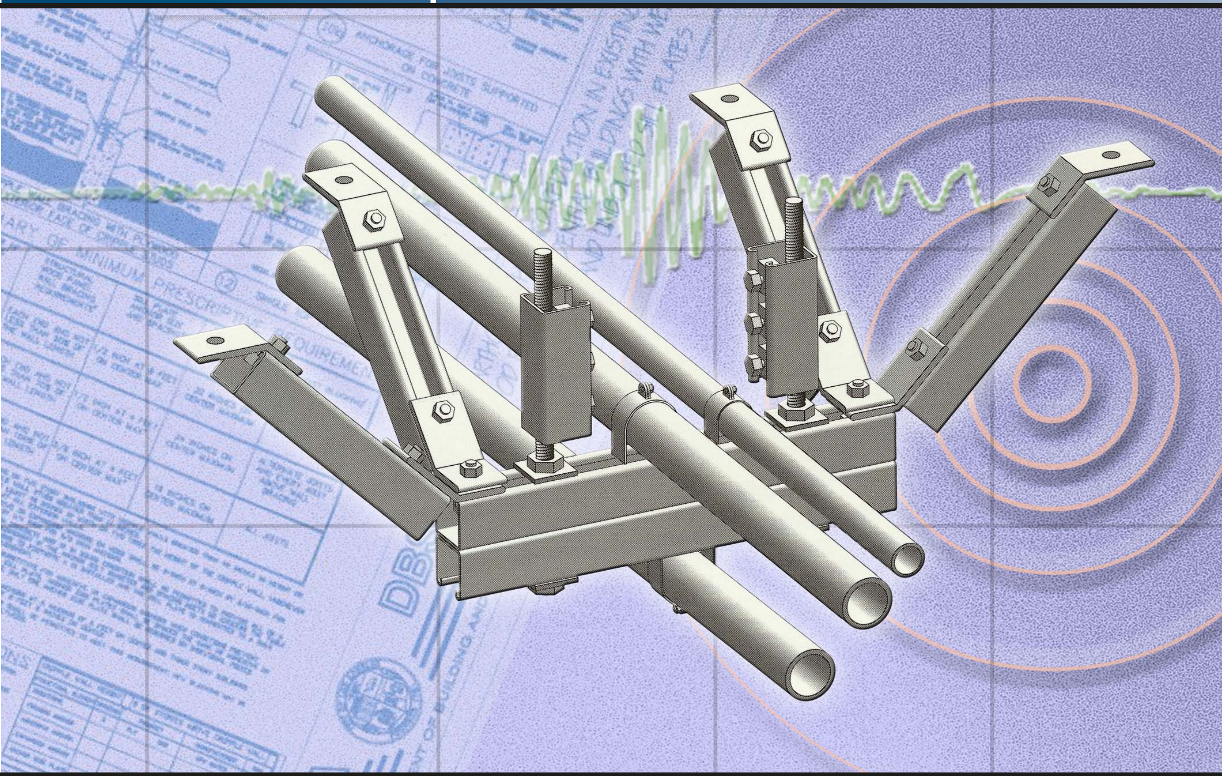
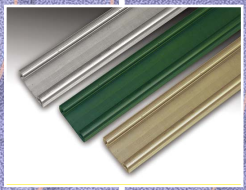
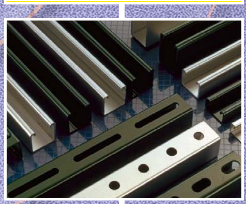
POWER-STRUT®

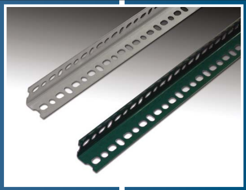
Seismic Bracing Systems

Electrical/Mechanical Uses









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

Electrical Infrastructure Solutions™

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.

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

POWER-STRUT®

TABLE OF CONTENTS

PREFACE

POWER-STRUT®

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.

S U B M I T T E D

OPA-0242, Rev 1

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TITLE

Preface

PAGE: i

DATE: **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.

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

GENERAL INFORMATION

POWER-STRUT®

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 ******
Bill Staehlin (916) 324-9106

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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, $Fp_{Shallow}$
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

GENERAL INFORMATION

POWER-STRUT®

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
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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		Min. Rod Dia.	Normal Weight Concrete (3,000psi min.)			LWC on 20ga Metal Deck (3,000psi)			Structural Wood Beam		Structural Bolting	
		Trans.	Long.		Qty	Dia.	Embed.	Qty	Dia.	Embed.	Thru Bolt	Dia.	A307 Bolt	Dia.
(in)	*Figure No.*	*(ft)*	*(ft)*	*(in)*	*(Min.)*	*(in)*	*(in)*	*(Min.)*	*(in)*	*(in)*	*Qty.*	*(in)*	*Qty.*	*(in)*
½	PS 67	40	80	⅜	1	⅜	3	1	⅜	3	1	½	1	½
¾	Type 3 Type 1 PS 67	40	80	⅜	1	⅜	3	1	⅜	3	1	½	1	½
1	Type 3 Type 1 PS 67	40	80	⅜	1	⅜	3	1	⅜	3	1	½	1	½
1½	Type 3 Type 1 PS 67	40	80	⅜	1	⅜	3	2	⅜	3	1	¾	1	½
2	Type 3 Type 1 PS 67	40	60	⅜	1	⅜	3	2	⅜	3	1	¾	1	½
2½	Type 3 Type 1 Type 43 PS 67	40	60	½	1	½	4⅛	2	½	4	2	½	1	½
3	Type 3 Type 1 Type 43 PS 67	40	40	½	1	½	4⅛	2	½	4	2	½	1	½
4	Type 3 Type 1 Type 43 PS 67	40	40	⅝	1	⅝	5⅛	2	⅝	5	2	⅝	1	½
5	Type 3 Type 1 Type 43 PS 67	30	30	⅝	2	½	4⅛	2	⅝	5	2	¾	1	½
6	Type 3 Type 1 Type 43 PS 67	20	20	¾	2	½	4⅛	2	⅝	5	2	¾	1	½
8	Type 3 Type 1 Type 43	10	10	¾	2	½	4⅛	2	⅝	5	2	¾	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. 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. ½" 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	½	1	½	4⅛	1	½	4	1	½	1	½
7	40	10	10	10	10	½	1	½	4⅛	1	½	4	1	⅝	1	½
10	40	8	10	10	10	½	1	½	4⅛	1	⅝	5	2	½	1	½
12	40	6	10	10	10	½	1	½	4⅛	1	⅝	5	2	½	1	½
15	40	5	10	8	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
17	40	5	10	8	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
20	30	5	10	8	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
22	30	5	10	7	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
25	20	5	10	7	10	½	2	½	4⅛	2	½	4	2	½	1	½
27	20	5	10	7	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
30	20	4	10	7	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
32	20	4	10	6	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
35	10	4	10	6	10	½	2	½	4⅛	2	½	4	2	½	1	½
37	10	4	10	6	10	½	2	½	4⅛	2	½	4	2	½	1	½
40	10	4	10	6	10	½	2	½	4⅛	2	½	4	2	½	1	½
42	10	4	10	6	10	½	2	½	4⅛	2	½	4	2	½	1	½
45	10	4	10	6	10	½	2	½	4⅛	2	½	4	2	½	1	½
47	10	4	10	6	10	½	2	½	4⅛	2	½	4	2	⅝	1	½
50	10	4	9	6	10	½	2	½	4⅛	2	½	4	2	⅝	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 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

PAGE
6

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.

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

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

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 2^{nd} 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**

S U B M I T T E D

OPA-0242, Rev 1

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TITLE

Trapeze Selection Sample Problem

PAGE **A2**

DATE **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 $^3/_8$" 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)

SUBMITTED		TITLE
OPA-0242, Rev 1	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	**Trapeze Selection Sample Problem**
		PAGE A3 / DATE 04/21/2005

Determine the need for rod stiffeners.

From Table Page B1, Determine Maximum Allowed Compression for 3/8" 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

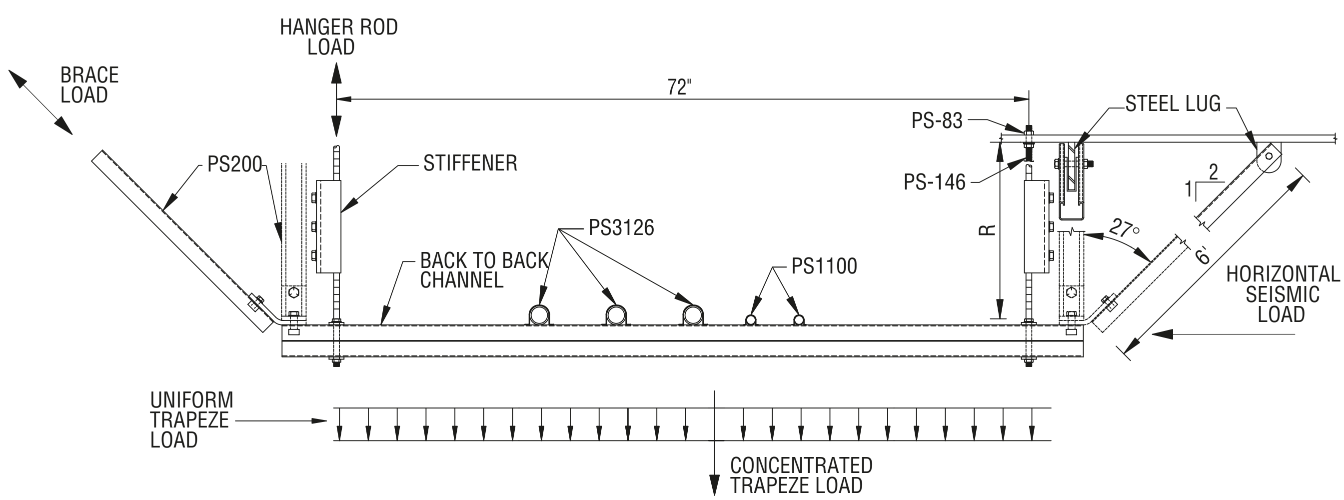
Adequate for brace earthquake load, F_b = 216 lbs.

11 Select anchorage detail:

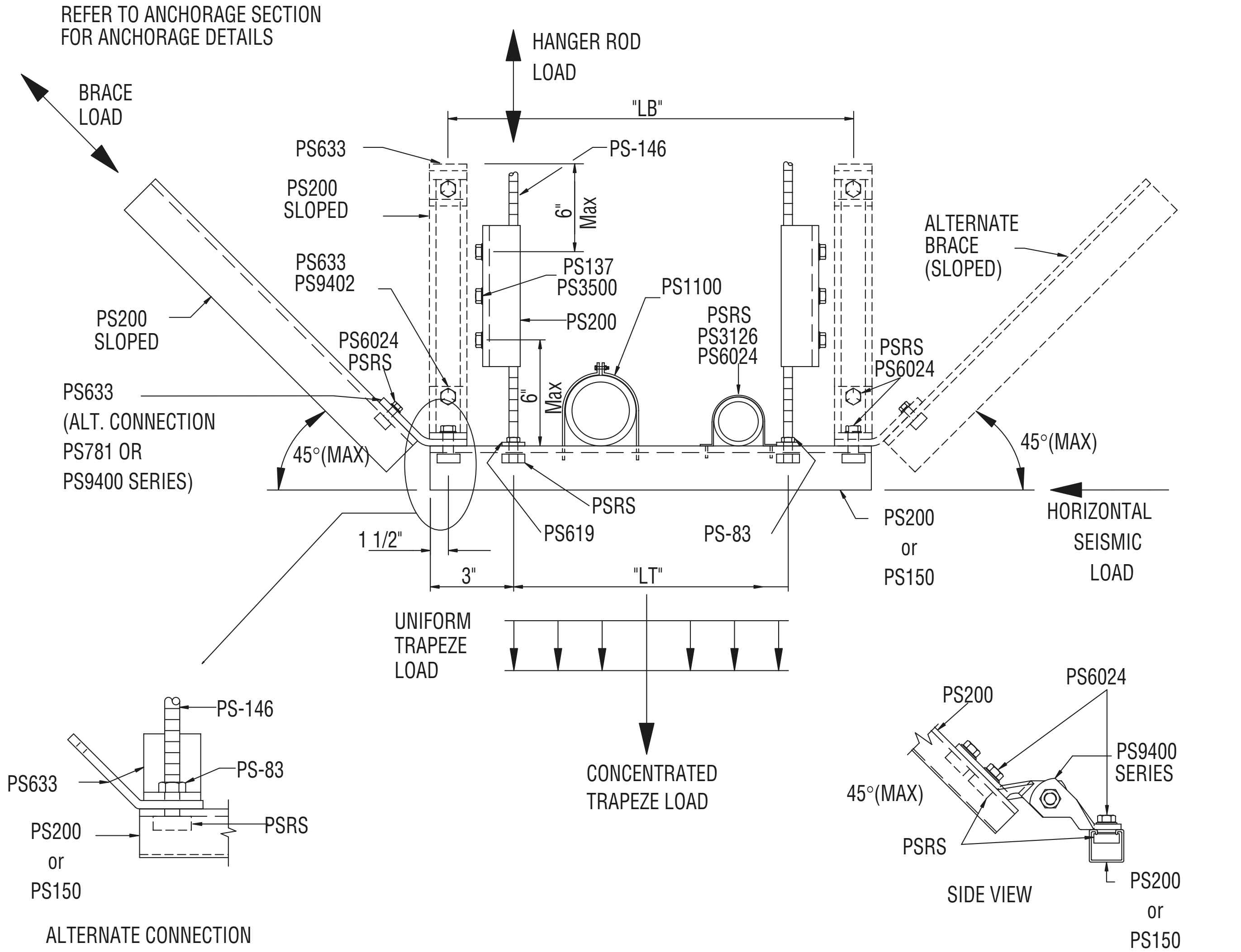
From *Sheet D1*, choose Beam Lug Assembly and Beam Rod Assembly.

