Memorandum

State of California

“Equitable Healthcare Accessibility for California”

To: All FDD Staff

Date: April 22, 2008

From: John D. Gillengarten, S.E.
Deputy Director

Subject: 2007 CBC and Use of Existing Pre-Approvals

Until further notice, existing OSHPD anchorage pre-approvals (OPA) may be used on projects subject to the 2007 California Building Code (CBC) without modification. All aspects of the design and installation of the pre-approved component or system, including computation of the lateral forces, shall be in accordance with the approved OPA.
<table>
<thead>
<tr>
<th>Section</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>General Information</td>
<td>5</td>
</tr>
<tr>
<td>Glossary of Terms</td>
<td>6</td>
</tr>
<tr>
<td>Brace Location Requirements</td>
<td>7 - 8</td>
</tr>
<tr>
<td>Design Procedures for Trapeze Hangers</td>
<td>9 - 14</td>
</tr>
<tr>
<td>Rigid &amp; Cable Brace Factors</td>
<td>15</td>
</tr>
<tr>
<td>Seismic Table Procedure</td>
<td>16</td>
</tr>
<tr>
<td>Trapeze Load Data</td>
<td>17 - 18</td>
</tr>
<tr>
<td>Trapeze Pipe Clamps</td>
<td>19 - 20</td>
</tr>
<tr>
<td>Single Pipe Clamps and Bracing</td>
<td>21</td>
</tr>
<tr>
<td>Hanger Rod Stiffeners/Bracing</td>
<td>22</td>
</tr>
<tr>
<td>Channel Styles</td>
<td>23 - 25</td>
</tr>
<tr>
<td>Channel Load Tables</td>
<td>26</td>
</tr>
<tr>
<td>Channel Nuts and Hardware</td>
<td>27</td>
</tr>
<tr>
<td>Brace &amp; Cable Design Loads</td>
<td>28</td>
</tr>
<tr>
<td>Channel Fittings</td>
<td>29 - 32</td>
</tr>
<tr>
<td>Structure Attachments</td>
<td>33 - 37</td>
</tr>
<tr>
<td>Typical Attachments</td>
<td>38</td>
</tr>
<tr>
<td>Concrete Inserts</td>
<td>39</td>
</tr>
<tr>
<td>Design Examples</td>
<td>40 - 44</td>
</tr>
<tr>
<td>Reference</td>
<td>45</td>
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</table>
UNISTRUT® Seismic Bracing Systems are designed and constructed to resist virtually all code specified seismic forces in the event of an earthquake; therefore, keeping non-building structural components of hospitals and other essential facilities operational and intact.

Essential facilities are those structures, which are necessary for emergency post-earthquake operations. Such facilities shall include, but not be limited to: Hospitals and other medical facilities having surgery of emergency treatment areas; fire and police stations; municipal government disaster operation and communication centers deemed to be vital in emergencies.

Actual applications may vary and are not limited to support methods shown. However, any changes to the support methods, hardware and designs depicted in these guidelines should only be made in accordance with standard engineering practices by a qualified registered engineer.

UNISTRUT bracing systems designed per the catalog requirements do not guarantee adequacy of existing structures to withstand the loads induced by the seismic attachments. It is the responsibility of the project engineer to verify that the structure is capable of supporting any and all items constructed using these guidelines. It is the responsibility of the project engineer and the installer to determine the adequacy of placement and installation in regards to these guidelines including compliance with all applicable codes.

Seismic bracing shall not limit the expansion and contraction of systems; the engineer of record shall ascertain that consideration is given to the individual dynamic and thermal properties of these systems and the building structure. Proper seismic & thermal joints should be provided as directed by the project engineer. The details and schedules presented do not include the weights from branch lines. The project engineer must verify the additional load from branch lines are within the allowable capacity of the bracing details.

Where possible, pipes and conduit and their connections shall be constructed of ductile materials [copper, ductile iron, steel or aluminum and brazed or welded connection]. Pipes and their connections, constructed of other material, e.g. cast iron and no-hub pipe, shall have the brace spacing reduced to one-half of the spacing for ductile pipe.

Pipes, ducts and conduit supported by a trapeze where none of those elements would individually be braced need not be braced if connections to the pipe/conduit/ductwork and directional changes do not restrict the movement of the trapeze.

NOTE: Information contained in this catalog is to be used with genuine Unistrut products only. It must not be used as a basis for certifying any system other than Unistrut.
1. These guidelines are intended to provide information for the seismic restraint of nonstructural components in buildings based on NZS 4219. Nonstructural components may include hospital piping, electrical conduit, cable trays, and air handling ducts. Anyone making use of the data does so at his own risk and assumes any and all liability resulting from such use. UNISTRUT disclaims any and all express or implied warranties of fitness for any general or particular application.

2. Seismic horizontal force factor:

\[ FH = (C_s)W_p \]

Factoring from Strength Design (FH) to Working Stress (Fh) is necessary for Seismic Force to be used in this catalog. Use the following formula: \( F_h = FH/1.35 \).  
Cs to be determined in accordance with NZS 42(9:2005)

3. When supporting pressure piping, spacing of seismic bracing should not exceed two (2) times the vertical support spacing. Stress in the pipes that are comparable to those required by ASME B31.1 will be maintained. Where lateral restraints are omitted, the piping, ducts or conduit shall be installed such that lateral motion of the piping or duct will not cause damaging impact with other systems of structural members, or loss of vertical support.

4. UNISTRUT nuts and bolts mounted to UNISTRUT channels shall be tightened to the following minimum torques:

<table>
<thead>
<tr>
<th>Bolt Diameter (mm)</th>
<th>Bolt Torque (N-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>M8</td>
<td>15</td>
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<td>M10</td>
<td>25</td>
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<tr>
<td>M12</td>
<td>67</td>
</tr>
<tr>
<td>M16</td>
<td>135</td>
</tr>
<tr>
<td>M20</td>
<td>169</td>
</tr>
</tbody>
</table>

5. The charts and information presented on the following pages are intended as a guide only. Prior to installation, the user and/or engineer of record shall determine structural adequacy of supports and the supporting structure and shall also determine compliance with applicable codes.

A copy of this Seismic Bracing catalog showing the proper Seismic Brace tables and Brace Location Requirements along with the UNISTRUT Engineering catalog shall be on the jobsite prior to starting the installation of the seismic bracing system. The Seismic Tables are for a seismic factor of 1.0g and can be used to determine brace location, sizes, and anchorage of pipe/duct/conduit and trapeze supports. The development of a new seismic table is required for seismic factors other than 1.0g and must be reviewed by OSHPD prior to seismic bracing. For OSHPD, these documents can be considered a change order in accordance with Part1, Title 24, CBC.
GLOSSARY OF TERMS

Grade – Ground level of building; referred to as 0 m elevation.

