History

• 1976 – Guidelines for Seismic Restraint of Mechanical Systems
  (Sheet Metal Industry Fund of Los Angeles)
• 1982 – Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems
  (Sheet Metal Industry Fund of Los Angeles and The Plumbing and Piping Industry Council, Inc.)
History

  - Included larger ducts
  - Included conduit
  - Created Seismic Hazard Level (SHL)

- 1993 – Appendix E
  - Corrections and Clarifications
  - Specific Requirements for OSHPD
  - OSHPD Approval
History

  - 2000 – ANSI Approval
  - 2000 – Addendum #1
    - Changes in the 1997 UBC
    - Brought about SHL AA
PHYSICS

\[ F = Ma \]
Older Codes

**BOCA**

\[ F_p = A_V C_C P a_C W_C \]

**SBCCI**

\[ F_p = A_V C_C P a_C W_C \]

**ICBO**

\[ F_p = Z I_{p C} W_p \]

**UBC 1997**

\[ F_p = \frac{a_p C a I_p}{R_p} \left( 1 + 3 \frac{h_x}{h_r} \right) W_p \]
Current Codes


\[ F_p = \frac{0.4a_p S_{DS} W_p}{R_p} \left( 1 + 2 \frac{z}{h} \right) \left( \frac{R_p}{I_p} \right) \]
All Codes Take the Form of

\[ F_p = C_s W_p \]

Where \( C_s \) = a series of variables given in the building code

\( C_s \) is a measure of acceleration
The Form is the Same

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

The portion in the green box is \( C_s \)
Simplifying

\[ F_p = C_s W_p \left( 1 + 2 \frac{z}{h} \right) \]
The Components

\[
\left( 1 + 2 \frac{z}{h} \right)
\]

Is an adjustment for the anticipated force levels dependant on the location in the building (height)
Basic Equation

\[ F_p = C_s W_p \]

Where \( C_s \) includes the location adjustment factors.
Rearranging the Equation

\[
\frac{F_p}{W_p} = C_s
\]
The SMACNA Seismic Restraint Manual has tables for four values of $C_s$.

These tables are identified as Seismic Hazard Level (SHL).
SMACNA SHL Values

SHL A = $C_s = 1.0$

SHL B = $C_s = 0.75$

SHL C = $C_s = 0.50$

SHL D = $C_s = 0.25$

These values differ from previous editions!
Responsibilities of the Design Professional

1. Calculate $C_s$ from the information in the applicable local building code
2. Calculate the values of $C_s$ at the various attachment locations in the building
3. Indicate the required SMACNA SHL tables to be used at the different attachment locations
\[ F_p = \frac{0.4a_p S_{DS} W_p}{\left( \frac{R_p}{I_p} \right)} \left( 1 + 2 \frac{z}{h} \right) \]
\[ F_p = \frac{0.4 \alpha_p S_{DS} W_p}{\left( \frac{R_p}{I_p} \right) \left( 1 + 2 \frac{z}{h} \right)} \]

\( F_p \) is the seismic design force
$F_p = \frac{0.4 \alpha_p S_{DS} W_p}{R_p I_p \left(1 + 2\frac{z}{h}\right)}$

$a_p$ is the component amplification factor that varies from 1.00 to 2.50 (select from table 13.5-1 or 13.6-1)

