SEISMIC BRACING SYSTEMS

Atkore™
Unistrut

Memorandum

State of California

oshpd

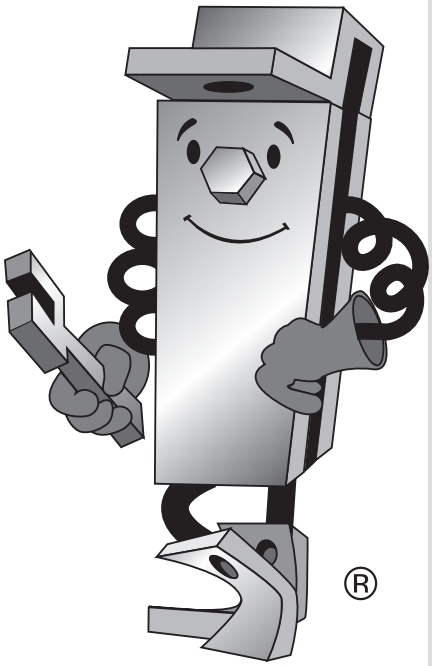
"Equitable Healthcare Accessibility for California"

To: All FDD Staff **Date:** April 22, 2008

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

Subject: 2007 CBC and Use of Existing Pre-Approvals

Until further notice, existing OSHPD anchorage pre-approvals (OPA) may be used on projects subject to the 2007 California Building Code (CBC) without modification. All aspects of the design and installation of the pre-approved component or system, including computation of the lateral forces, shall be in accordance with the approved OPA.



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UNISTRUT® Seismic Bracing Systems are designed and constructed to resist virtually all code specified seismic forces in the event of an earthquake; therefore, keeping non-building structural components of hospitals and other essential facilities operational and intact.

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

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

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

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

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

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

NOTE: Information contained in this catalog is to be used with genuine Unistrut products only. It must not be used as a basis for certifying any system other than Unistrut.

1. These guidelines are intended to provide information for the seismic restraint of nonstructural components in buildings based on NZS 4219. Nonstructural components may include hospital piping, electrical conduit, cable trays, and air handling ducts. Anyone making use of the data does so at his own risk and assumes any and all liability resulting from such use. UNISTRUT disclaims any and all express or implied warranties of fitness for any general or particular application.

2. Seismic horizontal force factor:

   $FH = (C_S)W_P$

   Factoring from Strength Design (FH) to Working Stress (Fh) is necessary for Seismic Force to be used in this catalog. Use the following formula: Fh = FH/1.35.

   Cs to be determined in accordance with NZS 42(9:2005)

3. When supporting pressure piping, spacing of seismic bracing should not exceed two (2) times the vertical support spacing. Stress in the pipes that are comparable to those required by ASME B31.1 will be maintained.

   Where lateral restraints are omitted, the piping, ducts or conduit shall be installed such that lateral motion of the piping or duct will not cause damaging impact with other systems of structural members, or loss of vertical support.

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

Bolt Diameter (mm)	Bolt Torque (N-M)
M6	8
M8	15
M10	25

Bolt Diameter (mm)	Bolt Torque (N-M)
M12	67
M16	135
M20	169

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

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

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

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

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

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

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

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

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

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

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

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

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

Working Stress – Allowable load used for design; factors down strength design loads, providing a safety factor. Generally, strength design forces/1.4.

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

3. LONGITUDINAL RESTRAINT OF A PIPE LENGTH CAN BE PROVIDED BY TRANSVERSE RESTRAINT OF CONNECTED PERPENDICULAR PIPES AS LONG AS THE CONNECTED PIPES ARE THE SAME SIZE AND THE TRANSVERSE RESTRAINT OF THE CONNECTED PIPE IS LOCATED WITHIN 600 MM FROM THE CONNECTION.

4. LONGITUDINAL PIPE RESTRAINTS SHALL BE INSTALLED AS PER THE GUIDELINES OF TABLE 7 OF NZS 4219:2005.

5. PIPES LESS THAN 50MM IN DIAMETER AND SUSPENDED 150MM OR LESS FROM THE SUPPORTING STRUCTURE DO NOT NEED SPECIFIC SEISMIC RESTRAINTS.

6. VERTICAL RUNS MUST HAVE TRANSVERSE BRACING IN EACH DIRECTION AT BOTH ENDS AND WITHIN TWO PIPE DIAMETERS OF THE VERTICAL SUPPORT.

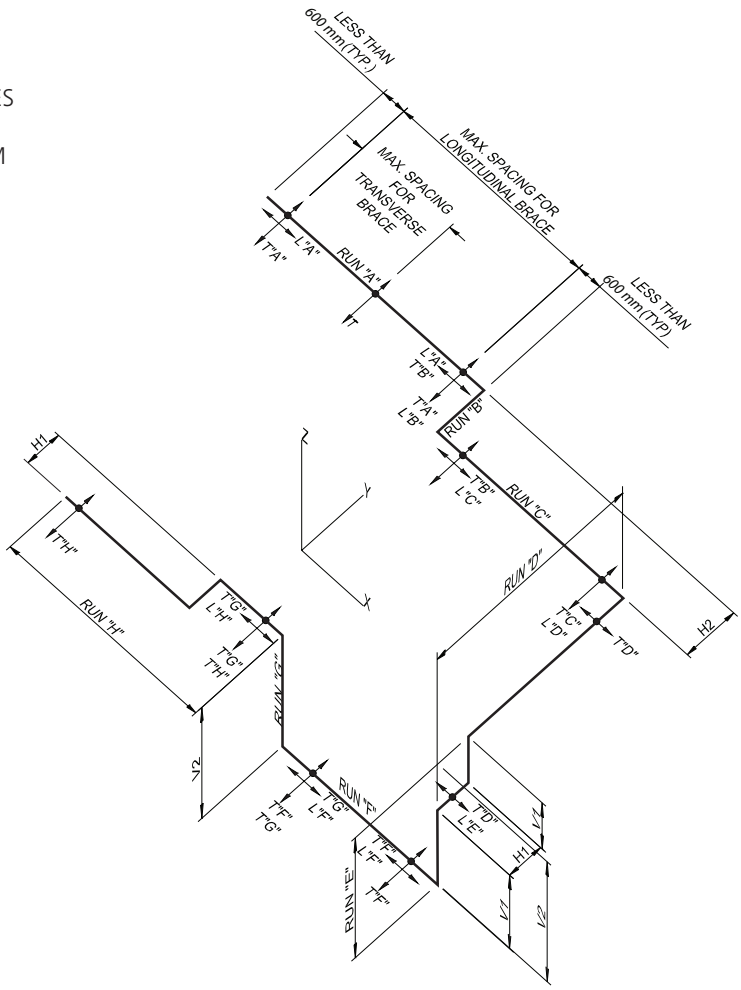
7. VERTICAL PIPES SHALL HAVE SUFFICIENT FLEXIBILITY TO ALLOW FOR RELATIVE HORISONTAL SEISMIC MOVEMENT BETWEEN FLOORS OR FIXING POINTS.

8. PIPES SHALL BE RESTRAINED AT THE POINT OF CONNECTION OF BRANCH PIPES, CONNECTIONS TO EQUIPMENT, ON AT LEAST ONE SIDE OF FLEXIBLE COUPLINGS, AND WHERE SWAYING OF THE PIPE MAY DAMAGE OTHER BUILDING ELEMENTS.

9. INFORMATION CONTAINED IN THIS CATALOG IS TO BE USED WITH GENUINE UNISTRUT PRODUCT ONLY. IT MUST NOT BE USED AS A BASIS FOR CERTIFYING ANY SYSTEM OTHER THAN UNISTRUT.

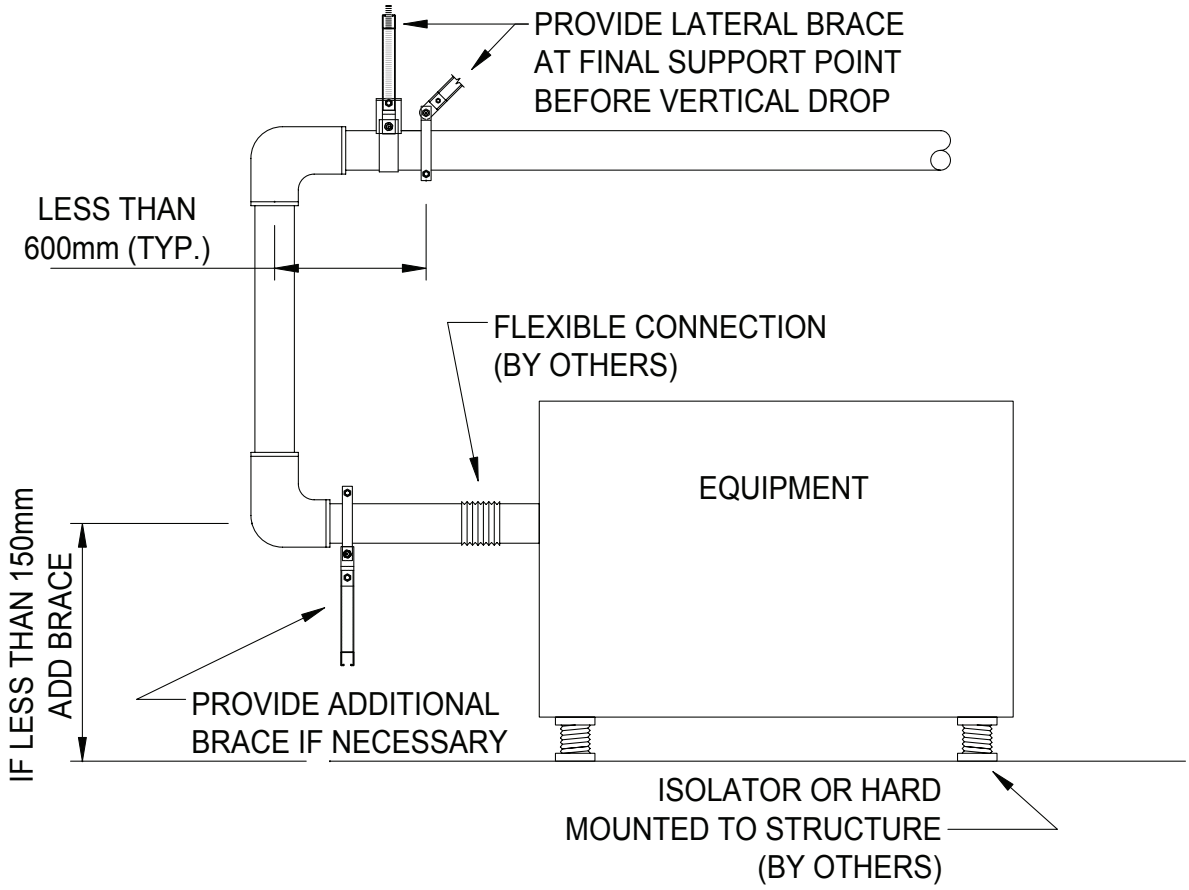
LEGEND

T = TRANSVERSE BRACE
L = LONGITUDINAL BRACE
V1 = LESS THAN 600mm OFFSET VERTICALLY
V2 = MORE THAN 600mm OFFSET VERTICALLY
H1 = LESS THAN 600mm OFFSET HORIZONTALLY
H2 = MORE THAN 600mm OFFSET HORIZONTALLY



AS/NZS 3500.1:2003
NZS 4219:2009

SEE SECTION 5 FOR CONNECTION
DETAILS TO STRUCTURE ABOVE



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

1. Determine the support spacing using the smallest pipe diameter (Page 11, Pipe Data Table).

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

   W = S x (p1 + p2 + p3 + … + pn)
   W = Total weight on trapeze (kg)
   pn = Weight of pipe plus water (kg/m)
   S = Support spacing (m)

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

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

   $F_{b\ Actual} = F_h/\cos 45° = 1.414F_h$

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

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

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

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

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

Brace on alternate hangers	Tmax = .5W + s(2W)	(Page 12, Figure 1)
Brace on every hanger	Tmax = .5W + sW	(Page 12, Figure 2)

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

$$\frac{\textbf{Actual Compression Load}}{\textbf{Allowable Compression Load}}$$

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

7. Select pipe clamps (Pages 19-20). Either style, P2024 Series or UN4/UN15 Series can be used.

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

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

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

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

$$\frac{\left[\begin{matrix}\text{Actual}\\ \text{Vertical Force}\end{matrix}\right]}{\left[\begin{matrix}\text{Lateral}\\ \text{Reduction Factor}\end{matrix}\right]\times\left[\begin{matrix}\text{Allowable}\\ \text{Vertical Force}\end{matrix}\right]}+\frac{\left[\begin{matrix}\text{Actual}\\ \text{Horizontal Force}\end{matrix}\right]}{\left[\begin{matrix}\text{Lateral}\\ \text{Reduction Factor}\end{matrix}\right]\times\left[\begin{matrix}\text{Allowable}\\ \text{Horizontal Force}\end{matrix}\right]}\leq 1.33$$

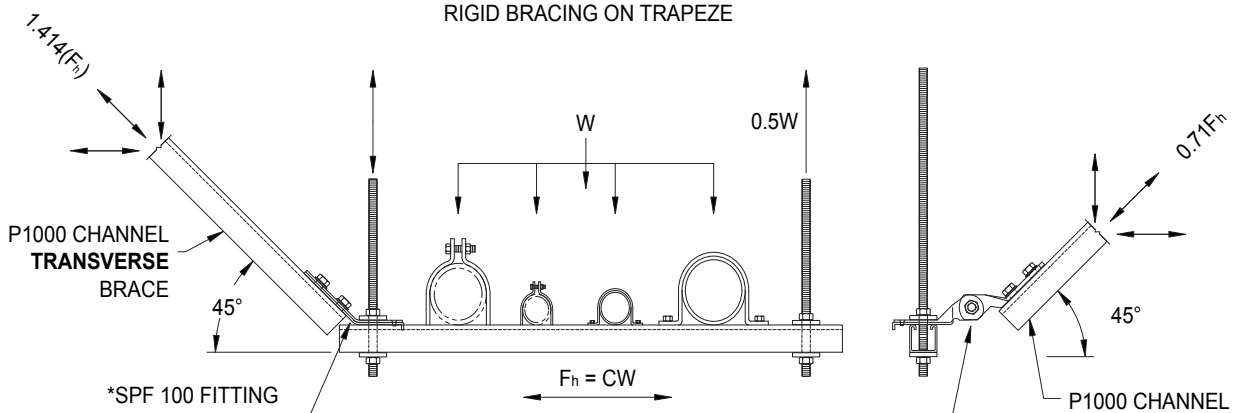
NOTE: All examples are based on the California EQ Code.

