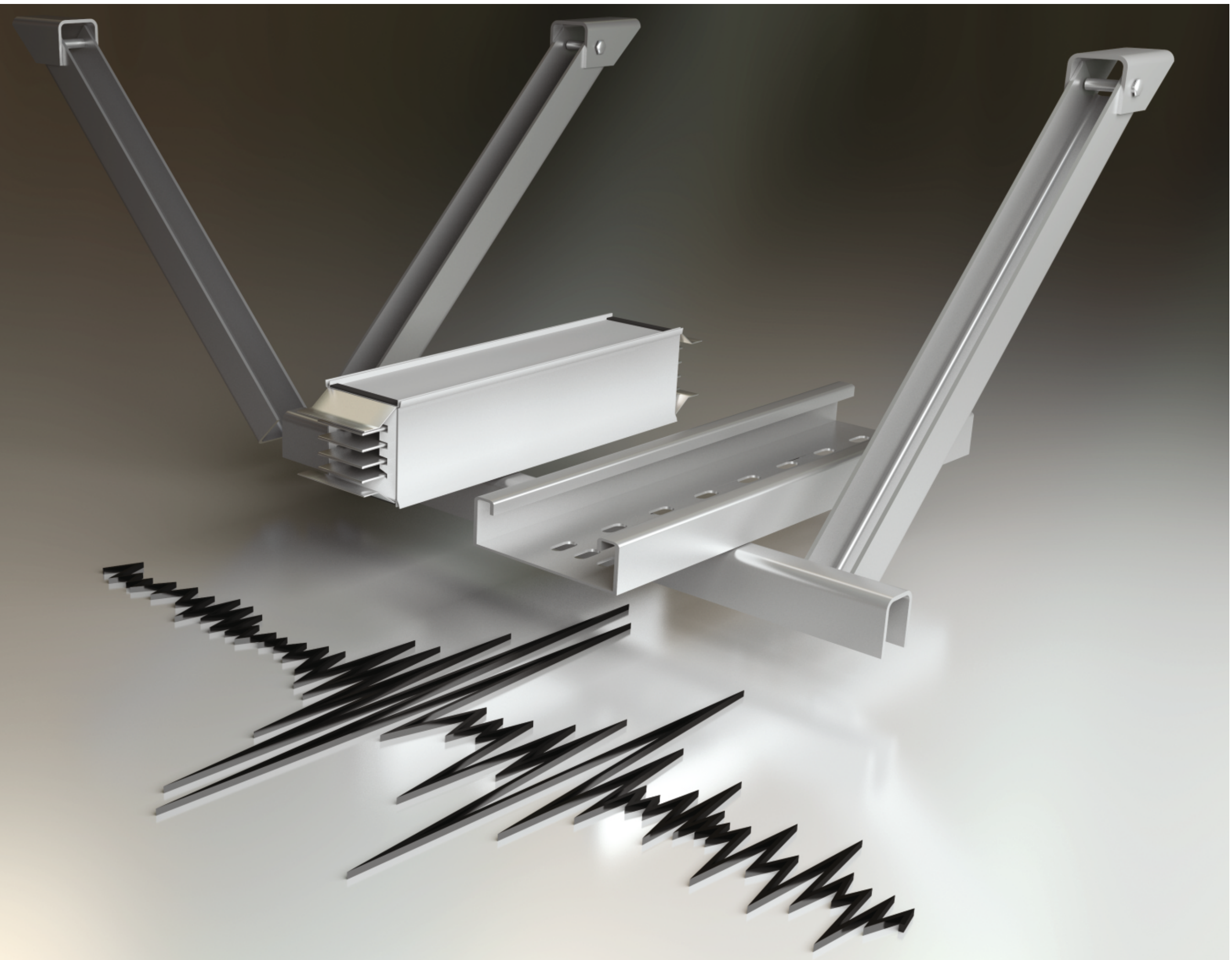
E-LINESEISMIC

Seismic Bracing Systems



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E-LINE SEISMIC

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EAE Seismic Bracing System Solutions

It is utmost important to seismically restrain mechanical and electrical distribution systems in a building, which are defined as non-structural components. These distribution systems should be protected via seismic bracing installations that are attached to structural components, against risks of breaking and failure.

EAE is a manufacturing company, specialized on busbar distribution systems, cable trays and lightening group products. EAE has been supplying products to industrial facilities, residential buildings, shopping malls, airports, hospitals, car manufacturers and similar facilities for forty years. EAE, also produces support installation components for these systems. However in the local market, lack of seismic support systems with additional calculations, testing and the production of proper seismic bracings were an important issue.

EAE, with wide range of products and long years of experience, has taken an important step with seismic bracing systems as an addition to its product groups in order to eliminate this inadequacy.

The seismic bracing systems are designed according to international standards. The general approach was, to design a cost efficient system that can be used in multiple ways, easily installed and cut labor costs.

In hospitals, education facilities, high risers, residences, shopping malls, power plants, automotive, steel and glass producing facilities, oil&gas facilities, which are located at seismic risk areas, seismic bracings with calculated load resistances have become a necessity for life safety and operational persistency.

With EAE seismic bracing products you can find solutions for electrical and mechanical distribution service seismic resilience on your building.

Connect strong, Live safe.

An earthquake can be described basically as shaking of ground.

There are three types of natural earthquakes:

1. Collapse Earthquakes
Earthquakes with limited area of effect, occurred by collapse of underground gaps such as caves and mines.

2. Volcanic Earthquakes
Earthquakes occurring as a result of volcanic activities.

3. Tectonic Earthquakes
It is the most commonly felt earthquake type. It occurs by the movement of plates, which generates earth's crust.

Plate Theory

This is the theory, which was put forward to understand and study the nature of earthquakes, largely accepted as early states and in the epicenter of earthquake studies. According to theory, earth's crustal mass stand on plates and those plates are ever moving. From past to present continents are formed by the movement of these plates and become distant to each other.

PERMIAN
250 million years ago

TRIASSIC
200 million years ago

JURASSIC
145 million years ago

CRETACEOUS
65 million years ago

PRESENT DAY

The inner areas of plates are relatively stable. But on the edges, where plates collide, they create fault lines and leads to major earthquakes.

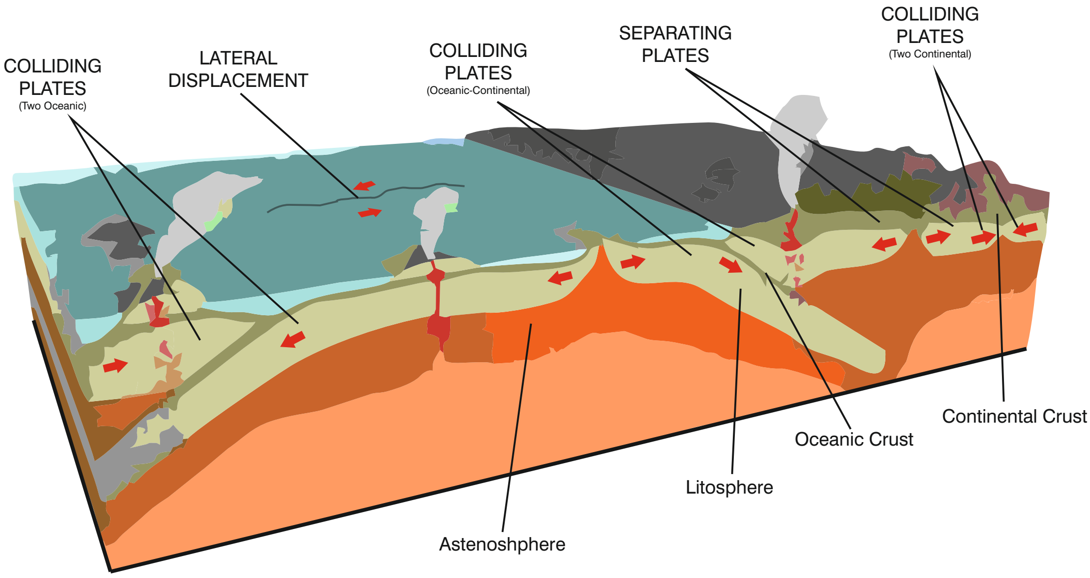


Figure 1.1 shows three main fault types.

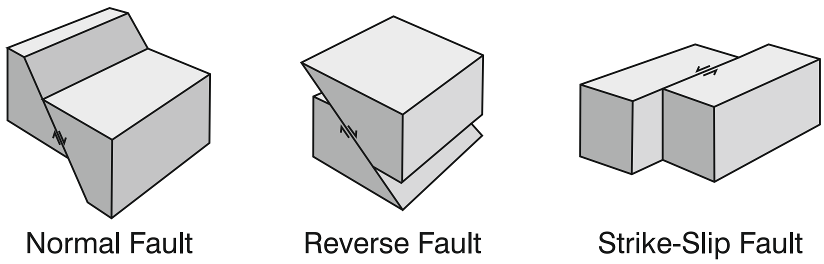
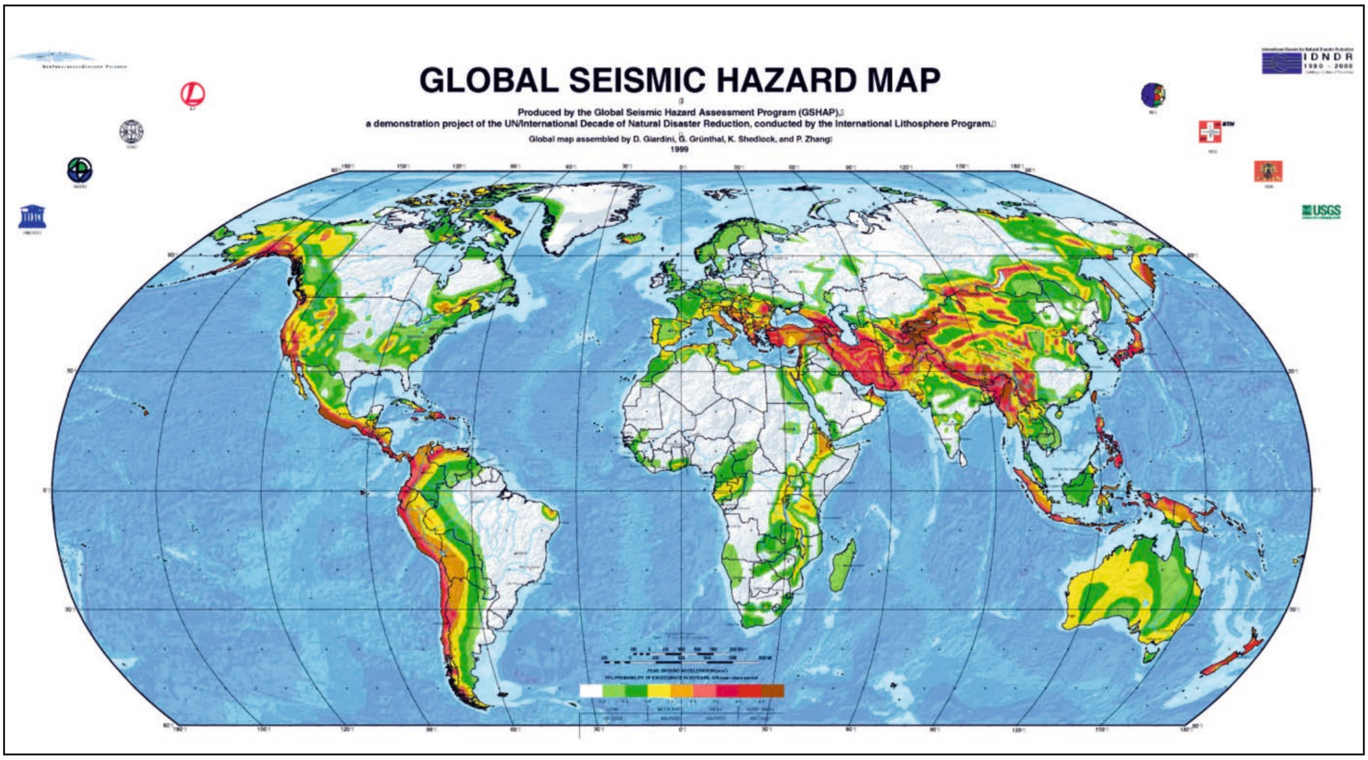


Figure 1.1 Three Main Fault Types

Regions with intense seismic activities are located around those fault lines, where plates are colliding. Global seismic hazard map can be seen below.



Earthquake Hazard of Distribution Systems

Researches on the subject shows that, up to 80% of the damage and loss are because of the fires following the earthquake. The functionality of sprinkler systems and electrical&mechanical distribution systems during and after an earthquake takes great importance in the present modern buildings. To mitigate life and financial loss from dysfunctionality of the distribution systems, proper seismic bracing is the most effective method.

Figure 2.1a Earthquake Hazard of Electrical Conduits
(Images from Federal Emergency management Agency Website, www.fema.gov)

Figure 2.1b Earthquake Hazard of Electrical Transformers
(Images from Federal Emergency management Agency Website, www.fema.gov)

Calculation of Seismic Loads

Any seismic force affecting a distribution system component in any level of the building is the result of the earthquake acceleration. Seismic force can be calculated according to principal physics equitation F=m.a (Figure 2.2). Seismic acceleration should be determined in order to calculate effecting force. Earthquake acceleration can be determined by various international and local codes.

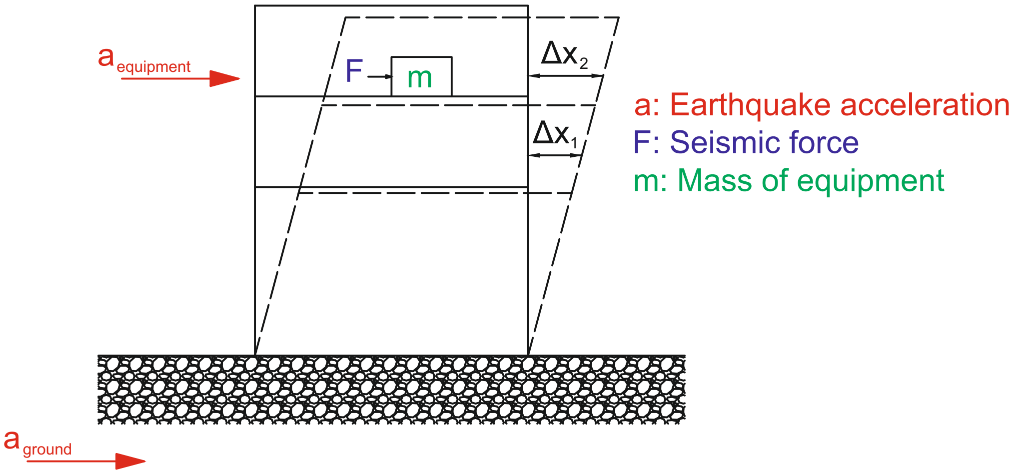


Figure 2.2 Earthquake Acceleration and Earthquake Load

Most accepted building code for seismic applications since 2011 is IBC® 2012 (International Building Code) which is governed by ICC® (International Code Council). According to IBC® 2012, where needed, seismic design force can be calculated by the equitation below:

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

Values shown in seismic design force **(F_p)** described below:

a_p: Component amplification factor.

S_{DS}: Short period spectral acceleration.

W_p: Component operating weight.

z: Height in structure of point of attachment of component with respect to the base.

h: Average roof height of structure with respect to the base.

R_p: Component response modification factor.

I_p: Component importance factor.

As seen in eq. 1, short period spectral acceleration **(S_{DS})** should be defined by designer in order to calculate seismic design force **(F_p)**. Additionally because of short period spectral acceleration **(S_{DS})** value contains certain constants for soil condition, it can be possible to calculate project specific earthquake loads. Likewise, component importance factor **(I_p)** can be determined by the requirements of project and/or demand of the project owner.

Suspended Equipments

To protect an equipment suspended via threaded rods or steel elements against seismic forces, equipment sould be restrained with seismic braces. The brace should satisfy seismic design load requirements. Seismic brace installation usually done by fixing the brace with 45°±10° angle both horizontal and vertical (Figure 3.1). The essential informations should be provided with supporting installation drawings and selection sheets as proof of brace meets the design load criteria.

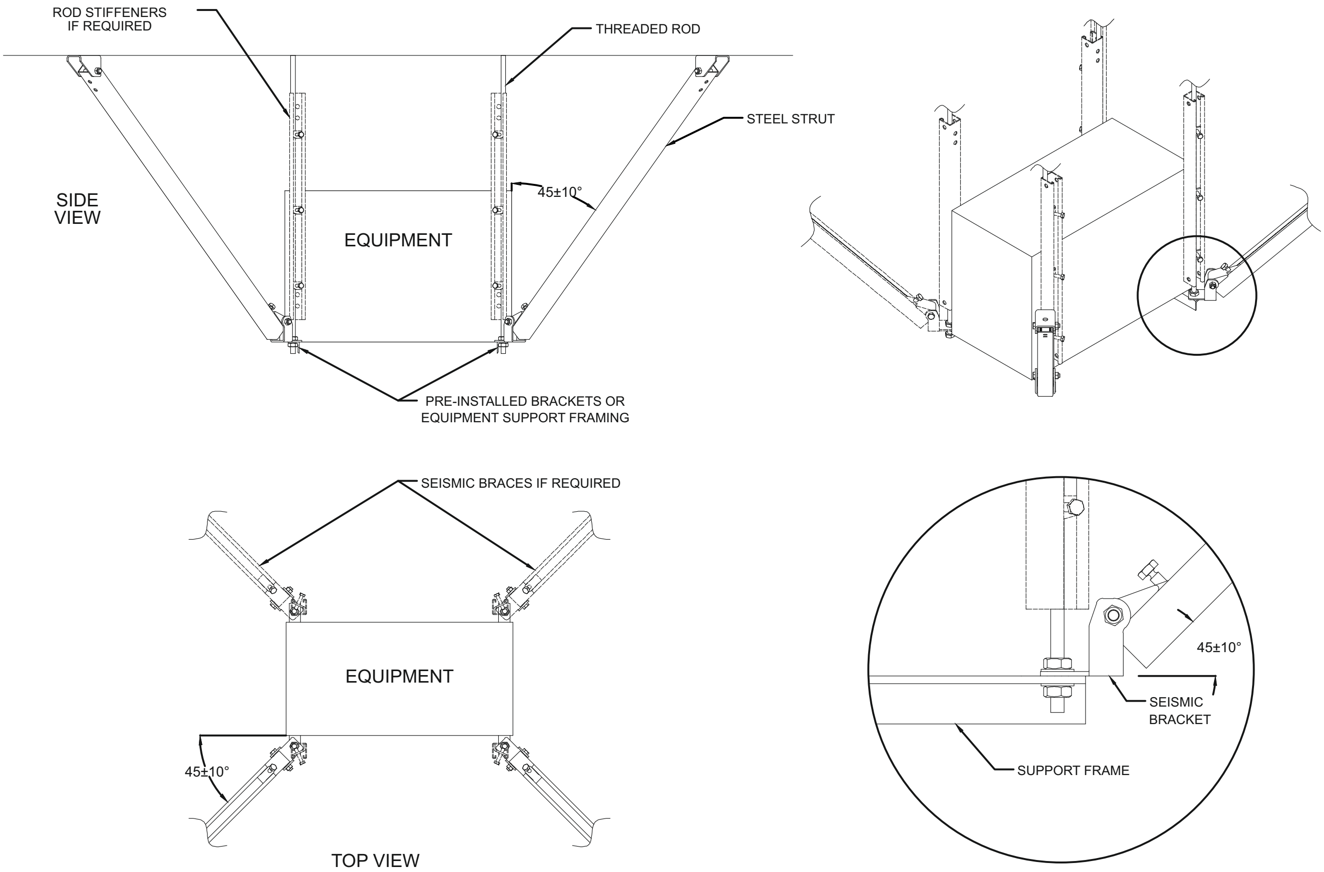


Figure 3.1 Seismic Bracing of Suspended Equipments

Distribution Systems

One of the critical non-structural seismic protection topic is electrical distibution systems. Main reason behind this is the variable components that are used to support bus ducts, conduits and cable trays. They can be suspended, wall fixed or floor supported. The crucial point is that every system in buildings, including essential fire pumps and other emergency systems, are powered by the electrical distribution systems. Generally suspended disribution systems are the most vulnerable non-structural components against seismic forces. Especially emergency systems like sprinkler pipes are fragile because of high pressure liquid inside. One crack on main pipe can turn into a system failure. Protection of the suspended distribution systems ,depending on project, are done by creating layouts of lateral and longitudinal bracing points. For the first step of determining seismic fixing points, lines should be given numbers (Figure 3.2). Then lateral braces should be provided on both end of the each line.

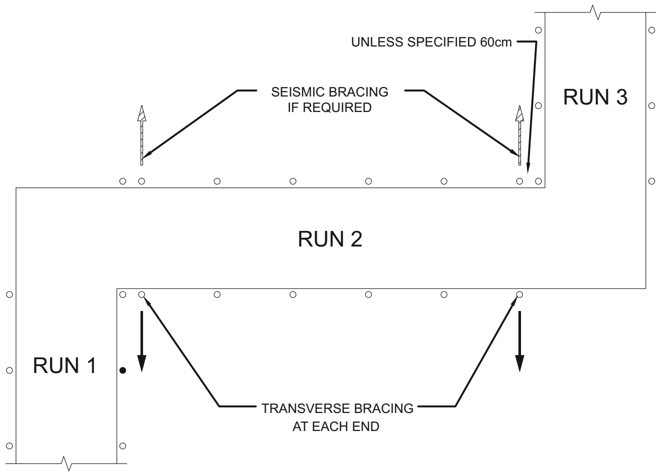


Figure 3.2 Layout of Lateral Braces on Both End

Although it can differ from specification to specification, generally maximum allowed spacing of lateral brace is 9m (30 ft) for HVAC ducts, busbar and cable trays, 12m (40 ft) for pipes and conduits. Again it can be generalized to 18m (60 ft) maximum allowed space between two longitudinal brace for HVAC ductwork, busbar and cable trays, 24m (80 ft) for pipes and conduits. If the spacing between two lateral brace at both end of the line is greater than allowed, more seismic braces should be added in order to meet required maximum brace spacing (Figure 3.4).

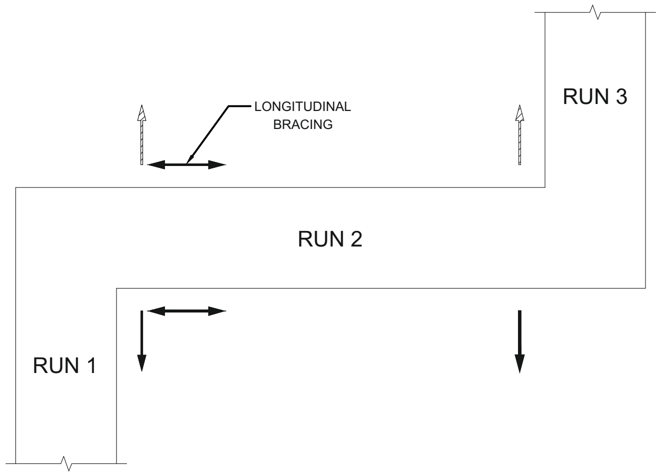


Figure 3.3 Layout of Longitudinal Brace for Each Line

Each line should have at least one longitudinal brace (Figure 3.3). If the lenght of the line is greater than maximum longitudinal brace span, more longitudinal braces should be added until the spacing bettween two longitudinal brace meets requirements (Figure 3.4).

Additionally, for being cost effective, the junction points of lines should be braced both lateral and longitudinal (Figure 3.4). In doing so, lateral brace works as longitudinal brace of the other line. Further cost decrease can be achieved by making 45° angular bracing designs, in order to make brace restrain both lateral and longitudinal loads (Figure 3.4).

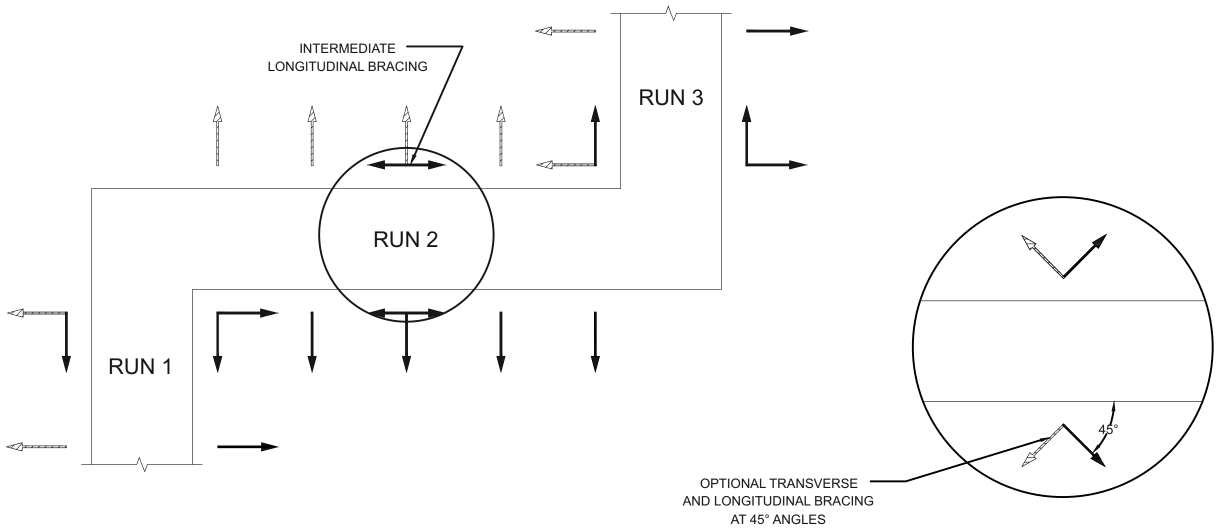


Figure 3.4 Angular Fourway Brace

Seismic fixings on distribution systems can be composed of steel struts or cables. But cables are tension only systems. Therefor two components are needed instead of one steel strut.

In cases, where multiple pipelines are suspended via trapeze supports, trapeze must be braced. Essential point on trapeze supports are the necessity of pipes being properly fixed at trapeze. Fixing have to meet seismic load requirements. In order to do this, U-straps or U-Bolts should be used (Figure 3.5). Classical one-point fix pipe clamps are usually inadequate because of the consisting moment on the fix point during a seismic event.

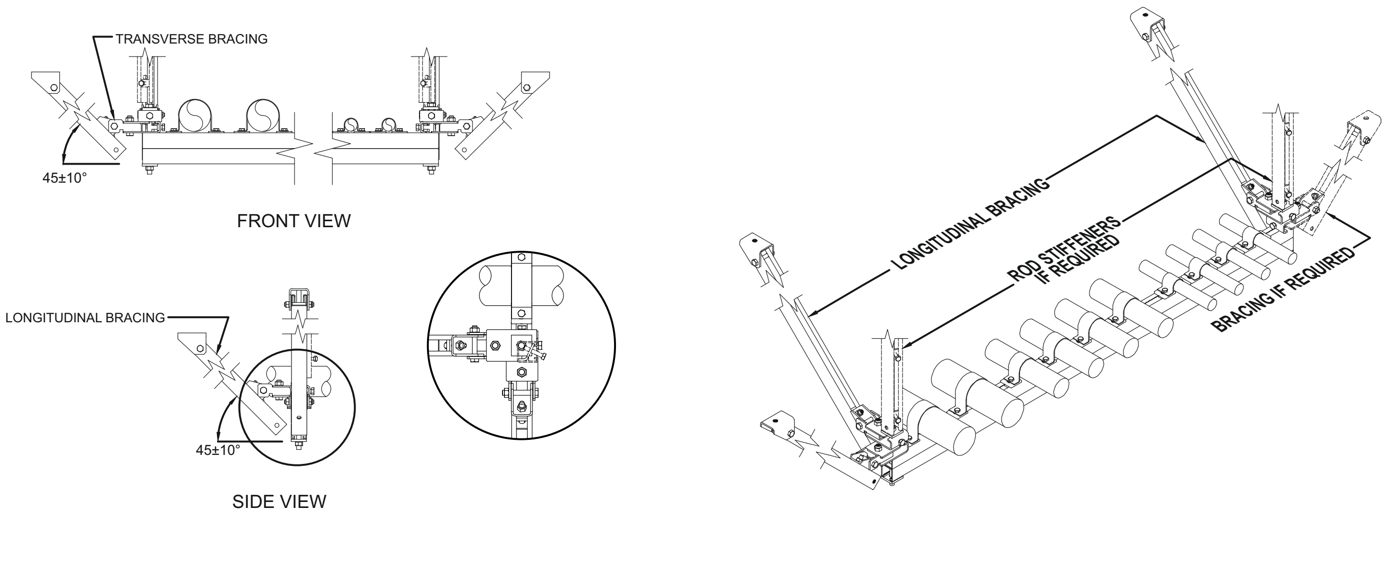


Figure 3.5 Multiple Pipe Fixings on Trapeze Assembly

Cable Trays and Other Systems

Suspended cable trays, conduits, busbars and HVAC ductworks, should also be braced with steel struts or cables (Figure 3.6). If it is wall supported or floor supported, it can be unnecessary to restrain it with additional seismic bracing, provided that structural component to be fixed is secure.