*Table 13.6-1 contains duct and piping*
| ASCE-7 05 Terms |

<table>
<thead>
<tr>
<th>MECHANICAL AND ELECTRICAL COMPONENTS</th>
<th>$\phi_p$</th>
<th>$F_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-side HVAC, fans, air handlers, air conditioning units, cabinet heaters, air distribution boxes, and other mechanical components constructed of sheet metal framing.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Wet-side HVAC, boilers, furnaces, atmospheric tanks and bins, chillers, water heaters, heat exchangers, evaporators, air separators, manufacturing or process equipment, and other mechanical components constructed of high-deformability materials.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Engines, turbines, pumps, compressors, and pressure vessels not supported on skirts and not within the scope of Chapter 15.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Skirt-supported pressure vessels not within the scope of Chapter 15.</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Elevator and escalator components.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high deformability materials.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Communication equipment, computers, instrumentation, and controls.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Roof-mounted chimneys, stacks, cooling and electrical towers laterally braced below their center of mass.</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Roof-mounted chimneys, stacks, cooling and electrical towers laterally braced above their center of mass.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Lighting fixtures.</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Other mechanical or electrical components.</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>VIBRATION ISOLATED COMPONENTS AND SYSTEMS$^b$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components and systems isolated using neoprene elements and neoprene isolated floors with built-in or separate elastomeric snubbing devices or resilient perimeter stops.</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Spring isolated components and systems and vibration isolated floors closely restrained using built-in or separate elastomeric snubbing devices or resilient perimeter stops.</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Internally isolated components and systems.</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Suspended vibration isolated equipment including in-line components and supported vibration isolated components.</td>
<td>2.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISTRIBUTION SYSTEMS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping in accordance with ASME B31, including in-line components with joints made by welding or brazing.</td>
<td>2.5</td>
<td>12.0</td>
</tr>
<tr>
<td>Piping in accordance with ASME B31, including in-line components, constructed of high or limited deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Piping and tubing in accordance with ASME B31, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing.</td>
<td>2.5</td>
<td>9.0</td>
</tr>
<tr>
<td>Piping and tubing in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings.</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Piping and tubing constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics.</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Ductwork, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing.</td>
<td>2.5</td>
<td>9.0</td>
</tr>
<tr>
<td>Ductwork, including in-line components, constructed of high- or limited-deformability materials with joints made by means other than welding or brazing.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Ductwork, including in-line components, constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics.</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Electrical conduit, bus ducts, rigidly mounted cable trays, and plumbing.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Manufacturing or process conveyors (nonpersonnel).</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Suspended cable trays.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

$^a$ A lower value for $\phi_p$ is permitted where justified by detailed dynamic analyses. The value for $\phi_p$ shall not be less than 1.0. The value of $\phi_p$ equal to 1.0 is for rigid components and rigidly attached components. The value of $\phi_p$ equal to 2.5 is for flexible components and flexibly attached components.

$^b$ Components mounted on vibration isolators shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$ if the nominal clearance (air gap) between the equipment support frame and restraint is greater than 0.25 in. If the nominal clearance specified on the construction documents is not greater than 0.25 in., the design force is permitted to be taken as $F_p$. 

---

**TABLE 13.6-1 SEISMIC COEFFICIENTS FOR MECHANICAL AND ELECTRICAL COMPONENTS**
<table>
<thead>
<tr>
<th>DISTRIBUTION SYSTEMS</th>
<th>2.5</th>
<th>6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping in accordance with ASME B31, including in-line components with joints made by welding or brazing.</td>
<td>2.5</td>
<td>12.0</td>
</tr>
<tr>
<td>Piping in accordance with ASME B31, including in-line components, constructed of high or limited deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing.</td>
<td>2.5</td>
<td>9.0</td>
</tr>
<tr>
<td>Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings.</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Piping and tubing constructed of low-deformability materials, such as cast iron, glass, and nontoxic plastics.</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Ductwork, including in-line components, constructed of high-deformability materials with joints made by welding or brazing.</td>
<td>2.5</td>
<td>9.0</td>
</tr>
<tr>
<td>Ductwork, including in-line components, constructed of high- or limited-deformability materials with joints made by means other than welding or brazing.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Ductwork, including in-line components, constructed of low-deformability materials, such as cast iron, glass, and nontoxic plastics.</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Electrical conduit, bus ducts, rigidly mounted cable trays, and plumbing.</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Manufacturing or process conveyors (nonpersonnel).</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Suspended cable trays.</td>
<td>2.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Typically ductwork will have \( a_p = 2.5 \) and \( R_p = 6.0 \)
ASCE-7 05 Terms

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

\( S_{DS} \) is the spectral acceleration, short period, as determined from Section 11.4.4

Based on the soil type (site class) and the maximum considered earthquake motion for 0.2 sec (the “contour maps”)
### ASCE-7 05 Terms

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

- \(F_p\) is the component operating weight
- \(W_p\) is the component operating weight

**When using the SMACNA seismic restraint manual be sure not to exceed the max wt. per linear ft.**
ASCE-7 05 Terms

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

\[ R_p \]

\[ I_p \]

\[\]

\[ R_p \] is the component response modification factor that varies from 1.00 to 12 (Select the appropriate value from Table 13.5-1 or 13.6-1)  
*Duct and piping are in 13.6-1*
ASCE-7 05 Terms