Pipe Data

Data for Schedule 40 Standard Weight Pipe			
Pipe Size (mm)	**Pipe Section Modulus (mm^3)**	**Max. Support Spacing AS/ NZS 3500.1:2003 Table 5.2 (m)**	**Weight of Pipe Plus Water, P kg/m**
15	91.82	2	0.39
20	244.14	2	0.75
25	526.23	2	1.25
40	1241.97	2.5	2.27
50	2261.17	3.0	3.57
65	3583.84	3.0**	5.07
80	6837.50	4.0**	7.60
100	12349.62	4.0**	12.18
150	36686.99	4.0**	25.86
200	313249.86	4.0**	42.63

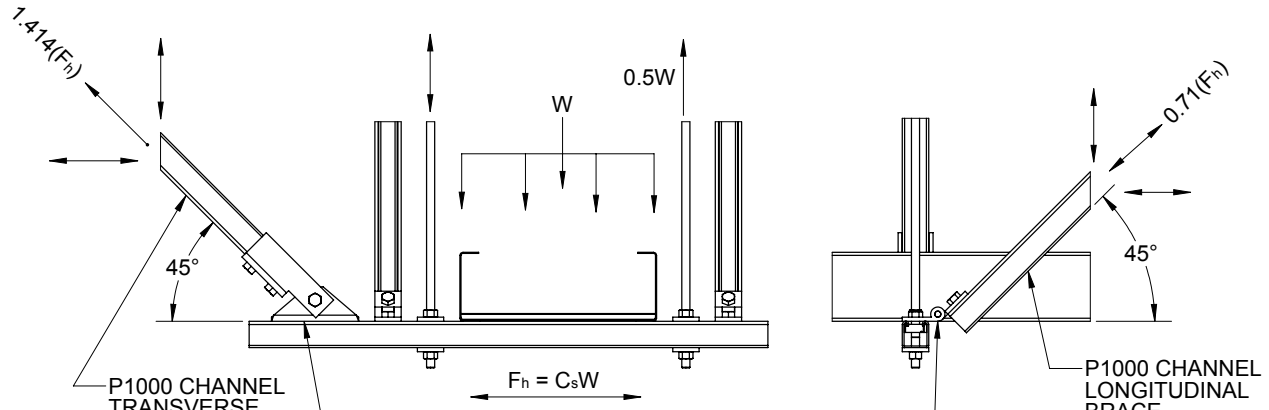
*ASME B31.1 does not list all sizes shown, therefore some sizes have been proportioned between.
**Spacing limited by AS/NZS 3500.1:2003.

RIGID BRACING ON TRAPEZE



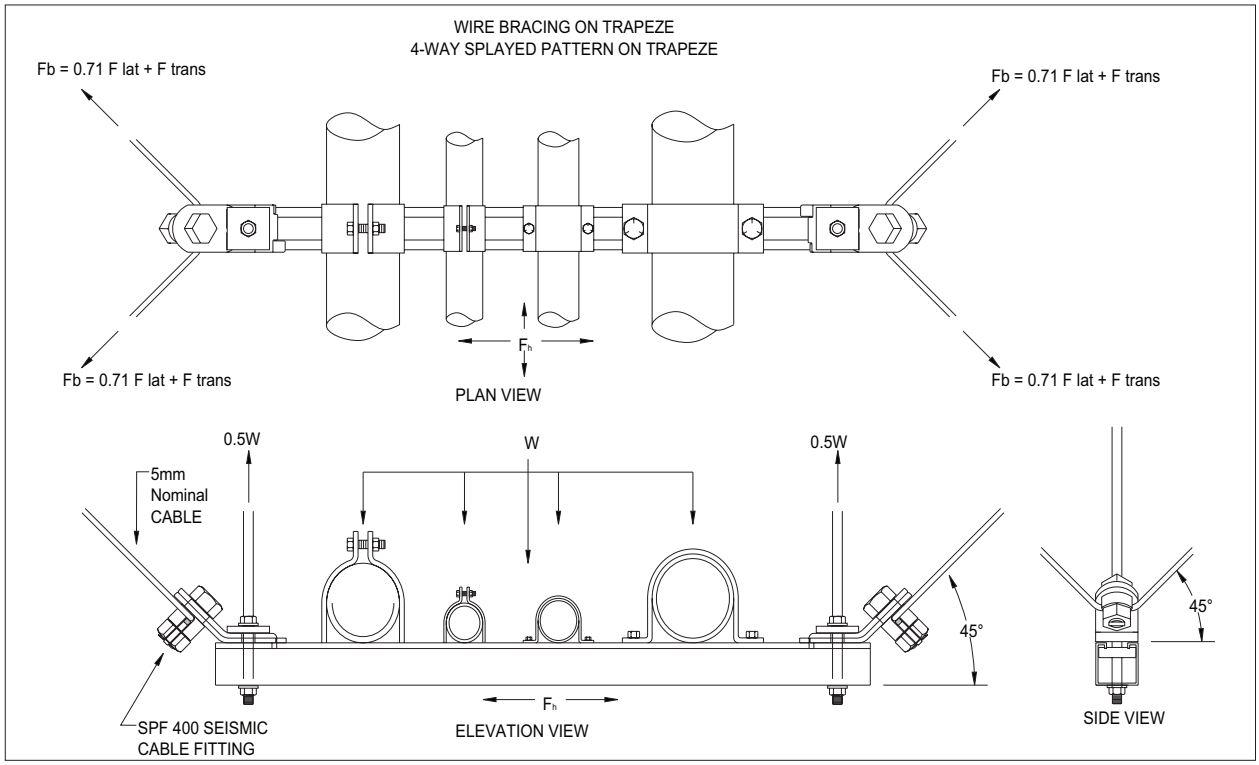
W = GRAVITY LOAD PER TRAPEZE
$F_h = CW$
ROD TENSION MAX. = 0.5W
ROD COMPRESSION MAX = 0.5W - F_h

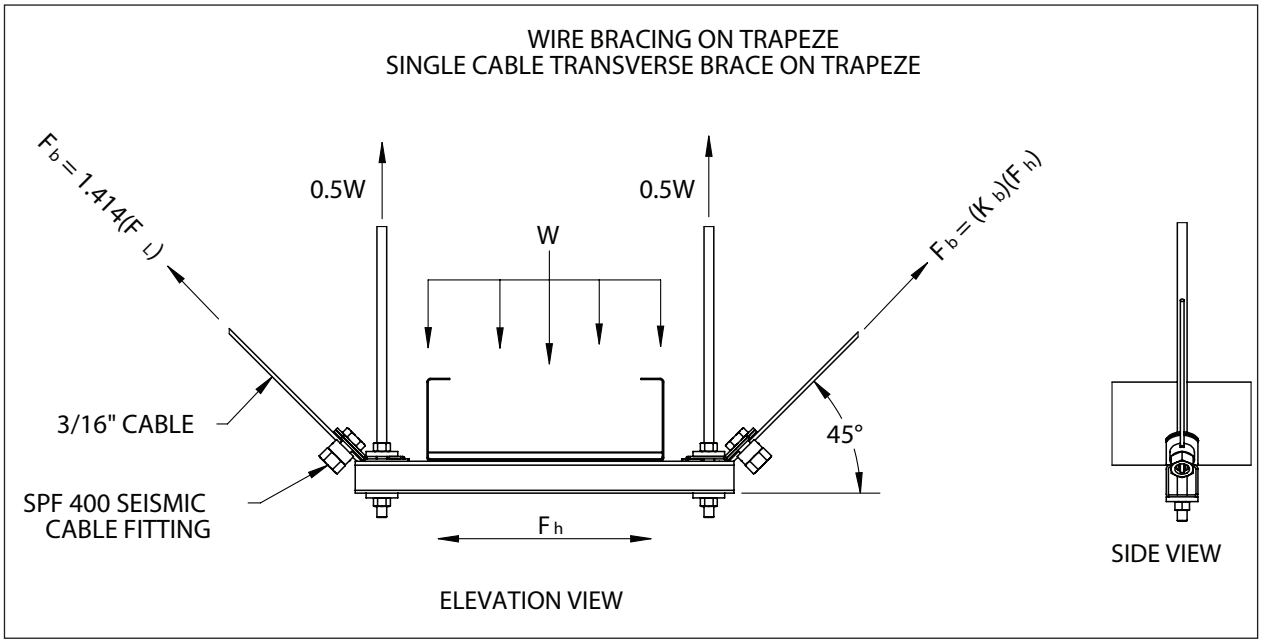
RIGID BRACING FOR TRAPEZE
CABLE TRAYS



W = GRAVITY LOAD PER TRAPEZE
$F_h = C_sW$
ROD TENSION MAX. = 0.5W
ROD COMPRESSION MAX = 0.5W - F_h

NOTE:
1) FOR LOAD REACTIONS SHOWN ON THIS PAGE, THE PIPE OR CONDUIT LOADS ON THE TRAPEZE SHOULD BE RELATIVELY UNIFORM AND SYMMETRIC ALONG THE LENGTH OF THE MEMBER.
*2) SPF FITTING IS A TRADEMARK OF LORD & SONS, Inc.





NOTE:
1) FOR LOAD REACTIONS SHOWN ON THIS PAGE, THE PIPE OR CONDUIT LOADS ON THE TRAPEZE SHOULD BE RELATIVELY UNIFORM AND SYMMETRIC ALONG THE LENGTH OF THE MEMBER.
2) SPF FITTING IS A TRADEMARK OF LORD & SONS, INC.
3) ALTERNATE FITTINGS CAN BE USED. SEE SECTION 4 CHANNEL FITTINGS.

DESIGN PROCEDURES FOR TRAPEZE HANGERS

1. Select hanger type (Page 21) given the diameter of the pipe/width of cable tray.

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

   W = S x p

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

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

   FH = CsW

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

4. Check brace forces (max. at 45°) at every other hanger and select fittings from Page 28.
   Reference Page 2-7 for brace connections other than 45°.
   $F_{b\ Actual} = F_h/co_s45° = 1.414F_h$

5. Select brace to be used, Rigid or Cable.
   Check brace against allowable design load (Page 28) and channel slip (Page 27).
   Select a fitting from Pages 29-31.
   The lowest allowable design load (Allowable Fh) governs.

