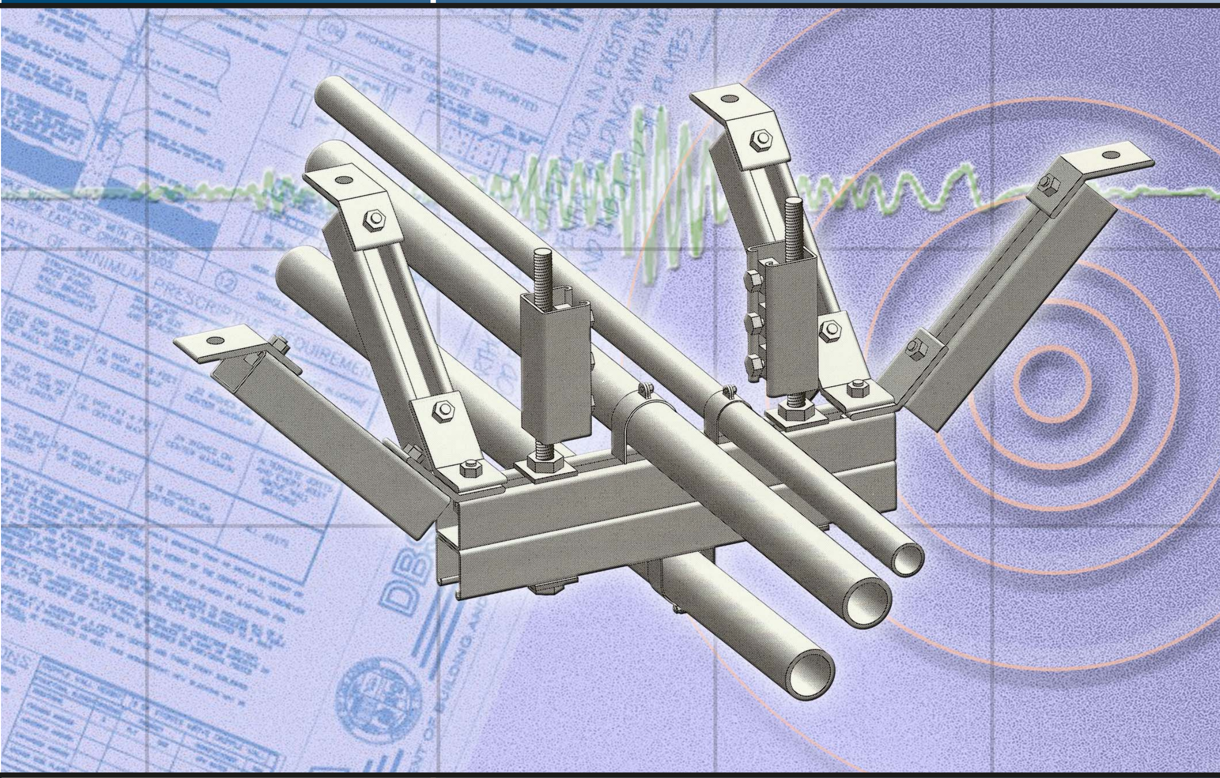
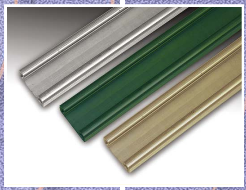
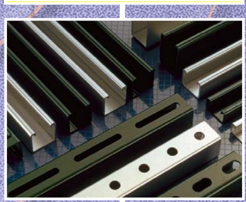
POWER-STRUT®

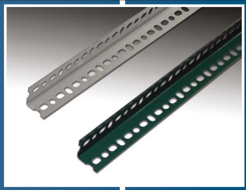
# Seismic Bracing Systems

## Electrical/Mechanical Uses









- Seismic Load Specifications
- Load & Horizontal Load Schedules
- Design Tables
- Bracing Channel, Fittings, & Accessories Images
- Through January 2009

*Electrical Infrastructure Solutions™*

POWER-STRUT®

# The Power to Handle Seismic Loads

The present line of Power-Strut continuous slot metal framing is the result of over one half century of experience in metal framing.

This complete line includes channels, finishes, fittings and accessories for any framing or support solution... large or small, heavy or light.

Power-Strut is proud of the exacting standards of research, design, engineering and manufacturing that go into production of the Power-Strut system.

Maximum recommended load ratings for channels have been established through testing and are based on allowable stresses applicable to the Power-Strut Material Specification. Electrical Power-Strut products are listed by the Underwriters' Laboratories, Inc. (U.L.) and certified by the Canadian Standards Association (CSA.)

# OPA 0242 NON-APPROVED PAGES

Some of the pages in this book are pending approval by OSHPD. They have been signed by the Structural Engineer and have been submitted but are awaiting review. Many of the approvals awaiting review need corrections and for this reason OSHPD is checking what they have approved before they approve new items even though many of those may be corrections to a previous approval.

**i thru iv:** The page numbers changed for this series of pages

**iv:** Added $F_v$ notation and changed s to $s_c$

**5 and 6:** New seismic table information

**A1 and A14:** The OSHPD approved pages may still be rejected by the SEOR as it does not include vertical seismic required by the CBC. The submitted, but not OSHPD approved pages meet the OSHPD requirement and the Code.

**A12 and A13:** Changed component names to comply with MSS SP-58 Type numbers

**B1:** The page added closer rod stiffener spacing where compression loads may exceed L/r = 200. This is especially important when using other OSHPD pre-approvals where compression loads have been ignored when using cable for brace material.

**B4:** Retrofit fittings use our sister company's pre-approval.

**B5 and B6:** Allowable loads for pipe clamps used a factor of 5 in order to cover all piping applications in accordance with MSS standards at that time. However, we did not print safety factors used for our products in the approval. Since then there is a proposal to change the standard. And OSHPD has approved these type clamps with a safety factor of 3.5. To convert to a safety factor of 3.5 multiply the approval by 5 and divide by 3.5.

Example: 200 pound rating x 5/3.5 = 286

**B7:** Changed component name to comply with MSS SP-58 Type number

**B9:** The PS 680 has been modified to meet the OSHPD requirement and renumbered to PS 681.

**C1:** The math has been clarified to allow other brace patterns including cable. Since cable can only be used for tension bracing two opposing cables are required wherever a single rigid brace may be used.

**C2:** This is somewhat redundant to C1 but includes a layout for the differing brace patterns.

**NOTES REGARDING SAFETY FACTORS**

Safety factors vary by product depending on the intended use. OSHPD requires safety factors for some products. For example, for a wedge anchor that has not been tested for cracked concrete OSHPD requires a safety factor of 10 in the tension zone (generally the underside of a slab). For cable the OSHPD guidelines have been an industry standard of 5 unless pre-stressed where they allow a safety factor of 3. On one approval OSHPD has approved cable with a safety factor barely more than 2 (must be pre-stressed) based on the testing submitted for that approval.

Note: Gray shading behind items that have changed since OSHPD approved the page.

# Memorandum

oshpd

**State of California**

*"Equitable Healthcare Accessibility for California"*

**To:** All FDD Staff

**Date:** April 22, 2008

**From:** John D. Gillengerten, 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.

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## OSHPD Pre-Approval Usage

The use of the Pre-Approvals, now designated as "OPA" numbers are valid for projects submitted to OSHPD after November 1, 2002 and designed to the requirements of the 2001 CBC. Either the manufacturer or the listed engineer must be contacted for copies of the Pre-Approval for your use. Copies of the Pre-Approval details must be on the job site prior to starting the installation of the component or system.

OSHPD does not currently enforce expiration dates. All Pre-Approvals are valid regardless of expiration date.

Specifying Pre-Approved systems does not preempt the Building Permit process. Contract documents shall be submitted to OSHPD for review and approval and issuance of a Building Permit prior to construction occurring.

Go to www.oshpd.ca.gov/fdd/Pre-Approval/ for additional information

Tuesday, August 26, 2008

# TABLE OF CONTENTS

# PREFACE

These guidelines were developed using sound engineering principles and judgment. They represent realistic and safe details compatible with the general guidelines and force factors in the State of California Code of Regulations, Title 24, also referred to as the California Building Standards Code. Material contained in this publication is for general information only and can be referenced in the **2001 California Building Code** based on the 1997 Uniform Building Code. Anyone making use of the data does so at his own risk and assumes any and all liability resulting from such use. **ALLIED ELECTRICAL™ Group** disclaims any and all express or implied warranties of fitness for any general or particular application.

**A copy of this Seismic Bracing catalog showing the proper Seismic Brace tables (Pages 5 & 6) and Brace Location Requirements (Page C3) along with the Power-Strut® Engineering catalog shall be on the jobsite prior to starting the installation of the seismic bracing system.**

**The Seismic Tables defined in Pages 5 & 6 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.**

| SUBMITTED | | TITLE | |
|---|---|---|---|
| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | Preface | |
| | | PAGE<br>i | DATE<br>04/21/2005 |

Power-Strut 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 or 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 and shall be approved by California Office of Statewide Health Planning and Development (OSHPD) or governing agency.

***Power-Strut 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. All fire sprinkler branch line bracing shall comply with the requirements of the current edition of the NFPA-13. 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, no-hub pipe and threaded connections, 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. If this flexibility is not provided, bracing will be required when the aggregate weight of the pipes and conduits exceed 10 lb/ft.

# GLOSSARY

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

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

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

**Longitudinal–** Direction along the horizontal of a component or element's run.

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

**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.

| SUBMITTED | | TITLE |  |
|---|---|---|---|
| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | Glossary | |
| | | PAGE<br>iii | DATE<br>04/21/2005 |

**$a_p$** – Component Amplification Factor.

**ASME** – American Society of Mechanical Engineers

**ASTM** – American Society for Testing Materials

**$C_a$** – Seismic Coefficient.

**$C_L$** – Longitudinal Clamp Capacity

**$C_T$** – Transverse Clamp Capacity

**$F_b$** – Transverse brace earthquake load along brace length.

**$F_{bALLOW}$** – Allowable Brace Force.

**$FH_L$** – Longitudinal Horizontal Force; force along horizontal run of pipe. ($FH_L = F_p x S_3$)

**$FH_{L\ ALLOW}$** - Allowable longitudinal horizontal force as per manufacturer's testing.

**$FH_T$** – Transverse Horizontal Force; force perpendicular to horizontal run of pipe. ($FH_T = F_p x S_2$)

*$F_p$* – Lateral force on a part of the structure; design seismic force (strength design).

**$F_p$** - Lateral force on a part of the structure factored to Working Stress level; design seismic force (Working Stress).

**$F_{ROD}$** – Rod axial force.

**$F_V$** – Vertical Seismic ($F_V$). Vertical acceleration from a seismic event and may be up (uplift) or down ($F_V$ = 33% * $FH_T$ * $S_1/S_2$)

**$F_x$** – Horizontal transverse brace earthquake load perpendicular to $F_y$.

**$F_y$** – Transverse brace earthquake load perpendicular to $F_x$.

**$h_r$** – Structure roof elevation with respect to grade.

**$h_x$** – Equipment attachment elevation with respect to grade (not less than 0.0).

**$I_p$** – Seismic Importance Factor.

**LB** – Distance from one angle fitting to another on a trapeze.

**LT** – Distance from one threaded rod to another on a trapeze.

**NFPA** – National Fire Protection Association

**PS –** Power-Strut

**$R_p$** – Component Response Modification Factor.

**$s_c$** – seismic coefficient used to define the following;

$$s_c = \frac{a\ C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right)$$

**$S_1$** – Hanger spacing

**$S_2$** – Transverse brace space

**$S_3$** – Longitudinal brace space

**$W_p$** – Weight of element or component.

**Wt** – Total Weight

| SUBMITTED | | TITLE | |
|---|---|---|---|
| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | Notations | |
| | | PAGE<br>iv | DATE<br>04/21/2005 |

The following defines the total design lateral seismic force, $Fp$, as described in Chapter 16A of the 2001 California Building Code (CBC). The values of the following coefficients have been determined to provide a safe approximation to use as a design lateral force. **The Engineer of Record shall qualify for the calculation of the seismic force as needed, see sample problem on the following page**.

$$Fp = \frac{a_p C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right)W_p = s_c W_p$$

**This is not part of the approved page. Specification Changed with Oct. 12, 2006 Amendment**

$$Fp = \frac{a_p C_a I_p}{R_p}\left(1 + 2\frac{h_x}{h_r}\right)W_p = sW_p$$

*$a_p$ = 1.0* — *in-structure Component Amplification Factor:*
For plumbing equipment and associated piping, necessary for the continuing operation of essential service buildings (Table 16A-O, 2001 CBC).

*$C_a$ = 0.66* — *Seismic Coefficient (.06 to .66):*
*0.66 derived from Table16A-Q of the 2001 CBC; knowing the seismic zone (Z) to be 4, having a stiff soil profile type ($S_D$), and a Type A seismic source having large magnitudes and slip rates, which results in a near source factor (Na) of 1.5. (refer to Tables 16A-S, 16A-J, 16A-I, & 16A-U)*

*$I_p$ = 1.50* — *Seismic Importance Factor:*
*For essential facilities with occupancies having surgery and emergency treatment areas (Table 16A-K, 2001 CBC).*

*$R_p$ =3.0* — *Component Response Modification Factor:*
*3.0 for plumbing equipment, associated piping and/or anchors with an l/d > 8, necessary for the continuing operation of essential service buildings.*
*1.5 for shallow anchors with an embedded length-to-diameter ratio of less than 8.*
**Adhesive or non-ductile anchors are not allowed when using the tables in this book.**

*$h_x$ =_____* — *Equipment attachment elevation with respect to grade (not less than 0.0).*

*$h_r$ =_____* — *Structure roof elevation with respect to grade.*

Limits to this lateral seismic force: $0.7C_a I_p W_p \leq Fp \leq 4C_a I_p W_p$.

The use of $Fp$ in this catalog necessitates a conversion from strength design of the seismic force to working stress of the seismic force. Thus, $Fp$**(strength design) = 1.4 $F_p$(working stress)**.

A P P R O V E D
**Fixed Equipment Anchorage**
**Office of Statewide Health Planning and Development**
**OPA-0242 Apr 25, 2003**
****** Valid for 3 Years Maximum ******
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TITLE
**Lateral Force Design**

PAGE 1

DATE **04/25/2003**

A 3-story building, 40' high, will have piping suspended above the ceiling of the first floor at an elevation of 20' from grade. The building is in California located on seismic zone 4 with a soil profile of $S_c$. The nearest proximity to a known seismic source is less than 1 mile (approximately 1.6 km) and has a seismic source type A.

***Solution***:

***1)*** $R_p = 3.0$
$C_a = 0.6$
$h_x = 20'$
$h_r = 40'$

$$Fp = \frac{a_p C_a I_p}{R_p}\left(1+3\frac{h_x}{h_r}\right)W_p = \frac{1.0\times0.6\times1.5}{3.0}\left(1+3\frac{20}{40}\right)W_p = 0.75W_p$$

$Fp$ shall not be less than $0.7C_a I_p W_p = 0.7(0.6)(1.5)W_p = 0.63W_p$
$Fp$ shall not be greater than $4C_a I_p W_p = 4(0.6)(1.5)W_p = 3.6W_p$
**Therefore use $Fp$ = $0.75W_p$**

2) Conversion from strength design to working stress:
$1.4\ \mathbf{F_p} = 0.75W_p$
$\mathbf{F_p} = 0.75W_p / 1.4$
$\mathbf{F_p = 0.54W_p}$

1a) For shallow anchors with an embedded length to diameter ratio less than 8 (e.g. ½" diameter concrete expansion anchor with an embedded length of 3.5"), $R_p = 1.5$.

$$Fp = \frac{a_p C_a I_p}{R_p}\left(1+3\frac{h_x}{h_r}\right)W_p = \frac{1.0*0.6*1.5}{1.5}\left(1+3\frac{20}{40}\right)W_p = 2F_{p(1)} = 1.5W_p$$

Compare to the minimum and maximum limits of this lateral force for shallow anchors:
$0.63W_p \le Fp \le 3.6W_p$
**Therefore use $Fp_{\text{Shallow}}$ = $1.5W_p$**

2a) Conversion from strength design to working stress:
$1.4\ \mathbf{F_p} = 1.5W_p$
$\mathbf{F_p} = 1.5W_p / 1.4$
$\mathbf{F_p = 1.07W_p}$ **(Shallow Concrete Anchors)**

Perform similar calculations for building levels 2 and 3. The results are tabulated in the following table.

**Data Tabulation**

| Building Level | Elevation To Grade | Lateral Seismic Force, Fp | Shallow Concrete Anchor, $Fp_{\text{Shallow}}$ |
|---|---|---|---|
| 1 | 20' | $0.54W_p$ | $1.07W_p$ |
| 2 | 30' | $0.70W_p$ | $1.39W_p$ |
| 3 | 40' | $0.86W_p$ | $1.71W_p$ |

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
OPA-0242 Apr 25, 2003
**** Valid for 3 Years Maximum ****
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TITLE
**Lateral Force Design Sample**

PAGE 2

DATE 04/25/2003

**Channel & Closure – Pre-Galvanized**

ASTM A-653 Grade 33, Pre-Galvanized;
ASTM A-1011 SS Grade 33, Plain, Painted or Hot Dipped Galvanized

**Fittings – Steel**

¼" Nominal Thickness – ASTM A-575 and A576;
⅜" Nominal Thickness – A36 (Structural Steel)

**Clamps – Steel**

ASTM A-1011 SS Grade 33

**Clamps – Stainless Steel**

ASTM A-240, Type 304

**Channel Nuts**

ASTM A1011 SS Grade 45;
ASTM A576 Grade 1015 Modified;
ASTM A675 Grade 60;
ASTM A36

**Hex Nuts and Bolts**

ASTM A-563, Grade A and ASTM A-307, Grade A

**Threaded Rod**

Commercial Grade – Low Carbon Steel
Yield Strength = 32 ksi (minimum)
Ultimate Strength = 52 ksi (minimum)

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
OPA-0242 Apr 25, 2003
**** Valid for 3 Years Maximum ****
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TITLE
**Material Specification**

PAGE
3

DATE
**04/25/2003**

The following procedures are for the Seismic Tables defined in Pages 5 & 6 with a Seismic Factor of 1.0g. The Sample Procedure in Pages A1 & A7 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. Reference Page A12. |
| 3. | Determine transverse and longitudinal brace location requirements. Reference Pages C3 & C4. |
| 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 C3 & C4. |
| 5. | Determine type of structure (concrete, wood, steel) and from the table select Anchorage quantity, size, & embedment (where applies). |

**Single Pipe Seismic Table - (Seismic Factor (not to exceed) = 1.0 g)**

| Pipe Dia. | MSS SP-58 Type No. or Power-Strut Part No. | Max. Brace Spacing: Trans. | Max. Brace Spacing: Long. | Min. Rod Dia. | Normal Weight Concrete (3,000psi min.): Qty | Normal Weight Concrete: Dia. | Normal Weight Concrete: Embed. | LWC on 20ga Metal Deck (3,000psi): Qty | LWC: Dia. | LWC: Embed. | Structural Wood Beam: Thru Bolt | Structural Wood Beam: Dia. | Structural Bolting: A307 Bolt | Structural Bolting: Dia. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *(in)* | *Figure No.* | *(ft)* | *(ft)* | *(in)* | *(Min.)* | *(in)* | *(in)* | *(Min.)* | *(in)* | *(in)* | *Qty.* | *(in)* | *Qty.* | *(in)* |
| 1/2 | PS 67 | 40 | 80 | 3/8 | 1 | 3/8 | 3 | 1 | 3/8 | 3 | 1 | 1/2 | 1 | 1/2 |
| 3/4 | Type 3<br>Type 1<br>PS 67 | 40 | 80 | 3/8 | 1 | 3/8 | 3 | 1 | 3/8 | 3 | 1 | 1/2 | 1 | 1/2 |
| 1 | Type 3<br>Type 1<br>PS 67 | 40 | 80 | 3/8 | 1 | 3/8 | 3 | 1 | 3/8 | 3 | 1 | 1/2 | 1 | 1/2 |
| 1 1/2 | Type 3<br>Type 1<br>PS 67 | 40 | 80 | 3/8 | 1 | 3/8 | 3 | 2 | 3/8 | 3 | 1 | 3/4 | 1 | 1/2 |
| 2 | Type 3<br>Type 1<br>PS 67 | 40 | 60 | 3/8 | 1 | 3/8 | 3 | 2 | 3/8 | 3 | 1 | 3/4 | 1 | 1/2 |
| 2 1/2 | Type 3<br>Type 1<br>Type 43<br>PS 67 | 40 | 60 | 1/2 | 1 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 3 | Type 3<br>Type 1<br>Type 43<br>PS 67 | 40 | 40 | 1/2 | 1 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 4 | Type 3<br>Type 1<br>Type 43<br>PS 67 | 40 | 40 | 5/8 | 1 | 5/8 | 5 1/8 | 2 | 5/8 | 5 | 2 | 5/8 | 1 | 1/2 |
| 5 | Type 3<br>Type 1<br>Type 43<br>PS 67 | 30 | 30 | 5/8 | 2 | 1/2 | 4 1/8 | 2 | 5/8 | 5 | 2 | 3/4 | 1 | 1/2 |
| 6 | Type 3<br>Type 1<br>Type 43<br>PS 67 | 20 | 20 | 3/4 | 2 | 1/2 | 4 1/8 | 2 | 5/8 | 5 | 2 | 3/4 | 1 | 1/2 |
| 8 | Type 3<br>Type 1<br>Type 43 | 10 | 10 | 3/4 | 2 | 1/2 | 4 1/8 | 2 | 5/8 | 5 | 2 | 3/4 | 1 | 1/2 |

NOTES:
1. System must be engineered for variation of components (ie: size, quantity, spacing) needed to the listed values that are outside the scope of this table.
2. Pipe properties (water filled), see Page C1.
3. Pipe Hanger capacity and details, see Page A12 and A13.
4. Brace location requirements, reference Page C3.
5. Maximum threaded rod spacing, reference Page C1.
6. Maximum PS200 allowable brace length is 10 ft. at maximum brace angle of 45°.
7. 1/2" bolt(s) and nut(s) required on brace connectors attached to channels in this catalog, see Page B2.

TITLE

**Single Pipe Seismic Table**

PAGE 5

DATE

| Trapeze Seismic Table - Not to Exceed 1.0 g | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max. Vertical Load | Max. Transverse Brace Spacing | Max. Trapeze Length | | | | Min. Rod Dia. | Wedge Anchors | | | | | | Structural Wood Beam | | Structural Steel Beam | |
| | | PS200 Trapeze | PS200 2T3 Trapeze | PS150 Trapeze | PS150 2T3 Trapeze | | Normal Wt. Concrete (3,000psi) | | | Light Wt. Concrete on Metal Deck (3,000psi) | | | | | | |
| | | | | | | | Qty | Dia. | Embed. | Qty | Dia. | Embed. | Qty | Dia. | A307 | Dia. |
| *(p/f)* | *(Max. ft)* | *(ft)* | *(ft)* | *(ft)* | *(ft)* | *(in)* | *(Min.)* | *(in)* | *(in)* | *(Min.)* | *(in)* | *(in)* | | *(in)* | Qty | *(in)* |
| 5 | 40 | 10 | 10 | 10 | 10 | 1/2 | 1 | 1/2 | 4 1/8 | 1 | 1/2 | 4 | 1 | 1/2 | 1 | 1/2 |
| 7 | 40 | 10 | 10 | 10 | 10 | 1/2 | 1 | 1/2 | 4 1/8 | 1 | 1/2 | 4 | 1 | 5/8 | 1 | 1/2 |
| 10 | 40 | 8 | 10 | 10 | 10 | 1/2 | 1 | 1/2 | 4 1/8 | 1 | 5/8 | 5 | 2 | 1/2 | 1 | 1/2 |
| 12 | 40 | 6 | 10 | 10 | 10 | 1/2 | 1 | 1/2 | 4 1/8 | 1 | 5/8 | 5 | 2 | 1/2 | 1 | 1/2 |
| 15 | 40 | 5 | 10 | 8 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 17 | 40 | 5 | 10 | 8 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 20 | 30 | 5 | 10 | 8 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 22 | 30 | 5 | 10 | 7 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 25 | 20 | 5 | 10 | 7 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 27 | 20 | 5 | 10 | 7 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 30 | 20 | 4 | 10 | 7 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 32 | 20 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 35 | 10 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 37 | 10 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 40 | 10 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 42 | 10 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 45 | 10 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 1/2 | 1 | 1/2 |
| 47 | 10 | 4 | 10 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |
| 50 | 10 | 4 | 9 | 6 | 10 | 1/2 | 2 | 1/2 | 4 1/8 | 2 | 1/2 | 4 | 2 | 5/8 | 1 | 1/2 |

Notes:
1. System must be engineered for variation of components (ie: size, quantity, spacing) needed to the listed values that are outside the scope of this table.
2. Maximum vertical load (plf) simulates linear load of pipe(s) along pipe axis uniformly distributed on trapeze.
3. Maximum Longitudinal Brace Space is 2x Transverse Brace Space, not to exceed 80 ft.
4. Maximum Trapeze Lengths are for Uniform Load Capacities of Trapeze (see Page C6) braced longitudinally.
   (When loads are concentrated at or near midspan of trapeze use 1/2 of maximum trapeze length defined in table (minimum of 2ft.)
5. For non-braced Trapeze: type, length, & use of smaller components can be acquired, reference Note 1.)
6. Maximum PS200 allowable brace length is 10 ft. for loads listed in table.
7. Maximum Hanger Spacing = 10ft.
8. 1/2" bolt(s) and nut(s) required on brace connectors attached to channels in this catalog.
9. Minimum 3,000 psi normal weight and light weight concrete slab/deck.

S U B M I T T E D

OPA-0242, Rev 1

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TITLE

**Trapeze Seismic Table**



DATE
**04/21/2005**

STEPS TRAPEZE SELECTION PROCEDURE FOR WATER FILLED PIPE

1. **Select the *maximum support spacing*.**
From code or using *Sheet C1* (use smallest pipe diameter).
Select rational brace spacing using *Sheet C3* as a guideline.

2. **Determine the *total weight (Wt)* supported by the trapeze.**
*Sheet C4* can be used to determine the trapeze weight.
By calculation: Wt $=\varnothing_{PIPE}$ Unit Weight x Hanger Space

3. **Determine the *strength design seismic load* ($F_p$) and the *unit seismic load* of the pipes.**
With $h_x/h_r$ known, refer to *Sheet C5* to get $F_p$, (for a more accurate value see *Sheet 2*).
Convert from strength design to working stress: $1.4\mathbf{F_p}$(Working Stress) = $F_p$(Strength Design)

4. **Determine the horizontal and vertical seismic forces.**
Solve for both *Transverse ($FH_T$), Longitudinal ($FH_L$) and Vertical ($F_v$)*.

5. **Select *pipe clamps* from *Sheets B5 and B6*.**
Verify clamp capacity exceeds actual forces.

6. **Select *trapeze channel.***
Use *Sheet C6 or C7* and verify channel can carry load.
a. Non-braced channels carry gravity (Wt) load only.
b. Braced channels must include horizontal longitudinal force and meet interaction (i) condition.

7. **Determine brace earthquake loads.**
From *Sheet C2*, solve for the Brace Horizontal, Vertical, and Axial Forces.

8. **Determine *rod axial forces* and select *rod size* from *Sheet B1*.**
Verify rod adequacy and determine the need for rod stiffeners.

$$F_{Rod\ Tension} = \left(\frac{\text{weight}}{\text{No. Hanger Rods}}\right) + \left(\frac{F_y}{\text{No. Braced Rods}}\right) + \left(\frac{F_v}{\text{No. Hanger Rods}}\right)$$

$$F_{Rod\ Compression} = \left(\frac{\text{weight}}{\text{No. Hanger Rods}}\right) - \left(\frac{F_y}{\text{No. Braced Rods}}\right) - \left(\frac{F_v}{\text{No. Hanger Rods}}\right)$$

9. **Verify *brace adequacy* from *Sheet C2*.**

10. **Select *brace fitting* with the required number of bolts from *Sheets B2-B4*.**

11. **Select appropriate *anchorage details* from Section D “anchorage”.**
Adjust seismic load as necessary: $\mathbf{F_p}$ (shallow anchors) = $2\mathbf{F_p}$

12 **Verify adequacy of anchorages.**
From the strength of the individual components, verify adequacy from *Section B* “components”.

S U B M I T T E D

**OPA-0242, Rev 1**

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TITLE

**Trapeze Selection Procedure**

PAGE A1

DATE **04/21/2005**

*PROBLEM:*

Provide vertical and horizontal pipe supports for a 6' trapeze supporting 2 – 1" diameter pipes and 3 – 2" diameter pipes placed above the ceiling of the 2nd floor (30' from grade) of a 45' tall building. The 6' long brace slope shall be 1 vertical and 2 horizontal. The supporting structure is structural steel.

*SOLUTION (refer to Sheet A1):*

STEPS DESCRIPTION

1 From *Sheet C1*:

Hanger spacing for 1" diameter pipe, $\mathbf{S_1=7'}$

Select rational brace spacing not to exceed maximum values listed on Sheet C3, Note 6:

Transverse brace spacing, $\mathbf{S_2=14'}$ (one side of trapeze)

Longitudinal brace spacing, $\mathbf{S_3=28'}$ (each side of trapeze)

2 From *Sheet C4*, determine weight, Wt:

Wt = 2(1"$\varnothing_{PIPE}$ @ 7') + 3(2"$\varnothing_{PIPE}$ @ 7')

= 2(14) + 3(36)

Wt = 136 lbs.

By calculation: 1"$\varnothing_{PIPE}$ @ 7' = 2.05 lbs/ft x 7' = 14 lbs x 2 pipes = 28 lbs.

2"$\varnothing_{PIPE}$ @ 7' = 5.11 lbs/ft x 7' = 36 lbs x 3 pipes = 108 lbs

**Total = 136lbs / 7 ft. = 19.4 lbs/ft**

3 From *Sheet C5*, determine seismic force (*Fp*):

With $h_x/h_r$ = 30'/45' = 0.67, follow graph horizontally to plotted diagonal line.

Then follow vertically down to a value of "s" coefficient. (s = 0.99)

Therefore: $Fp = 0.99W_p$ (for strength design)

$1.4\mathbf{F_p} = Fp$

$1.4\mathbf{F_p} = 0.99W_p$

$F_p = 0.71Wp$ (for working stress design)

Seismic load for 1"$\varnothing_{PIPE}$: 0.71(2.05 lbs/ft) **x 2 pipes x 7 ft = 20.37 lbs**

Seismic load for 2"$\varnothing_{PIPE}$: 0.71(5.11 lbs/ft) **x 3 pipes x 7 ft = 76.19 lbs**

**Total = 96.56 lbs / 7 ft = 13.79 lbs/ft**

4 Determine the horizontal force:

$FH_T$ = 2(1"$\varnothing_{PIPE}$ @ 14') + 3(2"$\varnothing_{PIPE}$ @ 14')

= 2(1.46 lbs/ft x 14') + 3(3.63 lbs/ft x 14')

= **193 lbs**

$F_v$ = 33% * $FH_T$ * $S_1/S_2$

=0.33 * 193 lbs * (7' / 14')

= **32 lbs**

$FH_L$ = 2(1"$\varnothing_{PIPE}$ @ 28') + 3(2"$\varnothing_{PIPE}$ @ 28')

= 2(1.46 lbs/ft x 28') + 3(3.63 lbs/ft x 28')

= **387 lbs**

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|---|---|---|---|
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| | | PAGE<br>**A2** | DATE<br>**04/21/2005** |

5 From *Sheet B5 and B6*, select pipe clamps:

**Use PS3126 for 2" diameter pipes**,

$C_T$ (2" $\varnothing_{PIPE}$) = 3.63 lbs/ft x 14' = 51 lbs (<Fy = 500 lbs)

$C_L$ (2" $\varnothing_{PIPE}$) = 3.63 lbs/ft x 28' = 102 lbs (<Fx = 200 lbs)

**Use PS1100 for 1" diameter pipes**,

$C_T$ (1" $\varnothing_{PIPE}$) = 1.46 lbs/ft x 14' = 20 lbs (<Fy = 150 lbs)

$C_L$ (1" $\varnothing_{PIPE}$) = 1.46 lbs/ft x 28' = 41 lbs (<Fx = 80 lbs)

*Note: Pipe clamp capacities are greater than horizontal forces.*

6 From *Sheet C7*, select trapeze:

**Use Back to Back Channel** PS200 2T3 with,

Vertical concentrated load capacity = 790lbs

Lateral concentrated load capacity = 810 lbs

$$\text{Interaction (i)} = \frac{136 \text{ lbs}}{790 \text{ lbs}} + \frac{387 \text{ lbs}}{810 \text{ lbs}} = 0.65 < 1.0$$

7 From *Sheet C2*, determine transverse brace earthquake loads:

$Fx = Kx(FH_T)$ = 1.000(193 lbs) = **193 lbs**

$Fy = Ky(FH_T)$ = 0.500(193 lbs) = **97 lbs**

$Fb = Kb(FH_T)$ = 1.118(193 lbs) = **216 lbs**

8 Determine rod axial forces and select rod size:

$$F_{Rod\ Tension} = \left(\frac{\text{weight}}{\text{No. Hanger Rods}}\right) + \left(\frac{F_y}{\text{No. Braced Rods}}\right) + \left(\frac{F_v}{\text{No. Hanger Rods}}\right)$$

$$= \left(\frac{136 \text{ lbs}}{2 \text{ Rods}}\right) + \left(\frac{97 \text{ lbs}}{1 \text{ Braced Rod}}\right) + \left(\frac{32 \text{ lbs}}{2 \text{ Rods}}\right)$$

$$= 181 \text{ lbs}$$

$$F_{Rod\ Compression} = \left(\frac{\text{weight}}{\text{No. Hanger Rods}}\right) - \left(\frac{F_y}{\text{No. Braced Rods}}\right) - \left(\frac{F_v}{\text{No. Hanger Rods}}\right)$$

$$= -45 \text{ lbs (Compression Exists)}$$

Choose rod size from *Sheet B1*. Try $\frac{3}{8}$" rod @ 100% Compression Stress.