12 From *Sheet B7*, verify component strength:

Use Steel Lug



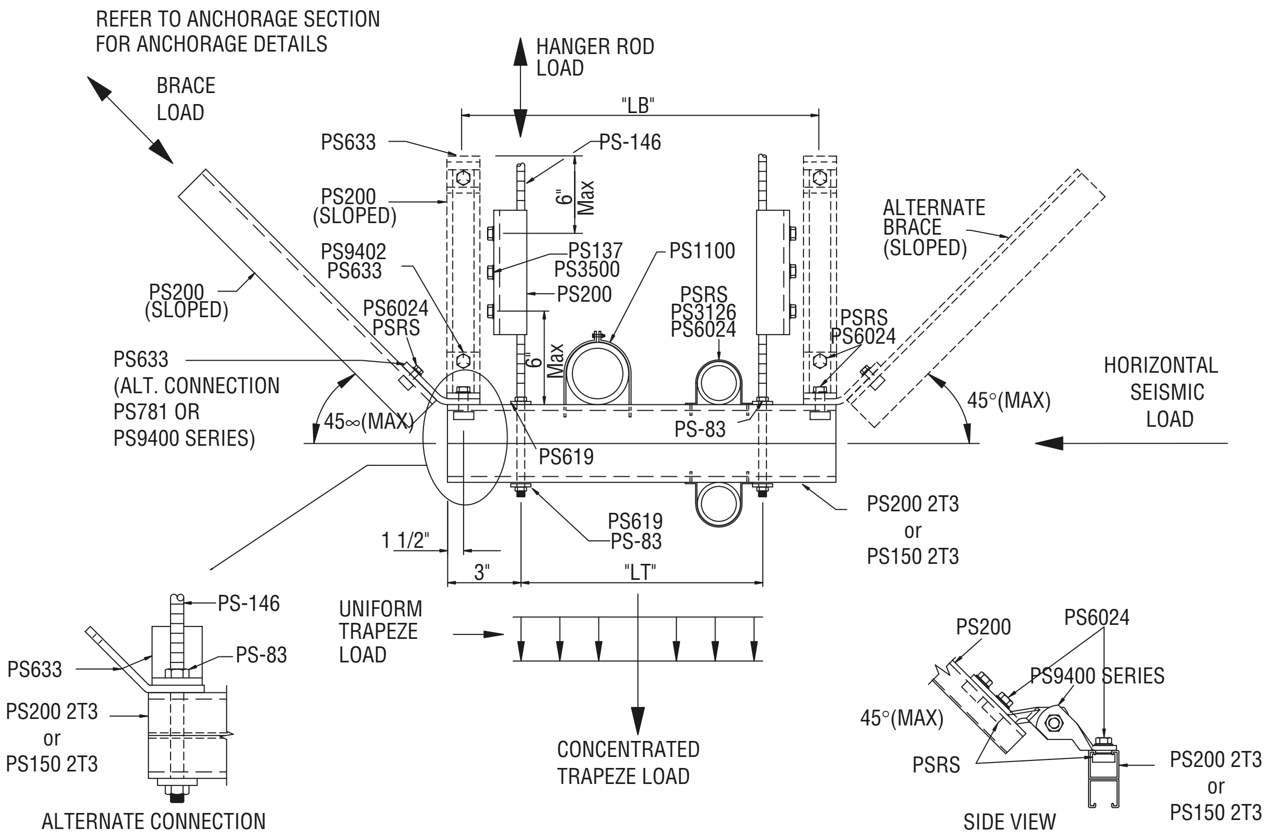
SUBMITTED		TITLE	
OPA-0242, Rev 1	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	**Trapeze Selection Sample Problem**	
		PAGE A4	DATE 04/21/2005



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	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	TITLE **Trapeze Assembly Single Channel**	
		PAGE A5	DATE 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.

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 **Trapeze Assembly Back to Back Channel**
		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.**

SUBMITTED		TITLE	
OPA-0242, Rev 1	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	Single Pipe Hanger Procedure	
		PAGE A7	DATE 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"$∅_{PIPE}$ @ 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"$∅_{PIPE}$: $\mathbf{F_p}$ (4"$∅_{PIPE}$) = 0.71 (16.31 lbs/ft) = **11.58 lbs/ft**

4 Determine lateral pipe forces:

FH_T = $\mathbf{F_p}$ (4"$∅_{PIPE}$) @ 28'	FH_L = $\mathbf{F_p}$ (4"$∅_{PIPE}$) @ 56'	F_V = FH_T/3 * S_1/S_2
= 11.58 lbs/ft x 28'	= 11.58 lbs/ft x 56'	= 324 lbs / 3 * (14'/28')
= **324 lbs**	= **650 lbs**	= **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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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)

S U B M I T T E D

OPA-0242, Rev 1

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TITLE

Single Pipe Hanger Example

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**

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

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

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

S U B M I T T E D		TITLE	
OPA-0242, Rev 1	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 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.

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

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

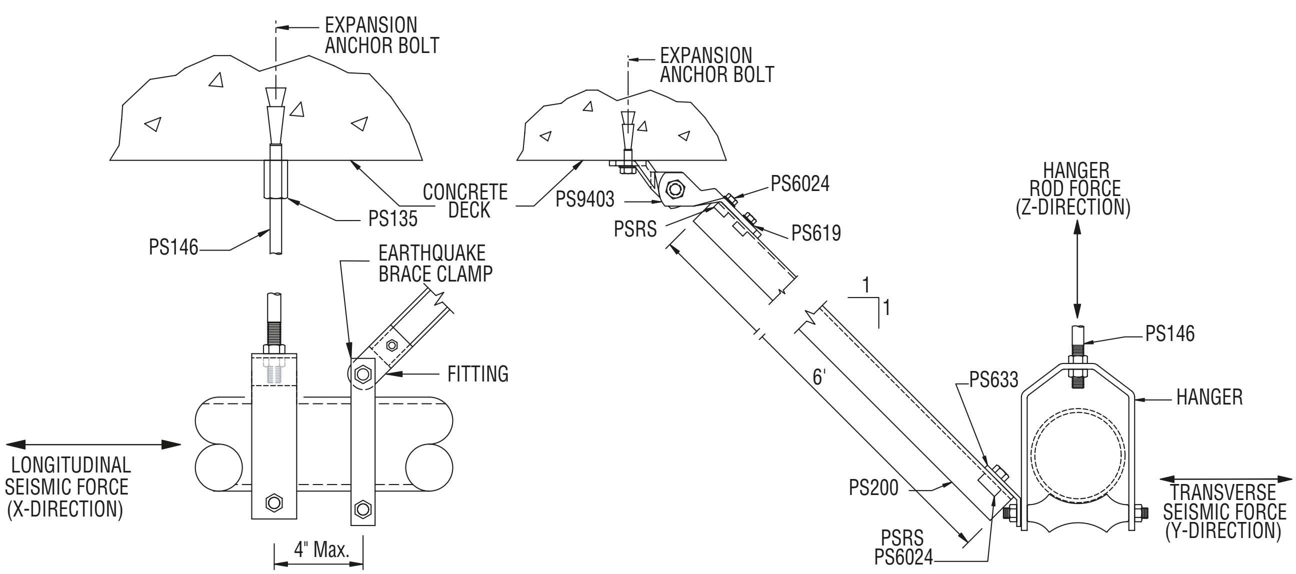
Rod Anchor Tension, From Step 8:

$F_{Anchor\ Tension} = 606$ lbs

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

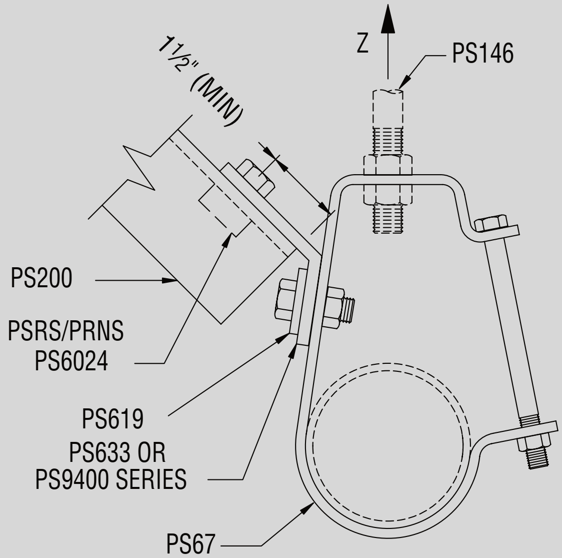
$$\left(\frac{F}{T_{allow}}\right)^{5/3} \leq 1.0$$

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

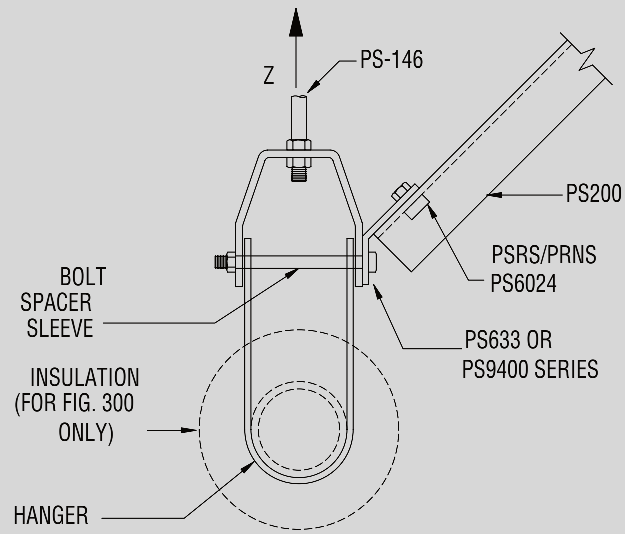


SUBMITTED		TITLE
OPA-0242, Rev 1	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	**Single Pipe Hanger Assembly**
		PAGE A11 — DATE **04/21/2005**

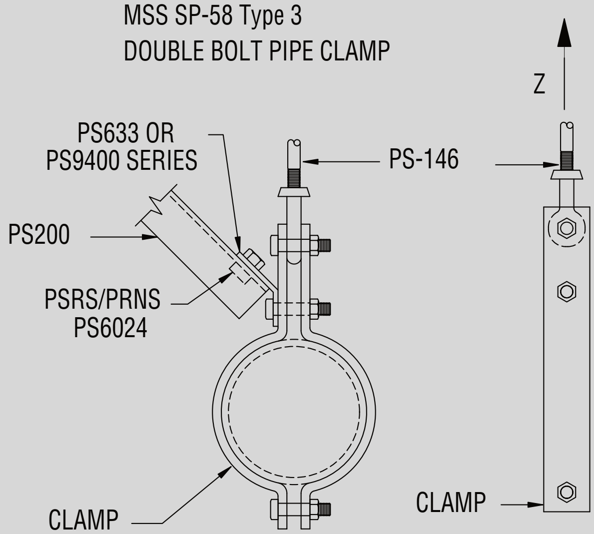
PIPE HANGER
PS67



MSS SP-58 Type 1
ADJUSTABLE CLEVIS PIPE HANGER

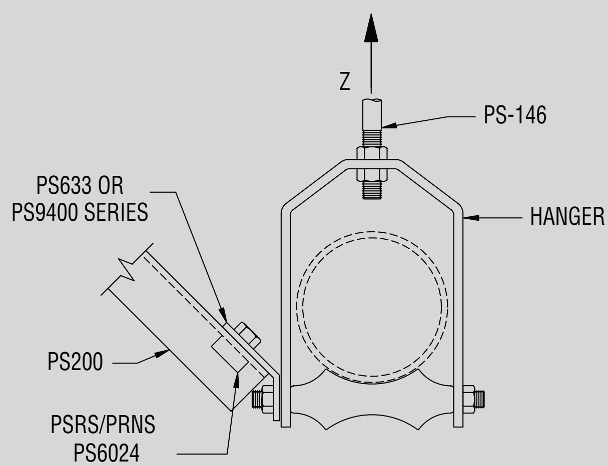


MSS SP-58 Type 3
DOUBLE BOLT PIPE CLAMP



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

MSS SP-58 Type 43
ADJUSTABLE STEEL YOKE PIPE ROLL

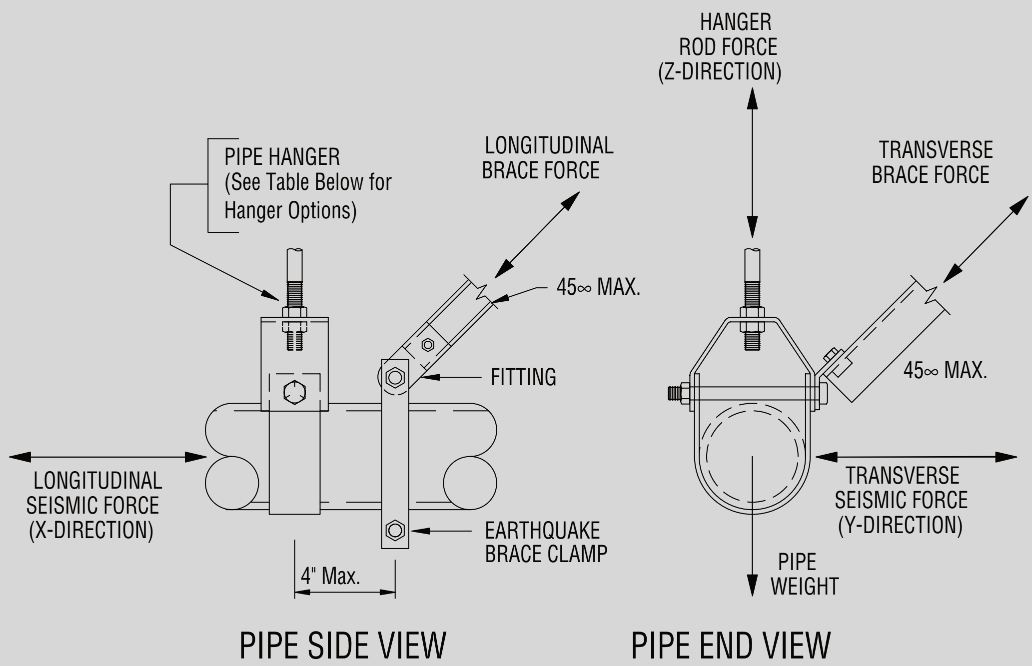


NOTE:
For 5 & 6"∅ pipe use PS9400 fitting.
Brace attachment for 8" pipe shall be selected and verified by the project engineer.

TITLE

Single Pipe Hanger Assembly

PAGE	DATE
A12	



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

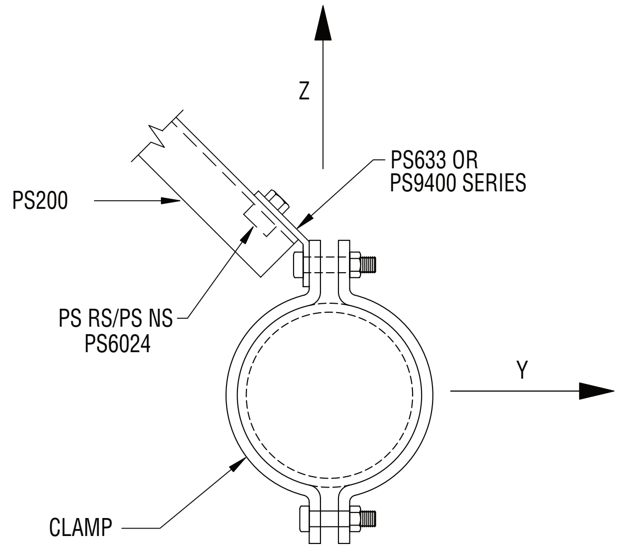
DATE
04/21/2005

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

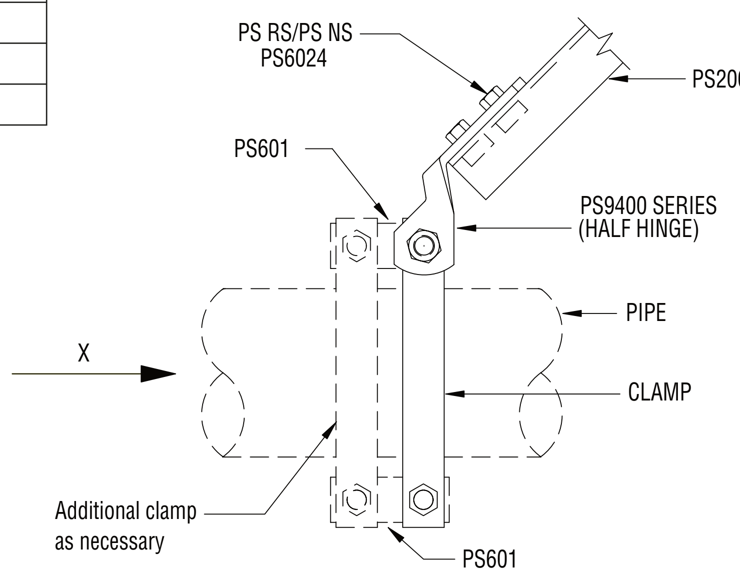
LOAD SCHEDULE

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

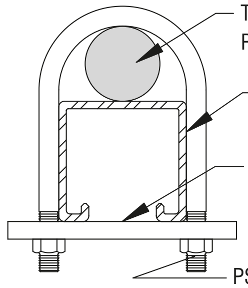


TRANSVERSE BRACE

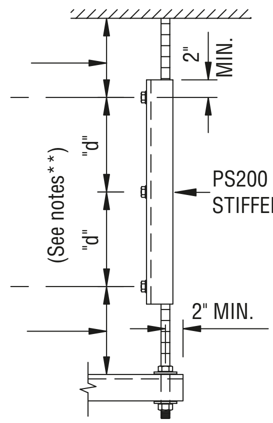


LONGITUDINAL BRACE

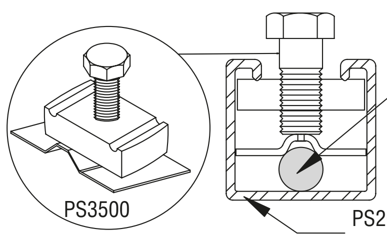
A P P R O V E D **Fixed Equipment Anchorage** Office of Statewide Health Planning and Development **OPA-0242 Apr 25, 2003** **** Valid for 3 Years Maximum **** Bill Staehlin (916) 324-9106	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	TITLE **Single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