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

\( z \) is the height in structure of point of attachment of component with respect to the base. For items at or below the base \( z \) shall be taken as 0. The value \( z/h \) need not exceed 1.0

\( h \) is the average roof height of structure with respect to the base
ASCE-7 05 Terms

\[ F_p = 0.4 \alpha_p S_{DS} W_p \left( 1 + 2 \frac{Z}{h} \right) \]

\( I_p \) is the component importance factor that varies from 1.0 to 1.5 (see Section 13.1.3)
Component Importance Factor

\( Ip = 1.5 \) if any of the following apply:

- The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems (sprinkler systems are *not covered in SMACNA’s seismic restraint manual*)
- The component contains hazardous materials
- The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility
Component Importance Factor

- \( I_{p} = 1.0 \) for all other components

- **DO NOT CONFUSE THIS WITH THE IMPORTANCE FACTOR I FOUND IN SECTION 11.5 OF ASCE 7-05 (for the structure itself)**
Occupancy Category

• Occupancy category is defined in Table 1-1 in ASCE7-05.
• The values go from I to IV
# Table 1-1 Occupancy Category

## TABLE 1-1 OCCUPANCY CATEGORY OF BUILDINGS AND OTHER STRUCTURES FOR FLOOD, WIND, SNOW, EARTHQUAKE, AND ICE LOADS

<table>
<thead>
<tr>
<th>Nature of Occupancy</th>
<th>Occupancy Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings and other structures that represent a low hazard to human life in the event of failure, including, but not limited to:</td>
<td>I</td>
</tr>
<tr>
<td>• Agricultural facilities</td>
<td></td>
</tr>
<tr>
<td>• Certain temporary facilities</td>
<td></td>
</tr>
<tr>
<td>• Minor storage facilities</td>
<td></td>
</tr>
<tr>
<td>All buildings and other structures except those listed in Occupancy Categories I, III, and IV</td>
<td>II</td>
</tr>
<tr>
<td>Buildings and other structures that represent a substantial hazard to human life in the event of failure, including, but not limited to:</td>
<td>III</td>
</tr>
<tr>
<td>• Buildings and other structures where more than 300 people congregate in one area</td>
<td></td>
</tr>
<tr>
<td>• Buildings and other structures with daycare facilities with a capacity greater than 150</td>
<td></td>
</tr>
<tr>
<td>• Buildings and other structures with elementary school or secondary school facilities with a capacity greater than 250</td>
<td></td>
</tr>
<tr>
<td>• Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities</td>
<td></td>
</tr>
<tr>
<td>• Health care facilities with a capacity of 50 or more resident patients, but not having surgery or emergency treatment facilities</td>
<td></td>
</tr>
<tr>
<td>• Jails and detention facilities</td>
<td></td>
</tr>
<tr>
<td>Buildings and other structures, not included in Occupancy Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure, including, but not limited to:</td>
<td>III</td>
</tr>
<tr>
<td>• Power generating stationsa</td>
<td></td>
</tr>
<tr>
<td>• Water treatment facilities</td>
<td></td>
</tr>
<tr>
<td>• Sewage treatment facilities</td>
<td></td>
</tr>
<tr>
<td>• Telecommunication centers</td>
<td></td>
</tr>
<tr>
<td>Buildings and other structures not included in Occupancy Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released.</td>
<td>III</td>
</tr>
<tr>
<td>Buildings and other structures containing toxic or explosive substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the toxic or explosive substances does not pose a threat to the public.</td>
<td>III</td>
</tr>
</tbody>
</table>
### Table 1-1 Occupancy Category

<table>
<thead>
<tr>
<th>Buildings and other structures designated as essential facilities, including, but not limited to:</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hospitals and other health care facilities having surgery or emergency treatment facilities</td>
<td></td>
</tr>
<tr>
<td>• Fire, rescue, ambulance, and police stations and emergency vehicle garages</td>
<td></td>
</tr>
<tr>
<td>• Designated earthquake, hurricane, or other emergency shelters</td>
<td></td>
</tr>
<tr>
<td>• Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response</td>
<td></td>
</tr>
<tr>
<td>• Power generating stations and other public utility facilities required in an emergency</td>
<td></td>
</tr>
<tr>
<td>• Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for operation of Occupancy Category IV structures during an emergency</td>
<td></td>
</tr>
<tr>
<td>• Aviation control towers, air traffic control centers, and emergency aircraft hangars</td>
<td></td>
</tr>
<tr>
<td>• Water storage facilities and pump structures required to maintain water pressure for fire suppression</td>
<td></td>
</tr>
<tr>
<td>• Buildings and other structures having critical national defense functions</td>
<td></td>
</tr>
</tbody>
</table>

Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction.