   Determine if longitudinal braces are required using the following equation:
   Brace Spacing = Allowable Fb / (1.414 Fh x hanger spacing)

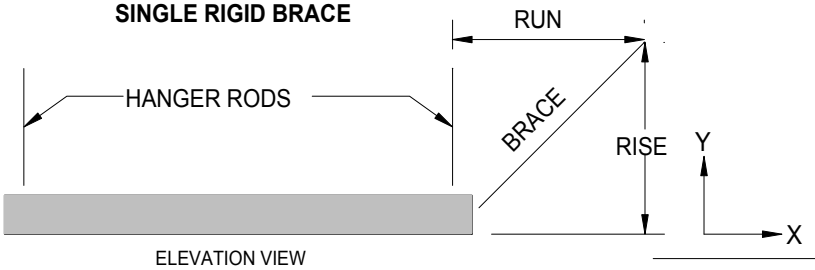
6. Check tension of rod (reference Page 15):
   Tmax = W + Fy
   Fy = Ky*Fh

   Check compression: $\frac{\textbf{Actual Compression Load}}{\textbf{Allowable Compression Load}}$

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

7. Verify pipe clamp capacity (use Design Table in Page 21)
   Actual Longitudinal Force = Fh x Longitudinal Brace space

SINGLE RIGID BRACE



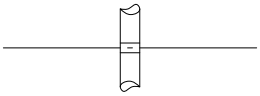
ELEVATION VIEW

TRAPEZE

BRACE SLOPE RISE	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

TWO OPPOSING CABLE BRACES

PLAN VIEW



SINGLE PIPE

TRAPEZE

BRACE AXIAL FORCE:

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

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

Kb = Brace Factor

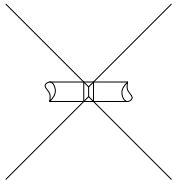
Fh = Horizontal Seismic Factor

Fy = Ky * Fh

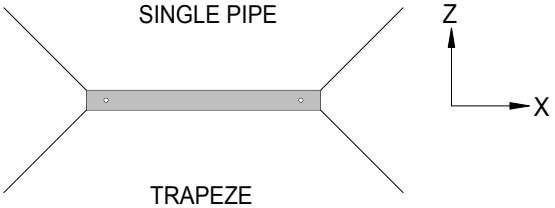
Fx = Kx * Fh

4-WAY SPLAYED PATTERN

PLAN VIEW



SINGLE PIPE



TRAPEZE

BRACE SLOPE X	Y	Z	SLOPE FACTORS Kb	Kx	Ky
1	1	1	2.000	1.000	1.000

BRACE AXIAL FORCE:

Fb = Kb *½ Fh = 2.000 * (½ Fh)

Fb = Fh (Tension only)

Kb = Brace Factor

Fh = Horizontal Seismic Factor

Fy = Ky * Fh

Fx = Kx * Fh

A P P R O V E D

Fixed Equipment Anchorage

Office of Statewide Health Planning and Development

OPA-0120 Apr 25, 2003

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

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PAGE

SEISMIC TABLE PROCEDURE

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

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

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

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

OPA-0120 Apr 25, 2003

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

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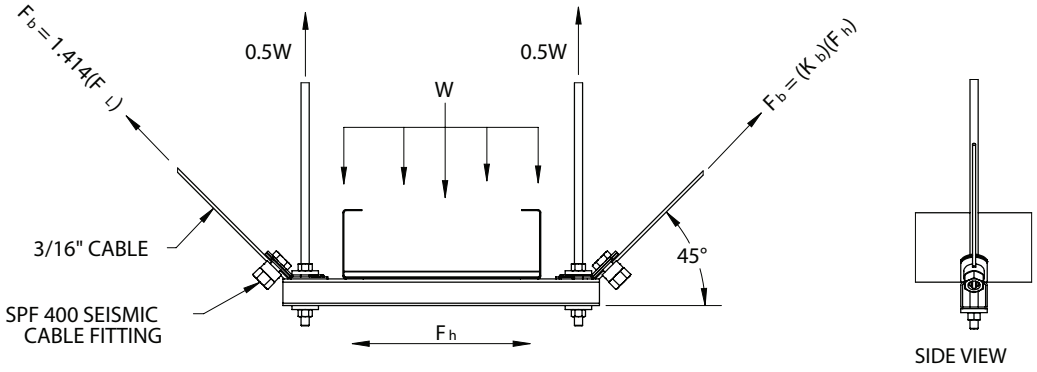
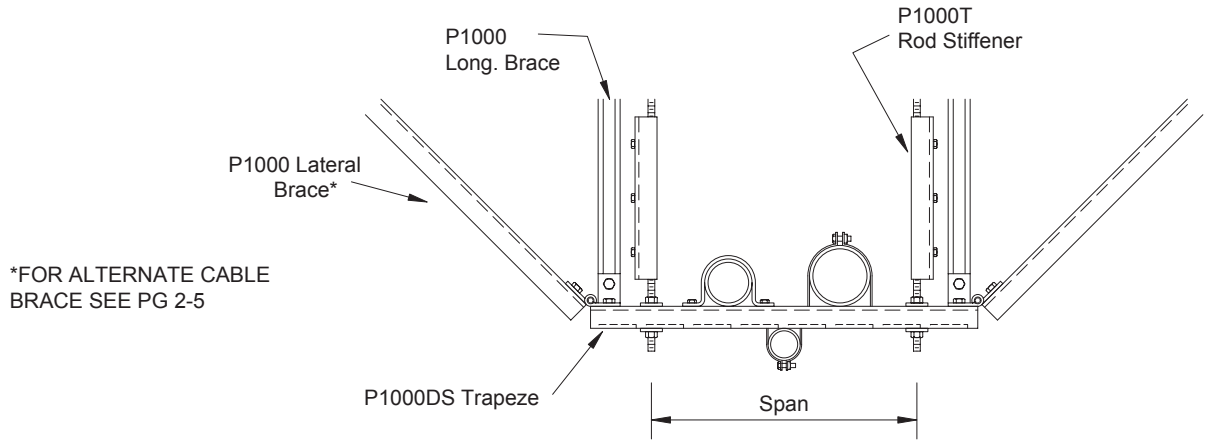
PAGE

WIRE BRACING ON TRAPEZE
SINGLE CABLE TRANSVERSE BRACE ON TRAPEZE



ELEVATION VIEW



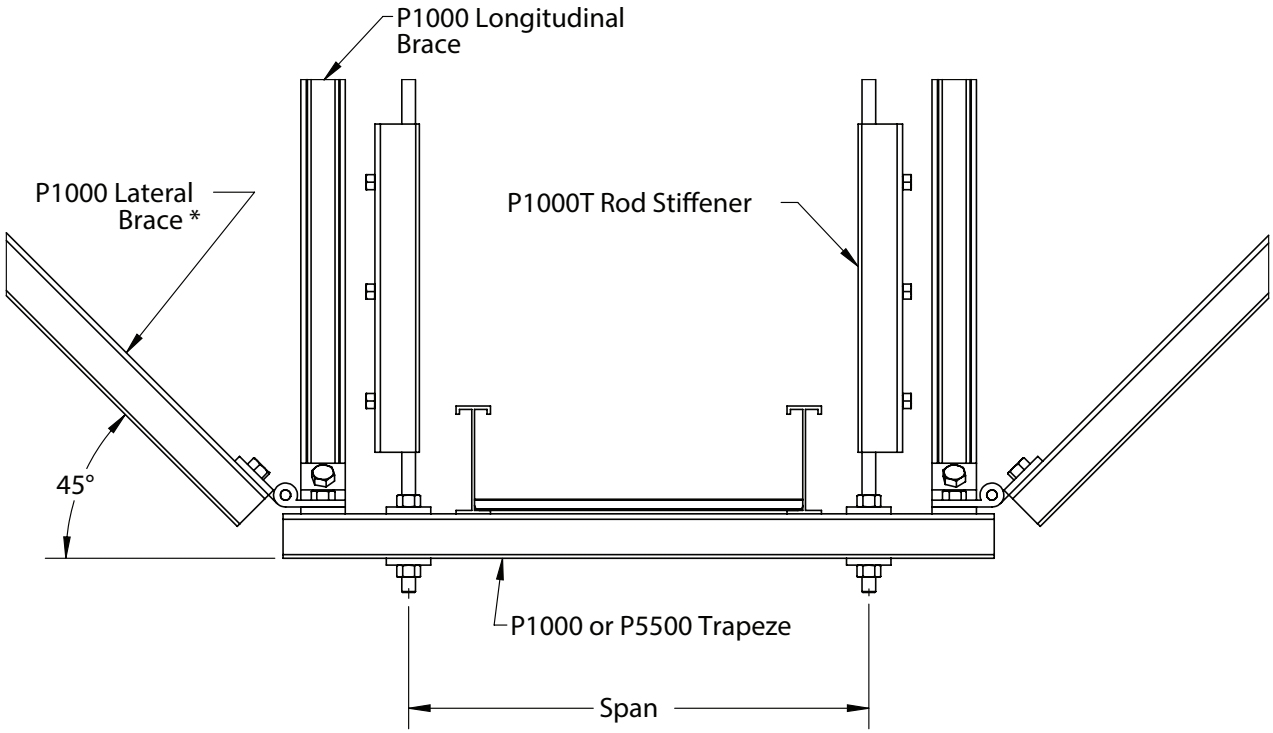
P1000 Trapeze Load Data

Span	SWL Uniform Design Load*	Concentrated Load @Center of Span
mm	kN	N
500	7.42	2,000
1000	3.71	2,490
1250	2.94	1,870
1500	2.67	1,510
2000	1.85	1,250
2250	1.65	1,070
2500	1.48	930
2750	1.35	850
3000	1.24	760

P5500 Trapeze Load Data

Span	SWL Uniform Design Load*	Concentrated Load @Center of Span
mm	kN	N
500	13.84	7,210
1000	6.92	4,800
1250	5.54	3,600
1500	4.61	2,920
2000	3.46	2,400
2250	3.08	2,050
2500	2.77	1,780
2750	2.52	1,600
3000	2.31	1,420

*Safety factor 2.5 applied against component failure

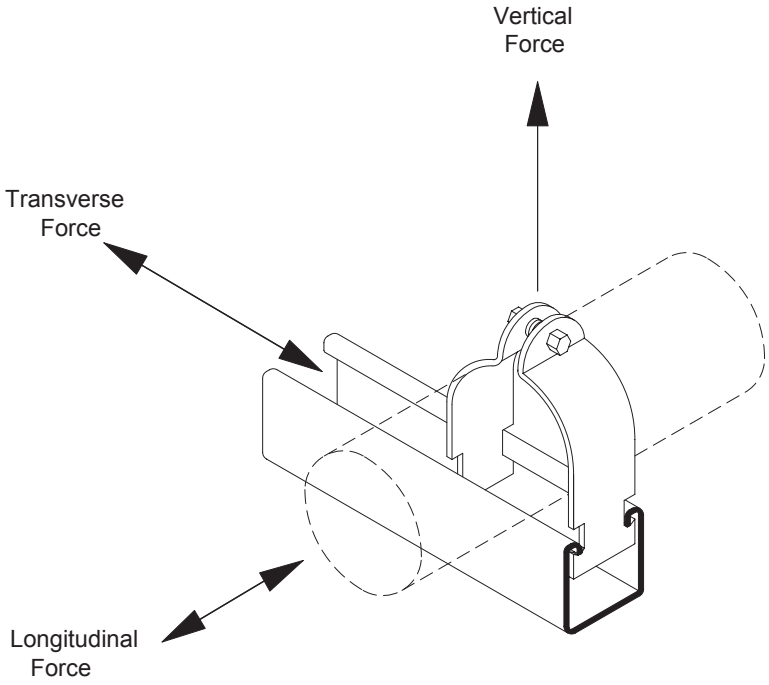


P1001 Trapeze Load Data

Span	Maximum Uniform Design Load	Concentrated Load @Center of Span
mm	N	N
1,200	10,680	5,290
1,500	8,540	4,230
1,800	7,120	3,510
2,000	6,090	3,020
2,500	5,340	2,620
2,750	4,760	2,360
3,000	4,270	2,090

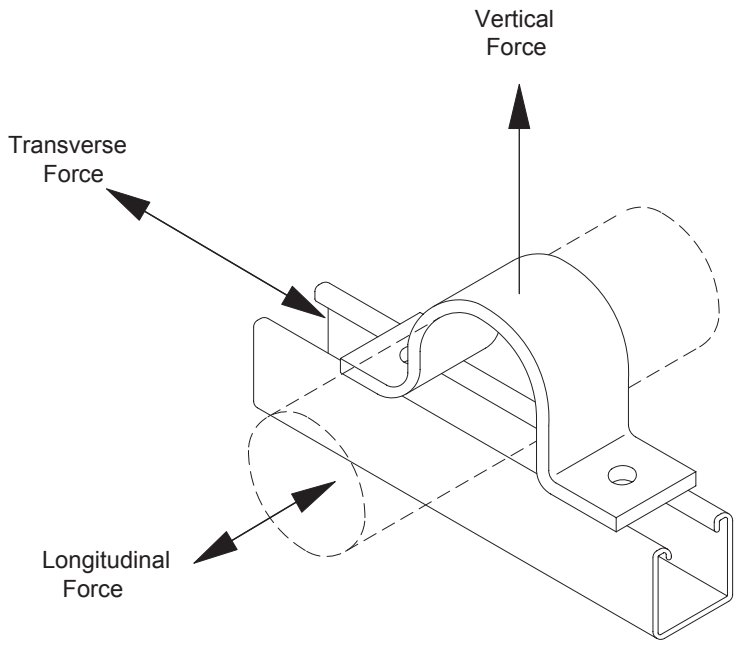
P5501Trapeze Load Data

Span	Maximum Uniform Design Load	Concentrated Load @Center of Span
mm	N	N
1,200	20,820	10,630
1,500	17,210	8,540
1,800	14,320	7,120
2,000	12,280	6,050
2,500	10,760	5,290
2,750	9,560	5,160
3,000	8,590	4,230



P2024 Series Pipe Clamps

Unistrut Part Number	Pipe Size	Strap thickness	Screw Size	Vertical Force	Design Loads	
					Transverse Force	Longitudinal Force
	mm	*mm*	*mm*	*N*	*N*	*N*
P2026	14	1.6	6	1,780	310	220
P2028	19	1.6	6	2,670	440	310
P2030	25	1.6	6	2,670	670	360
P2032	32	2.0	6	2,670	670	670
P2034	38	2.0	6	3,560	1,070	670
P2038	51	2.5	8	3,560	1,070	890
P2042	64	2.5	8	3,560	1,070	890
P2046	76	2.5	8	3,560	1,070	890
P2050	90	2.5	8	4,450	1,420	890
P2054	102	2.5	8	4,450	1,420	890
P2062	127	2.5	8	4,450	1,420	890
P2070	152	2.5	8	4,450	1,420	890
P2070-80	203	2.5	8	4,450	1,420	890