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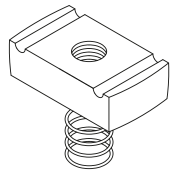
TITLE

Hanger Rod with Stiffener

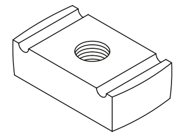
PAGE **B1**

DATE **04/21/2005**



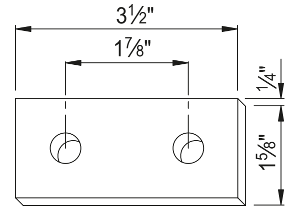
PS RS

*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"∅



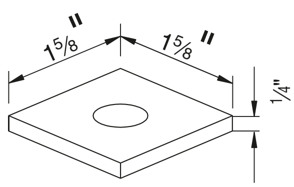
PS 601

Two Hole Plate
Available for ½"∅ bolts

*THE MAXIMUM ALLOWABLE LOAD OF BOLT CLAMPING NUTS IN CHANNEL

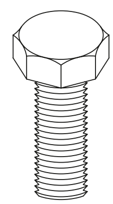
	1/4" BOLT	3/8" BOLT	1/2" BOLT
MAXIMUM SLIP LOAD RESISTANCE (LBS)	300	800	1500
MAXIMUM PULLOUT LOAD RESISTANCE (LBS)	600	1100	2000

SAFETY FACTOR = 3.0



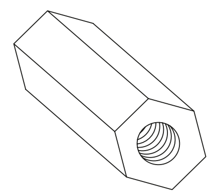
PS 619

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



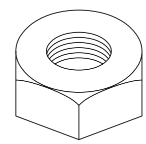
PS 6024

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 ******

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TITLE

Fasteners

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B2

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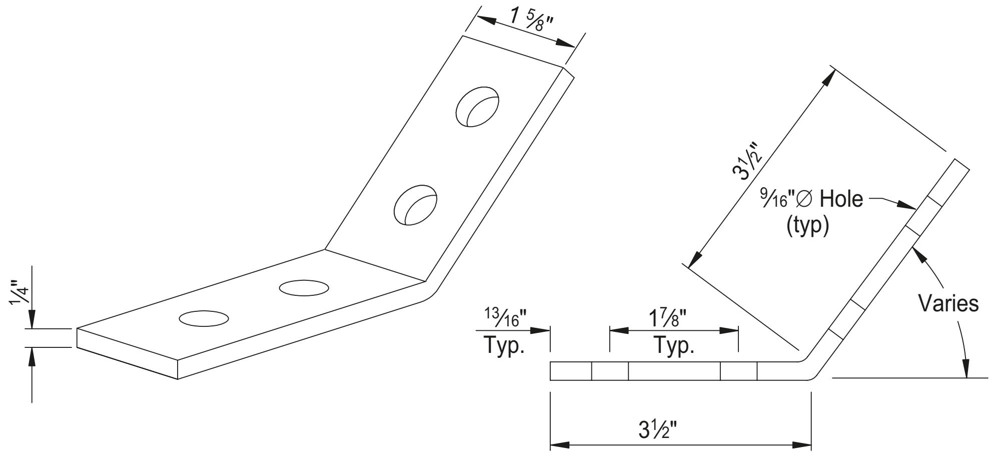
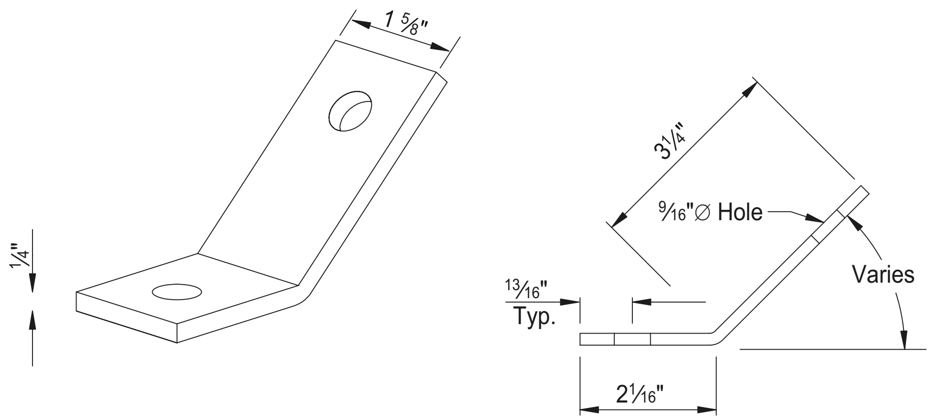
POWER-STRUT®



PS 781

Four Hole Open Angle Connector
Available for 1/2"Ø bolts or rods



PS 633

Two Hole Open Angle Connector
Available for 1/2"Ø 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

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
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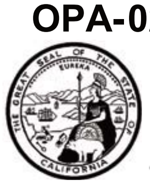
****** Valid for 3 Years Maximum ******



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TITLE
Angle Connectors

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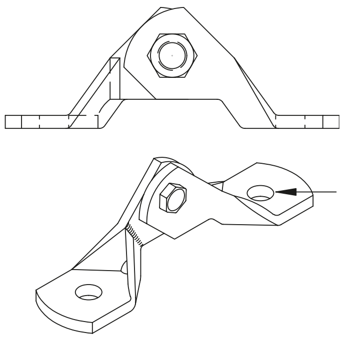
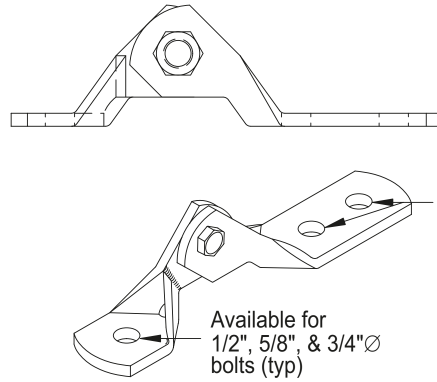
B3

DATE
04/25/2003



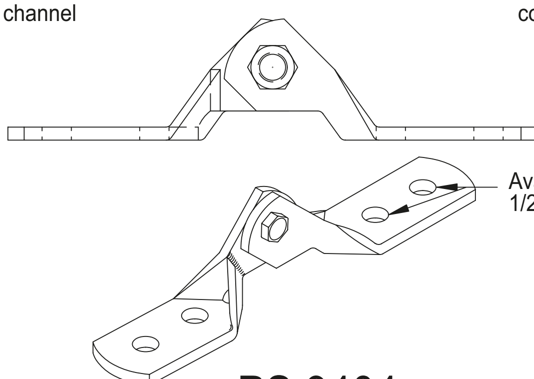
PS 9402*

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
Fixed Equipment Anchorage
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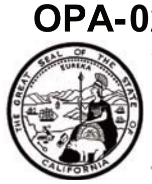

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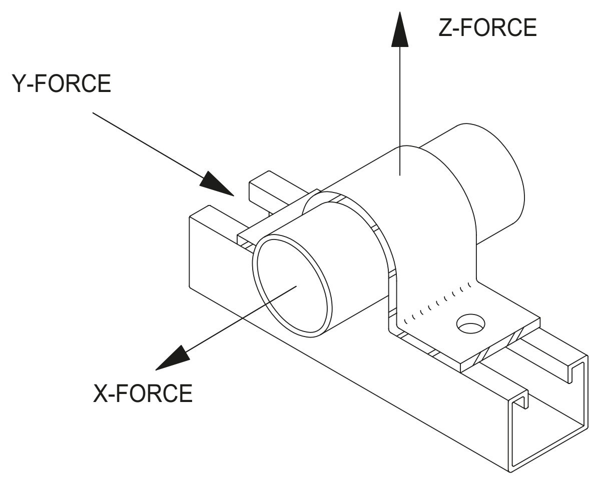
TITLE	
Hinge Connectors	
PAGE **B4**	DATE **04/25/2003**

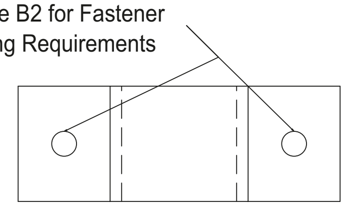
Load Schedule

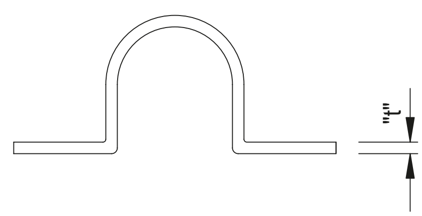
PIPE SIZE	Maximum Allowable Load* (lbs)			t
(in)	X	Y	Z	*(in)*
½	100	250	500	0.125
¾	100	250	500	0.125
1	100	250	500	0.125
1 ¼	100	250	500	0.125
1 ½	100	250	500	0.125
2	200	500	1000	0.25
2 ½	200	500	1000	0.25
3	200	500	1000	0.25
3 ½	200	500	1000	0.25
4	200	500	1000	0.25
5	200	500	1000	0.25
6	375	500	1000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

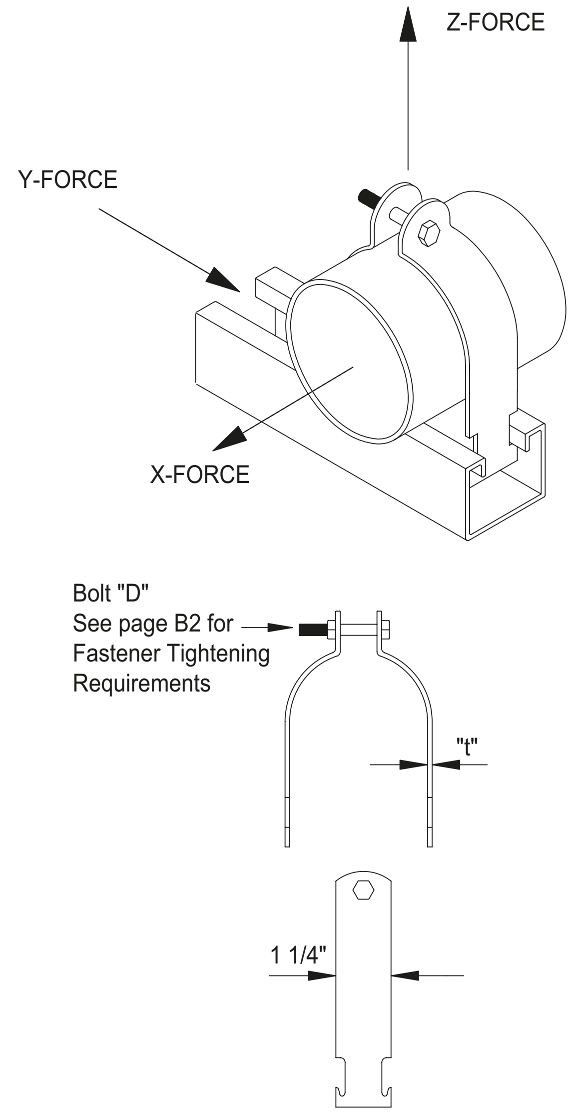
Hold Down Clamp

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 **One Piece Pipe Clamps**	
		PAGE **B5**	DATE **04/25/2003**

Load Schedule

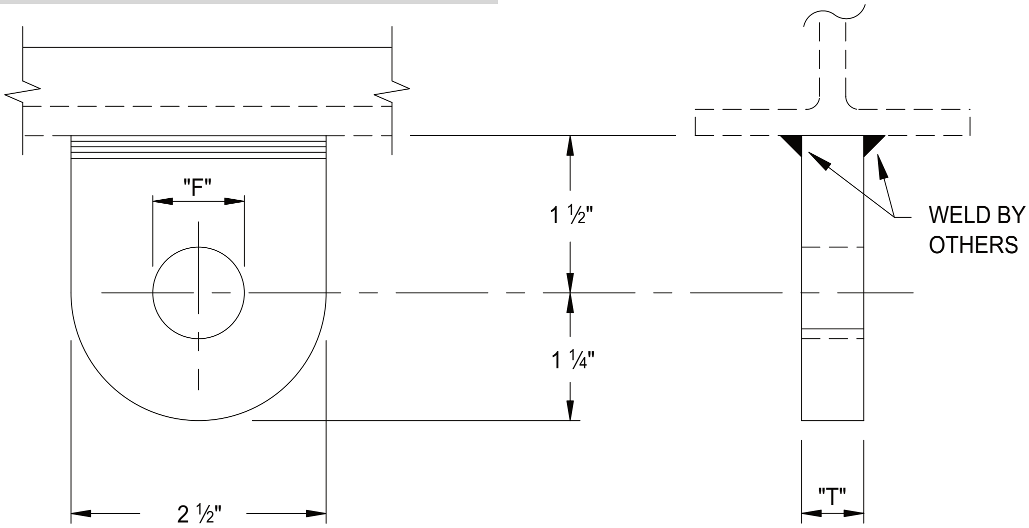
PIPE SIZE	Maximum Allowable Load* (lbs)			t	BOLT DIA."D"
(in)	X	Y	Z	*(in)*	*(in)*
⅜	30	60	400	0.060	¼
½	50	70	400	0.060	¼
¾	70	100	600	0.075	¼
1	80	150	600	0.075	¼
1 ¼	150	150	600	0.075	¼
1 ½	150	240	800	0.105	5/16
2	200	240	800	0.105	5/16
2 ½	200	240	800	0.105	5/16
3	200	240	800	0.105	5/16
3 ½	200	320	1000	0.125	⅜
4	200	320	1000	0.125	⅜
5	200	320	1000	0.125	⅜
6	375	450	1000	0.135	⅜
8	500	450	1000	0.135	⅜