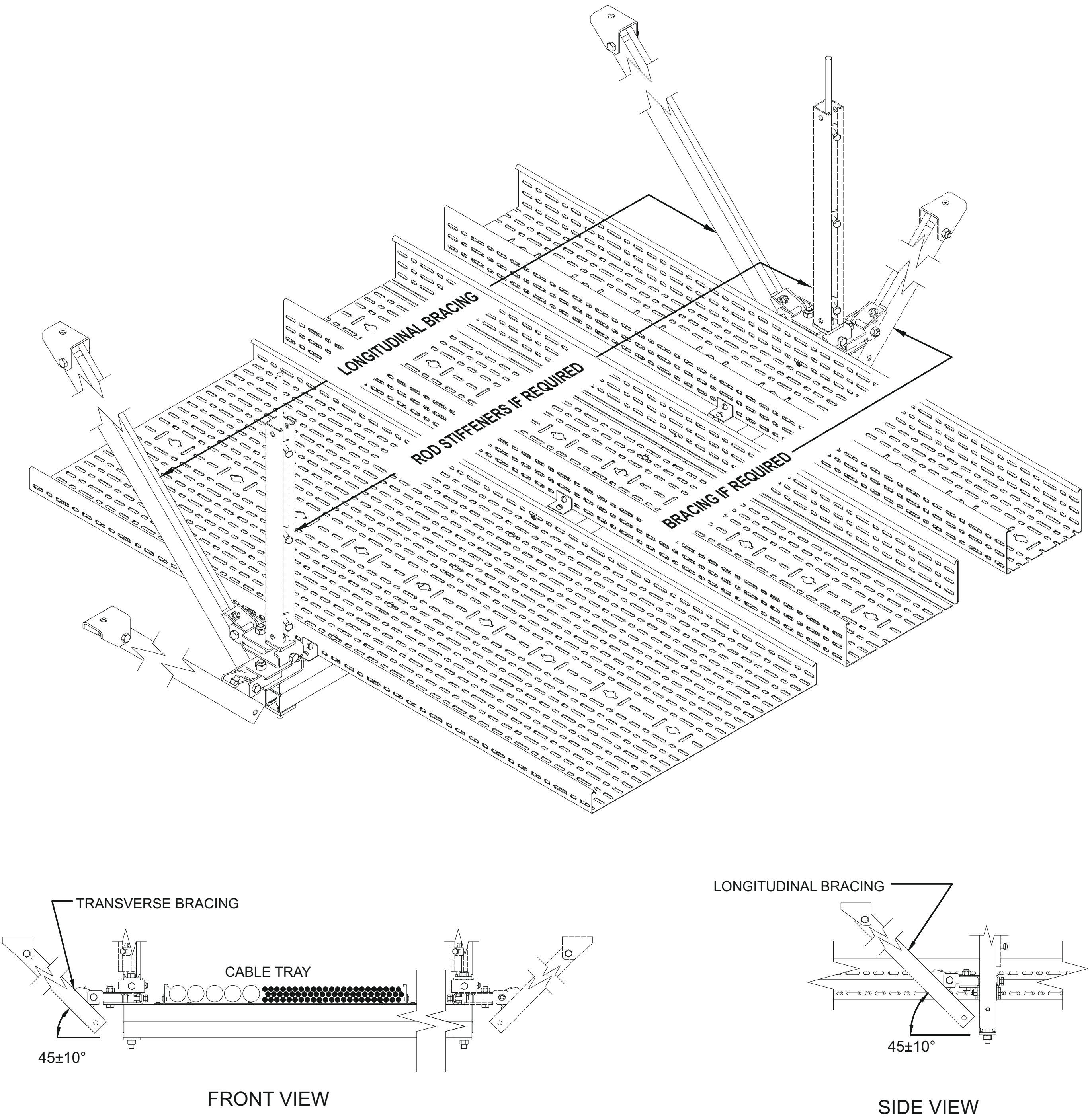


Figure 3.6 Seismic Bracing of Cable Trays

EAE ELEKTRİK

Application Examples

All distribution systems can be practically protected by using rigid (steel strut) seismic bracings (Figure 3.7-10).

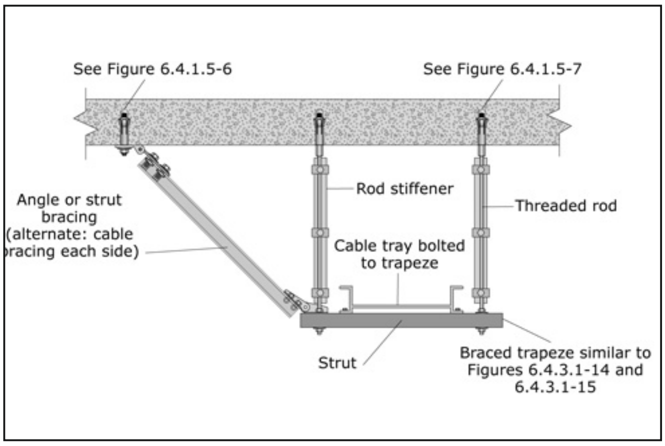


Figure 3.7, 3.8, 3.9, 3.10 Rigid Seismic Bracing (Steel Strut) Applications on Cable Trays and Conduits (Images from Federal Emergency Management Agency Website, www.fema.gov)

Seismic Bracing Layout – General Procedure

The following pages outline the steps to take when laying out the placement of seismic bracing for a mechanical or electrical system. Refer to the appropriate codes and standarts for additional information and requirements.

STEP 1

Begin by seperating the system to be braced into individual runs of pipe, conduit or duct. A run is defined as a section between two changes in direction. A single run may have an offset or several offsets. These minor directional changes may be ignored if the overall distance perpendicular to the run does not exceed 1/16 of the maximum allowable transverse spacing.

Example: I you have a run of that does not exceed 9m (30') and your maximum allowable transverse spacing is 9m (30') you can have an offset in this run up to 9m/16 = 0.57m (30'/16 = 1'-10”).

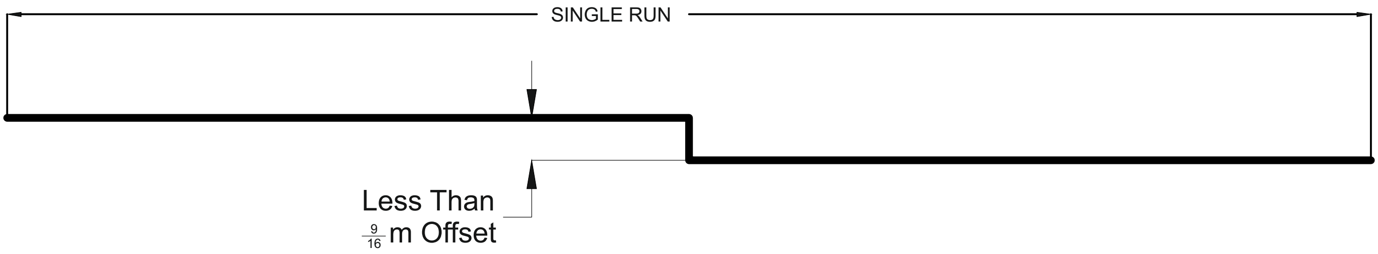


Figure 3.11 Run with Single Offset

Example: A run with several offsets can be treated the same way. As in the example above, assume that this run is 12m (30') long. As long as the total offset is no more than 0.57m (1'-10”) long it can be braced as one run.

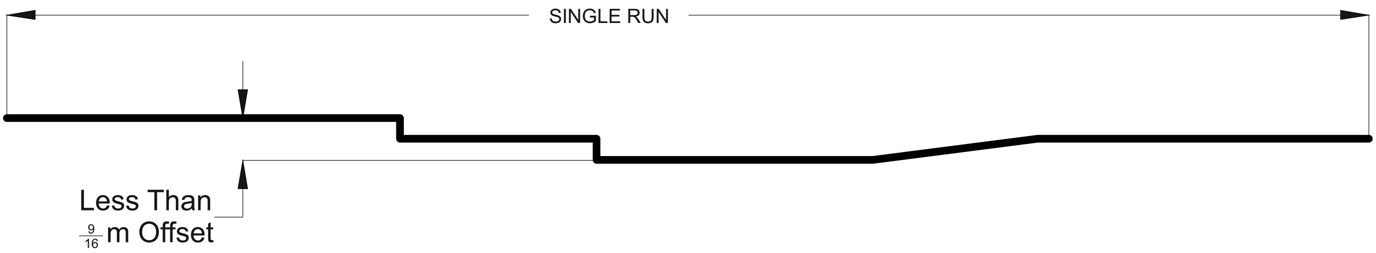


Figure 3.12 Run with Several Offsets

STEP 2

Each run must be braced in the transverse direction at each end of the run.

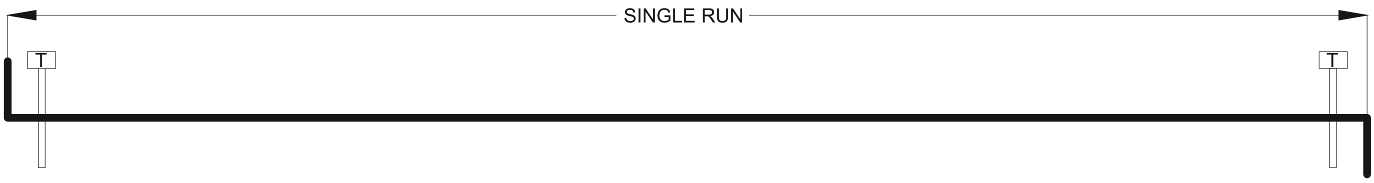


Figure 3.13 Transverse Bracing at Both Ends of the Run

If the distance between the two transverse braces exceeds the maximum allowable spacing, add transverse braces as needed.

Example: If you have a run to brace that is 18m (60') long, first place transverse braces at each end. One more brace is required along this run so that the maximum spacing of 9m (30') is not exceeded.

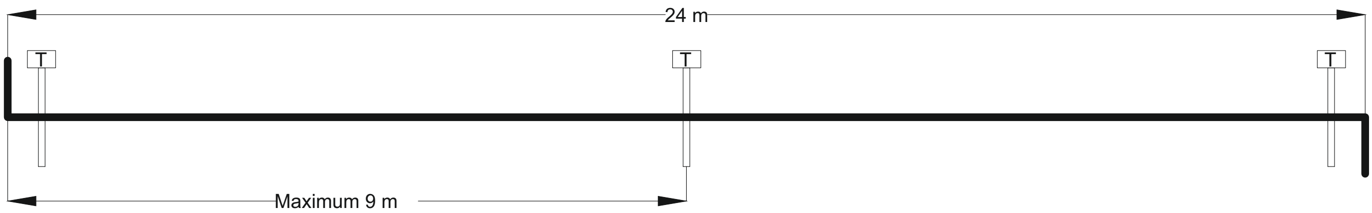


Figure 3.14 Additional Transverse Brace

STEP 3

Each run must have at least one longitudinal brace. If the maximum allowable longitudinal spacing is exceeded then add longitudinal braces to meet the spacing requirement.

Example: If you have a run that is 27m (90') long, first place one longitudinal brace along the run, then place additional longitudinal braces so the maximum allowable spacing is not exceeded.

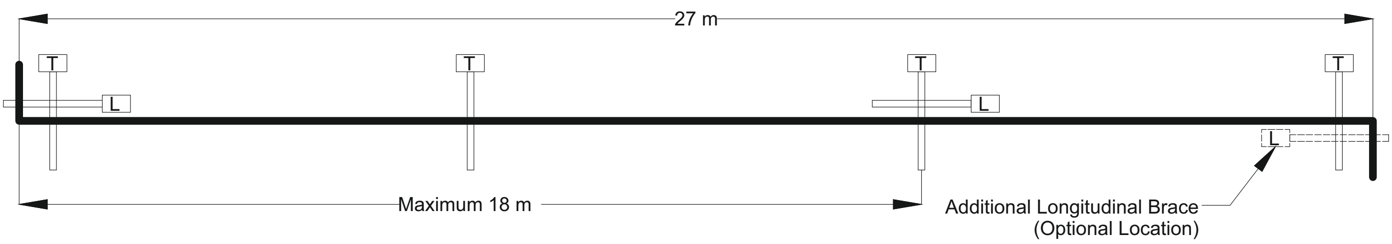


Figure 3.15 Longitudinal Braces

To increase the efficiency of your bracing, a “DUAL USE” transverse brace within 60 cm (24”) of a 90 degree elbow on an adjacent run can be used as longitudinal brace for the run being considered.

Example: If you have a run that is 27m (90') long, an adjacent “DUAL USE” transverse brace acts as a longitudinal brace for this run. The spacing is half the distance to the next longitudinal brace plus half the distance to the adjacent transverse brace (18/2+9/2=13,5m)

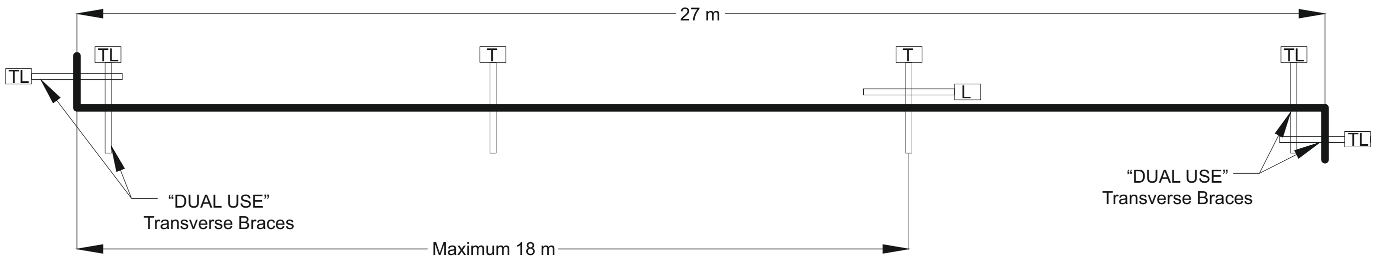


Figure 3.16 “DUAL USE” Seismic Braces

STEP 4

In some cases several short runs may occur in close proximity. By following the preceeding guidelines each run should have longitudinal and transverse bracing. Transverse bracing may be used as longitudinal bracing and vice versa on runs adjacent to each other as long as the total lenght of pipe tributary to the brace does not exceed the maximum allowable spacing. In cases where it does, additional braces are required.

Example: If the offsets are greater than the allowable length, pipe sections cannot be treated as one run. However, the number of braces can be minimized by using transverse braces as longitudinal braces and vice versa.

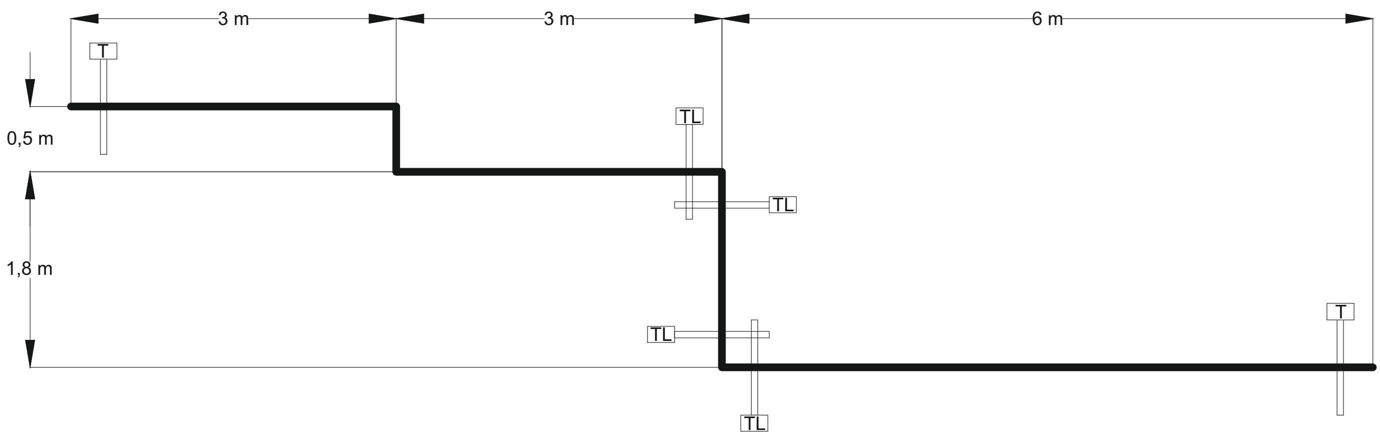


Figure 3.17 Number of Brace Decrease Applying “DUAL USE” Braces

STEP 5

At vertical pipe drop to mechanical equipment, where pipe is connected to the equipment using a flexible connection, provide transverse bracing before the vertical drop. The total length from the transverse brace to the vertical drop should not be more than the allowable offset previously determined. Provide transverse bracing at the floor after the vertical drop if the total length of the pipe from the transverse brace before the vertical drop to the flexible connection is greater than ½ of the maximum transverse brace spacing.

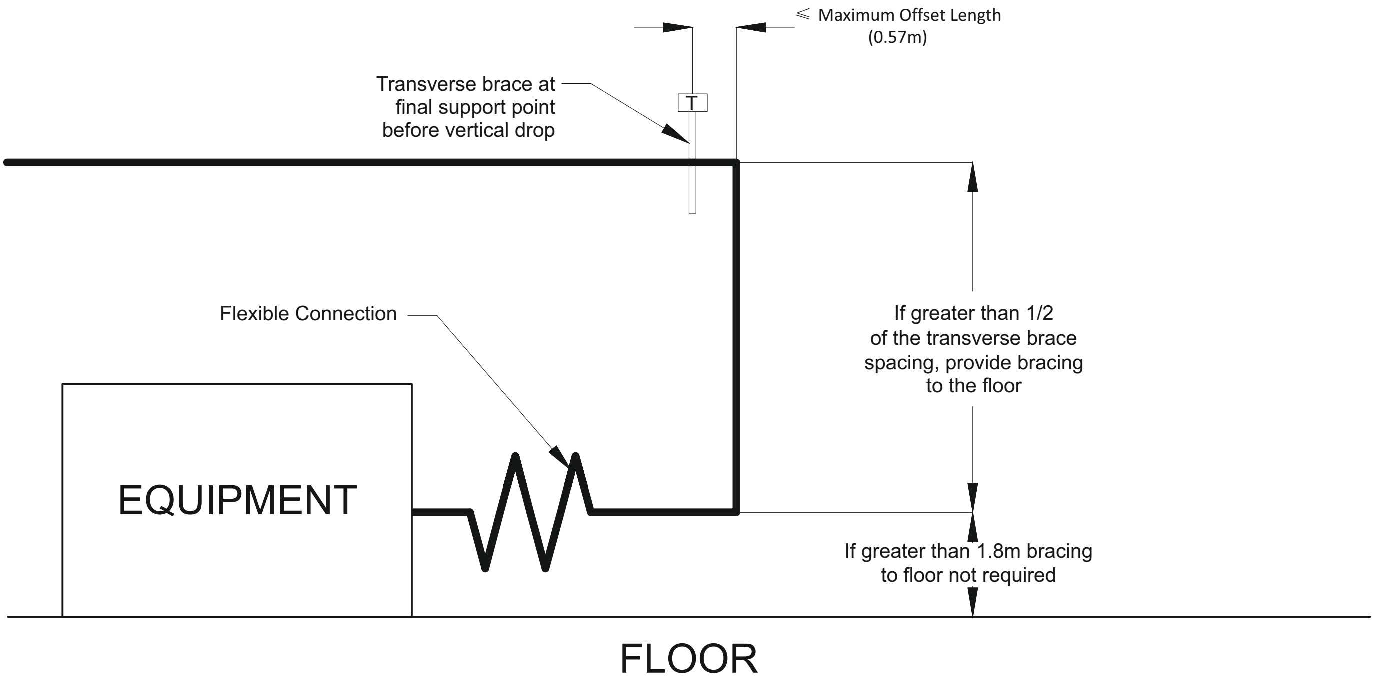
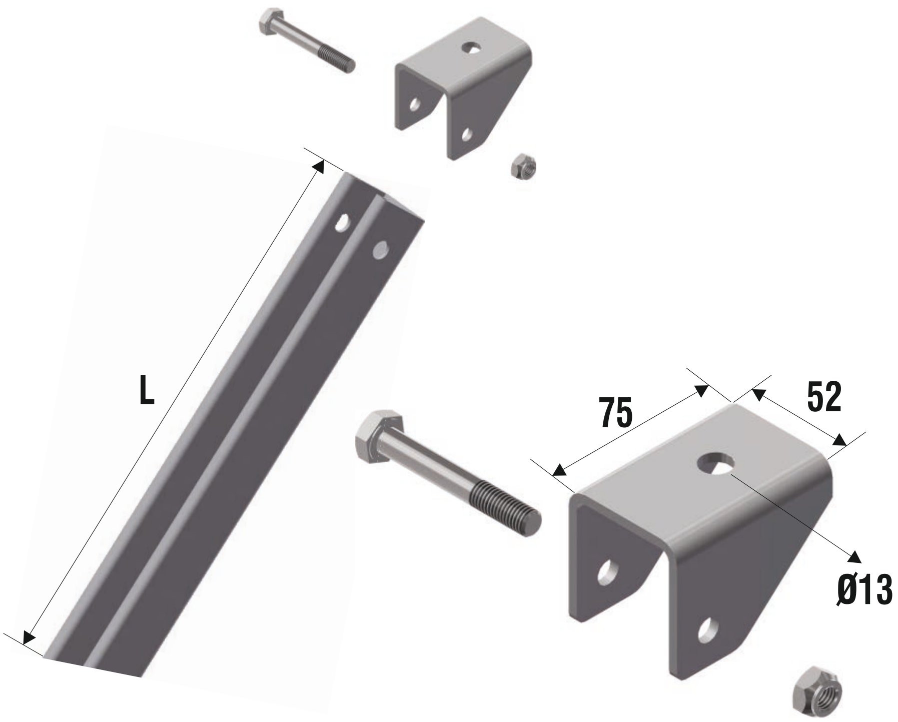
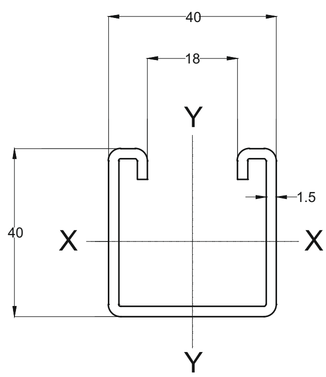


Figure 3.18 Seismic Bracing on Equipment Connections

Description	L (mm)	T (mm)	Order Unit	Weight (kg/set)	Order Code
BR 401 Seismic Brace Section L: 500	500	1,5	Set	1,530	3046473
BR 401 Seismic Brace Section L: 600	600	1,5	Set	1,767	3046474
BR 401 Seismic Brace Section L: 700	700	1,5	Set	2,003	3046475
BR 401 Seismic Brace Section L: 800	800	1,5	Set	2,240	3046476
BR 401 Seismic Brace Section L: 900	900	1,5	Set	2,477	3046477
BR 401 Seismic Brace Section L: 1000	1000	1,5	Set	2,713	3046478
BR 401 Seismic Brace Section L: 1100	1100	1,5	Set	2,950	3046479
BR 401 Seismic Brace Section L: 1200	1200	1,5	Set	3,186	3046480
BR 401 Seismic Brace Section L: 1300	1300	1,5	Set	3,425	3046481
BR 401 Seismic Brace Section L: 1400	1400	1,5	Set	3,660	3046482
BR 401 Seismic Brace Section L: 1500	1500	1,5	Set	3,896	3046483
BR 401 Seismic Brace Section L: 2000	2000	1,5	Set	5,079	3046484
BR 401 Seismic Brace Section L: 2500	2500	1,5	Set	6,262	3046485
BR 401 Seismic Brace Section L: 3000	3000	1,5	Set	7,445	3046486
BR 401 Seismic Brace Section L: 3500	3500	1,5	Set	8,628	3046487
BR 401 Seismic Brace Section L: 4000	4000	1,5	Set	9,811	3046488
BR 401 Seismic Brace Section L: 5000	5000	1,5	Set	12,177	3046490
BR 401 Seismic Brace Section L: 6000	6000	1,5	Set	14,543	3046492
BR 401 Seismic Brace Section L: 7000	7000	1,5	Set	16,943	3046489
BR 401 Seismic Brace Section L: 8000	8000	1,5	Set	19,267	3046491



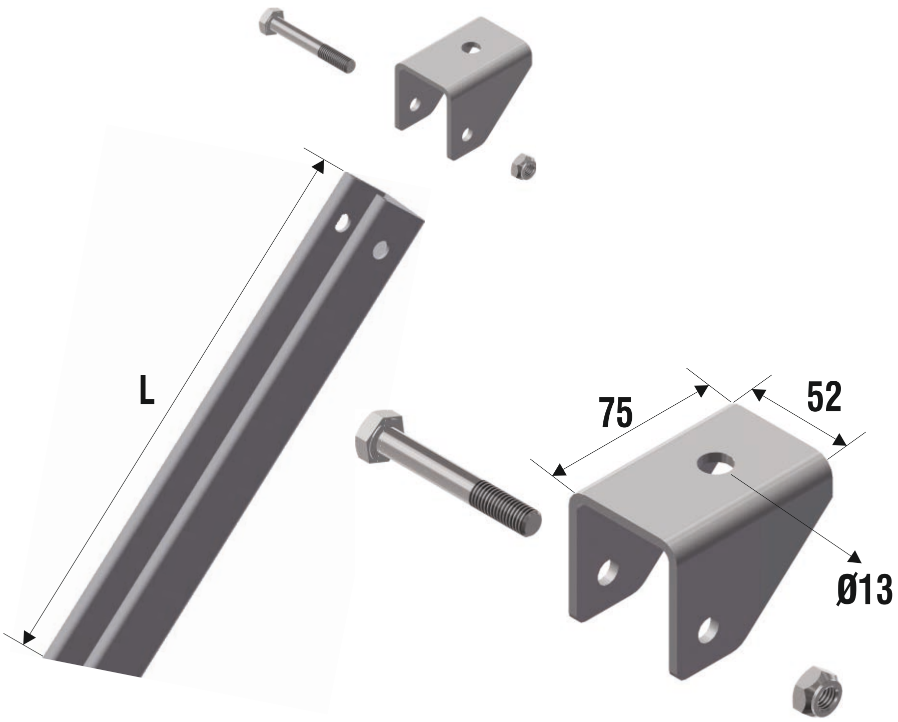
BR401



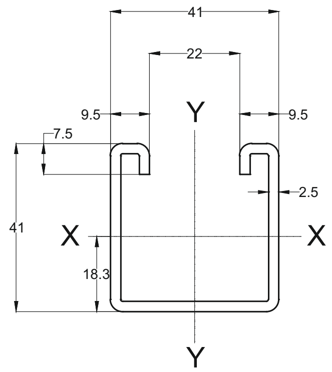
Assembly Includes
- 1,5 mm 40x40 Binrak steel channel Hot-dip galvanize finish
- Seismic brace ceiling attachment special zinc finish
- M10X70 bolt
- M10 Fiber nut

- **Please indicate order code in your orders.**
- 4000 mm and over 4000 mm orders should be attached
- Material weights are approximate values, it can variate ±10%.
- Please call us for non-standard components.