$T_{max} = C_{max}$ = 811 lbs for seismic event

Check Adequancy of Rod:

$T_{max} \geq F_{Rod\ Tension}$

811 lbs ≥ 181 lbs, Therefore $^3/_8$" Diameter Rod OK!!

$C_{max} \geq F_{Rod\ Compression}$

811 lbs ≥ 45 lbs, Therefore $^3/_8$" Diameter Rod OK!!

(Step continued on next page)

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| | | PAGE: A3 — DATE: **04/21/2005** |

Determine the need for rod stiffeners.

From Table Page B1, Determine Maximum Allowed Compression for ⅜" diameter load at l/r=200 during a seismic event.

$C_{200\ Seismic}$ = 250 lbs x 1.33 = 330 lbs

$C_{200\ Seismic} \geq F_{Rod\ Compression}$ (330 lbs ≥ 45 lbs)

Since actual compression ≥ allowed compression for l/r=200, use PS3500 Stiffener Assembly with clips spaced for l/r=200 ➔ 14" o.c.

9 From *Sheet C2*, verify brace adequacy:

PS200, 6' long brace has a compression load capacity of $F_{bALLOW}$ = 2230 lbs
The brace axial force is $F_b$ = 216 lbs

**$F_{bALLOW} > F_b$; Therefore the brace is adequate.**

10 From *Sheet B2 and B4*, select brace fittings:

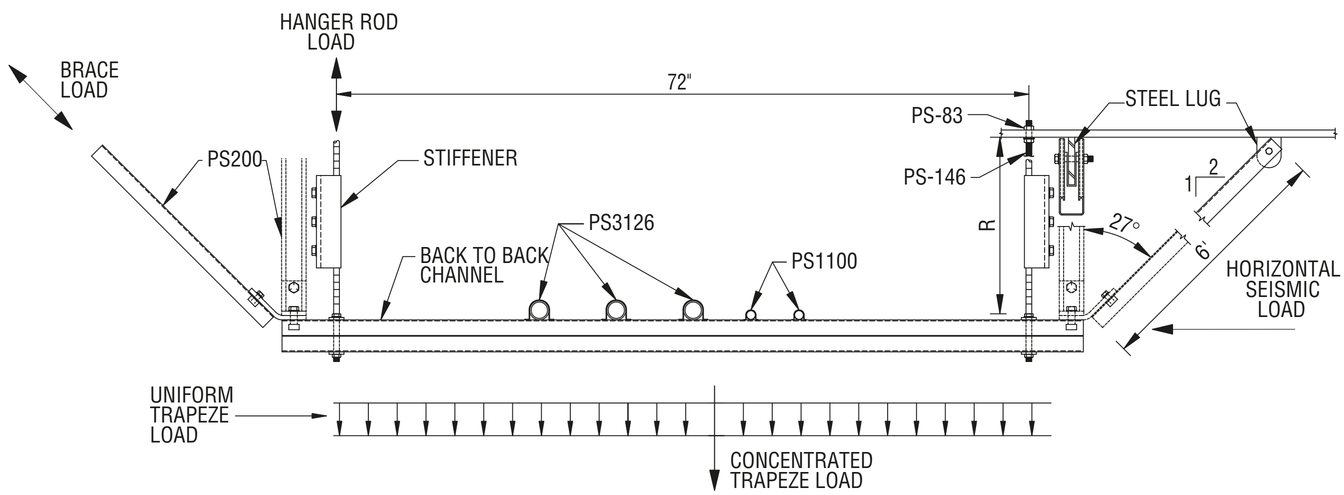
**PS9402 hinge connector with a single ½" diameter bolt in each leg.**
Maximum slip resistance = 1500 lbs
Maximum pullout resistance = 2000 lbs
Adequate for brace earthquake load, $F_b$ = 216 lbs.

11 Select anchorage detail:

**From *Sheet D1*, choose Beam Lug Assembly and Beam Rod Assembly**.

12 From *Sheet B7*, verify component strength:

**Use Steel Lug**



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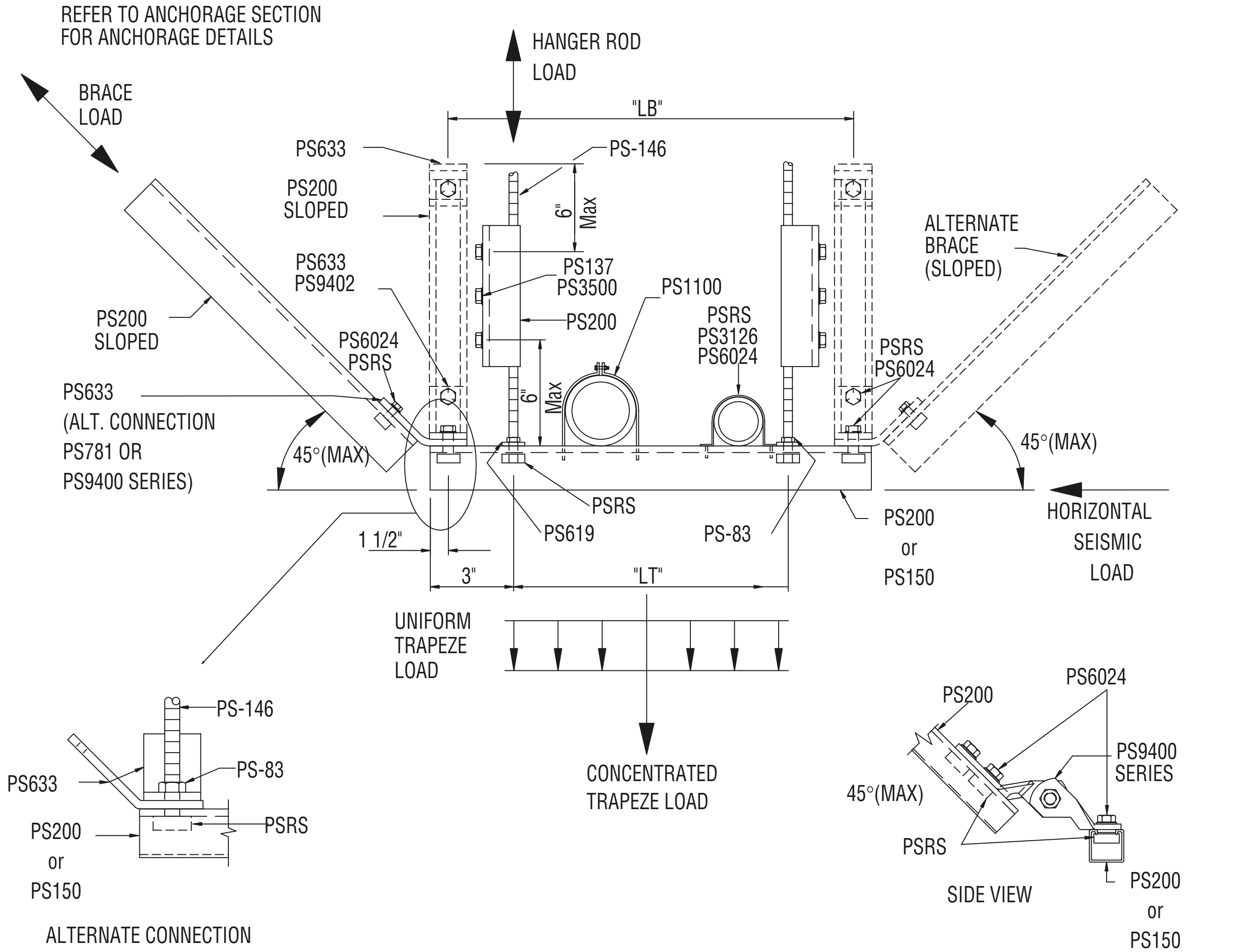
TITLE

**Trapeze Selection Sample Problem**




**SINGLE CHANNEL TRAPEZE ASSEMBLY**

NOTE:
1. SEE COMPONENT INDEX FOR COMPONENT LISTING AND PAGE REFERENCE.
2. REFER TO SHEET C6 FOR DESIGN LOAD TABLES.
3. TRANSVERSE BRACES MAY BE INSTALLED ON ONE SIDE OF TRAPEZE.
4. LONGITUDINAL BRACES SHALL BE INSTALLED ON BOTH SIDES OF TRAPEZE.

**A P P R O V E D**
**Fixed Equipment Anchorage**
**Office of Statewide Health Planning and Development**
**OPA-0242 Apr 25, 2003**
****** Valid for 3 Years Maximum ******
Bill Staehlin (916) 324-9106

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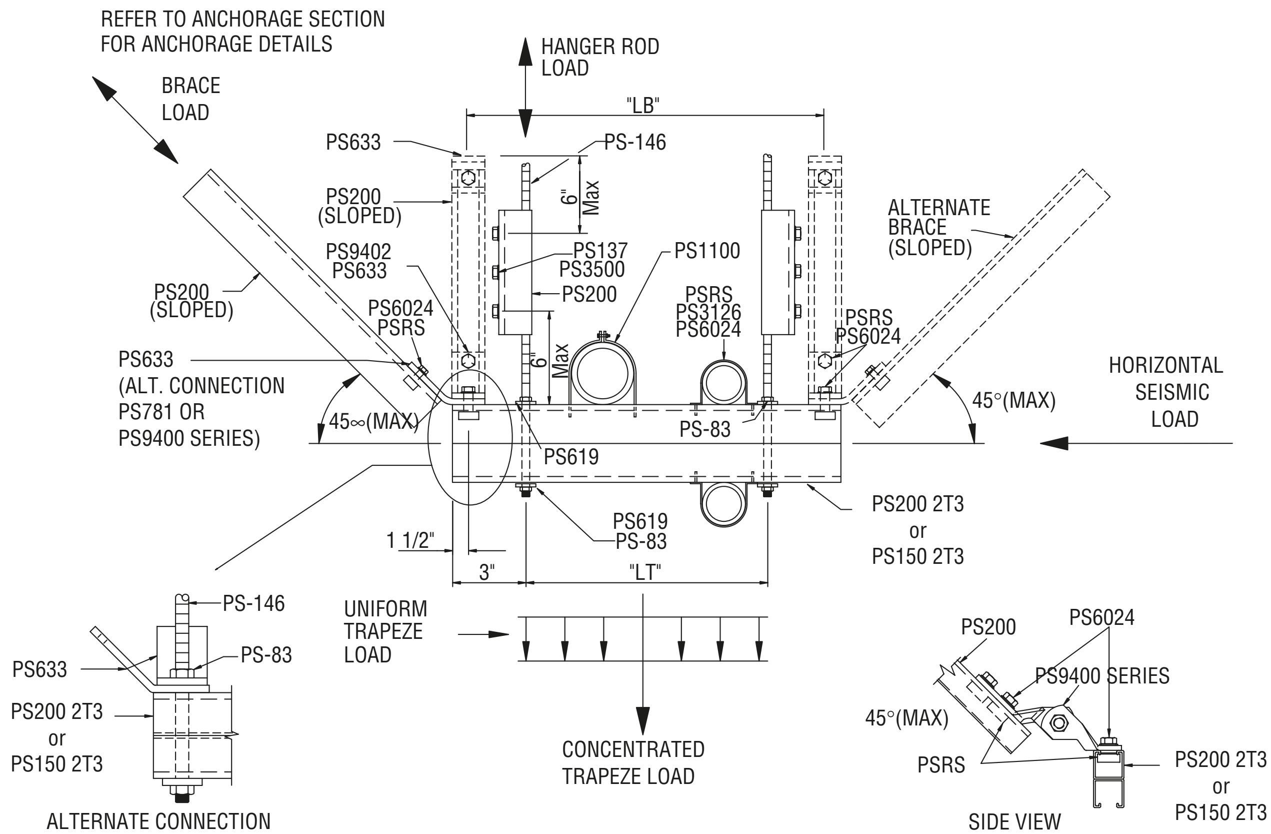
TITLE
**Trapeze Assembly Single Channel**

| PAGE | DATE |
|---|---|
| A5 | 04/25/2003 |




**BACK TO BACK CHANNEL TRAPEZE ASSEMBLY**

NOTE:
1. SEE COMPONENT INDEX FOR COMPONENT LISTING AND PAGE REFERENCE.
2. REFER TO SHEET C6 FOR DESIGN LOAD TABLES.
3. TRANSVERSE BRACES MAY BE INSTALLED ON ONE SIDE OF TRAPEZE.
4. LONGITUDINAL BRACES SHALL BE INSTALLED ON BOTH SIDES OF TRAPEZE.

| | | |
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| A P P R O V E D<br>**Fixed Equipment Anchorage**<br>Office of Statewide Health Planning and Development<br>**OPA-0242 Apr 25, 2003**<br>**** Valid for 3 Years Maximum ****<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Trapeze Assembly**<br>**Back to Back Channel**<br>PAGE **A6** DATE **04/25/2003** |

*STEPS* *SINGLE PIPE HANGER PROCEDURE FOR WATER FILLED PIPE*

1. **Select maximum support spacing**.
From code or using *Sheet C1* (use smallest pipe diameter).
Select rational brace spacing using *Sheet C3* as a guideline.

2. **Determine *pipe weight, Wt*.**
*Sheet C4* can be used to get pipe weight or,
By calculation: Wt = $\varnothing_{PIPE}$ Unit Weight x Rod Spacing

3. **Determine the *allowable seismic design load* (*Fp*) and the *unit seismic load* of the pipes.**
With $h_x/h_r$ known, refer to *Sheet C5* to get *Fp*, (for a more accurate value of see *Sheet 2)*.
Convert from strength design to working stress: 1.4$\mathbf{F_p}$ = *Fp*

4. **Determine the horizontal and vertical seismic forces.**
Solve for both Transverse ($FH_T$), Longitudinal ($FH_L$), and Vertical ($F_V$).

5. **Select pipe hanger from *Sheets A12 and A13.***

6. **Determine clamp capacity adequacy from *Sheet A14*.**
If the longitudinal clamp force capacity is less than the longitudinal, horizontal pipe force, provide additional longitudinal bracing or additional clamps.

7. **Determine brace earthquake loads.**
Use *Sheet C2* and solve for brace horizontal, vertical, and axial force.

8. **Determine hanger rod axial forces and select rod size from *Sheet B1*.**
Verify rod adequacy and determine the need for rod stiffeners.

$F_{Rod\ Tension} = W_t + F_y + F_V$
$F_{Rod\ Compression} = W_t - F_y + F_V$

9. **Verify brace adequacy from *Sheet C2*.**

10. **Select *brace fitting* from *Sheet B3-B4*.**
Use the required number of bolts as determined from *Sheet B2*.

11. **Select appropriate anchorage details from Section D "anchorage".**
Adjust seismic load as necessary: $\mathbf{F_p}$ (shallow anchors) = 2 $\mathbf{F_p}$.

12. **Verify adequacy of anchorages.**

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| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **Single Pipe Hanger Procedure** | |
| | | PAGE<br>A7 | DATE<br>**04/21/2005** |

PROBLEM:

Determine the required vertical and lateral support for a single 4" diameter pipe placed above the ceiling of the 2nd floor (30' from grade) of a 45' building. The supporting structure is cast in place concrete. The brace slope is 1 vertical to 1 horizontal (45°), and is 6'-0" long.

*SOLUTION (refer to Page A7):*

**STEPS DESCRIPTION**

1 From *Sheet C1*:

Hanger rod spacing: **$S_1$ = 14'**

Select rational brace spacing not to exceed maximum values listed on *Sheet C3*:

Transverse brace spacing: **$S_2$ = 28'**

Longitudinal Brace Spacing: **$S_3$ = 56'**

2 From *Sheet C4*, determine weight, Wt:

A 4"∅ pipe with hanger rods spaced at 14' results in a pipe weight of

**Wt. = 228 lbs**.

By calculation: $4"\varnothing_{PIPE}$ @ 14' = 16.31 lbs/ft x 14' = 228 lbs

3 From *Sheet C5*, determine *Fp*:

$h_x/h_r$ = 30'/45' = 0.67

$R_p$ = 3.0 (non-shallow anchors)

s = 0.99

Therefore *Fp* = $0.99W_p$ (for strength design)

1.4 $\mathbf{F_p}$ = $0.99W_p$

$\mathbf{F_p = 0.71W_p}$ **(for working stress design)**

Unit seismic load for $4"\varnothing_{PIPE}$: $\mathbf{F_p}$ $(4"\varnothing_{PIPE})$ = 0.71 (16.31 lbs/ft) = **11.58 lbs/ft**

4 Determine lateral pipe forces:

$FH_T$ = $\mathbf{F_p}$ $(4"\varnothing_{PIPE})$ @ 28'
= 11.58 lbs/ft x 28'
= **324 lbs**

$FH_L$ = $\mathbf{F_p}$ $(4"\varnothing_{PIPE})$ @ 56'
= 11.58 lbs/ft x 56'
= **650 lbs**

$F_V$ = $FH_T/3 * S_1/S_2$
= 324 lbs / 3 * (14'/28')
= **54 lbs**

5 From *Sheets A12 and A13*, select a pipe hanger that can handle a Wt = 228:

**Adjustable Steel Yoke Pipe Roll**

Maximum allowable hanger rod force on hanger = 475lbs.

| | | | |
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| | | PAGE<br>**A8** | DATE<br>**04/21/2005** |

6 From *Sheet A14* determine clamp capacity adequacy:

The brace clamp allowable load for a 4"$\varnothing_{PIPE}$ in the longitudinal (x) direction:

Brace Clamp $FH_{L\ ALLOW}$ = 200 lbs

Since, $FH_L$ = 650 lbs > $FH_{L\ ALLOW}$, provide additional Longitudinal Bracing.

Additional longitudinal bracing at 14':

New $FH_L$ = $\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) @ 14'

= 11.58 lbs/ft x 14'

= 162 lbs

**$FH_L$ = 162 lbs < $FH_{L\ ALLOW}$ = 200 lbs**

Therefore, acceptable use of brace clamp.

7 From *Sheet C2*, determine the brace slope factors for a 1-1 brace slope:

$K_x$ = 1.0 $K_y$ = 1.0 $K_b$ = 1.414

Determine brace earthquake loads ($FH = FH_T = 2FH_L$):

$F_x = K_x(FH_T) = 1.0(324^{\#}) = \mathbf{324^{\#}}$

$F_y = K_y(FH_T) = 1.0(324^{\#}) = \mathbf{324^{\#}}$

$F_b = K_b(FH_T) = 1.414(324^{\#}) = \mathbf{458^{\#}}$

8 Determine the maximum axial force on the rod:

$F_{Rod\ Tension}$ = Weight + $F_y$ + $F_V$

= 228 lbs + 324 lbs + 54 lbs

= 606 lbs

$F_{Rod\ Compression}$ = Weight - $F_y$ - $F_V$

= 228 lbs - 324 lbs - 54 lbs

= - 153 lbs (Compression Exists)

$F_{Anchor\ Tension}$ = Weight + $F_y$ + $F_V$

= 228 lbs + 324 lbs + 54 lbs

= 606 lbs

Choose Rod size from *Sheet B1*: Try ½" rod @ 100% Compression Stress.

$T_{max} = C_{max}$ = 1,500 lbs for seismic event

Check adequacy of rod:

$T_{max}$ = 1,500 lbs > $F_{1/2"\ Rod\ Tension}$ = 606 lbs, Therefore OK!

$C_{max}$ = 1,500 lbs > $F_{1/2"\ Rod\ Tension}$ = 153 lbs, Therefore OK!

(Step 8 continued on next page)

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| | | PAGE **A9** / DATE **04/21/2005** |

8 Determine the maximum axial force on the rod: (continued)

Determine rod stiffener requirements

From Table Page B1, determine maximum allowed compression for ⅝" diameter load at l/r=200 during a seismic event.

$C_{200\ Seismic}$ = 470 lbs x 1.33 = 625 lbs
$C_{200\ Seismic} \geq F_{Rod\ Compression}$ (625 lbs > 153 lbs)

Since actual compression = allowed compression for l/r=200 ➔ 20" o.c.

9 From *Sheet C2*, verify brace adequacy:
The 6' long brace has a compression load capacity of 2230 lbs.,
The seismic brace force, $F_b$ = 458 lbs.
**Capacity is greater than seismic load. Therefore it is adequate.**

10 From *Sheets B3 & B4*, select brace fittings:
Select fittings with the required number of bolts as determined from *Sheet B2*.

Try PS633
½" ∅ bolt
slip resistance = 1500# (greater than seismic brace loads)
pull out resistance = 2000# (greater than seismic brace loads)

11 From “anchorage section”, *Sheet D2,* select anchorage:
**Use one bolt assembly for hanger anchorage.**
**Use one bolt assembly for brace anchorage.**

For Shallow Anchors:
$(R_p/R_{pSHALLOW})\mathbf{F_p} = (3.0/1.5)\mathbf{F_p} = 2\ \mathbf{F_p}$ (seismic load doubles):
$\mathbf{F_p}$ **(Shallow Anchor)** = $(2)\mathbf{F_p} = (2)0.71W_p = \mathbf{1.42W_p}$
For 4"$\varnothing_{PIPE}$: 1.42 x 16.31 lbs/ft = **23.16 lbs/ft**

$FH_T$ = 4"$\varnothing_{PIPE}$ x $S_2$
= 23.16 lbs/ft x 28'
= **648 lbs**

$FH_L$ = 4"$\varnothing_{PIPE}$ x $S_3$
= 23.16 lbs/ft x 14' (from Step #6)
= **325 lbs**

Maximum Tension and Shear forces
on brace anchor for Shallow Anchors:
$F_x = K_x(FH) = 1.0(648^{\#}) = 648^{\#}$
$F_y = K_y(FH) = 1.0(648^{\#}) = 648^{\#}$

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| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **Single Pipe Hanger Example** | |
| | | PAGE **A10** | DATE **04/21/2005** |

12 From *Sheet C9*, verify anchorage adequacy from the allowable loads. Assume normal weight concrete with $f'_c$= 3,000 psi and anchors are in Tension Zone. Since anchorage is non-shallow, either use 50% of the table value or double the forces (as done in Step 11 on previous page)

**Brace Loads, From Step 11:**

$V = F_x = 648$ lbs

$T = F_y = 648$ lbs

**Try ½" diameter expansion bolts, From Page C9**

$T_{allow} = 1{,}430$ lbs

$V_{allow} = 1{,}448$ lbs

NOTE: Do not decrease table values by 50% since brace loads were doubled in Step 11.

$$\left(\frac{F_y}{T_{allow}}\right)^{5/3} + \left(\frac{F_x}{V_{allow}}\right)^{5/3} \le 1.0$$

$$\left(\frac{648}{1430}\right)^{5/3} + \left(\frac{648}{1448}\right)^{5/3} = 0.53 < 1.0\text{, Therefore OK!!}$$

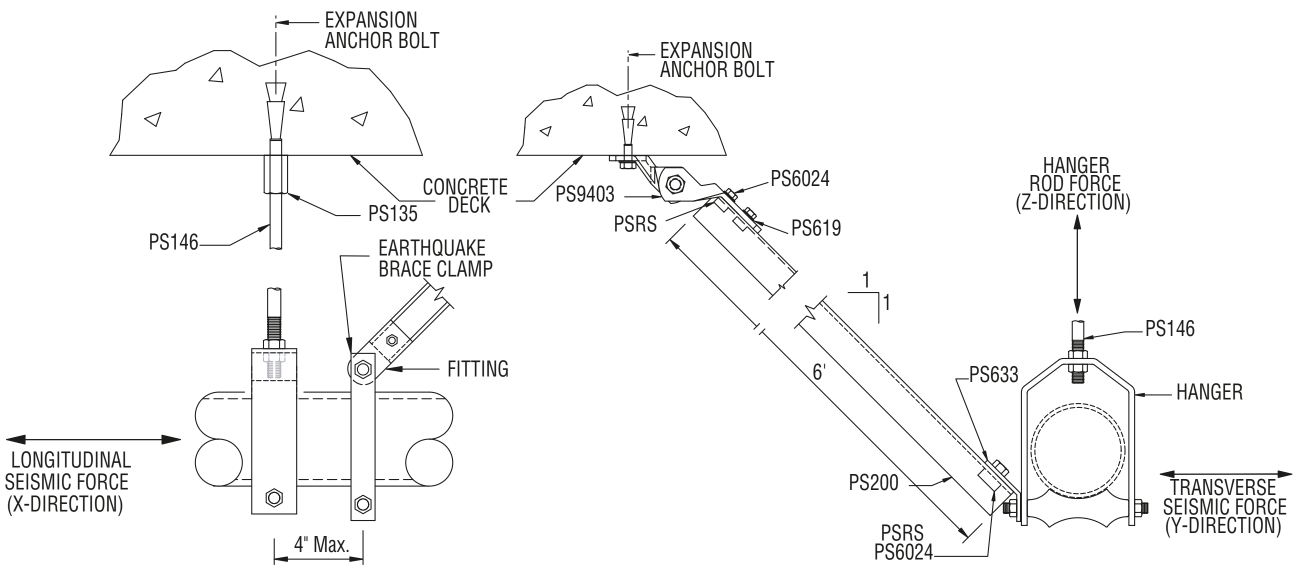
**Rod Anchor Tension, From Step 8:**

$F_{Anchor\ Tension} = 606$ lbs

Try ½" diameter expansion bolts, $T_{Allow} = 1{,}430$ lbs

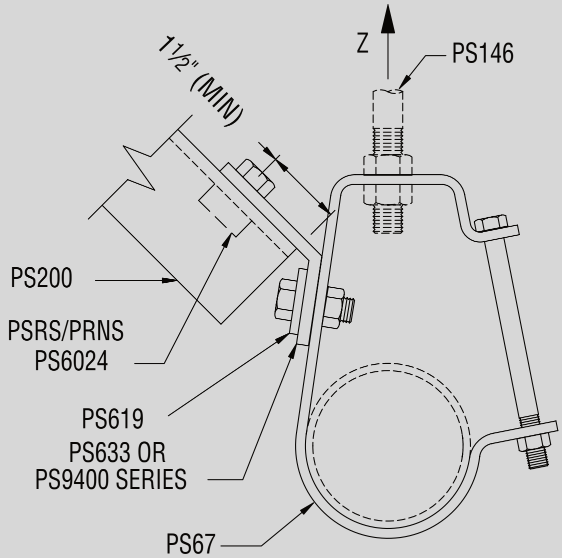
$$\left(\frac{F}{T_{allow}}\right)^{5/3} \le 1.0$$

$$\left(\frac{984}{1430}\right)^{5/3} = 0.43 < 1.0\text{, Therefore OK!!}$$

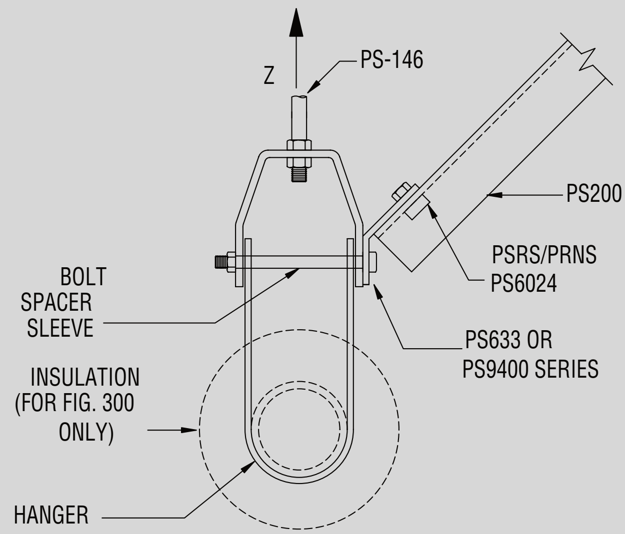



| SUBMITTED | | TITLE |
|---|---|---|
| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **Single Pipe Hanger Assembly** |
| | | PAGE: A11 / DATE: 04/21/2005 |

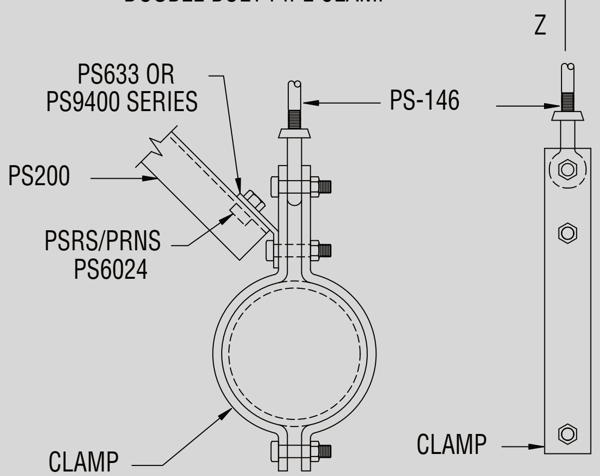
PIPE HANGER
PS67




MSS SP-58 Type 1
ADJUSTABLE CLEVIS PIPE HANGER

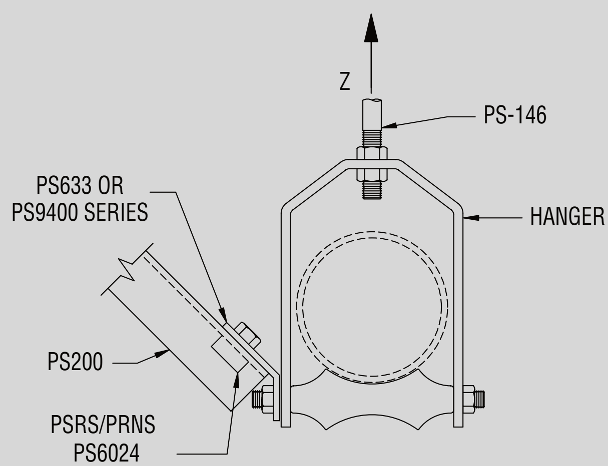



MSS SP-58 Type 3
DOUBLE BOLT PIPE CLAMP




NOTE:
For pipe sizes greater than 3 ½" use PS9402
or PS9403 fitting.