*Determined by the manufacturers testing, analysis and technical specifications



PS 1100
Pipe Clamp

MSS SP-69 Type 57
Plate Lug



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

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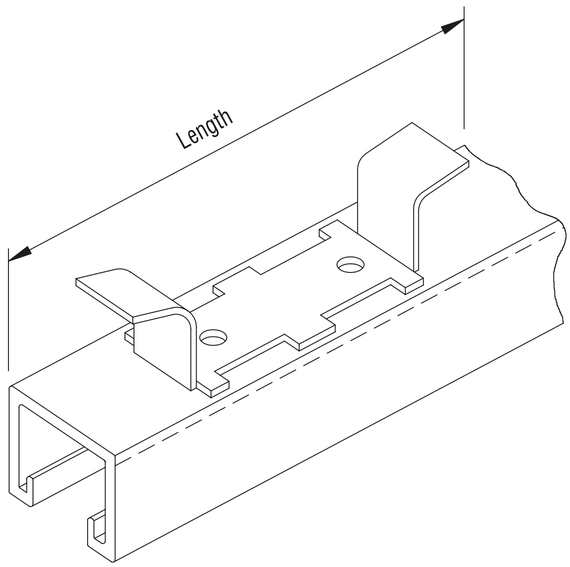
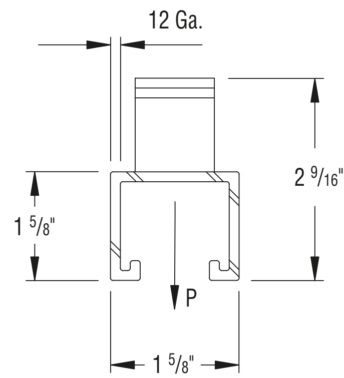
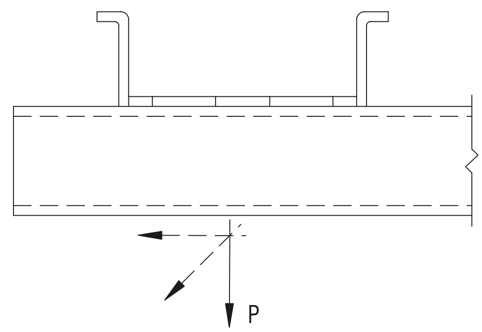
DATE
04/21/2005







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 ****

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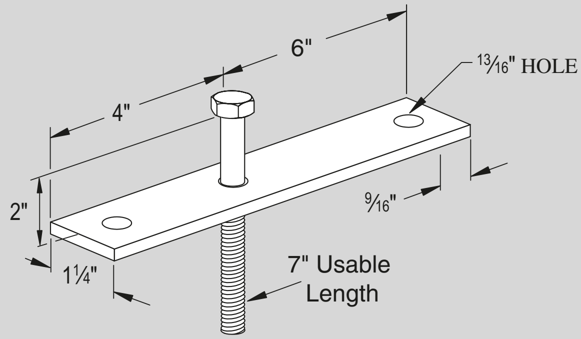
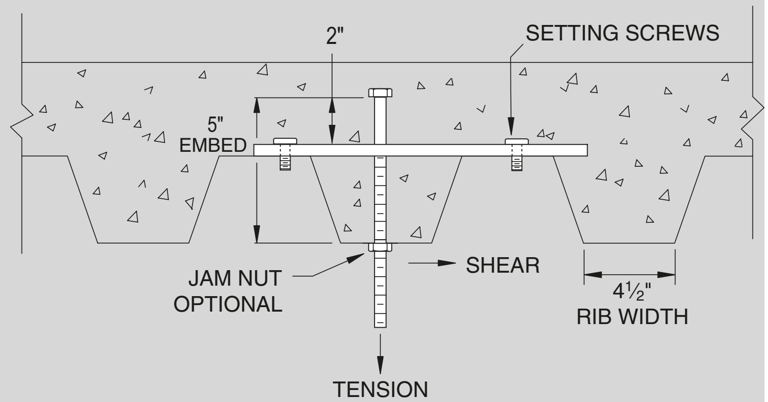
TITLE
Concrete Insert

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

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TITLE

Concrete Insert

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DATE
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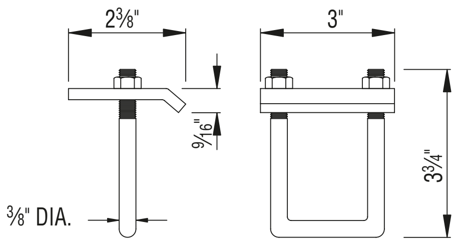
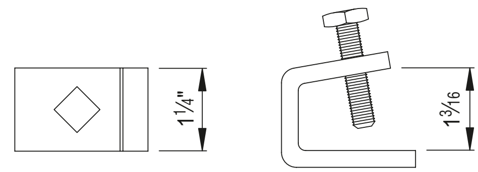


NOTE:

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

PS 2651

Beam Clamp



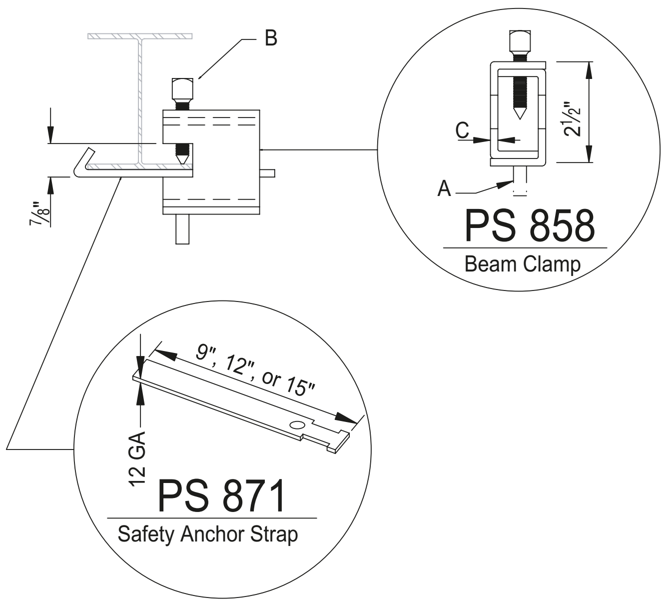
LOAD SCHEDULE

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

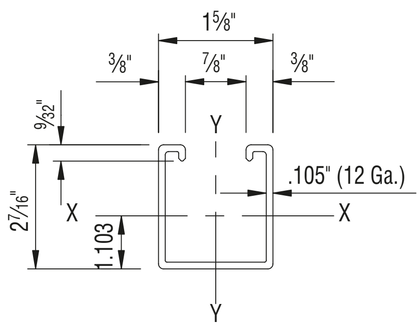


PS858 LOAD SCHEDULE

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

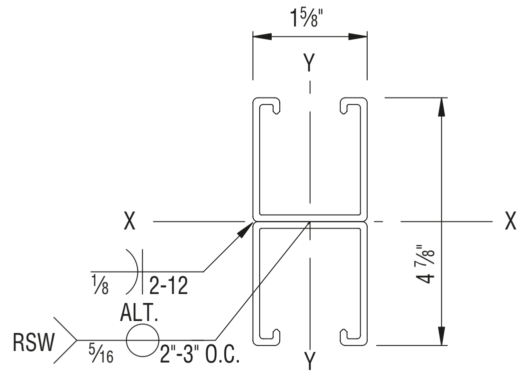
**NOTE:
Allowable loads have been determined by the manufacturers testing, analysis and technical specification

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 **** Bill Staehlin (916) 324-9106	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	TITLE **Beam Clamp**	
		PAGE B10	DATE 04/25/2003



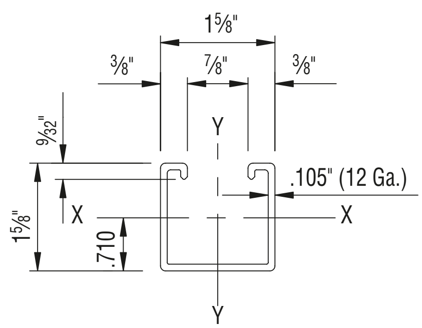
PS 150

STEEL CHANNEL



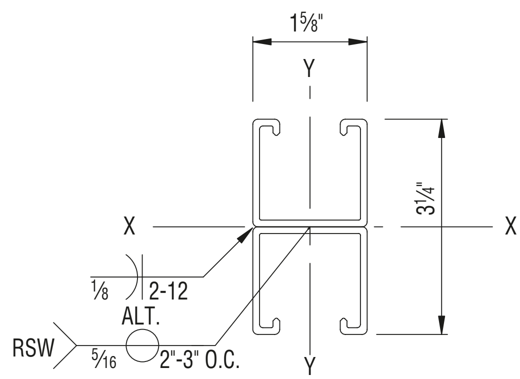
PS 150 2T3

WELDED STEEL CHANNEL



PS 200

STEEL CHANNEL



PS 200 2T3

WELDED STEEL CHANNEL

PROPERTIES

CHANNEL	AREA (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

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TITLE

Channel Properties

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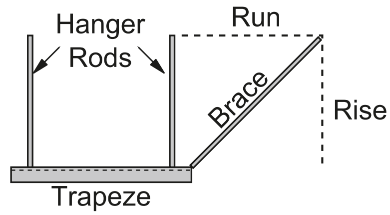
DATE **04/21/2005**

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: $F_b = K_b \times F_h$

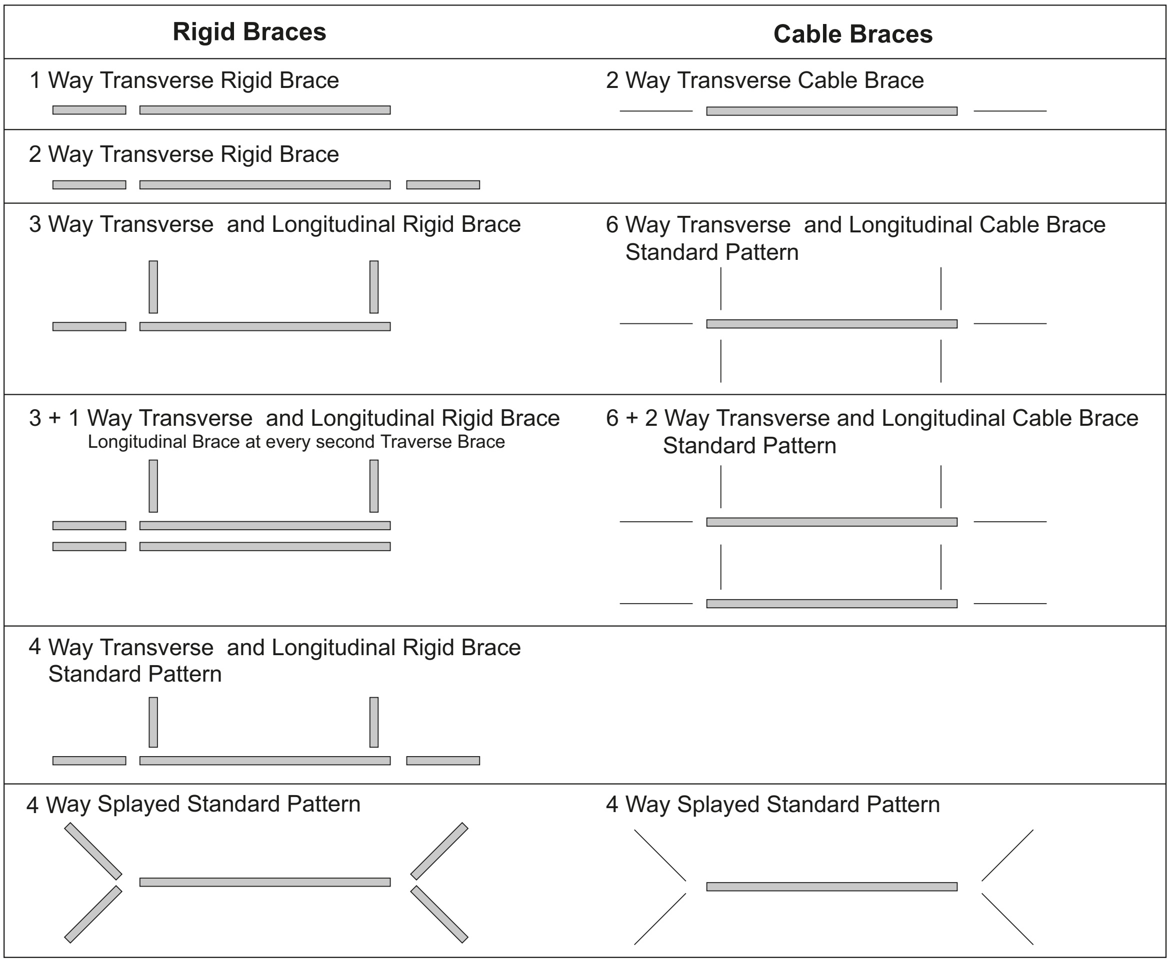
Selecting a Brace Pattern

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.

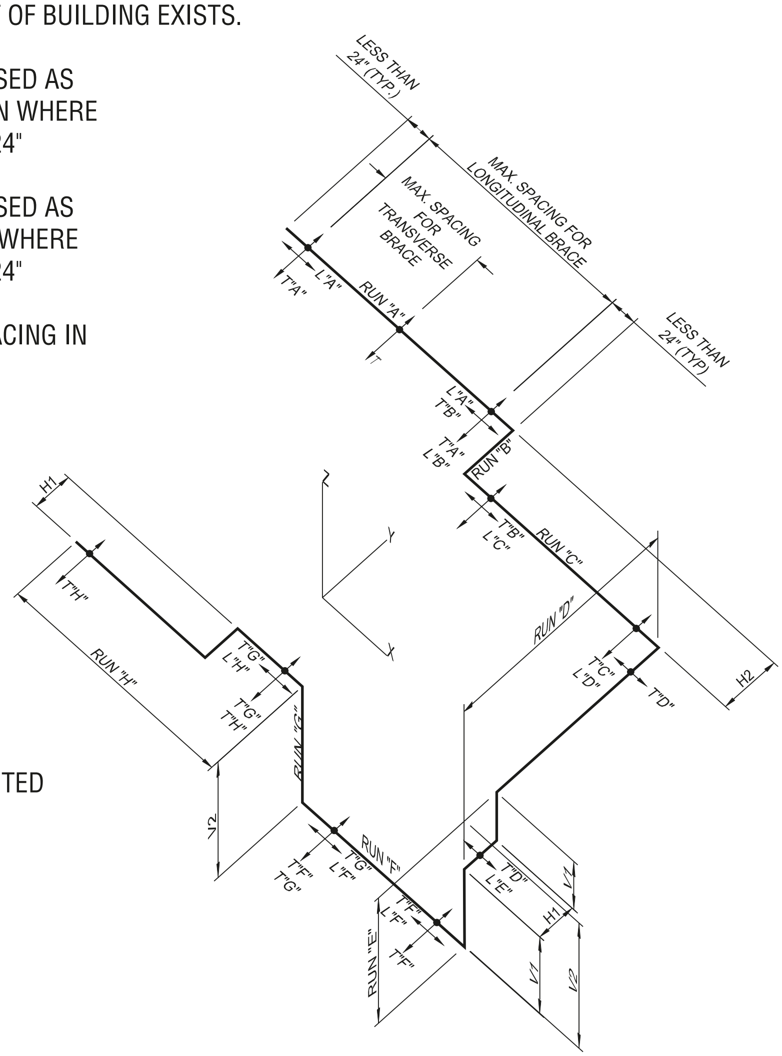
6. TRANSVERSE BRACE SPACING SHALL IN NO CASE EXCEED THE MAXIMUM CALCULATED DISTANCE OF 40ft. (QUALIFIED CALCULATIONS REQUIRED)

   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
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
Brace Location Requirements

PAGE **C3**
DATE **04/25/2003**

POWER-STRUT®

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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Fixed Equipment Anchorage
Office of Statewide Health Planning and Development

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

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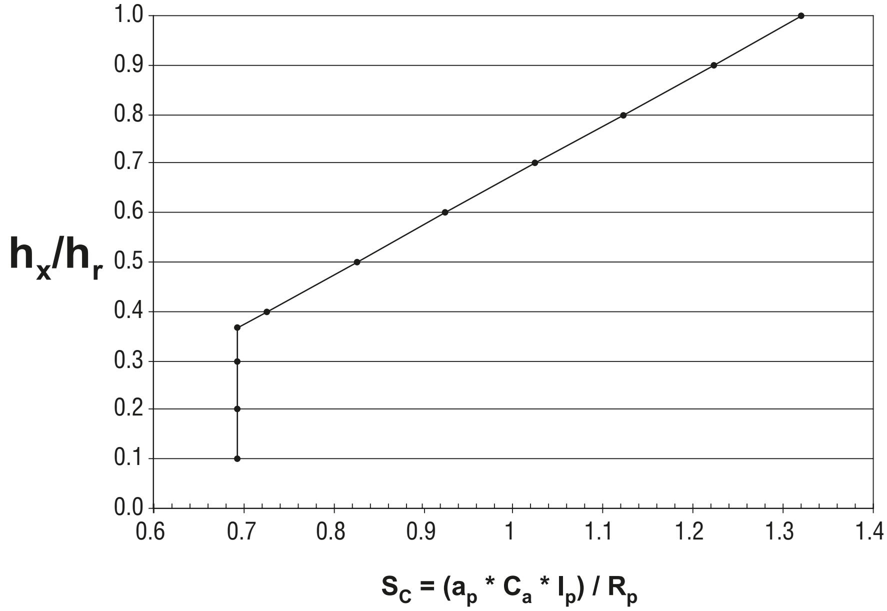
TITLE

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) :

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

S U B M I T T E D		TITLE
OPA-0242, Rev 1	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 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:

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

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
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.