Lateral Brace – A generic term used to describe a brace that resists lateral forces in the longitudinal or transverse direction;

Lateral Force – Force acting on a component or element that is positioned across, perpendicular, or at a 90° angle to its vertical, in the horizontal direction.

Longitudinal – Direction along the horizontal axis of a component or element’s run.

Shallow Anchors – Anchors with an embedded length to diameter ratio of less than 8.

SPF (Seismic Pivot Fitting) – A retro-fittable brace fitting used with strut or wire. Series SPF fittings are a trademark of Lord & Sons, Inc.

Run – Direction of pipe layout, along the axis of the pipe.

Strength Design – For load and resistance factor design; ultimate load (design for most critical effects of loads)

Sway Brace – A mechanical device used for resisting lateral forces.

Transverse – Direction perpendicular to the horizontal of a component or element’s run.

Trapeze – Part of an assembly used to help resist seismic forces.

Working Stress – Allowable load used for design; factors down strength design loads, providing a safety factor. Generally, strength design forces/1.4.
1. This bracing detail applies only for cold water pipe and gas pipe where movement of the pipe due to temperature differential is negligible.

2. It is the responsibility of the user of this guideline to ascertain that an adequate bracing and anchorage device be designed for pipe whenever the movement due to thermal differential and seismic joint of building exists.

3. Longitudinal restraint of a pipe length can be provided by transverse restraint of connected perpendicular pipes as long as the connected pipes are the same size and the transverse restraint of the connected pipe is located within 600 mm from the connection.

4. Longitudinal pipe restraints shall be installed as per the guidelines of Table 7 of NZS 4219:2005.

5. Pipes less than 50mm in diameter and suspended 150mm or less from the supporting structure do not need specific seismic restraints.

6. Vertical runs must have transverse bracing in each direction at both ends and within two pipe diameters of the vertical support.

7. Vertical pipes shall have sufficient flexibility to allow for relative horizontal seismic movement between floors or fixing points.

8. Pipes shall be restrained at the point of connection of branch pipes, connections to equipment, on at least one side of flexible couplings, and where swaying of the pipe may damage other building elements.

9. Information contained in this catalog is to be used with genuine Unistrut product only. It must not be used as a basis for certifying any system other than Unistrut.
BRACE LOCATION REQUIREMENTS

AS/NZS 3500.1:2003
NZS 4219:2009

SEE SECTION 5 FOR CONNECTION DETAILS TO STRUCTURE ABOVE

NOTE:
DETAIL SHOWS PIPING/CONDUIT HUNG FROM STRUCTURE ABOVE CONNECTING TO EQUIPMENT MOUNTED ON FLOOR TO ADDRESS THE DIFFERENTIAL MOVEMENT BETWEEN STORY TO STORY.
1. Determine the support spacing using the smallest pipe diameter (Page 11, Pipe Data Table).

2. Calculate the total weight of the pipes plus contents (W) on each trapeze using the following equation: (Page 11, Pipe Data Table)

   \[ W = S \times (p_1 + p_2 + p_3 + \ldots + p_n) \]

   \[ W = \text{Total weight on trapeze (kg)} \]

   \[ p_n = \text{Weight of pipe plus water (kg/m)} \]

   \[ S = \text{Support spacing (m)} \]

3. Calculate horizontal seismic force (Fh). Make necessary checks and conversion as defined in Page 5.

4. Determine the actual brace force (maximum at 45°). Reference Page 15 for brace connection other than 45°.

   \[ F_{b, \text{Actual}} = \frac{F_h}{\cos 45°} = 1.414F_h \]

5. Select brace to be used, Rigid or Cable.

   Select a channel fitting from Page 29-31.
   Check brace against allowable design load (Page 28) and channel slip (Page 27).
   Use the lowest design load as the allowable brace force (Fb Allow.).

   Determine if braces are required depending on type of brace used, Rigid or Cable:

6. Check compression and tension in the rod. When diagonal braces are used to stabilize trapeze hangers, they will cause tension and compression forces to be added to the tension already in the rod (see Page 8, Figure 1 or 2, or Page 15).

   a. Select threaded rod that has a tension strength that meets or exceeds the required tension (Page 22, Capacity of Threaded Rod Table)

      \[
      \begin{align*}
      \text{Brace on alternate hangers} & \quad T_{\text{max}} = .5W + s(2W) \quad \text{(Page 12, Figure 1)} \\
      \text{Brace on every hanger} & \quad T_{\text{max}} = .5W + sW \quad \text{(Page 12, Figure 2)}
      \end{align*}
      \]

   b. Check compression in the selected threaded rod. If the rod is subject to compression, it may require stiffener.
   Determine the percentage of full stress capacity on the rod using the following equation (Page 22):

   \[
   \frac{\text{Actual Compression Load}}{\text{Allowable Compression Load}}
   \]

   Select clip spacing (L) based on percentage above (Page 22, Channel Stiffener Table).
7. Select pipe clamps (Pages 19-20). Either style, P2024 Series or UN4/UN15 Series can be used.

Check forces on pipe clamps using the following equations:
Vertical Force = Pipe Wt. per meter x Trapeze spacing
Transverse Force = Fh x Lateral Brace Spacing
Longitudinal Force = Fh x Longitudinal Brace Spacing

Revise spacing of braces if necessary (not to exceed allowable design forces).

8. Select trapeze member using the total weight on the trapeze and the length of trapeze required to fit the given pipe sizes and quantities (Page 17, 18, and 26).

9. Check trapeze member for combined vertical and lateral seismic loads using the following interaction equation: (Revise trapeze spacing or brace if necessary).

\[
\frac{\text{Actual Vertical Force}}{\text{Lateral Reduction Factor} \times \text{Allowable Vertical Force}} + \frac{\text{Actual Horizontal Force}}{\text{Lateral Reduction Factor} \times \text{Allowable Horizontal Force}} \leq 1.33
\]

