INTRODUCTION
This publication is a design manual to be used in conjunction with concrete engineering principles. The design data included in this Technical Data Sheet relates to a variety of applications for Conlift Bracing. This information is provided for the assistance of appropriately qualified professionals in the preparation of propping design specifications for concrete panels and concrete precast elements. The appropriate personal protective equipment (safety eyewear, gloves, hardhats, hi-visibility vests and safety footwear) is to be worn during all stages of the production, transportation and installation of concrete elements.

IMPORTANT NOTE
This booklet was issued in May 2012 and supersedes all previous booklets with respect to these products.

Due to ongoing research and development, changes may occur to specifications and features without notice. It is recommended that you consult with Parchem Construction Supplies Pty Ltd or download the most current version of the handbook from www.parchem.com.au. The information in this manual should be read in conjunction with the other Conlift Design Manuals.

DISCLAIMER
These instructions are intended only for use by suitably qualified professional building, construction and erection specialists.

Parchem Construction Supplies Pty Ltd expressly excludes all or liability for an injury, damage, cost, expense or claim whatsoever suffered by any person resulting either directly or indirectly from failure to install the Conlift Precast and Tilt Up products in accordance with these installation instructions.
CONLIFT BRACE DESIGN MANUAL

CONLIFT BRACE

- Conlift braces are a quick, safe and economical system for temporary support of concrete panels and concrete elements in place until they are secured into a structure.
- Compliance plate with manufacturer, WLL test number and WLL at each extension.
- Versatile
- System to suit all applications
- Industry standard load range
- Engineered for safety. 450 strength / 350 flexibility steel.
- Square for stability and stacking.
- Duragal galvanised finish to reduce corrosion.
- Components of different WLL are incompatible and cannot be interchanged.
- The three extensions' working load limit (WLL) plainly marked.
- Straightforward obvious installation.
- Straightforward and rapid to install. Quick connections save labour and crane costs
- Easy to educate staff and manage
- Designed and tested to meet or exceed the requirements of AS3850 – 2003 (Tilt-up Concrete construction), AS3600 (Concrete Structures), AS1170 (Loading Code) and AS4100 (Steel Structures)
- Square for stability and stacking.
- Duragal galvanised finish to reduce corrosion.
- Components of different WLL are incompatible and cannot be interchanged.

HOW TO INSTALL

- A Design Engineer specifies the appropriate brace for each concrete element according to the loads, type and size of concrete element and wind rating of the site.
- A Design Engineer specifies the type of connection for the brace to the concrete element and the brace to the dead-man, slab or footing.
- A Design Engineer specifies the type of structure that the bottom foot of the brace is attached to. This could be a dead-man, slab or footing.
- A Design Engineer specifies the position of the top and bottom brace connection.
- Attach the top foot of the brace to the concrete element before it is lifted into place.
- Pull the inner and outer sleeve apart to the specified length.
- Insert the pin through the position holes in the inner and outer sleeves of the brace and lock the pin so that it cannot be removed.
- Attach a guide rope and or place the brace foot on a prop dolly to control the brace throughout the placement.
- When the concrete element is placed into position the bottom foot of the brace is attached to the brace support structure. (dead-man, slab or footing).
- Ensure that the foot is in line with the body of the brace to prevent rotation.
- Wind the bottom thread to adjust the length of the brace so that the concrete element is plumb.
BRACES

<table>
<thead>
<tr>
<th>BRACE NAME</th>
<th>LENGTH</th>
<th>CLOSED WLL kN</th>
<th>MIDDLE WLL kN</th>
<th>OPEN WLL kN</th>
<th>WEIGHT kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shisham Mini</td>
<td>2.4m - 4.1m</td>
<td>35kN</td>
<td>30kN</td>
<td>30kN</td>
<td>36</td>
</tr>
<tr>
<td>Shisham Standard 1</td>
<td>4.35m - 7.0m</td>
<td>40kN</td>
<td>22kN</td>
<td>18kN</td>
<td>55</td>
</tr>
<tr>
<td>Shisham Jumbo</td>
<td>6.4m - 11.5m</td>
<td>30kN</td>
<td>15kN</td>
<td>8kN</td>
<td>106</td>
</tr>
<tr>
<td>RJB Mini</td>
<td>2.6m - 4.4m</td>
<td>44kN</td>
<td>35kN</td>
<td>30kN</td>
<td>37</td>
</tr>
<tr>
<td>RJB Standard</td>
<td>4.4m - 6.8m</td>
<td>40kN</td>
<td>24kN</td>
<td>14kN</td>
<td>53</td>
</tr>
<tr>
<td>RJB Jumbo</td>
<td>6.2m - 10.0m</td>
<td>25kN</td>
<td>11kN</td>
<td>6kN</td>
<td>78</td>
</tr>
</tbody>
</table>

In-Service Inspection and Testing

Although Conlift Braces are long wearing; they should be inspected after every job. Check for signs of distortion or damage – especially the bolts holding on both feet. Clean off concrete and dirt. Wind thread to ensure that it turns. Slide the inner and outer sleeve to ensure that there is full movement.