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

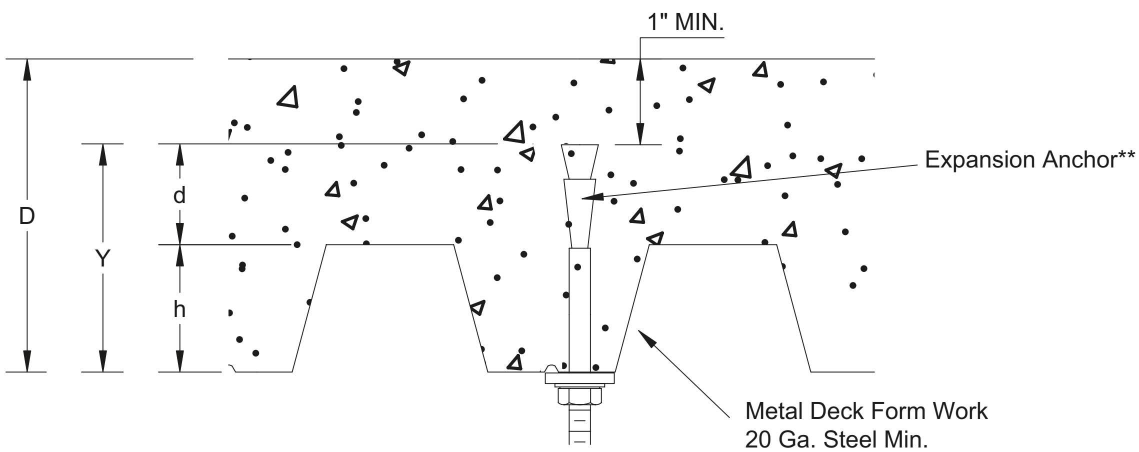
APPROVED	Engineer	TITLE	
A P P R O V E D Fixed Equipment Anchorage Office of Statewide Health Planning and Development OPA-0242 Apr 25, 2003 **** Valid for 3 Years Maximum **** Bill Staehlin (916) 324-9106	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	Concrete Expansion Anchor Load Table	
		PAGE C8	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)*
1/4	2 1/8	556	0	8	800
3/8	3	942	814	25	1,100
1/2	4 1/8	1,430	1,448	50	2,000
5/8	5 1/8	2,150	2,150	80	2,300
3/4	6 5/8	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)*
3/8	3	588	848	568	800	25	1,100
1/2	4	0	1,384	960	1,288	50	2,000
5/8	5	1,192	1,856	1,316	1,828	80	2,300
3/4	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.

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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
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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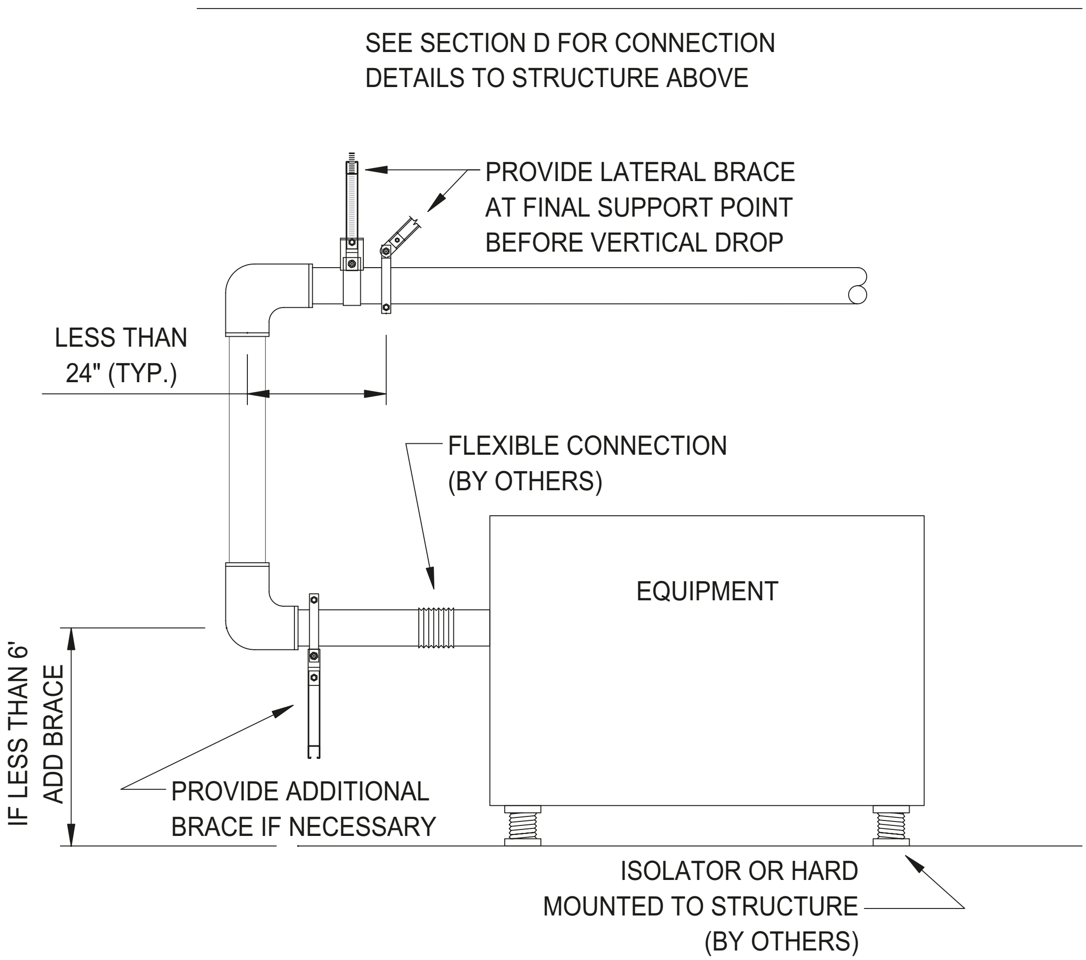
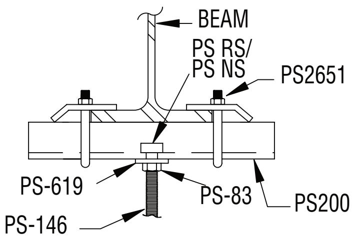
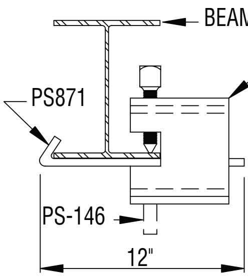


NOTE:
DETAIL SHOWS PIPING/CONDUIT HUNG FROM STRUCTURE ABOVE CONNECTING TO EQUIPMENT MOUNTED ON FLOOR TO ADDRESS THE DIFFERENTIAL MOVEMENT BETWEEN STORY TO STORY.

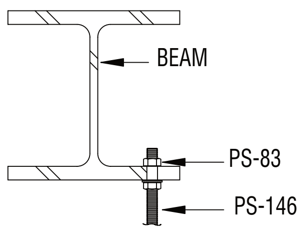
A P P R O V E D **Fixed Equipment Anchorage** Office of Statewide Health Planning and Development **OPA-0242 Apr 25, 2003** **** Valid for 3 Years Maximum **** Bill Staehlin (916) 324-9106	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	TITLE **Floor Mounted Equipment**	
		PAGE **C11**	DATE **04/25/2003**



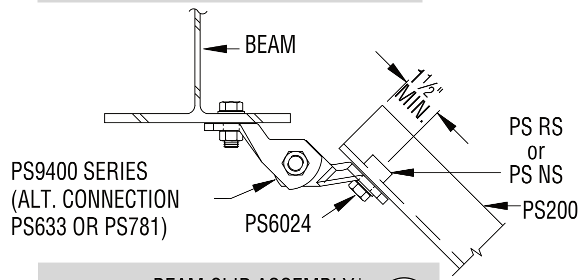
BEAM CLAMP ASSEMBLY* (1)



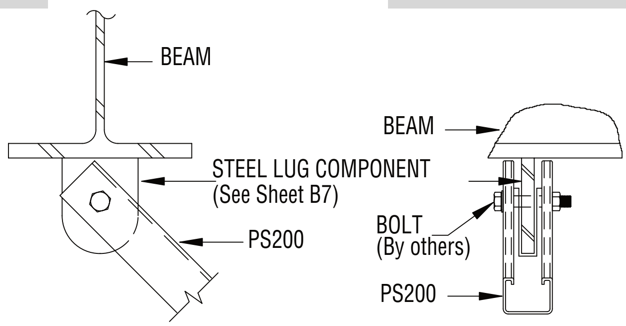
HEAVY BEAM CLAMP ASSEMBLY* (2)



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.

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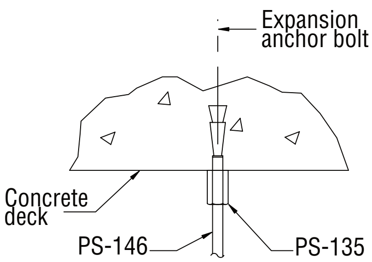
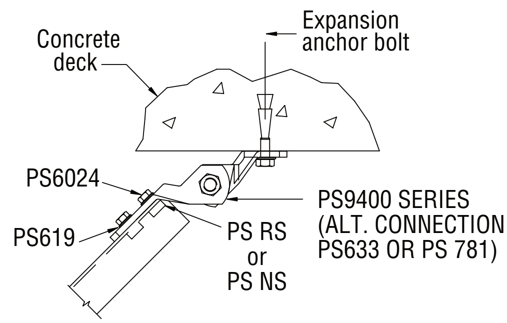
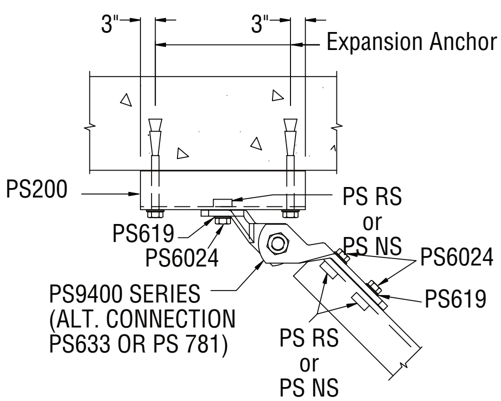
		PAGE **D1**	DATE **04/21/2005**



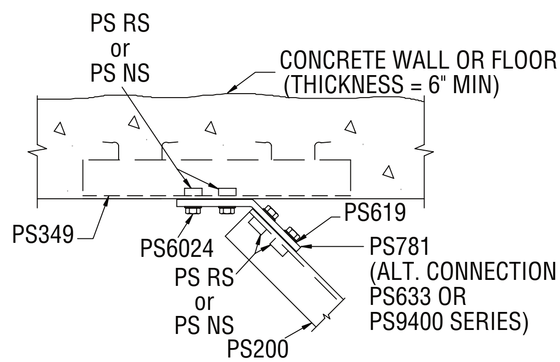
ONE BOLT ASSEMBLY* (1)
(Connections not for use in pre-stressed concrete deck)



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

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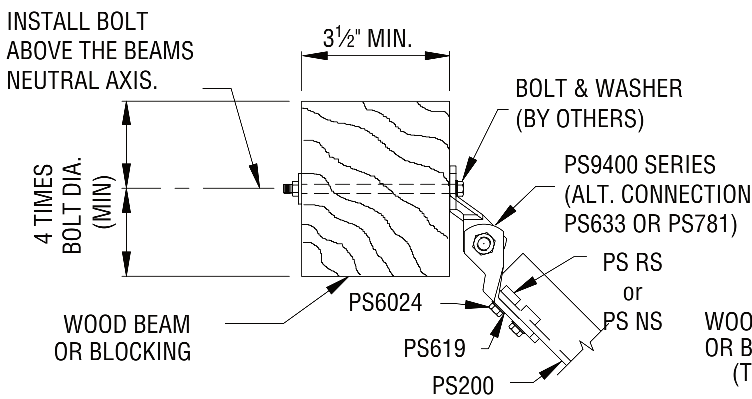
TITLE

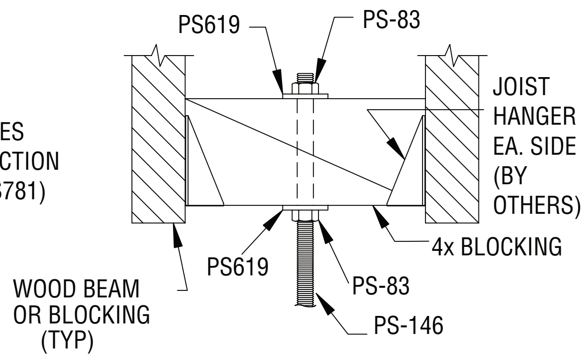
Concrete

PAGE
D2

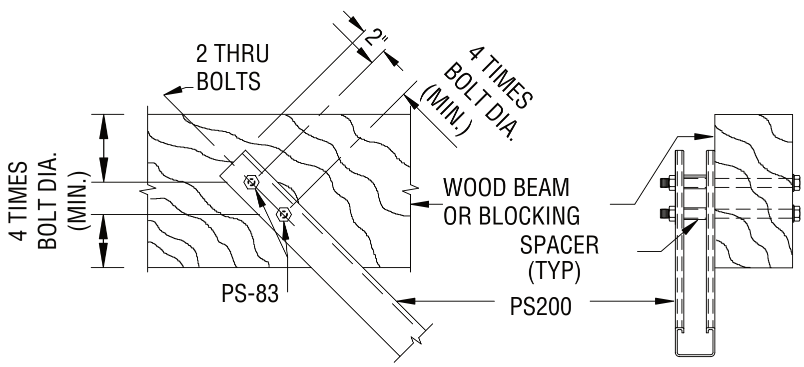
DATE
04/21/2005



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.