MSS SP-58 Type 43
ADJUSTABLE STEEL YOKE PIPE ROLL



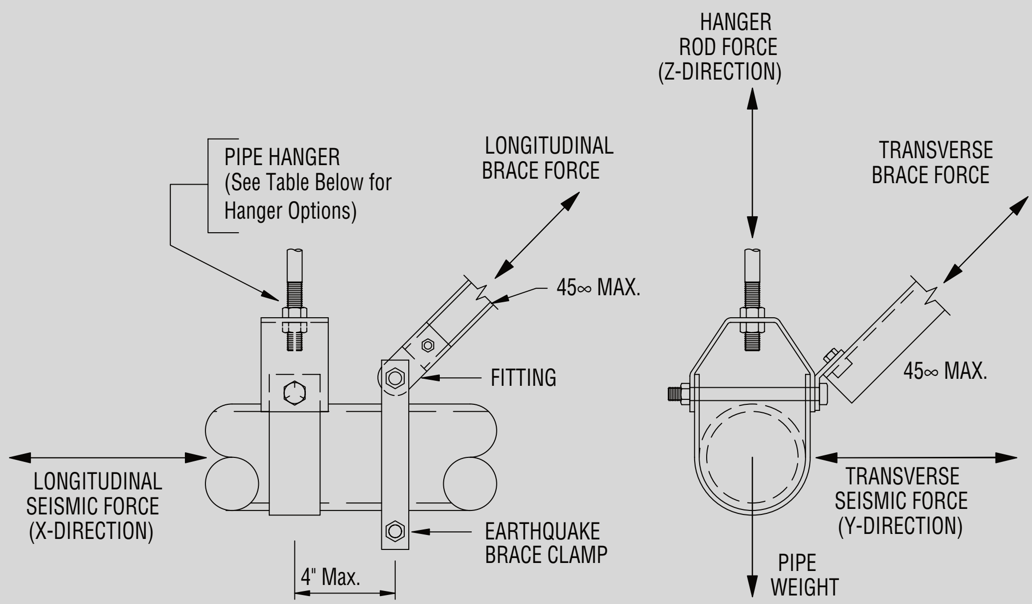

NOTE:
For 5 & 6"∅ pipe use PS9400 fitting.
Brace attachment for 8" pipe shall be selected
and verified by the project engineer.

TITLE

**Single Pipe Hanger Assembly**

PAGE
**A12**

DATE




PIPE SIDE VIEW

PIPE END VIEW

| NAME: | Pipe Hanger | Adj. Clevis Pipe Hanger | Double Bolt Pipe Clamp | Adj. St. Yoke Pipe Roll |
|---|---|---|---|---|
| MODEL: | PS 67 | Complies with MSS SP-58 Type 1 | Complies with MSS SP-58 Type 3 | Complies with MSS SP-58 Type 43 |
| PIPE SIZE *(in)* | MAX. ALLOW. HANGER ROD LOAD (Z DIRECTION) | | | |
| | *(lbs)** | *(lbs)** | *(lbs)** | *(lbs)** |
| ½ | 400 | - | - | - |
| ¾ | 400 | 610 | 950 | - |
| 1 | 400 | 610 | 950 | - |
| 1 ¼ | 400 | 610 | 950 | - |
| 1 ½ | 400 | 610 | 1545 | - |
| 2 | 400 | 610 | 1545 | - |
| 2 ½ | 500 | 1130 | 1545 | 225 |
| 3 | 500 | 1130 | 1545 | 310 |
| 3 ½ | 500 | 1130 | - | 390 |
| 4 | 550 | 1430 | 2500 | 475 |
| 5 | 550 | 1430 | 2500 | 685 |
| 6 | 600 | 1940 | 2865 | 780 |
| 8 | - | 2000 | 2865 | 780 |

*NOTE: Determined by the manufacturer's testing, analysis and technical specifications.

S U B M I T T E D

OPA-0242, Rev 1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TITLE

**Single Pipe Hanger Load Table**

PAGE A13

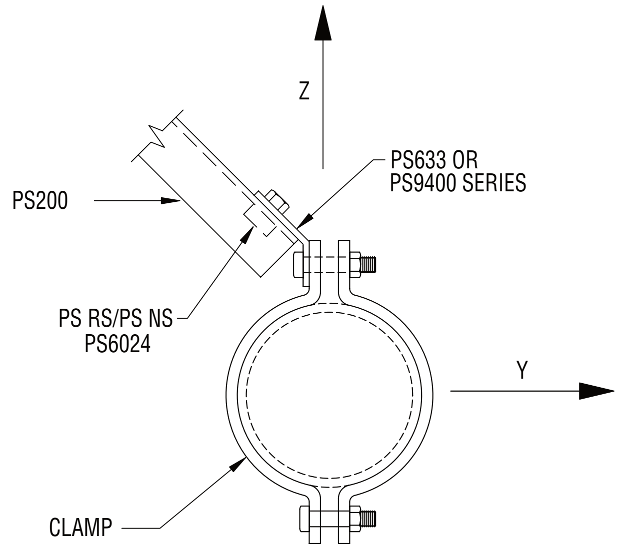
DATE **04/21/2005**

**EARTHQUAKE BRACE CLAMP**
(Complies with MSS SP-58 Type 4.)

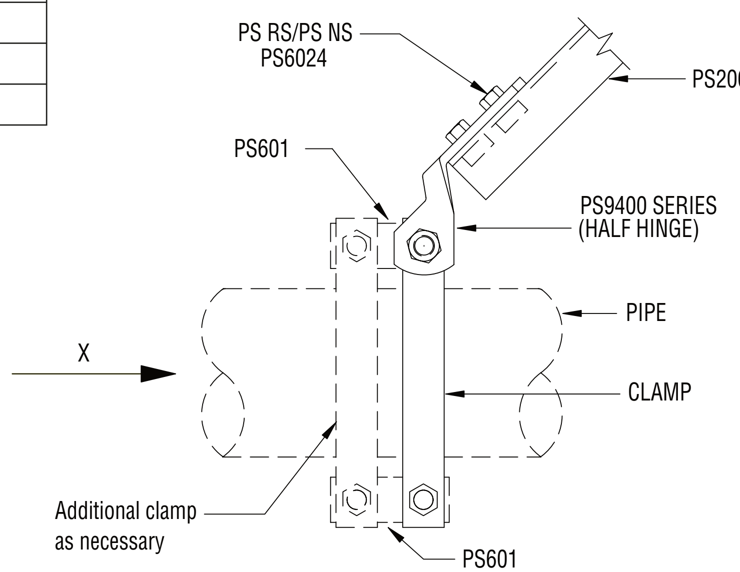
**LOAD SCHEDULE**

| Pipe Size *(in)* | Maximum Allowable Hanger Rod Load* *(lbs)* | |
|---|---|---|
| | (x-direction) | (y-direction) |
| ½ | 100 | 500 |
| ¾ | 100 | 500 |
| 1 | 100 | 500 |
| 1 ¼ | 100 | 500 |
| ½ | 100 | 800 |
| 2 | 200 | 1000 |
| 2 ½ | 200 | 1000 |
| 3 | 200 | 1000 |
| 3 ½ | 200 | 1000 |
| 4 | 200 | 1000 |
| 5 | 200 | 1000 |
| 6 | 375 | 1000 |
| 8 | 500 | 1000 |

*For fasterner tightening requirements see Page B2

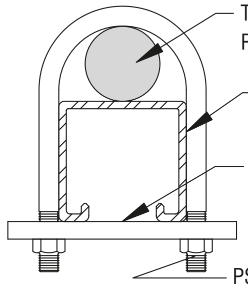



TRANSVERSE BRACE

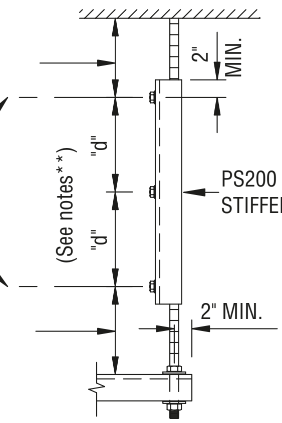



LONGITUDINAL BRACE

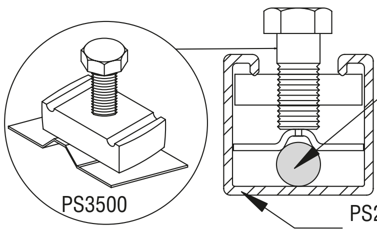
| | | |
|---|---|---|
| A P P R O V E D<br>**Fixed Equipment Anchorage**<br>Office of Statewide Health Planning and Development<br>**OPA-0242 Apr 25, 2003**<br>**** Valid for 3 Years Maximum ****<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Single Pipe Hanger Brace/Clamp**<br>PAGE **A14** DATE **04/25/2003** |




PS137 HANGER ROD STIFFENER ASSEMBLY
For ¾" & ⅞" Rods




THREADED ROD
WITH STIFFENER




PS3500 HANGER ROD STIFFENER ASSEMBLY
For ⅜" thru ⅝" Rods

**NOTES:
1. Refer to following table for hanger rod load capacities.
2. Rod stiffeners may be omitted where:
   a. Hanger rod is installed without brace.
   b. Hanger rod is installed with transverse brace on every trapeze.
3. Stiffener required where rod is in compression and the rod length exceeds "d".

**HANGER ROD ALLOWABLE LOADS AND MAXIMUM UNBRACED LENGTHS**

| Rod Size Diameter | Allowable Tension Of Compression | Max Clip Spacing @100% Comp. Stress (9,000psi) | Allowable Compression l/r<200 | Maximum Length W/O Stiffener l/r<200 | Maximum Seismic Load (Tension or Compression) |
|---|---|---|---|---|---|
| *(inches)* | *(lbs)* | *(inches)* | *(lbs)* | *(inches)* | *(lbs)* |
| ⅜ | 610 | 10 | 260 | 14 | 810 |
| ½ | 1,130 | 14 | 470 | 20 | 1,500 |
| ⅝ | 1,810 | 16 | 750 | 25 | 2,410 |
| ¾ | 2,710 | 20 | 1,130 | 30 | 3,610 |
| ⅞ | 3,770 | 25 | 1,560 | 35 | 5,030 |
| 1 | 4,960 | 28 | 2,060 | 40 | 6,610 |

* Maximum seismic loads are determined by increasing allowable loads by 33%..

**S U B M I T T E D**

**OPA-0242, Rev 1**

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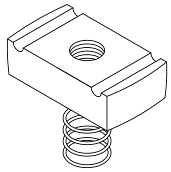
TITLE

**Hanger Rod with Stiffener**

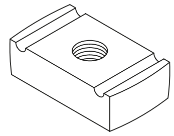
PAGE **B1**

DATE **04/21/2005**



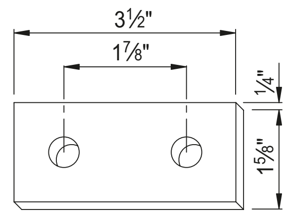
## PS RS

*Clamping Nut with Regular Spring
Available for bolt or rod
sizes of ¼"∅ to ⅞"∅



## PS NS

*Clamping Nut without Spring
Available for bolt or rod
sizes of ¼"∅ to ⅞"∅



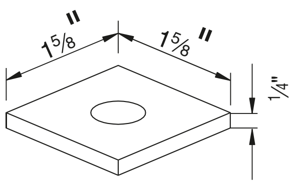

## PS 601

Two Hole Plate
Available for ½"∅ bolts

*THE MAXIMUM ALLOWABLE LOAD OF BOLT CLAMPING NUTS IN CHANNEL

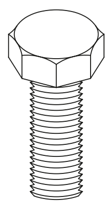
| | 1/4" BOLT | 3/8" BOLT | 1/2" BOLT |
|---|---|---|---|
| MAXIMUM SLIP LOAD RESISTANCE (LBS) | 300 | 800 | 1500 |
| MAXIMUM PULLOUT LOAD RESISTANCE (LBS) | 600 | 1100 | 2000 |

SAFETY FACTOR = 3.0



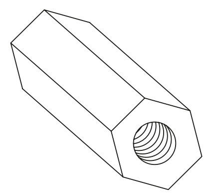

## PS 619

Square Washer
Available for bolt or rod
sizes of ¼"∅ to ¾"∅



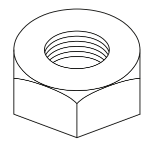
## PS 6024

Hex Head Cap Screw
Available sizes
from ¼"∅ to ½"∅



## PS-135

Rod Coupling
Available for bolt or rod
sizes of ¼"∅ to ¾"∅



## PS-83

Hexagon Nut
Available for bolt or rod
sizes of ¼"∅ to ¾"∅

**FASTENER TIGHTENING REQUIREMENTS**

Power-Strut nuts and bolts mounted to the Power-Strut channels must be tightened to the following torques.

| **Fastener Size** *(inches)* | **Channel Gauge** | **Tightening Torque** *(ft-lbs)* |
|---|---|---|
| ¼ | 12 | 6 |
| 5⁄16 | 12 | 11 |
| ⅜ | 12 | 19 |
| ½ | 12 | 50 |
| ⅝ | 12 | 100 |
| ¾ | 12 | 125 |

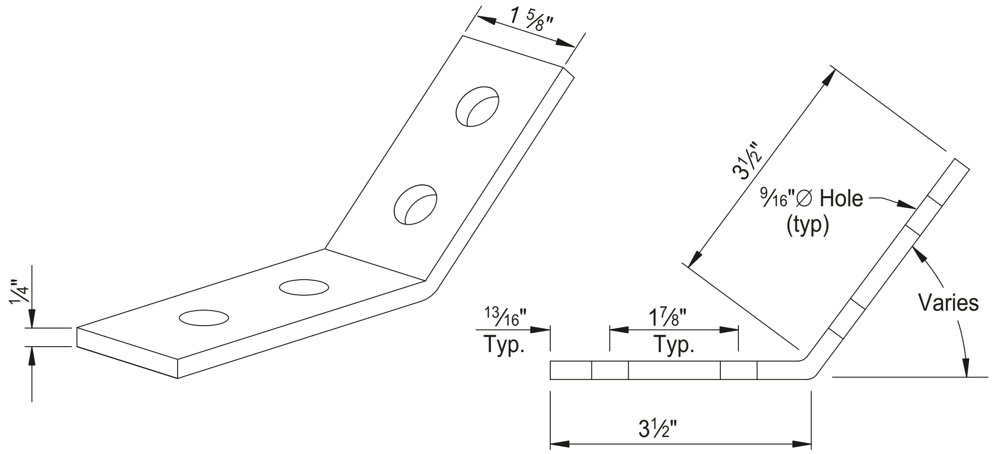
**A P P R O V E D**
**Fixed Equipment Anchorage**
**Office of Statewide Health Planning and Development**
**OPA-0242 Apr 25, 2003**
****** Valid for 3 Years Maximum ******
Bill Staehlin (916) 324-9106

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

TITLE
**Fasteners**

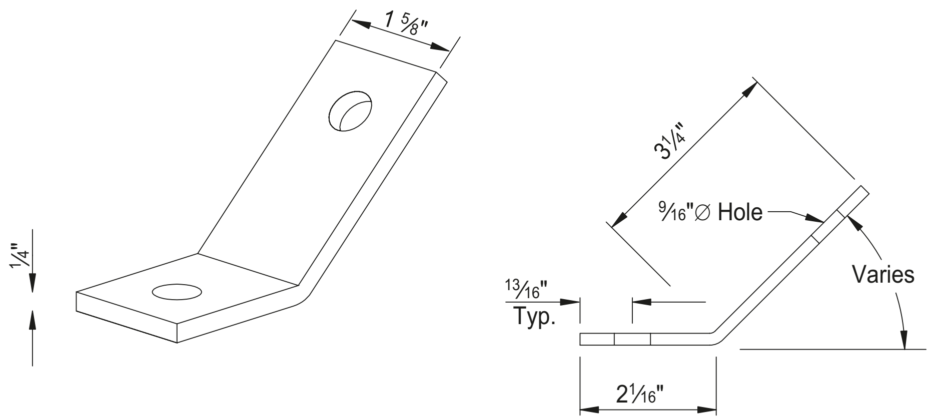
PAGE **B2**

DATE **04/25/2003**




PS 781

Four Hole Open Angle Connector
Available for ½"∅ bolts or rods




# PS 633

Two Hole Open Angle Connector
Available for ½"∅ bolts or rods

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 specification

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**Fixed Equipment Anchorage**
**Office of Statewide Health Planning and Development**
**OPA-0242 Apr 25, 2003**
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Bill Staehlin (916) 324-9106

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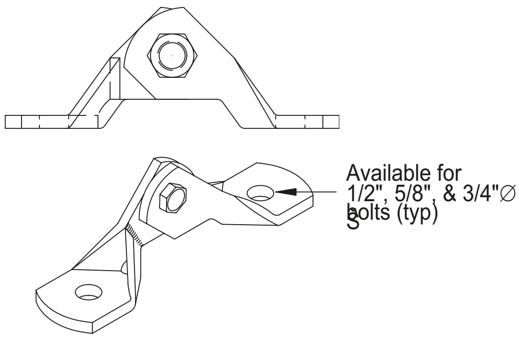
TITLE
**Angle Connectors**

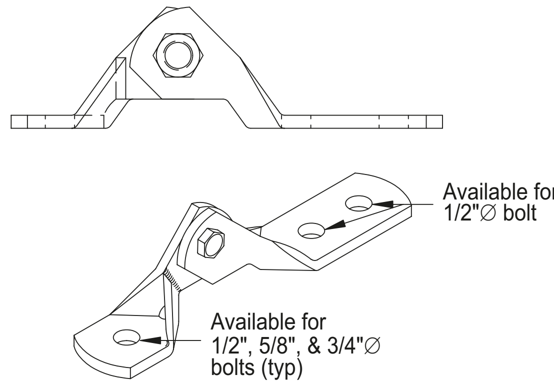
PAGE **B3**

DATE **04/25/2003**



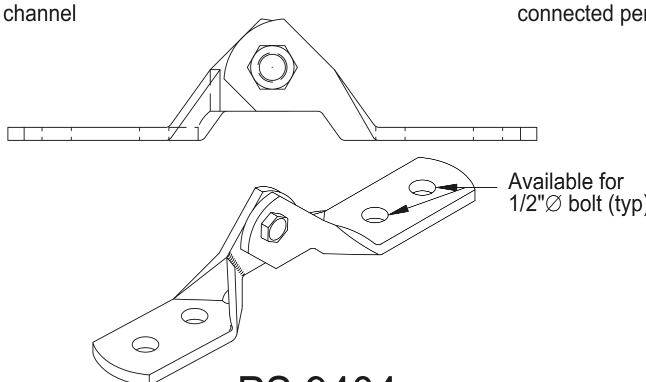

## PS 9402*

Two Hole Hinge
*Max. pullout limited to 1500 lbs when connected perpendicular to channel




## PS 9403*

Three Hole Hinge
*Max. pullout limited to 1500 lbs when connected perpendicular to channel




## PS 9404

Four Hole Hinge

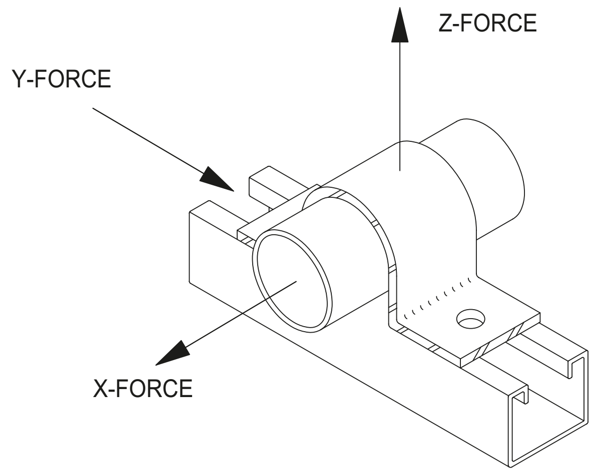
Note:
1. The load capacity of the fitting exceeds the slip and pull-out capacity of the bolt in the channel. (*Unless Noted)
2. Allowable loads have been determined by the manufacturers testing, analysis and technical specification
3. Patent Pending.

| | | | |
|---|---|---|---|
| **A P P R O V E D**<br>**Fixed Equipment Anchorage**<br>**Office of Statewide Health Planning and Development**<br>**OPA-0242 Apr 25, 2003**<br>****** Valid for 3 Years Maximum ******<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Hinge Connectors** | |
| | | PAGE<br>**B4** | DATE<br>**04/25/2003** |

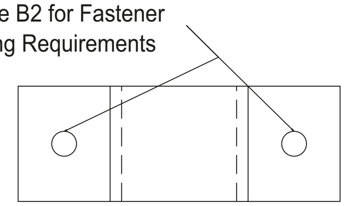
**Load Schedule**

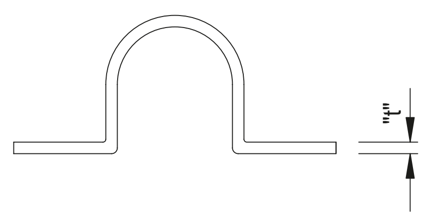
| PIPE SIZE | Maximum Allowable Load* (lbs) | | | t |
|---|---|---|---|---|
| *(in)* | X | Y | Z | *(in)* |
| ½ | 100 | 250 | 500 | 0.125 |
| ¾ | 100 | 250 | 500 | 0.125 |
| 1 | 100 | 250 | 500 | 0.125 |
| 1 ¼ | 100 | 250 | 500 | 0.125 |
| 1 ½ | 100 | 250 | 500 | 0.125 |
| 2 | 200 | 500 | 1000 | 0.25 |
| 2 ½ | 200 | 500 | 1000 | 0.25 |
| 3 | 200 | 500 | 1000 | 0.25 |
| 3 ½ | 200 | 500 | 1000 | 0.25 |
| 4 | 200 | 500 | 1000 | 0.25 |
| 5 | 200 | 500 | 1000 | 0.25 |
| 6 | 375 | 500 | 1000 | 0.25 |

*Determined by the manufacturers testing, analysis and technical specifications




3/8"Ø Bolt in 7/16"Ø hole (Typ.)
1/4"Ø Bolt in 5/16"Ø hole
(for pipe dia. less than 2")
See Page B2 for Fastener Tightening Requirements






## PS 3126

Hold Down Clamp

| | | | |
|---|---|---|---|
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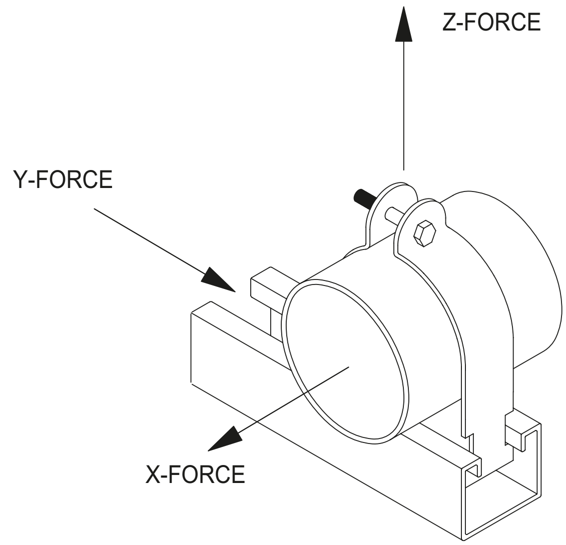
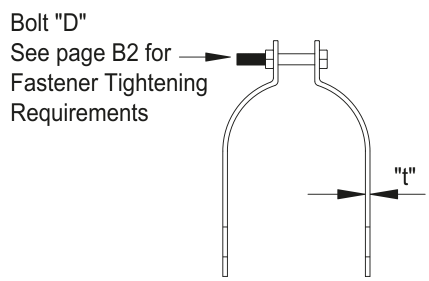
| | | PAGE **B5** | DATE **04/25/2003** |

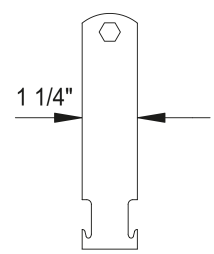
**Load Schedule**

| PIPE SIZE | Maximum Allowable Load* (lbs) | | | t | BOLT DIA.“D” |
|---|---|---|---|---|---|
| *(in)* | X | Y | Z | *(in)* | *(in)* |
| 3/8 | 30 | 60 | 400 | 0.060 | 1/4 |
| 1/2 | 50 | 70 | 400 | 0.060 | 1/4 |
| 3/4 | 70 | 100 | 600 | 0.075 | 1/4 |
| 1 | 80 | 150 | 600 | 0.075 | 1/4 |
| 1 1/4 | 150 | 150 | 600 | 0.075 | 1/4 |
| 1 1/2 | 150 | 240 | 800 | 0.105 | 5/16 |
| 2 | 200 | 240 | 800 | 0.105 | 5/16 |
| 2 1/2 | 200 | 240 | 800 | 0.105 | 5/16 |
| 3 | 200 | 240 | 800 | 0.105 | 5/16 |
| 3 1/2 | 200 | 320 | 1000 | 0.125 | 3/8 |
| 4 | 200 | 320 | 1000 | 0.125 | 3/8 |
| 5 | 200 | 320 | 1000 | 0.125 | 3/8 |
| 6 | 375 | 450 | 1000 | 0.135 | 3/8 |
| 8 | 500 | 450 | 1000 | 0.135 | 3/8 |

*Determined by the manufacturers testing, analysis and technical specifications




PS 1100
Pipe Clamp

A P P R O V E D
**Fixed Equipment Anchorage**
**Office of Statewide Health Planning and Development**
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Bill Staehlin (916) 324-9106

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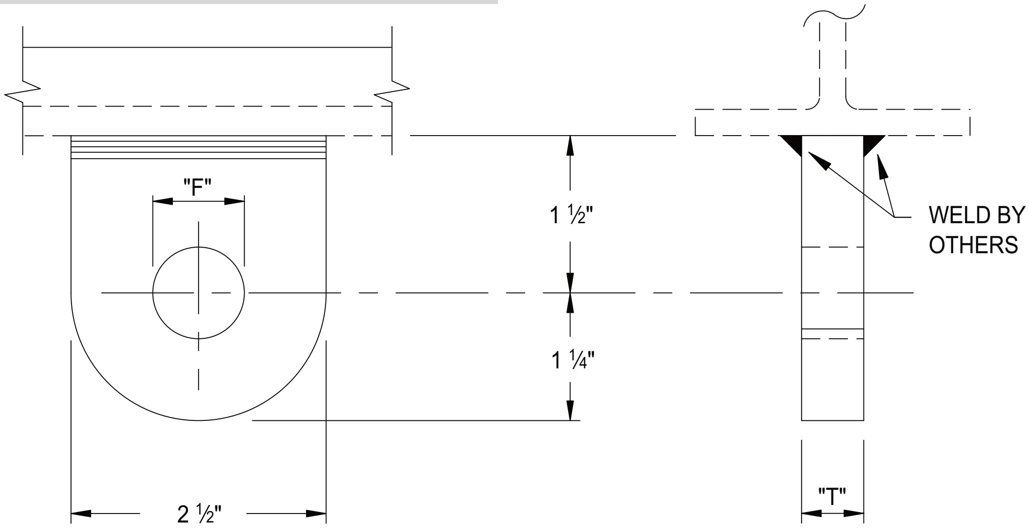
Arcadia, CA 91006

TITLE
**Two Piece Pipe Clamp**

PAGE **B6**
DATE **04/25/2003**

POWER-STRUT®

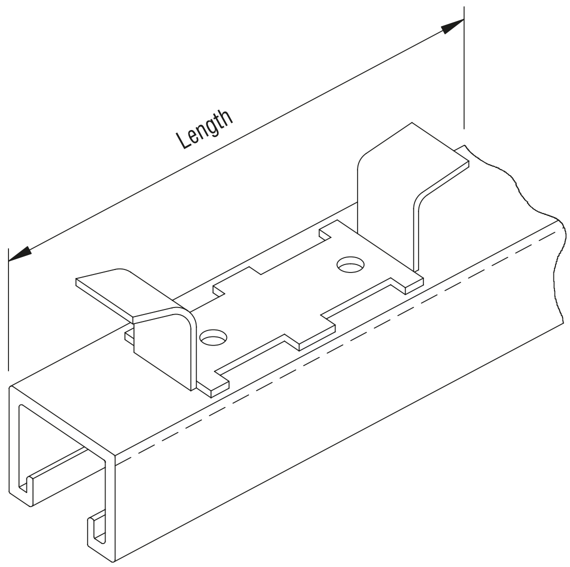
MSS SP-69 Type 57
Plate Lug

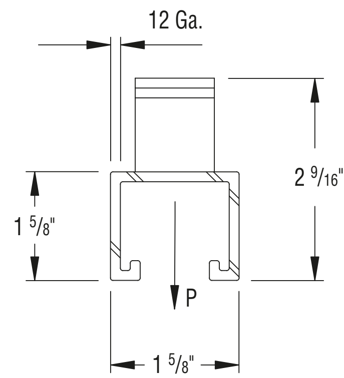


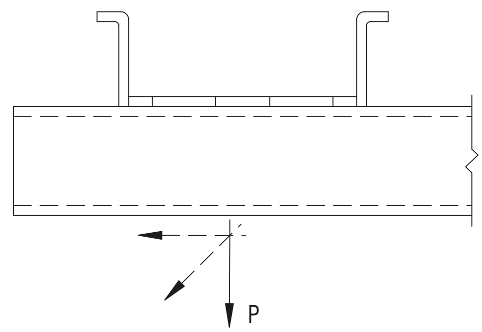

| ROD SIZE | MAXIMUM RECOMMENDED LOAD* | BOLT SIZE | "F" | "T" |
|---|---|---|---|---|
| *(in)* | *(lbs)* | *(in)* | *(in)* | *(in)* |
| ½ | 1130 | ⅝ | 1¹⁄₁₆ | ¼ |
| ⅝ | 1810 | ¾ | 1³⁄₁₆ | ¼ |

*Determined by the manufacturer's testing analysis and technical specification

| SUBMITTED | Engineer | TITLE |
|---|---|---|
| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **One Bolt Steel Lug**<br>PAGE B7<br>DATE **04/21/2005** |




| **Length** *(in)* | **Load Data*** *(lbs)* |
|---|---|
| 3 | 500 |
| 4 | 800 |
| 6 | 1000 |
| 8 | 1200 |
| 12 | 2000 |

*NOTE:
1. Allowable loads have been determined by the manufacturers testing, analysis, and technical specification
2. Minimum concrete $f'_c$ = 3000 psi, 6" minimum thickness.
3. 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 3".
4. Values are based on a safety factor of 3.
5. Use 50% of tabulated values when installed in tension zone of concrete. Project engineer to verify.
6. Use 65% of tabulated values when installed in hospitals.

## PS 349
CONRETE INSERT

A P P R O V E D
**Fixed Equipment Anchorage**
**Office of Statewide Health Planning and Development**
**OPA-0242 Apr 25, 2003**
**** Valid for 3 Years Maximum ****
Bill Staehlin (916) 324-9106

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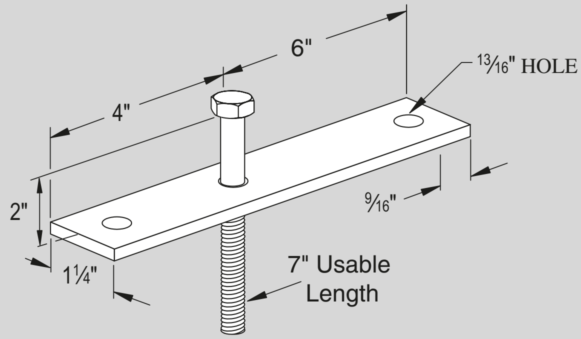
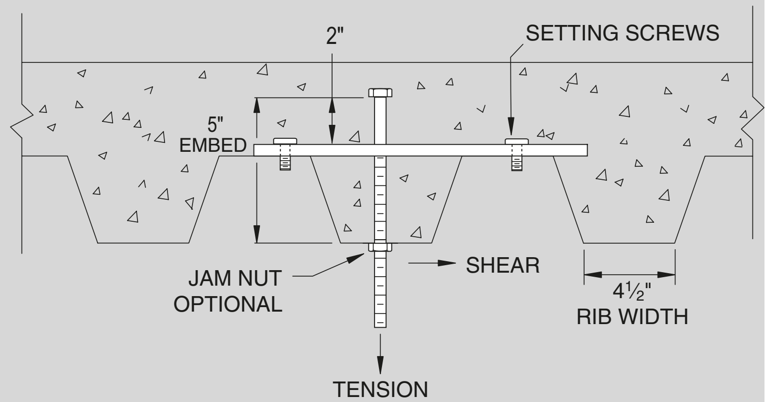
Arcadia, CA 91006

TITLE
**Concrete Insert**

PAGE **B8**

DATE **04/25/2003**



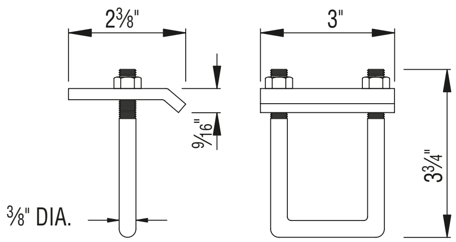




| *Part Number* | Rod Diameter *(in)* | Design Load *(lbs)* | |
|---|---|---|---|
| | | *Tension* | *Shear* |
| PS 681-3⁄8 | 3⁄8 | 850 | 610 |
| PS 681-1⁄2 | 1⁄2 | 1,380 | 1,000 |
| PS 681-5⁄8 | 5⁄8 | 1,920 | 1,760 |

## PS681

CONCRETE INSERT

| S U B M I T T E D | | TITLE |
|---|---|---|
| OPA-0242, Rev 1 |  JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **Concrete Insert** |
| | | PAGE B9 / DATE **04/21/2005** |

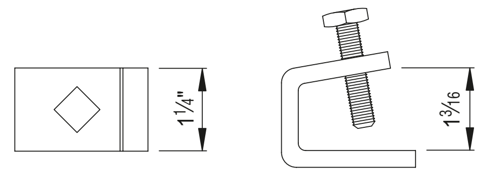



NOTE:

MAXIMUM ALLOWABLE LOAD IS 1000 LBS AS DETERMINED BY THE MANUFACTURERS TESTING, ANALYSIS AND TECHNICAL SPECIFICATION.