Buildings and other structures containing highly toxic substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the highly toxic substances does not pose a threat to the public. This reduced classification shall not be permitted if the buildings or other structures also function as essential facilities.

*Cogeneration power plants that do not supply power on the national grid shall be designated Occupancy Category II.*
Seismic Design Category

Section 11.6 in ASCE 7-05

- Occupancy Category I, II, or III where $S_{1} \geq 0.75$ shall be Seismic Design Category E
- Occupancy Category IV where $S_{1} \geq 0.75$ shall be Seismic Design Category F
Seismic Design Category

Section 11.6 in ASCE 7-05

- Otherwise pick the more severe option from Tables 11.6-1 or 11.6-2
- Other exceptions and conditions exist consult ASCE7-05 sections 11.6 and 11.7 for specifics
### Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

<table>
<thead>
<tr>
<th>Value of $S_{DS}$</th>
<th>Occupancy Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I or II</td>
</tr>
<tr>
<td>$S_{DS} &lt; 0.167$</td>
<td>A</td>
</tr>
<tr>
<td>$0.167 \leq S_{DS} &lt; 0.33$</td>
<td>B</td>
</tr>
<tr>
<td>$0.33 \leq S_{DS} &lt; 0.50$</td>
<td>C</td>
</tr>
<tr>
<td>$0.50 \leq S_{DS}$</td>
<td>D</td>
</tr>
</tbody>
</table>

### Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

<table>
<thead>
<tr>
<th>Value of $S_{D1}$</th>
<th>Occupancy Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I or II</td>
</tr>
<tr>
<td>$S_{D1} &lt; 0.067$</td>
<td>A</td>
</tr>
<tr>
<td>$0.067 \leq S_{D1} &lt; 0.133$</td>
<td>B</td>
</tr>
<tr>
<td>$0.133 \leq S_{D1} &lt; 0.20$</td>
<td>C</td>
</tr>
<tr>
<td>$0.20 \leq S_{D1}$</td>
<td>D</td>
</tr>
</tbody>
</table>
Seismic Hazard Level

- Seismic Hazard Level (SHL) is a term used in the SMACNA manual.

- SHL = \( \frac{F_p}{W_p} \) which = \( C_s \)

- SHL is the ratio of the seismic force to the item’s weight.
Terms

• It is not necessary for the contractor to fully understand the previous terms as these values should be determined by the designer.

• A basic understanding of the terms will help the contractor determine when exceptions can be applied.
General Requirements

1. Details provide lateral bracing system. Typical vertical supports per local building code must be used.

2. Thermal expansion not given but must be considered.

3. Duct construction to conform to the appropriate SMACNA publications.
General Requirements

4. Pipes will conform to ANSI/ASME B 31.9 Building Services Piping Code.

5. Brace in-line equipment independently of ducts and pipes.

6. Cold formed angles to conform to the requirements of the latest "Specifications for the Design of Cold-Formed Steel Structural Members" (AISI) ($F_Y = 33$ KSI)
General Requirements

7. Hot rolled shapes and plates to conform to ASTM A36. Pipes used as braces to conform to ASTM A120 or A53.

8. Cables to have minimum breaking strength. Per Table 3-2.
General Requirements

10. Expansion anchors per Table 3-3. Proprietary connectors may be used where values are greater.
11. Welding to conform to AWS D1.1 using shielded or submerged ARC method.
12. Brace conduit same as equivalent weight of pipe.
General Requirements

13. Do not mix solid and cable bracing.

14. Bracing for equipment **NOT** included.

15. All runs will have a minimum of two transverse and one longitudinal braces.

16. A run is defined as any change in direction except as allowed by offsets.
Bracing of Ducts

Seismic supports are not required for HVAC ductwork when the $I_p = 1.0$ if either of the following conditions is met for the entire duct run:

1. Ducts are suspended from hangers 12 in. or less as measured from the top of the duct to the bottom of the support where
Bracing of Ducts

the hanger is attached. Hangers must be positively attached to the duct within 2 in. of the top of the duct with a minimum of two #10 sheet metal screws. Lateral motion will not cause damaging impact with other systems. Lateral motion will not cause loss of vertical support.