Description	L (mm)	T (mm)	Order Unit	Weight (kg/set)	Order Code
BR 461 Seismic Brace Section L: 500	500	2,5	Set	1,825	3046493
BR 461 Seismic Brace Section L: 600	600	2,5	Set	2,121	3046494
BR 461 Seismic Brace Section L: 700	700	2,5	Set	2,417	3046495
BR 461 Seismic Brace Section L: 800	800	2,5	Set	2,712	3046496
BR 461 Seismic Brace Section L: 900	900	2,5	Set	3,008	3046497
BR 461 Seismic Brace Section L: 1000	1000	2,5	Set	3,304	3046498
BR 461 Seismic Brace Section L: 1100	1100	2,5	Set	3,600	3046499
BR 461 Seismic Brace Section L: 1200	1200	2,5	Set	3,895	3046500
BR 461 Seismic Brace Section L: 1300	1300	2,5	Set	4,191	3046501
BR 461 Seismic Brace Section L: 1400	1400	2,5	Set	4,487	3046502
BR 461 Seismic Brace Section L: 1500	1500	2,5	Set	4,783	3046503
BR 461 Seismic Brace Section L: 2000	2000	2,5	Set	6,261	3046504
BR 461 Seismic Brace Section L: 2500	2500	2,5	Set	7,740	3046505
BR 461 Seismic Brace Section L: 3000	3000	2,5	Set	9,219	3046506
BR 461 Seismic Brace Section L: 3500	3500	2,5	Set	10,698	3046507
BR 461 Seismic Brace Section L: 4000	4000	2,5	Set	12,176	3046508
BR 461 Seismic Brace Section L: 5000	5000	2,5	Set	13,655	3046509
BR 461 Seismic Brace Section L: 6000	6000	2,5	Set	15,134	3046510
BR 461 Seismic Brace Section L: 7000	7000	2,5	Set	16,613	3046511
BR 461 Seismic Brace Section L: 8000	8000	2,5	Set	18,091	3046512



BR461

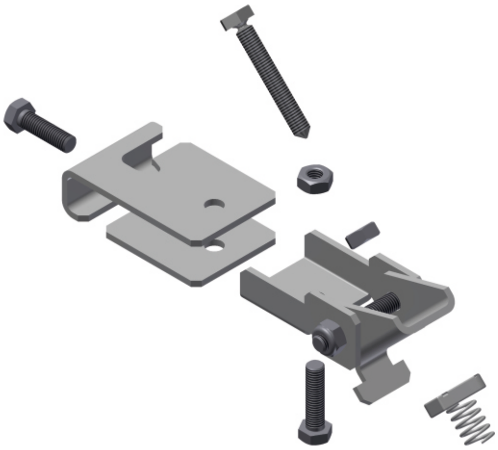


Assembly Includes
- 2,5 mm 41x41 Binrak steel channel Hot-dip galvanize finish
- Seismic brace ceiling attachment special zinc finish
- M10X70 bolt
- M10 Fiber nut

- **Please indicate order code in your orders.**
- 4000 mm and over 4000 mm orders should be attached
- Material weights are approximate values, it can variate ±10%.
- Please call us for non-standard components.

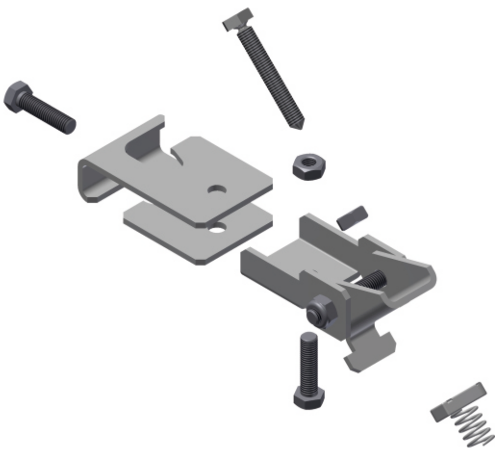
Description	Applicable Rod Size	Order Unit	Weight (kg/set)	Order Code
Seismic Rod Attacment (Secure Bolt) M8-M12	M8/M10/M12	Set	1,000	**3046513**
Seismic Rod Attacment (Secure Bolt) M14-20	M14/M16/M20	Set	0,966	**3046514**

Seismic Rod Attacment (Secure Bolt) M8-M12



M8-M12 Set Includes
- M10X70 secure head-off bolt
- M10X70 bolt
- M10X35 bolt
- M10X45 bolt
- M10 spring nut
- 2 pcs M10 fiber nut
- Seismic rod fixing assembly
  Special zinc finish
- Seismic rod connection piece
  Special zinc finish

Seismic Rod Attacment (Secure Bolt) M14-20

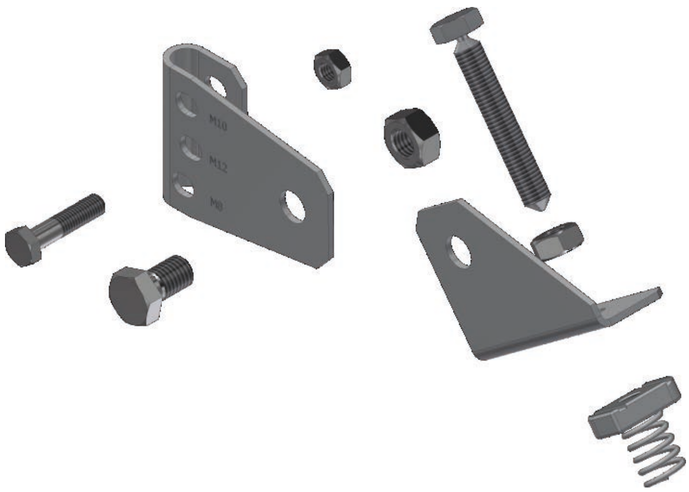


M14-M20 Set Includes
- M10X70 secure head-off bolt
- M10X70 bolt
- M10X35 bolt
- M10X45 bolt
- M10 spring nut
- 2 pcs M10 fiber nut
- Seismic rod fixing assembly
  Special zinc finish
- Seismic rod connection piece
  Special zinc finish

■ **Please indicate order code in your orders.**
■ Material weights are approximate values, it can variate ±10%.

Description	Applicable Rod Size	Order Unit	Weight (kg/set)	Order Code
Seismic Rod Set	M8/M10/M12	Set	0,381	**3048465**

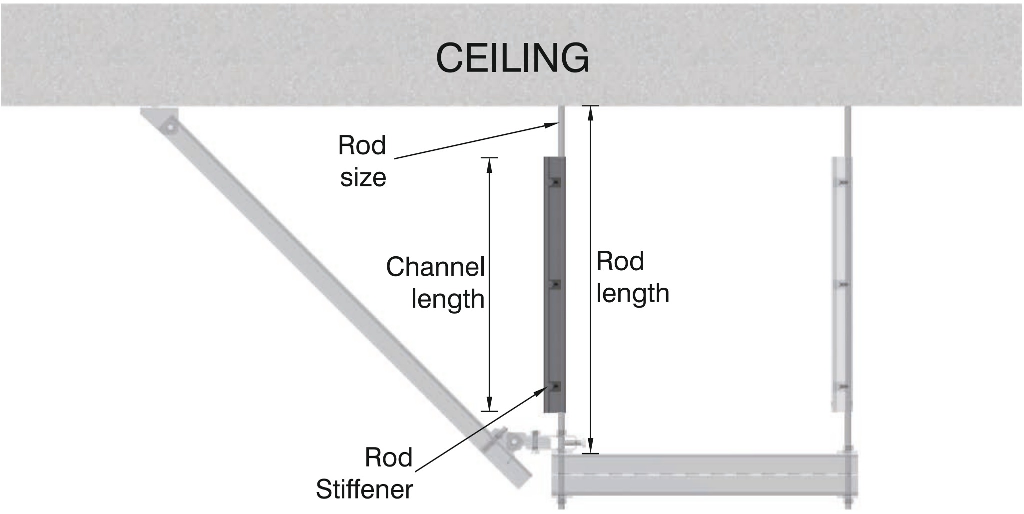
Seismic Rod Set



Set Includes
- M12X30 bolt
- M8 fiber nut
- M12 flanged nut
- M10 fiber nut
- Seismic brace ceiling
- M8X30 bolt
- M10X70 secure head-off bolt
- M10 spring nut

- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

Description	Rod Size	Rod Length (mm)	Channel Length (mm)	Channel Thickness (mm)	Stiffener Quantity	Order Unit	Weight (kg/set)	Order Code
Seismic Rod Stiffener Set (M8X700)	M8	700	500	2,5	3	Set	1,625	3046531
Seismic Rod Stiffener Set (M8X800)	M8	800	600	2,5	4	Set	1,970	3046624
Seismic Rod Stiffener Set (M8X900)	M8	900	700	2,5	4	Set	2,266	3046625
Seismic Rod Stiffener Set (M8X1000)	M8	1000	800	2,5	5	Set	2,610	3046626
Seismic Rod Stiffener Set (M8X1100)	M8	1100	900	2,5	5	Set	2,906	3046627
Seismic Rod Stiffener Set (M8X1200)	M8	1200	1000	2,5	5	Set	3,202	3046628
Seismic Rod Stiffener Set (M8X1300)	M8	1300	1100	2,5	6	Set	3,547	3046629
Seismic Rod Stiffener Set (M8X1400)	M8	1400	1200	2,5	6	Set	3,842	3046630
Seismic Rod Stiffener Set (M8X1500)	M8	1500	1300	2,5	7	Set	4,187	3046631
Seismic Rod Stiffener Set (M8X1600)	M8	1600	1400	2,5	7	Set	4,483	3046632
Seismic Rod Stiffener Set (M8X1700)	M8	1700	1500	2,5	8	Set	4,828	3046633
Seismic Rod Stiffener Set (M8X2200)	M8	2200	2000	2,5	10	Set	6,404	3046634
Seismic Rod Stiffener Set (M8X2700)	M8	2700	2500	2,5	12	Set	7,981	3046635
Seismic Rod Stiffener Set (M8X3200)	M8	3200	3000	2,5	14	Set	9,558	3046636

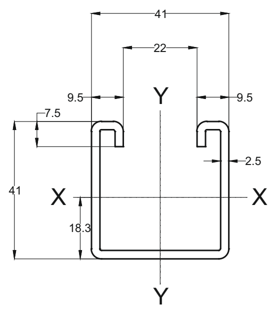


Description	Order Unit	Weight (kg/set)	Order Code
Rod Stiffener Piece	Set	0,045	3099402

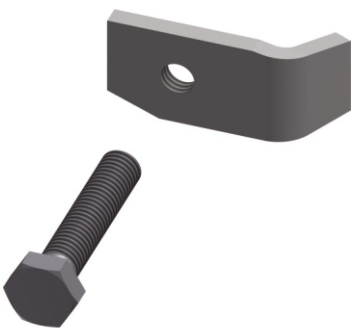
Rod Stiffener Set Includes

- M8X40 bolt (see table for quantity)
- Rod stiffener pieces (see table for quantity) Special zinc finish
- BR 461 steel channel (see table for channel length) Hot-dip galvanize finish

BR461



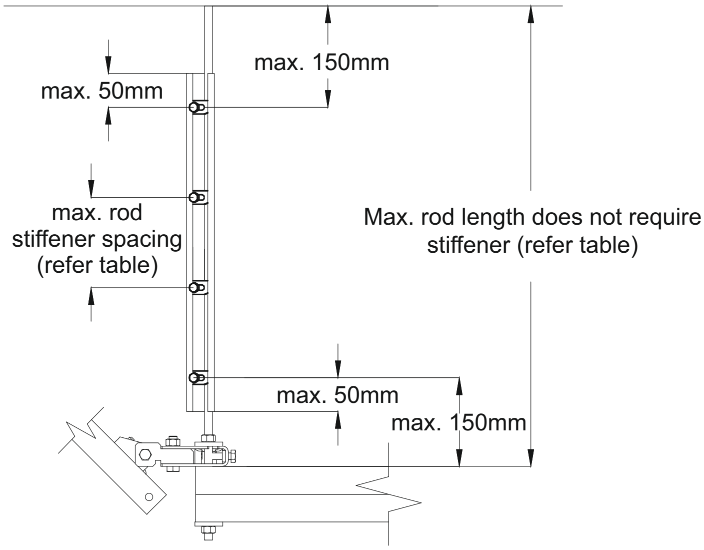
Rod Stiffener

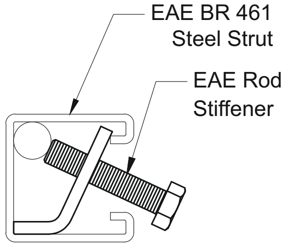


Rod Stiffener Pieces

- M8X40 bolt
- Rod Stiffener piece with special zinc finish

- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.





Up to M20 Rod Sizes

Rod Size	Max. Rod Length Without Stiffener (mm)	Max. Spacing Between Stiffener (mm)
M8	300	225
M10	475	325
M12	625	450
M16	775	575
M20	925	700

Rod Stiffener

- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

Description	Order Unit	Weight (kg/set)	Order Code
Seismic ID-UD Longitudinal Connection Set (Secure Bolt)	Set	0,584	**3046517**

Seismic ID-UD Longitudinal Connection Set (Secure Bolt)

Secure Head-off Bolt Set Includes

- M10X70 secure head-off bolt
- M10X70 bolt
- M10X30 bolt
- 2 pcs M10 nut
- M10 fiber nut
- M10 spring nut
- ID-UD seismic washer
  Special zinc finish
- Seismic U connection assembly
  Special zinc finish

- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

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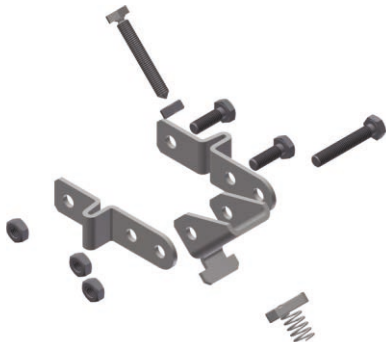
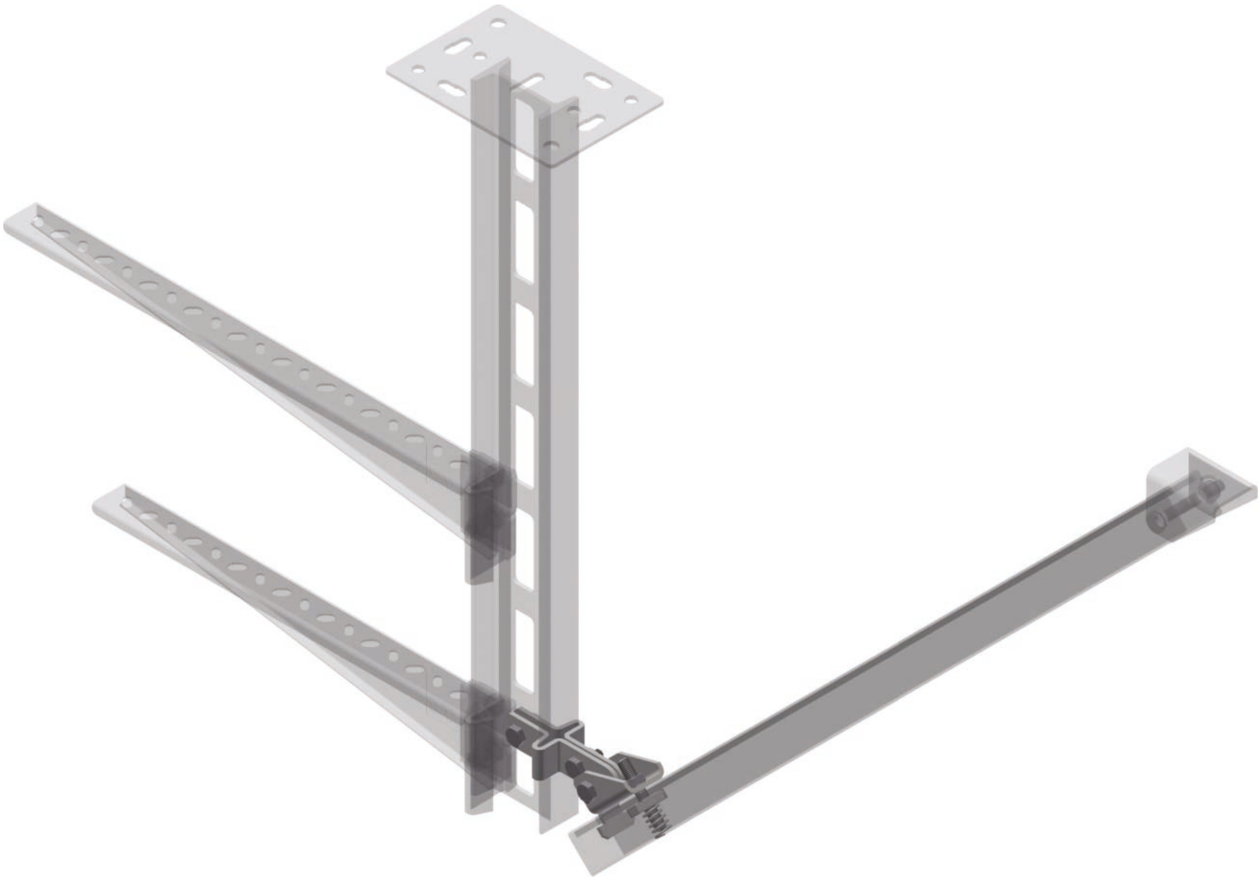
Description	Order Unit	Weight (kg/set)	Order Code
Seismic ID Lateral Connection Set (Secure Bolt)	Set	0,690	**3046518**

Seismic ID Lateral Connection Set
(Secure Bolt)



Secure Head-off Bolt Set Includes

- M10X70 secure head-off bolt
- M10X60 bolt
- 2 pcs M10X30 bolt
- M10 spring nut
- M10 fiber nut
- 3 pcs M10 nut
- 2 pcs ID seismic connection piece
  Special zinc finish
- Seismic length adjustment piece
  Special zinc finish

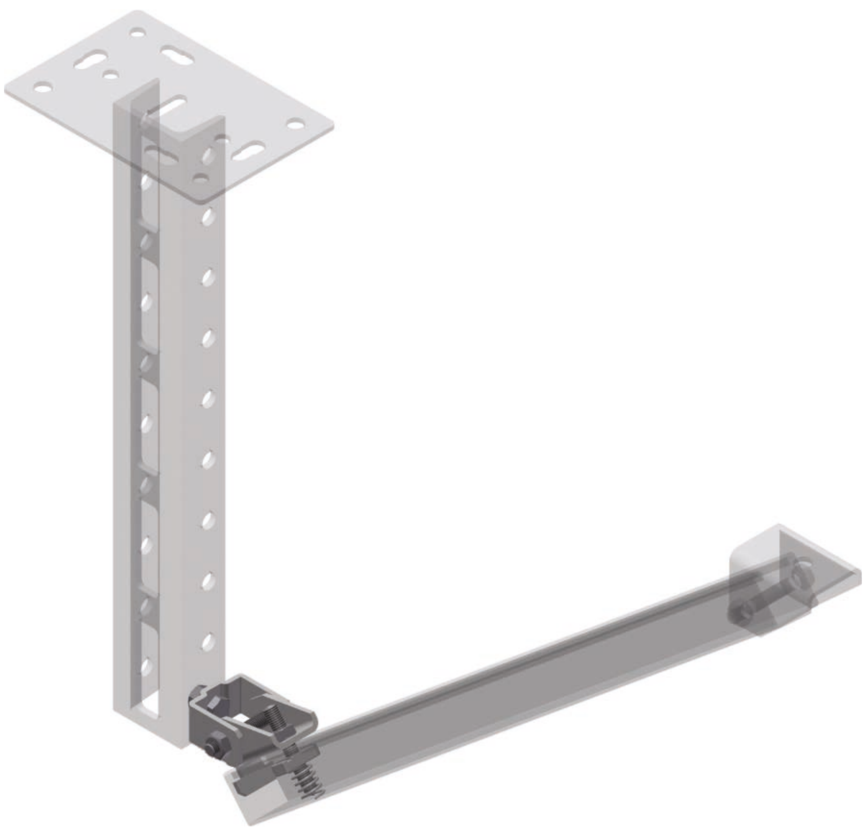


- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

Description	Order Unit	Weight (kg/set)	Order Code
Seismic UD Lateral Connection Set (Secure Bolt)	Set	0,510	3046519

Seismic UD Lateral Connection Set
(Secure Bolt)

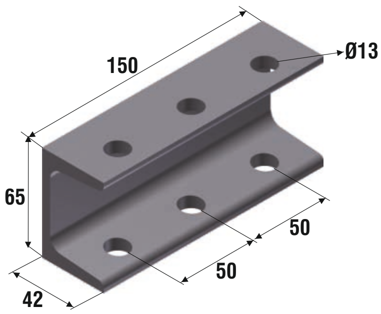
Secure Head-off Bolt Set Includes
- M10X70 secure head-off bolt
- M10X70 bolt
- M10X30 bolt
- 2 pcs M10 nut
- M10 fiber nut
- M10 spring nut
- Seismic U connection assembly
  Special zinc finish



- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

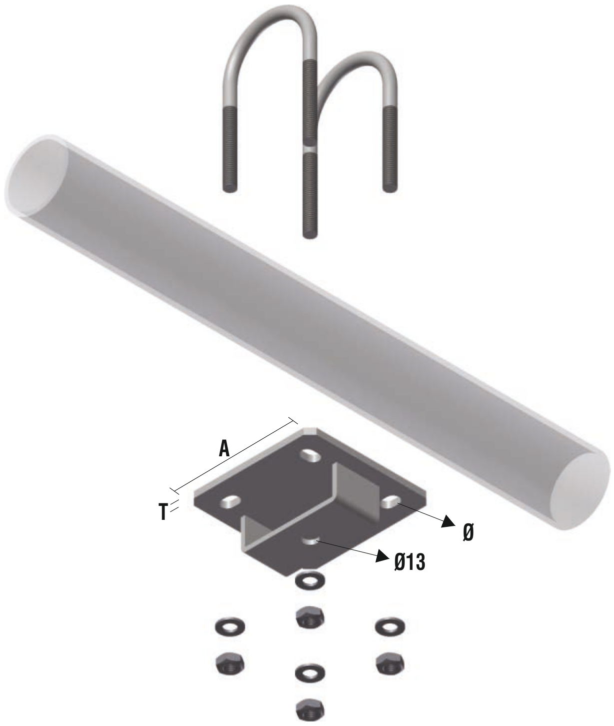
Hot-dip Galvanize (EN ISO 1461)

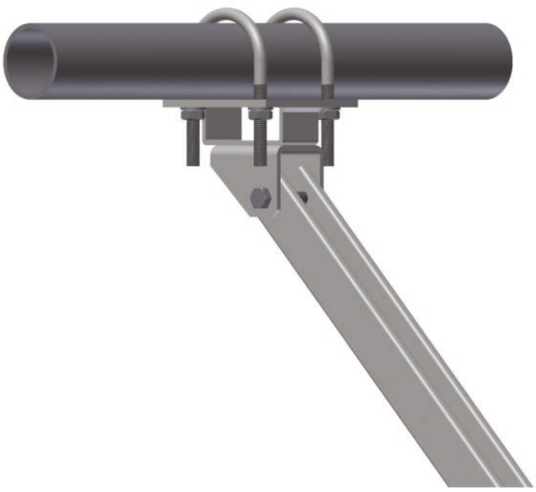
Description	L (mm)	Order Unit	Weight (kg/pcs.)	Order Code
UDY 150	150	Piece	1,006	3008376



Description	A (mm)	T (mm)	Ø (mm)	Order Unit	Weight (kg/set)	Order Code
Seismic Pipe Beam Hanger DN50 (2")	115	6	11	Set	1,249	3046525
Seismic Pipe Beam Hanger DN65 (2 1/2")	125	6	11	Set	1,429	3046526
Seismic Pipe Beam Hanger DN80 (3")	150	6	13	Set	2,050	3046527
Seismic Pipe Beam Hanger DN100 (4")	180	6	13	Set	2,684	3046528
Seismic Pipe Beam Hanger DN125 (5")	200	6	13	Set	3,190	3046529
Seismic Pipe Beam Hanger DN150 (6")	250	8	18	Set	6,499	3046530

Set Includes
- 2 pcs U-bolt
- 4 pcs nut
- 4 pcs washer
- Seismic pipe beam plate
  Hot-dip galvanize finish





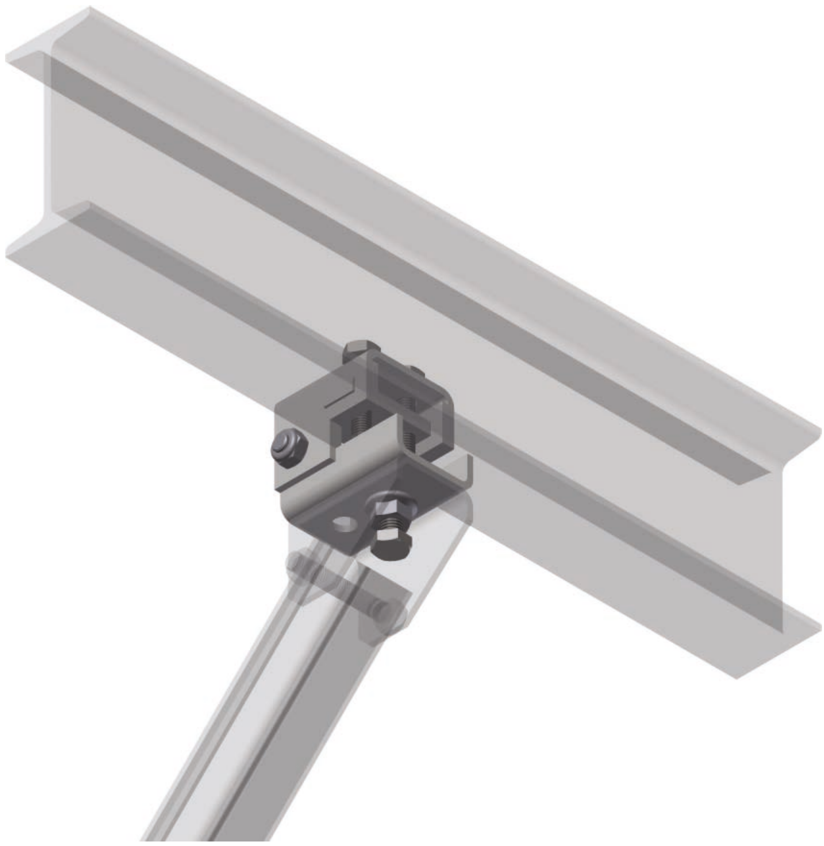
- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

Description	Compatible Steel Profile Size	Order Unit	Weight (kg/set)	Order Code
Seismic Steel Beam Hanger (Secure Bolt)	U80,I120 and upper	Set	0,880	**3046523**

Seismic Steel Beam Hanger
(Secure Bolt)

Secure Head-off Bolt Set Includes

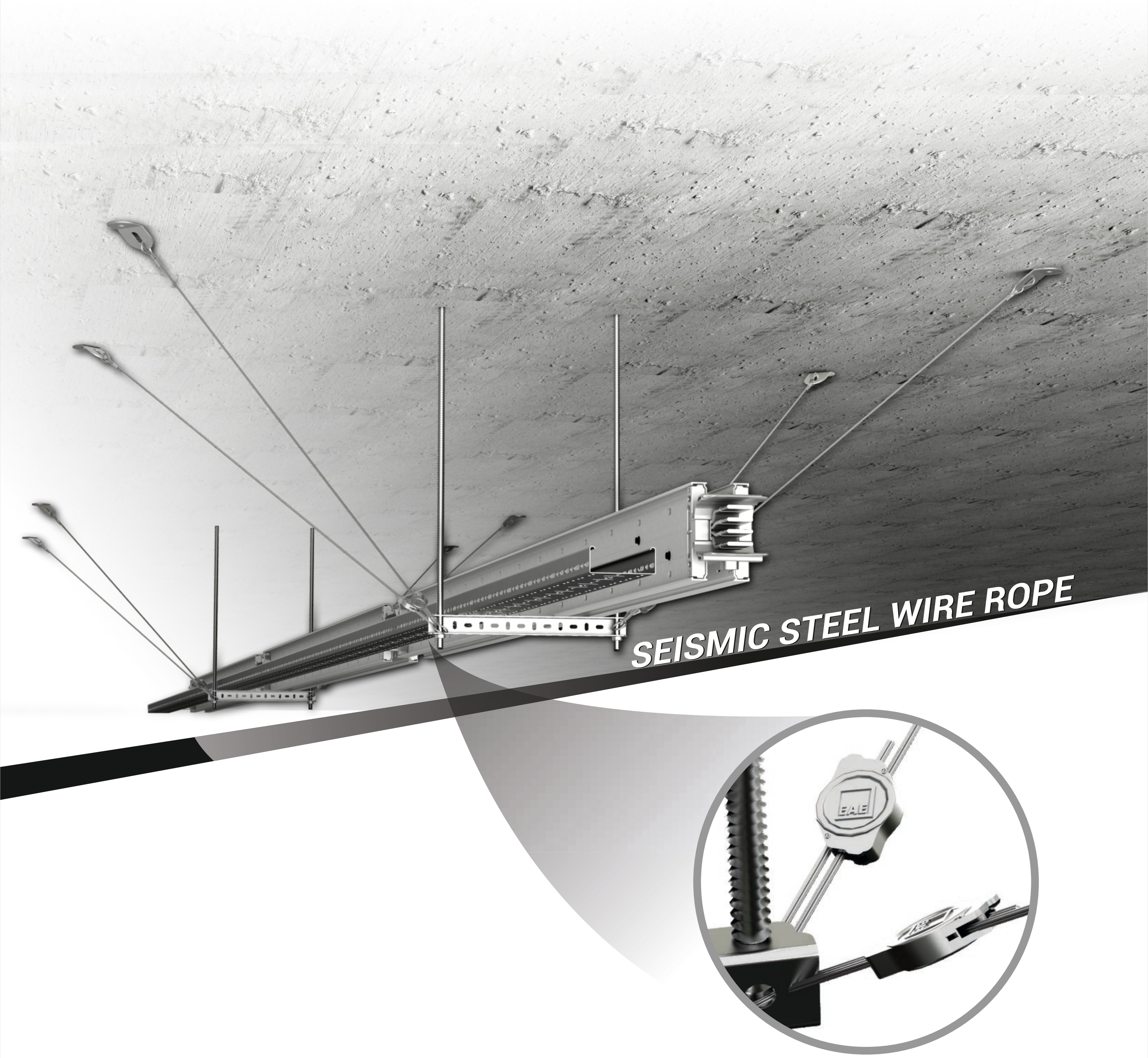
- 3 pcs M10X70 secure head-off bolt
- 2 pcs M10X20 bolt
- 2 pcs M10 fiber nut
- M10 nut
- Beam hanger nut
  Special zinc finish
- Beam hanger assembly
  Special zinc finish



- **Please indicate order code in your orders.**
- Material weights are approximate values, it can variate ±10%.

