary props | 1 |

**PROPERTIES OF BONDEK:**
- Moment capacity in positive bending \( \phi M_u \) \( kNm \) 4.89
- Negative bending moment at support \( M_u \) \( kNm \) 0.9
- (used in partial plastic analysis)
- Shear (web crippling) capacity \( \phi V_u \) \( kN \) 25.2
- Effective Second Moment of Area for serviceability calcs. \( I_{eff,ser} \) \( mm^4 \) 284500.0
- Yield stress \( f_y \) \( MPa \) 550.0
- Young’s modulus of elasticity \( f_y \) \( MPa \) 200000

**DESIGN LOADS:**
- Self weight of sheeting \( G_{sh} \) \( kPa \) 0.10
- Self weight of concrete and reinforcement \( G_c \) \( kPa \) 4.35
- Concentrated Live Load \( Q_c \) \( kPa \) 3.0
- Concentrated Live Load UDL equivalent \( Q_{c,equiv} \) \( kPa \) 3.00
- Load from stacked materials \( M \) \( kPa \) 4.0
- Live Load \( Q_{uv} \) \( kPa \) 1.0
- Concentrated point load \( Q_p \) \( kN \) 2.0
- Self weight of reinforcement \( Q_r \) \( kPa \) 0.1

**LOAD COMBINATIONS:**

**Strength:**
- Stage 1(before placing concrete):  
  \[ F_{da} = 1.2G_{sh} + 1.5Q_{uv} + 1.5QM \] \( kPa \) 7.6
  \[ F_{db} = 1.2G_{sh} + 1.5Q_r + Q_p \]
- Stage 2(after placing concrete):  
  \[ F_{da} = 1.2G_{sh} + 1.2G_c + 1.5Q_{uv} \] \( kPa \) 6.8
  \[ F_{db} = 1.2G_{sh} + 1.2G_c + Q_c \] \( kPa \) 8.3
- Serviceability:  
  \[ F_{def} = G_{sh} + G_c \] \( kPa \) 4.4

**DESIGN FOR STRENGTH:**
- Maximum positive bending moment \( M^* \) \( kNm \) 1.54
  \[ M^* < \phi M_u \] \( OK \)
- Maximum shear force \( F^* \) \( kN \) 5.7
  \[ F^* < \phi V_u \] \( OK \)
- Combined bending and shear
  Not applicable for partial plastic analysis

**DESIGN FOR SERVICEABILITY:**
- Deflections \( \Delta_{tot} \) \( mm \) 2.5
- Deflection limits \( \Delta_{tot,max} \) \( mm \) 11.2
  \[ \Delta_{tot} = \text{MIN}(\Delta_{tot,max}) \] \( OK \)
### Composite slab design

**MATERIAL PROPERTIES AND SLAB GEOMETRY:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield stress of mesh reinforcement $f_y$</td>
<td>500 MPa</td>
</tr>
<tr>
<td>Bondek sheeting yield stress $f_{y,sh}$</td>
<td>550 MPa</td>
</tr>
<tr>
<td>Yield stress of reinforcing bars $f_{y,bar}$</td>
<td>500 MPa</td>
</tr>
<tr>
<td>Longitudinal shear capacity $\gamma_{u,Rd}$</td>
<td>431.11</td>
</tr>
</tbody>
</table>

*(EN 1994-1-1:2005, Clause B.3.6)*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of compressed stress block $\gamma$</td>
<td>0.826</td>
</tr>
<tr>
<td>Long term shrinkage and creep factor $k_{sc}$</td>
<td>1.646</td>
</tr>
</tbody>
</table>

*(AS 3600-2009, Clause 8.5.3.2)*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus of elasticity of concrete $E_c$</td>
<td>28600 MPa</td>
</tr>
</tbody>
</table>

*(AS 3600-2009, Clause 3.1.2)*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrinkage induced tensile stress $\sigma_{cs}$</td>
<td>0.7982</td>
</tr>
</tbody>
</table>

*(AS 3600-2009, Clause 8.5.3.1)*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Bondek $h_r$</td>
<td>55 mm</td>
</tr>
<tr>
<td>Distance from centroidal axis of Bondek to extreme fibre in tension $y_{sh,eff}$</td>
<td>13.643 mm</td>
</tr>
<tr>
<td>Effective cross-sectional area of Bondek $A_{pe}$</td>
<td>1200.75 mm$^2$</td>
</tr>
</tbody>
</table>