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 Suite 277 Arcadia, CA 91006	TITLE **Wood**	
		PAGE **D3**	DATE **04/21/2005**

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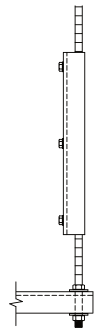
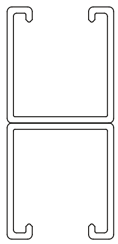
Power Strut Component Index

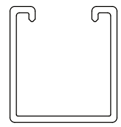
LEGEND
REF. DWG: MANUF. CAT. #
ITEM NAME



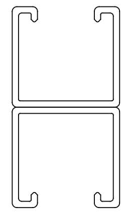
B1: PS-146
Threaded Rod w/ Stiffner



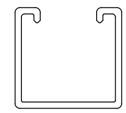
B11: PS 150 2T3
Back to Back Channel



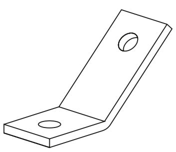
B11: PS 150
Trapeze/Channel



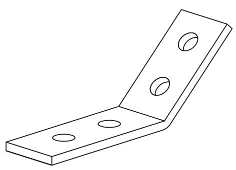
B11: PS200 2T3
Back to Back Channel



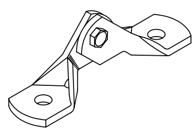
B11: PS200
Trapeze/Channel



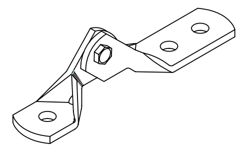
B3: PS 633
Angle Fitting



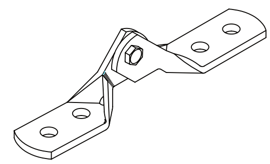
B3: PS 781
Angle Fitting



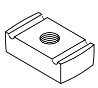
B4: PS 9402
Hinge Fitting



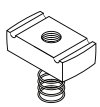
B4: PS 9403
Hinge Fitting



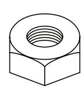
B4: PS 9404
Hinge Fitting



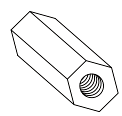
B2: PS NS
Channel Nut



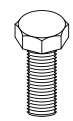
B2: PS RS
Channel Nut w/ Spring



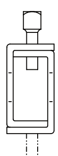
B2: PS-83
Hexagon Nut



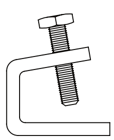
B2: PS-135
Rod Coupling



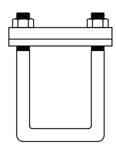
B2: PS 6024
Hex Head Screw



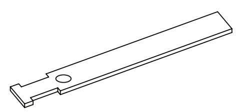
B10: PS 858
Beam Clamp



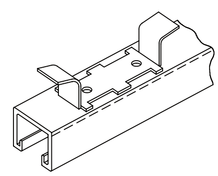
B10: PS 998
Beam Clamp



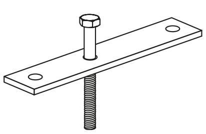
B10: PS 2651
Beam Clamp



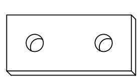
B10: PS 871
Safety Anchor Strap



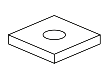
B8: PS 349
Concrete Insert



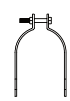
B9: PS 681
Concrete Insert



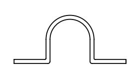
B2: PS 601
Plate



B2: PS 619
Square Washer



B6: PS 1100
Pipe Clamp



B5: PS 3126
Hold Down Clamp

A P P R O V E D
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

Component Index

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DATE
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: $0.3\, S_{DS}\, I_p\, W_p \le F_p \le 1.6\, S_{DS}\, I_p\, W_p$

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

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Office of Statewide Health Planning and Development
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2000 I.B.C. Seismic Force (F_p) NFPA Pipe Data Electrical Metallic Tubing Data	
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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)												
	½	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4	4 ½	5	6
½	1 3⁄16	-	-	-	-	-	-	-	-	-	-	-	-
	1 ⅜	-	-	-	-	-	-	-	-	-	-	-	-
¾	1 5⁄16	1 7⁄16	-	-	-	-	-	-	-	-	-	-	-
	1 ½	**1 ⅝**	-	-	-	-	-	-	-	-	-	-	-
1	1 ½	1 ⅝	1 ¾	-	-	-	-	-	-	-	-	-	-
	1 ¾	**1 ⅞**	**2**	-	-	-	-	-	-	-	-	-	-
1 ¼	1 ¾	1 ⅞	2	2 ¼	-	-	-	-	-	-	-	-	-
	2	**1 ⅛**	**2 ¼**	**2 ½**	-	-	-	-	-	-	-	-	-
1 ½	1 15⁄16	2 1⁄16	2 3⁄16	2 7⁄16	2 9⁄16	-	-	-	-	-	-	-	-
	2 ⅛	**2 ¼**	**2 ⅜**	**2 ⅝**	**2 ¾**	-	-	-	-	-	-	-	-
2	2 3⁄16	2 5⁄16	2 ½	2 ¾	2 ⅞	3 ⅛	-	-	-	-	-	-	-
	2 ⅜	**2 ½**	**2 ¾**	**3**	**3 ⅛**	**3 ⅜**	-	-	-	-	-	-	-
2 ½	2 7⁄16	2 9⁄16	2 ¾	3	3 ⅛	3 ⅜	3 ⅝	-	-	-	-	-	-
	2 ⅝	**2 ¾**	**3**	**3 ¼**	**3 ⅜**	**3 ⅝**	**4**	-	-	-	-	-	-
3	2 13⁄16	2 15⁄16	3 1⁄16	3 5⁄16	3 7⁄16	3 ¾	4	4 5⁄16	-	-	-	-	-
	3	**3 ⅛**	**3 ⅜**	**3 ⅝**	**3 ¾**	**4**	**4 ⅜**	**4 ¾**	-	-	-	-	-
3 ½	3 ⅛	3 ¼	3 ⅜	3 ⅝	3 ¾	4 1⁄16	4 5⁄16	4 ⅝	4 15⁄16	-	-	-	-
	3 ⅜	**3 ½**	**3 ⅝**	**3 ⅞**	**4**	**4 ⅜**	**4 ⅝**	**5**	**5 ⅜**	-	-	-	-
4	3 7⁄16	3 9⁄16	3 11⁄16	3 15⁄16	4 1⁄16	4 ⅜	4 ⅝	4 15⁄16	5 ¼	5 9⁄16	-	-	-
	3 ¾	**3 ⅞**	**4**	**4 ¼**	**4 ⅜**	**4 ¾**	**5**	**5 ⅜**	**5 ⅝**	**6**	-	-	-
4 ½	3 ¾	3 ⅞	4	4 ¼	4 ⅜	4 ⅝	4 ⅞	5 ¼	5 9⁄16	5 ⅞	6 ⅛	-	-
	4	**4 ⅛**	**4 ¼**	**4 ½**	**4 ¾**	**5**	**5 ¼**	**5 ⅝**	**6**	**6 ¼**	**6 ½**	-	-
5	4 ⅛	4 ¼	4 ⅜	4 ⅝	4 ¾	5	5 ¼	5 9⁄16	5 ⅞	6 3⁄16	6 ½	6 13⁄16	-
	4 ⅜	**4 ½**	**4 ⅝**	**4 ⅞**	**5**	**5 ⅜**	**5 ⅝**	**6**	**6 ¼**	**6 ⅝**	**7**	**7 ¼**	-
6	4 ¾	4 ⅞	5	5 ¼	5 ⅜	5 ⅝	5 ⅞	6 3⁄16	6 ½	6 13⁄16	7 ⅛	7 7⁄16	8 ⅛
	5	**5 ⅛**	**5 ¼**	**5 ½**	**5 ⅝**	**6**	**6 ¼**	**6 ⅝**	**7**	**7 ¼**	**7 ⅝**	**8**	**8 ⅝**

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
OPA-0242 Apr 25, 2003
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TITLE
Conduit Spacing

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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

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DATE **04/25/2003**

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STEEL PIPE DATA - Schedule 40 & 80

Nominal Pipe Size (in)	Schedule No.	O.D.	Wall Thickness	Wt/ft	Wt. of Water/ft
3/8	40	.675	0.091	0.567	0.830
	80		0.126	0.738	0.061
1/2	40	.840	0.109	0.850	0.132
	80		0.147	1.087	0.101
3/4	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 1/4	40	1.660	0.140	2.272	0.647
	80		0.199	2.996	0.555
1 1/2	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 1/2	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 1/2	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

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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)
1/8	40	0.405	0.068	0.043	0.025
	80		0.095	0.055	0.016
1/4	40	0.540	0.088	0.074	0.045
	80		0.119	0.094	0.031
3/8	40	0.675	0.091	0.100	0.083
	80		0.126	0.129	0.061
1/2	40	0.840	0.109	0.150	0.132
	80		0.147	0.150	0.101
3/4	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 1/4	40	1.660	0.140	0.400	0.647
	80		0.191	0.527	0.555
1 1/2	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 1/2	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 1/2	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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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**

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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OPA-0242, Original Approved Page, included for reference

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

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TITLE	
Notations	
PAGE vi	DATE 04/25/2003

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 Fig. 260/300 Fig. 67	40	80											
1	Fig. 295 Fig. 260/300 Fig. 67	40	80											
1 ½	Fig. 295 Fig. 260/300 Fig. 67	40	58											
2	Fig. 295 Fig. 260/300	40	41											
	Fig. 67	40	41											
2 ½	Fig. 295 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 Fig. 260/300	19	19											
	Fig. 181	28	28											
	Fig. 67	19	19											
4	Fig. 295 Fig. 260/300 Fig. 181 Fig. 67	12	12	⅝	1	½	4 ⅛	1	⅝	5	1	½	1	½
5	Fig. 295 Fig. 260/300 Fig. 181 Fig. 67	9	9											
6	Fig. 295 Fig. 260/300 Fig. 181 Fig. 67	6	6	¾	1	½	4 ⅛	1	⅝	5	1	½	1	½
8	Fig. 295 Fig. 260/300 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		4	9	6												
15	40	3	7	5	10	⅝		½	4 ⅛	2						
17	40	3	6	4	9			⅝	5⅛	2						
18	40	2	6	4	8											
22	30	2	6	4	9											
24			5		8											
28, 29	20	3	6	4	10	½		½	4⅛	2						
32		2			9			⅝	5⅛	2						
33, 34	20	2	5	4	8	⅝		⅝	5⅛	2						
37	10	3	8	6	10	½		½	4 ⅛	1						
40		3	8	5												
41, 44, 45		3	7	5												
48, 49, 50		2	6	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. 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

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<u>STEPS</u> <u>TRAPEZE SELECTION PROCEDURE FOR WATER FILLED PIPE</u>

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: **A1**
DATE: **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, **S_1=7'**

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

Transverse brace spacing, **S_2=14'** (one side of trapeze)

Longitudinal brace spacing, **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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		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:

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

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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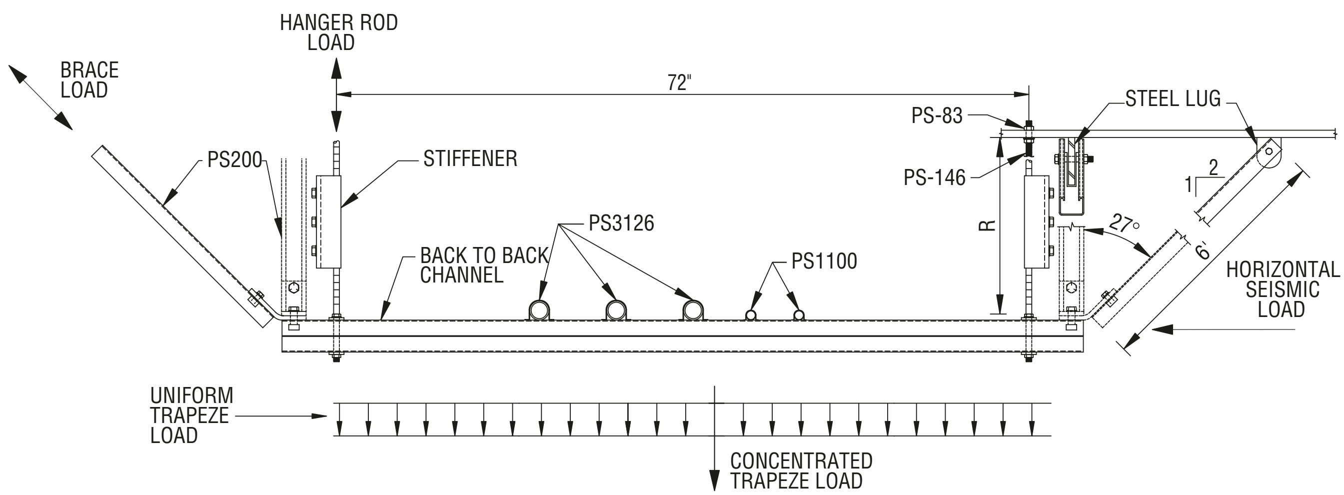
TITLE	
Trapeze Selection Sample Problem	
PAGE A3	DATE 04/25/2003

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.



<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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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	
Single Pipe Hanger Procedure	
PAGE	DATE
A7	**04/25/2003**

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)

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

$F_p = 0.71W_p$ (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**

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
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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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Fixed Equipment Anchorage
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TITLE
Single Pipe Hanger Example

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

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**

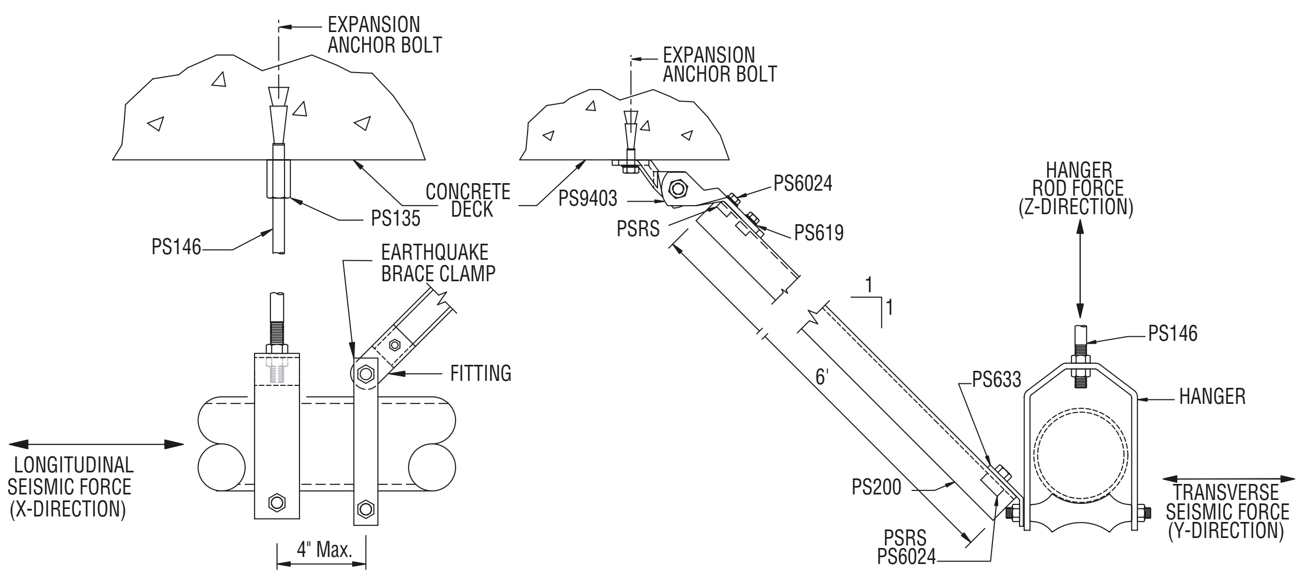
$F_x = K_x(FH) = 1.0(648^{\#}) = 648^{\#}$
$F_y = K_y(FH) = 1.0(648^{\#}) = 648^{\#}$
$F_b = K_b(FH) = 1.414(648^{\#}) = 916^{\#}$

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

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

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

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



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TITLE
Single Pipe Hanger Example