## PS 2651

Beam Clamp



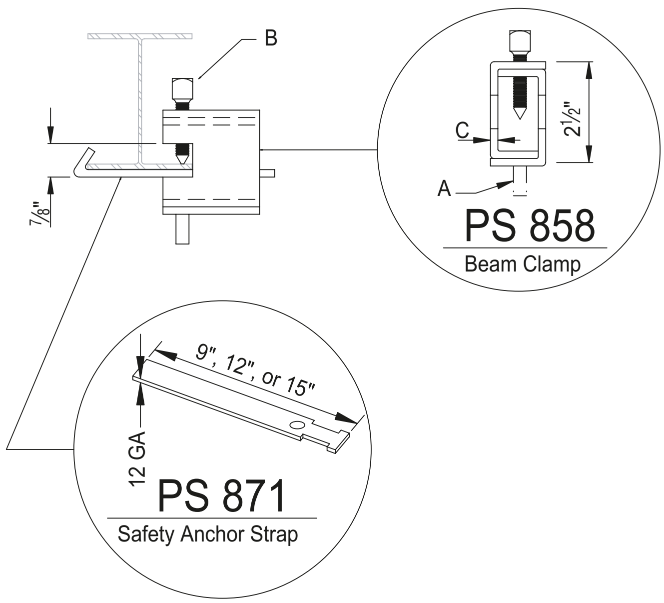

**LOAD SCHEDULE**

| Thickness | Set Screw | Design Load* | Set Screw Torque |
|---|---|---|---|
| 3/8” | 1/2 | 900 | 125 |

*Notes:
1. Allowable load has been determined by the manufacturers testing, analysis and technical specification.
2. 1" Maximum beam flange thickness.

## PS 998

Beam Clamp




**PS858 LOAD SCHEDULE**

| Rod Size A | B | C | Design Load** (lbs) | Set Screw Torque (in-lbs) |
|---|---|---|---|---|
| 3/8" | 1/2" | 3/16" | 1100 | 125 |
| 1/2" | 1/2" | 1/4" | 1600 | 125 |
| 5/8" | 5/8" | 5/16" | 2400 | 250 |

**NOTE:
Allowable loads have been determined by the manufacturers testing, analysis and technical specification

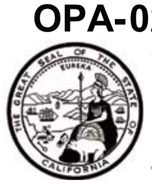
A P P R O V E D

**Fixed Equipment Anchorage**

**Office of Statewide Health Planning and Development**

**OPA-0242 Apr 25, 2003**

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



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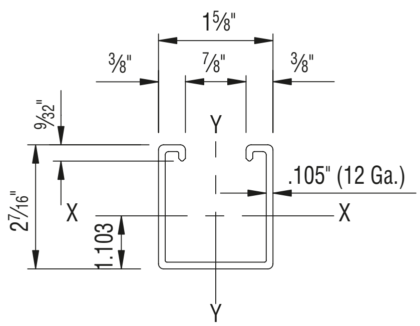
TITLE

**Beam Clamp**

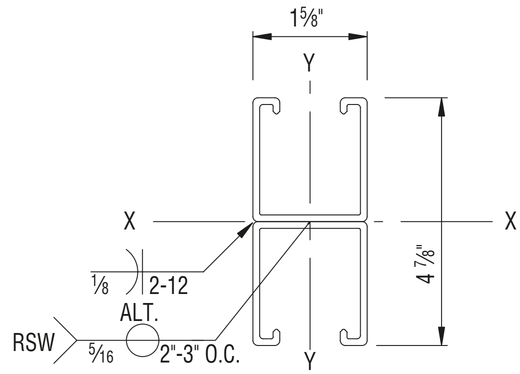
PAGE **B10**

DATE **04/25/2003**



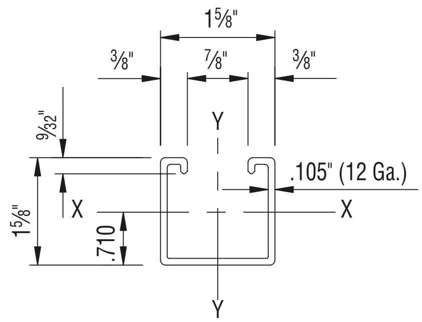

PS 150

STEEL CHANNEL



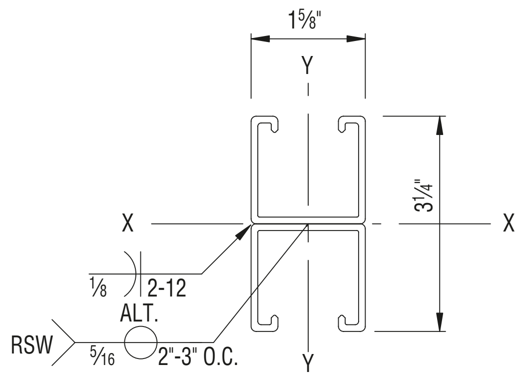

PS 150 2T3

WELDED STEEL CHANNEL




PS 200

STEEL CHANNEL




PS 200 2T3

WELDED STEEL CHANNEL

**PROPERTIES**

| CHANNEL | AREA | X-X AXIS | | | Y-Y AXIS | | |
|---|---|---|---|---|---|---|---|
| | | MOMENT OF INERTIA | SECTION MODULUS | RADIUS OF GYRATION | MOMENT OF INERTIA | SECTION MODULUS | RADIUS OF GYRATION |
| | ($in^2$) | ($in^4$) | ($in^3$) | (in) | ($in^4$) | ($in^3$) | (in) |
| PS200 | 0.556 | 0.185 | 0.202 | 0.577 | 0.236 | 0.290 | 0.651 |
| PS200 2T3 | 1.112 | 0.930 | 0.572 | 0.915 | 0.472 | 0.580 | 0.651 |
| PS150 | 0.726 | 0.523 | 0.391 | 0.848 | 0.335 | 0.412 | 0.679 |
| PS150 2T3 | 1.453 | 2.811 | 1.153 | 1.391 | 0.669 | 0.824 | 0.679 |

**S U B M I T T E D**

**OPA-0242, Rev 1**

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TITLE

**Channel Properties**

PAGE **B11**

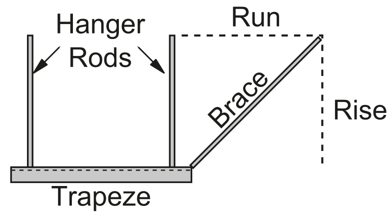
DATE **04/21/2005**

**BRACE DESIGN LOAD TABLE**
**PS200**

| Unsupported Length | Compression Load* |
|---|---|
| *(in)* | *(lbs)* |
| 24 | 4,200 |
| 36 | 3,650 |
| 48 | 3,130 |
| 60 | 2,650 |
| 72 | 2,230 |
| 84 | 1,850 |
| 96 | 1,570 |
| 108 | 1,360 |
| 120 | 1,200 |

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

## Brace Slope Factors




**Single Rigid Brace or Two Opposing Cable Braces**

| Base Slope | | | *Slope Factors* | | |
|---|---|---|---|---|---|
| Rise | | Run | $K_b$ | $K_h = K_x$ | $K_y$ |
| 1 | : | 1.0 | 1.414 | 1.000 | ±1.000 |
| 1 | : | 2.0 | 1.118 | 1.000 | ±0.500 |
| 1 | : | 3.0 | 1.054 | 1.000 | ±0.333 |
| 1 | : | 4.0 | 1.031 | 1.000 | ±0.250 |

Note: $K_y$ compression only when using cable.
Check for rod compression - C7

**Two Opposing Rigid Braces**

| Base Slope | | | *Slope Factors* | | |
|---|---|---|---|---|---|
| Rise | | Run | $K_b$ | $K_h = K_x$ | $K_y$ |
| 1 | : | 1.0 | 0.707 | 1.000 | ±0.500 |
| 1 | : | 2.0 | 0.559 | 1.000 | ±0.250 |
| 1 | : | 3.0 | 0.527 | 1.000 | ±0.167 |
| 1 | : | 4.0 | 0.516 | 1.000 | ±0.125 |

**Alternate Method A**

Brace Vertical Force Component $F_y = P \times (\sin a) = F_h / (\tan a)$
Brace Axial Force $F_b = F_h / (\cos a)$

**Alternate Method B - Measurement**

Brace Vertical Force Component $K_y$ = Rise Length / Run Length
Brace Axial Force $K_y$ = Brace Length / Run Length

**4 Way Splayed**

| Base Slope | | | *Slope Factors* | | | | |
|---|---|---|---|---|---|---|---|
| Rise | | Run | $K_b$ | | $K_h = K_x$ | $K_y$ | |
| | | | Rigid | Cable | | Rigid | Cable |
| 1 | : | 1.0 | 0.500 | 1.000 | 1.000 | ±1.000 | -1.000 |

Brace Horizontal Force Component: $F_x = K_x \times F_h$
Brace Vertical Force Component: $F_y = K_y \times F_h$
Brace Axial Force: $F_b = K_b \times F_h$

| TITLE | |
|---|---|
| **Pipe Data** **Brace Design** | |
| PAGE **C1** | DATE |

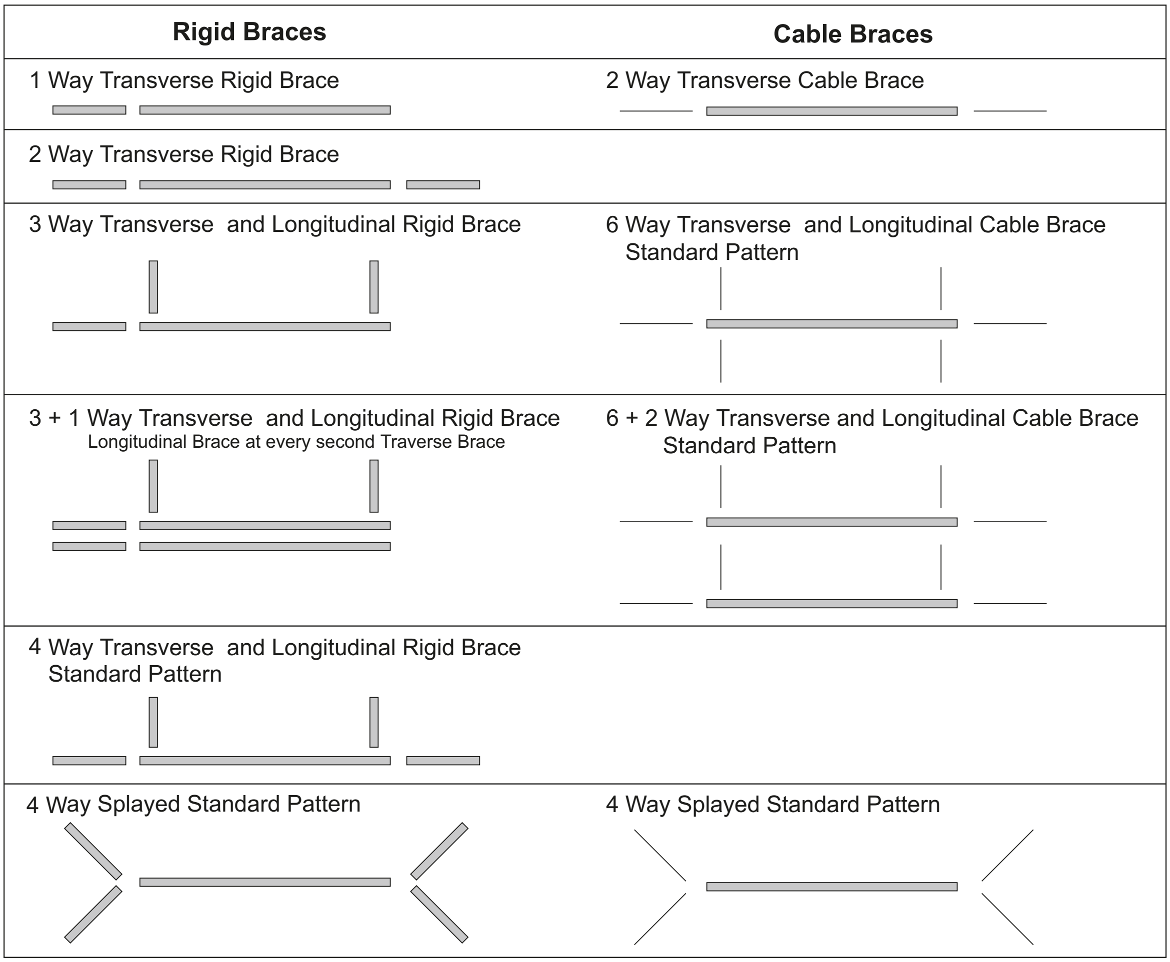
## Selecting a Brace Pattern

**Single Rigid Brace or Two Opposing Cable Braces**

| Brace Pattern | | | Transverse | Longitudinal |
|---|---|---|---|---|
| Rigid | Transverse and Longitudinal | 3 + 1 Way | 0.707 | 0.707 |
| Rigid | Transverse and Longitudinal | 4 Way | 0.707 | 0.707 |
| Rigid | Transverse and Longitudinal | 3 Way | 1.414 | 0.707 |
| Cable | Transverse and Longitudinal | 6 Way | 1.414 | 0.707 |
| Cable | Transverse and Longitudinal | 6 + 2 Way | 0.707 | 0.707 |
| Rigid | Splayed | 4 Way | 0.500 | |
| Cable | Splayed | 4 Way | 1.000 | |

Brace Axial Force: $F_b = K_b(F_h)$

Note: This Table assumes a Brace Slope of 1:1 or less - not to exceed 45-degrees above the horizontal




| TITLE | |
|---|---|
| **Brace Pattern Selection** | |
| PAGE **C2** | DATE |

NOTE:

1. THIS BRACING DETAIL APPLIES ONLY FOR COLD WATER PIPE AND GAS PIPE WHERE MOVEMENT OF THE PIPE DUE TO TEMPERATURE DIFFERENTIAL IS NEGLIBLE.

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 DIFERENTIAL AND SEISMIC JOINT OF BUILDING EXISTS.

3. TRANSVERSE BRACES FOR ONE RUN CAN BE USED AS LONGITUDINAL BRACES FOR AN ADJACENT RUN WHERE THE RUN OFFSET IS LESS THAN OR EQUAL TO 24"

4. TRANSVERSE BRACES FOR ONE RUN CAN BE USED AS TRANSVERSE BRACES FOR AN ADJACENT RUN WHERE THE RUN OFFSET IS LESS THAN OR EQUAL TO 24"

5. VERTICAL RUNS MUST HAVE TRANSVERSE BRACING IN EACH DIRECTION AT BOTH ENDS.

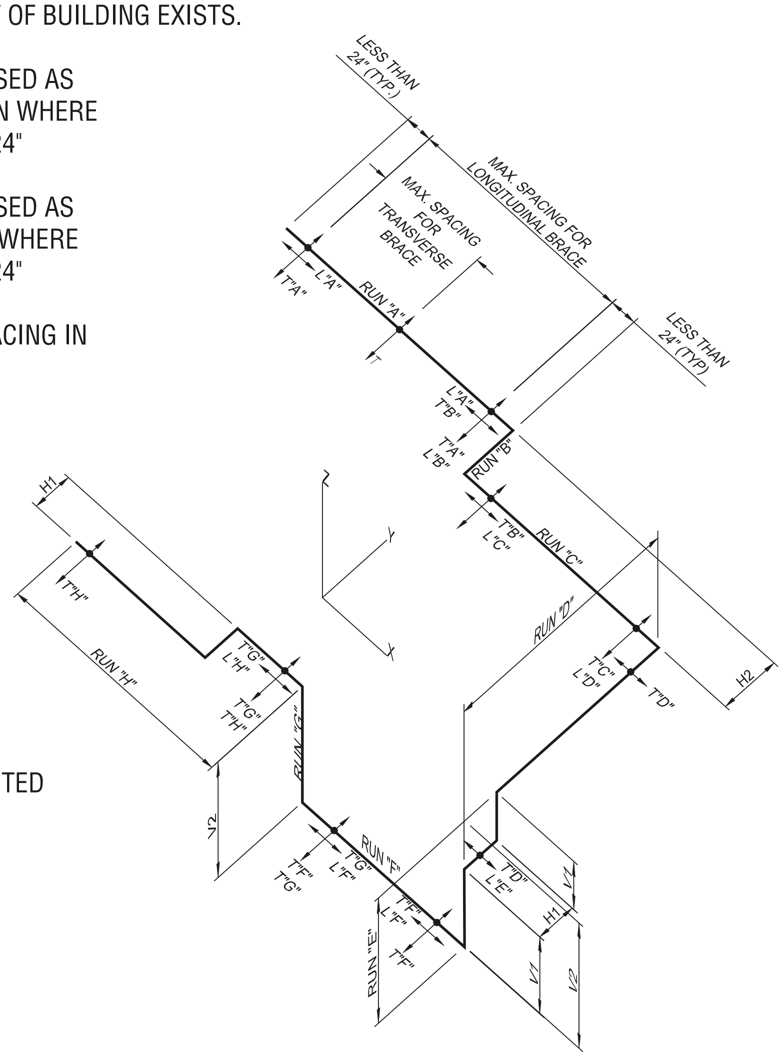
6. TRANSVERSE BRACE SPACING SHALL IN NO CASE EXCEED THE MAXIMUM CALCULATED DISTANCE OF 40ft. (QUALIFIED CALCULATIONS REQUIRED)

   LONGITUDINAL BRACE SPACING IS TWICE THE TRANSVERSE SPACING BUT IN NO CASE SHALL THE MAXIMUM CALCULATED DISTANCE EXCEED 80ft. (QUALIFIED CALCULATIONS REQUIRED)

7. REFERENCE PG C11 TO ADDRESS FLOOR MOUNTED EQUIPMENT WITH HUNG PIPE/CONDUIT.

**LEGEND**

T = TRANSVERSE BRACE
L = LONGITUDINAL BRACE
V1 = LESS THAN 24" OFFSET VERTICALLY
V2 = MORE THAN 24" OFFSET VERTICALLY
H1 = LESS THAN 24" OFFSET HORIZONTALLY
H2 = MORE THAN 24" OFFSET HORIZONTALLY




ISOMETRIC DIAGRAM OF TRANSVERESE AND LONGITUDINAL BRACE LOCATION REQUIREMENT

| | | | |
|---|---|---|---|
| **A P P R O V E D**<br>**Fixed Equipment Anchorage**<br>**Office of Statewide Health Planning and Development**<br>**OPA-0242 Apr 25, 2003**<br>****** Valid for 3 Years Maximum ******<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Brace Location Requirements** | |
| | | PAGE<br>**C3** | DATE<br>**04/25/2003** |

**HANGER LOAD***
**(LBS)**

| Pipe/Conduit Diameter (inches) | | 0.50 | 0.75 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 4.00 | 6.00 | 8.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit Weight (lbs/ft) | | 0.98 | 1.36 | 2.05 | 3.60 | 5.11 | 7.87 | 10.78 | 16.31 | 31.51 | 50.29 |
| HANGER SPACING | 5 | 5 | 7 | 10 | 18 | 26 | 39 | 54 | 82 | 158 | 251 |
| | 6 | 6 | 8 | 12 | 22 | 31 | 47 | 65 | 98 | 189 | 302 |
| | 7 | 7 | 10 | 14 | 25 | 36 | 55 | 75 | 114 | 221 | 352 |
| | 8 | 8 | 11 | 16 | 29 | 41 | 63 | 86 | 130 | 252 | 402 |
| | 9 | 9 | 12 | 18 | 32 | 46 | 71 | 97 | 147 | 284 | 453 |
| | 10 | 10 | 14 | 21 | 36 | 51 | 79 | 108 | 163 | 315 | 503 |
| | 11 | 11 | 15 | 23 | 40 | 56 | 87 | 119 | 179 | 347 | 553 |
| | 12 | 12 | 16 | 25 | 43 | 61 | 94 | 129 | 196 | 378 | 603 |
| | 13 | 13 | 18 | 27 | 47 | 66 | 102 | 140 | 212 | 410 | 654 |
| | 14 | 14 | 19 | 29 | 50 | 72 | 110 | 151 | 228 | 441 | 704 |
| | 15 | 15 | 20 | 31 | 54 | 77 | 118 | 162 | 245 | 473 | 754 |
| | 16 | 16 | 22 | 33 | 58 | 82 | 126 | 172 | 261 | 504 | 805 |
| | 17 | 17 | 23 | 35 | 61 | 87 | 134 | 183 | 277 | 536 | 855 |
| | 18 | 18 | 24 | 37 | 65 | 92 | 142 | 194 | 294 | 567 | 905 |
| | 19 | 19 | 26 | 39 | 68 | 97 | 150 | 205 | 310 | 599 | 956 |
| | 20 | 20 | 27 | 41 | 72 | 102 | 157 | 216 | 326 | 630 | 1006 |

*Note: Hanger Load (lbs) = Pipe Unit Wt (lbs/ft) x Hanger Space (ft)

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**Office of Statewide Health Planning and Development**
**OPA-0242 Apr 25, 2003**
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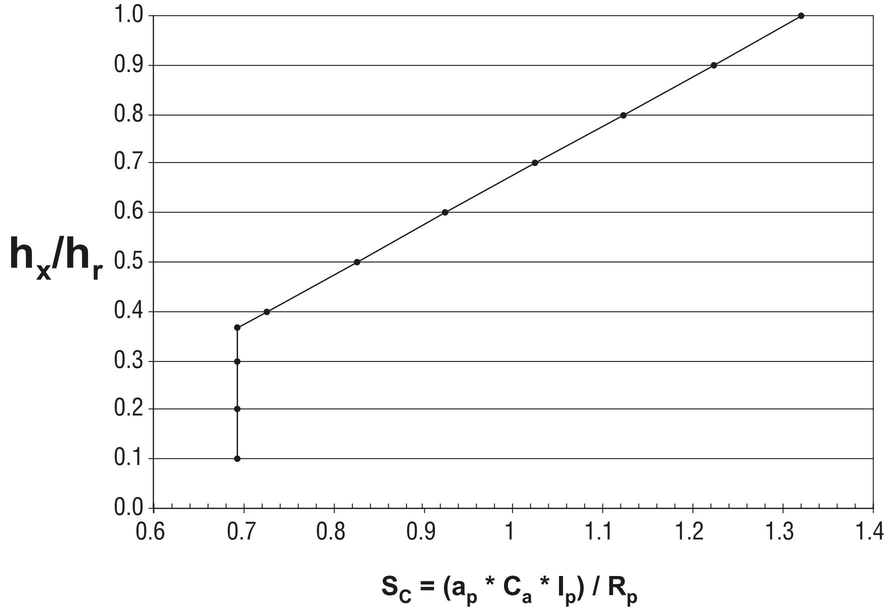
TITLE
**Hanger Load Table**

PAGE **C4**

DATE **04/25/2003**

## SEISMIC DESIGN




NOTE: THE FOLLOWING ASSIGNED VALUES ARE USED BY THE SEISMIC DESIGN TABLE.

| | |
|---|---|
| $a_p = 1.0$ | $h_r$ = varies: Roof Elevation of Building |
| $C_a = 0.66$ | $h_x$ = varies: Element Attachment Elevation with respect to grade |
| $I_p = 1.5$ | $R_p = 3.0$ |

Where : $$F_p = \frac{a_p C_a I_p}{R_p}\left[1+3\frac{h_x}{h_r}\right]W_p = \left(0.33\left[1+3\frac{h_x}{h_r}\right]\right)W_p = (s_c)(W_p)$$

For Shallow Anchors (Rp = 1.5) :

$$F_p\,(\text{shallow anchors}) = \frac{R_{p(3.0)}}{R_{p(1.5)}}(s_c)(W_p) = 2(s_c)(W_p)$$

| SUBMITTED | | TITLE |
|---|---|---|
| **OPA-0242, Rev 1** | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **Seismic Force Graph** |
| | | PAGE **C5** — DATE **04/21/2005** |

### Single Channel Design Table

| SPAN LT OR LB (in) | ALLOWABLE GRAVITY LOADS | | | |
|---|---|---|---|---|
| | CONCENTRATED LOAD (lbs)(NOTE 1) | | UNIFORM LOAD (lbs)(NOTE 2) | |
| | PS200 | PS150 | PS200 | PS150 |
| 24 | 850 | 1620 | 1690 | 3280 |
| 36 | 560 | 1080 | 1130 | 2190 |
| 48 | 420 | 810 | 850 | 1640 |
| 60 | 340 | 650 | 680 | 1310 |
| 72 | 280 | 540 | 560 | 1090 |
| 84 | 240 | 460 | 480 | 940 |
| 96 | 210 | 400 | 420 | 820 |
| 108 | 190 | 360 | 380 | 730 |
| 120 | 170 | 320 | 340 | 660 |

| SPAN LT OR LB (in) | ALLOWABLE HORIZONTAL SEISMIC LOADS (NOTE 3) | | | |
|---|---|---|---|---|
| | CONCENTRATED LOAD (lbs)(NOTE 1) | | UNIFORM LOAD (lbs) (NOTE 2) | |
| | PS200 | PS150 | PS200 | PS150 |
| 24 | 1210 | 1720 | 2430 | 3450 |
| 36 | 810 | 1150 | 1620 | 2300 |
| 48 | 600 | 860 | 1220 | 1730 |
| 60 | 480 | 690 | 970 | 1380 |
| 72 | 400 | 570 | 810 | 1150 |
| 84 | 340 | 490 | 690 | 990 |
| 96 | 300 | 430 | 610 | 860 |
| 108 | 270 | 380 | 540 | 770 |
| 120 | 240 | 340 | 490 | 690 |

### Back to Back Channel Design Table

| SPAN LT OR LB (in) | ALLOWABLE GRAVITY LOADS | | | |
|---|---|---|---|---|
| | CONCENTRATED LOAD (lbs)(NOTE 1) | | UNIFORM LOAD (lbs)(NOTE 2) | |
| | PS200 2T3 | PS150 2T3 | PS200 2T3 | PS150 2T3 |
| 24 | 1565* | 2340* | 3130* | 4680* |
| 36 | 1565* | 2340* | 3130* | 4680* |
| 48 | 1190 | 2340* | 2400 | 4680* |
| 60 | 950 | 1920 | 1920 | 3870 |
| 72 | 790 | 1600 | 1600 | 3220 |
| 84 | 680 | 1360 | 1370 | 2760 |
| 96 | 590 | 1190 | 1200 | 2420 |
| 108 | 530 | 1060 | 1070 | 2150 |
| 120 | 470 | 950 | 960 | 1930 |

| SPAN LT OR LB (in) | ALLOWABLE HORIZONTAL SEISMIC LOADS (NOTE 3) | | | |
|---|---|---|---|---|
| | CONCENTRATED LOAD (lbs)(NOTE 1) | | UNIFORM LOAD (lbs)(NOTE 2) | |
| | PS200 2T3 | PS150 2T3 | PS200 2T3 | PS150 2T3 |
| 24 | 1565* | 2340* | 3130* | 4680* |
| 36 | 1565* | 2300 | 3130* | 4610 |
| 48 | 1210 | 1720 | 2430 | 3450 |
| 60 | 970 | 1380 | 1940 | 2760 |
| 72 | 810 | 1150 | 1620 | 2300 |
| 84 | 690 | 980 | 1390 | 1970 |
| 96 | 600 | 860 | 1220 | 1730 |
| 108 | 540 | 760 | 1080 | 1540 |
| 120 | 490 | 690 | 970 | 1380 |

Notes:
1. Loads shall be concentrated at midspan of trapeze.
2. Loads shall be uniformly distributed along the length of the trapeze.
3. For short term seismic conditions apply 33% increase to allowable loads.
4. Loads based on sections that are braced for torsional lateral bracing.
5. Combined interaction is acceptable where:

$$\text{Interaction (i)} = \frac{\text{Design Gravity Load}}{\text{Allow. Gravity Load}} + \frac{\text{Design Horizontal Seismic Load}}{\text{Allow. Horizontal Seismic Load}} \leq 1.0$$

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Fixed Equipment Anchorage
Office of Statewide Health Planning and Development

OPA-0242 Apr 25, 2003

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

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TITLE

**Trapeze Load Table**
**Single Channel**
**Back to Back Channel**

PAGE C6/C7

DATE **04/25/2003**

## EXPANSION BOLT NOTES

1. Drilled-in anchors shall be ITW Ramset/Red Head Self-Drilling per I.C.B.O. Report No. 1372, March 1, 2000. Other anchors may be substituted providing they have an I.C.B.O rating equal or greater than the values tabulated below. User should be using load stated in (most recent) I.C.B.O. report. Tabulated loads have been reduced per OSHPD guidelines.

2. Minimum concrete $f'_c$ = 3,000 psi for normal weight concrete, lightweight concrete, and concrete over metal deck.

3. Minimum embedment of all bolts shall be as shown on C9.

4. When installing drilled-in anchors and or powder driven pins in existing non-stressed concrete, use care and caution to avoid cutting or damaging the existing reinforcement bars. Maintain a minimum clearance of one inch between the reinforcement and the drilled in anchor and or pin.

5. All concrete expansion type anchor bolts (loaded in either pullout or shear) shall have 50 percent of the bolts (alternate bolts in any group arrangement) proof tested in tension to twice the allowable tension load. If any anchor fails testing, test all anchors of the same category, installed by the same trade, not previously tested until twenty (20) consecutive pass, then resume the initial testing frequency.

6. Use 50% of allowable tension when anchors are installed in the tension zone of the concrete. Project Engineer to verify.