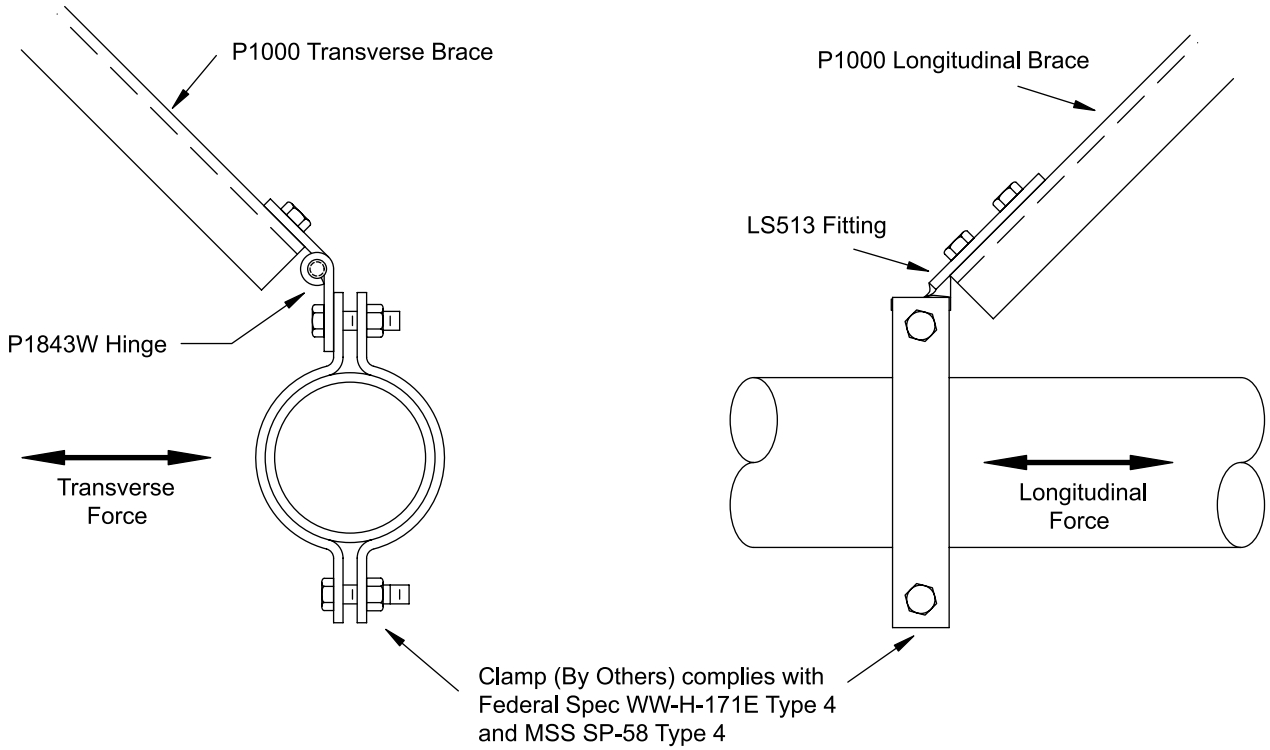


UN4/UN15 Series

Unistrut Part Number	Pipe Size	Strap thickness	Screw Size	Design Loads		
				Vertical Force	Transverse Force	
	mm	*mm*	*mm*	*N*	*N*	*N*
UN4-19	19	3	8	2,220	1,110	440
UN4-25	25	3	8	2,220	1,110	440
UN4-32	32	3	8	2,220	1,110	440
UN4-38	38	3	8	2,220	1,110	440
UN4-51	51	6	12	4,450	4,450	890
UN4-60	60	6	12	4,450	4,450	890
UN15-76	76	6	12	4,450	4,450	890
UN15-89	89	6	12	4,450	4,450	890
UN15-102	102	6	12	4,450	4,450	890
UN15-127	127	6	12	4,450	4,450	890
UN15-152	152	6	12	4,450	4,450	1,220

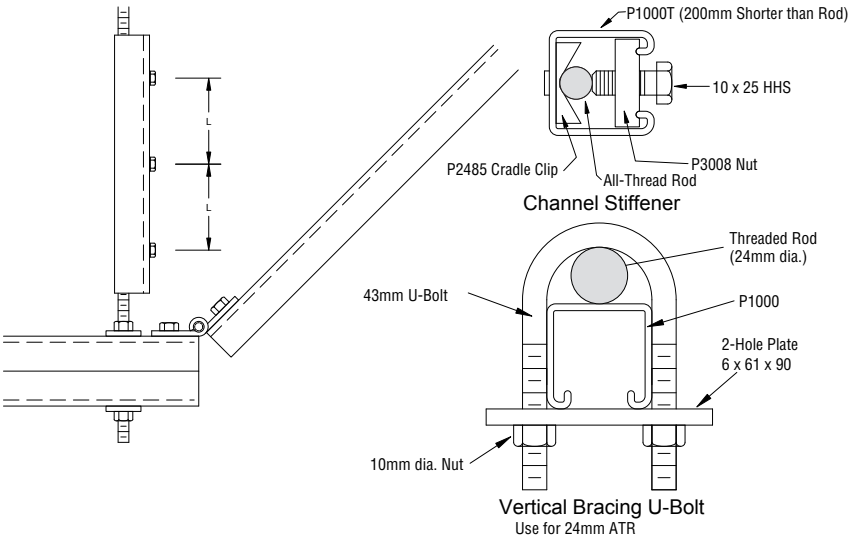
Transverse Brace

Longitudinal Brace



Design Longitudinal Force

Pipe Size m^2	Longitudinal Force *kN*
12 thru 40mm	0.445
43 thru 127mm	0.890
152	1.670
203	2.220



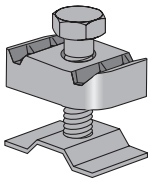
VERTICAL BRACING OR STIFFENER LOAD TABLE

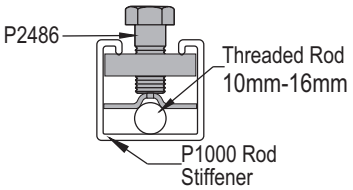
Rod Size mm.	Root Area mm.²	Root Diameter mm.	Radius of Gyration mm.	Max. Allowable Rod Compression	Clip Spacing L (mm.)			Max. Seismic Safe Load*
					Rod Stress at 50% 4,500 PSI	Rod Stress at 75% 6,750 PSI	Rod Stress at 100% 9,000 PSI	
10	0.068	0.314	0.0785	610	350	300	250	810
12	0.126	0.425	0.1063	1,130	500	400	350	1,500
16	0.202	0.536	0.1341	1,810	600	500	400	2,410
20	0.302	0.652	0.163	2,710	750	600	500	3,610
24	0.419	0.73	0.192	3,770	900	700	650	5,030

Assumptions:
1. Rod held against translation at location of cradle clips K equals 1.0.
2. L = Distance between connection points.
3. Trapeze with braces on alternate members.

*4. Loads are based on the root area of the thread and at a stress of 9,000 psi, 62 mpa.

*5. Safe seismic forces are determined by increasing allowable safe loads by 33%

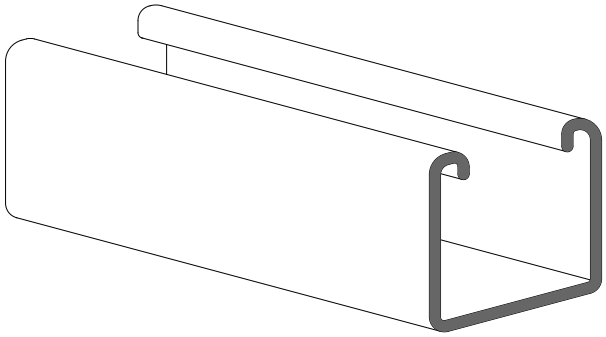




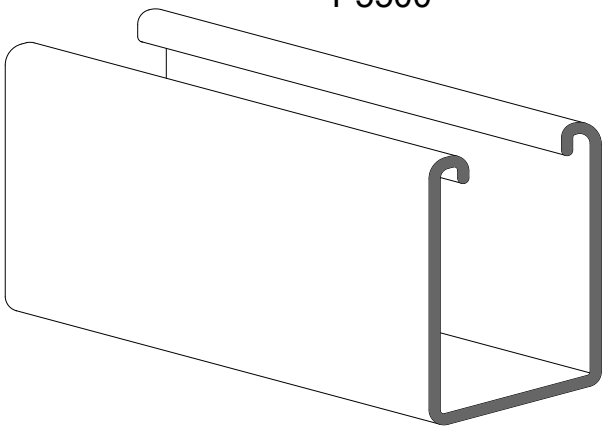
P2486 SEISMIC ROD STIFFENER

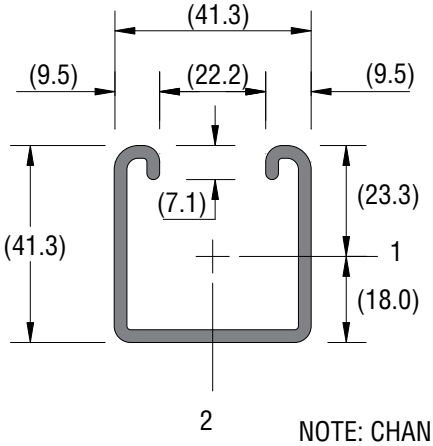
Part No.	Finish	Size	Weight
P2486	EG	10mm thru 16mm	16.00

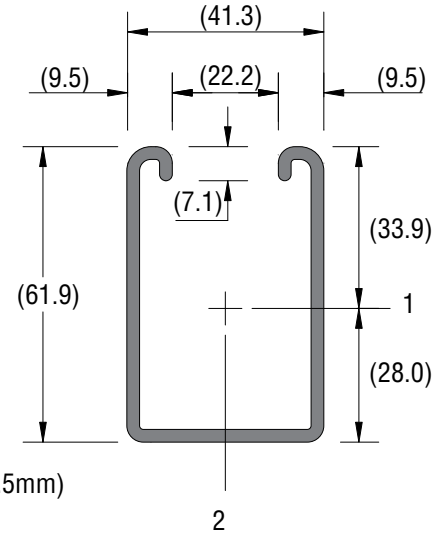
P1000



P5500

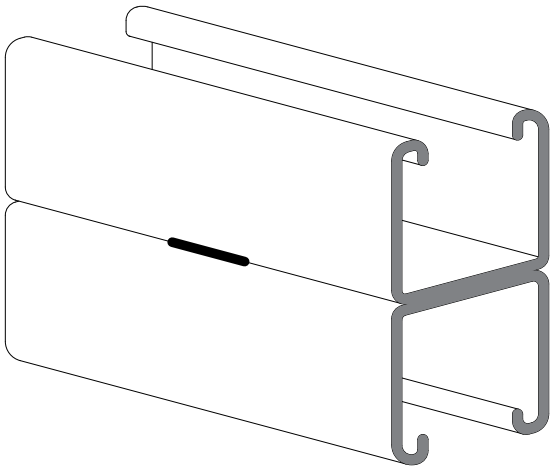




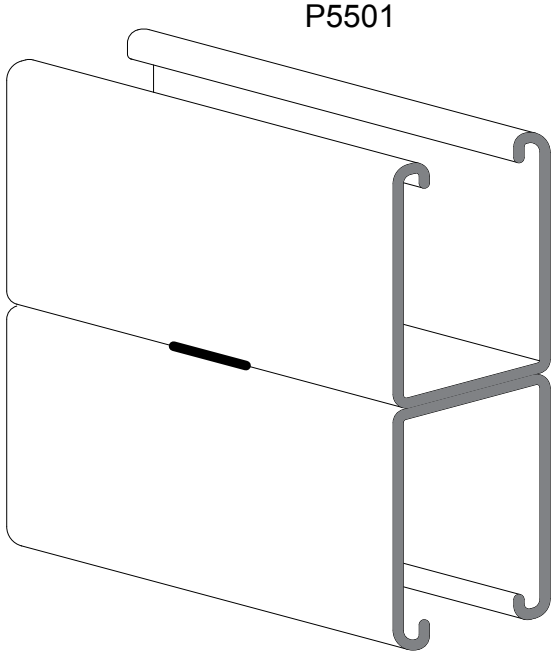


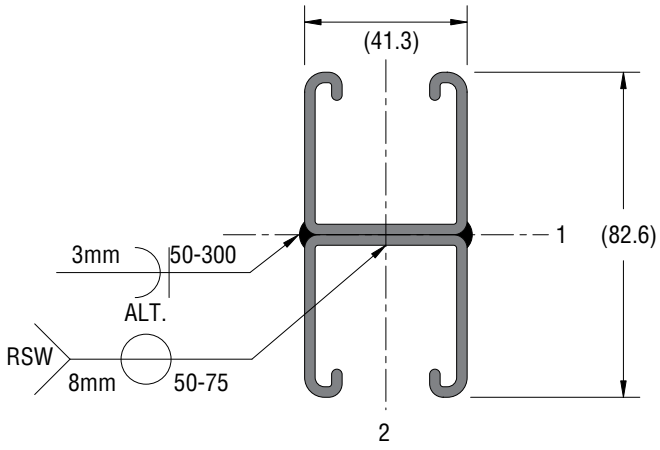
NOTE: CHANNEL WALL THICKNESS IS 12GA. (2.5mm)