NOTE: All examples are based on the California EQ Code.
Pipe Data

<table>
<thead>
<tr>
<th>Pipe Size (mm)</th>
<th>Pipe Section Modulus (mm³)</th>
<th>Max. Support Spacing AS/NZS 3500.1:2003 Table 5.2 (m)</th>
<th>Weight of Pipe Plus Water, P kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>91.82</td>
<td>2</td>
<td>0.39</td>
</tr>
<tr>
<td>20</td>
<td>244.14</td>
<td>2</td>
<td>0.75</td>
</tr>
<tr>
<td>25</td>
<td>526.23</td>
<td>2</td>
<td>1.25</td>
</tr>
<tr>
<td>40</td>
<td>1241.97</td>
<td>2.5</td>
<td>2.27</td>
</tr>
<tr>
<td>50</td>
<td>2261.17</td>
<td>3.0</td>
<td>3.57</td>
</tr>
<tr>
<td>65</td>
<td>3583.84</td>
<td>3.0**</td>
<td>5.07</td>
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<td>80</td>
<td>6837.50</td>
<td>4.0**</td>
<td>7.60</td>
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<td>100</td>
<td>12349.62</td>
<td>4.0**</td>
<td>12.18</td>
</tr>
<tr>
<td>150</td>
<td>36686.99</td>
<td>4.0**</td>
<td>25.86</td>
</tr>
<tr>
<td>200</td>
<td>313249.86</td>
<td>4.0**</td>
<td>42.63</td>
</tr>
</tbody>
</table>

*ASME B31.1 does not list all sizes shown, therefore some sizes have been proportioned between. **Spacing limited by AS/NZS 3500.1:2003.
DESIGN PROCEDURES FOR TRAPEZE HANGERS

RIGID BRACING ON TRAPEZE

W = GRAVITY LOAD PER TRAPEZE
Fh = CW
ROD TENSION MAX. = 0.5W
ROD COMPRESSION MAX = 0.5W - Fh

RIGID BRACING FOR TRAPEZE CABLE TRAYS

W = GRAVITY LOAD PER TRAPEZE
Fh = Cw
ROD TENSION MAX. = 0.5W
ROD COMPRESSION MAX = 0.5W - Fh

NOTE:
1) FOR LOAD REACTIONS SHOWN ON THIS PAGE, THE PIPE OR CONDUIT LOADS ON THE TRAPEZE SHOULD BE RELATIVELY UNIFORM AND SYMMETRIC ALONG THE LENGTH OF THE MEMBER.

*2) SPF FITTING IS A TRADEMARK OF LORD & SONS, Inc.
DESIGN PROCEDURES FOR TRAPEZE HANGERS

WIRE BRACING ON TRAPEZE
4-WAY SPALLED PATTERN ON TRAPEZE

Fb = 0.71 F lat + F trans

PLAN VIEW

Fb = 0.71 F lat + F trans

SIDE VIEW

SPF 400 SEISMIC CABLE FITTING

5mm Nominal CABLE

ELEVATION VIEW

WIRE BRACING ON TRAPEZE
SINGLE CABLE TRANSVERSE BRACE ON TRAPEZE

Fb = 1.414 F L

SPF 400 SEISMIC CABLE FITTING

3/16" CABLE

SIDE VIEW

ELEVATION VIEW

NOTE:
1) FOR LOAD REACTIONS SHOWN ON THIS PAGE, THE PIPE OR CONDUIT LOADS ON THE TRAPEZE SHOULD BE RELATIVELY UNIFORM AND SYMMETRIC ALONG THE LENGTH OF THE MEMBER.
2) SPF FITTING IS A TRADEMARK OF LORD & SONS, INC.
3) ALTERNATE FITTINGS CAN BE USED. SEE SECTION 4 CHANNEL FITTINGS.
1. Select hanger type (Page 21) given the diameter of the pipe/width of cable tray.

2. Determine the maximum hanger spacing (Page 11, Pipe Data Table). Calculate the total weight of the pipe and contents using the following equation:

\[ W = S \times p \]

- \( W \) = Total weight on hanger (kg)
- \( p \) = Weight of pipe/cable tray and cables plus water (kg/m)
- \( S \) = Support spacing (m)

3. Calculate horizontal seismic force (FH) from the following,

\[ FH = C_s W \]

Refer to NZS 4219:2009. Convert from strength design FH to working stress Fh for values to be used in this catalog.

4. Check brace forces (max. at 45°) at every other hanger and select fittings from Page 28.

   Reference Page 2-7 for brace connections other than 45°.

\[ F_{b\,\text{Actual}} = F_h / \cos 45° = 1.414 F_h \]

5. Select brace to be used, Rigid or Cable.

Check brace against allowable design load (Page 28) and channel slip (Page 27).
Select a fitting from Pages 29-31.

The lowest allowable design load (Allowable Fh) governs.

Determine if longitudinal braces are required using the following equation:

Brace Spacing = Allowable Fb / (1.414 Fh x hanger spacing)

6. Check tension of rod (reference Page 15):

\[ T_{\text{max}} = W + F_y \]

\[ F_y = K_y \times F_h \]

Check compression:

- **Actual Compression Load**
- **Allowable Compression Load**

Select clip spacing (L) based on percentage above (Page 22, Channel Stiffener Table)

7. Verify pipe clamp capacity (use Design Table in Page 21)

Actual Longitudinal Force = Fh x Longitudinal Brace space
**RIGID & CABLE BRACE FACTORS**

**SINGLE RIGID BRACE**

ELEVATION VIEW

TRAPEZE

**TWO OPPOSING CABLE BRACES**

PLAN VIEW

**4-WAY SPLAYED PATTERN**

PLAN VIEW

**BRACE SLOPE**

<table>
<thead>
<tr>
<th>RISE RUN</th>
<th>SLOPE FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 : 1</td>
<td>Kb 1.414  Kx 1.000  Ky 1.000</td>
</tr>
<tr>
<td>1 : 2</td>
<td>Kb 1.118  Kx 1.000  Ky 0.500</td>
</tr>
<tr>
<td>1 : 3</td>
<td>Kb 1.054  Kx 1.000  Ky 0.333</td>
</tr>
<tr>
<td>1 : 4</td>
<td>Kb 1.031  Kx 1.000  Ky 0.250</td>
</tr>
</tbody>
</table>

**BRACE AXIAL FORCE:**

±Fb = Kb * Fh  (Rigid Brace – Tension & Compression)

+Fb = Kb * Fh  (Cable Brace – Tension only)

Kb = Brace Factor

Fh = Horizontal Seismic Factor

Fy = Ky * Fh

Fx = Kx * Fh

**SLOPE FACTORS**

<table>
<thead>
<tr>
<th>X Y Z</th>
<th>Kb 2.000</th>
<th>Kx 1.000</th>
<th>Ky 1.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 : 1 : 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BRACE AXIAL FORCE:**

Fb = Kb *½ Fh = 2.000 * (½ Fh)

Fb = Fh  (Tension only)

Kb = Brace Factor

Fh = Horizontal Seismic Factor

Fy = Ky * Fh

Fx = Kx * Fh

**APPROVED**

Fixed Equipment Anchorage
Office of Statewide Health Planning and Development

OPA-0120  Apr 25, 2003

**** Valid for 3 Years Maximum ****

Bill Staehelin (916) 324-9106
SEISMIC TABLE PROCEDURE

The Sample Procedure in Pages 9 and 14 provides a detailed description for determining bracing of Trapeze and Individually supported Water Filled Pipes, when variation of components or the use of seismic factors other than 1.0g is required for design.