BRACE ACCESSORIES

- **Pin**
  A 16mm steel pin that slides through the inner and outer sleeve to hold the brace at the correct length. One end is bent so that the pin cannot slide right through and the other end has a small hole drilled right through to take the lock.

- **Lock**
  To pass through the drilled hole in the pin to prevent the pin from being removed. Designed to keep concrete slurry out of the lock.

- **Lock key**
  A Key to unlock the brace pin lock.
Knee Brace bracket
Bracket to hold the smaller brace to the main brace

DESIGN CONSIDERATIONS OF BRACING A CONCRETE ELEMENT

The designer must analyse all limit states and failure mechanisms.

Strength Considerations:

1. **Brace strength:**
A number of components contribute towards a Braces’ capacity.
- Connection to the element
- Connection to the deadman/ slab or footing
- Brace pin
- Welds on the brace
- Brace foot bolt

2. **Concrete strength:**
If the concrete ruptures it will cause the bottom or top connection to fail.
The concrete strength must have the capacity to withstand the brace load.

<table>
<thead>
<tr>
<th>CONCRETE COMPRESSIVE STRENGTH Mpa</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>MULTIPLYING FACTOR</td>
<td>0.68</td>
<td>0.79</td>
<td>0.88</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Chart for Reduction Factors for Concrete Strengths below 32MPa.

3. **Design for brace strength:**
Select the appropriate Brace to match the total load of the element.
When a Knee Brace is installed with a Brace, consideration must be given to the working load limit (WLL) of both Brace & Knee Brace (AS3850, AS1170, AS4100 & AS3600).

4. **Design for concrete strength:**
Correctly installed Braces transfer the applied load to the concrete element. Should the applied load exceed the Brace capacity and concrete strength the connection will fail and the concrete element will fall.
Extra reinforcement or increased concrete strength may be required to prevent connection failure. The design may still be limited by serviceability.

5. **Connection Limit State**
The WLL of the specified connections between the concrete element and the Brace must be sufficient to withstand the factored load. This connection could be a cast in ferrule and high tensile bolt or a mechanical expansion anchor.
When a mechanical expansion anchor is used the Ultimate Load Limit must be total by 1.5 times. Factoring is not required when the Working Load Limit of the anchor is used in calculations.

6. **Brace Anchoring Limit State**
The WLL of the specified base support for the Brace must be sufficient to withstand the factored load on the Brace.
This could be a deadman specifically poured for the job or existing slab or footing. A design engineer must specify the Brace anchoring system in accordance with AS1170.2.
Serviceability

1. **Impact Strength – Brace**

Braces are subject to high load concentration, possible impact loads and extreme environment conditions (temperatures, corrosion etc), requiring materials of high toughness.

Conlift Braces made from 450 grade high strength and 350 flexibility steel with impact strength exceeding the requirements of AS3850.

2. **Multiple Use**

Over time Conlift Braces could be subject to reduced capacity due to poor maintenance, harsh treatment, physical damage and pitting.

3. **Welding**

As welding can cause zinc contamination and embrittlement from uncontrolled applied heat Conlift Braces are not to be welded.
DESIGN CONSIDERATIONS FOR CONCRETE LIFTING SYSTEMS

The design engineer must take into account all limit states and failure mechanisms. The following limit states are to be considered during the design process. Guidance and recommendations can be found in AS3600 (Concrete structures) and AS1170 (Structural Design Actions).

- Anchor strength
- Concrete strength
- Combined anchor strength
  If a tension bar is to be installed with the anchor, their joint capacity must be considered.
- Design for concrete strength
- Serviceability
- Anchor robustness and flexibility
- Fatigue due to multiple lifting and corrosion
  Provided the Conlift anchor is showing no signs of corrosion or damage the are safe for multiple lifts.
- Atmospheric Corrosion
  All Conlift foot and eye anchors are galvanised (hot dipped) to ensure the are resistant to atmospheric corrosion. Stainless steel anchors are available for more aggressive environments.
  The lifetime of Conlift galvanised anchor coatings depends upon the category as shown below.