2. Ducts have a cross-sectional area of 6 ft$^2$ or less.** (less than 6 ft$^2$ per ASCE7-05)
Code Changes

● The third edition of the Seismic Restraint Manual was written to be compliant with IBC 2006 and ASCE 7-05.
    » Modify ASCE 7 Section 13.6.7 by the following: Requirements of this section shall also apply for $l_p=1.5$
  - The IBC 2009
    » 1613.6.8 HVAC ductwork with $l_p = 1.5$. Seismic supports are not required for HVAC ductwork with $l_p = 1.5$ if either of the following conditions is met for the full length of each duct run:
      » 1. HVAC ducts are suspended from hangers 12 inches (305 mm) or less in length with hangers detailed to avoid significant bending of the hangers and their attachments, or
      » 2. HVAC ducts have a cross-sectional area of less than 6 square feet (0.557 m²).
  - (expands the exceptions on previous slides)
Bracing of Ducts

1. Transverse and longitudinal bracing per tables (Chapters 5, 6, 7 and 8).

2. Ducts may be grouped. Select bracing requirements based on combined weight. Minimum of two sides to be attached to horizontal or vertical angles.
Bracing of Ducts

3. Wall penetrations may replace transverse brace. Solid blocking required.
Bracing of Pipes or Conduit

1. Brace fuel oil, and gas (such as, fuel gas, medical gas, and compressed air) as per local codes.

2. Brace all pipes 3 inch nominal diameter or larger.
Bracing of Pipes - Conduit

3. Transverse and longitudinal bracing as per tables (Chapters 5, 6, 7 and 8).

4. Provide joints/connections capable of accommodating seismic displacements where pipes pass through building seismic or expansion joints or where pipes connect to equipment with vibration isolators.
Bracing of Pipes - Conduit

- Seismic supports are not required for piping systems where one of the following conditions is met:
  1. Piping is supported by rod hangers; hangers in the pipe run are 12 in. (305 mm) or less in length from the top of the pipe to the supporting structure;
Bracing of Pipes - Conduit

1. hangers are detailed to avoid bending of the hangers and their attachments; and provisions are made for piping to accommodate expected deflections.

2. High-deformability piping is used; provisions are made to avoid impact with larger piping or mechanical
2. components or to protect the piping in the event of such impact; and the following requirements are satisfied:

a) For Seismic Design Categories D, E or F where $I_p$ is greater than 1.0, the nominal pipe size shall be 1 in. (25 mm) or less.
b) For Seismic Design Category C, where $I_p$ is greater than 1.0, the nominal pipe size shall be 2 in. (51 mm) or less.

c) For Seismic Design Category D, E or F where $I_p$ is equal to 1.0, the nominal pipe size shall be 3 in. (76 mm) or less.
Bracing of Pipes - Conduit

- Ductile pipes shall be braced as outlined in the manual when using brazed or welded connections (Copper, Ductile Iron, aluminum, or steel)

- Non-ductile pipes or pipes using screw connections (cast iron, no hub, PVC) shall reduce the brace spacing by ½ of the spacing allowed in the manual.

- CBC 2007 allows screw connections to be in the ductile category if the piping is ductile
Modify ASCE 7 Section 13.6.1 by adding Sections 13.6.1.1 and 13.6.1.2 as follows:

13.6.1.1 HVAC ductwork, plumbing/piping and conduit systems. Ductwork shall be constructed in accordance with provisions contained in Part 4, Title 24, California Mechanical Code. Where possible, pipes, conduit and their connections shall be constructed of ductile materials (copper, ductile iron, steel or aluminum and brazed, welded or screwed connections). Pipes, conduits and their connections, constructed of non-ductile materials (e.g., cast iron, no-hub pipe and plastic), shall have the brace spacing reduced to satisfy requirements of ASCE 7 Chapter 13 and not to exceed one-half of the spacing allowed for ductile materials.
Vertical risers not specifically engineered will be laterally supported with a riser clamp at each floor.
Figure 10-10 Riser Bracing for Hubless Pipe