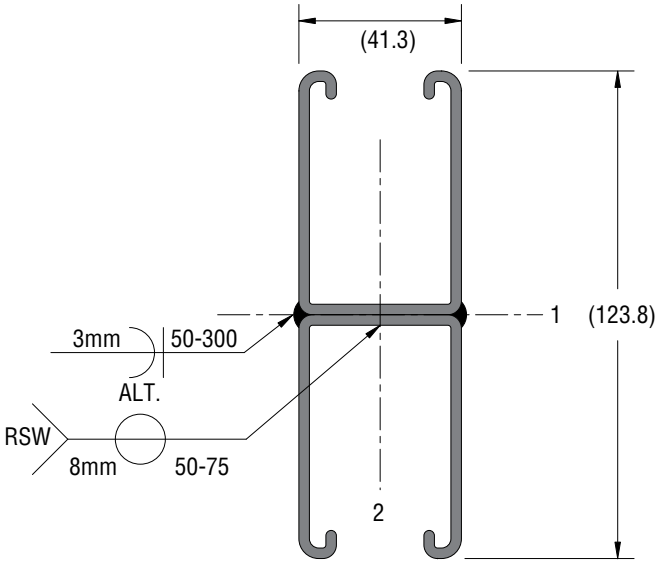
P1001



P5501

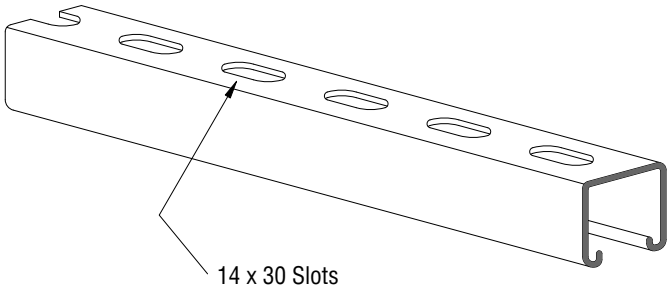






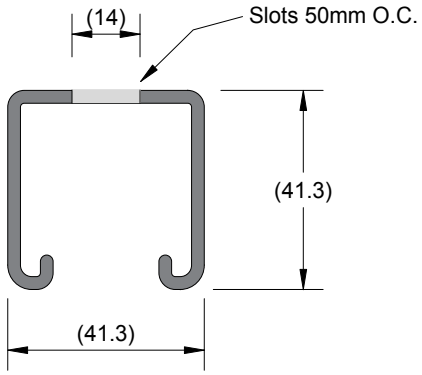
NOTE: CHANNEL WALL THICKNESS IS 12GA. (2.5mm)

P1000T



P1000T

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



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

Table 15 – ELEMENTS OF SECTION

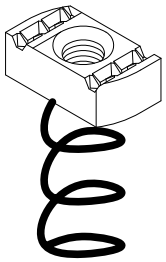
Channel Type	Weight	A	Axis, X - X			Axis, 4 - 4		
			I	z	r	I	z	r
	Kg/m	*mm²*	*mm⁴*	*mm³*	*mm*	*mm⁴*	*mm3³*	*mm*
P1000	2.81	3.59	7.7	3.31	1.466	9.82	4.75	1.65
P1001	5.62	7.17	38.71	9.37	2.324	19.65	9.5	1.65
P5500	3.68	4.68	21.77	6.41	2.154	13.94	6.75	1.72
P5501	7.35	9.37	117	18.89	3.533	27.85	13.5	1.72

Static Beam Load (X-X Axis)

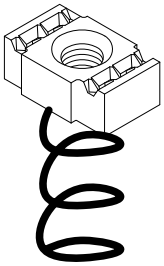
Span (mm)	Channel	Max Allowable Uniform Load	Deflection at Uniform Load	Max Allowable Horizontal Load
		N	*mm*	*N*
500	P1000	7.42	1.5	11.31
	P1001	19.58*	0.8	19.50*
	P5500	13.84	1	15.28
	P5501	27.04	0.5	27.00*
1000	P1000	3.71	3.3	5.65
	P1001	9.79	1.8	9.80*
	P5500	6.92	2.3	7.64*
	P5501	20.50	1.3	15.28*
1250	P1000	2.97	5.6	4.52
	P1001	7.83	3.3	8.10
	P5500	5.54	3.8	6.11
	P5501	16.40	2	12.22
1500	P1000	2.47	8.9	3.77
	P1001	6.53	5.1	6.60
	P5500	4.61	6.1	5.09
	P5501	13.67	3.3	10.19
2000	P1000	1.85	12.7	2.70
	P1001	4.90	7.1	5.00
	P5500	3.46	8.6	3.78
	P5501	10.25	4.8	8.04
2250	P1000	1.65	17.3	2.34
	P1001	4.35	9.9	4.50
	P5500	3.08	11.9	3.12
	P5501	9.11	6.6	7.55
2500	P1000	1.48	22.6	2.05
	P1001	3.92	12.7	4.00
	P5500	2.77	15.5	2.63
	P5501	8.20	8.6	6.75
2750	P1000	1.35	28.7	1.85
	P1001	3.56	16.3	3.60
	P5500	2.52	19.6	2.81
	P5501	7.46	10.7	5.59
3000	P1000	1.24	35.6	1.72
	P1001	3.26	20.1	3.30
	P5500	2.31	24.4	2.54
	P5501	6.83	13.2	5.14

* Load Limited by Weld Shear

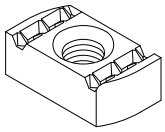
Notes:
1. Calculations of section properties are based on metal thicknesses as determined by AISI, Cold-Form Steel Design Manual
2. Prevent end rotation of beams that have vertical loads and lateral forces.
3. When loads are concentrated at or near midspan, allowable uniform loads should be multiplied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



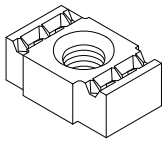
Spring Nut
P1006
P1008
P1010



Spring Nut
P1012S
-
-



Nut Without Spring
P3006
P3008
P3010

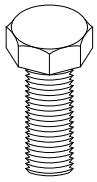


Nut Without Spring
P1012
-
-

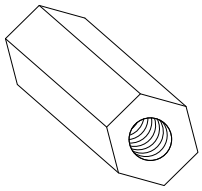
UNISTRUT NUT DIMENSION & DESIGN LOADS

Channel nut	Thread Size	Nut Thickness	Resistance to Slip 12 Ga. Channel	Pull-Out Strength* 12 Ga. Channel	Tightening Torque** 12 Ga. Channel
		mm	*N*	*N*	*(N-m)*
P1012S P1012	M16	13	6,670	11,120	135.00
P1010 P3010	M12	13	6,670	8,900	70.00
P1008 P3008	M10	10	3,560	4,450	25.00

*Safety factor of 3
**UNISTRUT nuts and bolts mounted to the UNISTRUT channels must be tightened to listed torque values (unless otherwise noted).



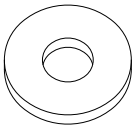
Hex Head Cap Screw
HHS



Coupler Nut
RC

Hex Nut
HN

Lock Washer
SW



Flat Washer
FW

P1000 BRACE DESIGN LOAD

Unsupported Length	Compression Load*
(mm)	*(KN)*
500	18.50
1000	16.00
1250	13.50
1500	11.50
1750	9.50
2000	8.00
2500	6.50
2750	6.00
3000	5.00

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

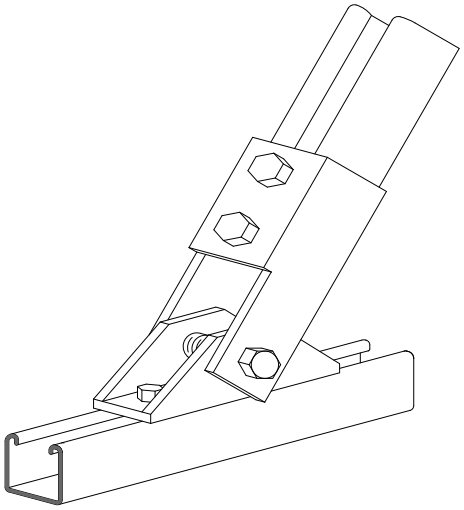
SPF 400 DESIGN LOAD

*** A Trademark of Lord & Sons, Inc.**

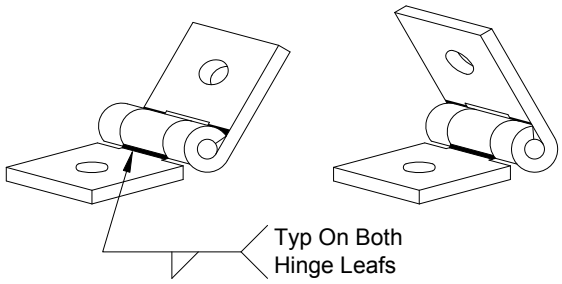
Wire Rope Diameter (mm)	4 Way Splayed		Single Cable
	Transverse Load	Longitudinal Load	Transverse Load
	(kN)	*(kN)*	*(kN)*
(5)	4.67	4.96	2.89