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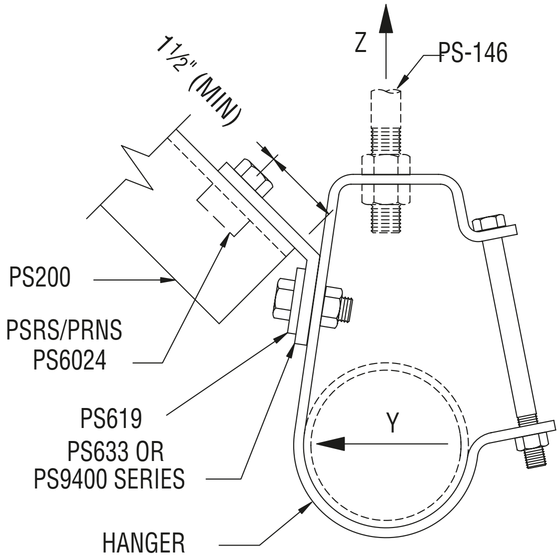
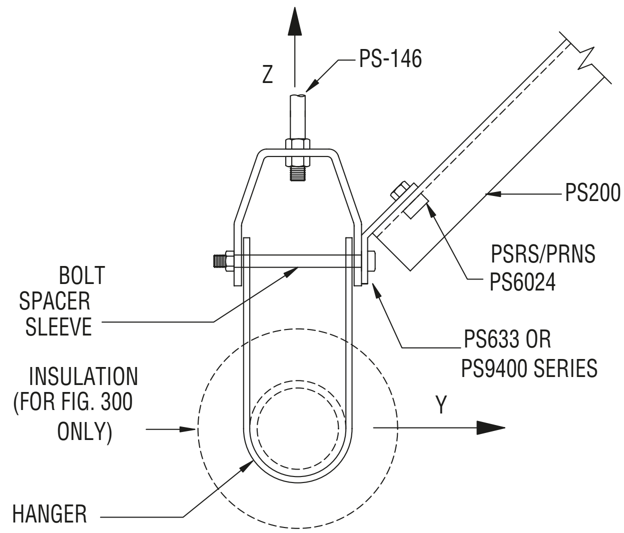
DATE **04/25/2003**

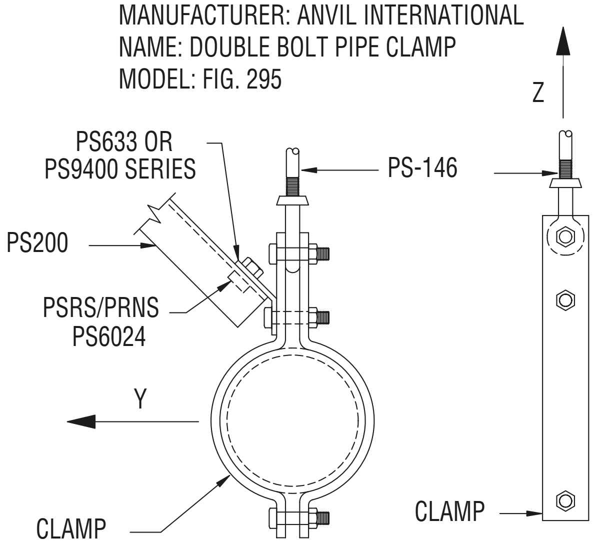
MANUFACTURER: ANVIL INTERNATIONAL
NAME: PIPE HANGER
MODEL: FIG. 67



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

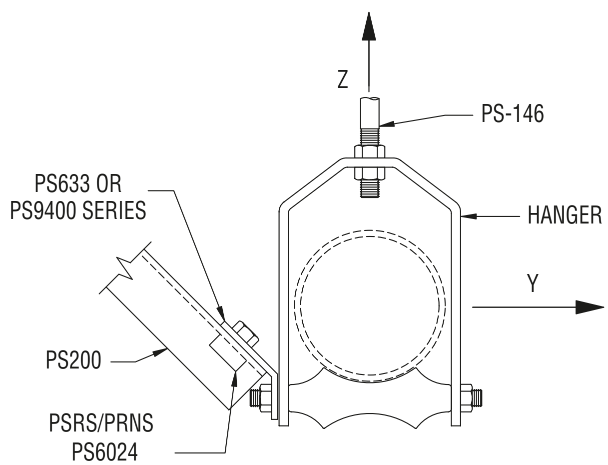


MANUFACTURER: ANVIL INTERNATIONAL
NAME: DOUBLE BOLT PIPE CLAMP
MODEL: FIG. 295



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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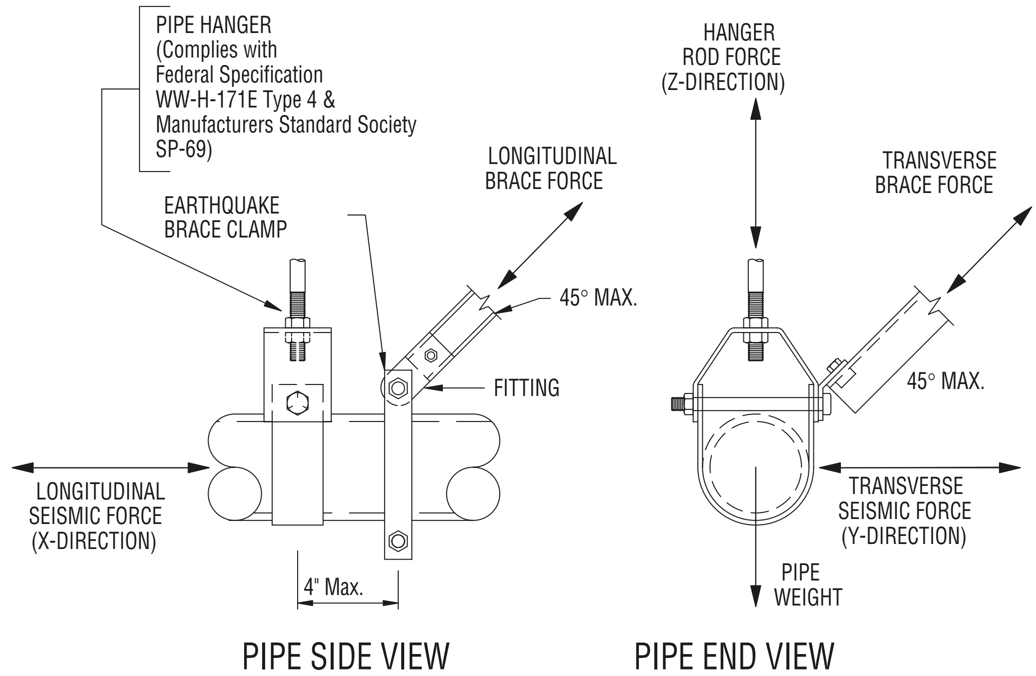
		PAGE **A11**	DATE **04/25/2003**



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

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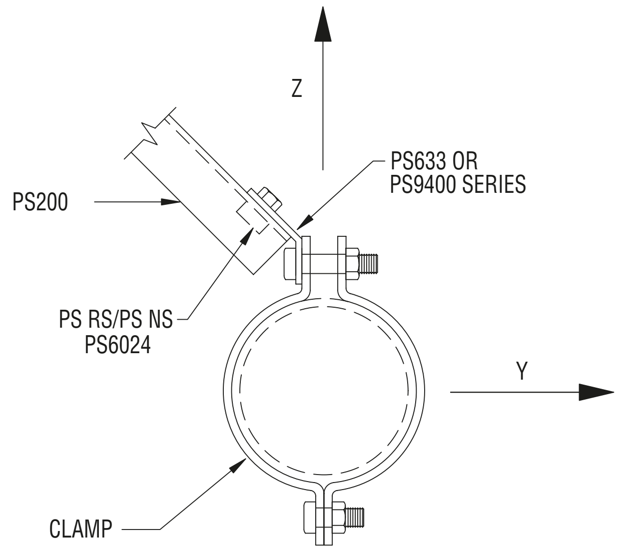
EARTHQUAKE BRACE CLAMP
(Clamp, supplied by Others, complies with Federal Specification WW-H-171E Type 4 and Manufacturers' Standardization Society SP-58 Type4.)

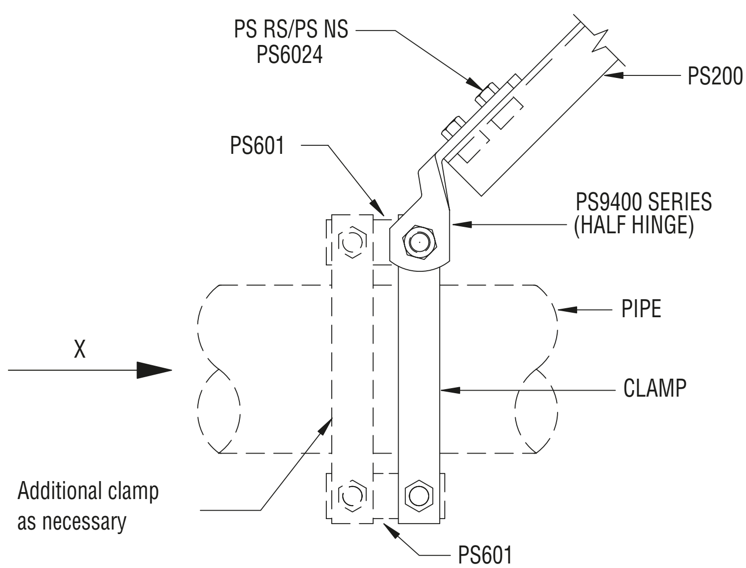
LOAD SCHEDULE

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 fastener tightening requirements see Page B2



TRANSVERSE BRACE



LONGITUDINAL BRACE

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TITLE
Single Pipe Hanger Brace/Clamp

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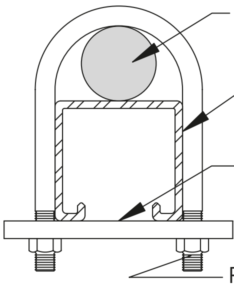
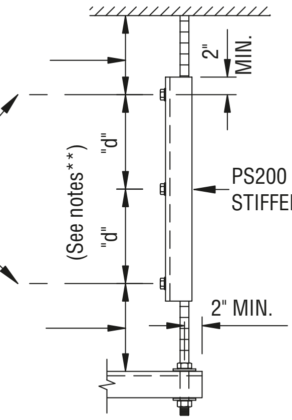
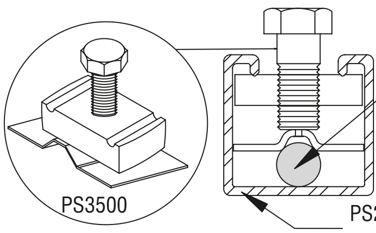


PS137 HANGER ROD STIFFENER ASSEMBLY
For ¾" & ⅞" Rods



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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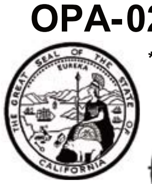

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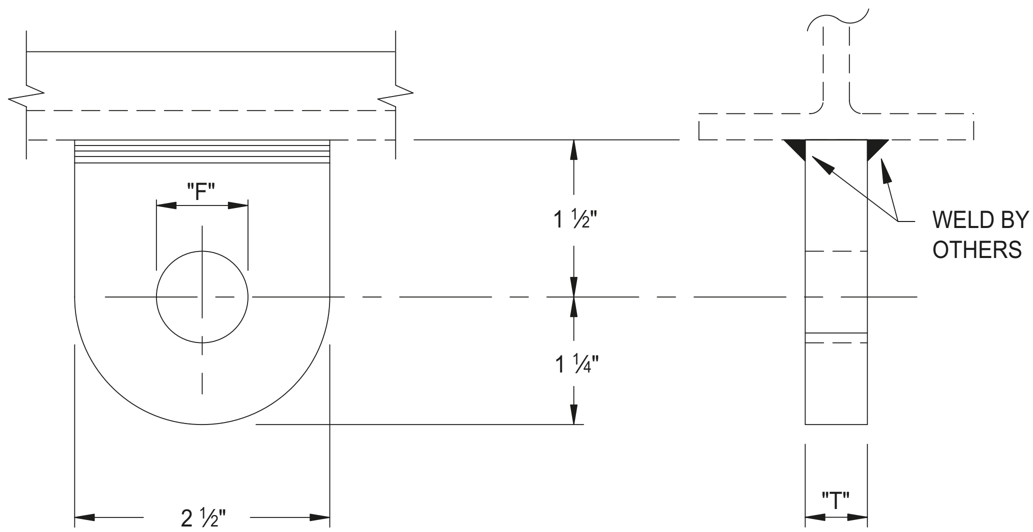
TITLE

Hanger Rod with Stiffener

PAGE	DATE
B1	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

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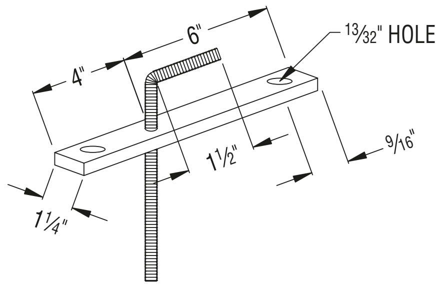
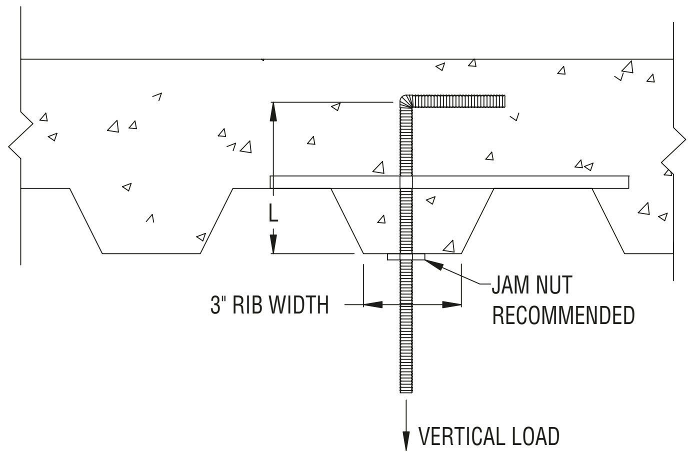
DATE **04/25/2003**





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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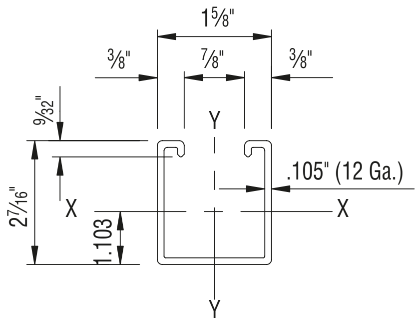
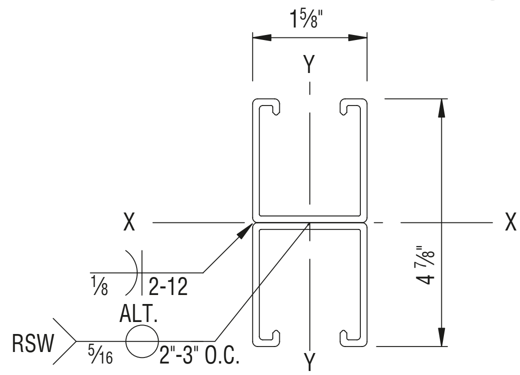