*(EN 1994-1-1:2005, Clause 9.7.2)*

**LOADING:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete slab self weight $(concrete, reinforcement and sheeting)$ $G$</td>
<td>4.30 kPa</td>
</tr>
<tr>
<td>Superimposed Dead Load $G_{sup}$</td>
<td>1 kPa</td>
</tr>
<tr>
<td>Live Load $Q$</td>
<td>1.5 kPa</td>
</tr>
</tbody>
</table>

**LOAD COMBINATIONS:**

**Strength:**

1. $F_u=1.2^*G + 1.5^*Q$ (all spans, adjacent, alternate spans) kPa 8.61
2. $F_u=1.5^*G$ (the rest of spans) kPa 6.36

*(AS/NZS 1170.0:2002)*

*(AS 3600-2009, Clause 2.4.4)*

1. $F_u=1.35^*G + 1.5^*Q$ (all spans, adjacent, alternate spans) kPa 9.40
2. $F_u=1.5^*G$ (the rest of spans) kPa 7.15

*(EN 1990:2002, Section 6)*

**Deflections:**

Total propped $F_{s,tp} = (1+k_{sc})G + (\psi_s + k_{csy})Q$ kPa 16.06

Total unpropped $F_{s,tup} = (1+k_{sc})G_{sup} + (\psi_s + k_{csy})Q$ kPa N/A

Incremental propped $F_{s,ip} = k_{sc}G + (\psi_s + k_{csy})Q$ kPa 10.76

Incremental unpropped $F_{s,iup} = k_{sc}G_{sup} + (\psi_s + k_{csy})Q$ kPa N/A

*(AS 3600-2009, Clause 8.5)*
Area of additional positive reinforcement \( A_{\text{pos}} \) mm\(^2\) 0
Area of mesh in longitudinal direction \( A_{\text{mesh}} \) mm\(^2\) 0
contributing to sagging bending resistance
Area of additional negative reinforcement over supports \( A_{\text{neg}} \) mm\(^2\) 110

**ACTION EFFECTS:**

- Bending Moment at 1/6 span \( M_2^{**} \) kNm 3.4
- Bending Moment at 1/3 span \( M_3^{**} \) kNm 5.4
- Bending Moment at 1/2 span \( M_4^{**} \) kNm 6.1
- Maximum shear force at end support \( V_{\text{esp}}^{*} \) kN 9.1

(EN 1990;2002, Section 6)

- Bending Moment at interior supports \( M_\text{isp}^{**} \) kNm 9.0
- Maximum shear force at interior support \( V_{\text{isp}}^{*} \) kN 14.1

(AS/NZS 1170.0:2002)

**SAGGING BENDING RESISTANCE:**

- Reduction factor for sheeting \( \gamma_M1 \) 1.1
- Reduction factor for reinforcement \( \gamma_s \) 1.15
- Reduction factor for concrete \( \gamma_c \) 1.5
- Design value of compressive force in concrete flange with full shear connection
  - at 1/6 span \( N_{c,2} \) kN 118.6
  - at 1/3 span \( N_{c,3} \) kN 274.8
  - at 1/2 span \( N_{c,4} \) kN 431.1
- Plastic section modulus of effective Bondek cross section \( Z_{\text{eff}} \) mm\(^3\) 15916.25
- Design value of plastic resistance moment of Bondek effective cross-section \( M_{\text{pa}} \) kNm 8.0
- Reduced plastic resistance moment of Bondek at 1/6 span \( M_{\text{pr},2} \) kNm 8.0
  - at 1/3 span \( M_{\text{pr},3} \) kNm 5.4
  - at 1/2 span \( M_{\text{pr},4} \) kNm 2.8

(EN 1994-1-1:2005, Clause 9.7.2)

**DESIGN FOR STRENGTH:**

- \( \tau_{u,Rd} \) MPa 431.11
- \( d_0 \) mm 161.357
- \( \rho_t \) 0.0010
- \( A_{\text{eff}} \) mm\(^2\) 147.4
- \( f_{\text{cd}} \) MPa 21.3
- \( f_{\text{ck}} \) MPa 32
- \( V_{\text{rd}1} \) kN 87.2
- \( V_{\text{rd}2} \) kN 744.5