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

*P2815 Adjustable Brace



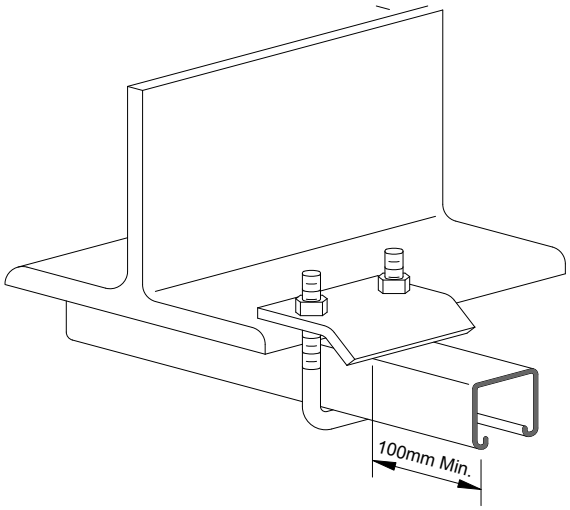
*P1843W Adjustable Hinge



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

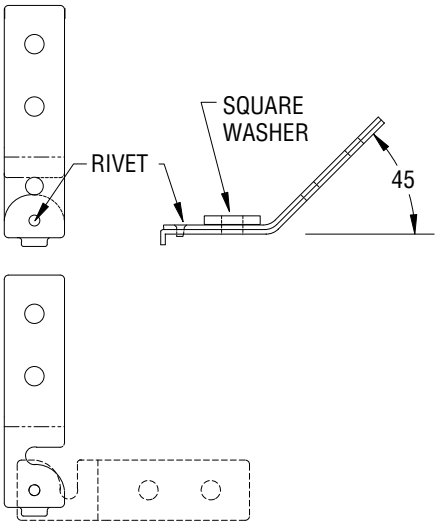
P2785 Beam Clamp

Use In Pairs



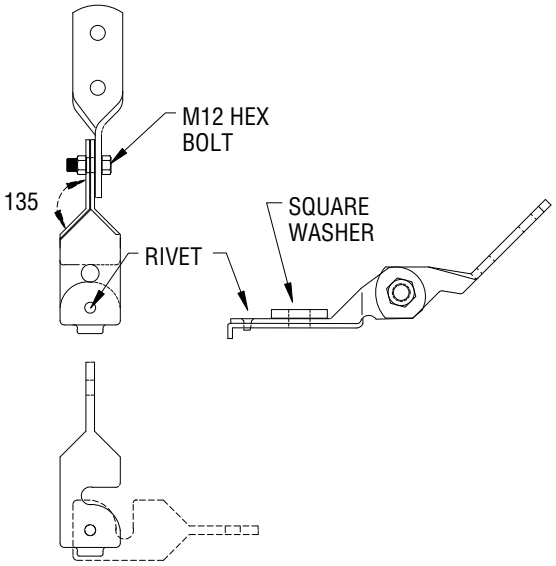
SERIES SPF100* FITTING

For rod sizes (mm): 10, 12, 16, 20



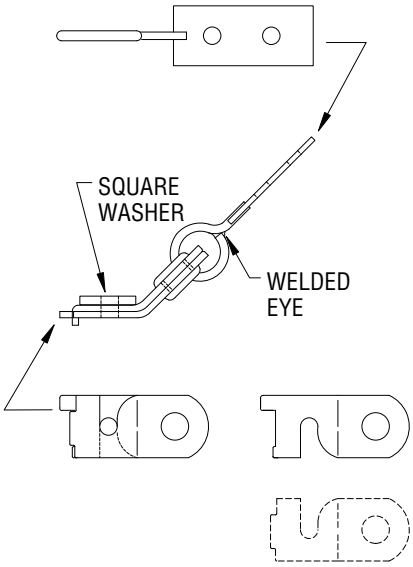
SERIES SPF200* ADJUSTABLE FITTING

For rod sizes (mm): 10, 12, 16, 20



SERIES SPF300* FITTING

For rod sizes (mm): 10, 12, 16, 20



*SEISMIC PIVOT FITTING (SPF) SERIES

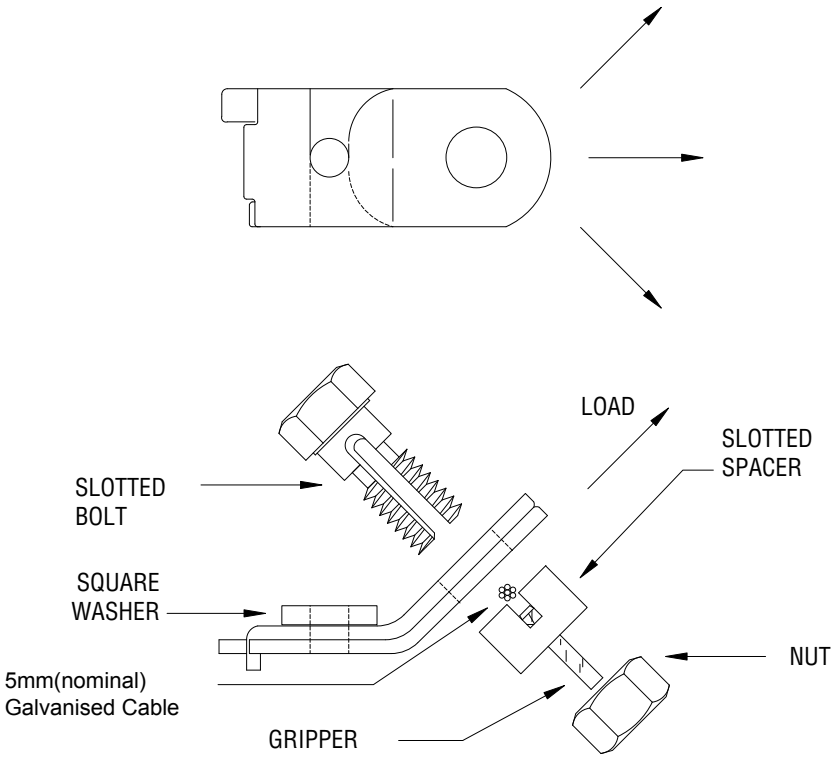
Note:

1. The load capacity of the fitting exceeds the slip and pull-out capacity of the bolt in the channel.
2. Allowable loads have been determined by the manufacturers testing, analysis and technical specifications.
3. For retrofit application, engineer of record must verify.
4. Patent Pending.
5. Square washer provided with fitting.

*6. A trademark of Lord & Sons, Inc.

SERIES SPF 400*

For rod sizes (mm): 10, 12, 16, 20



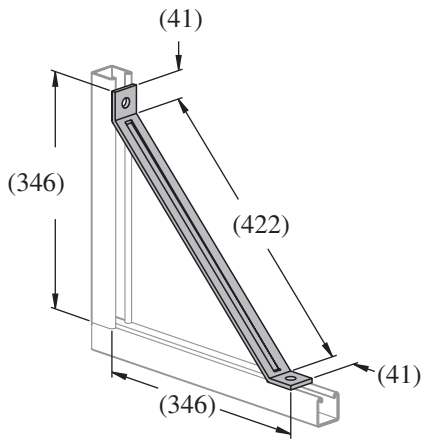
*SEISMIC PIVOT FITTING (SPF) SERIES

Note:

1. For Design loads see Page 28.
2. Conforms with FED. SPEC. RRW410
3. For retrofit application, engineer of record must verify.
4. Patent Pending.
5. Square washer provided with fitting

*6. A trademark of Lord & Sons, Inc.

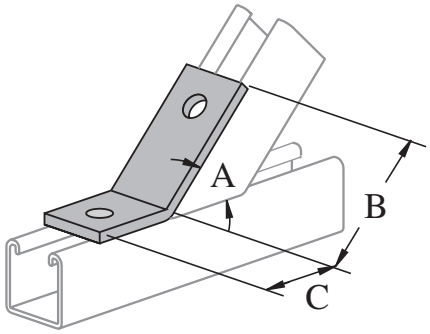
P2452 KNEE BRACE



Design Axial Load
5.36kN

Mass: 103kg/100

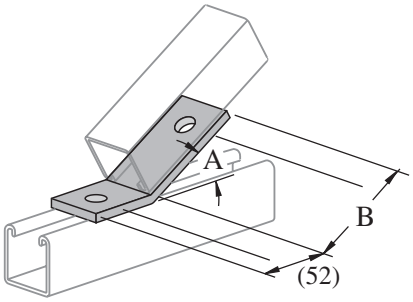
P2095 to P1546



Part No.	"A" Degree *(rad)*	"B" *(mm)*	"C" *(mm)*
P2094	82½°	3 9/16	1 11/16
P2095	75°	3 9/16	1 11/16
P2097	60°	3 3/8	1 1/8
P1546	45°	3	2 5/16

Mass: 26kg/100

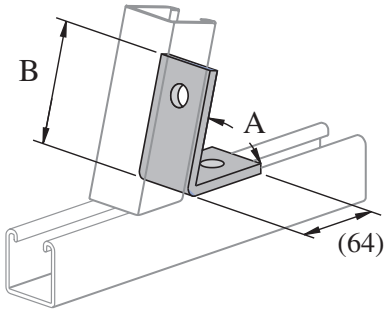
P2101 & P2103



Part No.	"A" Degree *(rad)*	"B" *(mm)*
P2101	30°	3 1/4
P2103	15°	3 5/16

Mass: 26kg/100

P2106 to P1186



Part Number	"A" Degree *(rad)*	"B" *(mm)*
P2106	75°	3 1/4
P2108	60°	3 3/16
P1186	45°	3 1/8

Mass: 26kg/100

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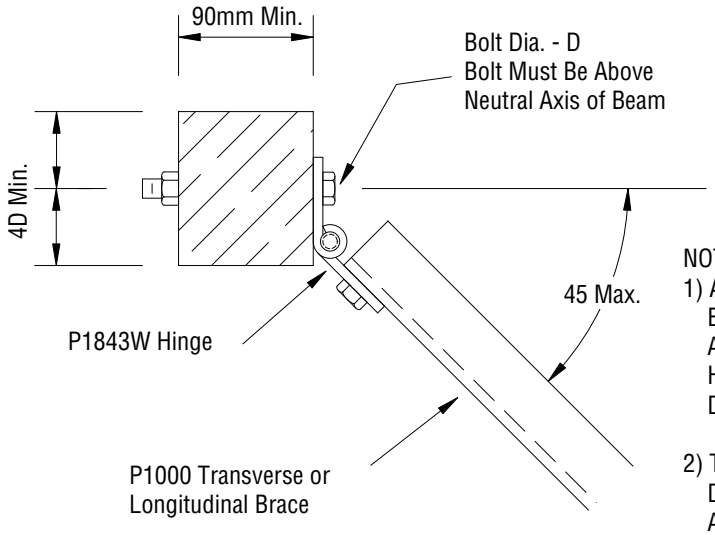
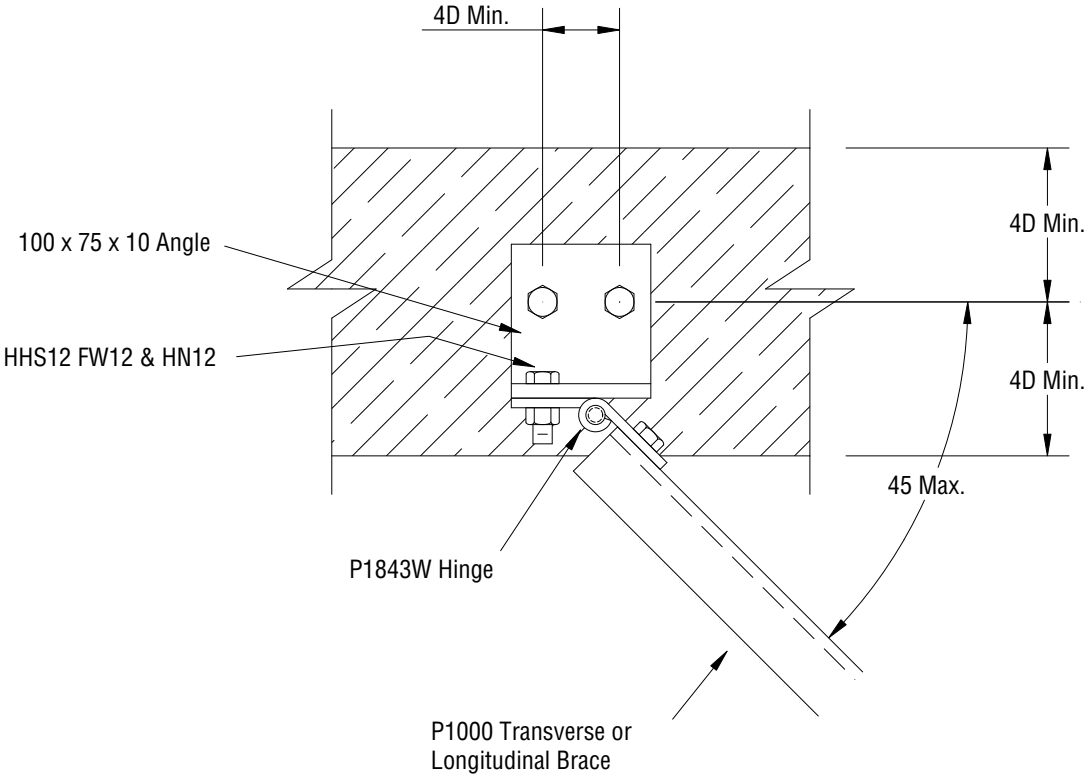


NOTE:
1) ABOVE DETAILS INDICATE HOW BRACES MAY BE ATTACHED TO THE STRUCTURE. IF BRACE ANGLE IS GREATER THAN 45 WITH THE HORIZONTAL, ALLOWABLE LOADING MUST BE DETERMINED BY THE PROJECT ENGINEER.

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



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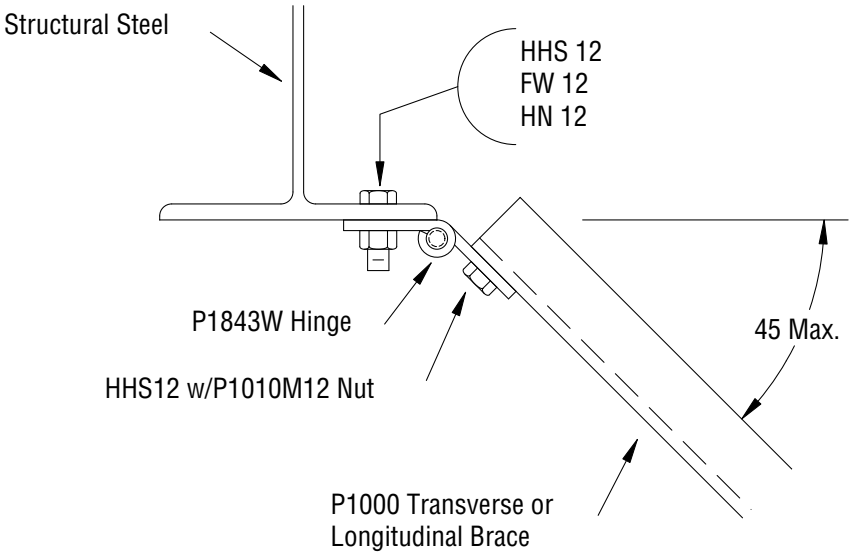
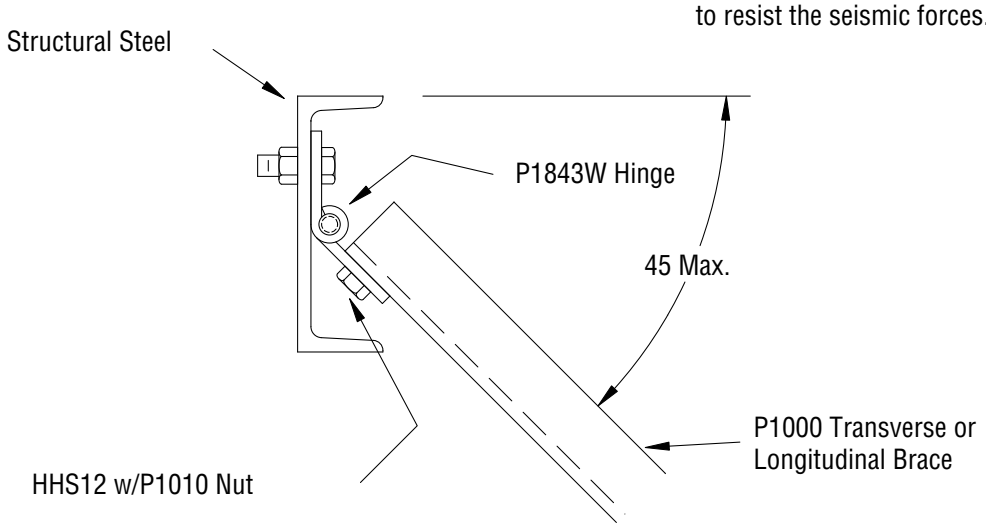


Note: 1) Above details indicate how braces may be attached to the structure. If brace angle is greater than 45 with the horizontal, allowable loading must be determined by the project engineer.