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>PLATE SIZE</th>
<th>BOLT SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP TO 2”</td>
<td>1/4” X 1–1/4”</td>
<td>1/4”</td>
</tr>
<tr>
<td>2–1/2” TO 3”</td>
<td>1/4” X 1–1/4”</td>
<td>3/8”</td>
</tr>
<tr>
<td>4” &amp; 5”</td>
<td>1/4” X 1–1/4”</td>
<td>1/2”</td>
</tr>
<tr>
<td>6”</td>
<td>3/8” X 1–1/2”</td>
<td>1/2”</td>
</tr>
<tr>
<td>8”</td>
<td>3/8” X 1–1/2”</td>
<td>5/8”</td>
</tr>
</tbody>
</table>
DEFINITIONS

• TRANSVERSE BRACE - those designed and installed to restrain movement in the direction perpendicular to the piping or duct run
DEFINITIONS

• LONGITUDINAL BRACE - those designed and installed to restrain movement in the direction parallel to the piping or duct run

• RUN (Piping or Duct) - a straight length with no changes in direction except as allowed by offsets
Elements of a Seismic Restraint

● Brace

● Attachment to the Component

● Attachment to the Structure
Bracing Members

RIGID
- Angles
- Pipes
- Strut Channels

NON-RIGID
- Cables
Connections to Ducts

The SMACNA Seismic Restraint Manual Contains 12 Different Details for Connecting to Ductwork, Rectangular and Round
FIGURE 4-2 SIDE BRACING FOR RECTANGULAR DUCTS

- 2-8" (813 mm) maximum to structural supporting member
- Vertical hangers
- Connection to supporting structural member
- Longitudinal brace on each side of duct (shown dotted)
- Transverse brace
- Vertical braces
- Horizontal brace
- 1/2" (12.7 mm) CLR. MAX
- 6" (152 mm)
- #10 self-tapping sheet metal screws equally spaced (450 mm) O.C. MAX
- Maximum 3 sides
The notes are specific to each drawing; these are just a typical representation.
FIGURE 4-3 SIDE BRACING FOR RECTANGULAR DUCTS

- Vertical Hangers
- Connection to Supporting Structural Member
- Transverse Brace
- Longitudinal Brace
- 1" (25.4 mm) Maximum
- 1/2" (12.7 mm) Clear Max.
- #10 Self-Tapping Sheet Metal Screws Equally Spaced (450 mm O.C. Max.)
- Typical 4 Sides
- Duct Size
- Duct
- Q of Bolts & Screws Equal Q of Angle
FIGURE 4-4 CABLE SIDE BRACING FOR RECTANGULAR DUCTS

- Connection to supporting structural member
- Vertical hangers
- Horizontal brace
- Longitudinal cable brace
  - Each side of hanger, each side of duct
- Transverse cable brace

Dimensions:
- 2" - 8" (81.3 mm) maximum to structural supporting member
- 1" (25.4 mm) typical 4 sides
- 1" (25.4 mm) maximum

Notes:
- See Fig. 10-3 or 10-4
FIGURE 4-5 SIDE BRACING FOR RECTANGULAR DUCTS

- CONNECTION TO SUPPORTING STRUCTURAL MEMBER
- ADD VERT. HANGERS FROM SCHEDULE WHEN 'L' IS GREATER THAN MAX. LENGTH PER TABLE.
- TRANSVERSE BRACE
- LONGITUDINAL BRACE ONE EACH SIDE OF DUCT.
- BENT PLATE, CONNECTION TYPE A THRU D 3" x 1/4" (75 mm x 6.4 mm)
- CONNECTION TYPE E THRU H 4" x 3/8" (100 mm x 9.53 mm)
- ROD PER TABLE 5-2, 6-2, 7-2 OR 8-2
- 1-5/8" x 1-5/8" x 14 GA. (41.3 x 41.3 x 2.0 mm) ANGLE.
FIGURE 4-6 CENTER BRACING FOR RECTANGULAR DUCTS

- Connection to supporting structural member
- Transverse brace
- Horizontal brace
- 1/2" (12.7 mm) clear max.
- Vertical hanger
- Longitudinal brace one ea. side of duct (shown dotted)
- Bolts equal angles
- Duct
- Insulation where req’d

10' (3050 mm) max.
L (25.4 mm)

1/2" (12.7 mm) clear max.