Wire Rope Specification

	No:2	No:3	No:4
Diameter (mm)	2 mm	3 mm	4,8 mm
Wire Configuration	7x7	7x7	7x7
Min. Breaking Load (Kg)	260	580	1400
Max. Safety Work Weight (Kg)	50	110	250
Tensile Strength (Nmm²)	1750	1750	1750



Seismic Steel Wire Rope Set

Description	Order Code
No:2 - L=1 Meter Set with Ceiling Attachment	2064287
No:2 - L=2 Meter Set with Ceiling Attachment	2064288
No:2 - L=3 Meter Set with Ceiling Attachment	2064289
No:2 - L=5 Meter Set with Ceiling Attachment	2064290
No:2 - L=8 Meter Set with Ceiling Attachment	2064291
No:3 - L=1 Meter Set with Ceiling Attachment	2064292
No:3 - L=2 Meter Set with Ceiling Attachment	2064293
No:3 - L=3 Meter Set with Ceiling Attachment	2064294
No:3 - L=5 Meter Set with Ceiling Attachment	2064295
No:3 - L=8 Meter Set with Ceiling Attachment	2064296
No:4 - L=1 Meter Set with Ceiling Attachment	2064297
No:4 - L=2 Meter Set with Ceiling Attachment	2064298
No:4 - L=3 Meter Set with Ceiling Attachment	2064299
No:4 - L=5 Meter Set with Ceiling Attachment	2064300
No:4 - L=8 Meter Set with Ceiling Attachment	2064301

Sets include ;
- Ordered length of steel rope
- Ordered size of special clamp
- Aluminum Sleeves
- Thimble
- Ceiling Attachment

Description	Order Code
No: 2 - L = 1 Meter Set	2065271
No: 2 - L = 2 Meter Set	2065272
No: 2 - L = 3 Meter Set	2065273
No: 2 - L = 5 Meter Set	2065274
No: 2 - L = 8 Meter Set	2065276
No: 3 - L = 1 Meter Set	2065277
No : 3 - L = 2 Meter Set	2065278
No : 3 - L = 3 Meter Set	2065279
No : 3 - L = 5 Meter Set	2065280
No : 3 - L = 8 Meter Set	2065281
No : 4 - L = 1 Meter Set	2065282
No : 4 - L = 2 Meter Set	2065283
No : 4 - L = 3 Meter Set	2065284
No : 4 - L = 5 Meter Set	2065285
No : 4 - L = 8 Meter Set	2065286

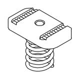
Sets include ;
- Ordered length of steel rope
- Ordered size of special clamp
- Aluminum Sleeves
- Thimble

No:2

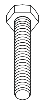
No:3

No:4

EAE SEISMIC COMPONENTS

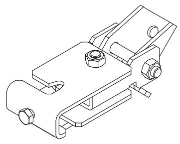


Spring Nut
Available for bolt or rod sizes of m6 to m12

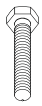


DIN 933 8.8 Bolts
Various sizes

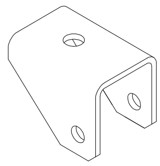
Hexagon Nut
Available for bolt or rod sizes of m6 to m16



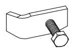
Seismic Brace Rod Attachment
Compatible for rod sizes m8 to m12 or M14 to m20



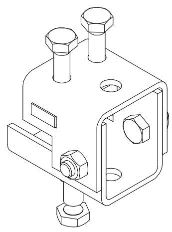
Secure Head-off Bolt
Available sizes of m10 and m12



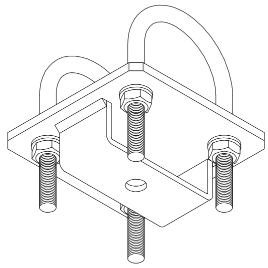
Seismic Brace Ceiling Attachment
Compatible for Anchor sizes up to m12



Rod Stiffener
Compatible up to M20 rod sizes



EAE Steel Beam Fastener
Compatible for I120, U80 and bigger steel beams



EAE Pipe Beam Fastener
Available sizes for DN50 to DN150 Pipe Beams

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DESIGN PROCEDURE

Design procedure given here is for determining brace spacing and trapeze width of the distribution system being braced. Calculations examples are according to IBC® 2012. These calculations are for determining seismic acceleration. The tables given here are however showing universal system allowable loads. Therefore, can be applied to any building code. Please consult with a design professional for project specific brace layout.

Design process should follow steps below:

Trapeze Assembly Design Steps

Stage - 1 Trapeze Section

1 - Determine system max. trapeze spacing.
2 - Determine system dead load (operating load).
3 - Determine system max. brace spacing.
4 - Determine system max. horizontal seismic load.
5 - Determine system max. vertical seismic load.
6 - Determine combined loads and trapeze section.

Stage - 2 Rod

7 - Determine threaded rod.
8 - Determine rod stiffener usage.

Stage - 3 Brace

9 - Determine brace section length and installation angle.
10 - Determine brace section.
11 - Determine brace anchor loads.
12 - Determine brace anchor.

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STEP 1

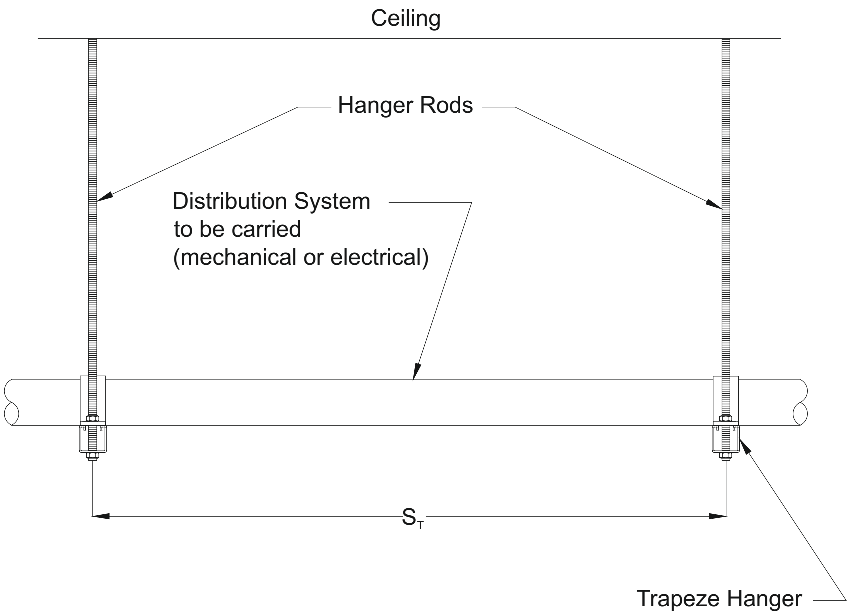
Determining Trapeze Spacing

Maximum trapeze hanger spacings S_T should be determined by including but not limited to; governing regulations, technical specifications of the distribution system to be installed.

Consult with a project specialist for more information.

Most accepted trapeze spacing is 1.5m for most of the distribution system, including but not limited to; electrical cable trays, electrical bus ducts.

S_T : Maximum trapeze spacing in meters allowed by governing regulation or technical specification.



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STEP 2

Determining Dead Load

Maximum operating vertical load D, should be determined using following calculation;

D = S_T x Wt x 1.15

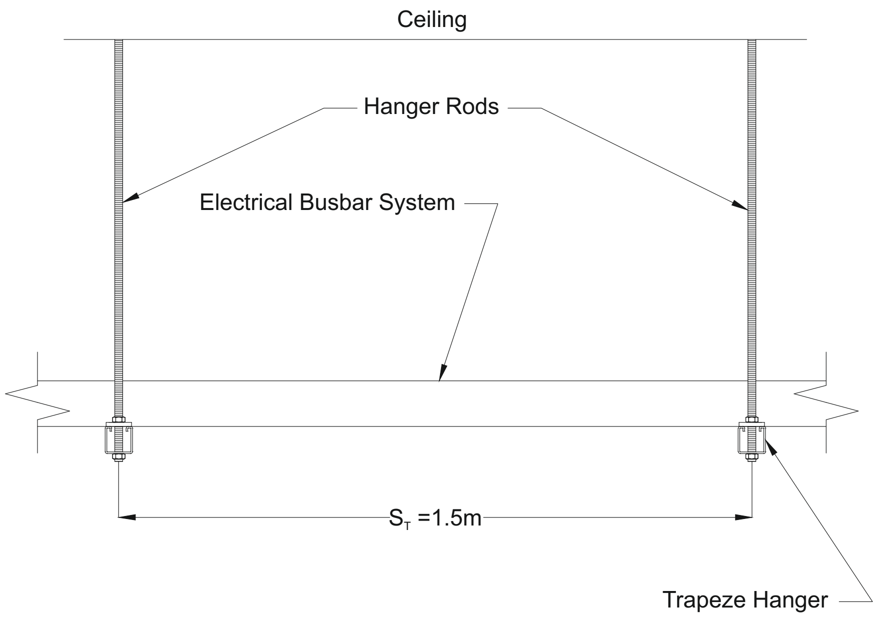
D : Component operating weight (operating vertical load,dead load).
S_T : Maximum trapeze spacing in meters allowed by governing regulation or technical specification.
Wt : Operating weight of the distribution system per meter.

1.15 factor stands for applying self weight of the trapeze assembly.

Example 1:

The system to be braced is an electrical busbar system that weigh 0.588 kN per meter. Technical specification of the busbar system limits the maximum support spacing to 1.5 meters. System maximum dead load will be;

D = 1.5 x 0.588 x 1.15 = 1.015 kN's.



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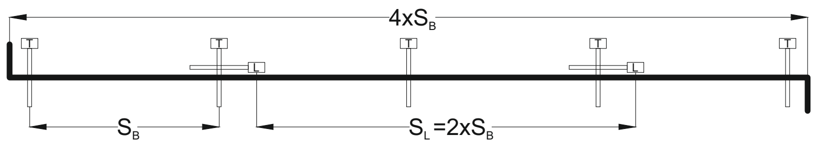
STEP 3

Determining Brace Spacing

Generally maximum transverse (lateral) sway brace spacing is 12m for fire protection sprinkler systems, pipes, conduits and 9m for cable trays and busbar systems. Most accepted spacing of transverse (lateral) braces for HVAC ductworks are 9m according to 1998 Seismic Restraint Guidelines for Mechanical Systems (SMACNA). Longitudinal brace spacing is two times of transverse (lateral) span. Please note that these spacings are mostly accepted values by the specifications and codes. Project specific criterias may vary internationally.

Refer NFPA 13 for more detailed information on seismic bracing layout on fire protection systems.

Design professionals can be consulted for bracing layouts. Following sections include the data needed for design specialists. For more information, contact EAE customer relations or visit www.eae.com.tr.



T : Transverse (lateral) brace trapeze assembly

L : Longitudinal brace trapeze assembly

S_B : Maximum allowed transverse (lateral) brace spacing

S_L : Maximum allowed longitudinal brace spacing

Example Layout of Max. Brace spacings for Suspended Distribution Systems

Suspended distribution system to be braced	Max. trasverse brace spacing S_B	Max. longitudinal brace spacing S_L
Steel and copper pipe with welded, brazed, grooved or screwed connections	12 m	24 m
PVC of PVDF pipe with solvent-welded connections	6 m	12 m
No-hub Pipe with shield and clamp connections	6 m	12 m
Sheet metal ductwork	9 m	18 m

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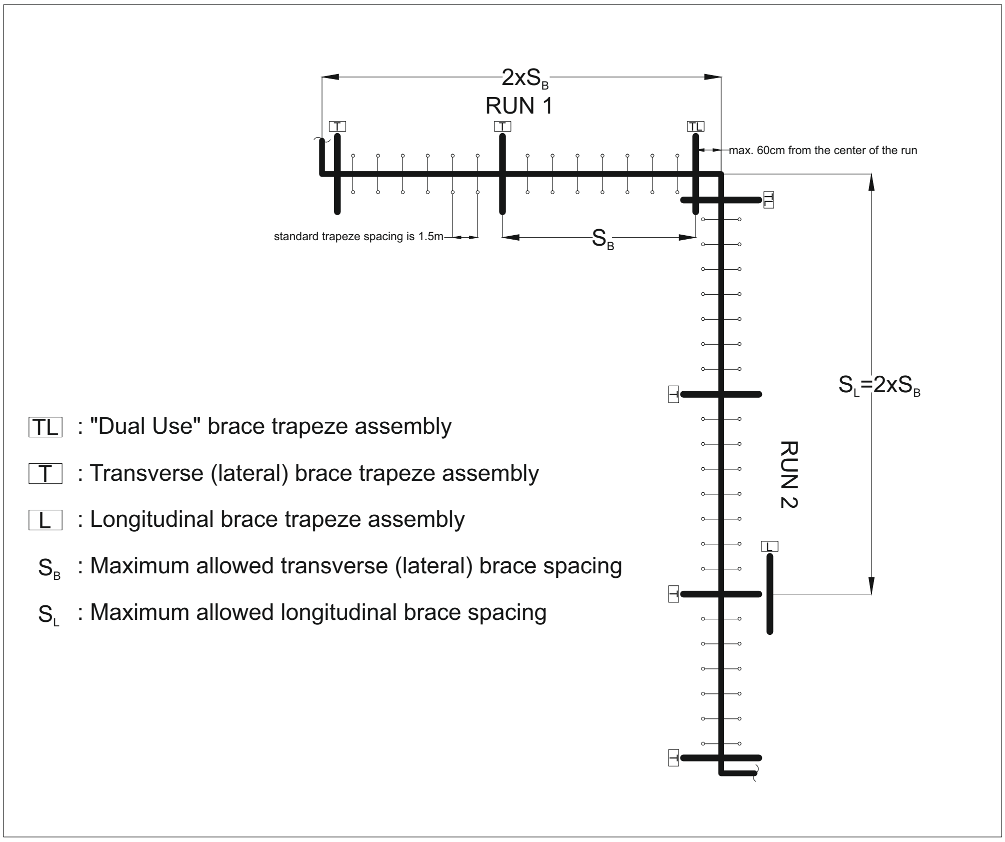
STEP 3

Determining Brace Spacing

This section is for making bracing layouts easier. Figures shown in this section are provided for all trapeze assemblies that carry any specific distribution system. Conditions taken into count is for worst case scenario for 1.5m trapeze span and S_B lateral brace spacing.

Dual Use Transverse (lateral) Brace:

A "Dual Use" transverse (lateral) brace works both as lateral brace of the distribution system run installed, and as the longitudinal brace of the neighboring run. Example layout for a "Dual Use" brace is given below.



General Bracing Layout

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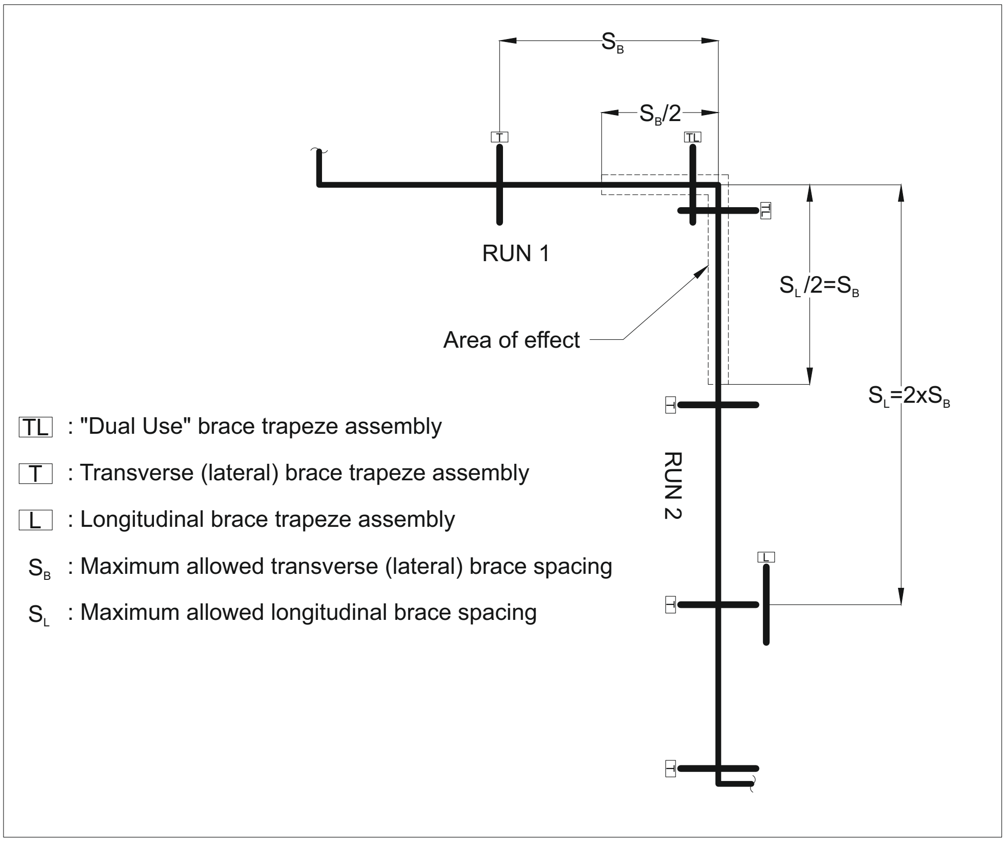
STEP 3

Determining Brace Spacing

At the maximum allowed brace spacing and standard 1.5m trapeze span, a "Dual Use" trapeze brace assembly should withstand 1.5m of dead load plus 3/2 S_B meters of earthquake load of the distribution system. Examples given in following sections are provided with that respect. Refer to concerned table for load combinations and allowable loads for the trapeze assembly.



"Dual Use" Brace Area of Effect

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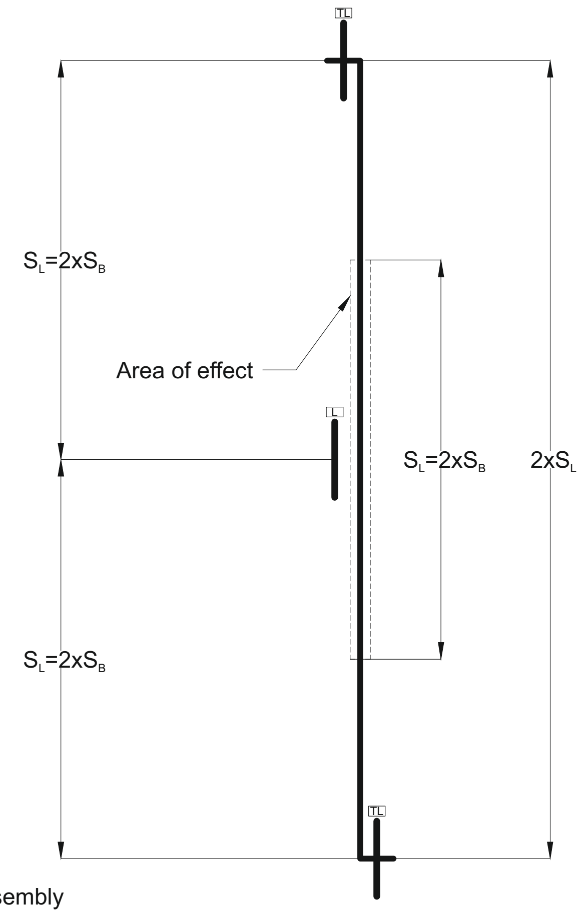
STEP 3

Determining Brace Spacing

Longitudinal Brace:

Longitudinal Trapeze Brace assembly at 1.5m standard trapeze span, and S_L maximum allowed longitudinal brace spacing should withstand 1.5m of dead load plus S_L meters of earthquake load. Examples given in following section are provided with that respect. Refer to concerned table for load combinations and allowable loads for the trapeze assembly.



TL : "Dual Use" brace trapeze assembly

L : Longitudinal brace trapeze assembly

S_B : Maximum allowed transverse (lateral) brace spacing

S_L : Maximum allowed longitudinal brace spacing

Longitudinal Brace Area of Effect

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STEP 4

Determining Horizontal Seismic Load

System acceleration "G", can be determined by use of any building code. Below calculation examples are according to IBC® 2012 governed by ICC®. IBC® referred calculations and constants are from ASCE/SEI 7-10 chapter 13.

G : Horizontal seismic design acceleration is equal to F_P / W_P .

Horizontal seismic design force:

$$F_P = \frac{0.4 a_P S_{DS} W_P}{\left(\frac{R_P}{I_P}\right)}\left(1 + 2\frac{z}{h}\right)$$

where, $0.3 S_{DS} I_P W_P \leqslant F_P \leqslant 1.6 S_{DS} I_P W_P$

$S_{DS} = 2/3 S_S F_a$

F_P : Horizontal seismic design force.
S_{DS} : Spectral acceleration, short period.
a_P : Component amplification factor varies from 1.00 to 2.50 (ASCE/SEI 7-10 Table 13.5-1 or 13.6-1).
I_P : Component importance factor that varies from 1.00 to 1.50 (ASCE/SEI 7-10 13.1.3).
W_P : Component operating weight.
R_P : Component response modification factor that varies from 1.00 to 12 (ASCE/SEI 7-10 Table 13.5-1 or 13.6-1).
z : Height in structure of point of attachment of component with respect to the base. For items at or below base, z shall be taken as 0. The value z/h need not exceed 1.0.
h : Average roof height of structure with respect to the base.
S_S : Spectral response acceleration.
F_a : Site coefficient.

Example 2:

The trapeze system in example 1 is on a basement floor of a building located at Istanbul/TURKEY. The distribution system carried by the trapeze assembly is an electrical busbar system, that supplies fire pumps. The system seismic acceleration "G" should be:

$0.3 S_{DS} I_P \leqslant \frac{F_P}{W_P} \leqslant 1.6 S_{DS} I_P$, $0.3x1.1x1.5 \leqslant 0.4x1x1.1x1.5/2.5x(1+(2x0/1)) \leqslant 1.6x1.1x1.5$

$0.495 \leqslant 0.264 \leqslant 2.64$

"G" value is smaller than the minimum value, therefore system acceleration "G" will be:

G = 0.495

Notes:

Values a_P , R_P are selected from ASCE/SEI 7-10 Table 13.6-1. I_P is determined as 1.50 for electrical system that supplies an emergency system. S_{DS} is determined by selecting S_S values from US COE 1998 international locations, and with soil condition unknown, site coefficient F_a is taken as 1.00 according to IBC® 2012 Table 1613.3.3(1).

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STEP 4

Determining Horizontal Seismic Load

Maximum brace spacings must be considered when determining system seismic design load. Once design acceleration "G" is determined, horizontal seismic loads of the system should be determined using following calculation:

$F_{Plmax} = S_L \times Wt \times 1.15 \times G$
$F_{Ptmax} = 3/2S_B \times Wt \times 1.15 \times G$

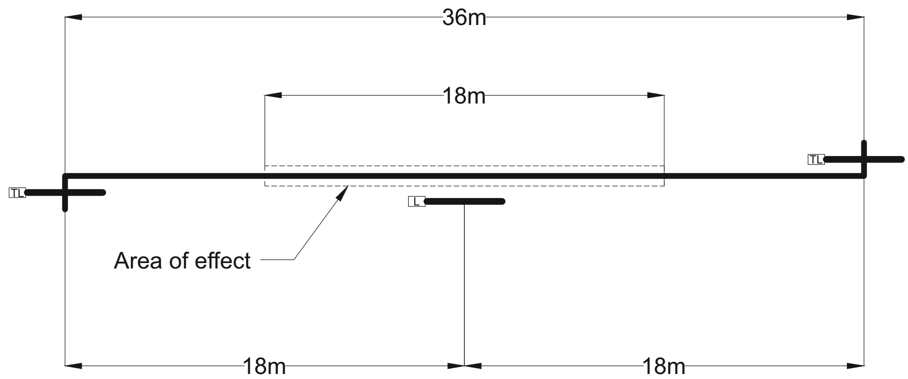
F_{Plmax} : Maximum longitudinal seismic design force.
F_{Ptmax} : Maximum transverse (lateral) seismic design force.
S_L : Maximum longtudinal brace spacing in meters allowed by governing code or technical specification.
S_B : Maximum transverse (lateral) brace spacing in meters allowed by governing code or technical specification.
Wt : Operating weight of the distribution system per meter.
G : Horizontal seismic design acceleration.

1.15 factor stands for applying self weight of the trapeze assembly.

Example 3:

Maximum brace spacing of the busbar system described in example 2 is 9m for lateral bracing and 18m for longitudinal bracing. And the weight of the busbar system is 0.588 kN/m. The system maximuml horizontal seismic design forces will be:

F_{Plmax} = 18x0.588x1.15x0.495 = 6.024 kN's.



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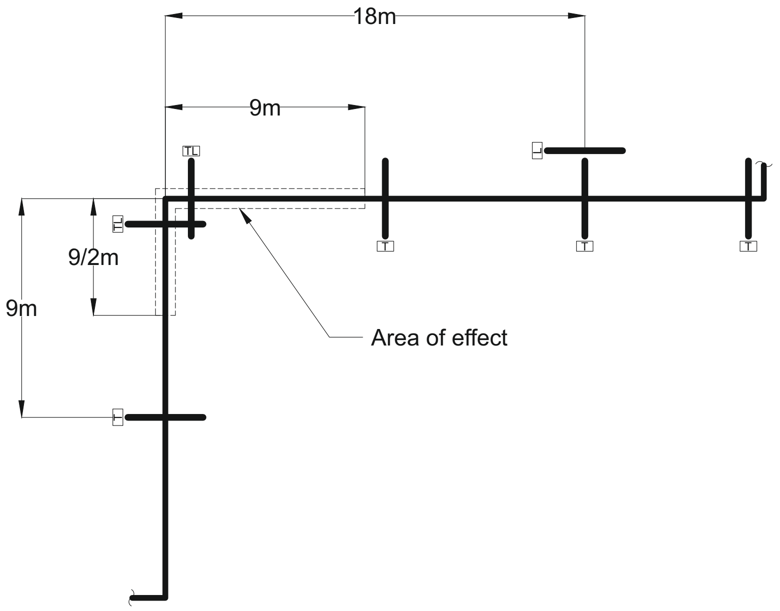
STEP 4

Determining Horizontal Seismic Load

Example 3 continue:

F_{Ptmax} = 3/2x9x0.588x1.15x0.495 = 4.518 kN's.



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STEP 5

Determining Vertical Seismic Load

Seismic vertical loads can be determided by use of any building code. Below calculation examples are according to IBC® 2012 governed by ICC®. IBC® referred calculations and constants are from ASCE/SEI 7-10 chapter 13.