7. Bolt spacing and edge distance shall conform to the requirements of the I.C.B.O. report.

$$\text{Combined Interaction (i)} = \left(\frac{\text{Applied Service Tension Load}}{\text{Allowable Service Tension Load}}\right)^{5/3} + \left(\frac{\text{Applied Service Shear Load}}{\text{Allowable Service Shear Load}}\right)^{5/3} \le 1$$

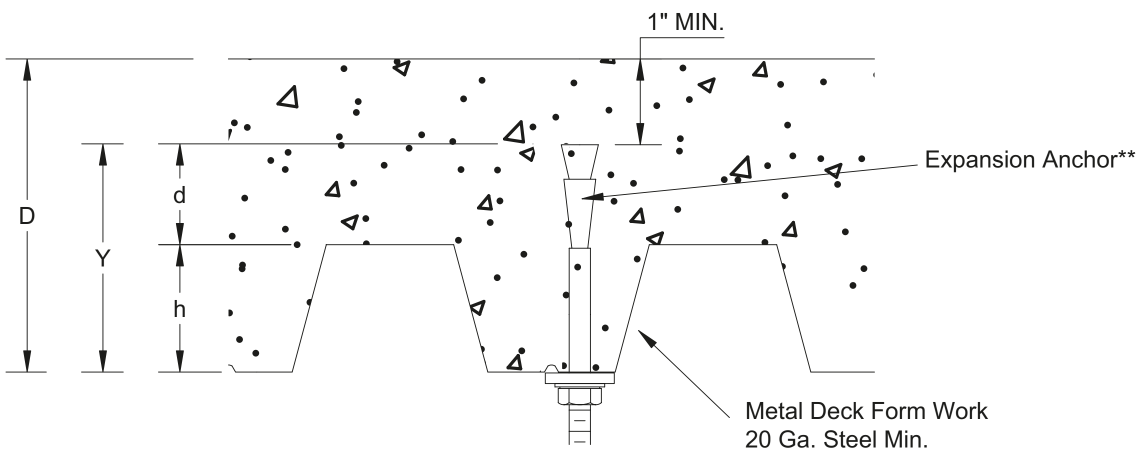
| | | |
|---|---|---|
| A P P R O V E D<br>Fixed Equipment Anchorage<br>Office of Statewide Health Planning and Development<br>OPA-0242 Apr 25, 2003<br>**** Valid for 3 Years Maximum ****<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Concrete Expansion Anchor Load Table**<br>PAGE C8<br>DATE 04/25/2003 |

## WEDGE ANCHOR TEST LOADS

| Normal Weight Concrete | | | | | |
|---|---|---|---|---|---|
| Anchor Diameter | Minimum Embedment | Allowable Tension | Allowable Shear | Torque Test Tension | Direct Tension |
| *(in)* | *(in)* | *(lbs)* | *(lbs)* | *(ft-lbs)* | *(lbs)* |
| ¼ | 2 ⅛ | 556 | 0 | 8 | 800 |
| ⅜ | 3 | 942 | 814 | 25 | 1,100 |
| ½ | 4 ⅛ | 1,430 | 1,448 | 50 | 2,000 |
| ⅝ | 5 ⅛ | 2,150 | 2,150 | 80 | 2,300 |
| ¾ | 6 ⅝ | 2,868 | 4,406 | 150 | 3,700 |

| Anchor Diameter | Minimum Embedment | LIghtweight Concrete | | L/W Conc. over Mtl. Deck (Lower Flute) | | Torque Test Tension | Direct Tension |
|---|---|---|---|---|---|---|---|
| | | Allowable Tension | Allowable Shear | Allowable Tension | Allowable Shear | | |
| *(in)* | *(in)* | *(lbs)* | *(lbs)* | *(lbs)* | *(lbs)* | *(ft-lbs)* | *(lbs)* |
| ⅜ | 3 | 588 | 848 | 568 | 800 | 25 | 1,100 |
| ½ | 4 | 0 | 1,384 | 960 | 1,288 | 50 | 2,000 |
| ⅝ | 5 | 1,192 | 1,856 | 1,316 | 1,828 | 80 | 2,300 |
| ¾ | n/a | n/a | n/a | n/a | n/a | 150 | 3,700 |

Refer to Manufacyturer's I.C.B.O. for spacing and edge distance reductions to load.




d ≥ Larger of 1 1/2" OR (Required embedment for the proposed anchor* - h/3) ≤ (Depth of Slab (D) - 1")
Y = 8 x Anchor Diameter for 100% of Design Load Values for Anchor
If less than 8x then use 50% of Design Load Values for Anchor
*See Anchor Load Table.
**Where offsets are required apply edge distance reductions to load per Manufacturer's I.C.B.O.

A P P R O V E D
**Fixed Equipment Anchorage**
Office of Statewide Health Planning and Development
**OPA-0242 Apr 25, 2003**
**** Valid for 3 Years Maximum ****
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TITLE
**Concrete Expansion Anchor Load Table**

PAGE
**C9**

DATE
**04/25/2003**

## EXPANSION BOLT TEST SPECIFICATIONS

1. Anchor diameter refers to the thread size of the WEDGE category.

2. Apply proof test loads to WEDGE anchors without removing the nut if possible. If not, remove nut & install a threaded coupler to the same tightness of the original nut using a torque wrench and apply load.

3. Reaction loads from test fixtures may be applied close to the anchor being tested, provided the anchor is not restrained from withdrawing by the fixture(s).

4. Test equipment is to be calibrated by an approved testing laboratory in accordance with standard recognized procedures.

5. The following criteria apply for the acceptance of installed anchors:

   HYDRAULIC RAM METHOD: The anchor should have no observable movement at the applicable test load. For wedge and sleeve type anchors, a practical way to determine observable movement is that the washer under the nut becomes loose.

   TORQUE WRENCH METHOD: The applicable test torque must be reached within the following limits:

   Wedge: One-half (½) turn of the nut.

6. Testing should occur 24 hours minimum after installation of the subject anchors.

7. All tests shall be performed in the presence of the Inspector of Record.

8. If manufacturer's installation torque is less than the test torque, use the installation torque in lieu of the tabulated values.

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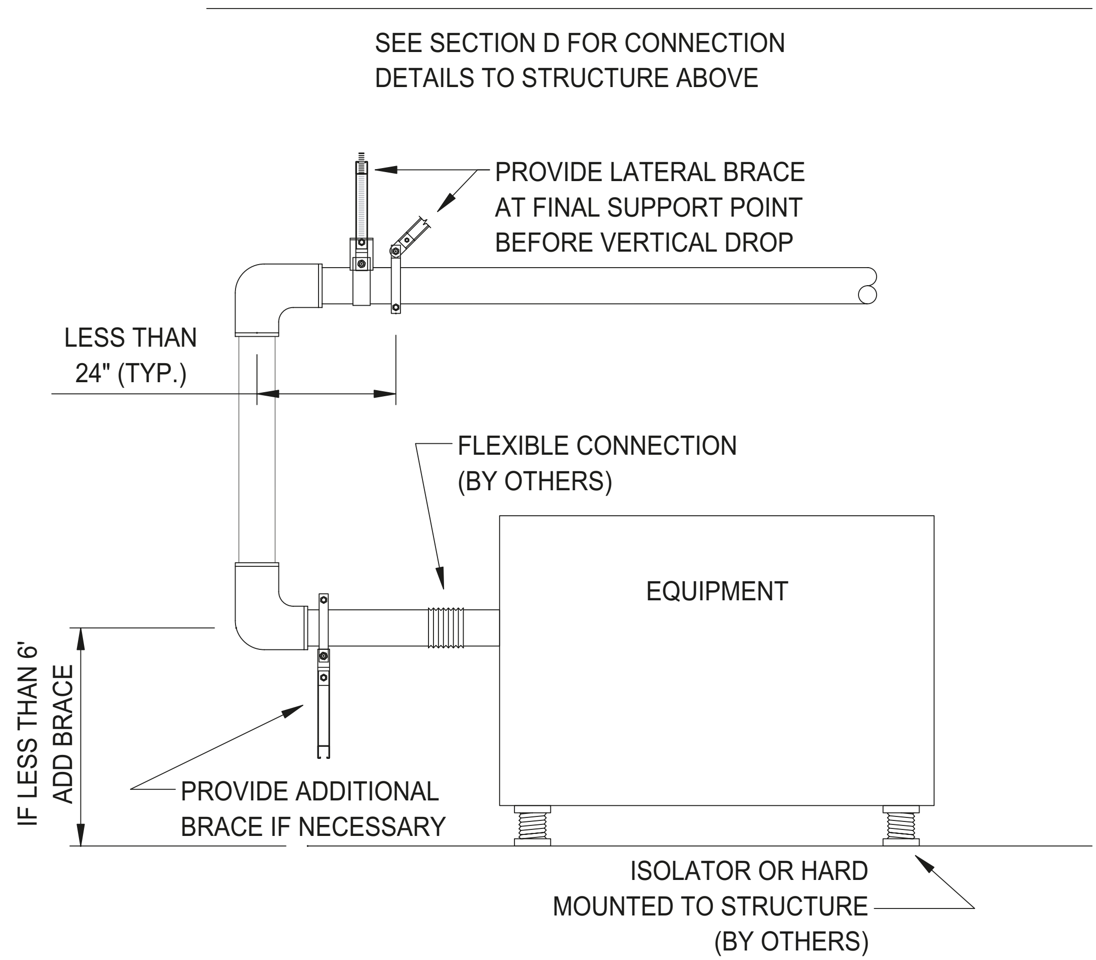



NOTE:
DETAIL SHOWS PIPING/CONDUIT HUNG FROM STRUCTURE ABOVE CONNECTING TO EQUIPMENT MOUNTED ON FLOOR TO ADDRESS THE DIFFERENTIAL MOVEMENT BETWEEN STORY TO STORY.

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
OPA-0242 Apr 25, 2003
**** Valid for 3 Years Maximum ****
Bill Staehlin (916) 324-9106

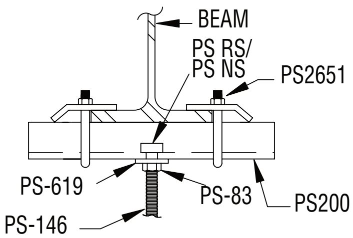
JOSEPH L. LA BRIE
Structural Engineer
No. SE 3566
55 E Huntington Dr
Suite 277
Arcadia, CA 91006

TITLE

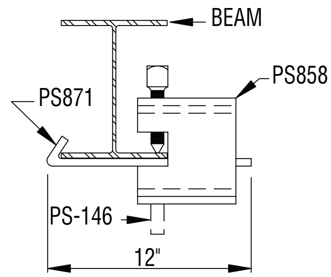
**Floor Mounted Equipment**

PAGE **C11**

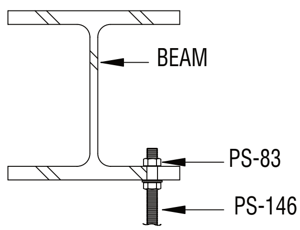
DATE **04/25/2003**



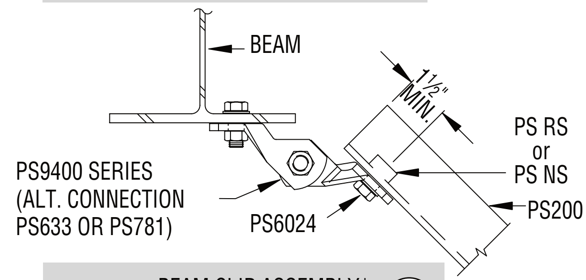

BEAM CLAMP ASSEMBLY* 1



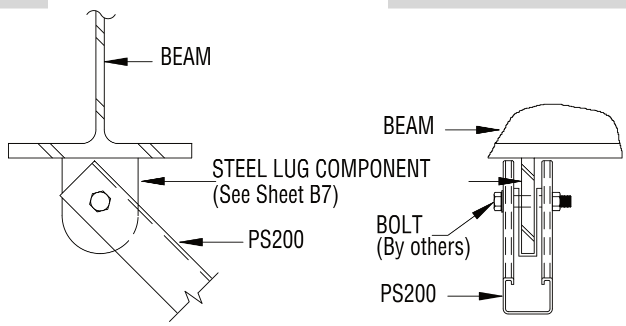

HEAVY BEAM CLAMP ASSEMBLY* 2




BEAM ROD ASSEMBLY* 3




BEAM CLIP ASSEMBLY* 4



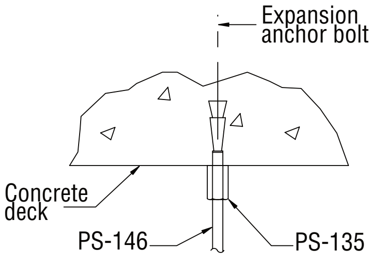

BEAM LUG ASSEMBLY* 5

*Note:

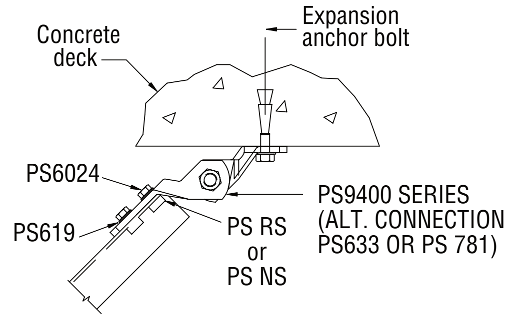
1. The adequacy of the steel beam and its support connections shall be verified by the project structural engineer.
2. Refer to Component Index for reference drawings.

| | | |
|---|---|---|
| S U B M I T T E D<br><br>**OPA-0242, Rev 1** | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Steel**<br>PAGE **D1** DATE **04/21/2005** |

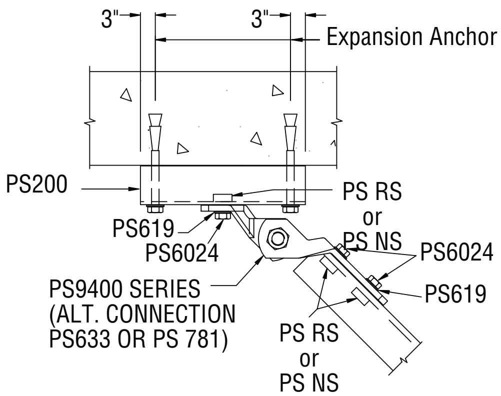
# ANCHORAGE



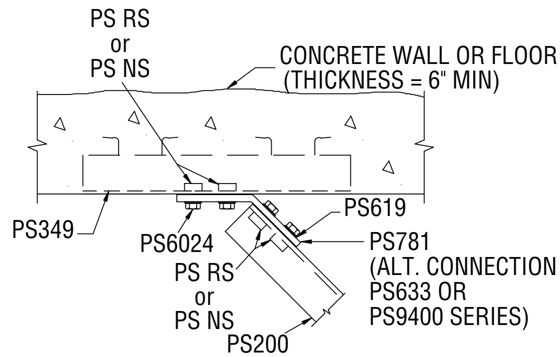

ONE BOLT ASSEMBLY* (1)
(Connections not for use in pre-stressed concrete deck)




ONE BOLT ASSEMBLY* (2)




TWO BOLT ASSEMBLY* (3)




EMBEDMENT CHANNEL* (4)
(Minimum edge distance = 6")

*Note:
1. Refer to Sheet C8 & C9 for expansion bolt capacity and testing.
2. The project engineer shall verify the adequacy of the concrete and the overall structural system.
3. Refer to Component Index for reference drawings.

S U B M I T T E D

**OPA-0242, Rev 1**


JOSEPH L. LA BRIE
Structural Engineer
No. SE 3566
55 E Huntington Dr
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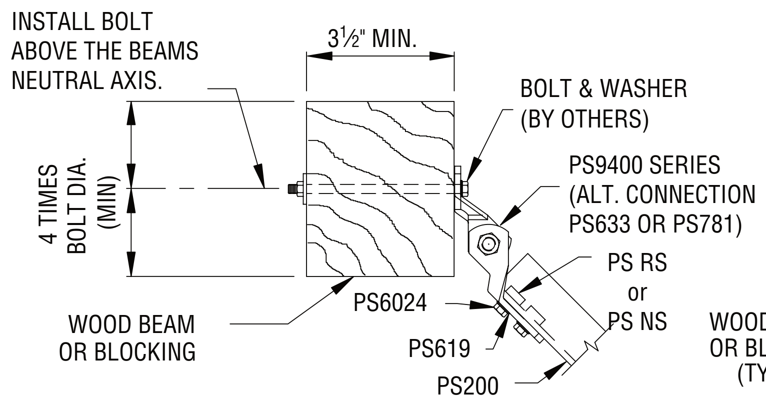
Arcadia, CA 91006


TITLE

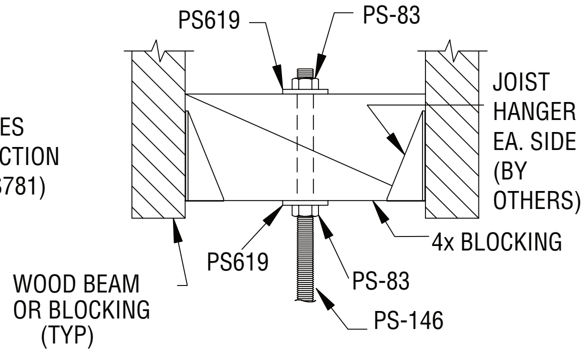
**Concrete**

PAGE **D2**

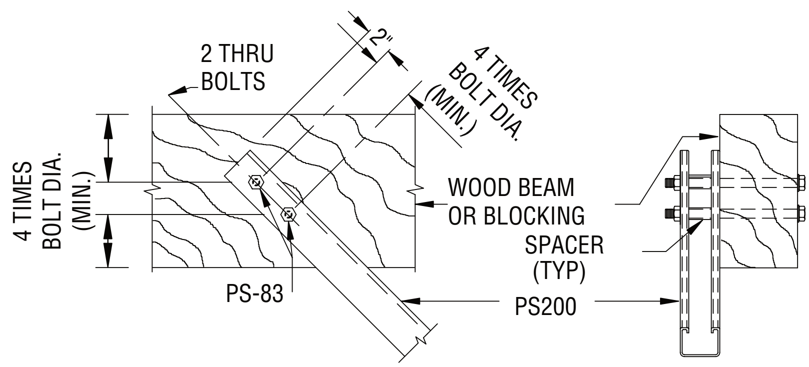
DATE **04/21/2005**




BEAM CLIP ASSEMBLY* 1




BEAM ROD ASSEMBLY* 2




BRACE ASSEMBLY* 3

*Note:

1. The adequacy of the wood beam and 4x blocking (Beam Rod Assy.) and its support connections shall be verified by the project engineer.
2. Refer to Component Index for reference drawings.

| SUBMITTED | | TITLE |
|---|---|---|
| OPA-0242, Rev 1 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | Wood |
| | | PAGE D3 — DATE 04/21/2005 |

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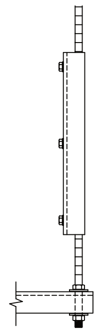
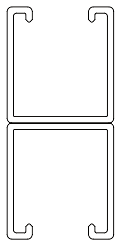
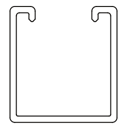
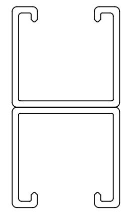
## Power Strut Component Index

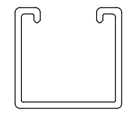
LEGEND
REF. MANUF.
DWG: CAT. #
ITEM NAME

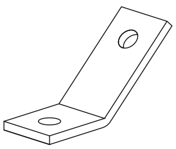

B1: PS-146
Threaded Rod
w/ Stiffner

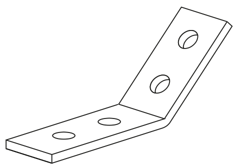

B11: PS 150 2T3
Back to Back Channel

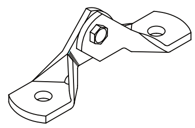

B11: PS 150
Trapeze/Channel

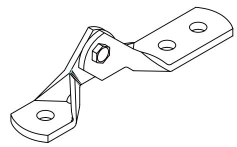

B11: PS200 2T3
Back to Back Channel

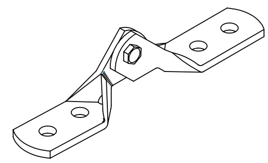

B11: PS200
Trapeze/Channel

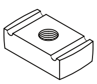

B3: PS 633
Angle Fitting

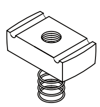

B3: PS 781
Angle Fitting

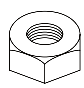

B4: PS 9402
Hinge Fitting

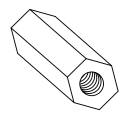

B4: PS 9403
Hinge Fitting

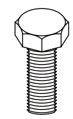

B4: PS 9404
Hinge Fitting

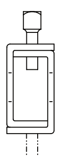

B2: PS NS
Channel Nut

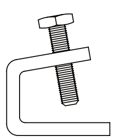

B2: PS RS
Channel Nut w/ Spring

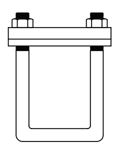

B2: PS-83
Hexagon Nut

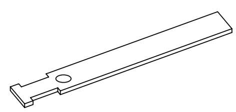

B2: PS-135
Rod Coupling

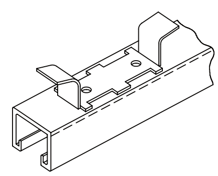

B2: PS 6024
Hex Head Screw

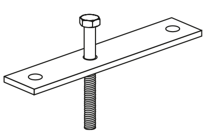

B10: PS 858
Beam Clamp

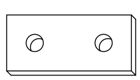

B10: PS 998
Beam Clamp

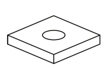

B10: PS 2651
Beam Clamp

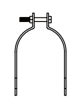

B10: PS 871
Safety Anchor Strap

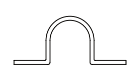

B8: PS 349
Concrete Insert


B9: PS 681
Concrete Insert


B2: PS 601
Plate


B2: PS 619
Square Washer


B6: PS 1100
Pipe Clamp


B5: PS 3126
Hold Down Clamp

| | | | |
|---|---|---|---|
| A P P R O V E D<br>Fixed Equipment Anchorage<br>Office of Statewide Health Planning and Development<br>OPA-0242 Apr 25, 2003<br>**** Valid for 3 Years Maximum ****<br><br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Component Index** | |
| | | PAGE<br>**R1** | DATE<br>**04/25/2003** |

## 2000 I.B.C. Seismic Force ($F_p$)

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**.

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

- $a_p$ = 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 $S_{DS} \cong 2.5C_a$, 2000 IBC)
- z = Height in structure at point of attachment of component.

Limits to lateral seismic force: $0.3\, S_{DS}\, I_p\, W_p \le F_p \le 1.6\, S_{DS}\, I_p\, Wp$

**NFPA Pipe Guidelines**
**For Fire Sprinkler Piping Single Rod Hangers**

| Pipe Size | Maximum Hanger Spacing | Minimum Rod Diameter | Weight of Sch.40 Pipe Filled with Water* | Weight of Sch.10 Pipe Filled with Water* |
|---|---|---|---|---|
| (in) | (feet) | (in) | (lbs/ft) | (lbs/ft) |
| ½ | | | 0.98 | |
| ¾ | | | 1.36 | |
| 1 | 12 | ⅜ | 2.05 | 1.81 |
| 1 ¼ | 12 | ⅜ | 2.93 | 2.52 |
| 1 ½ | 15 | ⅜ | 3.60 | 3.04 |
| 2 | 15 | ⅜ | 5.11 | 4.22 |
| 2 ½ | 15 | ⅜ | 7.87 | 5.89 |
| 3 | 15 | ⅜ | 10.78 | 7.94 |
| 3 ½ | 15 | ⅜ | 13.39 | 9.78 |
| 4 | 15 | ⅜ | 16.31 | 11.78 |
| 5 | 15 | ½ | 23.29 | 17.30 |
| 6 | 15 | ½ | 31.51 | 23.03 |
| 8 | 15 | ½ | 50.29 | 40.08 |

* Pipe Weight data taken from manual of Steel Construction Book ASD 9th edition

**ELECTRICAL METALLIC TUBING DATA**

| Nom. Size EMT Conduit | OD Conduit | Conduit Wt. | Approx. Max. Wt. Conduit and Conductor Not Lead Covered |
|---|---|---|---|
| in | in | lbs/ft | lbs-ft |
| ½ | 0.706 | 0.29 | 0.54 |
| ¾ | 0.922 | 0.45 | 1.16 |
| 1 | 1.163 | 0.65 | 1.83 |
| 1 ¼ | 1.510 | 0.96 | 2.96 |
| 1 ½ | 1.740 | 1.11 | 3.68 |
| 2 | 2.197 | 1.41 | 4.45 |
| 2 ½ | 2.875 | 2.15 | 6.41 |
| 3 | 3.500 | 2.60 | 9.30 |
| 3 ½ | 4.000 | 3.25 | 12.15 |
| 4 | 4.500 | 3.90 | 15.40 |

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
OPA-0242 Apr 25, 2003
**** Valid for 3 Years Maximum ****
Bill Staehlin (916) 324-9106

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

TITLE
2000 I.B.C. Seismic Force ($F_p$)
NFPA Pipe Data
Electrical Metallic Tubing Data

PAGE R2/R3/R4

DATE 04/25/2003

POWER-STRUT®

**APPLICATION ENGINEERING DATA - Conduit Spacings**

Spacing in inches between centers of conduits. The light face figures are the minimum dimensions to provide clearance between locknuts. The more liberal spacings printed in bold face type should be used whenever possible.

| Size (in) | Size (in) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1/2** | **3/4** | **1** | **1 1/4** | **1 1/2** | **2** | **2 1/2** | **3** | **3 1/2** | **4** | **4 1/2** | **5** | **6** |
| 1/2 | 1 3/16 | - | - | - | - | - | - | - | - | - | - | - | - |
| | **1 3/8** | - | - | - | - | - | - | - | - | - | - | - | - |
| 3/4 | 1 5/16 | 1 7/16 | - | - | - | - | - | - | - | - | - | - | - |
| | **1 1/2** | **1 5/8** | - | - | - | - | - | - | - | - | - | - | - |
| 1 | 1 1/2 | 1 5/8 | 1 3/4 | - | - | - | - | - | - | - | - | - | - |
| | **1 3/4** | **1 7/8** | **2** | - | - | - | - | - | - | - | - | - | - |
| 1 1/4 | 1 3/4 | 1 7/8 | 2 | 2 1/4 | - | - | - | - | - | - | - | - | - |
| | **2** | **1 1/8** | **2 1/4** | **2 1/2** | - | - | - | - | - | - | - | - | - |
| 1 1/2 | 1 15/16 | 2 1/16 | 2 3/16 | 2 7/16 | 2 9/16 | - | - | - | - | - | - | - | - |
| | **2 1/8** | **2 1/4** | **2 3/8** | **2 5/8** | **2 3/4** | - | - | - | - | - | - | - | - |
| 2 | 2 3/16 | 2 5/16 | 2 1/2 | 2 3/4 | 2 7/8 | 3 1/8 | - | - | - | - | - | - | - |
| | **2 3/8** | **2 1/2** | **2 3/4** | **3** | **3 1/8** | **3 3/8** | - | - | - | - | - | - | - |
| 2 1/2 | 2 7/16 | 2 9/16 | 2 3/4 | 3 | 3 1/8 | 3 3/8 | 3 5/8 | - | - | - | - | - | - |
| | **2 5/8** | **2 3/4** | **3** | **3 1/4** | **3 3/8** | **3 5/8** | **4** | - | - | - | - | - | - |
| 3 | 2 13/16 | 2 15/16 | 3 1/16 | 3 5/16 | 3 7/16 | 3 3/4 | 4 | 4 5/16 | - | - | - | - | - |
| | **3** | **3 1/8** | **3 3/8** | **3 5/8** | **3 3/4** | **4** | **4 3/8** | **4 3/4** | - | - | - | - | - |
| 3 1/2 | 3 1/8 | 3 1/4 | 3 3/8 | 3 5/8 | 3 3/4 | 4 1/16 | 4 5/16 | 4 5/8 | 4 15/16 | - | - | - | - |
| | **3 3/8** | **3 1/2** | **3 5/8** | **3 7/8** | **4** | **4 3/8** | **4 5/8** | **5** | **5 3/8** | - | - | - | - |
| 4 | 3 7/16 | 3 9/16 | 3 11/16 | 3 15/16 | 4 1/16 | 4 3/8 | 4 5/8 | 4 15/16 | 5 1/4 | 5 9/16 | - | - | - |
| | **3 3/4** | **3 7/8** | **4** | **4 1/4** | **4 3/8** | **4 3/4** | **5** | **5 3/8** | **5 5/8** | **6** | - | - | - |
| 4 1/2 | 3 3/4 | 3 7/8 | 4 | 4 1/4 | 4 3/8 | 4 5/8 | 4 7/8 | 5 1/4 | 5 9/16 | 5 7/8 | 6 1/8 | - | - |
| | **4** | **4 1/8** | **4 1/4** | **4 1/2** | **4 3/4** | **5** | **5 1/4** | **5 5/8** | **6** | **6 1/4** | **6 1/2** | - | - |
| 5 | 4 1/8 | 4 1/4 | 4 3/8 | 4 5/8 | 4 3/4 | 5 | 5 1/4 | 5 9/16 | 5 7/8 | 6 3/16 | 6 1/2 | 6 13/16 | - |
| | **4 3/8** | **4 1/2** | **4 5/8** | **4 7/8** | **5** | **5 3/8** | **5 5/8** | **6** | **6 1/4** | **6 5/8** | **7** | **7 1/4** | - |
| 6 | 4 3/4 | 4 7/8 | 5 | 5 1/4 | 5 3/8 | 5 5/8 | 5 7/8 | 6 3/16 | 6 1/2 | 6 13/16 | 7 1/8 | 7 7/16 | 8 1/8 |
| | **5** | **5 1/8** | **5 1/4** | **5 1/2** | **5 5/8** | **6** | **6 1/4** | **6 5/8** | **7** | **7 1/4** | **7 5/8** | **8** | **8 5/8** |

A P P R O V E D
**Fixed Equipment Anchorage**
Office of Statewide Health Planning and Development

**OPA-0242 Apr 25, 2003**

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

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TITLE

**Conduit Spacing**

PAGE
**R5**

DATE
**04/25/2003**

### STEEL RIGID CONDUIT DATA

| Nominal Size (in) Rigid Conduit | OD Conduit | OD Coupling | Weight Conduit W/C Pkg. lbs/ft | Approx. Max Wt.(lbs/ft) Conduit and Conductor | |
|---|---|---|---|---|---|
| | | | | Lead Covered | Not Lead Covered |
| ½ | .840 | 1.010 | 0.80 | 1.17 | 1.04 |
| ¾ | 1.050 | 1.250 | 1.09 | 1.75 | 1.40 |
| 1 | 1.315 | 1.525 | 1.65 | 2.62 | 2.35 |
| 1 ¼ | 1.660 | 1.869 | 2.15 | 4.31 | 3.58 |
| 1 ½ | 1.900 | 2.155 | 2.58 | 5.89 | 4.55 |
| 2 | 2.375 | 2.650 | 3.52 | 8.53 | 7.21 |
| 2 ½ | 2.875 | 3.250 | 5.67 | 11.51 | 10.22 |
| 3 | 3.500 | 3.870 | 7.14 | 16.51 | 14.51 |
| 3 ½ | 4.000 | 4.500 | 8.60 | 19.05 | 17.49 |
| 4 | 4.500 | 4.875 | 10.00 | 24.75 | 21.48 |
| 5 | 5.563 | 6.000 | 13.20 | 35.87 | 30.83 |
| 6 | 6.625 | 7.200 | 17.85 | 50.69 | 43.43 |

Maximum weight equals weight of rigid conduit plus weight of heaviest conductor combinations as specified by the 1996 edition of the "National Electric Code Handbook"

### INTERMEDIATE METAL CONDUIT DATA

| Nominal Size (in) Rigid Conduit | OD Conduit | OD Coupling | Weight Conduit W/C Pkg. lbs/ft | Approx. Max Wt.(lbs/ft) Conduit and Conductor | |
|---|---|---|---|---|---|
| | | | | Lead Covered | Not Lead Covered |
| ½ | 0.815 | 1.010 | 0.60 | 0.97 | 0.84 |
| ¾ | 1.029 | 1.250 | 0.82 | 1.48 | 1.13 |
| 1 | 1.290 | 1.525 | 1.16 | 2.13 | 1.86 |
| 1 ¼ | 1.638 | 1.869 | 1.50 | 3.66 | 2.93 |
| 1 ½ | 1.883 | 2.115 | 1.82 | 5.13 | 3.79 |
| 2 | 2.360 | 2.650 | 2.42 | 7.43 | 6.11 |
| 2 ½ | 2.857 | 3.250 | 4.28 | 10.12 | 8.83 |
| 3 | 3.476 | 3.870 | 5.26 | 14.63 | 12.63 |
| 3 ½ | 3.971 | 4.500 | 6.12 | 16.57 | 15.01 |
| 4 | 4.466 | 4.875 | 6.82 | 21.57 | 18.30 |