**STEPS**

**PROCEDURE FOR USE OF SINGLE PIPE SEISMIC TABLE**
1. Determine size of pipe to be braced.
2. Select type of Pipe Hanger to be used.
3. Determine transverse and longitudinal brace location requirements. Reference Pages 7 and 8.
4. From Single Pipe Seismic Table, obtain Maximum Brace Spacing, Minimum Rod Diameter, & Limiting Brace Length.
5. Determine type of structure (concrete, wood, steel) and from the table select Anchorage quantity, size, & embedment (where applies).

**STEPS**

**PROCEDURE FOR USE OF TRAPEZE SEISMIC TABLE**
1. Determine the maximum vertical load distributed uniformly on the trapeze from pipe(s) being braced.
2. Knowing the pipe size(s), select the type and length of Trapeze from the Trapeze Seismic Table.
3. From the table, select Maximum Transverse Brace Space and Minimum Rod Diameter.
4. Determine transverse and longitudinal brace location requirements. Reference Pages 7 and 8.
5. Determine type of structure (concrete, wood, steel) and from the table select Anchorage quantity, size, & embedment (where applies).
TRAPEZE LOAD DATA

WIRE BRACING ON TRAPEZE
SINGLE CABLE TRANSVERSE BRACE ON TRAPEZE

SPAN

Fb = 1.414(Fh)0.5W

3/16" CABLE

SPF 400 SEISMIC CABLE FITTING

SIDE VIEW

ELEVATION VIEW

W

0.5W

Fh

45°

P1000 Long. Brace

P1000 T Rod Stiffener

P1000 Lateral Brace*

P1000DS Trapeze

*FOR ALTERNATE CABLE
BRACE SEE PG 2-5

P1000 Trapeze Load Data

<table>
<thead>
<tr>
<th>Span (mm)</th>
<th>SWL Uniform Design Load* (kN)</th>
<th>Concentrated Load @Center of Span (N)</th>
</tr>
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<tbody>
<tr>
<td>500</td>
<td>7.42</td>
<td>2,000</td>
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<tr>
<td>1000</td>
<td>3.71</td>
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<td>1,510</td>
</tr>
<tr>
<td>2000</td>
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<tr>
<td>2250</td>
<td>1.65</td>
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</tr>
<tr>
<td>2500</td>
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<td>850</td>
</tr>
<tr>
<td>3000</td>
<td>1.24</td>
<td>760</td>
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P5500 Trapeze Load Data

<table>
<thead>
<tr>
<th>Span (mm)</th>
<th>SWL Uniform Design Load* (kN)</th>
<th>Concentrated Load @Center of Span (N)</th>
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</thead>
<tbody>
<tr>
<td>500</td>
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*Safety factor 2.5 applied against component failure
TRAPEZE LOAD DATA

P1000 Trapeze Load Data

<table>
<thead>
<tr>
<th>Span (mm)</th>
<th>Maximum Uniform Design Load (N)</th>
<th>Concentrated Load @Center of Span (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,200</td>
<td>10,680</td>
<td>5,290</td>
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<td>1,500</td>
<td>8,540</td>
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P1001 Trapeze Load Data

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<th>Concentrated Load @Center of Span (N)</th>
</tr>
</thead>
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<td>1,200</td>
<td>10,680</td>
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</tr>
<tr>
<td>1,500</td>
<td>8,540</td>
<td>4,230</td>
</tr>
<tr>
<td>1,800</td>
<td>7,120</td>
<td>3,510</td>
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<td>2,000</td>
<td>6,090</td>
<td>3,020</td>
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</table>

P5501 Trapeze Load Data

<table>
<thead>
<tr>
<th>Span (mm)</th>
<th>Maximum Uniform Design Load (N)</th>
<th>Concentrated Load @Center of Span (N)</th>
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<tr>
<td>1,200</td>
<td>20,820</td>
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<td>1,500</td>
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### P2024 Series Pipe Clamps

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<tr>
<th>Unistrut Part Number</th>
<th>Pipe Size (mm)</th>
<th>Strap Thickness (mm)</th>
<th>Screw Size (mm)</th>
<th>Vertical Force (N)</th>
<th>Transverse Force (N)</th>
<th>Longitudinal Force (N)</th>
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<tr>
<td>P2026</td>
<td>14</td>
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<td>1,420</td>
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<td>1,420</td>
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<tr>
<td>P2070-80</td>
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</table>
## UN4/UN15 Series

<table>
<thead>
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<th>Unistrut Part Number</th>
<th>Pipe Size</th>
<th>Strap thickness</th>
<th>Screw Size</th>
<th>Vertical Force</th>
<th>Transverse Force</th>
<th>Longitudinal Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN4-19</td>
<td>19</td>
<td>3</td>
<td>8</td>
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<tr>
<td>UN4-25</td>
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<td>8</td>
<td>2,220</td>
<td>1,110</td>
<td>440</td>
</tr>
<tr>
<td>UN4-32</td>
<td>32</td>
<td>3</td>
<td>8</td>
<td>2,220</td>
<td>1,110</td>
<td>440</td>
</tr>
<tr>
<td>UN4-38</td>
<td>38</td>
<td>3</td>
<td>8</td>
<td>2,220</td>
<td>1,110</td>
<td>440</td>
</tr>
<tr>
<td>UN4-51</td>
<td>51</td>
<td>6</td>
<td>12</td>
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<td>4,450</td>
<td>890</td>
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<tr>
<td>UN4-60</td>
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<td>12</td>
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<td>UN15-76</td>
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<td>4,450</td>
<td>890</td>
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<tr>
<td>UN15-89</td>
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<td>UN15-102</td>
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<td>890</td>
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<td>UN15-127</td>
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<td>12</td>
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<td>4,450</td>
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<tr>
<td>UN15-152</td>
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<td>12</td>
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<td>4,450</td>
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</table>
### Design Longitudinal Force

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Longitudinal Force</th>
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<tbody>
<tr>
<td>12 thru 40mm</td>
<td>0.445 kN</td>
</tr>
<tr>
<td>43 thru 127mm</td>
<td>0.890 kN</td>
</tr>
<tr>
<td>152</td>
<td>1.670 kN</td>
</tr>
<tr>
<td>203</td>
<td>2.220 kN</td>
</tr>
</tbody>
</table>