Seismic Vertical Design Force:

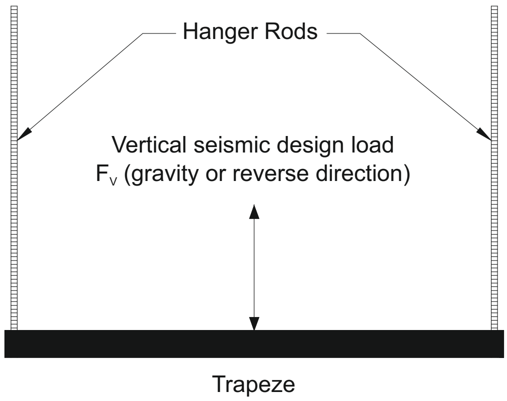
$F_V = 0.2 \times S_{DS} \times D$

F_V : Vertical sysmic design force.
S_{DS} : Spectral acceleration, short period.
D : Component operating weight (operating vertical load,dead load).

Example 4:

Vertical seismic design force of the system described in previous examples will be:

$F_V = 0.2 \times 1.1 \times 1.015 = 0.224$ kN's.



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STEP 6

Determining Trapeze Section

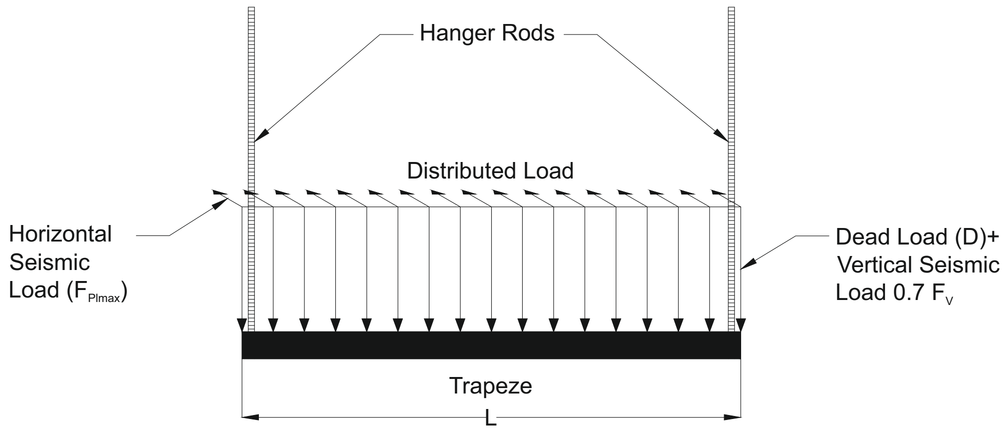
Loading Conditions:

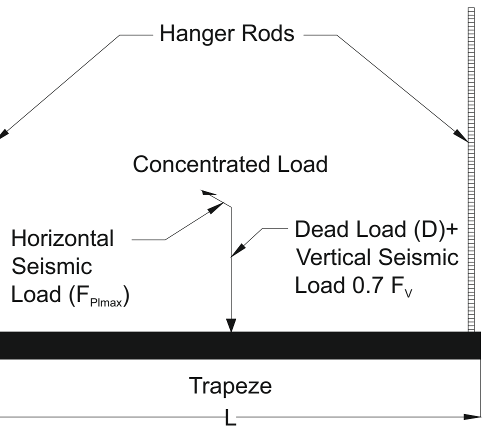
Allowable loads given in this section are calculated according to AISI 1999 allowable stress design. Load combination used is as per specified in ASCE/SEI 7-10 2.4.1 combination 5 (D + 0.7E).

Loading diagram given below is used for uniform loading and concentrated loading.

Refer to the loading combination notes for exact loading force directions.

D : Dead Loads
E : Earthquake Loads (F_{Plmax} and $0.7F_V$)





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STEP 6

Determining Trapeze Section

Loading Combinations:

Once all loads are determined, the trapeze section will be chosen from the tables on pages A6-3 to A6-17. Allowable vertical force values in tables are according to flexural strength of the section in x-x axis. Allowable horizontal seismic load values in tables are according to flexural strength of the section in y-y axis divided by 0.7 for ASD combination. Final combination of loads should satisfy below calculation*.

$$\frac{\text{Total vertical load}}{\text{Allowable vertical load}} + \frac{\text{Total horizontal seismic load}}{\text{Allowable horizontal seismic load}} \leqslant 1$$

Example 5:

Trapeze section of the system is determined BR 461 section with lenght of 300 mm in concentrated loading. The section is:

$[(0.7F_V + D) / \text{Allowable vertical load}] + [F_{Plmax} / \text{Allowable horizontal seismic load}] \leqslant 1$

$[((0.7x0.224+1.015)/9.520]+[6.024/11.750] = 0.64 \leqslant 1$, ok.

F_V : Vertical seismic design force.
D : Component operating weight (operating vertical load,dead load).
F_{Plmax} : Maximum longitudinal seismic design force.

For allowable load values** see tables on pages A6-3 to A6-17.

* The design worse case scenario for the trapeze section is under maximum longitudinal seismic design forces. Therefor, trapeze section should be determined by the longitudinal design forces.
**The values are calculated according to AISI 1999 allowable stress design (ASD) and the material used is DIN10025-P2 S235JR.

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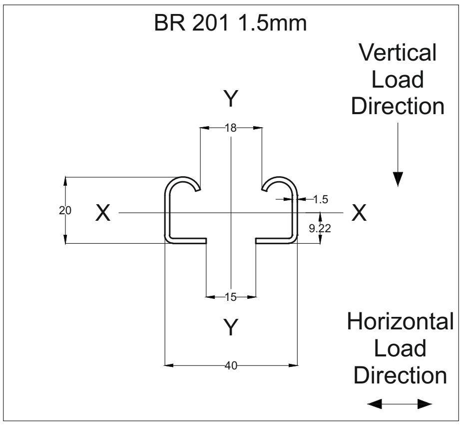
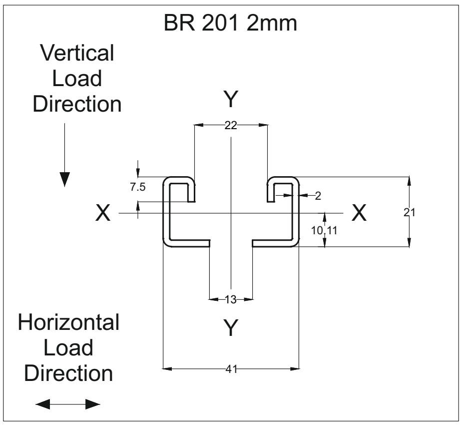


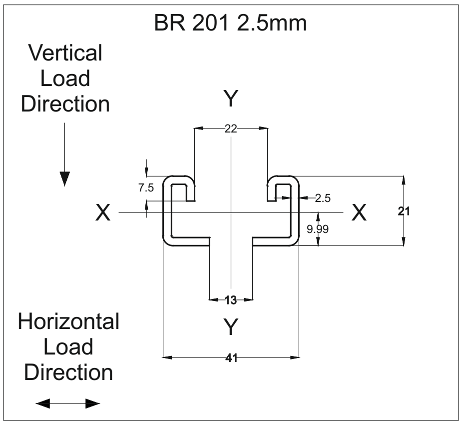
Lenght	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	1,042	2,084	0,803	1,606
400	0,781	1,563	0,803	1,606
500	0,625	1,250	0,803	1,606
600	0,521	1,042	0,803	1,606
700	0,447	0,893	0,803	1,606
800	0,391	0,781	0,803	1,606
900	0,347	0,695	0,803	1,606
1000	0,313	0,625	0,803	1,606
1100	0,284	0,568	0,803	1,606
1200	0,260	0,521	0,803	1,606
1300	0,240	0,481	0,803	1,606
1400	0,223	0,447	0,803	1,606
1500	0,208	0,417	0,803	1,606
1600	0,195	0,391	0,803	1,606
1700	0,184	0,368	0,803	1,606
1800	0,174	0,347	0,803	1,606
1900	0,165	0,329	0,803	1,606
2000	0,156	0,313	0,803	1,606
3000	0,104	0,208	0,573	1,147

BR 201-1,5mm Steel Section



BR 201-2mm Steel Section

Lenght	İzin Verilen Düşey Yük		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	2,553	5,107	7,481	14,962
400	1,915	3,830	5,611	11,221
500	1,532	3,064	4,489	8,977
600	1,277	2,553	3,740	7,481
700	1,094	2,189	3,206	6,412
800	0,958	1,915	2,805	5,611
900	0,851	1,702	2,494	4,987
1000	0,766	1,532	2,244	4,489
1100	0,696	1,393	2,040	4,081
1200	0,638	1,277	1,870	3,740
1300	0,589	1,179	1,726	3,453
1400	0,547	1,094	1,603	3,206
1500	0,511	1,021	1,496	2,992
1600	0,479	0,958	1,403	2,805
1700	0,451	0,901	1,320	2,640
1800	0,426	0,851	1,247	2,496
1900	0,403	0,806	1,181	2,362
2000	0,383	0,766	1,122	2,244
3000	0,255	0,511	0,748	1,496



BR 201-2,5mm Steel Section

Lenght	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	2,995	5,989	9,172	18,343
400	2,246	4,492	6,879	13,757
500	1,797	3,594	5,503	11,006
600	1,497	2,995	4,586	9,172
700	1,283	2,567	3,931	7,861
800	1,123	2,246	3,439	6,879
900	0,992	1,996	3,057	6,114
1000	0,898	1,797	2,751	5,503
1100	0,817	1,633	2,501	5,003
1200	0,749	1,497	2,293	4,586
1300	0,691	1,382	2,117	4,233
1400	0,642	1,283	1,965	3,931
1500	0,599	1,198	1,834	3,669
1600	0,562	1,123	1,720	3,439
1700	0,528	1,057	1,619	3,237
1800	0,499	0,998	1,529	3,057
1900	0,473	0,946	1,448	2,896
2000	0,449	0,898	1,376	2,751
3000	0,299	0,599	0,917	1,834

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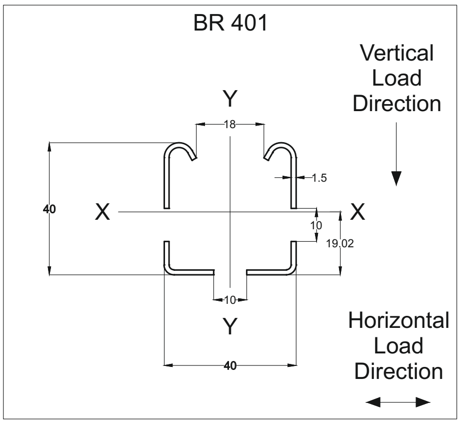
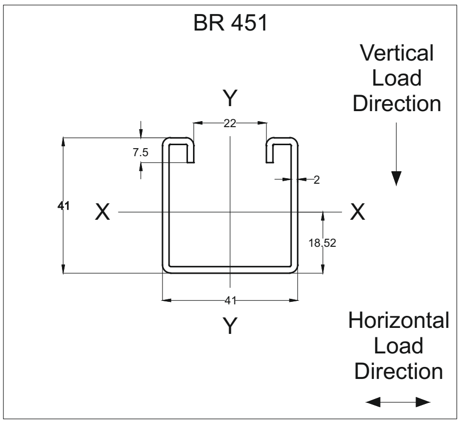
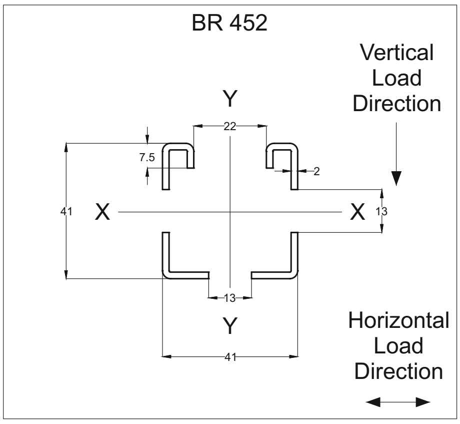


BR 401 Steel Section				
Lenght	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	3,260	6,519	3,856	7,712
400	2,445	4,890	2,892	5,784
500	1,956	3,912	2,313	4,627
600	1,630	3,260	1,928	3,856
700	1,397	2,794	1,652	3,305
800	1,222	2,445	1,446	2,892
900	1,087	2,179	1,285	2,571
1000	0,978	1,956	1,157	2,313
1100	0,889	1,778	1,052	2,103
1200	0,815	1,630	0,964	1,928
1300	0,752	1,504	0,890	1,780
1400	0,699	1,397	0,826	1,652
1500	0,652	1,304	0,771	1,542
1600	0,611	1,222	0,723	1,446
1700	0,575	1,150	0,680	1,361
1800	0,543	1,087	0,643	1,285
1900	0,515	1,029	0,609	1,218
2000	0,489	0,978	0,578	1,157
3000	0,326	0,652	0,386	0,771



BR 451 Steel Section				
Lenght	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	7,780	15,560	9,723	19,446
400	5,835	11,670	8,478	16,956
500	4,668	9,336	6,782	13,565
600	3,890	7,780	5,652	11,304
700	3,334	6,669	4,844	9,689
800	2,918	5,835	4,239	8,478
900	2,593	5,187	3,768	7,536
1000	2,334	4,668	3,391	6,782
1100	2,122	4,244	3,083	6,166
1200	1,945	3,890	2,826	5,652
1300	1,795	3,591	2,609	5,217
1400	1,667	3,334	2,422	4,844
1500	1,556	3,112	2,261	4,522
1600	1,459	2,918	2,119	4,239
1700	1,373	2,746	1,995	3,990
1800	1,297	2,593	1,884	3,768
1900	1,228	2,457	1,785	3,570
2000	1,167	2,334	1,696	3,391
3000	0,778	1,556	1,130	2,261



BR 452 Steel Section				
Lenght	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	7,172	14,344	8,400	16,800
400	5,379	10,758	6,300	12,600
500	4,303	8,606	5,040	10,080
600	3,586	7,172	4,200	8,400
700	3,074	6,147	3,600	7,200
800	2,689	5,379	3,150	6,300
900	2,391	4,781	2,800	5,600
1000	2,152	4,303	2,520	5,040
1100	1,956	3,912	2,291	4,582
1200	1,793	3,586	2,100	4,200
1300	1,655	3,310	1,938	3,877
1400	1,537	3,074	1,800	3,600
1500	1,434	2,869	1,680	3,360
1600	1,345	2,689	1,575	3,150
1700	1,266	2,531	1,482	2,965
1800	1,195	2,391	1,400	2,800
1900	1,132	2,265	1,326	2,653
2000	1,076	2,152	1,260	2,520
3000	0,717	1,434	0,840	1,680

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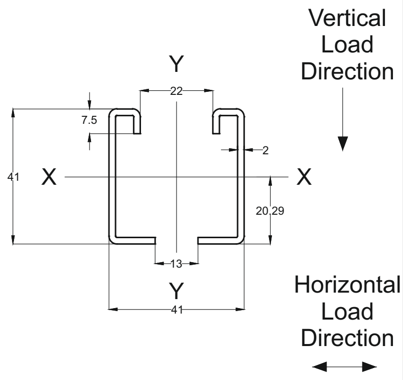
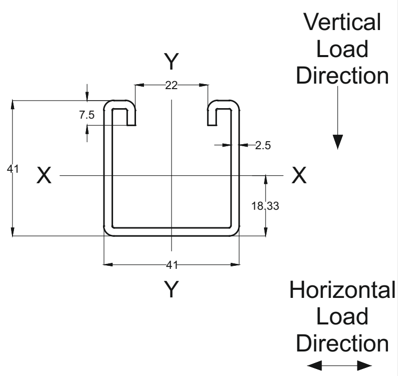
BR 453



Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	7,287	14,574	9,723	19,446
400	5,465	10,930	8,438	16,877
500	4,372	8,744	6,751	13,501
600	3,643	7,287	5,626	11,251
700	3,123	6,246	4,822	9,644
800	2,733	5,465	4,219	8,438
900	2,429	4,858	3,750	7,501
1000	2,186	4,372	3,375	6,751
1100	1,987	3,975	3,068	6,137
1200	1,822	3,643	2,813	5,626
1300	1,682	3,363	2,596	5,193
1400	1,561	3,123	2,411	4,822
1500	1,457	2,915	2,250	4,500
1600	1,366	2,733	2,110	4,219
1700	1,286	2,572	1,985	3,971
1800	1,214	2,429	1,875	3,750
1900	1,151	2,301	1,776	3,553
2000	1,093	2,186	1,688	3,375
3000	0,729	1,457	1,125	2,250

BR 453 Steel Section

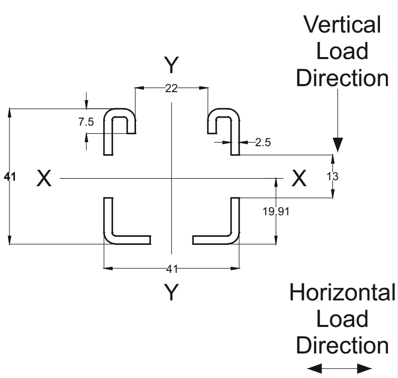
BR 461



Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	9,520	19,039	11,750	23,500
400	7,140	14,280	10,349	20,697
500	5,712	11,424	8,279	16,558
600	4,760	9,520	6,899	19,798
700	4,080	8,160	5,913	11,827
800	3,570	7,140	5,174	10,349
900	3,173	6,346	4,599	9,199
1000	2,856	5,712	4,139	8,279
1100	2,596	5,193	3,763	7,526
1200	2,380	4,760	4,450	6,899
1300	2,197	4,394	3,184	6,368
1400	2,040	4,080	2,957	5,913
1500	1,904	3,808	2,760	5,519
1600	1,785	3,570	2,587	5,174
1700	1,680	3,360	2,435	4,870
1800	1,587	3,173	2,300	4,599
1900	1,503	3,006	2,179	4,357
2000	1,428	2,856	2,070	4,139
3000	0,952	1,904	1,380	2,760

BR 461 Steel Section

BR 462



Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	8,719	17,438	10,174	20,348
400	6,539	13,079	7,631	15,261
500	5,231	10,463	6,104	12,209
600	4,360	8,719	5,087	10,174
700	3,737	7,473	4,360	8,721
800	3,270	6,539	3,815	7,631
900	2,906	5,813	3,391	6,783
1000	2,616	5,231	3,052	6,104
1100	2,378	4,756	2,775	5,550
1200	2,180	4,360	2,544	5,087
1300	2,012	4,024	2,348	4,696
1400	1,868	3,737	2,180	4,360
1500	1,744	3,488	2,035	4,070
1600	1,635	3,270	1,908	3,815
1700	1,539	3,077	1,795	3,591
1800	1,453	2,906	1,696	3,391
1900	1,377	2,753	1,606	3,213
2000	1,308	2,616	1,526	3,052
3000	0,872	1,744	1,017	2,035

BR 462 Steel Section

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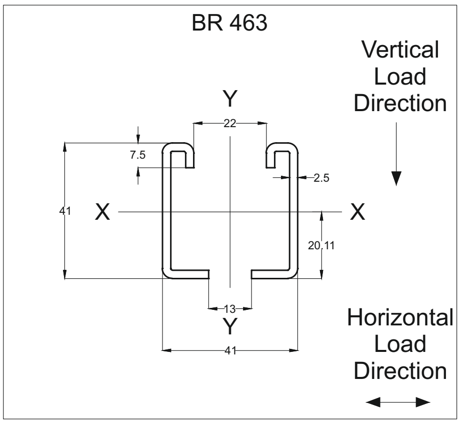
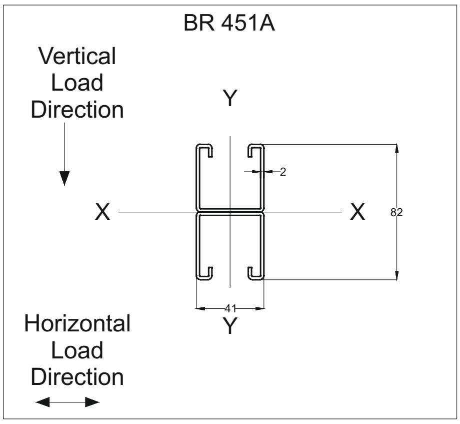
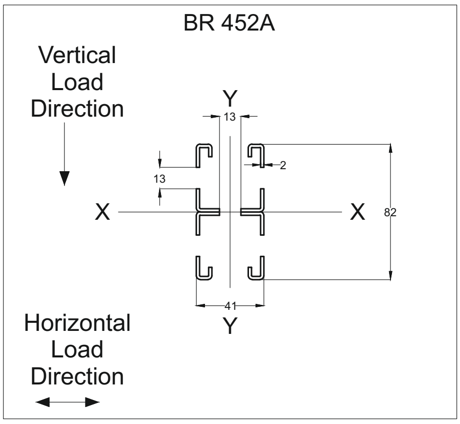


Length	BR 463 Steel Section Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	8,889	17,779	11,750	23,500
400	6,667	13,334	10,298	20,596
500	5,334	10,667	8,238	16,477
600	4,445	8,889	6,865	13,730
700	3,810	7,619	5,884	11,769
800	3,334	6,667	5,149	10,298
900	2,963	5,926	4,577	9,154
1000	2,667	5,334	4,119	8,238
1100	2,424	4,849	3,745	7,489
1200	2,222	4,445	3,433	6,865
1300	2,051	4,103	3,169	6,337
1400	1,905	3,810	2,942	5,884
1500	1,778	3,556	2,746	5,492
1600	1,667	3,334	2,574	5,149
1700	1,569	3,137	2,423	4,846
1800	1,482	2,963	2,288	4,577
1900	1,404	2,807	2,168	4,336
2000	1,333	2,667	2,060	4,119
3000	0,889	1,778	1,373	2,746



Length	BR 451A Steel Section Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	21,447	42,893	19,444	38,889
400	16,085	32,170	16,956	33,911
500	12,868	25,736	13,565	27,129
600	10,723	21,447	11,304	22,608
700	9,191	18,383	9,689	19,378
800	8,043	16,085	8,478	16,956
900	7,149	14,298	7,536	15,072
1000	6,434	12,868	6,782	13,565
1100	5,849	11,698	6,166	12,331
1200	5,362	10,723	5,652	11,304
1300	4,949	9,898	5,217	10,434
1400	4,596	9,191	4,844	9,689
1500	4,289	8,579	4,522	9,043
1600	4,021	8,043	4,239	8,478
1700	3,785	7,569	3,990	7,979
1800	3,574	7,149	3,768	7,536
1900	3,386	6,773	3,570	7,139
2000	3,217	6,434	3,391	6,782
3000	2,145	4,289	2,261	4,522



Length	BR 452A Steel Section Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	18,436	36,872	16,800	33,600
400	13,827	27,654	12,600	25,200
500	11,062	22,123	10,080	20,160
600	9,218	18,436	8,400	16,800
700	7,901	15,802	7,200	14,400
800	6,914	13,827	6,300	12,600
900	6,145	12,291	5,600	11,200
1000	5,531	11,062	5,040	10,080
1100	5,028	10,056	4,582	9,164
1200	4,609	9,218	4,200	8,400
1300	4,254	8,509	3,877	7,754
1400	3,951	7,901	3,600	7,200
1500	3,687	7,374	3,360	6,720
1600	3,457	6,914	3,150	6,300
1700	3,253	6,507	2,965	5,929
1800	3,073	6,145	2,800	5,600
1900	2,911	5,822	2,653	5,305
2000	2,765	5,531	2,520	5,040
3000	1,844	3,687	1,680	3,360

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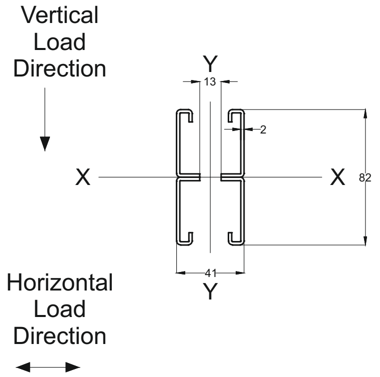
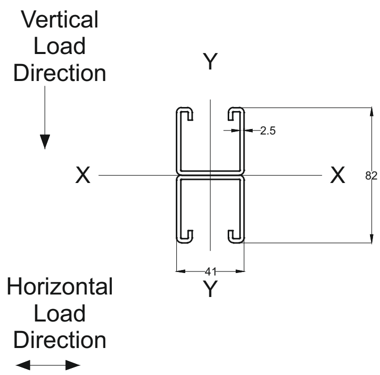
BR 453A



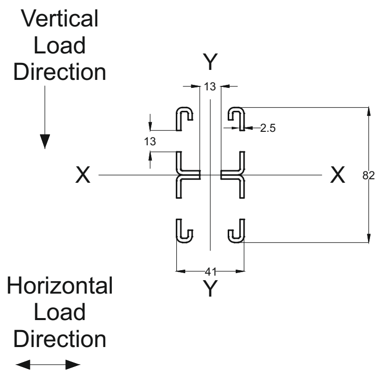
BR 453A Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concantrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	21,443	42,885	19,444	38,889
400	16,082	32,164	16,877	33,754
500	12,866	25,731	13,502	27,003
600	10,721	21,443	11,251	22,503
700	9,190	18,379	9,644	19,288
800	8,041	16,082	8,439	16,877
900	7,148	14,295	7,501	15,002
1000	6,433	12,866	6,751	13,502
1100	5,848	11,696	6,137	12,274
1200	5,361	10,721	5,626	11,251
1300	4,948	9,897	5,193	10,386
1400	4,595	9,190	4,822	9,644
1500	4,289	8,577	4,501	9,001
1600	4,021	8,041	4,219	8,439
1700	3,784	7,568	3,971	7,942
1800	3,574	7,148	3,750	7,501
1900	3,386	6,771	3,553	7,106
2000	3,216	6,433	3,375	6,751
3000	2,144	4,289	2,250	4,501

BR 461A



BR 461A Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concantrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	26,720	53,440	23,500	47,000
400	20,040	40,080	20,697	41,394
500	16,032	32,064	16,558	33,115
600	13,360	26,720	13,798	27,596
700	11,451	22,903	11,827	23,654
800	10,020	20,040	10,349	20,697
900	8,907	17,813	9,199	18,397
1000	8,016	16,032	8,279	16,558
1100	7,287	14,575	7,526	15,052
1200	6,680	13,360	6,899	13,798
1300	6,166	12,332	6,368	12,737
1400	5,726	11,451	5,913	11,827
1500	5,344	10,688	5,519	11,038
1600	5,010	10,020	5,174	10,349
1700	4,715	9,431	4,870	9,740
1800	4,453	8,907	4,599	9,199
1900	4,219	8,438	4,357	8,715
2000	4,008	8,016	4,139	8,279
3000	2,672	5,344	2,760	5,519

BR 462A



BR 462A Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concantrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	22,752	45,504	20,349	40,697
400	17,064	34,128	15,261	30,523
500	13,651	27,302	12,209	24,418
600	11,376	22,752	10,174	20,349
700	9,751	19,502	8,721	17,442
800	8,532	17,064	7,631	15,261
900	7,584	15,168	6,783	13,566
1000	6,826	13,651	6,105	12,209
1100	6,205	12,410	5,550	11,099
1200	5,688	11,376	5,087	10,174
1300	5,250	10,501	4,696	9,392
1400	4,875	9,751	4,360	8,721
1500	4,550	9,101	4,070	8,139
1600	4,266	8,532	3,815	7,631
1700	4,015	8,030	3,591	7,182
1800	3,792	7,584	3,391	6,783
1900	3,592	7,185	3,213	6,426
2000	3,413	6,826	3,052	6,105
3000	2,275	4,550	2,035	4,070

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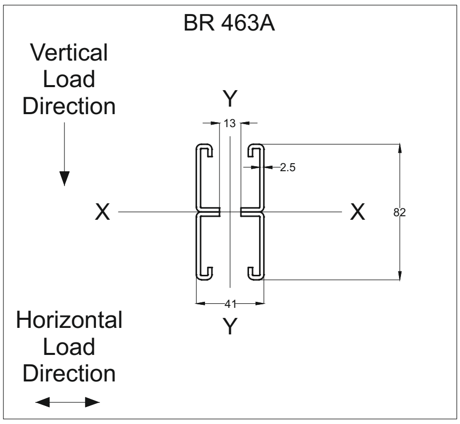
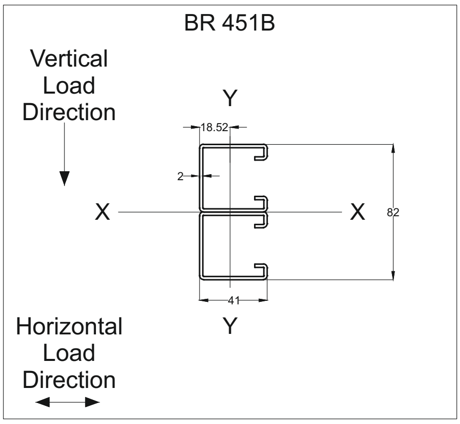
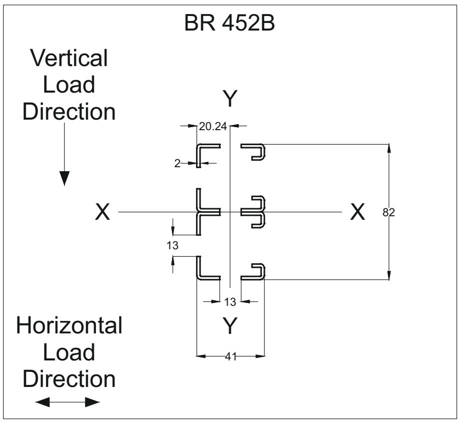