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



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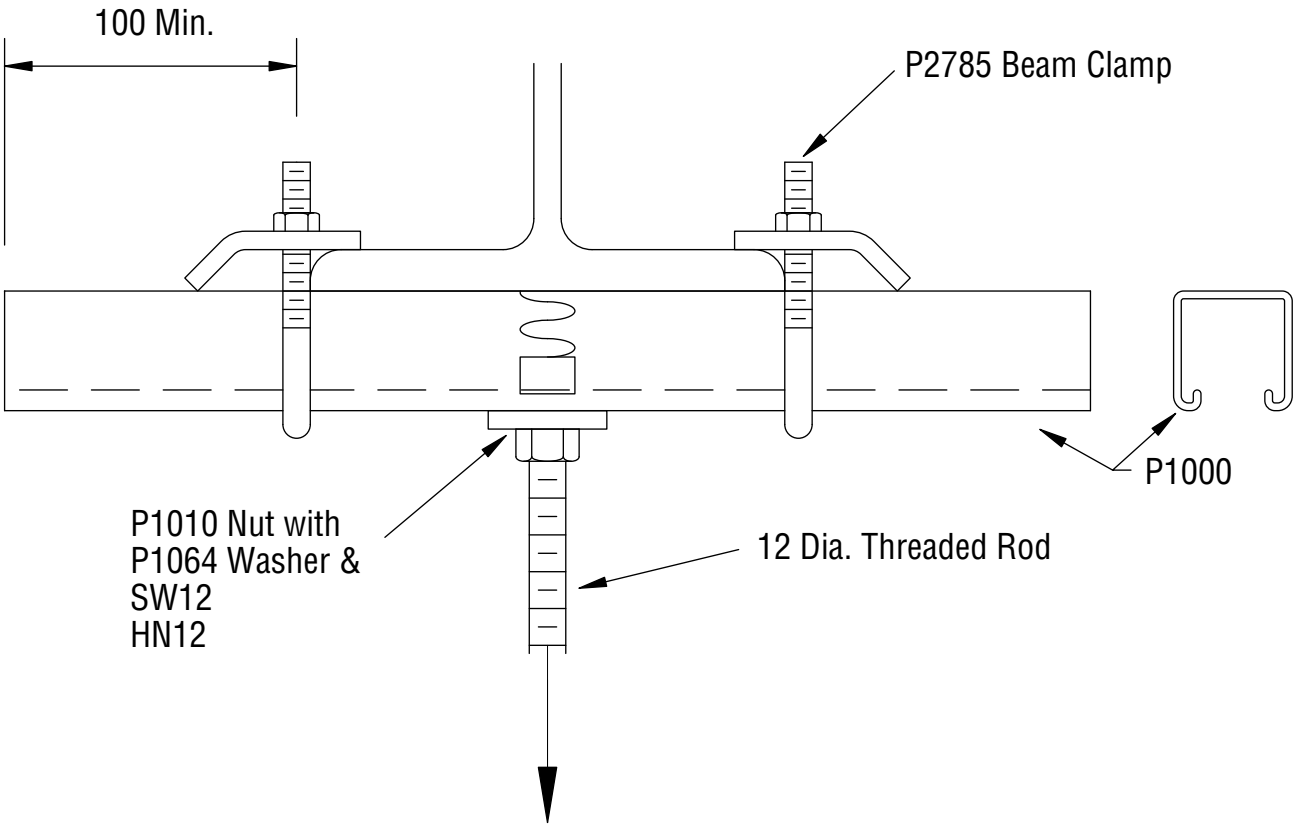

Note: The Engineer of Record shall verify the adequacy of the steel beams.

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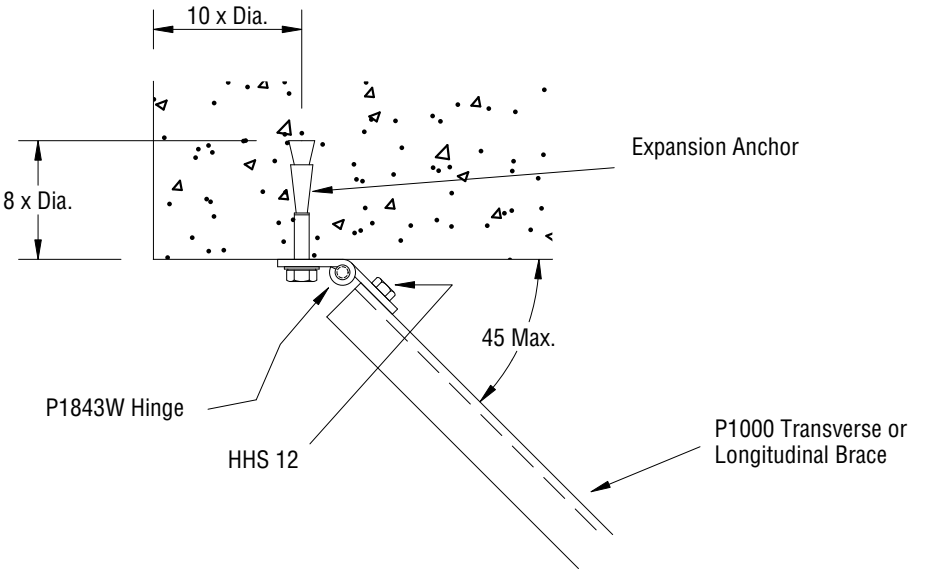

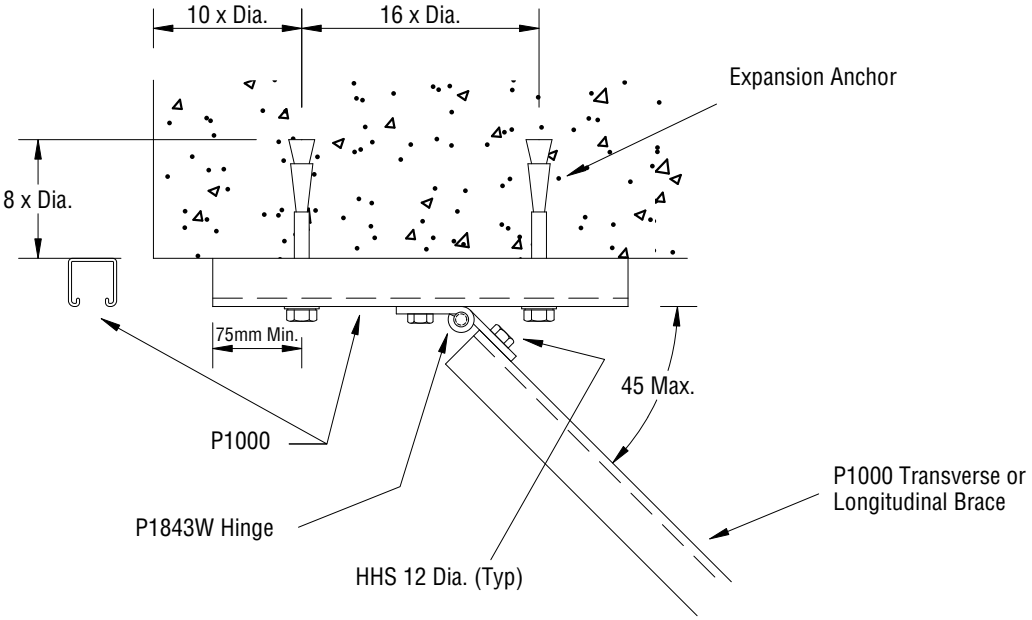

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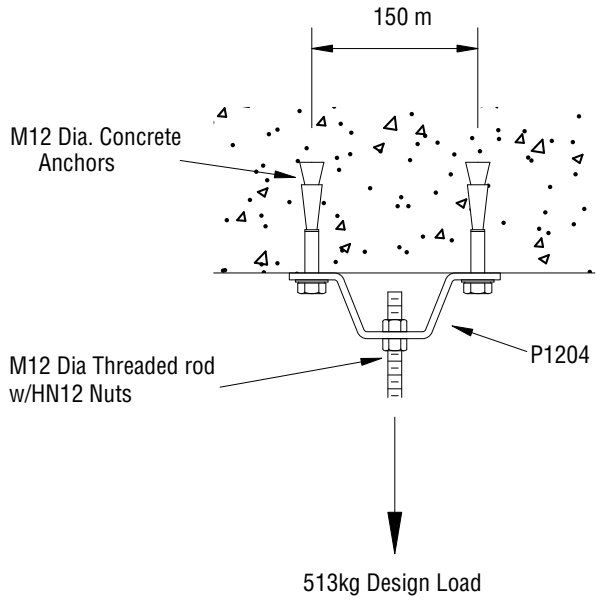

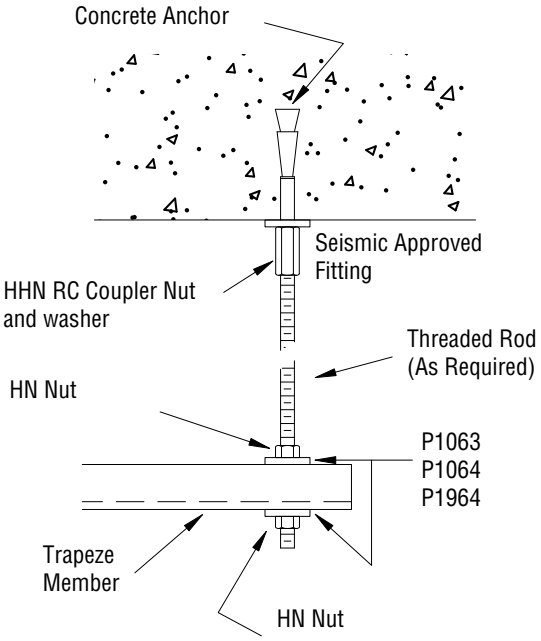

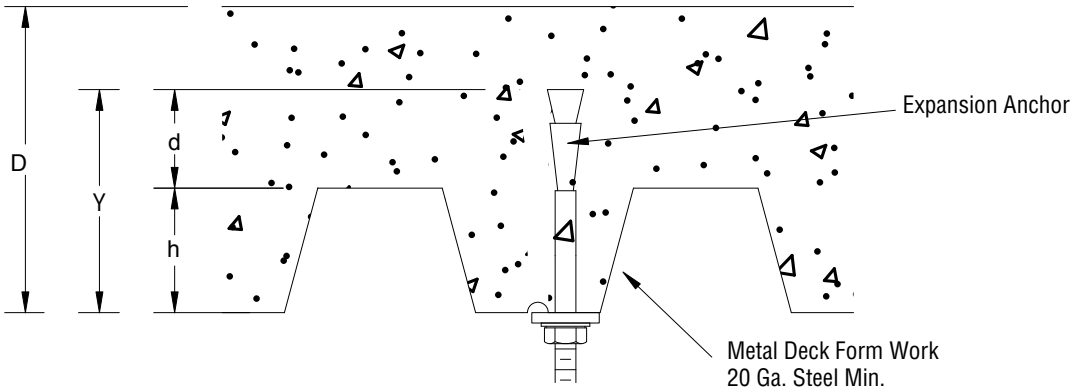

d ≥ Larger of 40mm OR (Required embedment for the proposed anchor - h/3) ≤ (Depth of Slab (D) - 25mm)
Y = 8 x Anchor Diameter for 100% of Design Load Values for Anchor
If less than 8x then use 50% of Design Load Values for Anchor