<table>
<thead>
<tr>
<th>Atmospheric Corrosivity Zones ISO 9223:2012 and ISO 14713-1:2009</th>
<th>Description</th>
<th>Typical Environment</th>
<th>Corrosion rate for the first year of exposure (µm/y)</th>
<th>Typical service life (years)</th>
<th>Galvanizing thickness (µm) and coating mass (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mild Steel</td>
<td>Zinc</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>Very low</td>
<td>Dry indoors</td>
<td>≤1.3</td>
<td>≤0.1</td>
<td>100+</td>
</tr>
<tr>
<td>C2</td>
<td>Low</td>
<td>Arid/Urban inland</td>
<td>&gt;1.3 to ≤25</td>
<td>&gt;0.1 to ≤0.7</td>
<td>21-100+</td>
</tr>
<tr>
<td>C3</td>
<td>Medium</td>
<td>Coastal or industrial</td>
<td>&gt;25 to ≤50</td>
<td>&gt;0.7 to ≤2.1</td>
<td>7-21</td>
</tr>
<tr>
<td>C4</td>
<td>High</td>
<td>Calm sea-shore</td>
<td>&gt;50 to ≤80</td>
<td>&gt;2.1 to ≤4.2</td>
<td>4-7</td>
</tr>
<tr>
<td>C5</td>
<td>Very High</td>
<td>Surf sea-shore</td>
<td>&gt;80 to ≤200</td>
<td>&gt;4.2 to ≤8.4</td>
<td>2-4</td>
</tr>
<tr>
<td>CX</td>
<td>Extreme</td>
<td>Off-shore</td>
<td>&gt;200 to ≤700</td>
<td>&gt;8.4 to ≤25</td>
<td>1-2</td>
</tr>
</tbody>
</table>

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Note 1 This table is an extrapolation of well-established corrosion rates and is supported by case history evidence in Australia, where service life records of 50 years are common and up to 110 years are recorded. The corrosion rates are consistent with ISO 9223:2012 and ISO 14713-1:2009.

Note 2 Because the actual galvanizing thickness applied is usually well above the specification minimum, the service lives quoted in rain exposed locations are likely to be conservative. In addition, ISO 9224:2012 applies lower corrosion rates for both steel and zinc where the object is exposed to long term steady state environmental conditions.

Note 3 Sheltered and not rain-washed surfaces, in a marine atmospheric environment where chlorides are deposited, can experience a higher corrosivity category due to the presence of hygroscopic salts.

Note 4 The coastal zone is defined as between 100 metres to 1 km inland from sheltered seas and between 1 km and 10 – 50 km from surf beaches depending upon prevailing winds and topography.

Note 5 Measured corrosion rates for steel in selected locations in Australia are shown in AS 4312:2006.

Note 6 Galvanizing thicknesses of 14 µm (100 g/m²) and 20 µm (140 g/m²) are typically applied by an in-line process.

Note 7 A more complete description of each of the typical environments is available in ISO 9223:2012, ISO 14713-1:2009, AS 4312:2006, and from the GAA.
FACTORED LOAD

Calculate the loads to each brace when the concrete element is held in place.

Wind Pressure – Working Wind Load not Ultimate Wind Load

Factors to be considered:-
  - Wind Direction
  - Public Space Safety Coefficients
  - Terrain Category Coefficients (Set out in AS1170.2)
  - Panel Size Coefficients (Set out in AS1170.2)
  - Housing Density Coefficients (Set out in AS1170.2)

As stated in the Australian Standard - AS3850 – 2003 (Tilt-up Concrete Construction)
Select the number of bracing points

Determine the minimum (normally 2 points) or required number of bracing points to ensure that the stresses from bracing do not exceed the strength of the object being braced e.g. a long thin concrete element may require multiple bracing points so that the flexural stresses do not exceed the concrete element strength.

If there are more than 2, the Design Engineer must take into account the occurrence of uneven load distribution. As stated in the Australian Standard - AS3850 – 2003 (Tilt-up Concrete Construction). Secondary bracing may be required to give additional load capacity.

CROSS LACING is a continuous lap connected to the main braces and should have a connection to the concrete element each end and in the middle with knee braces.