BR 463A Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concantrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	26,711	53,421	23,500	47,000
400	20,033	40,066	20,596	41,191
500	16,026	32,053	16,477	32,953
600	13,355	26,711	13,730	27,461
700	11,447	22,895	11,769	23,538
800	10,017	20,033	10,298	20,596
900	8,904	17,807	9,154	18,307
1000	8,013	16,026	8,238	16,477
1100	7,285	14,569	7,489	14,979
1200	6,678	13,355	6,865	13,730
1300	6,164	12,328	6,337	12,674
1400	5,724	11,447	5,884	11,769
1500	5,342	10,684	5,492	10,984
1600	5,008	10,017	5,149	10,298
1700	4,714	9,427	4,846	9,692
1800	4,452	8,904	4,577	9,154
1900	4,217	8,435	4,336	8,672
2000	4,007	8,013	4,119	8,238
3000	2,671	5,342	2,746	5,492



BR 451B Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concantrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	13,611	27,222	22,229	44,457
400	13,611	27,222	16,671	33,343
500	11,939	23,878	13,337	26,674
600	9,949	19,899	11,114	22,229
700	8,528	17,056	9,527	19,053
800	7,462	14,924	8,336	16,671
900	6,633	13,266	7,410	14,819
1000	5,970	11,939	6,669	13,337
1100	5,427	10,854	6,062	12,125
1200	4,975	9,949	5,557	11,114
1300	4,592	9,184	5,130	10,259
1400	4,264	8,528	4,763	9,527
1500	3,980	7,959	4,446	8,891
1600	3,731	7,462	4,168	8,336
1700	3,512	7,023	3,923	7,845
1800	3,316	6,633	3,705	7,410
1900	3,142	6,284	3,510	7,020
2000	2,985	5,970	3,334	6,669
3000	1,990	3,980	2,223	4,446



BR 452B Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concantrated	Distributed	Concantrated	Distributed
mm	kN	kN	kN	kN
300	13,611	27,222	20,491	40,983
400	10,920	21,840	15,369	30,737
500	8,736	17,472	12,295	24,590
600	7,280	14,560	10,246	20,491
700	6,240	12,480	8,782	17,564
800	5,460	10,920	7,684	15,369
900	4,853	9,707	6,830	13,661
1000	4,368	8,736	6,147	12,295
1100	3,971	7,942	5,589	11,177
1200	3,640	7,280	5,123	10,246
1300	3,360	6,720	4,729	9,458
1400	3,120	6,240	4,391	8,782
1500	2,912	5,824	4,098	8,197
1600	2,730	5,460	3,842	7,684
1700	2,569	5,139	3,616	7,232
1800	2,427	4,853	3,415	6,830
1900	2,299	4,598	3,235	6,471
2000	2,184	4,368	3,074	6,147
3000	1,456	2,912	2,049	4,098

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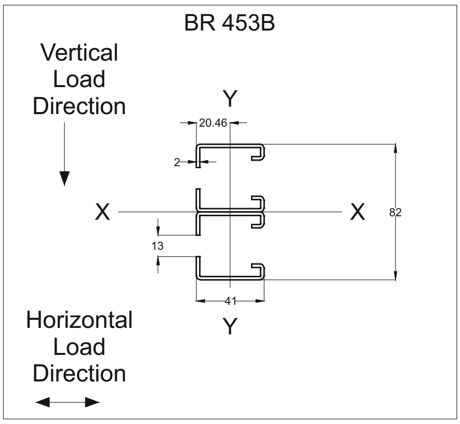
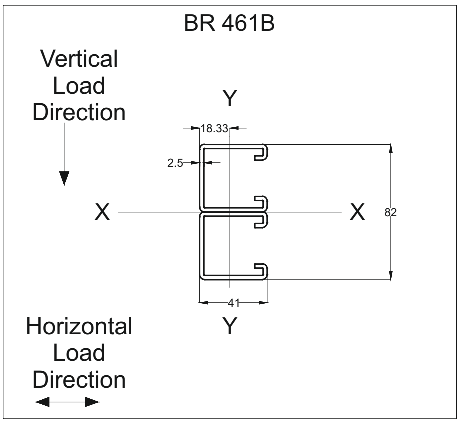
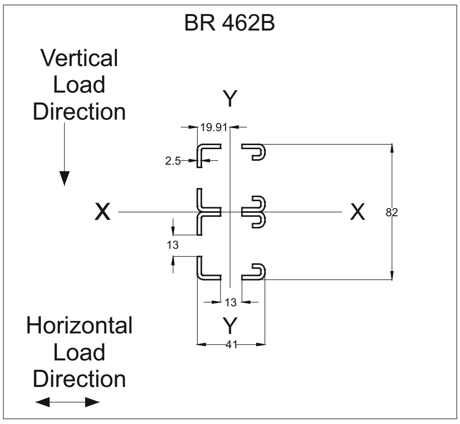


BR 453B Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	13,611	27,222	20,819	41,638
400	13,611	27,222	15,614	31,229
500	11,255	22,510	12,491	24,983
600	9,379	18,759	10,410	20,819
700	8,039	16,079	8,922	17,845
800	7,035	14,069	7,807	15,614
900	6,253	12,506	6,940	13,879
1000	5,628	11,255	6,246	12,491
1100	5,116	10,232	5,678	11,356
1200	4,690	9,379	5,205	10,410
1300	4,329	8,658	4,804	9,609
1400	4,020	8,039	4,461	8,922
1500	3,752	7,503	4,164	8,328
1600	3,517	7,035	3,904	7,807
1700	3,310	6,621	3,674	7,348
1800	3,126	6,253	3,470	6,940
1900	2,962	5,924	3,287	6,574
2000	2,814	5,628	3,123	6,246
3000	1,876	3,752	2,082	4,164



BR 461B Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	16,450	32,900	27,198	54,396
400	16,450	32,900	20,399	40,797
500	14,741	29,482	16,319	32,638
600	12,284	24,568	13,599	27,198
700	10,529	21,058	11,656	23,313
800	9,213	18,426	10,199	20,399
900	8,189	16,379	9,066	18,132
1000	7,370	14,741	8,159	16,319
1100	6,700	13,401	7,418	14,835
1200	6,142	12,284	6,800	13,599
1300	5,670	11,339	6,276	12,553
1400	5,265	10,529	5,828	11,656
1500	4,914	9,827	5,440	10,879
1600	4,607	9,213	5,100	10,199
1700	4,336	8,671	4,800	9,599
1800	4,095	8,189	4,533	9,066
1900	3,879	7,758	4,294	8,589
2000	3,685	7,370	4,080	8,159
3000	2,457	4,914	2,720	5,440



BR 462B Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	16,450	32,900	24,912	49,825
400	13,352	26,704	18,684	37,369
500	10,682	21,363	14,947	29,895
600	8,901	17,803	12,456	24,912
700	7,630	15,259	10,677	21,353
800	6,676	13,352	9,342	18,684
900	5,934	11,868	8,304	16,608
1000	5,341	10,682	7,474	14,947
1100	4,855	9,711	6,794	13,589
1200	4,451	8,901	6,228	12,456
1300	4,108	8,217	5,749	11,498
1400	3,815	7,630	5,338	10,677
1500	3,561	7,121	4,982	9,965
1600	3,338	6,676	4,671	9,342
1700	3,142	6,283	4,396	8,793
1800	2,967	5,934	4,152	8,304
1900	2,811	5,622	3,934	7,867
2000	2,670	5,341	3,737	7,474
3000	1,780	3,561	2,491	4,982

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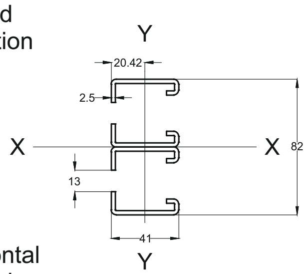
STEP 6

BR 463B

Vertical Load Direction



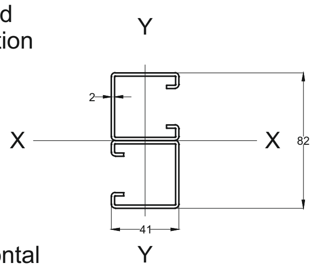
Horizontal Load Direction

Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	16,450	32,900	25,398	50,796
400	16,450	32,900	19,049	38,097
500	13,866	27,733	15,239	30,478
600	11,555	23,111	12,699	25,398
700	9,905	19,809	10,885	21,770
800	8,667	17,333	9,524	19,049
900	7,704	15,407	8,466	16,932
1000	6,933	13,866	7,619	15,239
1100	6,303	12,606	6,927	13,854
1200	5,778	11,555	6,350	12,699
1300	5,333	10,666	5,861	11,722
1400	4,952	9,905	5,442	10,885
1500	4,622	9,244	5,080	10,159
1600	4,333	8,667	4,762	9,524
1700	4,078	8,157	4,482	8,964
1800	3,852	7,704	4,233	8,466
1900	3,649	7,298	4,010	8,020
2000	3,467	6,933	3,810	7,619
3000	2,311	4,622	2,540	5,080

BR 463B Steel Section

BR 451C

Vertical Load Direction



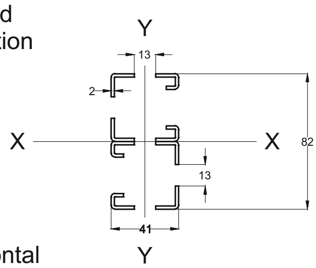
Horizontal Load Direction

Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	13,611	27,222	20,642	41,284
400	13,611	27,222	15,481	30,963
500	11,939	23,878	12,385	24,770
600	9,949	19,899	10,321	20,642
700	8,528	17,056	8,847	17,693
800	7,462	14,924	7,741	15,481
900	6,633	13,266	6,881	13,761
1000	5,970	11,939	6,193	12,385
1100	5,427	10,854	5,630	11,259
1200	4,975	9,949	5,160	10,321
1300	4,592	9,184	4,764	9,527
1400	4,264	8,528	4,423	8,847
1500	3,980	7,959	4,128	8,257
1600	3,731	7,462	3,870	7,741
1700	3,512	7,023	3,643	7,285
1800	3,316	6,633	3,440	6,881
1900	3,142	6,284	3,259	6,518
2000	2,985	5,970	3,096	6,193
3000	1,990	3,980	2,064	4,128

BR 451C Steel Section

BR 452C

Vertical Load Direction



Horizontal Load Direction

Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	13,611	27,222	17,276	34,552
400	10,920	21,840	12,957	25,914
500	8,736	17,472	10,366	20,731
600	7,280	14,560	8,638	17,276
700	6,240	12,480	7,404	14,808
800	5,460	10,920	6,479	12,957
900	4,853	9,707	5,759	11,517
1000	4,368	8,736	5,183	10,366
1100	3,971	7,942	4,712	9,423
1200	3,640	7,280	4,319	8,638
1300	3,360	6,720	3,987	7,974
1400	3,120	6,240	3,702	7,404
1500	2,912	5,824	3,455	6,910
1600	2,730	5,460	3,239	6,479
1700	2,569	5,139	3,049	6,097
1800	2,427	4,853	2,879	5,759
1900	2,299	4,598	2,728	5,456
2000	2,184	4,368	2,591	5,183
3000	1,456	2,912	1,728	3,455

BR 452C Steel Section

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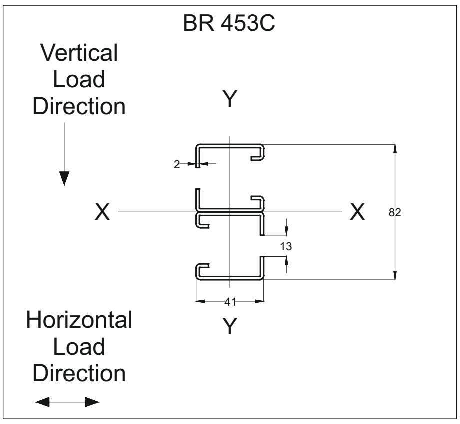
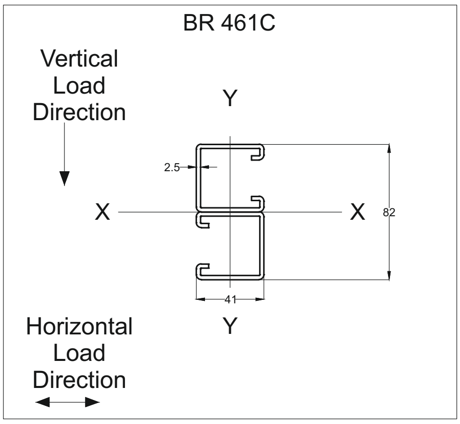


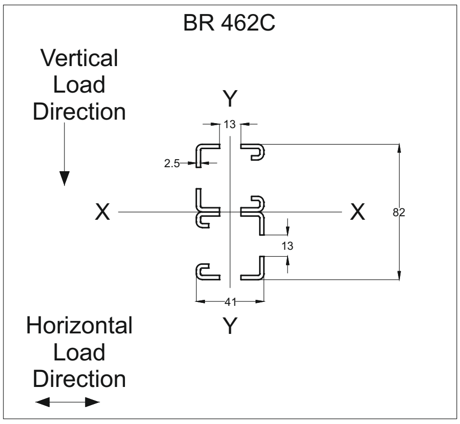
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	13,611	27,222	17,509	35,017
400	13,611	27,222	13,131	26,263
500	11,255	22,510	10,505	21,010
600	9,379	18,759	8,754	17,509
700	8,039	16,079	7,504	15,007
800	7,035	14,069	6,566	13,131
900	6,253	12,506	5,836	11,672
1000	5,628	11,255	5,253	10,505
1100	5,116	10,232	4,775	9,550
1200	4,690	9,379	4,377	8,754
1300	4,329	8,658	4,040	8,081
1400	4,020	8,039	3,752	7,504
1500	3,752	7,503	3,502	7,003
1600	3,517	7,035	3,283	6,566
1700	3,310	6,621	3,090	6,179
1800	3,126	6,253	2,918	5,836
1900	2,962	5,924	2,765	5,529
2000	2,814	5,628	2,626	5,253
3000	1,876	3,752	1,751	3,502

BR 453C Steel Section



BR 461C Steel Section

Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	16,450	32,900	25,379	50,758
400	16,450	32,900	19,034	38,069
500	14,741	29,482	15,227	30,455
600	12,284	24,568	12,690	25,379
700	10,529	21,058	10,877	21,753
800	9,213	18,426	9,517	19,034
900	8,189	16,379	8,460	16,919
1000	7,370	14,741	7,614	15,227
1100	6,700	13,401	6,922	13,843
1200	6,142	12,284	6,345	12,690
1300	5,670	11,339	5,857	11,713
1400	5,265	10,529	5,438	10,877
1500	4,914	9,827	5,076	10,152
1600	4,607	9,213	4,759	9,517
1700	4,336	8,671	4,479	8,957
1800	4,095	8,189	4,230	8,460
1900	3,879	7,758	4,007	8,014
2000	3,685	7,370	3,807	7,614
3000	2,457	4,914	2,538	5,076



BR 462C Steel Section

Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	16,450	32,900	21,389	42,777
400	13,352	26,704	16,041	32,083
500	10,682	21,363	12,833	25,666
600	8,901	17,803	10,694	21,389
700	7,630	15,259	9,167	18,333
800	6,676	13,352	8,021	16,041
900	5,934	11,868	7,130	14,259
1000	5,341	10,682	6,417	12,833
1100	4,855	9,711	5,833	11,666
1200	4,451	8,901	5,347	10,694
1300	4,108	8,217	4,936	9,872
1400	3,815	7,630	4,583	9,167
1500	3,561	7,121	4,278	8,555
1600	3,338	6,676	4,010	8,021
1700	3,142	6,283	3,774	7,549
1800	2,967	5,934	3,565	7,130
1900	2,811	5,622	3,377	6,754
2000	2,670	5,341	3,208	6,417
3000	1,780	3,561	2,139	4,278

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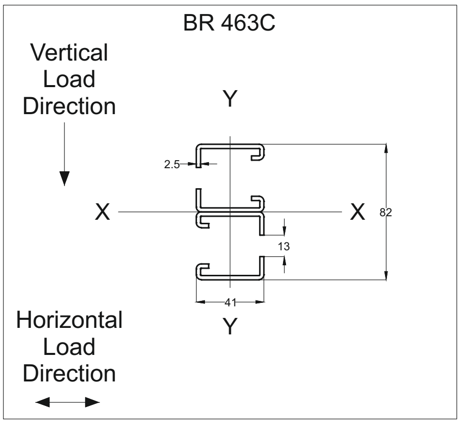
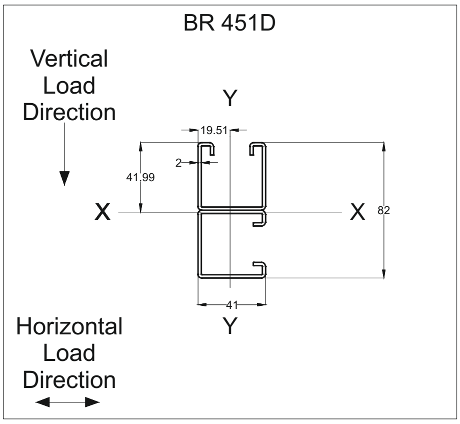
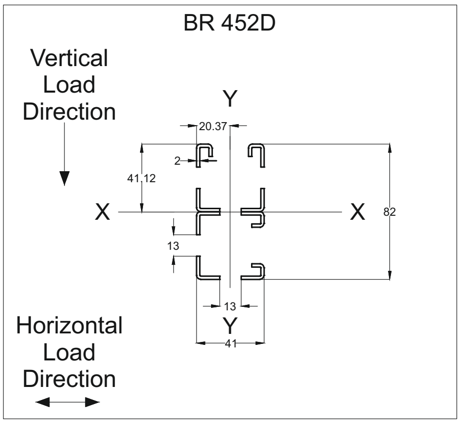


BR 463C Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	16,450	32,900	21,389	42,777
400	16,450	32,900	16,041	32,083
500	13,866	27,733	12,833	25,666
600	11,555	23,111	10,694	21,389
700	9,905	19,809	9,167	18,333
800	8,667	17,333	8,021	16,041
900	7,704	15,407	7,130	14,259
1000	6,933	13,866	6,417	12,833
1100	6,303	12,606	5,833	11,666
1200	5,778	11,555	5,347	10,694
1300	5,333	10,666	4,936	9,872
1400	4,952	9,905	4,583	9,167
1500	4,622	9,244	4,278	8,555
1600	4,333	8,667	4,010	8,021
1700	4,078	8,157	3,774	7,549
1800	3,852	7,704	3,565	7,130
1900	3,649	7,298	3,377	6,754
2000	3,467	6,933	3,208	6,417
3000	2,311	4,622	2,139	4,278



BR 451D Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	20,417	40,834	21,615	43,230
400	17,445	34,890	16,211	32,423
500	13,956	27,912	12,969	25,938
600	11,630	23,260	10,808	21,615
700	9,969	19,937	9,264	18,527
800	8,723	17,445	8,106	16,211
900	7,753	15,507	7,205	14,410
1000	6,978	13,956	6,485	12,969
1100	6,344	12,687	5,895	11,790
1200	5,815	11,630	5,404	10,808
1300	5,368	10,735	4,988	9,976
1400	4,984	9,969	4,632	9,264
1500	4,652	9,304	4,323	8,646
1600	4,361	8,723	4,053	8,106
1700	4,105	8,209	3,814	7,629
1800	3,877	7,753	3,603	7,205
1900	3,673	7,345	3,413	6,826
2000	3,489	6,978	3,242	6,485
3000	2,326	4,652	2,162	4,323



BR 452D Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	18,769	37,539	17,758	35,516
400	14,077	28,154	13,319	26,637
500	11,262	22,523	10,655	21,310
600	9,385	18,769	8,879	17,758
700	8,044	16,088	7,611	15,221
800	7,039	14,077	6,659	13,319
900	6,256	12,513	5,919	11,839
1000	5,631	11,262	5,327	10,655
1100	5,119	10,238	4,843	9,686
1200	4,692	9,385	4,440	8,879
1300	4,331	8,663	4,098	8,196
1400	4,022	8,044	3,805	7,611
1500	3,754	7,508	3,552	7,103
1600	3,519	7,039	3,330	6,659
1700	3,312	6,624	3,134	6,268
1800	3,128	6,256	2,960	5,919
1900	2,964	5,927	2,804	5,608
2000	2,815	5,631	2,664	5,327
3000	1,877	3,754	1,776	3,552

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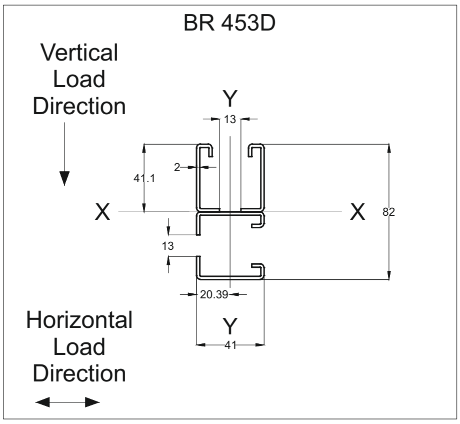
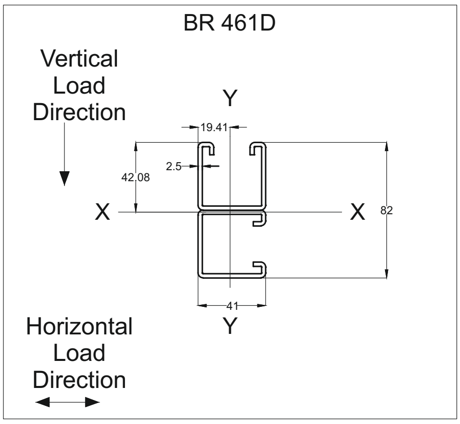
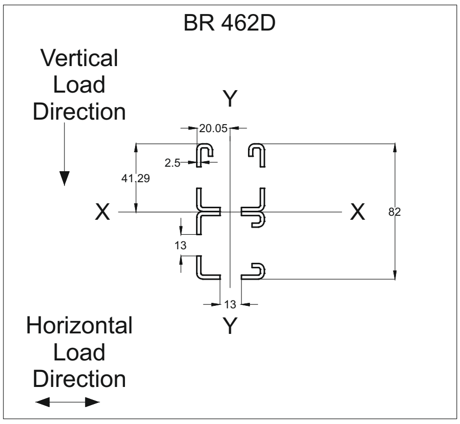
STEP 6



Length	BR 453D Steel Section			
	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	20,417	40,834	21,015	42,030
400	17,285	34,570	15,761	31,523
500	13,828	27,656	12,609	25,218
600	11,523	23,047	10,508	21,015
700	9,877	19,754	9,007	18,013
800	8,643	17,285	7,881	15,761
900	7,682	15,364	7,005	14,010
1000	6,914	13,828	6,305	12,609
1100	6,285	12,571	5,731	11,463
1200	5,762	11,523	5,254	10,508
1300	5,318	10,637	4,850	9,699
1400	4,939	9,877	4,503	9,007
1500	4,609	9,219	4,203	8,406
1600	4,321	8,643	3,940	7,881
1700	4,067	8,134	3,709	7,417
1800	3,841	7,682	3,503	7,005
1900	3,639	7,278	3,318	6,636
2000	3,457	6,914	3,152	6,305
3000	2,305	4,609	2,102	4,203



Length	BR 461D Steel Section			
	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	24,670	49,340	26,627	53,253
400	21,913	43,826	19,970	39,940
500	17,530	35,061	15,976	31,952
600	14,609	29,217	13,313	26,627
700	12,522	25,043	11,411	22,823
800	10,957	21,913	9,985	19,970
900	9,739	19,478	8,876	17,751
1000	8,765	17,530	7,988	15,976
1100	7,968	15,937	7,262	14,524
1200	7,304	14,609	6,657	13,313
1300	6,742	13,485	6,145	12,289
1400	6,261	12,522	5,706	11,411
1500	5,843	11,687	5,325	10,651
1600	5,478	10,957	4,993	9,985
1700	5,156	10,312	4,699	9,398
1800	4,870	9,739	4,438	8,876
1900	4,613	9,227	4,204	8,408
2000	4,383	8,765	3,994	7,988
3000	2,922	5,843	2,663	5,325



Length	BR 462D Steel Section			
	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	23,327	46,653	21,693	43,387
400	17,495	34,990	16,270	32,540
500	13,996	27,992	13,016	26,032
600	11,663	23,327	10,847	21,693
700	9,997	19,994	9,297	18,594
800	8,748	17,495	8,135	16,270
900	7,776	15,551	7,231	14,462
1000	6,998	13,996	6,508	13,016
1100	6,362	12,724	5,916	11,833
1200	5,832	11,663	5,423	10,847
1300	5,383	10,766	5,006	10,012
1400	4,999	9,997	4,649	9,297
1500	4,665	9,331	4,339	8,677
1600	4,374	8,748	4,068	8,135
1700	4,116	8,233	3,828	7,656
1800	3,888	7,776	3,616	7,231
1900	3,683	7,366	3,425	6,851
2000	3,499	6,998	3,254	6,508
3000	2,333	4,665	2,169	4,339

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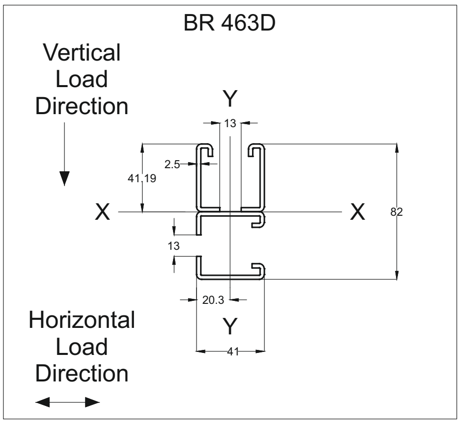
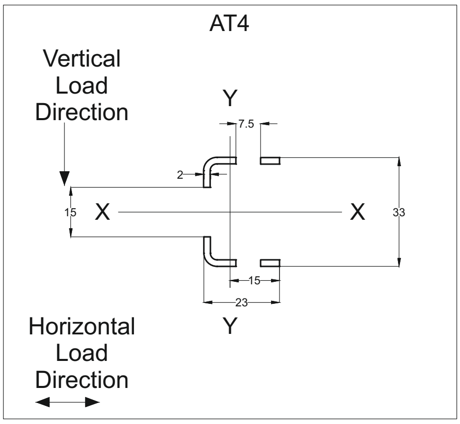
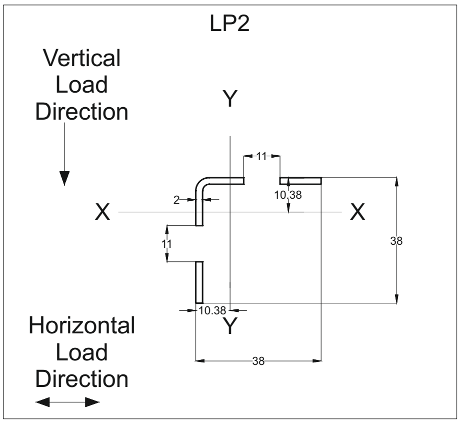


BR 463D Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	24,670	49,340	25,851	51,703
400	21,686	43,372	19,389	38,777
500	17,349	34,698	15,511	31,022
600	14,457	28,915	12,926	25,851
700	12,392	24,784	11,079	22,158
800	10,843	21,686	9,694	19,389
900	9,638	19,276	8,617	17,234
1000	8,674	17,349	7,755	15,511
1100	7,886	15,772	7,050	14,101
1200	7,229	14,457	6,463	12,926
1300	6,673	13,345	5,966	11,931
1400	6,196	12,392	5,540	11,079
1500	5,783	11,566	5,170	10,341
1600	5,422	10,843	4,847	9,694
1700	5,103	10,205	4,562	9,124
1800	4,819	9,638	4,309	8,617
1900	4,565	9,131	4,082	8,164
2000	4,337	8,674	3,878	7,755
3000	2,891	5,783	2,585	5,170