1/2" (12.7 mm)

1" (25.4 mm)

#10 self-tapping sheet metal screws equally spaced 18° O.C. max. 450 mm (18"") max.

Typical 4 sides
FIGURE 4-7 CABLE CENTER BRACING FOR RECTANGULAR DUCTS
FIGURE 4-8 FLOOR SUPPORTED DUCT

(3) #10 SELF TAPPING SHEET METAL SCREWS

CLIP ANGLE SAME AS HORIZ. BEAM W/ 3 #10 SCREWS TO DUCT. SEE TABLES FOR BOLT SIZE TO HORIZ. BEAM

LONGITUDINAL BRACE SAME AS TRANSVERSE BRACE

VERT. LEGS

1/2" (12.7 mm) CLR. MAX

" (76.2 mm) MAX

MAX

DUCT WIDTH + 6" (150 mm) MAX

2" (50.8 mm) x 18 GA. (1.31 mm) DUCT STRAP ALTERNATIVE TO CLIP ANGLES.

DUCT SIZES SHOWN IN TABLES 5-6, 6-6, AND 7-6

HORIZ. BEAM LLV

CONNECTION TYPE A & B SHOWN

MAX (250 mm) 0-7
FIGURE 4-8 FLOOR SUPPORTED DUCT

- CONNECTION TO SUPPORTING STRUCTURAL MEMBER
- 2" (50.8 mm) WIDE 18 GA. (1.31 mm) DUCT STRAP
- #10 SELF TAPPING SHEET METAL SCREWS – 3 PLACES
- 5/16" (7.9 mm) BOLT TYP. 2 PLACES

ROUND OR OVAL DUCT

ROUND / OVAL DUCT DETAIL
FIGURE 4-9 SINGLE HANGER SPACING FOR ROUND DUCTS
33-36 INCHES (838-900 MM)
FIGURE 4-10 SINGLE HANGER CABLE BRACING FOR ROUND DUCTS
33-36 INCHES (838-900 MM)

- CONNECTION TO SUPPORTING STRUCTURAL MEMBER
- VERTICAL HANGER 1 MIN 2 MAX
- TRANSVERSE CABLE BRACE. SEE FIG. 10-5
- MACHINE BOLT
- LONGITUDINAL CABLE BRACE
- 5'-0" (1525 mm) MAXIMUM TO STRUCTURAL SUPPORTING MEMBER
- W.P.
- 2-1/2" x 12 GAUGE (63.5 x 2.5 mm) SHEET METAL STRAP
- DUCT SIZE
FIGURE 4-11 DOUBLE HANGER BRACING FOR ROUND DUCTS UP TO 84 INCHES (2100 MM)
FIGURE 4-12 DOUBLE HANGER CABLE BRACING FOR ROUND DUCTS
33-36 INCHES (838-900 MM)

- CONNECTION TO SUPPORTING STRUCTURAL MEMBER
- LONGITUDINAL CABLE BRACE (EACH SIDE OF DUCT)
- TRANSVERSE CABLE BRACE

MAXIMUM TO STRUCTURAL MEMBER:

- 8'-0" (2450 mm)

DUCT SIZE:

- 2 1/2" x 12 GAUGE (63.5 x 2.75 mm) STRAP

TRANSVERSE BRACE, SEE FIG. 10-1 OR 10-2 ONE. PER HANGER

- 2 1/2" x 14 GAUGE (63.5 x 2.0 mm) STRAP
- 3" x 3" x 1/4" x 0'-3"
  (75 x 75 x 6.4 x 75 mm)
- 3" x 3" x 3/16" PL WASHER
  (75 x 75 x 4.76 mm)

NOTES:
Connections to Piping/Conduit Systems

- The SMACNA Seismic Restraint Manual Contains 10 Different Details for Connecting to Piping/Conduit Systems
FIGURE 4-13 TRANSVERSE BRACING FOR PIPES