Clamp (By Others) complies with Federal Spec WW-H-171E Type 4 and MSS SP-58 Type 4
### VERTICAL BRACING OR STIFFENER LOAD TABLE

<table>
<thead>
<tr>
<th>Rod Size (mm.)</th>
<th>Root Area (mm.²)</th>
<th>Root Diameter (mm.)</th>
<th>Radius of Gyration (mm.)</th>
<th>Max. Allowable Rod Compression (psi)</th>
<th>Clip Spacing L (mm.)</th>
<th>Max. Seismic Safe Load* (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50% 4,500 PSI</td>
<td>75% 6,750 PSI</td>
<td>100% 9,000 PSI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.068</td>
<td>0.314</td>
<td>0.0785</td>
<td>610</td>
<td>350</td>
<td>250</td>
</tr>
<tr>
<td>12</td>
<td>0.126</td>
<td>0.425</td>
<td>0.1063</td>
<td>1,130</td>
<td>500</td>
<td>400</td>
</tr>
<tr>
<td>16</td>
<td>0.202</td>
<td>0.536</td>
<td>0.1341</td>
<td>1,810</td>
<td>600</td>
<td>500</td>
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<tr>
<td>20</td>
<td>0.302</td>
<td>0.652</td>
<td>0.163</td>
<td>2,710</td>
<td>750</td>
<td>600</td>
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<tr>
<td>24</td>
<td>0.419</td>
<td>0.73</td>
<td>0.192</td>
<td>3,770</td>
<td>900</td>
<td>700</td>
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</tbody>
</table>

**Assumptions:**
1. Rod held against translation at location of cradle clips K equals 1.0.
2. L = Distance between connection points.
3. Trapeze with braces on alternate members.
4. Loads are based on the root area of the thread and at a stress of 9,000 psi, 62 mpa.
5. Safe seismic forces are determined by increasing allowable safe loads by 33%
CHANNEL STYLES

P1000

P5500

NOTE: CHANNEL WALL THICKNESS IS 12GA. (2.5mm)
CHANNEL STYLES

P1001

P5501

NOTE: CHANNEL WALL THICKNESS IS 12GA. (2.5mm)
P1000T

For Beam Load Capacity,
Use 85% of P1000 Load Table

NOTE: CHANNEL WALL THICKNESS IS 12GA. (2.5mm)
### Table 15 – ELEMENTS OF SECTION

<table>
<thead>
<tr>
<th>Channel Type</th>
<th>Weight Kg/m</th>
<th>A - Axis, X - X</th>
<th>Type</th>
<th>Weight Kg/m</th>
<th>A - Axis, 4 - 4</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>mm²</td>
<td>z</td>
<td>mm²</td>
</tr>
<tr>
<td>P1000</td>
<td>2.81</td>
<td>7.7</td>
<td>3.31</td>
<td>1.466</td>
<td>9.82</td>
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<tr>
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<td>5.62</td>
<td>38.71</td>
<td>9.37</td>
<td>2.324</td>
<td>19.65</td>
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<td>3.68</td>
<td>21.77</td>
<td>6.41</td>
<td>2.154</td>
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<td>7.35</td>
<td>117</td>
<td>18.89</td>
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### Static Beam Load (X-X Axis)

<table>
<thead>
<tr>
<th>Span (mm)</th>
<th>Channel</th>
<th>Max Allowable Uniform Load</th>
<th>Deflection at Uniform Load</th>
<th>Max Allowable Horizontal Load</th>
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<tbody>
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<td>500</td>
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<td>7.42</td>
<td>1.5</td>
<td>11.31</td>
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<tr>
<td></td>
<td>P1001</td>
<td>19.58*</td>
<td>0.8</td>
<td>19.50*</td>
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<tr>
<td></td>
<td>P5500</td>
<td>13.84</td>
<td>1</td>
<td>15.28</td>
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<td>P5501</td>
<td>27.04</td>
<td>0.5</td>
<td>27.00*</td>
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<td>P1000</td>
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<td>3.3</td>
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<td>1.8</td>
<td>9.80*</td>
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<td>P5500</td>
<td>6.92</td>
<td>2.3</td>
<td>7.64*</td>
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<td>P5501</td>
<td>20.50</td>
<td>1.3</td>
<td>15.28*</td>
</tr>
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<td>2.97</td>
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<td>4.52</td>
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<td>6.11</td>
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<td>8.9</td>
<td>3.77</td>
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<td>6.1</td>
<td>5.09</td>
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<td>12.7</td>
<td>2.70</td>
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<td>P1001</td>
<td>4.90</td>
<td>7.1</td>
<td>5.00</td>
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<td>8.04</td>
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<td>9.9</td>
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<td>11.9</td>
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<td>4.00</td>
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<td>28.7</td>
<td>1.85</td>
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<td>5.59</td>
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<td>20.1</td>
<td>3.30</td>
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<td></td>
<td>P5500</td>
<td>2.31</td>
<td>24.4</td>
<td>2.54</td>
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<td>P5501</td>
<td>6.83</td>
<td>13.2</td>
<td>5.14</td>
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</tbody>
</table>

* Load Limited by Weld Shear

Notes:
1. Calculations of section properties are based on metal thicknesses as determined by AISI, Cold-Form Steel Design Manual.
2. Prevent end rotation of beams that have vertical loads and lateral forces.
3. When loads are concentrated at or near midspan, allowable uniform loads should be multiplied by 0.5 and deflections by 0.8.
4. Laterally unbraced beams should have allowable loads reduced by multiplying by the load reduction factor given in the last column.
5. For short term seismic conditions apply a 33% increase in allowable loads.
UNISTRUT NUT DIMENSION & DESIGN LOADS

<table>
<thead>
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<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
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<td>P1012S P1012</td>
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<td>6,670</td>
<td>11,120</td>
<td>135.00</td>
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<td>6,670</td>
<td>8,900</td>
<td>70.00</td>
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</table>

*Safety factor of 3

**UNISTRUT nuts and bolts mounted to the UNISTRUT channels must be tightened to listed torque values (unless otherwise noted).
## P1000 Brace Design Load

<table>
<thead>
<tr>
<th>Unsupported Length (mm)</th>
<th>Compression Load (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>18.50</td>
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<tr>
<td>1000</td>
<td>16.00</td>
</tr>
<tr>
<td>1250</td>
<td>13.50</td>
</tr>
<tr>
<td>1500</td>
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<tr>
<td>1750</td>
<td>9.50</td>
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<td>2000</td>
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<td>2500</td>
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</tr>
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<td>2750</td>
<td>6.00</td>
</tr>
<tr>
<td>3000</td>
<td>5.00</td>
</tr>
</tbody>
</table>

*Note: 1. Maximum axial load under seismic loading conditions.  
2. The design load shall not exceed the allowable loads for connection detail.*

## SPF 400 Design Load

* A Trademark of Lord & Sons, Inc.