AT4 Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	1,851	3,702	0,954	1,908
400	1,388	2,776	0,715	1,431
500	1,111	2,221	0,572	1,145
600	0,925	1,851	0,477	0,954
700	0,793	1,587	0,409	0,818
800	0,694	1,388	0,358	0,715
900	0,617	1,234	0,318	0,636
1000	0,555	1,111	0,286	0,572
1100	0,505	1,010	0,260	0,520
1200	0,463	0,925	0,238	0,477
1300	0,427	0,854	0,220	0,440
1400	0,397	0,793	0,204	0,409
1500	0,370	0,740	0,191	0,382
1600	0,347	0,694	0,179	0,358
1700	0,327	0,653	0,168	0,337
1800	0,308	0,617	0,159	0,318
1900	0,292	0,585	0,151	0,301
2000	0,278	0,555	0,143	0,286
3000	0,185	0,370	0,095	0,191



LP2 Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	0,902	1,804	1,288	2,577
400	0,676	1,353	0,966	1,933
500	0,541	1,082	0,773	1,546
600	0,451	0,902	0,644	1,288
700	0,387	0,773	0,552	1,104
800	0,338	0,676	0,483	0,966
900	0,301	0,601	0,429	0,859
1000	0,271	0,541	0,387	0,773
1100	0,246	0,492	0,351	0,703
1200	0,225	0,451	0,322	0,644
1300	0,208	0,416	0,297	0,595
1400	0,193	0,387	0,276	0,552
1500	0,180	0,361	0,258	0,515
1600	0,169	0,338	0,242	0,483
1700	0,159	0,318	0,227	0,455
1800	0,150	0,301	0,215	0,429
1900	0,142	0,285	0,203	0,407
2000	0,135	0,271	0,193	0,387
3000	0,090	0,180	0,129	0,258

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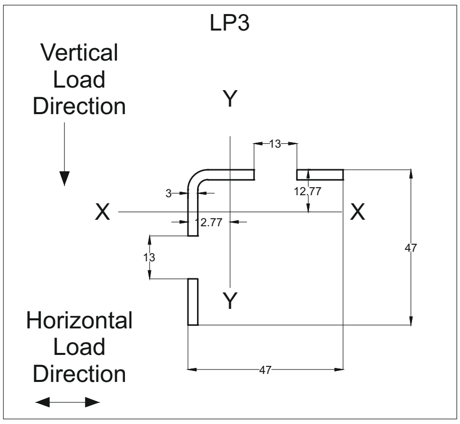
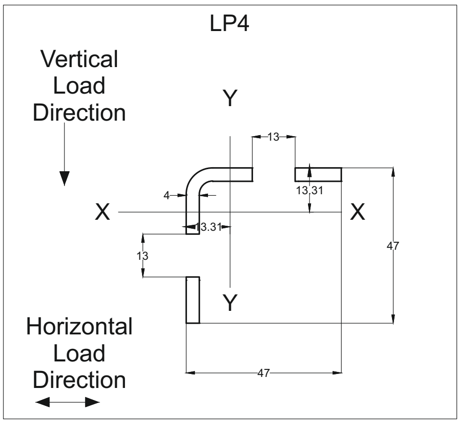
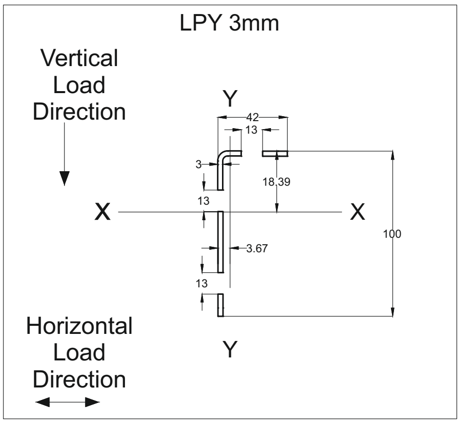


Length	LP3 Steel Section Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	2,685	5,370	3,836	7,672
400	2,014	4,028	2,877	5,754
500	1,611	3,222	2,301	4,603
600	1,343	2,685	1,918	3,836
700	1,151	2,301	1,644	3,288
800	1,007	2,014	1,438	2,877
900	0,895	1,790	1,279	2,557
1000	0,806	1,611	1,151	2,301
1100	0,732	1,465	1,046	2,092
1200	0,671	1,343	0,959	1,918
1300	0,620	1,239	0,885	1,770
1400	0,575	1,151	0,822	1,644
1500	0,537	1,074	0,767	1,534
1600	0,503	1,007	0,719	1,438
1700	0,474	0,948	0,677	1,354
1800	0,448	0,895	0,639	1,279
1900	0,424	0,848	0,606	1,211
2000	0,403	0,806	0,575	1,151
3000	0,269	0,537	0,384	0,767



Length	LP4 Steel Section Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	3,509	7,017	5,012	10,024
400	2,631	5,263	3,759	7,518
500	2,105	4,210	3,007	6,015
600	1,754	3,509	2,506	5,012
700	1,504	3,007	2,148	4,296
800	1,316	2,631	1,880	3,759
900	1,170	2,339	1,671	3,341
1000	1,053	2,105	1,504	3,007
1100	0,957	1,914	1,367	2,734
1200	0,877	1,754	1,253	2,506
1300	0,810	1,619	1,157	2,313
1400	0,752	1,504	1,074	2,148
1500	0,702	1,403	1,002	2,005
1600	0,658	1,316	0,940	1,880
1700	0,619	1,238	0,885	1,769
1800	0,585	1,170	0,835	1,671
1900	0,554	1,108	0,791	1,583
2000	0,526	1,053	0,752	1,504
3000	0,351	0,702	0,501	1,002



Length	LPY-3mm Steel Section Allowable Vertical Load		Allowable Horizontel Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	6,618	13,237	3,194	6,388
400	4,964	9,928	2,396	4,791
500	3,971	7,942	1,916	3,833
600	3,309	6,618	1,597	3,194
700	2,836	5,673	1,369	2,738
800	2,482	4,964	1,198	2,396
900	2,206	4,412	1,065	2,129
1000	1,986	3,971	0,958	1,916
1100	1,805	3,610	0,871	1,742
1200	1,655	3,309	0,799	1,597
1300	1,527	3,055	0,737	1,474
1400	1,418	2,836	0,684	1,369
1500	1,324	2,647	0,639	1,278
1600	1,241	2,482	0,599	1,198
1700	1,168	2,336	0,564	1,127
1800	1,103	2,206	0,532	1,065
1900	1,045	2,090	0,504	1,009
2000	0,993	1,986	0,479	0,958
3000	0,662	1,324	0,319	0,639

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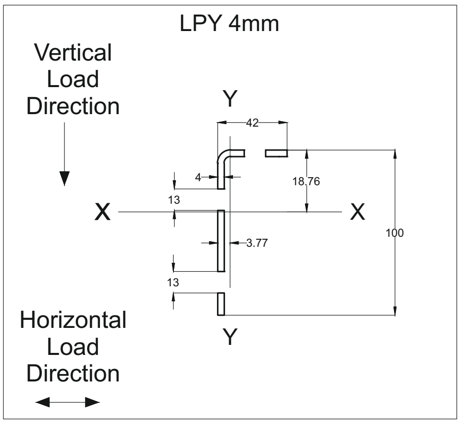
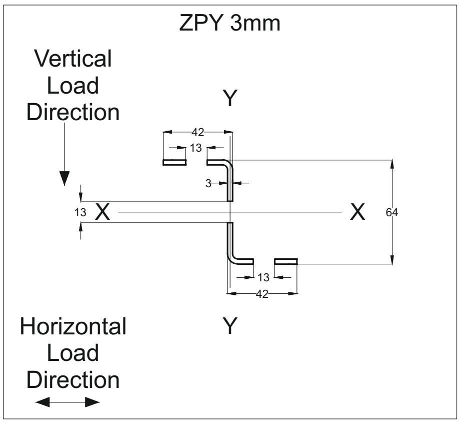
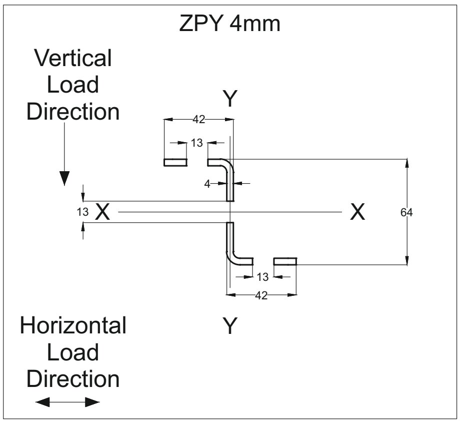


Length	LPY-4mm Steel Section Allowable Vertical Load		Allowable Horizontel Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	12,844	25,687	4,184	8,368
400	9,633	19,265	3,138	6,276
500	7,706	15,412	2,511	5,021
600	6,422	12,844	2,092	4,184
700	5,504	11,009	1,793	3,586
800	4,816	9,633	1,569	3,138
900	4,281	8,562	1,395	2,789
1000	3,853	7,706	1,255	2,511
1100	3,503	7,006	1,141	2,282
1200	3,211	6,422	1,046	2,092
1300	2,964	5,928	0,966	1,931
1400	2,752	5,504	0,897	1,793
1500	2,569	5,137	0,837	1,674
1600	2,408	4,816	0,785	1,569
1700	2,267	4,533	0,738	1,477
1800	2,141	4,281	0,697	1,395
1900	2,028	4,056	0,661	1,321
2000	1,927	3,853	0,628	1,255
3000	1,284	2,569	0,418	0,837



Length	ZPY-3mm Steel Section Allowable Vertical Load		Allowable Horizontel Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	11,284	22,569	6,549	13,099
400	8,463	16,927	4,912	9,824
500	6,771	13,541	3,930	7,859
600	5,642	11,284	3,275	6,549
700	4,836	9,672	2,807	5,614
800	4,232	8,463	2,456	4,912
900	3,761	7,523	2,183	4,366
1000	3,385	6,771	1,965	3,930
1100	3,078	6,155	1,786	3,572
1200	2,821	5,642	1,637	3,275
1300	2,604	5,208	1,511	3,023
1400	2,418	4,836	1,403	2,807
1500	2,257	4,514	1,310	2,620
1600	2,116	4,232	1,228	2,456
1700	1,991	3,983	1,156	2,312
1800	1,881	3,761	1,092	2,183
1900	1,782	3,563	1,034	2,068
2000	1,693	3,385	0,982	1,965
3000	1,128	2,257	0,655	1,310



Length	ZPY-4mm Steel Section Allowable Vertical Load		Allowable Horizontel Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	14,012	28,024	8,558	17,116
400	10,509	21,018	6,419	12,837
500	8,407	16,814	5,135	10,270
600	7,006	14,012	4,279	8,558
700	6,005	12,010	3,668	7,336
800	5,255	10,509	3,209	6,419
900	4,671	9,341	2,853	5,705
1000	4,204	8,407	2,567	5,135
1100	3,821	7,643	2,334	4,668
1200	3,503	7,006	2,140	4,279
1300	3,234	6,467	1,975	3,950
1400	3,003	6,005	1,834	3,668
1500	2,802	5,605	1,712	3,423
1600	2,627	5,255	1,605	3,209
1700	2,473	4,945	1,510	3,021
1800	2,335	4,671	1,426	2,853
1900	2,212	4,425	1,351	2,703
2000	2,102	4,204	1,284	2,567
3000	1,401	2,802	0,856	1,712

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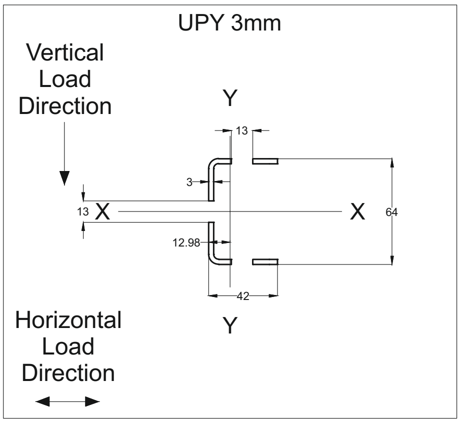
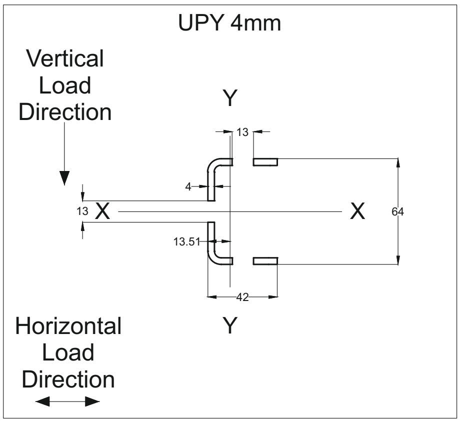


UPY-3mm Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	12,941	25,883	5,835	11,670
400	9,706	19,412	4,376	8,753
500	7,765	15,530	3,501	7,002
600	6,471	12,941	2,918	5,835
700	5,546	11,093	2,501	5,001
800	4,853	9,706	2,188	4,376
900	4,314	8,628	1,945	3,890
1000	3,882	7,765	1,751	3,501
1100	3,529	7,059	1,591	3,183
1200	3,235	6,471	1,459	2,918
1300	2,986	5,973	1,347	2,693
1400	2,773	5,546	1,250	2,501
1500	2,588	5,177	1,167	2,334
1600	2,427	4,853	1,094	2,188
1700	2,284	4,568	1,030	2,059
1800	2,157	4,314	0,973	1,945
1900	2,043	4,087	0,921	1,843
2000	1,941	3,882	0,875	1,751
3000	1,294	2,588	0,584	1,167



UPY-4mm Steel Section				
Length	Allowable Vertical Load		Allowable Horizontal Seismic Load	
	Concentrated	Distributed	Concentrated	Distributed
mm	kN	kN	kN	kN
300	17,427	34,853	7,600	15,200
400	13,070	26,140	5,700	11,400
500	10,456	20,912	4,560	9,120
600	8,713	17,427	3,800	7,600
700	7,469	14,937	3,257	6,514
800	6,535	13,070	2,850	5,700
900	5,809	11,618	2,533	5,067
1000	5,228	10,456	2,280	4,560
1100	4,753	9,505	2,073	4,145
1200	4,357	8,713	1,900	3,800
1300	4,022	8,043	1,754	3,508
1400	3,734	7,469	1,629	3,257
1500	3,485	6,971	1,520	3,040
1600	3,268	6,535	1,425	2,850
1700	3,075	6,151	1,341	2,682
1800	2,904	5,809	1,267	2,533
1900	2,752	5,503	1,200	2,400
2000	2,614	5,228	1,140	2,280
3000	1,743	3,485	0,760	1,520

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STEP 7

Determining Rod

Tensional loading of trapeze rods should be determined by following calculation:

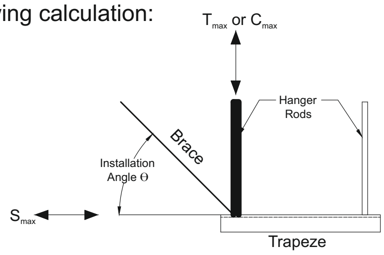
$T_{max} = [\frac{D+0.7F_V}{2} + (F_{Ptmax} \times 0.7 \times \tan\Theta)]$

Compression loading of trapeze rods should be determined by following calculation:

$C_{max} = [\frac{D-0.7F}{2} - (F_{Ptmax} \times 0.7 \times \tan\Theta)]$

Shear load of trapeze rods should be determined by following calculation:

$S_{max} = F_{Ptmax} \times 0.7$



T_{max} : Maximum rod tension.
C_{max} : Maximum rod compression.
S_{max} : Maximum rod shear.
D : Component operating weight (operating vertical load,dead load).
F_{Ptmax} : Maximum transverse (lateral) seismic design force.
F_V : Vertical sysmic design force.
$\tan\Theta$: Tangent of installation angle.

Rod Size	Allowable Tension Load	Allowable Compression Load l/r <200	Allowable Seismic Load tension or compression	Allowable Shear Load for rod-brace fix point
mm	kN	kN	kN	kN
M8	1.64	0.83	2.18	10.4
M10	2.6	1.11	3.45	16.26
M12	3.8	1.58	5.05	23.11

Combined loads should satisfy below calculation:

$$\frac{T_{max} \text{ or } C_{max}}{\text{Allowable seismic load}} + \frac{S_{max}}{\text{Allowable shear load}} \leqslant 1$$

Example 6:

Installation angle for system described in example 5 is 45 degrees. Rod loads are:

T_{max} = [(1.015+0.7x0.224)/2+(4.518x0.7x1)] = 3.748 kN's.
C_{max} = [(1.015-0.7x0.224)/2-(4.518x0.7x1)] = -2.74 kN's , compression exists.
S_{max} = 4.518x0.7=3.163 kN's.

$\frac{3.748}{5.05} + \frac{3.163}{23.11} = 0.88 < 1$, M12 Rod is ok.

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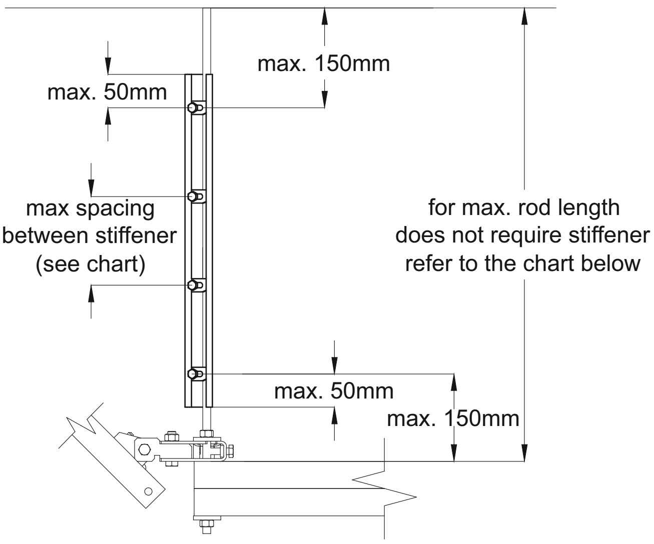
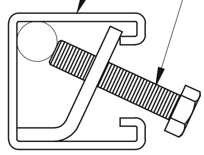
STEP 8

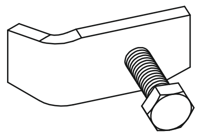
Determining Rod Stiffener

If threaded rod length exceed the values of table below, rod stiffeners should be used in order to prevent rod from buckling.





Up to M20 Rod Sizes



Rod Size	Max. Rod Length Without Stiffener	Max. Spacing Between Stiffener
M 8	300 mm	225 mm
M 10	475 mm	325 mm
M 12	625 mm	450 mm
M 16	775 mm	575 mm
M 20	925 mm	700 mm

Rod stiffeners are required only on hanger and trapeze assemblies that have seismic bracing attached at or within 100mm of the rod. A minimum of two stiffeners must be installed.

*Recommended Torque is 10.8 Nm (or finger tight plus one full turn with a wrench).

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STEP 9

Determining Brace Installation

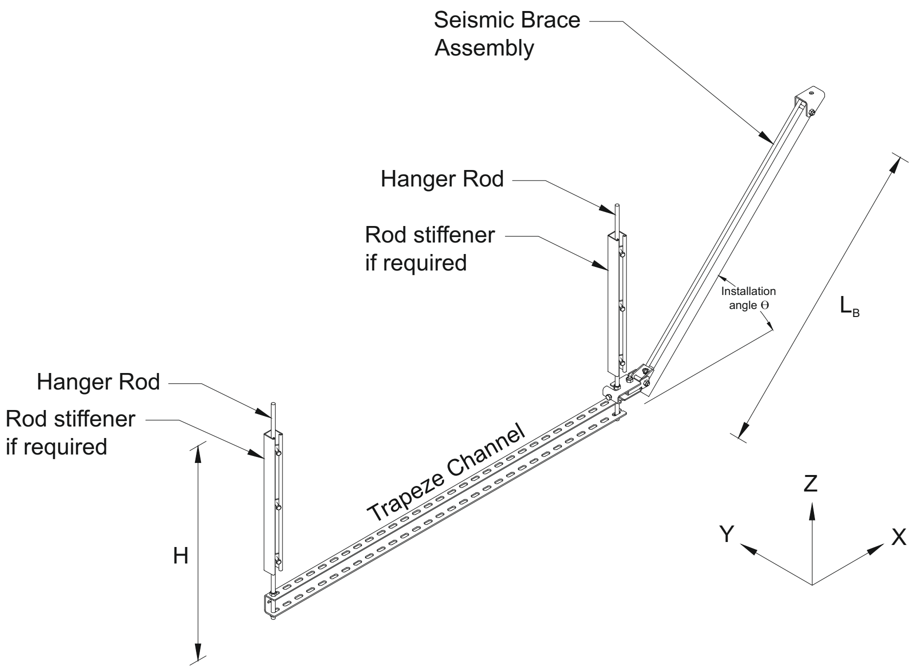
In order to determine brace installation, following values must be specified.

L_B : Brace section length must be determined. In case of brace and rod anchored to ceiling, brace length can be calculated by the total rod length (H) divided by cosine of the installation angle(Θ).

If brace is planning to be attached other than ceiling keep in mind;

- Brace should be attached to a structural component.
- Do not attach brace to a different structural component than trapeze assembly. ie. ceiling and wall.
- In case of brace attached to wall, proper wall anchorage should be done by using right anchors.
- In case of brace attached to a steel beam, right attachment tool should be provided. Refer step 12 for steel beam attachments.

Installation angle should also be provided. Optimum installation angle is 45°, but the design of the brace permits 35° to 70° of installation angle.



Robert E. Simmons, P.E. STATE OF TEXAS ROBERT EDWARD SIMMONS 71979 REGISTERED PROFESSIONAL ENGINEER 10/1/13 Professional Eng. TX No. 71979 Petra Seismic Design, LLC www.petraseismicdesign.com	Robert E. Simmons, PE, Petra Seismic Design, LLC has reviewed this drawing for compliance with the IBC and accepted engineering practice for non-structural seismic restraint components. Only the components are verified to meet published design strengths if installed per this manual. Users of this document assume all risk and liability. Restraint level, selection, location and layout must be approved by a seismic design professional. The registered design professionals for Mechanical, Electrical, Plumbing, Fire and Structural are responsible for their pertinent design scope. Structural engineer must approve loads applied to the structure. Drawings, and/or comments shall not be construed as directing the Contractor from complying with project plans and specifications, nor departures there from. Neither EAE, PSD, or Robert Simmons are the project design professionals.	E-LINE SEISMIC Akcaburgaz Mahallesi, 3114. Sokak, No:10 34522 Esenyurt-Istanbul-TURKEY Tel: +90 (212) 866 20 00 Fax: +90 (212) 886 24 20 www.eae.com.tr	
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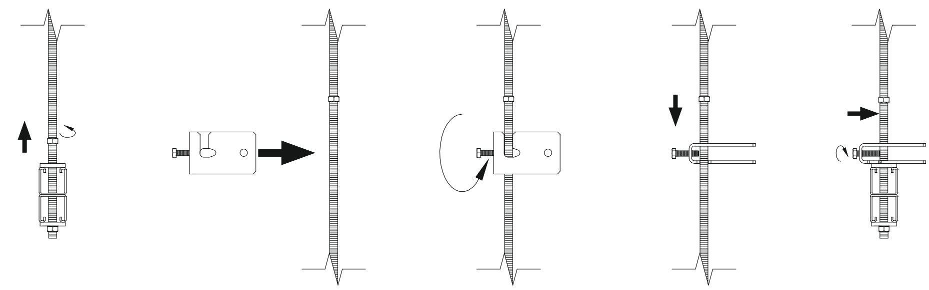
STEP 9

Determining Brace Installation

Installation Instructions for seismic brace assembly:

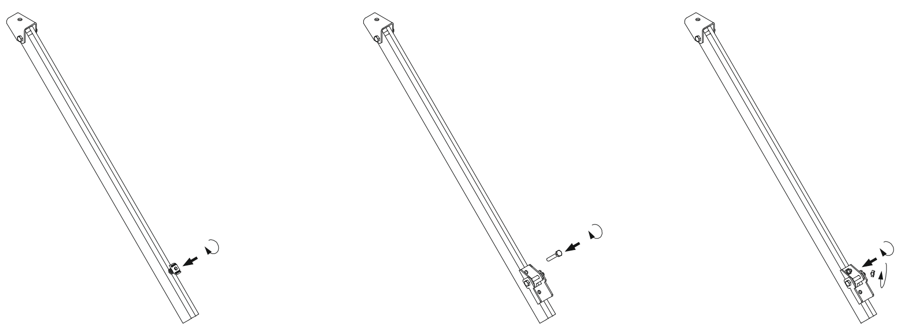
Stage I: Preperation of threaded rod retrofit fixing

Step i | Step ii | Step iii | Step iv | Step v



Stage II: Preperation of brace section

Step vi | Step vii | Step viii



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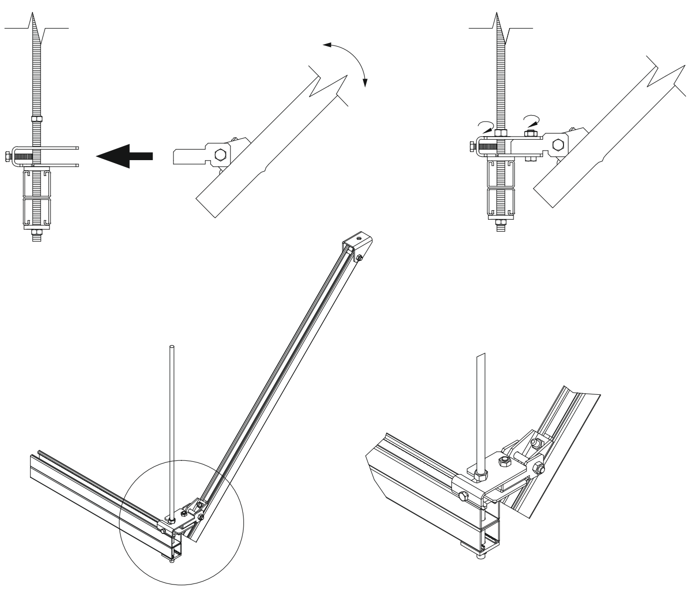
STEP 9

Determining Brace Installation

Installation Instructions for seismic brace assembly continue:

Stage III: Fastening brace to trapeze assembly



Stage I :
unfasten trapeze nut, place retrofit fixing to trapeze rod and rotate until it faces down. Fasten rod screw on retrofit fixing (recommended torque 20 Nm).

Stage II :
Place spring nut into brace channel. Place brace joint into brace channel. Set brace length before fastening. Fasten secure head-off bolt until its head brakes off, than fasten nut (recommended torque 20 Nm).

Stage III:
Place brace into retrofit fixing. Adjust installation angle. Fasten retrofit fixing to brace and fasten trapeze nut (recommended torque 20 Nm).

Notes:
For anchorage see section 12

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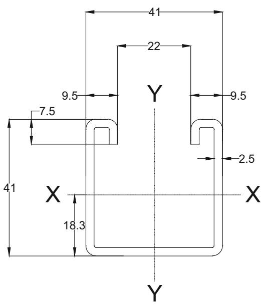
STEP 10

Determining Brace Section

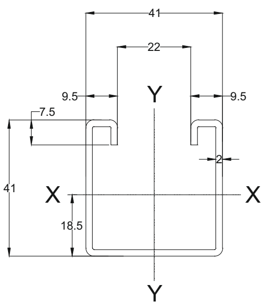
Once brace length and installation angle is determined, brace section should be selected following tables. Use round up values for brace length and installation angle. If section strength is not enough for seismic forces, decrease maximum brace spacing S_B and therefor F_P horizontal seismic design force.

BR461 Channel



Unsupported Length	Max. Allowable Compression Load
mm	kN
1500	12.61
2000	9.20
2500	7.07
3000	5.53
3500	4.51
4000	3.57
4500	2.81
5000	2.23
5500	1.87
6000	1.53

BR451 Channel



Unsupported Length	Max. Allowable Compression Load
mm	kN
1500	8.43
2000	6.13
2500	4.77
3000	3.83
3500	3.15
4000	2.64
4500	2.21
5000	1.87
5500	1.61
6000	1.27

Notes:

The allowable compression loads are calculated according to AISI 1996 allowable stress design (ASD) and the material used is DIN10025-P2 S235JR.