(EN 1992-1-1:2004, Clause 4.3.2.3)

\[ V_{\text{esp}}^{*} < \min(V_{\text{rd}1}, V_{\text{rd}2}) \]

**PARAMETERS WITHOUT CONTRIBUTION OF ADDITIONAL POSITIVE REINFORCEMENT:**

- Distance between plastic neutral axis and extreme fibre of concrete in compression at 1/6 span \( x_{p,1,2} \) mm 6.5
  - at 1/3 span \( x_{p,1,3} \) mm 15.2
  - at 1/2 span \( x_{p,1,4} \) mm 23.8
- Lever arm at 1/6 span \( z_{1,2} \) mm 164.3
  - at 1/3 span \( z_{1,3} \) mm 148.4
  - at 1/2 span \( z_{1,4} \) mm 140.9
- Design value of resistance of composite slab
  - at 1/6 span \( M_{\text{rd},2} \) kNm 27.4
  - at 1/3 span \( M_{\text{rd},3} \) kNm 46.2
  - at 1/2 span \( M_{\text{rd},4} \) kNm 63.5

(EN 1994-1-1:2005, Clause 9.7.2)
Parameters with contribution of additional positive reinforcement:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N&lt;sub&gt;as&lt;/sub&gt;</td>
<td>0.0 kN</td>
</tr>
<tr>
<td>Distance between plastic neutral axis and extreme fibre of concrete in compression at 1/6 span</td>
<td></td>
</tr>
<tr>
<td>x&lt;sub&gt;p,1&lt;/sub&gt;</td>
<td>6.5 mm</td>
</tr>
<tr>
<td>x&lt;sub&gt;p,3&lt;/sub&gt;</td>
<td>15.2 mm</td>
</tr>
<tr>
<td>x&lt;sub&gt;p,4&lt;/sub&gt;</td>
<td>23.8 mm</td>
</tr>
<tr>
<td>Lever arm for Bondek at 1/6 span</td>
<td></td>
</tr>
<tr>
<td>z&lt;sub&gt;1&lt;/sub&gt;</td>
<td>164.3 mm</td>
</tr>
<tr>
<td>z&lt;sub&gt;1,2&lt;/sub&gt;</td>
<td>148.4 mm</td>
</tr>
<tr>
<td>z&lt;sub&gt;1,3&lt;/sub&gt;</td>
<td>140.9 mm</td>
</tr>
<tr>
<td>Lever arm for positive reinforcement at 1/6 span</td>
<td></td>
</tr>
<tr>
<td>z&lt;sub&gt;2&lt;/sub&gt;</td>
<td>101.2 mm</td>
</tr>
<tr>
<td>z&lt;sub&gt;2,1&lt;/sub&gt;</td>
<td>96.9 mm</td>
</tr>
<tr>
<td>z&lt;sub&gt;2,2&lt;/sub&gt;</td>
<td>92.6 mm</td>
</tr>
</tbody>
</table>

Design value of resistance of composite slab

<table>
<thead>
<tr>
<th>Span</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/6 span</td>
<td>M&lt;sub&gt;rd,2&lt;/sub&gt;</td>
</tr>
<tr>
<td>1/3 span</td>
<td>M&lt;sub&gt;rd,3&lt;/sub&gt;</td>
</tr>
<tr>
<td>1/2 span</td>
<td>M&lt;sub&gt;rd,4&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

OK

Positive reinforcement is at yield at 1/6 span

OK

OK

NEGATIVE SHEAR CAPACITY:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from extreme compression fibre of concrete to centroid of outermost layer of tensile reinforcement</td>
<td>148.0 mm</td>
</tr>
<tr>
<td>Cross sectional area of tension reinforcement</td>
<td>464.0 mm&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Shear strength excluding shear reinforcement</td>
<td>76.9 kN</td>
</tr>
</tbody>
</table>

Shear strength limited by web crushing

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;u&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