1 Cubic ft. of water weighs 62.35 lbs
1 Gallon US weighs 8.335 lbs

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TITLE
**Conduit Data**

PAGE **R6**

DATE **04/25/2003**

**STEEL PIPE DATA - Schedule 40 & 80**

| Nominal Pipe Size (in) | Schedule No. | O.D. | Wall Thickness | Wt/ft | Wt. of Water/ft |
|---|---|---|---|---|---|
| ⅜ | 40 | .675 | 0.091 | 0.567 | 0.830 |
| | 80 | | 0.126 | 0.738 | 0.061 |
| ½ | 40 | .840 | 0.109 | 0.850 | 0.132 |
| | 80 | | 0.147 | 1.087 | 0.101 |
| ¾ | 40 | 1.050 | 0.133 | 1.130 | 0.230 |
| | 80 | | 0.154 | 1.473 | 0.186 |
| 1 | 40 | 1.315 | 0.133 | 1.678 | 0.374 |
| | 80 | | 0.179 | 2.171 | 0.311 |
| 1 ¼ | 40 | 1.660 | 0.140 | 2.272 | 0.647 |
| | 80 | | 0.199 | 2.996 | 0.555 |
| 1 ½ | 40 | 1.900 | 0.145 | 2.717 | 0.882 |
| | 80 | | 0.200 | 3.631 | 0.765 |
| 2 | 40 | 2.375 | 0.154 | 3.652 | 1.452 |
| | 80 | | 0.218 | 5.022 | 1.279 |
| 2 ½ | 40 | 2.875 | 0.203 | 5.790 | 2.072 |
| | 80 | | 0.276 | 7.660 | 1.834 |
| 3 | 40 | 3.500 | 0.216 | 7.570 | 3.200 |
| | 80 | | 0.300 | 10.250 | 2.860 |
| 3 ½ | 40 | 4.000 | 0.226 | 9.110 | 4.280 |
| | 80 | | 0.318 | 12.510 | 3.850 |
| 4 | 40 | 4.500 | 0.237 | 10.790 | 5.510 |
| | 80 | | 0.337 | 14.980 | 4.980 |
| 5 | 40 | 5.563 | 0.258 | 14.620 | 8.660 |
| | 80 | | 0.375 | 20.780 | 7.870 |
| 6 | 40 | 6.625 | 0.280 | 18.970 | 12.510 |
| | 80 | | 0.432 | 28.570 | 11.290 |
| 8 | 40 | 8.625 | 0.322 | 28.550 | 21.600 |
| | 80 | | 0.500 | 43.390 | 19.800 |

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TITLE
**Steel Pipe Data**

PAGE R7

DATE **04/25/2003**

## COPPER TUBE DATA Type L

| Tube Size in | Nominal O.D.Tubing | O.D. | Wall Thick | Wt./Ft. lbs | Wt. of Water/Ft lbs |
|---|---|---|---|---|---|
| ¼ | ⅜ | 0.375 | 0.030 | 0.126 | 0.034 |
| ⅜ | ½ | 0.500 | 0.035 | 0.198 | 0.062 |
| ½ | ⅝ | 0.625 | 0.040 | 0.285 | 0.100 |
| ⅝ | ¾ | 0.750 | 0.042 | 0.362 | 0.151 |
| ¾ | ⅞ | 0.875 | 0.045 | 0.455 | 0.209 |
| 1 | 1 ⅛ | 1.125 | 0.050 | 0.655 | 0.357 |
| 1 ¼ | 1 ⅜ | 1.375 | 0.055 | 0.884 | 0.546 |
| 1 ½ | 1 ⅝ | 1.625 | 0.060 | 1.140 | 0.767 |
| 2 | 2 ⅛ | 2.125 | 0.070 | 1.750 | 1.341 |
| 2 ½ | 2 ⅝ | 2.625 | 0.080 | 2.480 | 2.064 |
| 3 | 3 ⅛ | 3.125 | 0.090 | 3.330 | 2.949 |
| 3 ½ | 3 ⅝ | 3.625 | 0.100 | 4.290 | 3.989 |
| 4 | 4 ⅛ | 4.125 | 0.110 | 5.380 | 5.188 |
| 5 | 5 ⅛ | 5.125 | 0.125 | 7.610 | 8.081 |
| 6 | 6 ⅛ | 6.125 | 0.140 | 10.200 | 11.616 |
| 8 | 8 ⅛ | 8.125 | 0.200 | 19.290 | 20.289 |
| 10 | 10 ⅛ | 10.125 | 0.250 | 30.100 | 31.590 |
| 12 | 12 ⅛ | 12.125 | 0.280 | 40.400 | 45.426 |

## COPPER TUBE DATA Type K

| Tube Size in | Nominal O.D.Tubing | O.D. | Wall Thick | Wt./Ft. lbs | Wt. of Water/Ft lbs |
|---|---|---|---|---|---|
| ¼ | ⅜ | 0.375 | 0.035 | 0.145 | 0.032 |
| ⅜ | ½ | 0.500 | 0.005 | 0.269 | 0.055 |
| ½ | ⅝ | 0.625 | 0.049 | 0.344 | 0.094 |
| ⅝ | ¾ | 0.750 | 0.049 | 0.418 | 0.144 |
| ¾ | ⅞ | 0.875 | 0.065 | 0.641 | 0.188 |
| 1 | 1 ⅛ | 1.125 | 0.065 | 0.839 | 0.337 |
| 1 ¼ | 1 ⅜ | 1.375 | 0.065 | 1.040 | 0.527 |
| 1 ½ | 1 ⅝ | 1.625 | 0.072 | 1.360 | 0.743 |
| 2 | 2 ⅛ | 2.125 | 0.083 | 2.060 | 1.310 |
| 2 ½ | 2 ⅝ | 2.625 | 0.095 | 2.920 | 2.000 |
| 3 | 3 ⅛ | 3.125 | 0.109 | 4.000 | 2.960 |
| 3 ½ | 3 ⅝ | 3.625 | 0.120 | 5.120 | 3.900 |
| 4 | 4 ⅛ | 4.125 | 0.134 | 6.510 | 5.060 |
| 5 | 5 ⅛ | 5.125 | 0.160 | 9.670 | 8.000 |
| 6 | 6 ⅛ | 6.125 | 0.192 | 13.870 | 11.200 |
| 8 | 8 ⅛ | 8.125 | 0.271 | 25.900 | 19.500 |
| 10 | 10 ⅛ | 10.125 | 0.338 | 40.300 | 30.423 |
| 12 | 12 ⅛ | 12.125 | 0.405 | 57.800 | 43.675 |

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TITLE
**Copper Tube Data**

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DATE **04/25/2003**

PVC PLASTIC PIPE DATA - Schedule 40 & 80

| Nominal Tube Size (inches) | Schedule Number | Outer Diameter (inches) | Wall Thickness (inches) | Weight per Foot (lbs/ft) | Wt. of Water/ft (ft-lbs) |
|---|---|---|---|---|---|
| ⅛ | 40 | 0.405 | 0.068 | 0.043 | 0.025 |
| | 80 | | 0.095 | 0.055 | 0.016 |
| ¼ | 40 | 0.540 | 0.088 | 0.074 | 0.045 |
| | 80 | | 0.119 | 0.094 | 0.031 |
| ⅜ | 40 | 0.675 | 0.091 | 0.100 | 0.083 |
| | 80 | | 0.126 | 0.129 | 0.061 |
| ½ | 40 | 0.840 | 0.109 | 0.150 | 0.132 |
| | 80 | | 0.147 | 0.150 | 0.101 |
| ¾ | 40 | 1.050 | 0.110 | 0.199 | 0.230 |
| | 80 | | 0.154 | 0.259 | 0.186 |
| 1 | 40 | 1.315 | 0.133 | 0.295 | 0.374 |
| | 80 | | 0.179 | 0.382 | 0.311 |
| 1 ¼ | 40 | 1.660 | 0.140 | 0.400 | 0.647 |
| | 80 | | 0.191 | 0.527 | 0.555 |
| 1 ½ | 40 | 1.990 | 0.145 | 0.478 | 0.882 |
| | 80 | | 0.200 | 0.639 | 0.765 |
| 2 | 40 | 2.375 | 0.154 | 0.643 | 1.452 |
| | 80 | | 0.218 | 0.884 | 1.279 |
| 2 ½ | 40 | 2.875 | 0.203 | 1.020 | 2.072 |
| | 80 | | 0.276 | 1.350 | 1.834 |
| 3 | 40 | 3.500 | 0.216 | 1.333 | 3.200 |
| | 80 | | 0.300 | 1.804 | 2.860 |
| 3 ½ | 40 | 4.000 | 0.226 | 1.598 | 4.280 |
| | 80 | | 0.318 | 2.195 | 3.850 |
| 4 | 40 | 4.500 | 0.237 | 1.899 | 5.510 |
| | 80 | | 0.337 | 2.636 | 4.980 |
| 5 | 40 | 5.563 | 0.258 | 2.770 | 8.660 |
| | 80 | | 0.375 | 4.126 | 7.870 |
| 6 | 40 | 6.625 | 0.280 | 3.339 | 12.150 |
| | 80 | | 0.432 | 5.028 | 11.290 |
| 8 | 40 | 8.625 | 0.322 | 5.280 | 21.600 |
| | 80 | | 0.500 | 8.023 | 19.800 |

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**Fixed Equipment Anchorage**

Office of Statewide Health Planning and Development

**OPA-0242 Apr 25, 2003**

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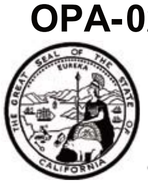



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TITLE

**PVC Data**

PAGE R10

DATE **04/25/2003**

## SPACING OF HANGERS FOR PVC PLASTIC PIPE

| Sch. 40 Pipe Size | Support Spacing in Feet at Temperatures Shown Above | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *in* | *20°F* | *40°F* | *60°F* | *80°F* | *100°F* | *110°F* | *120°F* | *130°F* | *140°F* | *150°F* |
| ⅛ - ¾ | 5 | 4.75 | 4.5 | 4.25 | 4 | 3.75 | 3.33 | 3 | 2.66 | 2 |
| 1 - 1¼ | 5.5 | 5.25 | 5 | 4.66 | 4.33 | 4 | 3.75 | 3.33 | 2.8 | 2.25 |
| 1½ - 2 | 5.8 | 5.5 | 5.25 | 5 | 4.66 | 4.33 | 3.8 | 3.5 | 3 | 2.5 |
| 2½ | 6.66 | 6.33 | 6 | 5.5 | 5.25 | 4.8 | 4.5 | 4 | 3.5 | 2.8 |
| 3 | 6.8 | 6.5 | 6.25 | 5.8 | 5.5 | 5.25 | 4.75 | 4.25 | 3.66 | 3 |
| 4 | 7.33 | 7 | 6.5 | 6.25 | 5.8 | 5.5 | 5 | 4.5 | 3.8 | 3.25 |
| 6 | 7.8 | 7.5 | 7 | 6.8 | 6.33 | 5.8 | 5.33 | 4.8 | 4.25 | 3.5 |
| **Sch. 80 Pipe Size** | **Support Spacing in Feet at Temperatures Shown Above** | | | | | | | | | |
| *in* | *20°F* | *40°F* | *60°F* | *80°F* | *100°F* | *110°F* | *120°F* | *130°F* | *140°F* | *150°F* |
| ⅛ - ¾ | 5.75 | 5.5 | 5.25 | 4.8 | 4.5 | 4.33 | 3.8 | 3.5 | 3 | 2.5 |
| 1 - 1¼ | 6.33 | 6 | 5.75 | 5.33 | 5 | 4.6 | 4.33 | 3.8 | 3.33 | 2.75 |
| 1½ - 2 | 6.66 | 6.33 | 6 | 5.66 | 5.25 | 4.8 | 4.5 | 4 | 3.5 | 3 |
| 2½ | 7 | 6.5 | 6.25 | 6 | 5.5 | 5.12 | 4.75 | 4.33 | 3.66 | 3.12 |
| 3 | 7.8 | 7.5 | 7 | 6.66 | 6.33 | 5.8 | 5.33 | 4.75 | 4.25 | 3.33 |
| 4 | 8.2 | 7.75 | 7.33 | 7 | 6.5 | 6 | 5.5 | 5 | 4.33 | 3.5 |
| 6 | 8.66 | 8.25 | 7.8 | 7.33 | 6.8 | 6.33 | 5.8 | 5.25 | 4.66 | 3.75 |
| 6 | 9.8 | 9.33 | 8.8 | 8.33 | 7.8 | 7.33 | 6.5 | 6 | 5.12 | 4.25 |

Note: Tables assume fluid loads up to 1.35 specific gravity (85 lb./cu.ft.), but not concentrated heavy loads.

## LOAD CARRYING CAPACITIES OF THREADED HOT ROLLED STEEL ROD

| Nominal Rod Dia. *(inches)* | Root Area *(in2)* | Maximum Safe Load | |
|---|---|---|---|
| | | 650° *(lbs)* | 750° *(lbs)* |
| ¼ | 0.027 | 240 | 210 |
| ⅜ | 0.068 | 610 | 540 |
| ½ | 0.126 | 1,130 | 1,010 |
| ⅝ | 0.202 | 1,810 | 1,610 |
| ¾ | 0.302 | 2,710 | 2,420 |
| ⅞ | 0.419 | 3,771 | 3,030 |
| 1 | 0.552 | 4,960 | 4,420 |
| 1 ⅛ | 0.693 | 6,230 | 5,560 |
| 1 ¼ | 0.889 | 8,000 | 7,140 |
| 1 ½ | 1.293 | 11,630 | 10,370 |
| 1 ¾ | 1.744 | 15,700 | 14,000 |
| 2 | 2.300 | 20,700 | 18,460 |
| 2 ¼ | 3.023 | 27,200 | 24,260 |
| 2 ½ | 3.719 | 33,500 | 29,880 |

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TITLE
**Hanger Spacing for PVC Plastic Pipe**

**Hot Rolled Steel Rod Loads**

PAGE
**R11/R12**

DATE
**04/25/2003**

# PREFACE



These guidelines were developed using sound engineering principles and judgment. They represent realistic and safe details compatible with the general guidelines and force factors in the State of California Code of Regulations, Title 24, also referred to as the California Building Standards Code. Material contained in this publication is for general information only and can be referenced in the **2001 California Building Code** based on the 1997 Uniform Building Code. Anyone making use of the data does so at his own risk and assumes any and all liability resulting from such use. **Allied Support Systems** disclaims any and all express or implied warranties of fitness for any general or particular application.

**A copy of this Seismic Bracing catalog showing the proper Seismic Brace tables (Pages 5 & 6) and Brace Location Requirements (Page C3) along with the Power-Strut Engineering catalog shall be on the jobsite prior to starting the installation of the seismic bracing system.**

**The Seismic Tables defined in Pages 5 & 6 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.**

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TITLE
**Preface**

PAGE
iii

DATE
**04/25/2003**

Power-Strut 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 or 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 and shall be approved by California Office of Statewide Health Planning and Development (OSHPD) or governing agency.

***Power Strut 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. All fire sprinkler branch line bracing shall comply with the requirements of the current edition of the NFPA-13. 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, no-hub pipe and threaded connections, 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. If this flexibility is not provided, bracing will be required when the aggregate weight of the pipes and conduits exceed 10 lb/ft.

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| TITLE | |
|---|---|
| Introduction | |
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# GLOSSARY



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

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

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

**Longitudinal–** Direction along the horizontal of a component or element's run.

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

**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.

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| TITLE | |
|---|---|
| Glossary | |
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**$a_p$** – Component Amplification Factor.

**Anvil International** – Formerly Grinnell.

**ASME** – American Society of Mechanical Engineers

**ASTM** – American Society for Testing Materials

**$C_a$** – Seismic Coefficient.

**$C_L$** – Longitudinal Clamp Capacity

**$C_T$** – Transverse Clamp Capacity

**$F_b$** – Transverse brace earthquake load along brace length.

**$F_{bALLOW}$** – Allowable Brace Force.

**$FH_L$** – Longitudinal Horizontal Force; force along horizontal run of pipe. ($FH_L = \mathbf{F_p} x S_3$)

**$FH_{L\ ALLOW}$** - Allowable longitudinal horizontal force as per manufacturer's testing.

**$FH_T$** – Transverse Horizontal Force; force perpendicular to horizontal run of pipe. ($FH_T = \mathbf{F_p} x S_2$)

*Fp* – Lateral force on a part of the structure; design seismic force (strength design).

**$F_p$** - Lateral force on a part of the structure factored to Working Stress level; design seismic force (Working Stress).

**$F_{ROD}$** – Rod axial force.

**$F_x$** – Horizontal transverse brace earthquake load perpendicular to $F_y$.

**$F_y$** – Transverse brace earthquake load perpendicular to $F_x$.

**$h_r$** – Structure roof elevation with respect to grade.

**$h_x$** – Equipment attachment elevation with respect to grade (not less than 0.0).

**$I_p$** – Seismic Importance Factor.

**LB** – Distance from one angle fitting to another on a trapeze.

**LT** – Distance from one threaded rod to another on a trapeze.

**NFPA** – National Fire Protection Association

**PS –** Power Strut

**$R_p$** – Component Response Modification Factor.

**s** – seismic coefficient used to define the following;

$$s = \frac{a_p C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right)$$

**$S_1$** – Hanger spacing

**$S_2$** – Transverse brace space

**$S_3$** – Longitudinal brace space

**$W_p$** – Weight of element or component.

**Wt** – Total Weight

| A P P R O V E D<br>Fixed Equipment Anchorage<br>Office of Statewide Health Planning and Development<br>OPA-0242 Apr 25, 2003<br>**** Valid for 3 Years Maximum ****<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Notations** | |
|---|---|---|---|
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## SINGLE PIPE SEISMIC TABLE [Seismic Factor (not to exceed) = 1.0g]

| Pipe Dia. | Pipe Hanger Type | Max. Brace Spacing | | Min. Rod Dia. | ANCHORAGE (Reference Section D for anchorage details) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Normal Weight Concrete | | | Light Weight Concrete | | | Structural Wood Beam | | Structural Steel Beam | |
| | | Trans. | Long. | | Qty | Dia. | Embed. | Qty | Dia. | Embed. | Thru Bolt | Diameter | A307 Bolt | Diameter |
| (in) | | (ft) | (ft) | (in) | (Min.) | (in) | (in) | (Min.) | (in) | (in) | (Qty) | (in) | (Qty) | (in) |
| ½ | Fig. 67 | 40 | 80 | ⅜ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 1 | ½ | 1 | ½ |
| ¾ | Fig. 295<br>Fig. 260/300<br>Fig. 67 | 40 | 80 | | | | | | | | | | | |
| 1 | Fig. 295<br>Fig. 260/300<br>Fig. 67 | 40 | 80 | | | | | | | | | | | |
| 1 ½ | Fig. 295<br>Fig. 260/300<br>Fig. 67 | 40 | 58 | | | | | | | | | | | |
| 2 | Fig. 295<br>Fig. 260/300 | 40 | 41 | | | | | | | | | | | |
| | Fig. 67 | 40 | 41 | | | | | | | | | | | |
| 2 ½ | Fig. 295<br>Fig. 260/300 | 26 | 26 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 1 | ½ | 1 | ½ |
| | Fig. 181 | 28 | 28 | | | | | | | | | | | |
| | Fig. 67 | 26 | 26 | | | | | | | | | | | |
| 3 | Fig. 295<br>Fig. 260/300 | 19 | 19 | | | | | | | | | | | |
| | Fig. 181 | 28 | 28 | | | | | | | | | | | |
| | Fig. 67 | 19 | 19 | | | | | | | | | | | |
| 4 | Fig. 295<br>Fig. 260/300<br>Fig. 181<br>Fig. 67 | 12 | 12 | ⅝ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 1 | ½ | 1 | ½ |
| 5 | Fig. 295<br>Fig. 260/300<br>Fig. 181<br>Fig. 67 | 9 | 9 | | | | | | | | | | | |
| 6 | Fig. 295<br>Fig. 260/300<br>Fig. 181<br>Fig. 67 | 6 | 6 | ¾ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 1 | ½ | 1 | ½ |
| 8 | Fig. 295<br>Fig. 260/300<br>Fig. 181 | 4 | 4 | | | | | | | | | | | |

Notes:
1. System must be engineered for variation of components (ie: size, quantity, spacing) needed to the listed values that are outside the scope of this table.
2. Pipe properties (water filled), see Page C1.
3. Pipe Hanger capacity and details, see Page A11 and A12.
4. Brace location requirements, reference Page C3.
5. Maximum threaded rod spacing, reference Page C1.
6. Maximum PS200 allowable brace length is 10 ft. at maximum brace angle of 45°.
7. ½" bolt(s) and nut(s) required on brace connectors attached to channels in this catalog, see Page B2.

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TITLE
**Single Pipe Seismic Table**

PAGE 5

DATE **04/25/2003**

## TRAPEZE SEISMIC TABLE

Seismic Factor (not to exceed) = 1.0g

| Maximum Vertical Load | Transv. Brace Space (max) | Maximum Trapeze Lengths | | | | Min. Rod Dia. | Anchorage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PS200 Trapeze | PS200-2T3 Trapeze | PS150 Trapeze | PS150-2T3 Trapeze | | Normal Weight Concrete | | | Light Weight Concrete | | | Structural Wood Beam | | Structural Steel Beam | |
| | | | | | | | Qty | Dia. | Embed. | Qty | Dia. | Embed. | Thru Bolt | Dia. | A307 Bolt | Dia. |
| *(plf)* | *(ft)* | *(ft)* | *(ft)* | *(ft)* | *(ft)* | *(in)* | *(Min.)* | *(in)* | *(in)* | *(Min.)* | *(in)* | *(in)* | *(Qty)* | *(in)* | *(Qty)* | *(in)* |
| 9 | 40 | 5 | 10 | 8 | 10 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 11 | 40 | 4 | 9 | 6 | 10 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 15 | 40 | 3 | 7 | 5 | 10 | ⅝ | 1 | ½ | 4 ⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 17 | 40 | 3 | 6 | 4 | 9 | ⅝ | 1 | ⅝ | 5⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 18 | 40 | 2 | 6 | 4 | 8 | ⅝ | 1 | ⅝ | 5⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 22 | 30 | 2 | 6 | 4 | 9 | ⅝ | 1 | ⅝ | 5⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 24 | 30 | 2 | 5 | 4 | 8 | ⅝ | 1 | ⅝ | 5⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 28, 29 | 20 | 3 | 6 | 4 | 10 | ½ | 1 | ½ | 4⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 32 | 20 | 2 | 6 | 4 | 9 | ½ | 1 | ⅝ | 5⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 33, 34 | 20 | 2 | 5 | 4 | 8 | ⅝ | 1 | ⅝ | 5⅛ | 2 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 37 | 10 | 3 | 8 | 6 | 10 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 40 | 10 | 3 | 8 | 5 | 10 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 41, 44, 45 | 10 | 3 | 7 | 5 | 10 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 2 | ½ | 1 | ½ |
| 48, 49, 50 | 10 | 2 | 6 | 4 | 10 | ½ | 1 | ½ | 4 ⅛ | 1 | ⅝ | 5 | 2 | ½ | 1 | ½ |

Notes:
1. System must be engineered for variation of components (ie: size, quantity, spacing) needed to the listed values that are outside the scope of this table.
2. Maximum vertical load (plf) simulates linear load of pipe(s) along pipe axis uniformly distributed on trapeze.
3. Maximum Longitudinal Brace Space is 2x Transverse Brace Space, not to exceed 80 ft.
4. Maximum Trapeze Lengths are for Uniform Load Capacities of Trapeze (see Page C6) braced longitudinally. (When loads are concentrated at or near midspan of trapeze use ½ of maximum trapeze length defined in table (min. of 2ft).
5. For non-braced Trapeze: type, length, & use of smaller components can be acquired, reference Note 1.
6. Maximum PS200 allowable brace length is 10 ft. for loads listed in table.
7. Maximum Hanger Spacing = 10ft.
8. ½" bolt(s) and nut(s) required on brace connectors attached to channels in this catalog.
9. Minimum 3,000 psi normal weight and light weight concrete slab/deck.

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TITLE
**Trapeze Seismic Table**

PAGE 6

DATE **04/25/2003**

STEPS TRAPEZE SELECTION PROCEDURE FOR WATER FILLED PIPE

1. **Select the *maximum support spacing*.**
From code or using *Sheet C1* (use smallest pipe diameter).
Select rational brace spacing using *Sheet C3* as a guideline.

2. **Determine the *total weight (Wt)* supported by the trapeze.**
*Sheet C4* can be used to determine the trapeze weight.
By calculation: Wt $=\varnothing_{PIPE}$ Unit Weight x Hanger Space

3. **Determine the *strength design seismic load* ($F_p$) and the *unit seismic load* of the pipes.**
With $h_x/h_r$ known, refer to *Sheet C5* to get $F_p$, (for a more accurate value see *Sheet 2*).
Convert from strength design to working stress: $1.4\mathbf{F_p}$(Working Stress) = $F_p$(Strength Design)

4. **Determine the total horizontal force (FH).**
Solve for both *Transverse ($FH_T$)* and *Longitudinal ($FH_L$)*.

5. **Select *pipe clamps* from *Sheets B5 and B6*.**
Verify clamp capacity exceeds actual forces.

6. **Select *trapeze channel.***
Use *Sheet C6 or C7* and verify channel can carry load.
a. Non-braced channels carry gravity (Wt) load only.
b. Braced channels must include horizontal longitudinal force and meet interaction (i) condition.

7. **Determine brace earthquake loads.**
From *Sheet C2*, solve for the Brace Horizontal, Vertical, and Axial Forces.

8. **Determine *rod axial forces* and select *rod size* from *Sheet B1*.**
Verify rod adequacy and determine the need for rod stiffeners.

$$F_{\text{Rod Tension}} = \left(\frac{\text{weight}}{\text{No. Hanger Rods}}\right) + \left(\frac{F_y}{\text{No. Braced Rods}}\right) + \left(\frac{F_v}{\text{No. Hanger Rods}}\right)$$

9. **Verify *brace adequacy* from *Sheet C2*.**

10. **Select *brace fitting* with the required number of bolts from *Sheets B2-B4*.**

11. **Select appropriate *anchorage details* from Section D "anchorage".**
Adjust seismic load as necessary: $\mathbf{F_p}$ (shallow anchors) = $2\mathbf{F_p}$

12 **Verify adequacy of anchorages.**
From the strength of the individual components, verify adequacy from *Section B* "components".

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| TITLE | |
|---|---|
| **Trapeze Selection Procedure** | |
| PAGE | DATE |
| **A1** | **04/25/2003** |

*PROBLEM:*

Provide vertical and horizontal pipe supports for a 6' trapeze supporting 2 – 1" diameter pipes and 3 – 2" diameter pipes placed above the ceiling of the 2nd floor (30' from grade) of a 45' tall building. The 6' long brace slope shall be 1 vertical and 2 horizontal. The supporting structure is structural steel.

*SOLUTION (refer to Sheet A1):*

STEPS DESCRIPTION

1 From *Sheet C1*:
Hanger spacing for 1" diameter pipe, $\mathbf{S_1=7'}$
Select rational brace spacing not to exceed maximum values listed on Sheet C3, Note 6:
Transverse brace spacing, $\mathbf{S_2=14'}$ (one side of trapeze)
Longitudinal brace spacing, $\mathbf{S_3=28'}$ (each side of trapeze)

2 From *Sheet C4*, determine weight, Wt:
Wt $= 2(1"\varnothing_{PIPE} @ 7') + 3(2"\varnothing_{PIPE} @ 7')$
$= 2(14) + 3(36)$
Wt = 136 lbs.

By calculation: $1"\varnothing_{PIPE}$ @ 7' = 2.05 lbs/ft x 7' = 14 lbs
$2"\varnothing_{PIPE}$ @ 7' = 5.11 lbs/ft x 7' = 36 lbs

3 From *Sheet C5*, determine seismic force (*Fp*):
With $h_x/h_r$ = 30'/45' = 0.67, follow graph horizontally to plotted diagonal line.
Then follow vertically down to a value of "s" coefficient. (s = 0.99)
Therefore: $Fp = 0.99W_p$ (for strength design)

$1.4\mathbf{F_p} = Fp$
$1.4\mathbf{F_p} = 0.99W_p$
$F_p = 0.71Wp$ (for working stress design)

Unit seismic load for $1"\varnothing_{PIPE}$: 0.71(2.05 lbs/ft) = **1.46 lbs/ft**
Unit seismic load for $2"\varnothing_{PIPE}$: 0.71(5.11 lbs/ft) = **3.63 lbs/ft**

4 Determine the horizontal force:
$FH_T$ $= 2(1"\varnothing_{PIPE} @ 14') + 3(2"\varnothing_{PIPE} @ 14')$
= 2(1.46 lbs/ft x 14') + 3(3.63 lbs/ft x 14')
= **193 lbs**
$FH_L$ $= 2(1"\varnothing_{PIPE} @ 28') + 3(2"\varnothing_{PIPE} @ 28')$
= 2(1.46 lbs/ft x 28') + 3(3.63 lbs/ft x 28')
= **387 lbs**

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TITLE
**Trapeze Selection Sample Problem**

PAGE A2
DATE 04/25/2003

5 From *Sheet B5 and B6*, select pipe clamps:

**Use PS3126 for 2" diameter pipes**,

$C_T$ (2" $\varnothing_{PIPE}$) = 3.63 lbs/ft x 14' = 51 lbs (<Fy = 500 lbs)

$C_L$ (2" $\varnothing_{PIPE}$) = 3.63 lbs/ft x 28' = 102 lbs (<Fx = 200 lbs)

**Use PS1100 for 1" diameter pipes**,

$C_T$ (1" $\varnothing_{PIPE}$) = 1.46 lbs/ft x 14' = 20 lbs (<Fy = 150 lbs)

$C_L$ (1" $\varnothing_{PIPE}$) = 1.46 lbs/ft x 28' = 41 lbs (<Fx = 80 lbs)

*Note: Pipe clamp capacities are greater than horizontal forces.*

6 From *Sheet C7*, select trapeze:

**Use Back to Back Channel** PS200 2T3 with,

Vertical concentrated load capacity = 790lbs

Lateral concentrated load capacity = 810 lbs

$$\text{Interaction (i)} = \frac{136\text{ lbs}}{790\text{ lbs}} + \frac{387\text{ lbs}}{810\text{ lbs}} = 0.65 < 1.0$$

7 From *Sheet C2*, determine transverse brace earthquake loads:

$Fx = Kx(FH_T)$ = 1.000(193 lbs) = **193 lbs**

$Fy = Ky(FH_T)$ = 0.500(193 lbs) = **97 lbs**

$Fb = Kb(FH_T)$ = 1.118(193 lbs) = **216 lbs**

8 Determine rod axial forces and select rod size:

$$F_{ROD} = \frac{Wt}{2\text{ rods}} \pm Fy = \frac{136\text{ lbs}}{2\text{ rods}} \pm 97\text{ lbs} = \begin{matrix}165\text{ lbs (tension)}\\ 29\text{ lbs (compression)}\end{matrix}$$

Choose rod size from *Sheet B1*.

⅜" rod capacity: allowable tension = 610 lbs

allowable compression = 260 lbs

Determine the need for rod stiffeners.

R = (6)Cos 27° = 5.3' = 64" (*See drawing at end*)

Maximum length for ⅜" rod to be used without stiffener is 14", from *Sheet B1*.

Therefore use ⅜" diameter rod with PS200 Rod Stiffener and PS3500 Stiffener Assembly.

9 From *Sheet C2*, verify brace adequacy:

PS200, 6' long brace has a compression load capacity of $F_{bALLOW}$ = 2230 lbs

The brace axial force is $F_b$ = 216 lbs

**$F_{bALLOW} > F_b$; Therefore the brace is adequate.**

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TITLE
**Trapeze Selection Sample Problem**

PAGE **A3**
DATE **04/25/2003**

10 From *Sheet B2 and B4*, select brace fittings:

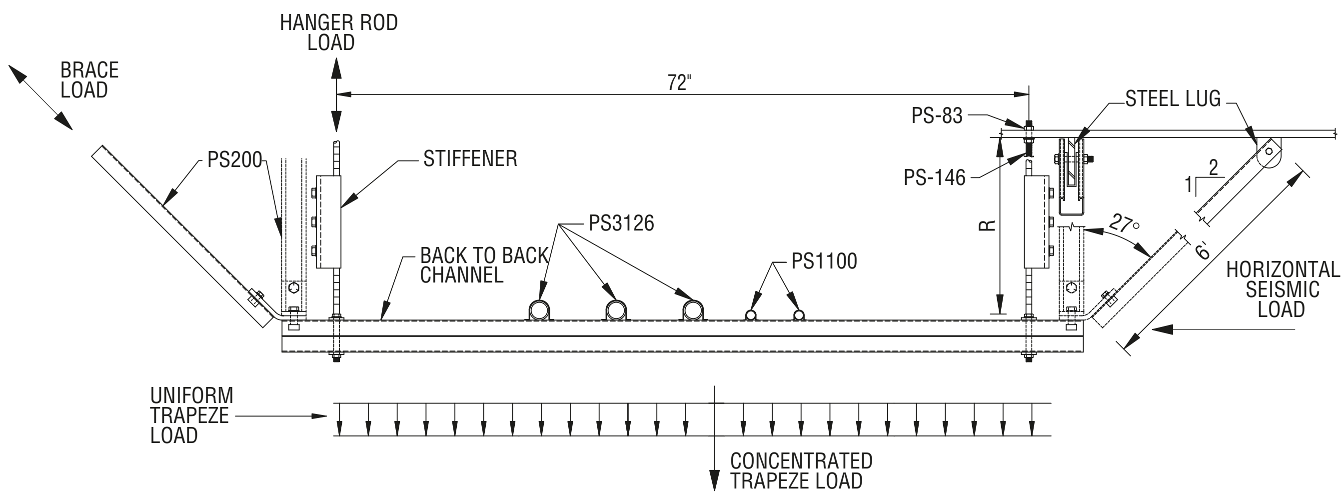
**PS9402 hinge connector with a single ½" diameter bolt in each leg.**
Maximum slip resistance = 1500 lbs
Maximum pullout resistance = 2000 lbs
Adequate for brace earthquake load, $F_b$ = 216 lbs.