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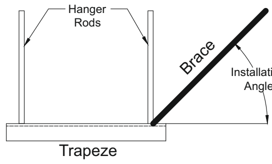
STEP 10

Determining Brace Section



BR461 Channel

Length of the Channel used in the Brace Assembly (L_B)	max. Allowable Horizontal Seismic Load (F_P) at max. Compressive load	
	45±10° installation angle Θ	60±10° installation angle Θ
mm	kN	kN
1500	10.33	6.16
2000	7.54	4.49
2500	5.79	3.45
3000	4.53	2.70
3500	3.70	2.20
4000	2.92	1.74
4500	2.31	1.38
5000	1.82	1.09
5500	1.53	0.92
6000	1.25	0.75

BR451 Channel

Length of the Channel used in the Brace Assembly (L_B)	max. Allowable Horizontal Seismic Load (F_P) at max. Compressive load	
	45±10° installation angle Θ	60±10° installation angle Θ
mm	kN	kN
1500	6.91	4.12
2000	5.02	2.99
2500	3.91	2.33
3000	3.14	1.87
3500	2.58	1.54
4000	2.16	1.29
4500	1.81	1.08
5000	1.53	0.92
5500	1.32	0.79
6000	1.04	0.62

Notes:

The allowable horizontal seismic loads given are according ASCE/SEI 7.10 2.4.1 ASD combination 5 (D+0.7E).

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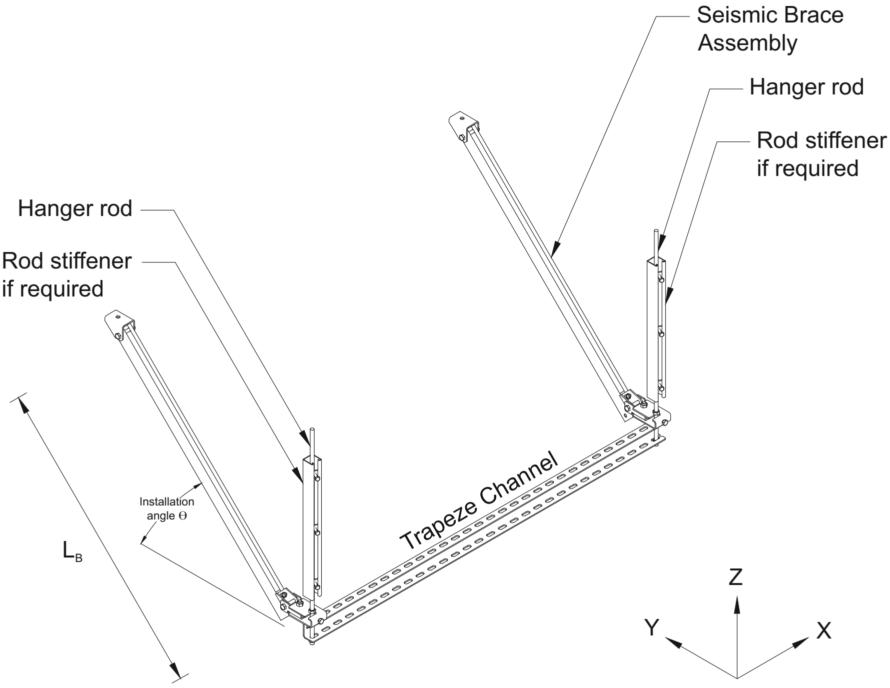
STEP 10

Determining Brace Section

Example 7:

Lateral and longitudinal brace sections of example 6 are being determined. L_B of the brace section is 1500mm and installation angle (Θ) is 45±10°. Brace section should be able to resist:

Longitudinal:



Brace section load = F_{Plmax} / 2

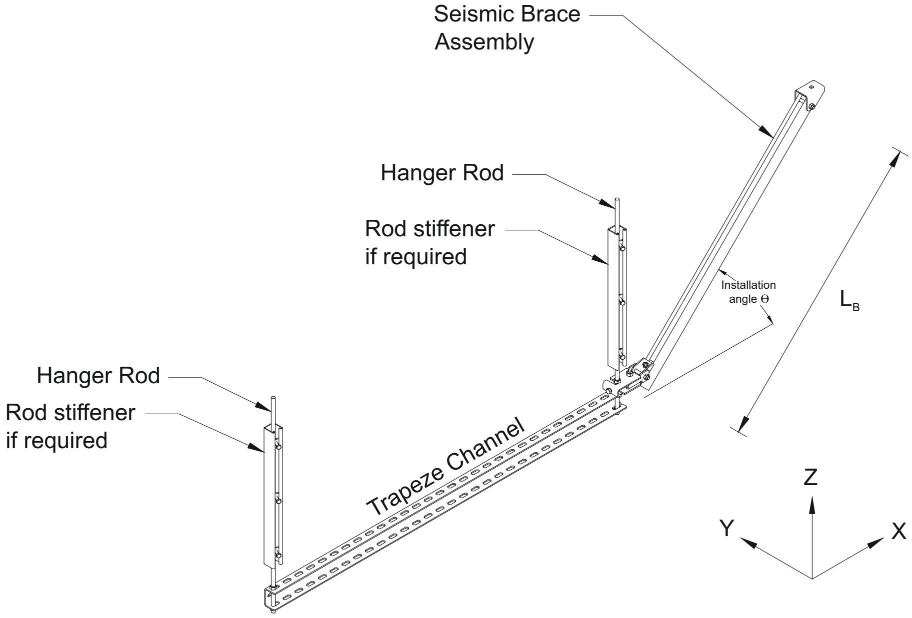
= 6.024/2 = 3.013 kN's.

STEP 10

Determining Brace Section

Example 7 continue:

Transverse (lateral):



Brace section load = F_{Ptmax}

4.518 kN's.

3.013 kN<6.91 kN	for longitudinal brace, BR451 section is ok.
4.518 kN<6.91 kN	for transverse (lateral) brace, BR451 section is ok.

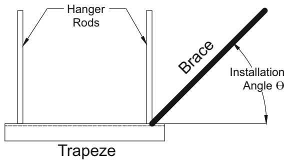
Notes:

Refer to page A4-1 to A4-3 for F_{Plmax} and F_{Ptmax}.

STEP 11

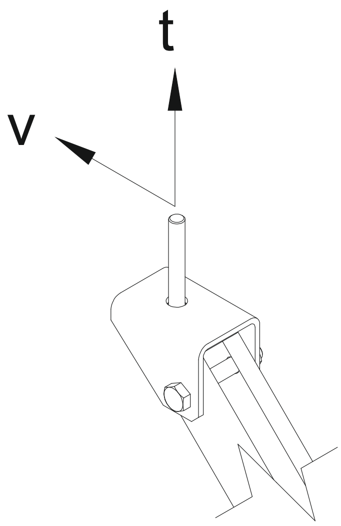
Determining Anchor Loads

Anchor load values with prying factors at maximum allowable loads are given in the tables below. Interpolation can be done to reach actual load values.



BR461 Channel

Length of the Channel used in the Brace Assembly	Anchor Reactions under max. Allowable Loads with Prying Factor			
	45±10° installation angle ϴ		60±10° installation angle ϴ	
	t	v	t	v
mm	kN	kN	kN	kN
1500	8.45	7.23	17.54	4.31
2000	6.17	5.28	12.79	3.15
2500	4.74	4.06	9.83	2.42
3000	3.71	3.17	7.69	1.89
3500	3.02	2.59	6.27	1.54
4000	2.39	2.05	4.96	1.22
4500	1.89	1.61	3.91	0.96
5000	1.49	1.28	3.10	0.76
5500	1.26	1.07	2.60	0.64
6000	1.03	0.88	2.13	0.52



BR451 Channel

Length of the Channel used in the Brace Assembly	Anchor Reactions under max. Allowable Loads with Prying Factor			
	45±10° installation angle ϴ		60±10° installation angle ϴ	
	t	v	t	v
mm	kN	kN	kN	kN
1500	5.65	4.84	11.73	2.88
2000	4.11	3.52	8.52	2.10
2500	3.19	2.73	6.63	1.63
3000	2.57	2.20	5.33	1.31
3500	2.11	1.81	4.38	1.08
4000	1.77	1.51	3.67	0.90
4500	1.48	1.27	3.07	0.75
5000	1.26	1.07	2.60	0.64
5500	1.08	0.92	2.24	0.55
6000	0.85	0.73	1.76	0.43

t: Anchor tension
v: Anchor shear

Notes:

Values given in the tables are for installations parallel to trapeze level like ceiling. The prying factor is changing with installation angle. Consult with a design professional for more information.

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STEP 11

Determining Anchor Loads

Example 8:

To Determine brace anchor reactions in example 7, following interpolation should be done:

Load percentage = Brace section load / max. Allowable brace section load x 100

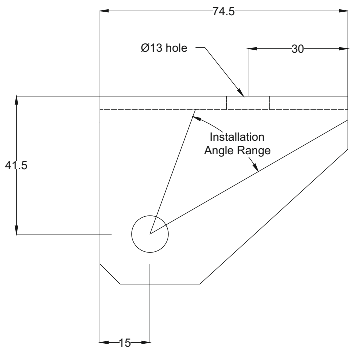
Load percentage = 4.518/6.91x100 = 66% for transverse (lateral) brace.

Actual anchor reaction = load percentage x Reaction at max. allowable loads

t = 0.66x5.65 = 3.73 kN's	for lateral brace.
v =0.66x4.84 = 3.20 kN's	for lateral brace.

Load percentage = 3.013/6.91x100 = 44% for longitudinal brace.

t = 0.44x5.65 = 2.49 kN's	for longitudinal brace.
v = 0.44x4.84 = 2.13 kN's	for longitudinal brace.



Brace Ceiling Attachment Piece

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STEP 12

Determining Brace Anchor

Once anchor reactions determined, concrete anchor selection and calculations should be done according to ACI-318 appendix D. Provided min. edge distance, min. slab quality and thickness is present, single concrete anchor installations should meet following condition:

$$\left(\frac{t}{T_{ASDallow}}\right)^{5/3} + \left(\frac{v}{V_{ASDallow}}\right)^{5/3} < 1$$

Example 9:

The concrete anchor decided to fasten brace to ceiling has following properties:

$T_{ASD,allow}$ = 10.67 kN
$V_{ASD,allow}$ = 23.6 kN

Combined load calculation of the brace anchor in example 8 should be done:

$(3.73/10.67)^{(5/3)} + (3.20/23.6)^{(5/3)} = 0.21 < 1$ lateral anchorage is ok.

$(2.49/10.67)^{(5/3)} + (2.13/23.6)^{(5/3)} = 0.11 < 1$ longitudinal anchorage is ok.

Notes:

Installation instructions of anchor manufacturer should be followed. Post-installed concrete anchors should be prequalified for seismic applications in accordance with ACI 355.2 or manufacturer should approve anchor should withstand anchor loads by other equivalent sources like ETAG. In cases where single anchor does not meet the load criteria above, use UDY 150 anchor assembly in order to increase anchor quantity. Group anchor calculations should be done in accordance with ACI 318 appendix D or manufacturer should approve anchors should withstand anchor loads by other equivalent sources like ETAG. For more information on post-installed concrete anchors, consult with manufacturer design professional.

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STEP 12

Determining Brace Anchor

Generic expansion anchor allowable loads are given below for consideration.

Expansion Anchor Tension and Shear Values (3000 psi normal weight concrete slab)

Anchor Diameter	Anchor Embedment	Minimum Slab Thickness	Minimum Edge Distance	Allowable Tension	Allowable Shear
in - mm	in - mm	in - mm	in - mm	lb - kN	lb - kN
3/8 - M10	2 - 102	4 - 102	6 - 152	485 - 2.16	710 - 3.16
	2 7/8 - 127	5 - 127	6 - 152	1035 - 4.60	820 - 3.65
1/2 - M12	2 3/4 - 127	5 - 127	6 - 152	1070 - 4.76	1055 - 4.69
	3 7/8 - 152	6 - 152	8 - 203	1395 - 6.21	2100 - 9.34
5/8 - M16	3 3/8 - 203	6 - 203	8 - 203	1450 - 6.45	2155 - 9.59
	5 1/8 - 203	8 - 203	8 - 203	2575 - 11.45	2750 - 12.23
3/4 - M20	4 1/8 - 203	8 - 203	10 - 229	1665 - 7.41	3425 - 15.24
	5 3/4 - 229	9 - 229	10 - 229	3005 - 13.37	3930 - 17.48
1 - M24	5 1/4 - 229	9 - 229	10 - 229	2435 - 10.83	4195 - 18.66

Notes:
1. Values in table are for single anchors only and not valid for anchors installed in groups.
2. Each anchor is considered to be in the corner of slab with the minimum edge distance present on two sides.
3. Values are for ASD Seismic loads in cracked concrete for nonstructural component attachments.
4. Calculations assume supplementary reinforcement Condition B and minimum #4 bar between the anchor and edge of the slab.
5. Values used for anchor design must be determined using ACI 318 Appendix D in conjunction with appropriate ICC ES Report.

Expansion Anchor Tension And Shear Values
(Underside of 3000 psi lightweight-comcrete-filled metal deck)

Anchor Diameter	Anchor Embedment	Minimum Spacing	Allowable Tension	Allowable Shear
in - mm	in - mm	in - mm	lb - kN	lb - kN
3/8 - M10	3 3/8 - 86	9 - 229	761 - 3.39	1588 - 7.06
1/2 - M12	4 1/2 - 114	12 - 305	932 - 4.15	2084 - 9.27
5/8 - M16	4 5/8 - 117	12 - 305	1342 - 5.97	2302 - 10.24

Notes:
1. Minimum 20 gage profile metal deck with min. 4 1/2 in. (114mm) wide x maximm 3 in. (76 mm) deep flutes.
2. Anchors installed in the lower flute with up to 1 in. (25 mm) offset from center.
3. Values used for anchor design must be determined using ACI 318 Appendix D in conjunction with the appropriate ICC ES Report.

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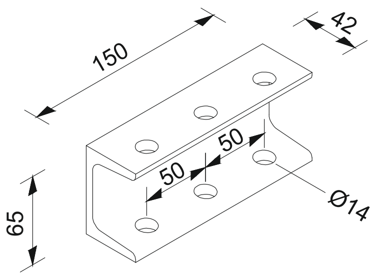
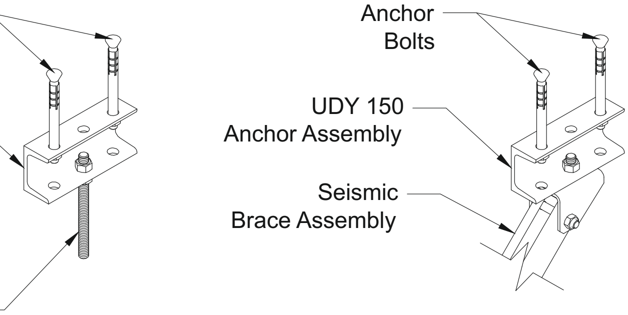
STEP 12

Determining Brace Anchor

Where single anchor does not meet the design criteria, Use UDY 150 anchor assembly in order to increase anchor quantity. Group anchor calculations should be done in accordance with ACI 318 appendix D or by manufacturers approval other sources like ETAG. Consult with manufacturers design professional for more information.

UDY 150 Anchor Assembly:





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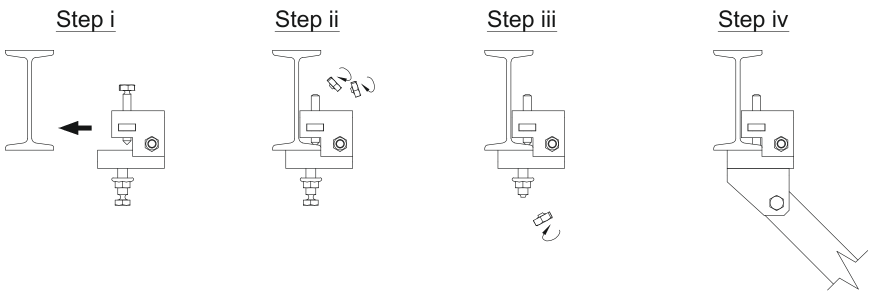
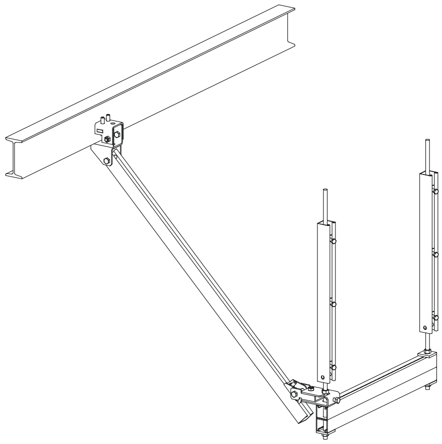
STEP 12

Determining Brace Anchor

In cases where fastening brace assembly to a steel beam, use EAE Steel Beam Fastener.

Installation Instructions for EAE Steel Beam Fastener:





Step i :
Place fastener assembly to steel beam's bottom flange.

Step ii :
Fasten upper bolts until their heads breaks off.

Step iii :
Fasten bottom bolt until it's head breaks off.

Step iv :
Fasten brace ceiling attachment to bottom bolt with nut (recommended torque 25 Nm).

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10/1/13

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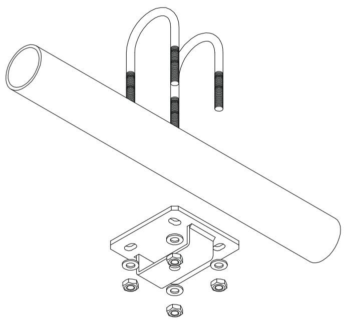
STEP 12

Determining Brace Anchor

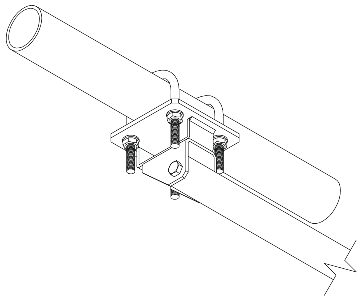
In cases where fastening brace assembly to a pipe beam, use EAE Pipe Beam Fastener.

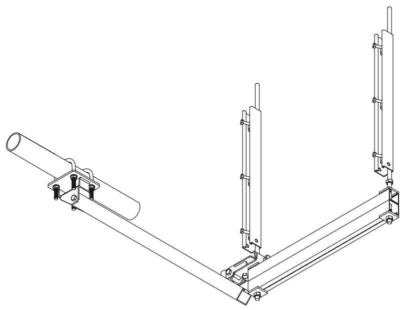
Installation Instructions for EAE Pipe Beam Fastener:

Step i



Step ii





Step i :
Fasten U bolts to fastener plate with nuts and washers (recommended torques for M8 Nuts 15 Nm, M10 nuts 20 Nm, M12 nuts 25 Nm, M16 nuts 30 Nm)

Step ii :
Fasten brace ceiling attachment to beam fastener with M12 bolt and nut (recommended torque 25 Nm)

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Date: 10/01/2013 | Page No: A12-5

STANDARDS & CERTIFICATES

SEISMIC STANDARDS & TEST CERTIFICATES

VIRLAB S.A. TEST LABORATORY - SPAIN

- ✓ **IEEE 693-2005** » North American Standard
- ✓ **EN 60068-3-3:1993** » European Standard

VIRLAB, S.A.

SEISMIC
Qualification Certificate

Delivered on: **Thursday, 26 September2013**

References:

- **VIRLAB** test procedure number **130612E2,** issue 0, dated 12/06/2013: *"Standard Test Procedure for Seismic Qualification of a Cable Tray Assembly from "EAE ELEKTROTEKNIK SAN VE TIC A.Ş." according to IEEE Standard 693-2005 and European Standard EN60068-3-3:1993".*
- European standard **EN 60068 3-3: 1993:** *Enviromental testing – Part 3: Guidance. Seismic test methods for equipments.*
- North American standard **IEEE- 693/2005:** *" IEEE Recommended Practice for Seismic Design of Substations"* .
- European standard **EN 60068 2-6: 2008**: *Environmental testing – Part 2-6: Tests – Fc: Vibration (sinusoidal).*
- European standard **EN 60068 2-47: 2005**: *"Environmental testing– Part 2-47: Tests. Mounting of specimens for vibration, impact and similar dynamic tests".*

Laboratory Name: **VIRLAB, S.A.** (accredited by ENAC, Spanish National Accreditation Entity). ENAC certificate number 54/LE131.

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20159 ASTEASU (SPAIN)

Equipment tested: An ***"AN ASSEMBLY OF:UKS, UKF, CT Cable Trays, CR Cast resin Busbar, URC Trolley Busbar, KX Busbar, Wind Busbar Module AND AT3, AT4, AT5, UPD, STS, LP4, UDD, UDYB, UDY, IDD AND IDY HANGER ASSEMBLIES from EAE ELEKTRİKSAN VE TİC A.Ş"***, according to the set of drawings number TRF001, of EAE ELEKTRIK, dated 26/03/2013.

Photograph included here below shows the ***Assembly*** on the test platform.

REPORT ON THE SEISMIC QUALIFICATION TESTS OF

"AN ASSEMBLY OF:
UKS, UKF, CT Cable Trays, CR Cast resin Busbar,
URC Trolley Busbar, KX Busbar, Wind Busbar Module AND
AT3, AT4, AT5, UPD, STS, LP4, UDD, UDYB, UDY, IDD AND IDY
HANGER ASSEMBLIES
from EAE ELEKTRİKSAN VE TİC A.Ş",

ACCORDING TO IEE STANDARD 693-2005
AND EUROPEAN STANDARD EN 60068-3-3:1993

NOTE: *As indicated in section 5.10.2 of Standard ISO-IEC 17025:2005, it is stated that:*
The results of this report concern the simple tested solely and exclusively.
The Laboratory forbids the partial reproduction of this document without written authorisation.

Date	Carried out by:	Revised by:	
02.09.2013	*Denis AGOTE*	*Juan Antonio PÉREZ*	

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SEISMIC BRACING GENERAL PRODUCT SPECIFICATIONS FOR SUSPENDED DISTRIBUTION SYSTEM AND EQUIPMENTS (E-LINE SEISMIC)

1- General Description:
Technical precautions should be done for the suspended electrical&mechanical distribution systems and equipments in the building against suffering in case of earthquake occurrence. Distribution systems should not pose a threat to life and property security after an earthquake. Distribution systems and equipments in the building should be protected against earthquakes with seismic braces, which should be in accordance to the standards and technical specifications given below.

2- Standards & Certifications:
- Seismic bracing systems should be tested and certificated in an internationally accepted and accredited test laboratory according to IEEE 693 standard and EN 60068-2-6, EN 60068-2-47, EN 60068-3-3 norms.
- Calculated according to IBC 2012 horizontal seismic acceleration, stated allowable loads of seismic braces should be approved by an IBC authorized seismic design engineer (P.E., Professional Engineer).
- Seismic bracing systems should be in compliance with the schematic details in FEMA 412,413,414.
- Seismic bracing systems should be manufactured in a facility, where ISO 9001 quality management and ISO 14001 environmental management procedures are being followed.

3- System General Composition:
Finishes of seismic brace systems should be hot-dip galvanized for rigid seismic brace section and alkali zinc coated for bolts/nuts, rod connection and other fastening components according to below stated composition. The bolt, which connects rigid brace section to distribution system, should be torque controlled or provided with a proper tool for this torque level.

3.1- Mechanical Strength:
- Calculated according to AISI 1999 ASD, stated allowable compression loads for section length and thickness of rigid seismic brace sections should be approved by an IBC authorized seismic design engineer (P.E., Professional Engineer).

For 2.5mm Seismic Brace Section Thickness:

1.5 m	: 12.61	kN	Allowable Compression Load
2 m	: 9.20	kN	Allowable Compression Load
3 m	: 5.53	kN	Allowable Compression Load

For 2mm seismic Brace Section Thickness:

1.5 m	: 8.43	kN	Allowable Compression Load
2 m	: 6.13	kN	Allowable Compression Load
3 m	: 3.83	kN	Allowable Compression Load

3.2- General Body Structure:
- Fastening piece, which connects brace to threaded rods, should be compatible to M8-M10-M12 or M14-M16-M20 rods and should be applicable to the installed hanger, without requiring rod hanger to be dismantled.
- Determined by threaded rod length and diameter, rod stiffeners should be applied.
- Calculated according to AISI 1999 ASD and IBC 2012 load combinations, stated trapeze hanger allowable loads on seismic brace applications should be approved by an IBC authorized seismic design engineer (P.E., Professional Engineer).
- Other than threaded rods, seismic braces should have compatible fastening accessory for the hanger, which braces are being attached.
- Seismic brace body should have rotational joints, which allows optimum 45 degrees installation angle in accordance with FEMA 412, 413, 414 along with various installation angles. Stated allowable horizontal seismic loads for variable installation angles should be approved by an IBC authorized seismic design engineer (P.E., Professional Engineer)
- Seismic brace should be compatible for lateral (transverse) and longitudinal brace connections.
- Brace length should be adjustable without requiring rigid brace section to be cut. Where needed, brace system should also allow rigid brace section to be cut.
-Rigid brace section should be hot-dip galvanized approximately 55 µm in a facility, where galvanizing is available according to EN ISO 1461 standard.
- Bolts/nuts, rod connection and other pieces should be passivized and lacquered over alkali zinc according to DIN 50961 standard. Thickness of the coating should be between 7-12 µm and should be able to complete 400 hours of salt-spray test.

3.3- Structural Connection:
- Loads of the anchor/bolt of the structural connection should be stated with prying factor. Stated loads should be approved by an IBC authorized seismic design engineer (P.E., Professional Engineer).
- The design of the structural connection component should be able to minimize the prying factor in 35-70 degrees of installation angle range.
- Seismic brace should have appropriate accessories for fixing to steel structures.

3.4- Secure Head-off Bolt/Conic Bolt:
- Secure head-off bolt, which serves rigid brace section length adjustment, should be 8.8 steel or upon request A70 stainless steel.
- Conic bolt, which can be used instead of secure head-off bolt, should be 8.8 steel.

3.5- Rod Stiffener:
- Rod stiffeners should be used only on the seismic brace connections, where threaded rod hangers of the distribution system exceed diameter and length stated below. Maximum spacing of rod stiffener pieces should also be stated and approved by an IBC authorized seismic design engineer (P.E., Professional Engineer).
Maximum M8 rod length without stiffener : 300 mm
Maximum M10 rod length without stiffener : 475 mm
Maximum M12 rod length without stiffener : 625 mm
Maximum M16 rod length without stiffener : 775 mm
Maximum M20 rod length without stiffener : 925 mm

4- Distribution System Connection:
- In compliance with FEMA 412,413,414, U bolts or special fixing pieces for the distribution system should be used on hanger sections, where hangers fastened with brace. The distribution system should not be left unrestrained.

5- Application & Installation:
- The suspended distribution systems should be restrained with transverse (lateral) and longitudinal seismic braces.
-Spacing between two transverse (lateral) brace should not exceed, 12m for heating&cooling and plumbing pipes, stated values in NFPA for sprinkler pipes and stated values in SMACNA seismic restraint guidelines for HVAC ducts.
- Spacing between two transverse (lateral) brace should not exceed 9m for electrical busbars and cable trays, 12m for electrical conduit pipes.
- Spacing between two transverse (lateral) brace should not exceed 6m for the pipes, in which flows life endangering fluids, toxic or explosive in nature.
- Spacing between two longitudinal brace should not exceed two times the values stated above for related distribution system.
- Seismic bracing systems should be installed according to calculated strengths, product types and figures shown in these calculations. Installations instructions of the manufacturer should be followed carefully. Secure head-off bolts should be fastened until its head breaks off and then fixed with nuts. Conic bolts should be fastened with proper tools for stated torque levels and then fixed with nuts.
- After the installation, heads of the secure bolts should be checked to approve that installation is done with appropriate torque levels.

ELINESEISMIC

Project Design Form

Component List

Item	Component	Quantity

Company :

Project :

Project No :

Prepared by

Name :

Date :

Signature :

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▶▶ Project Design Form

EAE
ELEKTRİK

Component List

Item	Component	Quantity

Company :

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Prepared by

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Signature :

EAE

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PRODUCT TYPES

BUSBAR ENERGY DISTRIBUTION SYSTEMS

CABLE TRAYS

TROLLEY BUSBAR ENERGY DISTRIBUTION SYSTEMS

INDOOR SOLUTIONS

SUPPORT SYSTEMS

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IEEE 693-2005 EN 60068-3-3:1993

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