OK

HOGGING BENDING RESISTANCE:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral axis parameter, (mesh reinforcement included)</td>
<td>0.07</td>
</tr>
<tr>
<td>Neutral axis parameter, (only additional neg. reinforcement)</td>
<td>0.02</td>
</tr>
<tr>
<td>Bending moment capacity, (mesh reinforcement included)</td>
<td>21.3 kNm</td>
</tr>
<tr>
<td>Bending moment capacity, (only additional neg. reinforcement)</td>
<td>6.5 kNm</td>
</tr>
<tr>
<td>Shrinkage mesh is at yield</td>
<td>TRUE</td>
</tr>
<tr>
<td>Bending moment capacity, final</td>
<td>21.3 kNm</td>
</tr>
<tr>
<td>Characteristic tensile strength of concrete</td>
<td>3.4 MPa</td>
</tr>
<tr>
<td>Minimum ultimate strength in bending</td>
<td>21.0 kNm</td>
</tr>
</tbody>
</table>

OK

OK

AS 3600-2009, Clause 8.1.1, 8.1.1 to 8.1.6
**DEFLECTIONS:**

- Deflection limit for total loads: $\Delta_{\text{tot}}$, mm = 11.6
- Deflection limit for incremental loads: $\Delta_{\text{inc}}$, mm = 5.8
- Second moment of area, Bondek: $I_{g}$, mm$^4$ = 658248
- Depth of concrete cross section in compression, positive: $y^{+\text{cc,uncracked}}$, mm = 88.8
- Gross second moment of area of concrete: $I_{\text{ef}}$, mm$^4$ = 487486330
- Cross section, positive
- Deflection limit for total loads: $\Delta_{\text{tot}}$, mm = 11.6
- Deflection limit for incremental loads: $\Delta_{\text{inc}}$, mm = 5.8
- Second moment of area of concrete: $I_{\text{cr}}$, mm$^4$ = 149235649
- Cracked second moment of area of concrete: $I_{\text{cr,cracked}}$, mm$^4$ = 149235649
- Bending moment causing cracking, positive: $M^+\text{cr}$, kNm = 14.67
- Bending moment based on short term: $M^+\text{s}$, kNm = 4.11
- Serviceability load, positive
- Effective second moment of area of concrete: $I_{\text{ef}}$, mm$^4$ = 487486330
- Cross section, positive
- Depth of concrete cross section in compression: $y^{+\text{cc,cracked}}$, mm = 43.7
- Second moment of area, Bondek: $I_{g}$, mm$^4$ = 438781237
- Gross second moment of area of concrete: $I_{-\text{cr}}$, mm$^4$ = 487486330
- Cross section, negative
- Depth of concrete cross section in compression: $y^{-\text{cc,cracked}}$, mm = 146.0
- Second moment of area of concrete: $I_{-\text{cr,cracked}}$, mm$^4$ = 149235649
- Bending moment causing cracking, negative: $M^-\text{cr}$, kNm = 17.13
- Bending moment based on short term: $M^-\text{s}$, kNm = 5.74
- Serviceability load, negative
- Effective second moment of area of concrete: $I_{-\text{ef}}$, mm$^4$ = 263268742
- Cross section, negative
- Effective second moment of area of concrete, total: $I_{\text{ef}}$, mm$^4$ = 3753777536
- Deflections due to total load, propped: $\delta_{\text{tot,pr}}$, mm = 0.7
- Deflections due to total load, unpropped: $\delta_{\text{tot,unpr}}$, mm = N/A
- Deflections due to incremental load, propped: $\delta_{\text{inc,pr}}$, mm = 0.5
- Deflections due to incremental load, unpropped: $\delta_{\text{inc,unpr}}$, mm = N/A

**TRANSVERSE REINFORCEMENT TO CONTROL SHRINKAGE AND TEMPERATURE EFFECTS:**

- Total area of shrinkage reinforcement necessary: $A_{\text{shrink, tot}}$, mm$^2$ = 210
- Additional to specified area of shrinkage reinforcement necessary: $A_{\text{shrink}}$, mm$^2$ = 0

**CRACK CONTROL FOR FLEXURE**

- Minimum tensile reinforcement in addition to specified mesh: $A_{\text{min}}$, mm$^2$ = 0