KNEE BRACING is the use of a shorter brace connected to the middle of the main brace and to the concrete element at a height on the element so that there is a 90° angle at the main brace / knee brace connection.

Check the factored load at each brace

If the factored brace load
   Exceeds the WLL of the brace:
   Increase the number of braces or:
   Select a higher WLL brace.
Angle at the brace base connection

This angle must be between 45° and 60°. As stated in the Australian Standard - AS3850 – 2003 (Tilt-up Concrete Construction)

\[
\text{ANGLE} = \sin \left( \frac{\text{HEIGHT OF BRACING POINT}}{\text{BRACE LENGTH}} \right) \\
\text{ANGLE} = \tan \left( \frac{\text{HEIGHT OF BRACING POINT}}{\text{DISTANCE FROM ELEMENT TO BRACE FOOT}} \right)
\]

Placement of braces

They must be at 90° +/- 5° to the face of the concrete element. If there is a need to have a different angle, the Design Engineer must respecify the brace WLL taking into account that a skewed brace will reduce the panel stability and could induce lateral and torsional forces to the panel. As stated in the Australian Standard - AS3850 – 2003 (Tilt-up Concrete Construction)

Placement of the foot of the brace

They must be in line with the body of the brace. Otherwise they could skew and release the load. As stated in the Australian Standard - AS3850 – 2003 (Tilt-up Concrete Construction)
Inspection of the connected braces

They must be visually inspected regularly. Particular attention to the brace connections, torque of the connection bolts, pins and locks, brace foot and brace condition. As stated in the Australian Standard - AS3850 – 2003 (Tilt-up Concrete Construction)

Storage and transport of braces

They must be stacked in a steel stillage to prevent injury or damage from a falling brace.
POWERS PBI BRACE-IT ANCHOR INSTALLATION

The PBI Anchor is a high load, low slip expansion anchor that has been tested in accordance with AS3850-2003. It is ideally suited to the needs of the Tilt-up and Precast Construction Industry. To attain the anchor’s full capacity the manufacturer’s Technical Data Guide must be understood and followed.

NEW POWERS PBI BRACE-IT ANCHOR

The NEW PBI anchor is a high performance load (torque) controlled, thick sleeve expansion anchor, which is designed for bracing of precast and tilt-up concrete panels. The NEW high performance PBI is a high load/low slip expansion anchor which has been tested in accordance with AS3850-2003, Appendix A8.2 (Tilt-up concrete construction standard), AS 3850-2003 clause 2.4.3 (iii) Bracing Inserts stipulates that where expansion anchors are to be used as brace fixing inserts they shall be of the load controlled type and the WLL (Working Load Limit) shall be limited to 0.65 of the first slip load (residual preload) in accordance with Appendix A8.2 AS 3850 - 2003 BRACE FIXING COMPLIANCE REQUIREMENT. Appendix A8.2 of AS3850 - 2003 requires the WLL (Working Load Limit) of a brace fixing to be determined by first measuring the residual preload in tension 14 days after setting into 20MPa concrete.

Installation procedure

1. Using the proper diameter bit, drill a hole into the base material to the depth required. This must be no more than 80% of the base material thickness.
2. Bow and brush the hole clean of dust and other material. Position the fixture. Do not overlap the anchor prior to installation.
3. Drive the anchor through the fixture into the anchor hole until the bolt head is firmly seated against the fixture. Be sure the anchor is driven to the required embedment depth.
4. Tighten the anchor by applying the guide installation torque from the finger tight position. This information is on the head of the PBI anchor.
Anchor sizes for bracing only

<table>
<thead>
<tr>
<th>Part No</th>
<th>Description</th>
<th>Drill Ø mm</th>
<th>Depth mm</th>
<th>Fixture thickness mm</th>
<th>Installation Torque Nm</th>
<th>Box qty</th>
<th>Carton qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBI18-20/115</td>
<td>M12 x 115mm</td>
<td>18</td>
<td>95</td>
<td>20</td>
<td>90</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>PBI20-20/115</td>
<td>M14 x 115mm</td>
<td>20</td>
<td>95</td>
<td></td>
<td>150</td>
<td>10</td>
<td>40</td>
</tr>
</tbody>
</table>

Load controlled expansion anchors for brace fixing. Tested in accordance with AS3850 - 2003 (Appendix A8.2)