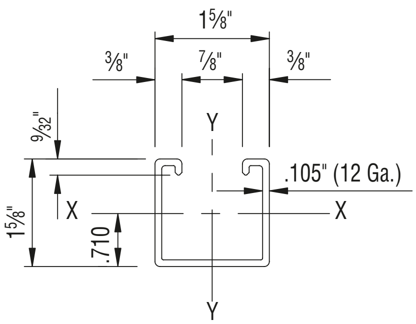
PS 150

STEEL CHANNEL

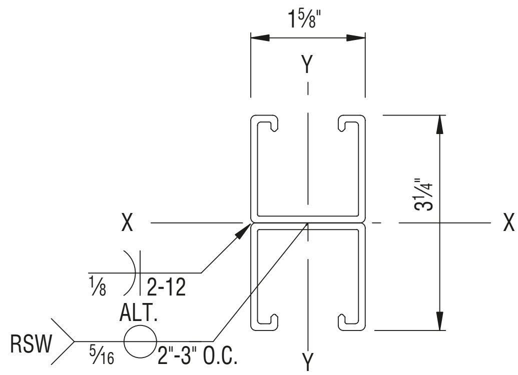


PS 150 2T3

WELDED STEEL CHANNEL



PS 200



PS 200 2T3

PROPERTIES

CHANNEL	AREA (in^2)	X-X AXIS: MOMENT OF INERTIA (in^4)	X-X AXIS: SECTION MODULUS (in^3)	X-X AXIS: RADIUS OF GYRATION (in)	Y-Y AXIS: MOMENT OF INERTIA (in^4)	Y-Y AXIS: SECTION MODULUS (in^3)	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

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TITLE

Channel Properties

PAGE **B11**

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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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OPA-0242 Apr 25, 2003

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TITLE

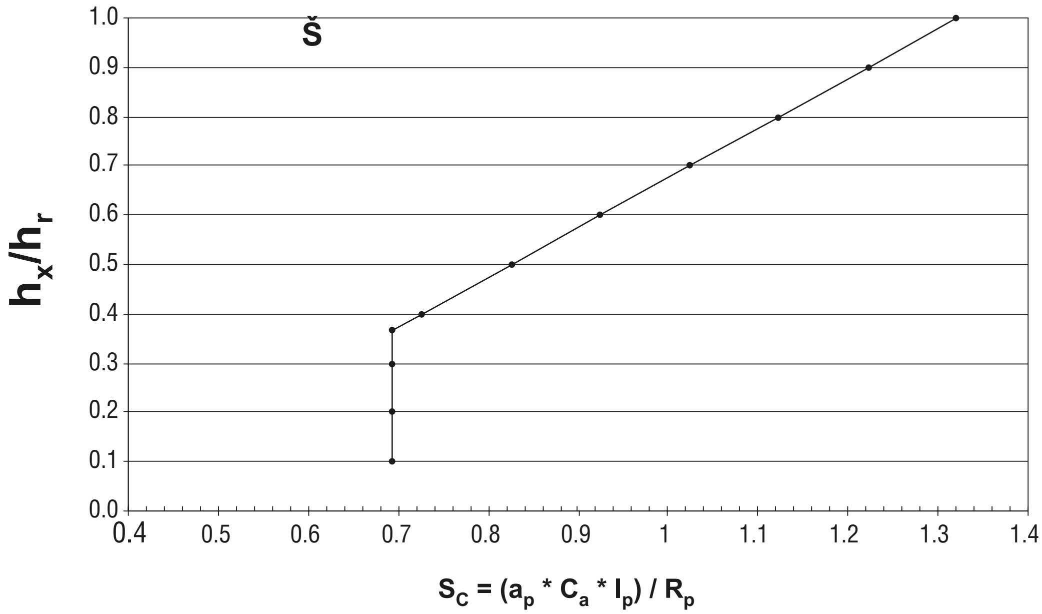
Pipe Data

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) :

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

A P P R O V E D

Fixed Equipment Anchorage

Office of Statewide Health Planning and Development

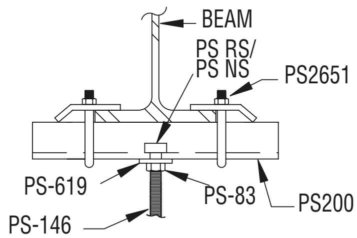
OPA-0242 Apr 25, 2003

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

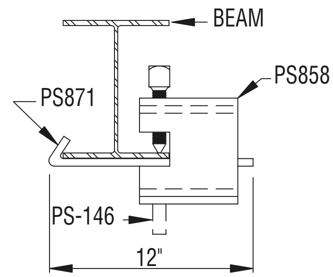
Bill Staehlin (916) 324-9106

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

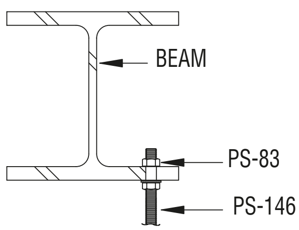
TITLE	
Seismic Force Graph	
PAGE	DATE
C5	**04/25/2003**



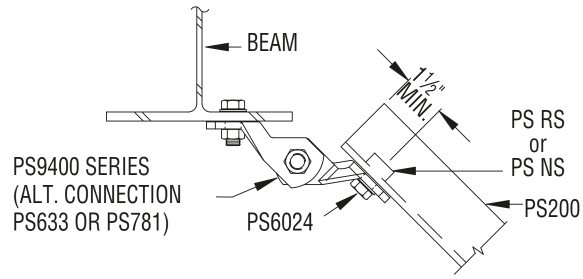
BEAM CLAMP ASSEMBLY*



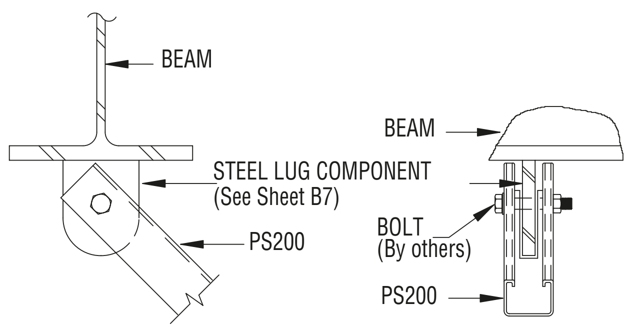
HEAVY BEAM CLAMP ASSEMBLY*



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.

A P P R O V E D
Fixed Equipment Anchorage
Office of Statewide Health Planning and Development
OPA-0242 Apr 25, 2003
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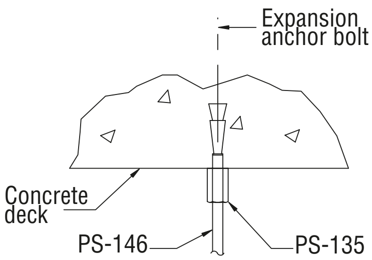
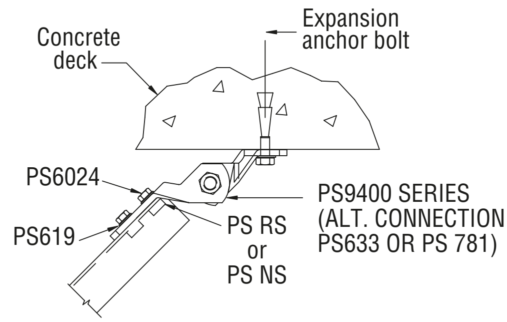
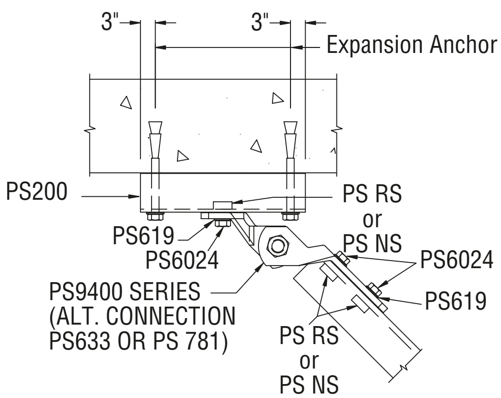
TITLE	
Steel	
PAGE	DATE
D1	04/25/2003



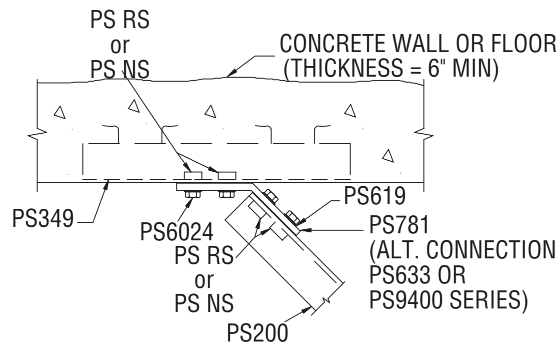
ONE BOLT ASSEMBLY*
(Connections not for use in pre-stressed concrete deck)



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.

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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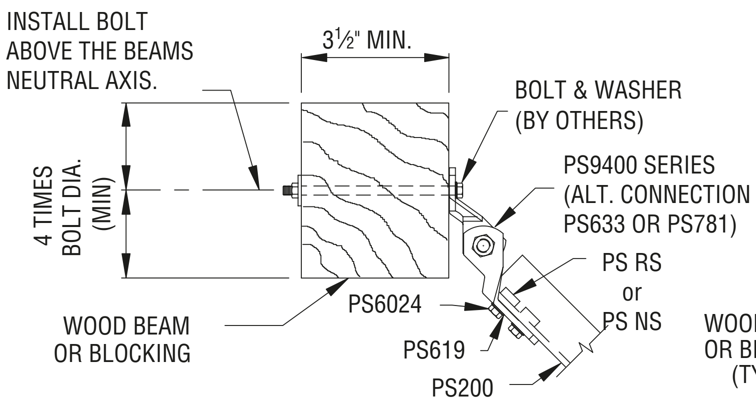
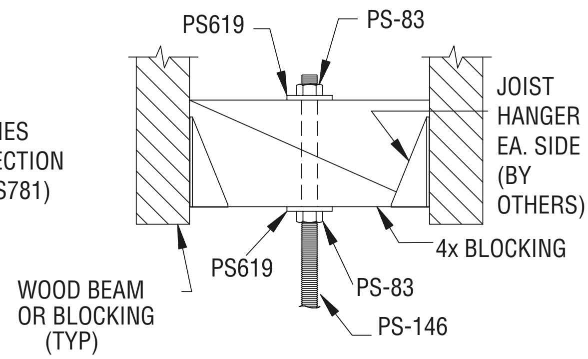
Arcadia, CA 91006

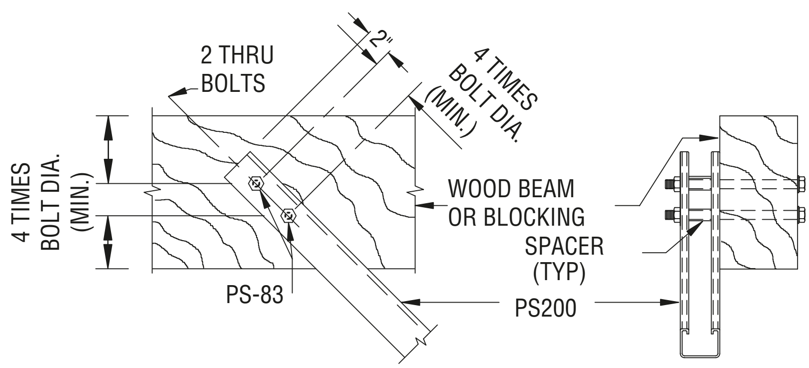
TITLE	
Concrete	
PAGE **D2**	DATE **04/25/2003**



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.

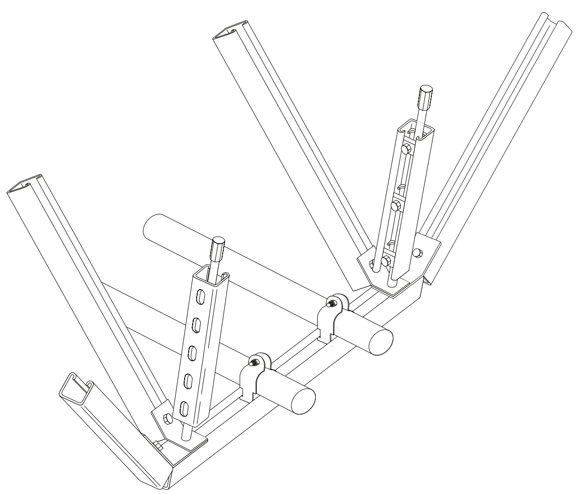
A P P R O V E D Fixed Equipment Anchorage Office of Statewide Health Planning and Development OPA-0242 Apr 25, 2003 **** Valid for 3 Years Maximum **** Bill Staehlin (916) 324-9106	JOSEPH L. LA BRIE Structural Engineer No. SE 3566 55 E Huntington Dr Suite 277 Arcadia, CA 91006	TITLE **Wood**	
		PAGE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

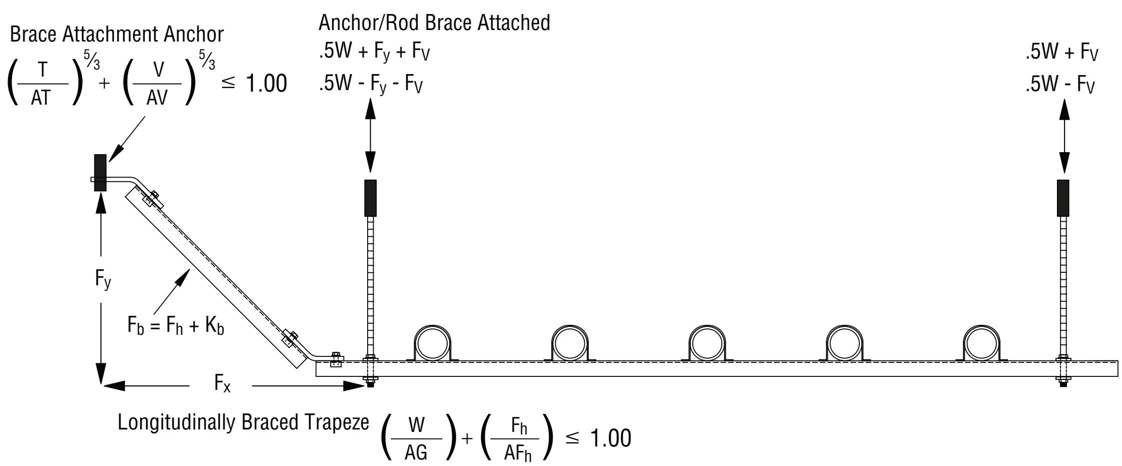
OPA-0242, Original Approved Page, included for reference

SEISMIC RESTRAINT SYSTEM

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

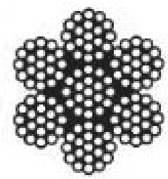
CONDUIT WEIGHTS PER FOOT

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

CABLE ALLOWABLE LOADS

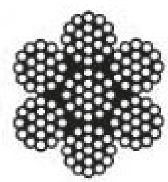
ALLOWABLE LOAD

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

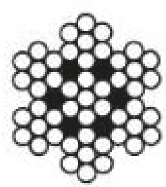
7 X 19 STAINLESS WIRE ROPE



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

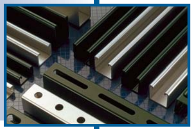
Wire Basket
- CAT-TRAY™ Wire Basket
- CAT-TRAY™ Accessories

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

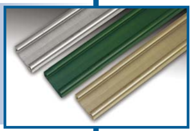
Other Cope Products
- Cable Channel

POWER-STRUT®
Family of Innovative Products

- CHANNELS



- VARIETY OF FINISHES



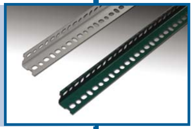
- CLAMPS

- PIPE CLAMPS

- BRACKETS & INSERTS

- PLATES

- POWER-ANGLE®
  Slotted Angles



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  Harvey, IL 60426
  Tel. 800-882-5543
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