<table>
<thead>
<tr>
<th>Wire Rope Diameter (mm)</th>
<th>4 Way Splayed</th>
<th>Single Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transverse Load (kN)</td>
<td>Longitudinal Load (kN)</td>
</tr>
<tr>
<td>(5)</td>
<td>4.67</td>
<td>4.96</td>
</tr>
</tbody>
</table>

Note: 1. Allowable loads have been determined by the manufacturer’s testing, analysis, and technical specifications.  
2. Galvanized Wire Rope, 7 x 19 IWSC, RHRL (PRESTRETCHED)  
3. Maximum torque on nut: 67 Nm.  
4. Safety Factor of 3 for prestretched cable.
*P2815 Adjustable Brace

*P1843W Adjustable Hinge

Typ On Both Hinge Leafs

**Note:**
1. The load capacity of the fitting exceeds the slip and pull-out capacity of the bolt in the channel.
2. Allowable loads have been determined by the manufacturers testing, analysis and technical specifications. Hinges must be welded version to achieve loadings.

P2785 Beam Clamp

Use In Pairs

100mm Min.
**SERIES SPF100* FITTING**  
For rod sizes (mm): 10, 12, 16, 20

**SERIES SPF200* ADJUSTABLE FITTING**  
For rod sizes (mm): 10, 12, 16, 20

**SERIES SPF300* FITTING**  
For rod sizes (mm): 10, 12, 16, 20

---

**SEISMIC PIVOT FITTING (SPF) SERIES**

Note:
1. The load capacity of the fitting exceeds the slip and pull-out capacity of the bolt in the channel.
2. Allowable loads have been determined by the manufacturers testing, analysis and technical specifications.
3. For retrofit application, engineer of record must verify.
5. Square washer provided with fitting.
6. A trademark of Lord & Sons, Inc.
SERIES SPF 400*
For rod sizes (mm): 10, 12, 16, 20

*SEISMIC PIVOT FITTING (SPF) SERIES

Note:
1. For Design loads see Page 28.
2. Conforms with FED. SPEC. RRW410
3. For retrofit application, engineer of record must verify.
5. Square washer provided with fitting
*6. A trademark of Lord & Sons, Inc.
### CHANNEL FITTINGS

**P2452 KNEE BRACE**

Design Axial Load  
5.36kN  
Mass: 103kg/100

**P2095 to P1546**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>&quot;A&quot; Degree (rad)</th>
<th>&quot;B&quot; (mm)</th>
<th>&quot;C&quot; (mm)</th>
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</thead>
<tbody>
<tr>
<td>P2094</td>
<td>82½°</td>
<td>37⁄₄</td>
<td>1½</td>
</tr>
<tr>
<td>P2095</td>
<td>75°</td>
<td>37⁄₄</td>
<td>1½</td>
</tr>
<tr>
<td>P2097</td>
<td>60°</td>
<td>37⁄₄</td>
<td>1½</td>
</tr>
<tr>
<td>P1546</td>
<td>45°</td>
<td>3</td>
<td>2½₁₄</td>
</tr>
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</table>

Mass: 26kg/100

**P2101 & P2103**

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<th>&quot;B&quot; (mm)</th>
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</thead>
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<tr>
<td>P2101</td>
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<td>37⁄₄</td>
</tr>
<tr>
<td>P2103</td>
<td>15°</td>
<td>37⁄₄₈</td>
</tr>
</tbody>
</table>

Mass: 26kg/100

**P2106 to P1186**

<table>
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<th>&quot;A&quot; Degree (rad)</th>
<th>&quot;B&quot; (mm)</th>
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</thead>
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<tr>
<td>P2106</td>
<td>75°</td>
<td>37⁄₄</td>
</tr>
<tr>
<td>P2108</td>
<td>60°</td>
<td>37⁄₄₈</td>
</tr>
<tr>
<td>P1186</td>
<td>45°</td>
<td>37⁄₄</td>
</tr>
</tbody>
</table>

Mass: 26kg/100

---

**APPROVED**

Fixed Equipment Anchorage  
Office of Statewide Health Planning and Development  
OPA-0120  Apr 25, 2003  
**** Valid for 3 Years Maximum ****

Bill Staehlin  
(916) 324-9106

JOSEPH L. LA BRIE  
Structural Engineer  
No. SE 3566  
55 E. Walnut St. Suite 277  
Arcadia, CA 91006

DATE:  
04/25/2003

PAGE: 32
STRUCTURE ATTACHMENTS - Wood

NOTE:
1) ABOVE DETAILS INDICATE HOW BRACES MAY BE ATTACHED TO THE STRUCTURE. IF BRACE ANGLE IS GREATER THAN 45 WITH THE HORIZONTAL, ALLOWABLE LOADING MUST BE DETERMINED BY THE PROJECT ENGINEER.

2) THE PROJECT ENGINEER SHALL DETERMINE THAT THE WOOD MEMBERS AND ATTACHMENTS ARE ADEQUATE TO RESIST THE SEISMIC FORCES.

---

100 x 75 x 10 Angle

HHS12 FW12 & HN12

P1843W Hinge

P1000 Transverse or Longitudinal Brace

Bolt Dia. - D
Bolt Must Be Above Neutral Axis of Beam

4D Min.

45 Max.

90mm Min.
Note: 1) Above details indicate how braces may be attached to the structure. If brace angle is greater than 45 with the horizontal, allowable loading must be determined by the project engineer.

2) The project engineer shall determine that the steel members are adequate to resist the seismic forces.
STRUCTURE ATTACHMENTS - Steel

P1010 Nut with P1064 Washer & SW12 HN12

12 Dia. Threaded Rod

P2785 Beam Clamp

P1000

100 Min.

513 kg Design Load

Note: The Engineer of Record shall verify the adequacy of the steel beams.
STRUCTURE ATTACHMENTS - Concrete

UNISTRUT®
35660 Clinton Street
Wayne, Michigan 48184
PH: (800) 521-7730
FAX: (734) 721-4106
JOSEPH L. LA BRIE
     Structural Engineer
         No. SE 3566
 55 E. Walnut  St. Suite 277
       Arcadia, CA 91006
DATE:
04/25/2003
PAGE

STRUCTURE ATTACHMENTS - Concrete

P1843W Hinge
HHS 12
45 Max.
P1000 Transverse or Longitudinal Brace

Expansion Anchor

P1843W Hinge
HHS 12 Dia. (Typ)
45 Max.
P1000 Transverse or Longitudinal Brace

Expansion Anchor

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
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UNISTRUT®
35660 Clinton Street
Wayne, Michigan 48184
PH: (800) 521-7730
FAX: (734) 721-4106