M12 / Ø 18 - PBI Specification Data

<table>
<thead>
<tr>
<th>Product</th>
<th>PBI Powers BRACE-IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>PBI 18-20/115</td>
</tr>
<tr>
<td>Sizes</td>
<td>18 x 115mm</td>
</tr>
<tr>
<td>Bolt</td>
<td>M12 (class 8.8)</td>
</tr>
<tr>
<td>Drill diameter</td>
<td>18mm</td>
</tr>
<tr>
<td>Embedment depth</td>
<td>95mm</td>
</tr>
<tr>
<td>Anchor spacing</td>
<td>180mm (nominal)</td>
</tr>
<tr>
<td>Anchor edge distance</td>
<td>216mm (nominal)</td>
</tr>
<tr>
<td>Fixture thickness</td>
<td>20mm (nominal)</td>
</tr>
<tr>
<td>Fixture clearance hole</td>
<td>20 to 22mm</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>90Nm</td>
</tr>
</tbody>
</table>

Performance in 20MPa concrete

<table>
<thead>
<tr>
<th>Tension</th>
<th>First slip load (0.1mm)</th>
<th>24.5kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear</td>
<td>$R_{WLL}$ (0.65 x First Slip Load)</td>
<td>15.9kN</td>
</tr>
<tr>
<td>Anchor Allowable Working Load</td>
<td>23.1kN</td>
<td></td>
</tr>
</tbody>
</table>

M14 / Ø 20 - PBI Specification Data

<table>
<thead>
<tr>
<th>Product</th>
<th>PBI Powers BRACE-IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>PBI 20-20/115</td>
</tr>
<tr>
<td>Sizes</td>
<td>20 x 115mm</td>
</tr>
<tr>
<td>Bolt</td>
<td>M14 (class 8.8)</td>
</tr>
<tr>
<td>Drill diameter</td>
<td>20mm</td>
</tr>
<tr>
<td>Embedment depth</td>
<td>95mm</td>
</tr>
<tr>
<td>Anchor spacing</td>
<td>200mm (nominal)</td>
</tr>
<tr>
<td>Anchor edge distance</td>
<td>240mm (nominal)</td>
</tr>
<tr>
<td>Fixture thickness</td>
<td>20mm (nominal)</td>
</tr>
<tr>
<td>Fixture clearance hole</td>
<td>22 x 24mm</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>150Nm</td>
</tr>
</tbody>
</table>

Performance in 20MPa concrete

<table>
<thead>
<tr>
<th>Tension</th>
<th>First slip load (0.1mm)</th>
<th>35.6kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear</td>
<td>$R_{WLL}$ (0.65 x First Slip Load)</td>
<td>23.1kN</td>
</tr>
<tr>
<td>Anchor Allowable Working Load</td>
<td>29.0kN</td>
<td></td>
</tr>
</tbody>
</table>

Material specifications

<table>
<thead>
<tr>
<th>Anchor components</th>
<th>Carbon Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt</td>
<td>Class 8.8 (UTS = 800 MPa min. / Y.S. = 640MPa min.)</td>
</tr>
<tr>
<td>Washer</td>
<td>C1040 (heat treated)</td>
</tr>
<tr>
<td>Expander sleeve</td>
<td>C1022</td>
</tr>
<tr>
<td>Extension sleeve</td>
<td>C1022</td>
</tr>
<tr>
<td>Expander cone</td>
<td>C1040 (heat treated) + Proprietary coating</td>
</tr>
<tr>
<td>Compression ring</td>
<td>Nylon</td>
</tr>
<tr>
<td>Plating</td>
<td>Zinc plated in accordance with AS1789-2003</td>
</tr>
<tr>
<td>Head style</td>
<td>Heavy Hex Flange Head M12 / O.D. = 25.5mm M14 / O.D. = 30.5mm</td>
</tr>
<tr>
<td>Socket size</td>
<td>M12 / 18 = 18mm socket M14 / 20 = 21mm socket</td>
</tr>
</tbody>
</table>

Combined loading

Anchors loaded in both Tension & Shear shall be designed to satisfy -

$$\left( \frac{F(T) \cdot S.W.L.}{R_{WLL}} \right)^{\frac{1}{2}} + \left( \frac{F(S) \cdot S.W.L.}{R_{(S)A}} \right)^{\frac{1}{2}} \leq 1$$

Where:

- $F_{T(S)W.L}$ = Applied service load (tension)
- $R_{WLL}$ = 0.65 x First Slip Load (tension)
- $F_{T(S)W.L}$ = Applied service load (shear)
- $R_{(S)A}$ = Anchor allowable working load (shear)