**Final crack control**

(AS 3600-2009, Clause 9.4)
Fire design

**Fire detail 1 (top):**

- Reinforcement mesh capacity reduction factor: \( R^\text{mesh} \) = 1.00
- Fire reinforcing bars capacity reduction factor: \( R^\text{st} \) = 1.000
- Concrete capacity reduction factor at support: \( R^\text{ct,A} \) = 0
- Concrete capacity reduction factor at point of top of negative reinforcement termination: \( R^\text{ct,B} \) = 0
- Distance from centroid of top negative reinforcement to outer fibre of concrete in compression at support: \( y^b \) = 149 mm

**Fire load**

\[
W_f = 1.0 \cdot G + cQ \quad \text{w}f \quad \text{kPa} = 5.90
\]

- Ineffective depth of concrete exposed to fire: \( a_{\text{ineff}} \) = 0.00 mm
- Neutral axis parameter at support: \( k < 0.4 \quad \text{TRUE} \)

- Bending moment capacity at support: \( \phi M^+_{\text{uo,A}} \) = 6.22 kNm
- Bending moment capacity at point of negative reinforcement termination: \( \phi M^-_{\text{uo,B}} \) = 0.00 kNm

- Distance from mesh reinforcement centroid to outer fibre of concrete in compression at mid span: \( d^\text{mesh} \) = 27.25 mm
- Distance from bar reinforcement centroid to outer fibre of concrete in compression at mid span: \( d^\text{bars} \) = 26.00 mm

- Concrete capacity reduction factor at mid span: \( R^+\text{ct,C} \) = 1.00
- Bending moment capacity at mid span: \( \phi M^+_{\text{uo,C}} \) = 14.85 kNm

**Hinge A bending moments at:**

- Point A (support): \( M_A \) = 6.22 kNm
- Point B (termination of reinforcement): \( M_B \) = -0.85 kNm
- Point C (mid span): \( M_C \) = -3.48 kNm

**Hinge B bending moments at:**

- Point A (support): \( M_A \) = 7.44 kNm
- Point B (termination of reinforcement): \( M_B \) = 0.00 kNm
- Point C (mid span): \( M_C \) = -3.04 kNm

- Structural adequacy, Hinge A: TRUE
- Structural adequacy, Hinge B: N/A
- Final results: TRUE

**Fire detail 2 (bottom):**

- Reinforcement mesh capacity reduction factor: \( R^\text{mesh} \) = 1.00
- Fire reinforcing bars capacity reduction factor: \( R^\text{st} \) = 1
- Concrete capacity reduction factor at support: \( R^\text{ct,A} \) = 0
- Concrete capacity reduction factor at point of top of negative reinforcement termination: \( R^\text{ct,B} \) = 0
- Distance from centroid of top negative reinforcement to outer fibre of concrete in compression at support: \( y^b \) = 149 mm

**Fire load**

\[
W_f = 1.0 \cdot G + cQ \quad \text{w}f \quad \text{kPa} = 5.90
\]

- Ineffective depth of concrete exposed to fire: \( a_{\text{ineff}} \) = 0.00 mm
- Neutral axis parameter at support: \( k < 0.36 \quad \text{TRUE} \)

- Bending moment capacity at support: \( \phi M^+_{\text{uo,A}} \) = 6.22 kNm
- Bending moment capacity at point of negative reinforcement termination: \( \phi M^-_{\text{uo,B}} \) = 0.00 kNm

- Concrete capacity reduction factor at mid span: \( R^+\text{ct,C} \) = 1.00
- Bending moment capacity at mid span: \( \phi M^+_{\text{uo,C}} \) = 14.85 kNm

**Hinge A bending moments at:**

- Point A (support): \( M_A \) = 6.22 kNm
- Point B (termination of reinforcement): \( M_B \) = -0.85 kNm
- Point C (mid span): \( M_C \) = -3.48 kNm

**Hinge B bending moments at:**

- Point A (support): \( M_A \) = 7.44 kNm
- Point B (termination of reinforcement): \( M_B \) = 0.00 kNm
- Point C (mid span): \( M_C \) = -3.04 kNm

- Structural adequacy, Hinge A: TRUE
- Structural adequacy, Hinge B: N/A
- Final results: TRUE

---

11.0 Software

Download your free copy of BONDEK® Design Software from:

http://professionals.lysaght.com/products/bondek
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