JOSEPH L. LA BRIE
Structural Engineer
No. SE 3566
55 E. Walnut St. Suite 277
Arcadia, CA 91006

DATE:  04/25/2003  PAGE
STRUCTURE ATTACHMENTS - Concrete

M12 Dia. Concrete Anchors

M12 Dia Threaded rod w/HN12 Nuts

513kg Design Load

Concrete Anchor

Seismic Approved Fitting

Threaded Rod (As Required)

HN Nut

Trapeze Member

HN Nut

Expansion Anchor

Metal Deck Form Work

20 Ga. Steel Min.

P1204

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35660 Clinton Street
Wayne, Michigan 48184
PH: (800) 521-7730
FAX: (734) 721-4106

JOSEPH L. LA BRIE
Structural Engineer
No. SE 3566
55 E. Walnut St. Suite 277
Arcadia, CA 91006

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PAGE

---

d \geq \text{Larger of 40mm OR (Required embedment for the proposed anchor - \(h/3\))} \leq (\text{Depth of Slab (D)} - 25\text{mm})

Y = 8 \times \text{Anchor Diameter for 100\% of Design Load Values for Anchor}

If less than 8x then use 50\% of Design Load Values for Anchor

---

STRUCTURE ATTACHMENTS - Concrete

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Bill Staehlin  (916) 324-9106

JOSEPH L. LA BRIE
Structural Engineer
No. SE 3566
55 E. Walnut St. Suite 277
Arcadia, CA 91006

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PAGE
** TYPICAL ATTACHMENTS **

- P2815 Adjustable Brace
- HHS 12 w/ P1010 Nut
- P3300 CI Series Concrete Insert OR P1000 Attached to Concrete Structure
- ** Reduce Loads by 50% in This Area.**

---

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---

**UNISTRUT®**
35660 Clinton Street
Wayne, Michigan 48184
PH: (800) 521-7730
FAX: (734) 721-4106

JOSEPH L. LA BRIE
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55 E. Walnut St. Suite 277
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---
### CONCRETE INSERTS

**NOTE:**
Recommended loading on inserts in 20 mpa concrete. Sufficient concrete must surround inserts to conform to design shear stress. The distance between the insert centerline and the concrete edge must be a minimum of 75 mm.

Values in the Table are based on a safety factor of 3 to 1. For installation in Hospitals, use 65% of tabulated values. When installing underside of slab, use 50% of tabulated values.

<table>
<thead>
<tr>
<th>Insert Length</th>
<th>Design Load</th>
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<tbody>
<tr>
<td>mm</td>
<td>kN</td>
</tr>
<tr>
<td>76</td>
<td>2</td>
</tr>
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<td>102</td>
<td>3.5</td>
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<td>152</td>
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<tr>
<td>6,096</td>
<td></td>
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</tbody>
</table>

**P3300 SERIES CONCRETE INSERTS**

- 8.9 kN Load Allowed in Each 300 mm of Length, Reduce to 4.4 kN Load within 50 mm of Each End.
Problem:

Design a brace for a single pipe hanger with 203mm diameter pipe and hangers spaced at maximum distance (see figure below).

Solution:

Step 1 Select hanger for 203mm diameter pipe.

For 51mm Diameter: \( S = 3.0 \text{m} \)

Step 2 (Page 2-3 Pipe Data Table) Determine the maximum hanger spacing (\( S \)):

\( S = 3.0 \text{m (On Center)} \)

the unit weight of the 203mm pipe full of water (\( W \)):

\( W = 79.84 \text{ kg/m} \)

Step 3 Calculate horizontal seismic force (\( F_H \)):

If pipe placed above ceiling of 2nd floor (6m) of a 4 story (12m) building and is within the seismic limits defined in page 5, then \( C_s \) can be taken from Page 5:

\[
\begin{align*}
    \frac{h_x}{h_r} &= 0.5 \\
    C_s &= 0.83 \\
\end{align*}
\]

\( C_s \) within \( 0.693 \leq C_s \leq 3.96 \)

\[
\begin{align*}
    F_H &= C_s (2W) = 0.83 (74.84 \text{ kg}) = 62.12 \text{ kg/m} \\
    F_H &= F_H / 1.4 = 44.37 \text{ kg/m} \\
\end{align*}
\]

(brace on alternating trapeze) (converts to working stress loads)
Step 4 Actual brace force (maximum at 45°) at every other hanger,

\[ F_{b,\text{Actual}} = 1.414F_h = 1.414(44.37 \text{ kg/m} \times 7.3 \text{m} = 459 \text{ kg}) = 4.5 \text{kN} \]

Step 5 Select rigid brace P1000.

Check brace against allowable design load:
From Page 28 (Brace Design Table), a Brace Span of 2.134m has a capacity of 8.0kN and is greater than \( F_{b,\text{Actual}} \). Therefore okay.

Check slip along channel:
From Page 27 (Design Load Table) The maximum slip for a single bolt fitting P1843W is 6.67kN (>\( F_{b,\text{Actual}} \)). Therefore okay.

Can use any brace length less than 2.134m to allow slip to be the limiting allowable load. Therefore \( F_{b,\text{Allowable}} = 6.67 \text{kN} \)

Determine if longitudinal braces are required:

\[
\text{Brace Spacing} = \frac{F_{b,\text{Allowable}}}{(1.414 \times F_h \times \text{hanger spacing})} = \frac{6.67 \text{kN}}{(1.414 \times 443.7 \times 9.81 \times 3 \times 10^{-3})} = 3.6 \text{ Bays}
\]

Therefore, use hangers 3m on center, Transverse Brace on every other hanger, and Longitudinal Brace on every Transverse Brace.

Step 6 (Page 22, Capacity of Threaded Rod Table) Maximum Allowable Load (12mm rod) = 681.8kg

Actual Seismic Load \( (T_{\text{max}}) = W + (F_h \times 7.3 \text{m ft}) = 276.5 \text{ kg} + (44.37 \text{kg/m} \times 7.3 \text{m}) = 600 \text{ kg} \)
Therefore okay.

Compression is not considered.