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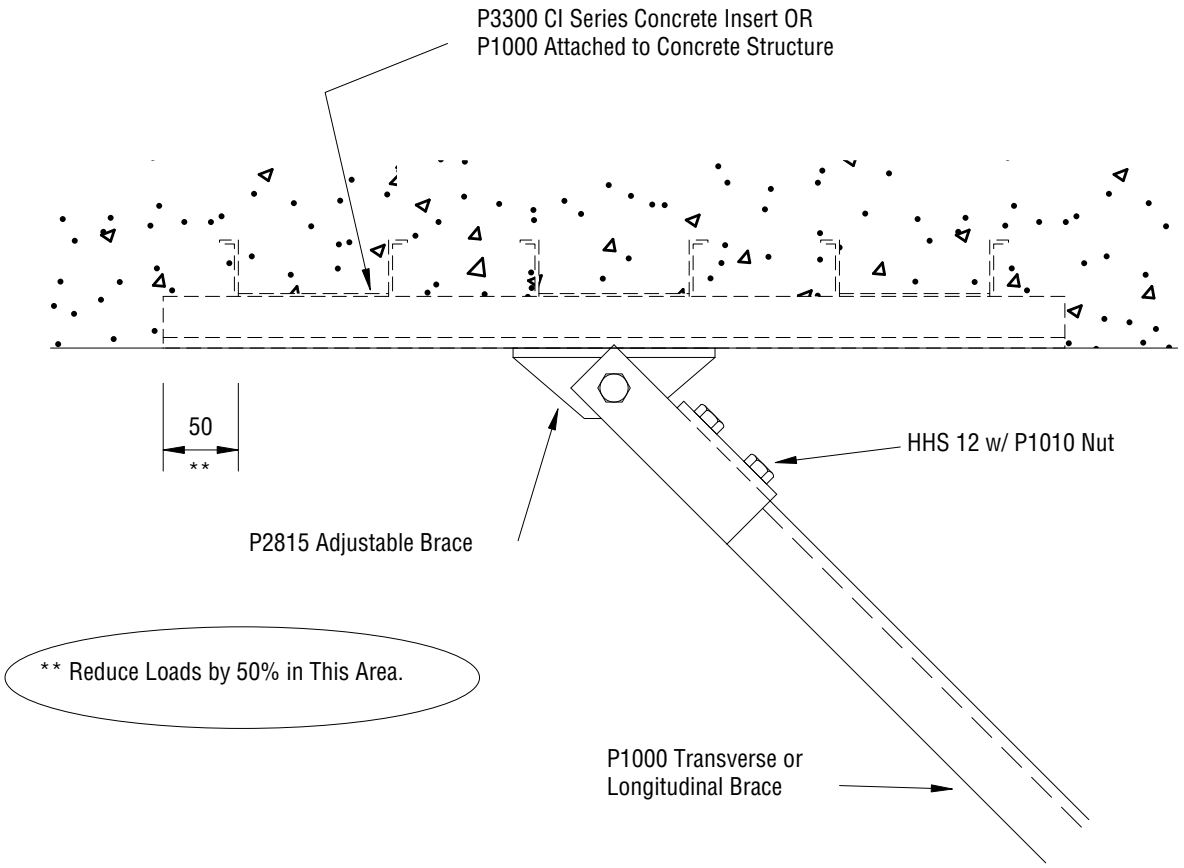

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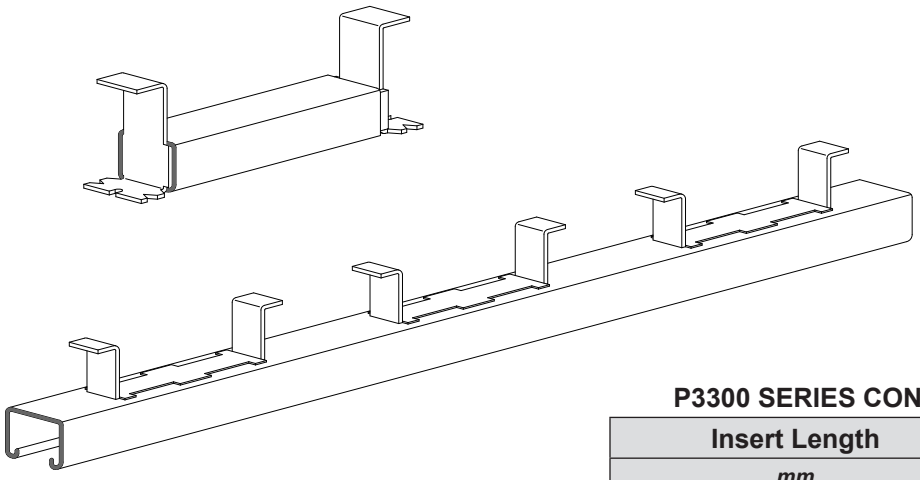

NOTE:
Recommended loading on inserts in 20 mpa concrete. Sufficient concrete must surround inserts to conform to design sheer stress. The distance between the insert centerlline and the concrete edge must be a minimum of 75 mm.

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

P3300 SERIES CONCRETE INSERTS

Insert Length	Design Load
mm	*kN*
76	2
102	3.5
152	4.4
203	5.3
302	**8.9 kN Load Allowed in Each 300 mm of Length. Reduce to 4.4kN Load within 50 mm of Each End.**
406	
508	
610	
813	
914	
1,016	
1,224	
1,524	
1,824	
2,136	
2,436	
2,748	
3,048	
3,660	
4,272	
4,872	
5,484	
6,096	

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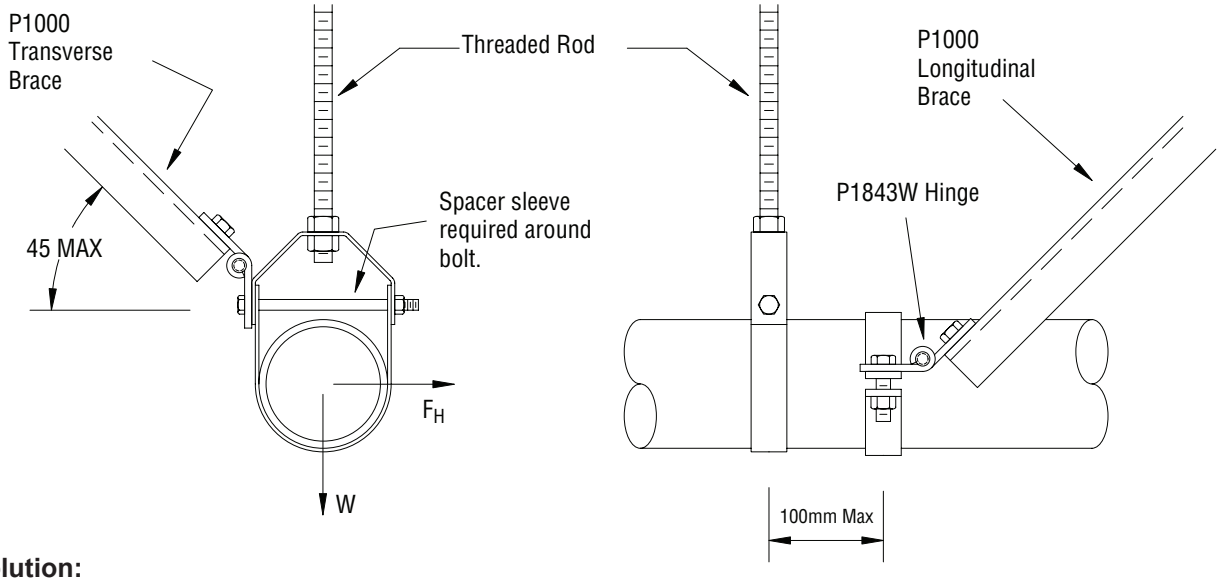
Problem:

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



Solution:

Step 1 Select hanger for 203mm diameter pipe.

For 51mm Diameter: S = 3.0m

Step 2 (Page 2-3 Pipe Data Table) Determine the maximum hanger spacing (S):
S = 3.0m (On Center)
the unit weight of the 203mm pipe full of water (W):
W = 79.84 kg/m

Step 3 Calculate horizontal seismic force (F_H):

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

h_x =6m
h_r = 12m
h_x/h_r = 0.5

C_s = 0.83
(within 0.693≤ C_s≤ 3.96)

$F_H = C_s(2W) = 0.83\ (74.84\ kg) = 62.12$ kg/m (brace on alternating trapeze)
$F_h = F_H/1.4 = 44.37$ kg/m **(converts to working stress loads)**

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Step 4 Actual brace force (maximum at 45°) at every other hanger,

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

Step 5 Select rigid brace P1000.

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

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

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

Determine if longitudinal braces are required:

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

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

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

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

Compression is not considered.

Step 7 Verify pipe clamp capacity.

Longitudinal Force = F_h x brace spacing = 44.37 kg/m x 14.6m = 650 kg

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

Longitudinal Force = 44.37 kg/m x 3.6m = 162.3 kg

Therefore, adjust Longitudinal Brace spacing to every hanger (3.6m on center).

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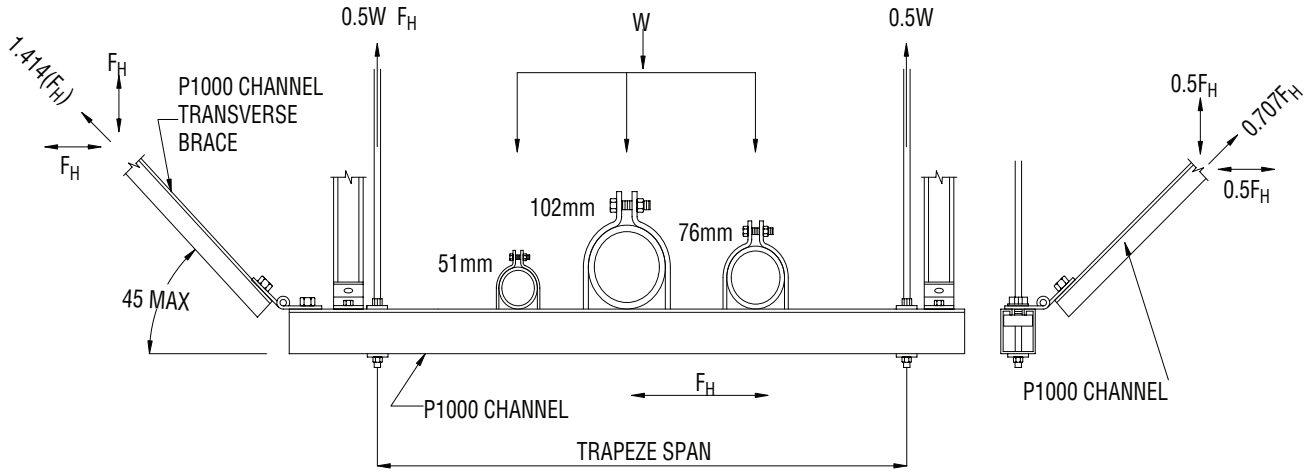
Problem:

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



Solution:

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

For 51mm Diameter: S = 3.0m

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

$W = S \times (p_1 + p_2 + p_3) = 3.0m \times (1.7 + 16.1 + 24.3)\ kg/m = 146\ kg$

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

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

h_x =6m
h_r = 12m
h_x/h_r = 0.5

} s = 0.83
(within $0.693 \le C_s \le 3.96$)

$F_H = C_s(2W) = 0.83 \times 2 \times 146.4 = 243kg$ (brace on alternating trapeze)
$F_h = F_H/1.4 = 243\ kg/1.4 = 173.6\ kg$ **(converts to working stress loads)**

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Step 4 Actual Brace Force (maximum at 45°):

$F_{b\ Actual} = 1.414(F_h) = 1.414(173.6\ kg) = 265\ kg$

Step 5 Select fitting P1843W from Page 29 & check slip along channel:

From Page 4-5 (Design Load Table), the maximum slip resistance for a single bolt fitting P1843W is 1.80 kg and is greater than $F_{b\ Actual}$. **Therefore O.K.**

Check brace against allowable design load:

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

Can use any brace length less than 3.048m.

The limiting allowable load is the Brace Design Load. Therefore $F_{b\ Allow.} = 545\ kg$

Determine if **longitudinal** braces are required:

Brace Spacing (# of bays) = $F_{b\ Allow.} / (0.5F_h)$

$= 545\ kg / (0.5 \times 173.6\ kg)$

≈ 6 bays

Determine if **transverse** bracing is required:

Brace Spacing (# of bays) = $F_{b\ Allow.} / (F_h)$

$= 545\ kg / 173.6\ kg$

≈ 3 bays

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

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

a. $T_{max} = 0.5W + F_h = .5(146.3) + 173.6 = 246\ kg$

(Page 3-11, Threaded Rod Table) **A ⅜" rod will carry a Seismic Load of 368 kg, which is greater than T_{max}. Therefore is acceptable.**

b. $C_{max} = 0.5W - F_h = .5(146.3) - 173.6 = -100\ kg$

Check buckling due to compression by determining the percentage of full stress capacity:

$C_{max}/C_{Allowable} = 100/368 = 0.27$

(Page 3-10, Channel Stiffener Table) Since 27% is less than 50%:

Use P1000T stiffener with P2485 clips spaced 355mm on center.

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Step 7 Select clamps from Pages 19 and 20.
Style P2024 series or UN4/UN15 series can be used.

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

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

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

Step 8 (Page 17) Select a trapeze member.

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

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

$$\frac{146}{0.92\times 768}+\frac{176.3}{0.92\times 1104}\le 1.33$$

$$0.207+\ 0.17\ =\mathbf{0.38}\le\mathbf{1.33}$$ **Therefore O.K.**

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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**.

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

a_p = Component amplification factor:
(Table 1621.3, 2000 IBC)

I_p = Component importance factor:
(Section 1621.1.6, 2000 IBC)

h = Average roof height of structure relative to the base elevation

R_p = Component response modification factor:
(Table 1621.2 or 1621.3, 2000 IBC)

S_{DS} = Design spectral response acceleration at short period:
(Section 1615.1.3 or $S_{DS} \cong 2.5C_{a,}$ 2000 IBC)

z = Height in structure at point of attachment of component.

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

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Power-Strut ▲ Calconduit ▲ Razor Ribbon ▲ Calpipe Security
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