11 Select anchorage detail:

**From *Sheet D1*, choose Beam Lug Assembly and Beam Rod Assembly**.

12 From *Sheet B7*, verify component strength:

**Use Steel Lug Fig. 55**.

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|---|---|---|
| | | PAGE A4 — DATE 04/25/2003 |

<u>STEPS</u> <u>*SINGLE PIPE HANGER PROCEDURE FOR WATER FILLED PIPE*</u>

1. **Select maximum support spacing**.
   From code or using *Sheet C1* (use smallest pipe diameter).
   Select rational brace spacing using *Sheet C3* as a guideline.

2. **Determine *pipe weight, Wt*.**
   *Sheet C4* can be used to get pipe weight or,
   By calculation: $Wt = \varnothing_{PIPE}$ Unit Weight x Rod Spacing

3. **Determine the *allowable seismic design load* (*Fp*) and the *unit seismic load* of the pipes.**
   With $h_x/h_r$ known, refer to *Sheet C5* to get *Fp*, (for a more accurate value of see *Sheet 2)*.
   Convert from strength design to working stress: $1.4\mathbf{F_p} = Fp$

4. **Determine lateral pipe forces.**
   Solve for both Longitudinal ($FH_L$) and Transverse ($FH_T$)**.**

5. **Select pipe hanger from *Sheets A11 and A12.***

6. **Determine clamp capacity adequacy from *Sheet A13*.**
   If the longitudinal clamp force capacity is less than the longitudinal, horizontal pipe force, provide additional longitudinal bracing or additional clamps.

7. **Determine brace earthquake loads.**
   Use *Sheet C2* and solve for brace horizontal, vertical, and axial force.

8. **Determine hanger rod axial forces and select rod size from *Sheet B1*.**
   Verify rod adequacy and determine the need for rod stiffeners.

   $F_{Rod\ Tension} = W_t + F_y$ $F_{Rod\ Compression} = W_t - Fy$

9. **Verify brace adequacy from *Sheet C2*.**

10. **Select *brace fitting* from *Sheet B3-B4*.**
    Use the required number of bolts as determined from *Sheet B2*.

11. **Select appropriate anchorage details from Section D "anchorage".**
    Adjust seismic load as necessary: $\mathbf{F_p}$ (shallow anchors) = 2 $\mathbf{F_p}$.

12. **Verify adequacy of anchorages.**

| | | |
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PROBLEM:

Determine the required vertical and lateral support for a single 4" diameter pipe placed above the ceiling of the 2nd floor (30' from grade) of a 45' building. The supporting structure is cast in place concrete. The brace slope is 1 vertical to 1 horizontal, and is 6'-0" long. Use shallow anchors, $R_p = 1.5$.

*SOLUTION (refer to Page A7):*

**STEPS DESCRIPTION**

1 From *Sheet C1*:

Hanger rod spacing: **$S_1$ = 14'**

Select rational brace spacing not to exceed maximum values listed on *Sheet C3*:

Transverse brace spacing: **$S_2$ = 28'**

Longitudinal Brace Spacing: **$S_3$ = 56'**

2 From *Sheet C4*, determine weight, Wt:

A 4"∅ pipe with hanger rods spaced at 14' results in a pipe weight of

**Wt. = 228 lbs**.

By calculation: 4"$\varnothing_{PIPE}$ @ 14' = 16.31 lbs/ft x 14' = 228 lbs

3 From *Sheet C5*, determine *Fp*:

$h_x/h_r$ = 30'/45' = 0.67

$R_p$ = 3.0

s = 0.99

Therefore *Fp* = $0.99W_p$ (for strength design)

1.4 $\mathbf{F_p}$ = $0.99W_p$

**$F_p$ = 0.71$W_p$ (for working stress design)**

Unit seismic load for 4"$\varnothing_{PIPE}$: $\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) = 0.71 (16.31 lbs/ft) = **11.58 lbs/ft**

4 Determine lateral pipe forces:

| | | | |
|---|---|---|---|
| $FH_T$ | = $\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) @ 28' | $FH_L$ | = $\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) @ 56' |
| | = 11.58 lbs/ft x 28' | | = 11.58 lbs/ft x 56' |
| | = **324 lbs** | | = **650 lbs** |

5 From *Sheets A11 and A12*, select a pipe hanger that can handle a Wt = 228:

**Grinnell adjustable steel yoke pipe roll, Fig 181**

Maximum allowable hanger rod force on hanger = 475lbs.

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TITLE

**Single Pipe Hanger Example**

PAGE A8

DATE 04/25/2003

6 From *Sheet A13* determine clamp capacity adequacy:

The brace clamp allowable load for a 4"$\varnothing_{PIPE}$ in the longitudinal (x) direction:
Brace Clamp $FH_{L\,ALLOW}$ = 200 lbs

Since, $FH_L$ = 650 lbs > $FH_{L\,ALLOW}$, provide additional Longitudinal Bracing.
Additional longitudinal bracing at 14':

New $FH_L$ = $\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) @ 14'
= 11.58 lbs/ft x 14'
= 162 lbs

**$FH_L$ = 162 lbs < $FH_{L\,ALLOW}$ = 200 lbs**
Therefore, acceptable use of brace clamp.

7 From *Sheet C2*, determine the brace slope factors for a 1-1 brace slope:

$K_x = 1.0$ $K_y = 1.0$ $K_b = 1.414$

Determine brace earthquake loads ($FH = FH_T = 2FH_L$):

$F_x = K_x(FH) = 1.0(324^\#) = \mathbf{324^\#}$
$F_y = K_y(FH) = 1.0(324^\#) = \mathbf{324^\#}$
$F_b = K_b(FH) = 1.414(324^\#) = \mathbf{458^\#}$

8 Determine the maximum axial force on the rod:

$F_{rod}(T) = Wt + F_y = 228^\# + 324^\# = 552^\#$
$F_{rod}(C) = Wt - F_y = 228^\# - 324^\# = -96^\#$

From *Sheet B1*, select rod size:

**5/8" rod is adequate,** $\mathbf{T_{ALLOW} = 1810^\# > F_{rod}(T) = 552^\#}$
$\mathbf{C_{ALLOW} = 775^\# > F_{rod}(C) = 96^\#}$

9 From *Sheet C2*, verify brace adequacy:

The 6' long brace has a compression load capacity of 2230 lbs.,
The seismic brace force, $F_b$ = 458 lbs.
**Capacity is greater than seismic load. Therefore it is adequate.**

10 From *Sheets B3 & B4*, select brace fittings:

Select fittings with the required number of bolts as determined from *Sheet B2*.

Try PS633

1/2" $\varnothing$ bolt
slip resistance = $1500^\#$ (greater than seismic brace loads)
pull out resistance = $2000^\#$ (greater than seismic brace loads)

| | | |
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| | | PAGE A9 — DATE 04/25/2003 |

11 From "anchorage section", *Sheet D1,* select anchorage:

**Use one bolt assembly for hanger anchorage.**
**Use one bolt assembly for brace anchorage.**

For Shallow Anchors: $(R_p/R_{pSHALLOW})\mathbf{F_p} = (3.0/1.5)\mathbf{F_p} = 2\ \mathbf{F_p}$ (seismic load doubles):

$\mathbf{F_p}$ **(Shallow Anchor)** $= (2)\mathbf{F_p} = (2)0.71W_p = \mathbf{1.42W_p}$

Unit seismic load for 4"$\varnothing_{PIPE}$: $(2)\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) = (2) 11.58 = **23.16 lbs/ft**

$FH_T$ = $(2)\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) @ 28'
= (2) 324#
= **648 lbs**

$FH_L$ = $(2)\mathbf{F_p}$ (4"$\varnothing_{PIPE}$) @ 56'
= (2) 650#
= **1300 lbs**

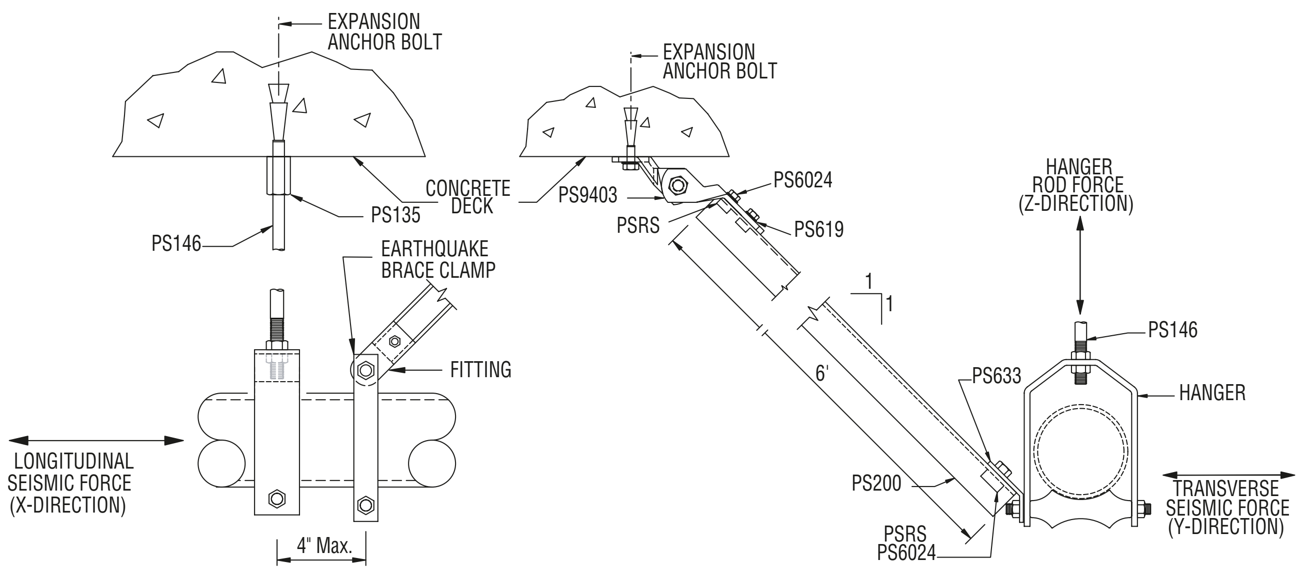
$F_x = K_x(FH) = 1.0(648^{\#}) = 648^{\#}$
$F_y = K_y(FH) = 1.0(648^{\#}) = 648^{\#}$
$F_b = K_b(FH) = 1.414(648^{\#}) = 916^{\#}$

12 From *Sheet C8*, verify anchorage adequacy from the allowable loads:

**Use 5⁄8" diameter expansion bolts,**
$T_{allow} = 1376^{\#}$
$V_{allow} = 1424^{\#}$

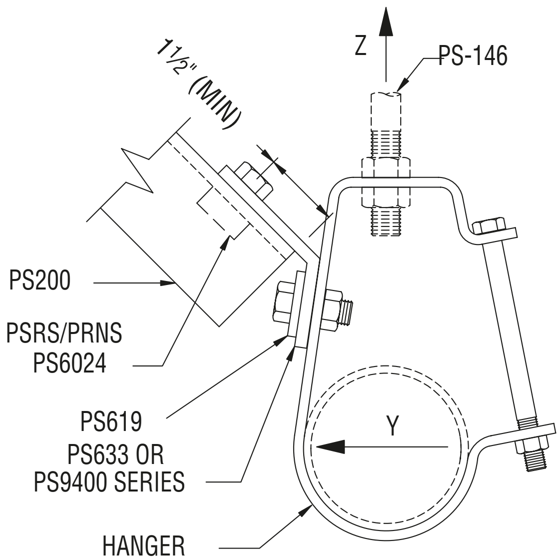
$$\left(\frac{F_b}{T_{allow}}\right)^{5/3} + \left(\frac{F_x}{V_{allow}}\right)^{5/3} \leq 1.0$$

$$\left(\frac{916}{1430}\right)^{5/3} + \left(\frac{648}{1448}\right)^{5/3} = 0.74 < 1.0$$

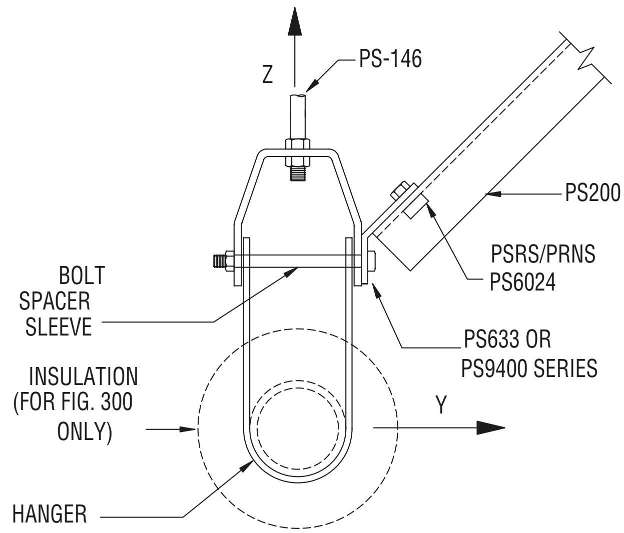



| APPROVED | | TITLE |
|---|---|---|
| **A P P R O V E D**<br>**Fixed Equipment Anchorage**<br>Office of Statewide Health Planning and Development<br>**OPA-0242 Apr 25, 2003**<br>**** Valid for 3 Years Maximum ****<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | **Single Pipe Hanger Example** |
| | | PAGE: **A10** DATE: **04/25/2003** |

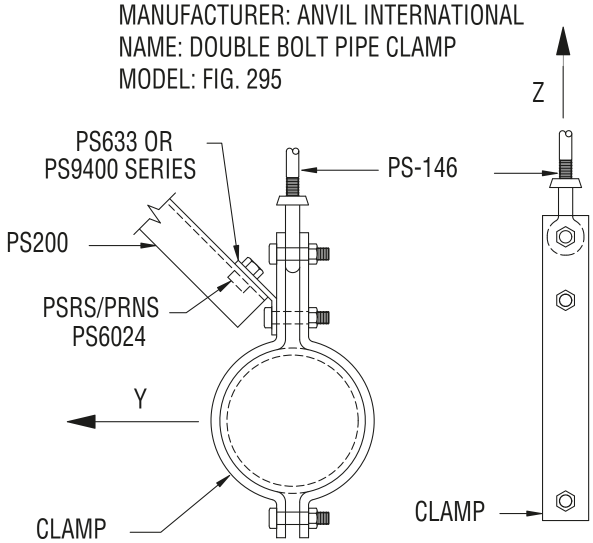
MANUFACTURER: ANVIL INTERNATIONAL
NAME: PIPE HANGER
MODEL: FIG. 67




MANUFACTURER: ANVIL INTERNATIONAL
NAME: ADJUSTABLE CLEVIS PIPE HANGER (INSULATED)
MODEL: FIG. 300, FIG. 260

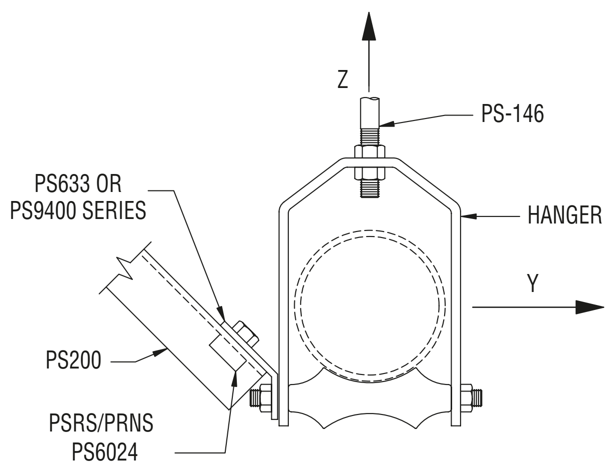



MANUFACTURER: ANVIL INTERNATIONAL
NAME: DOUBLE BOLT PIPE CLAMP
MODEL: FIG. 295




NOTE:
For pipe sizes greater than 3 ½" use PS9402
or PS9403 fitting.

MANUFACTURER: ANVIL INTERNATIONAL
NAME: ADJUSTABLE STEEL YOKE PIPE ROLL
MODEL: FIG. 181




NOTE:
For 5 & 6"∅ pipe use PS9400 fitting.
Brace attachment for 8" pipe shall be selected
and verified by the project engineer.

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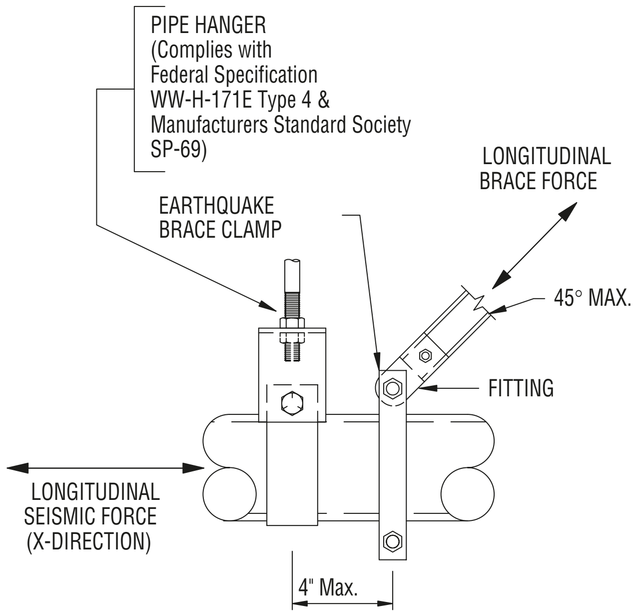
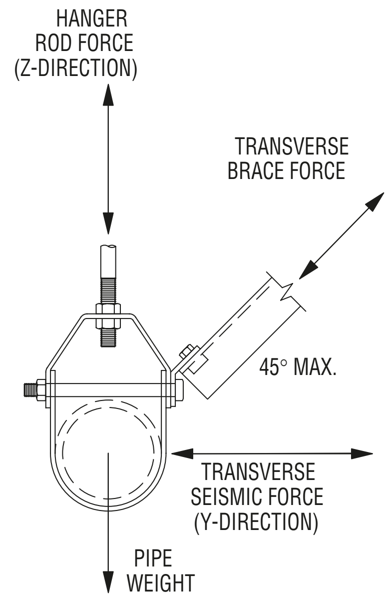
TITLE
**Single Pipe Hanger Assembly**

PAGE A11

DATE **04/25/2003**




PIPE SIDE VIEW




PIPE END VIEW

| MANUFACTURER: | Anvil International | Anvil International | Anvil International | Anvil International |
|---|---|---|---|---|
| NAME: | Pipe Hanger | Adj. Clevis Pipe Hanger | Double Bolt Pipe Clamp | Adj. St. Yoke Pipe Roll |
| MODEL: | Fig. 67 | Fig. 300, Fig. 260 | Fig. 295 | Fig. 181 |
| PIPE SIZE *(in)* | MAX. ALLOW. HANGER ROD LOAD (Z DIRECTION) | | | |
| | *(lbs)** | *(lbs)** | *(lbs)** | *(lbs)** |
| ½ | 400 | - | - | - |
| ¾ | 400 | 610 | 950 | - |
| 1 | 400 | 610 | 950 | - |
| 1 ¼ | 400 | 610 | 950 | - |
| 1 ½ | 400 | 610 | 1545 | - |
| 2 | 400 | 610 | 1545 | - |
| 2 ½ | 500 | 1130 | 1545 | 225 |
| 3 | 500 | 1130 | 1545 | 310 |
| 3 ½ | 500 | 1130 | - | 390 |
| 4 | 550 | 1430 | 2500 | 475 |
| 5 | 550 | 1430 | 2500 | 685 |
| 6 | 600 | 1940 | 2865 | 780 |
| 8 | - | 2000 | 2865 | 780 |

*NOTE: Determined by the manufacturer's testing, analysis and technical specifications.

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TITLE

**Single Pipe Hanger Load Table**

PAGE A12

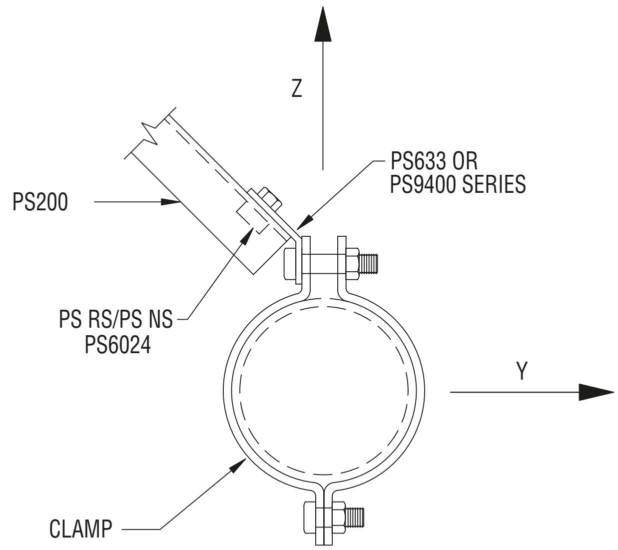
DATE 04/25/2003

**EARTHQUAKE BRACE CLAMP**
(Clamp, supplied by Others, complies with Federal Specification WW-H-171E Type 4 and Manufacturers' Standardization Society SP-58 Type4.)

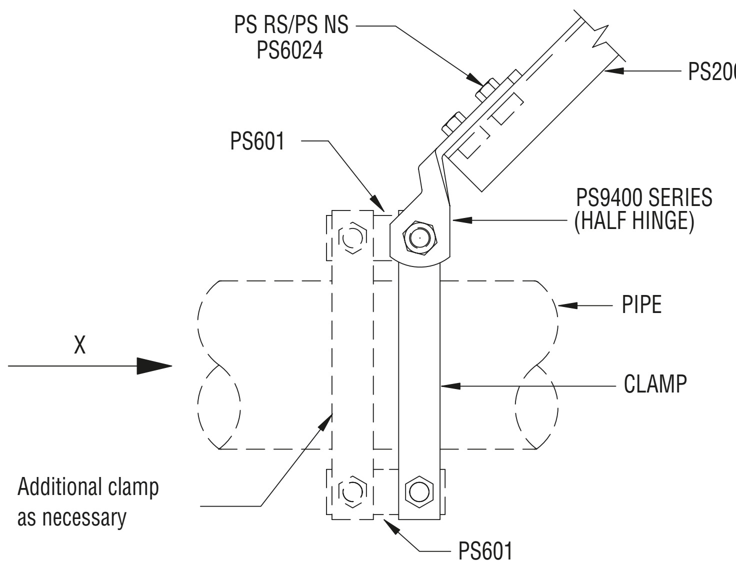
**LOAD SCHEDULE**

| Pipe Size *(in)* | Maximum Allowable Hanger Rod Load* *(lbs)* | |
|---|---|---|
| | (x-direction) | (y-direction) |
| ½ | 100 | 500 |
| ¾ | 100 | 500 |
| 1 | 100 | 500 |
| 1 ¼ | 100 | 500 |
| ½ | 100 | 800 |
| 2 | 200 | 1000 |
| 2 ½ | 200 | 1000 |
| 3 | 200 | 1000 |
| 3 ½ | 200 | 1000 |
| 4 | 200 | 1000 |
| 5 | 200 | 1000 |
| 6 | 375 | 1000 |
| 8 | 500 | 1000 |

*For fasterner tightening requirements see Page B2



TRANSVERSE BRACE



LONGITUDINAL BRACE

A P P R O V E D
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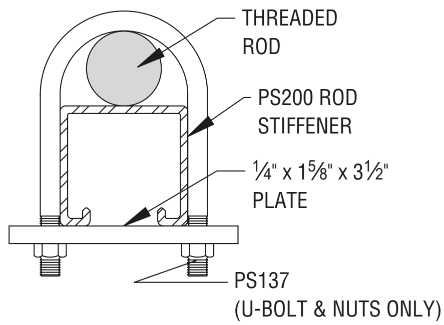
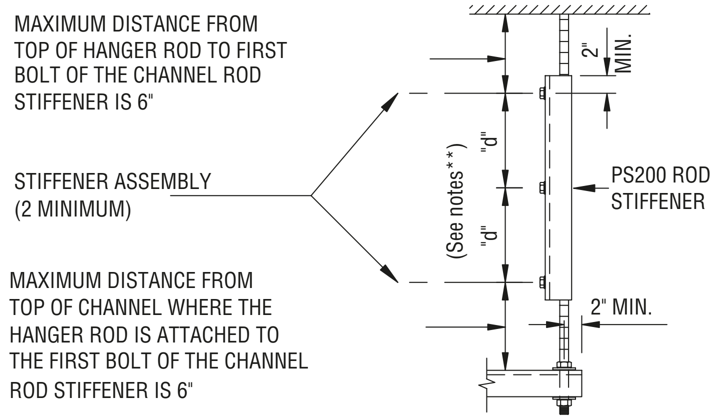
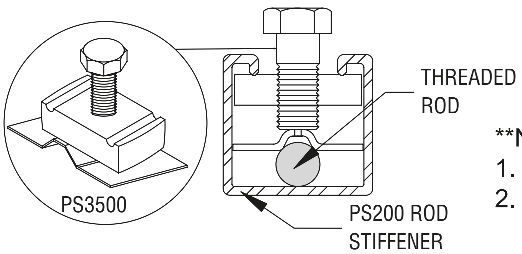
| TITLE | |
|---|---|
| **Single Pipe Hanger Brace/Clamp** | |
| PAGE A13 | DATE 04/25/2003 |




PS137 HANGER ROD STIFFENER ASSEMBLY
For ¾" & ⅞" Rods




THREADED ROD WITH STIFFENER




PS3500 HANGER ROD STIFFENER ASSEMBLY
For ⅜" thru ⅝" Rods

**NOTES:
1. Refer to following table for hanger rod load capacities.
2. Rod stiffeners may be omitted where:
   a. Hanger rod is installed without brace.
   b. Hanger rod is installed with transverse brace on every trapeze.
3. Stiffener required where rod is in compression and the rod length exceeds "d".

**HANGER ROD ALLOWABLE LOADS AND MAXIMUM UNBRACED LENGTHS**

| ROD SIZE DIAMETER | ALLOWABLE TENSION | MAXIMUM LENGTH W/O STIFFENER | ALLOWABLE COMPRESSION |
|---|---|---|---|
| *(inches)* | *(lbs)* | *(inches)* | *(lbs)** |
| ⅜ | 610 | 14 | 260 |
| ½ | 1130 | 20 | 483 |
| ⅝ | 1810 | 25 | 775 |
| ¾ | 2710 | 30 | 1247 |

NOTE: *A 33% increase of allowable rod loads is permitted where seismic loads are supported by lateral bracing.

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TITLE
**Hanger Rod with Stiffener**

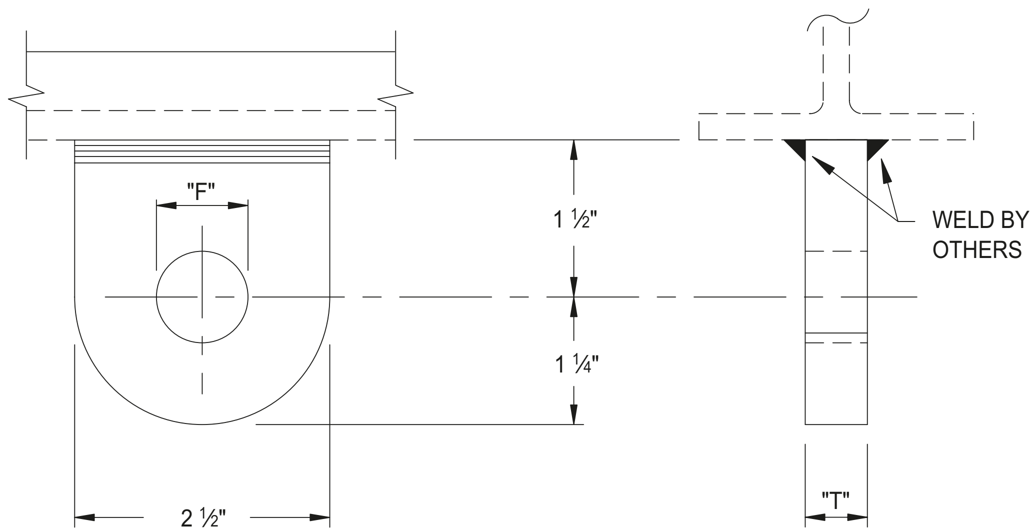
PAGE B1

DATE **04/25/2003**

MANUFACTURER: ANVIL

NAME: STEEL LUG

MODEL: FIG. 55




| ROD SIZE | MAXIMUM RECOMMENDED LOAD* | BOLT SIZE | "F" | "T" |
|---|---|---|---|---|
| *(in)* | *(lbs)* | *(in)* | *(in)* | *(in)* |
| ½ | 1130 | ⅝ | 1 1⁄16 | ¼ |
| ⅝ | 1810 | ¾ | 1 3⁄16 | ¼ |

*Determined by the manufacturer's testing analysis and technical specification

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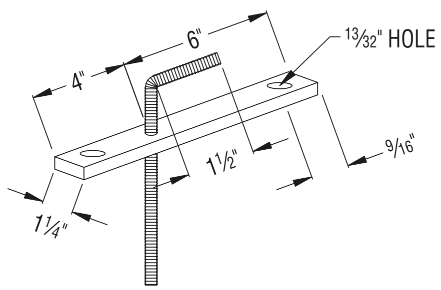
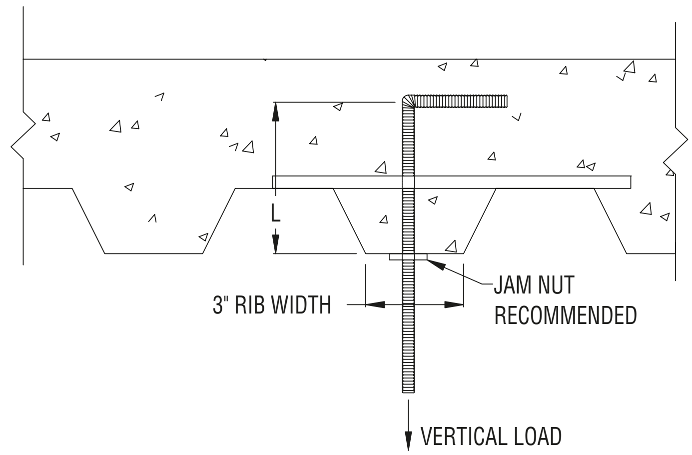
TITLE
**One Bolt Steel Lug**

PAGE B7

DATE **04/25/2003**




| Rod Diameter *(in)* | Load Rating *(lbs)* |
|---|---|
| 3/8 | 610 |
| 1/2 | 1130 |
| 5/8 | 1810 |

Notes:
1) Shallow anchors are those with an embedded length less than 8 times the diameter.
2) Loads are at the working level with a built in factor of safety.
3) **NOT FOR USE IN CALIFORNIA HOSPITALS OR SCHOOLS.**

## PS680
CONCRETE INSERT

| | | | |
|---|---|---|---|
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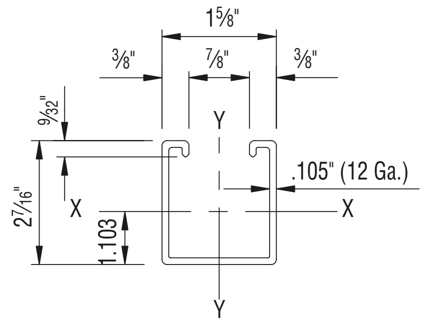
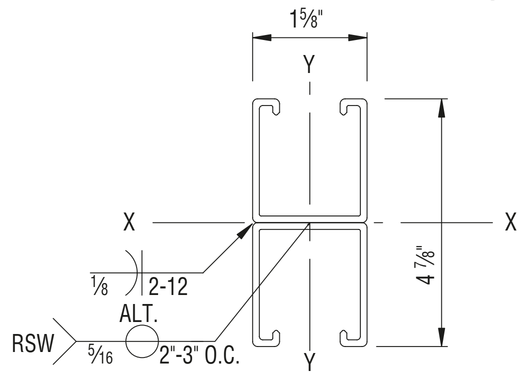
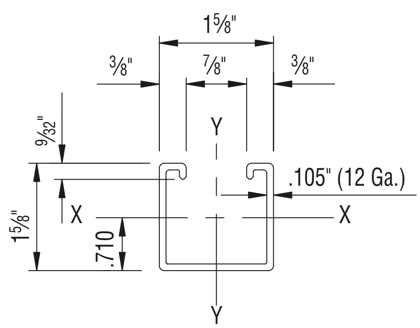
| | | PAGE<br>**B9** | DATE<br>**04/25/2003** |



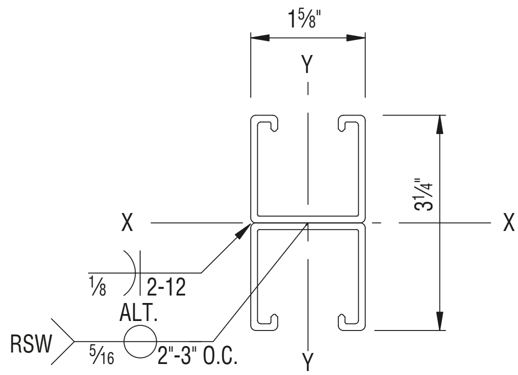

## PS 150
STEEL CHANNEL




## PS 150 2T3
WELDED STEEL CHANNEL




## PS 200




## PS 200 2T3

**PROPERTIES**

| CHANNEL | AREA (in²) | X-X AXIS MOMENT OF INERTIA (in⁴) | X-X AXIS SECTION MODULUS (in³) | X-X AXIS RADIUS OF GYRATION (in) | Y-Y AXIS MOMENT OF INERTIA (in⁴) | Y-Y AXIS SECTION MODULUS (in³) | Y-Y AXIS RADIUS OF GYRATION (in) |
|---|---|---|---|---|---|---|---|
| PS200 | 0.556 | 0.185 | 0.202 | 0.577 | 0.236 | 0.290 | 0.651 |
| PS200 2T3 | 1.112 | 0.930 | 0.572 | 0.915 | 0.472 | 0.580 | 0.651 |
| PS150 | 0.726 | 0.523 | 0.391 | 0.848 | 0.335 | 0.412 | 0.679 |
| PS150 2T3 | 1.453 | 2.811 | 1.153 | 1.391 | 0.669 | 0.824 | 0.679 |

**A P P R O V E D**

**Fixed Equipment Anchorage**

**Office of Statewide Health Planning and Development**

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TITLE

**Channel Properties**

PAGE **B11**

DATE **04/25/2003**

## PIPE DATA
### DATA FOR SCHEDULE 40 STANDARD WEIGHT PIPE

| Pipe Size | Pipe Section Modulus* | Maximum Support Spacing | Minimum Rod Diameter | Weight of Pipe Plus Water |
|---|---|---|---|---|
| (in) | (in^3) | (feet) | (in) | (lbs/ft) |
| ½ | 0.041 | 7 | ⅜ | 0.98 |
| ¾ | 0.071 | 7 | ⅜ | 1.36 |
| 1 | 0.133 | 7 | ⅜ | 2.05 |
| 1 ¼ | 0.235 | 7 | ⅜ | 2.93 |
| 1 ½ | 0.326 | 9 | ⅜ | 3.60 |
| 2 | 0.561 | 10 | ⅜ | 5.11 |
| 2 ½ | 1.060 | 11 | ½ | 7.87 |
| 3 | 1.720 | 12 | ½ | 10.78 |
| 3 ½ | 2.390 | 13 | ½ | 13.39 |
| 4 | 3.210 | 14 | ⅝ | 16.31 |
| 5 | 5.450 | 16 | ⅝ | 23.29 |
| 6 | 8.500 | 17 | ¾ | 31.51 |
| 8 | 16.800 | 19 | ¾ | 50.29 |

Note:
Pipe Section and Weight data taken from manual of Steel Concstruction, ASD 9th Ed.
Maximum Support Spacing taken from ASME B31.1
*Maximum Support Spacing limited by CPC 2001
Reference Appendix for NFPA Pipe Data.