Step 7 Verify pipe clamp capacity.

\[
\text{Longitudinal Force} = F_h \times \text{brace spacing} = 44.37 \text{ kg/m} \times 14.6 \text{m} = 650 \text{ kg}
\]

From Page 21, an 203mm pipe has a longitudinal capacity = 2.22kN
Since the 203mm pipe longitudinal capacity is less than the actual longitudinal force, adjust longitudinal brace space:

\[
\text{Longitudinal Force} = 44.37 \text{ kg/m} \times 3.6 \text{m} = 162.3 \text{ kg}
\]

Therefore, adjust Longitudinal Brace spacing to every hanger (3.6m on center).
**DESIGN EXAMPLES - Trapeze Hanger**

**Problem:**

Trapeze hanger spanning 610mm hung from rods with a seismic brace to be used on left end (see figure below). There is one 51mm diameter pipe, one 76mm pipe, and one 102mm pipe with the load evenly distributed on the trapeze.

![Diagram of Trapeze Hanger]

**Solution:**

Step 1 (Page 11) Determine the Trapeze Spacing (S) using the smallest pipe diameter.

For 51mm Diameter: \( S = 3.0m \)

Step 2 (Page 11) Calculate the weight of the pipes plus contents (W) on each trapeze.

\[
W = S \times (p_1 + p_2 + p_3) = 3.0m \times (1.7 + 16.1 + 24.3) \text{ kg/m} = 146 \text{ kg}
\]

Step 3 Calculate horizontal seismic force (\( F_H \)) assuming braces on alternate trapeze supports

If pipe placed above ceiling of 2nd floor (6m) of a 4 story (12m) building and is within the seismic limits defined in page 1-1, then \( C_s \) can be taken from Page 1-1, Seismic Design Coefficient Graph:

\[
\begin{align*}
  h_x &= 6m \\
  h_y &= 12m \\
  h_x/h_y &= 0.5
\end{align*}
\]

\[
F_H = C_s (2W) = 0.83 \times 2 \times 146.4 = 243 \text{ kg} \\
F_H = F_h/1.4 = 243 \text{ kg}/1.4 = 173.6 \text{ kg}
\]

(converts to working stress loads)
DESIGN EXAMPLES - Trapeze Hanger

Step 4  Actual Brace Force (maximum at 45°):
\[ F_{b\text{Actual}} = 1.414(F_h) = 1.414(173.6 \text{ kg}) = 265 \text{ kg} \]

Step 5  Select fitting P1843W from Page 29 & check slip along channel:
From Page 4-5 (Design Load Table), the maximum slip resistance for a single bolt fitting P1843W is 1.80 kg and is greater than \( F_{b\text{Actual}} \). Therefore O.K.

Check brace against allowable design load:
From Page 28 (Brace Design Table), the maximum brace span that can be used is 3.048m, which yields a capacity of 545 kg and is greater than \( F_{b\text{Actual}} \). Therefore O.K.

Can use any brace length less than 3.048m.
The limiting allowable load is the Brace Design Load. Therefore \( F_{b\text{Allow.}} = 545 \text{ kg} \)

Determine if longitudinal braces are required:
Brace Spacing (# of bays) = \( \frac{F_{b\text{Allow.}}}{0.5F_h} \)
\[ = \frac{545 \text{ kg}}{0.5 \times 173.6 \text{ kg}} \approx 6 \text{ bays} \]

Determine if transverse bracing is required:
Brace Spacing (# of bays) = \( \frac{F_{b\text{Allow.}}}{F_h} \)
\[ = \frac{545 \text{ kg}}{173.6 \text{ kg}} \approx 3 \text{ bays} \]

Therefore provide Transverse Brace at every other hanger and Longitudinal Brace at every other Transverse Brace.

Step 6  Check compression and tension forces in the rod with brace on alternate hangers.

a. \( T_{\text{max}} = 0.5W + F_h = 0.5(146.3) + 173.6 = 246 \text{ kg} \)
(Page 3-11, Threaded Rod Table) A 3/8" rod will carry a Seismic Load of 368 kg, which is greater than \( T_{\text{max}} \). Therefore is acceptable.

b. \( C_{\text{max}} = 0.5W - F_h = 0.5(146.3) - 173.6 = -100 \text{ kg} \)

Check buckling due to compression by determining the percentage of full stress capacity:
\[ \frac{C_{\text{max}}}{C_{\text{Allowable}}} = 100/368 = 0.27 \]
(Page 3-10, Channel Stiffener Table) Since 27% is less than 50%:
Use P1000T stiffener with P2485 clips spaced 355mm on center.
Step 7  Select clamps from Pages 19 and 20.  
**Style P2024 series or UN4/UN15 series can be used.**

Check P1121 clamp against transverse and longitudinal seismic forces.  
(Reference Page 11, Pipe Data Table) Use largest pipe – 102mm diameter:  
Transverse Force = 24.3 kg/m x 3m x 0.83/1.4 = 44 kgs  
Longitudinal Force = 26.3 kg/m x 6m x 0.83/1.4 = 88 kgs  

From Page 19, *allowable transverse* force is 145 x 1.33 = 193 kg  
Transverse force (44 kgs) is less than allowable (121 kg), therefore okay.  

From Page 19, *allowable longitudinal* force is 200 x 1.33 = 120 kgs  
Longitudinal force (88 kgs) is less than allowable (120 kgs), therefore okay.  

Step 8  (Page 17) Select a trapeze member.  

**A P1000 spanning 610mm will carry 768 kgs, which is greater than the calculated W= 146 kg (from Step 2).**  

Step 9  Check combined vertical and lateral bending using interaction formula given on Page 10.  
(Using a P1000 with 24” span, get allowable loads from Page 4-4, Beam Load Table):  

\[
\frac{146}{0.92 \times 768} + \frac{176.3}{0.92 \times 1104} \leq 1.33
\]

\[
0.207 + 0.17 = 0.38 \leq 1.33 \quad \text{Therefore O.K.}
\]
The following defines the design seismic force \( F_p \) as described in the 2000 International Building Code (I.B.C.). The engineer of record shall qualify for the calculation of the seismic force as needed. This sheet provided for reference only.

\[
F_p = \frac{0.4a_p S_{DS} W_p}{R_p I_p (1 + 2 \frac{z}{h})}
\]

- \( a_p \): Component amplification factor:
  (Table 1621.3, 2000 IBC)
- \( I_p \): Component importance factor:
  (Section 1621.1.6, 2000 IBC)
- \( h \): Average roof height of structure relative to the base elevation
- \( R_p \): Component response modification factor:
  (Table 1621.2 or 1621.3, 2000 IBC)
- \( S_{DS} \): Design spectral response acceleration at short period:
  (Section 1615.1.3 or \( S_{DS} \approx 2.5C_a \), 2000 IBC)
- \( z \): Height in structure at point of attachment of component.

Limits to lateral seismic force: \( 0.3 S_{DS} I_p W_p \leq F_p \leq 1.6 S_{DS} I_p W_p \)