## BRACE DESIGN LOAD TABLE
### PS200

| UNSUPPORTED LENGTH | COMPRESSION LOAD* |
|---|---|
| *(in)* | *(lbs)* |
| 24 | 4,200 |
| 36 | 3,650 |
| 48 | 3,130 |
| 60 | 2,650 |
| 72 | 2,230 |
| 84 | 1,850 |
| 96 | 1,570 |
| 108 | 1,360 |
| 120 | 1,200 |

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

## BRACE SLOPE FACTORS

| *BRACE RISE: SLOPE RUN* | *SLOPE FACTORS* | | |
|---|---|---|---|
| | *Kb* | *Kx* | *Ky* |
| 1: 1 | 1.414 | 1.000 | 1.000 |
| 1: 2 | 1.118 | 1.000 | 0.500 |
| 1: 3 | 1.054 | 1.000 | 0.333 |
| 1: 4 | 1.031 | 1.000 | 0.250 |

$$K_b = \sqrt{K_x^2 + K_y^2}$$

$$K_x = 1.000$$

$$K_y = \frac{1}{run}$$

Brace Horizontal Force Component: Fx = Kx(FH)
Brace Vertical Force Component: Fy = Ky(FH)
Brace Axial Force: Fb = Kb(FH)

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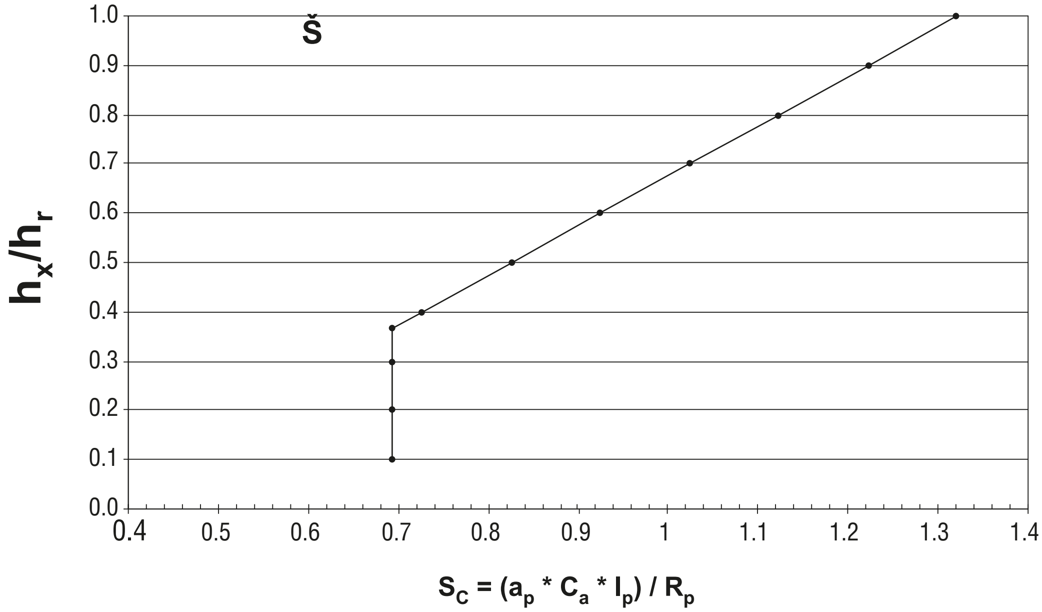
TITLE
**Pipe Data**
**Brace Design**

PAGE C1/C2

DATE 04/25/2003

## SEISMIC DESIGN COEFFICIENT




NOTE: THE FOLLOWING ASSIGNED VALUES ARE USED BY THE SEISMIC DESIGN TABLE.

$a_p$ = 1.0 $h_r$ = varies: Roof Elevation of Building
$C_a$ = 0.66 $h_x$ = varies: Element Attachment Elevation with respect to grade
$I_p$ = 1.5 $R_p$ = 3.0

Where :
$$F_p = \frac{a_p C_a I_p}{R_p}\left[1 + 3\frac{h_x}{h_r}\right]W_p = \left(0.33\left[1 + 3\frac{h_x}{h_r}\right]\right)W_p = (s_c)(W_p)$$

For Shallow Anchors $(Rp = 1.5)$:

$$F_p\,(\text{shallow anchors}) = \frac{R_{p(3.0)}}{R_{p(1.5)}}(s_c)(W_p) = 2(s_c)(W_p)$$

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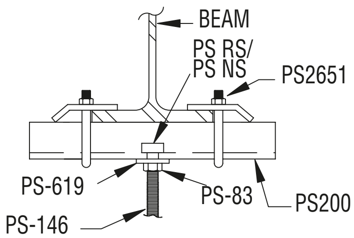
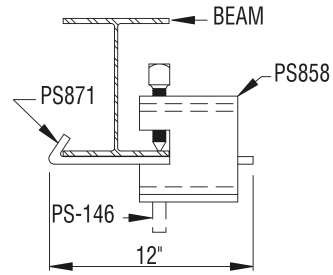
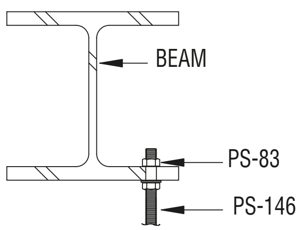
| TITLE | |
|---|---|
| **Seismic Force Graph** | |
| PAGE | DATE |
| **C5** | **04/25/2003** |



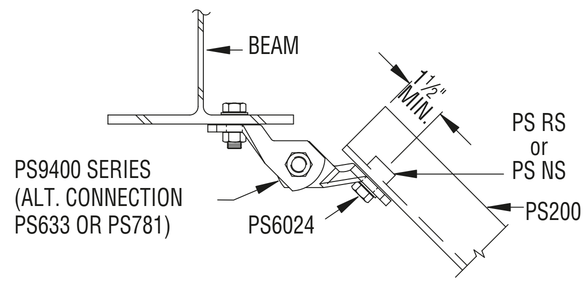

BEAM CLAMP ASSEMBLY*



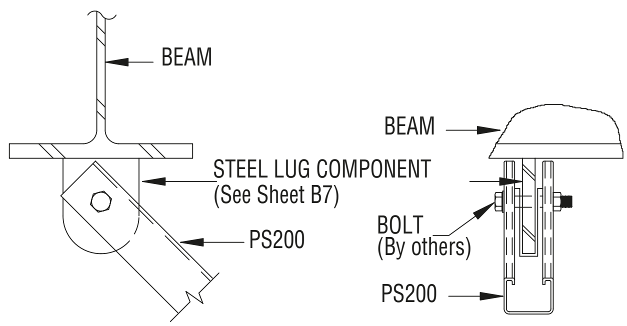

HEAVY BEAM CLAMP ASSEMBLY*




BEAM ROD ASSEMBLY*




BEAM CLIP ASSEMBLY*




BEAM LUG ASSEMBLY*

*Note:
1. The adequacy of the steel beam and its support connections shall be verified by the project structural engineer.
2. Refer to Component Index for reference drawings.

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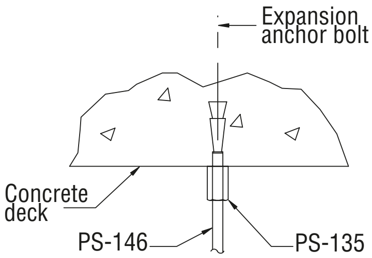
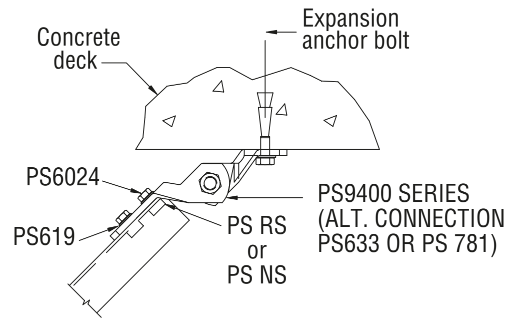
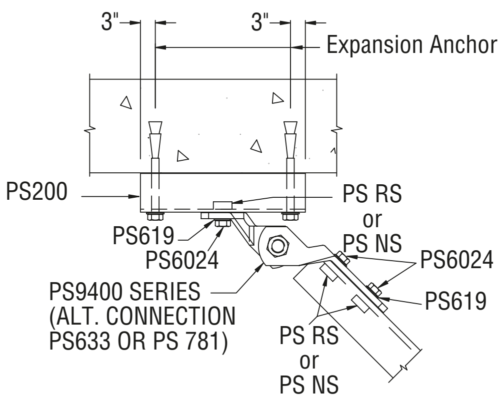
| TITLE | |
|---|---|
| Steel | |
| PAGE D1 | DATE 04/25/2003 |



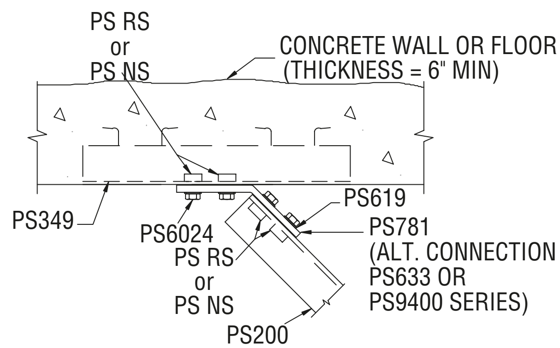

ONE BOLT ASSEMBLY*
(Connections not for use in
pre-stressed concrete deck)




ONE BOLT ASSEMBLY*




TWO BOLT ASSEMBLY*




EMBEDMENT CHANNEL*
(Minimum edge distance = 6")

*Note:

1. Refer to Sheet C8 & C9 for expansion bolt capacity and testing.
2. The project engineer shall verify the adequacy of the concrete and the overall structural system.
3. Refer to Component Index for reference drawings.

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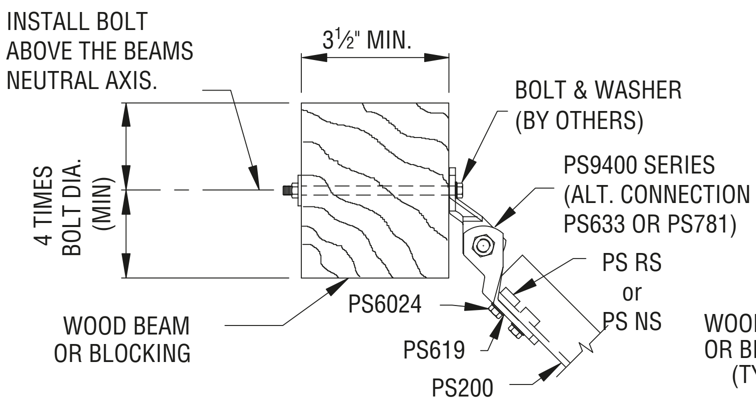
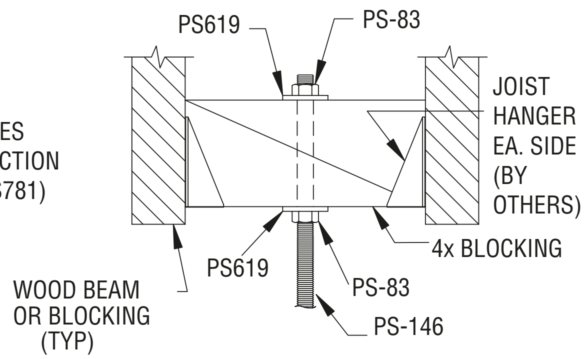
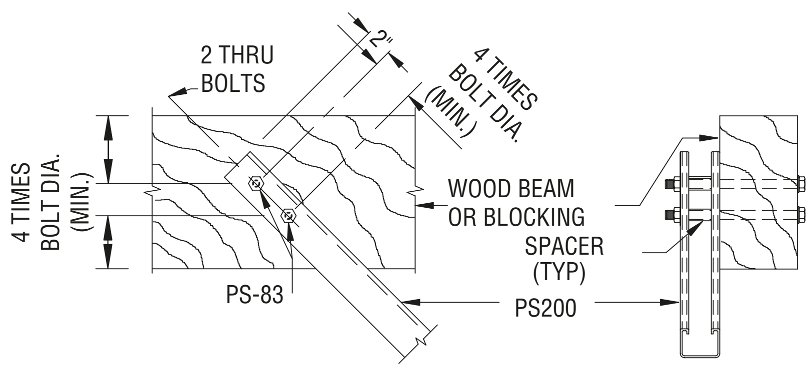
| TITLE | |
|---|---|
| **Concrete** | |
| PAGE **D2** | DATE **04/25/2003** |




BEAM CLIP ASSEMBLY*




BEAM ROD ASSEMBLY*




BRACE ASSEMBLY*

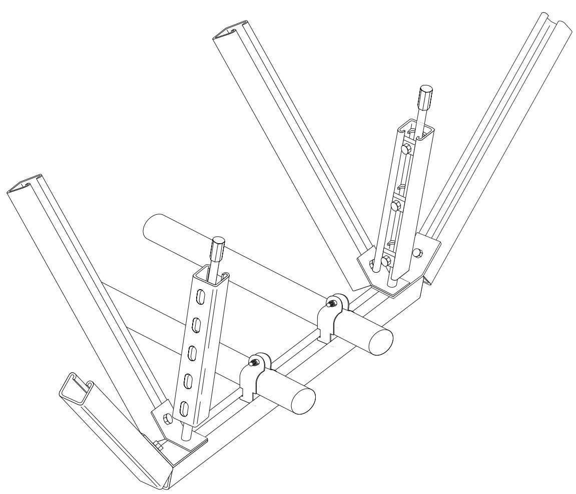
*Note:

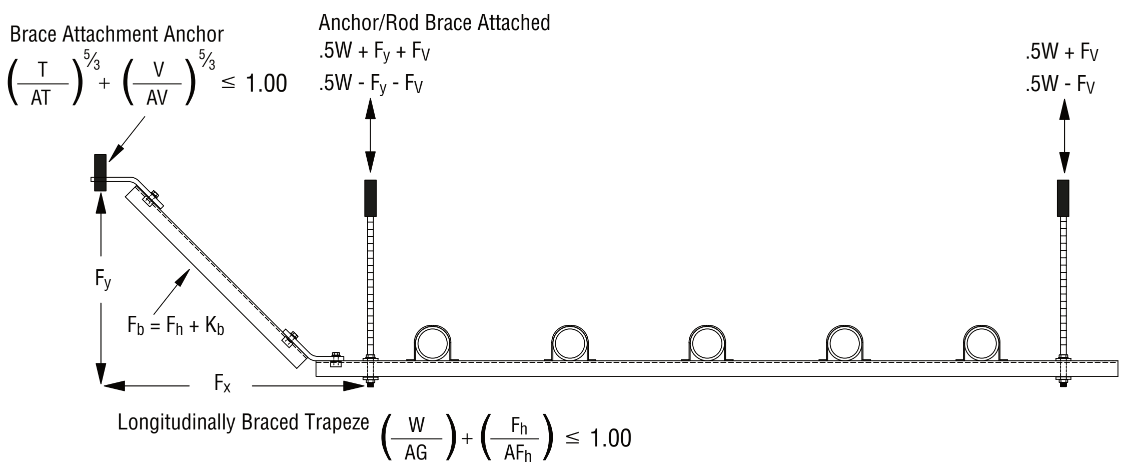
1. The adequacy of the wood beam and 4x blocking (Beam Rod Assy.) and its support connections shall be verified by the project engineer.
2. Refer to Component Index for reference drawings.

| | | | |
|---|---|---|---|
| A P P R O V E D<br>Fixed Equipment Anchorage<br>Office of Statewide Health Planning and Development<br>OPA-0242 Apr 25, 2003<br>**** Valid for 3 Years Maximum ****<br>Bill Staehlin (916) 324-9106 | JOSEPH L. LA BRIE<br>Structural Engineer<br>No. SE 3566<br>55 E Huntington Dr<br>Suite 277<br>Arcadia, CA 91006 | TITLE<br>**Wood** | |
| | | PAGE<br>**D3** | DATE<br>**04/25/2003** |

POWER-STRUT®

| A SEISMIC RESTRAINT SYSTEM SHOULD INCLUDE CHECKS FOR THE FOLLOWING | |
|---|---|
| **ANCHOR** | **POWER-STRUT** |
| 1. Brace Attachment. | Yes |
| 2. Anchor for rods supporting gravity (vertical) loads. | Yes |
| 3. Anchors supporting rods attached to braces. | Yes |
| **ROD** | |
| 1. Rods supporting gravity loads. | Yes |
| 2. Rods attached to braces must include the vertical force component tension. | Yes |
| 3. Rods attached to braces must include the vertical force component compression. | Yes |
| 4. Vertical Seismic (CBC) added to all rods | Yes |
| 5. Rod Shear when brace attached to rod | Yes |
| **TRAPEZE** | |
| 1. SUPPORT—Gravity load only. | Yes |
| 2. BRACED—Must include combined gravity and longitudinal force interaction. | Yes |
| **PIPE CLAMP** | |
| 1. Vertical (gravity) load ratings. | Yes |
| 2. Transverse load ratings. | Yes |
| 3. Longitudinal load ratings. | Yes |
| **BRACE** — Tension and Compression | Yes |
| **BRACE ATTACHMENT** | Yes |
| **BOLT-NUT** (Must include combined shear and tension.) | Yes |





## 2001 CALIFORNIA BUILDING CODE

**1632A.6.1** All trapeze assemblies supporting pipes, ducts and conduit shall be braced to resist the forces of Section 16324.2, considering the total weight of the elements on the trapeze.

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 or directional changes do not restrict the movement of the trapeze. If this flexibility is not provided, bracing will be required when the aggregate weight of the pipes and conduit exceed 10 pounds/feet (146 N/rn). The weight shall be determined assuming all pipes and conduit are filled with water.

*Note, this section is only in part A of the CBC for DSA and OSHPD. By requiring water-filled weights it permits their use even where wire filled conduit weights may be greater. On non-OSHPD or DSA projects actual weights may be required. There are instances where part A requirements and exceptions are less stringent.*

## FILLED PIPE/CONDUIT WEIGHTS PER FOOT

| | Sched 40 | GRC | | EMT | | IMC | | Rigid Aluminum | |
|---|---|---|---|---|---|---|---|---|---|
| Trade Size | $H_2O$ Filled | $H_2O$ Filled | @ Max | $H_2O$ Filled | @ Max | $H_2O$ Filled | @ Max | $H_2O$ Filled | @ Max |
| ½” | 0.98 | 0.96 | 1.06 | 0.43 | 0.53 | 0.78 | 0.86 | 0.42 | 0.52 |
| ¾” | 1.36 | 1.33 | 1.51 | 0.69 | 0.88 | 1.10 | 1.30 | 0.62 | 0.79 |
| 1” | 2.05 | 2.03 | 2.37 | 1.05 | 1.40 | 1.62 | 1.97 | 0.95 | 1.27 |
| 1 ¼” | 2.92 | 2.85 | 3.37 | 1.66 | 2.23 | 2.31 | 2.91 | 1.42 | 1.94 |
| 1 ½” | 3.60 | 3.53 | 4.33 | 2.05 | 2.92 | 2.90 | 3.70 | 1.81 | 2.64 |
| 2” | 5.11 | 5.00 | 6.61 | 2.94 | 4.58 | 4.16 | 5.51 | 2.70 | 4.28 |
| 2 ½” | 7.87 | 7.78 | 10.05 | 4.84 | 7.72 | 6.67 | 9.45 | 4.05 | 6.26 |
| 3” | 10.78 | 10.52 | 14.79 | 6.53 | 11.87 | 8.91 | 13.83 | 5.78 | 9.99 |
| 3 ½” | 13.39 | 13.14 | 18.83 | 8.50 | 14.69 | 10.93 | 17.49 | 7.39 | 12.99 |
| 4” | 16.31 | 15.90 | 23.55 | 10.40 | 18.16 | 12.97 | 21.00 | 9.19 | 16.74 |
| 5” | 23.28 | 22.76 | 33.86 | | | | | 13.64 | 24.65 |
| 6” | 31.51 | 31.04 | 46.40 | | | | | 18.98 | 34.30 |

EMT, IMC and GRC weights are combined conduit and copper conductor at maximum fill with 3 or more conductors per the 2005 NEC.

## CONDUCTOR WEIGHTS PER FOOT

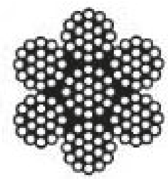
| THHN | Wt/Ft |
|---|---|
| #14 | .017 |
| #12 | .026 |
| #10 | .040 |
| #8 | .066 |
| #6 | .100 |
| #4 | .159 |
| #3 | .203 |
| #2 | .241 |
| #1 | .306 |
| 1/0 | .379 |
| 2/0 | .470 |
| 3/0 | .584 |
| 4/0 | .730 |
| 250 | .870 |
| 300 | 1.030 |
| 350 | 1.194 |
| 400 | 1.355 |
| 500 | 1.680 |
| 600 | 2.023 |
| 750 | 2.508 |
| 800 | 2.800 |
| 900 | 3.055 |
| 1000 | 3.310 |

## CONDUIT WEIGHTS PER FOOT

| Trade Size | GRC | GRC PV | PVC | Al |
|---|---|---|---|---|
| ½” | 0.82 | .90 | 0.13 | 0.28 |
| ¾” | 1.09 | 1.20 | 0.23 | 0.37 |
| 1” | 1.65 | 1.70 | 0.35 | 0.55 |
| 1 ¼” | 2.18 | 2.20 | 0.48 | 0.72 |
| 1 ½” | 2.63 | 2.70 | 0.57 | 0.89 |
| 2” | 3.52 | 3.60 | 0.76 | 1.19 |
| 2 ½” | 5.67 | 5.70 | 1.25 | 1.88 |
| 3” | 7.27 | 7.40 | 1.64 | 2.46 |
| 3 ½” | 8.80 | 8.80 | 1.98 | 2.96 |
| 4” | 10.31 | 10.10 | 2.34 | 3.50 |
| 5” | 14.00 | 133.75 | 3.17 | 4.79 |
| 6” | 18.40 | 199.30 | 4.12 | 6.30 |
| **Trade Size** | **EMT** | **IMC** | **SS** | **Al EMT** |
| ½” | 0.30 | 0.60 | 0.85 | |
| ¾” | 0.46 | 0.82 | 1.13 | |
| 1” | 0.68 | 1.16 | 1.68 | |
| 1 ¼” | 1.01 | 1.50 | 2.27 | |
| 1 ½” | 1.17 | 1.82 | 2.72 | |
| 2” | 1.49 | 2.42 | 3.65 | 0.57 |
| 2 ½” | 2.30 | 4.28 | 5.79 | 0.85 |
| 3” | 2.70 | 5.26 | 7.58 | 1.06 |
| 3 ½” | 3.49 | 6.12 | | 1.37 |
| 4” | 4.00 | 6.82 | 10.79 | 1.60 |

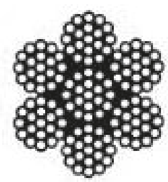
## ALLOWABLE LOAD

### 7 X 19 GALVANIZED WIRE ROPE



| Cable Diameter | SF = 5 | Pre-stretched SF = 3 |
|---|---|---|
| 3/32 | 200 | 300 |
| 1/8 | 400 | 650 |
| 3/16 | 840 | 1400 |
| 1/4 | 1400 | 2300 |
| 5/16 | 1960 | 3200 |
| 3/8 | 2880 | 4800 |

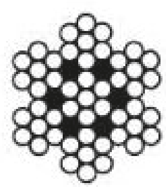
### 7 X 19 STAINLESS WIRE ROPE



| Cable Diameter | Type 302/304 | Type 316 |
|---|---|---|
| 1/8 | 350 | |
| 3/16 | 740 | 580 |
| 1/4 | 1280 | 980 |
| 5/16 | 1800 | 1520 |
| 3/8 | 2400 | 2200 |

1. Safety Factor = 5 on minimum breaking strength.
2. Reduce allowable loads 15% when using “U-Bolt” type cable clamps.
3. OSHPD may allow a safety factor of 3 for pre-stretched aircraft cable.
4. UL Listed Wire Rope/Cable (Aircraft Cable) conforming to the applicable requirements of ASTM A-603 for materials and strengths which has been pre-stretched and which utilize end fittings that maintain the breaking strength of the cable may be permitted a safety factor of 1 ½.

### 7 x 7 WIRE ROPE (For comparison)



| Cable Diameter | Galvanized | Stainless 302 |
|---|---|---|
| 3/16 | 740 | 740 |
| 1/4 | 1220 | 1220 |
| 5/16 | 1960 | 1800 |
| 3/8 | 2880 | 2400 |

## Allied Electrical Conduit

### Steel Conduit
- Rigid (GRC)
- IMC

### Aluminum Conduit
- Rigid
- Aluminum Elbows
- Aluminum Couplings

### Steel EMT
- True Color™ EMT
- Fire Alarm™
- Blue EMT
- E-Z Pull® EMT

### Kwik Products
- Kwik-Fit® EMT (built-in set-screw coupling)
- Kwik-Couple® IMC/GRC (built-in 3 piece rotating coupling)
- Kwik-Fit® Compression EMT (built-in compression fitting)

### PVC
- Rigid PVC
- Schedule - 40 & 80 Products
- EB/DB Duct
- Fittings, Spacers, & Accessories

## AFC Cable Systems®

### AC & MC Cable
- MC TUFF® Lightweight Steel (MC) Cable
- MC TUFF® IG (MC) Cable with Isolated Ground
- MC-Lite® Metal Clad Aluminum (MC) Cable
- HCF-90® & HCF-Lite®
- AC-90® & AC-Lite®
- Fire Alarm/Control Cable™
- Home Run Cable®
- Parking Deck/Lot Cable™
- Super Neutral Cable®

### Flexible Conduit
- LIQUID-TUFF™ Liquid-Tight Flexible Conduit
- Full and Reduced Wall Flexible Metal Conduit

### Fittings
- EMT Steel Compression & Set-Screw Fittings
- Liquid-Tight Metallic & Non-Metallic Fittings
- MC/AC Cable Connectors

### AFC Accessories
- Lighting, Power, & Appliance Whips
- Temp-Lites®
- Bare Armored Ground

### ACS/Uni-Fab
- Modular Lighting Systems
- Raised Floor Assemblies
- Pre-Fab Assemblies
- Custom Fabrication

## Power-Strut® Framing Systems

### Channel
- Steel Channel
- Aluminum Channel
- Stainless Steel Channel
- Fiberglass Channel
- Junior Strut

### Fittings & Accessories
- Strut Brackets
- Strut Fittings
- Pipe Clamps
- Threaded Rods
- Fiberglass Fittings
- Junior Strut Fittings
- Concrete Inserts
- Power-Angle® Slotted Angles

### Finishes
- Pre-Galvanized Channel
- Power-Green® Channel
- Hot-Dip Galv. Channel
- Power-Gold™ Channel

## Cope® Cable Tray Systems

### Aluminum Tray
- Aluminum Ladder Tray
- Aluminum Hat Tray
- Aluminum Trof Tray
- Aluminum Channel
- Aluminum Fittings

### Steel Tray
- Steel Ladder Tray
- Steel Hat Tray
- Steel Trof Tray
- Steel Channel
- Steel Fittings

### Fiberglass Tray
- Cope-glas™ Fiberglass Tray
- Fiberglass Fittings

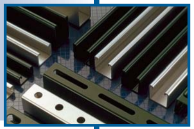
### Wire Basket
- CAT-TRAY™ Wire Basket
- CAT-TRAY™ Accessories

### Center Hung Tray
- Centipede® Center Hung Tray
- Centipede® Accessories

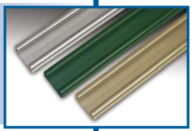
### Other Cope Products
- Cable Channel

# POWER-STRUT®
# Family of Innovative Products

- CHANNELS



- VARIETY OF FINISHES



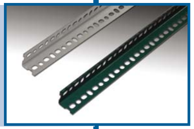
- CLAMPS

- PIPE CLAMPS

- BRACKETS & INSERTS

- PLATES

- POWER-ANGLE®
  Slotted Angles



- AICKINSTRUT®
  Non-Metallic Framing System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