- CONNECTION TO SUPPORTING STRUCTURAL MEMBER
- EXPANSION ANCHORS SHOWN HERE FOR EXAMPLE
- 1/8” (3.2 mm) 1” – 24” (25.4 – 609 mm)
- ADD VERTICAL HANGERS FROM SCHEDULE WHEN ‘L’ GREATER
- HANGER ROD
- PIPE HANGER ROD CLIP
- CONNECTION TYPE A THRU D BENT
  - 3”x1/4” (76.2 x 6.4 mm)
  - 4”x3/8” (101.6 x 9.5 mm)
- ADD PIPE SLEEVE THAT HAS AN INSIDE DIAMETER, 1/4” (6.4 mm) ± LARGER THAN OUTSIDE DIAMETER OF BOLT.
- TO SUPPORTING STRUCTURE
- SEE FIG. 9- ALTERN DETAIL
FIGURE 4-14 TRANSVERSE STRUT BRACING FOR PIPES

- **Supporting Structure**: "L" 6'-0" (1.8 m) max. to 6" max. (152.4 mm) min.
- **Channel Brace**: For connection see Fig. 10-7
  - Channel Size: 1-1/2" (38.1 mm)
  - Connection Type: A thru D bend
  - Dimensions: 3" x 1/4" (76.2 x 6.4 mm) E thru H bend
  - Dimensions: 4" x 3/8" (101.6 x 9.5 mm)
- **Pipe Hanger**: Rod clip
- **Add Pipe Sleeve**: That has an inside diameter, 1/4" (6.4 mm) larger than outside diameter of bolt.
FIGURE 4-15 ALTERNATE ATTACHMENT TO HANGER FOR PIPE BRACING

INSTALL BENT P FOR LONGITUDINAL BRACE AT THIS POINT.

CONNECTION TYPE
A THRU D BENT
P 3”x1/4”
E THRU H BENT
P 4”x3/8”

ADJUSTABLE SOLID OR SPLIT RING HANGER

“J” HANGER

NOTE: REFER TO FIGURE 4.14 FOR NOTES AND TIE

FELT PAD OR ISOLATION IF REQUIRED

GALV. HOLD-DOWN WIRE FOR GLASS PIPE ONLY.

TRANSVERSE BRACE

TRANSVERSE BRACE
FIGURE 4-16 LONGITUDINAL BRACING FOR PIPES
FIGURE 4-17 ALTERNATE BRACING FOR PIPES

NOTES:
1. INSTALL BRACES SHOWN ON THIS PAGE WITHIN 4" (101.6 mm) OF HANGER SHOWN ON FIG. 4-14.
2. REFER TO FIG. 4-16 FOR OTHER REQUIREMENTS.

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>BOLT SIZE</th>
<th>DIM A</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP TO 1-1/2&quot; (38.1 mm)</td>
<td>1/2&quot; (12.7 mm)</td>
<td>1/8&quot; (3.2 mm)</td>
</tr>
<tr>
<td>2&quot; TO 6&quot; (50.8 TO 152.4 mm)</td>
<td>3/4&quot; (19.1 mm)</td>
<td>1/4&quot; (6.4 mm)</td>
</tr>
</tbody>
</table>
FIGURE 4-18 TRANSVERSE CABLE BRACING FOR PIPES

ADD FRAMING CHANNEL OR ANGLE WHEN 'L' IS GREATER THAN MAX. LENGTH

SYMETRICAL ABOUT C

FOR CHANNEL SIZE AND CONNECTION SEE FIG. 10-11

CABLE BRACING SEE DETAIL FIG. 10-3, 10-5

SAME AS OPPOSITE SIDE

PIPE HANGER
ROD CUP CONNECTION TYPE
A THRU D BENT
B 3"x1/4" (76.2 x 6.4 mm)
C THRU H BENT
D 4"x3/8" (101.6 x 9.5 mm)

ADD PIPE SLEEVE THAT HAS AN INSIDE DIAMETER, 1/4" (6.4 mm) + LARGER THAN OUTSIDE DIAMETER OF BOLT.
FIGURE 4-19 LONGITUDINAL CABLE BRACING FORPIPES
FIGURE 4-20 STRUT BRACING FOR PIPE TRAPEZE

Connection to Supporting Structural Member

Maximum Trapeze Span

Vertical Support Same as Opposite Side

Add Vertical Angle from Schedule When 'L' Greater than Maximum Length

Longitudinal Brace
One Each End of Trapeze (Slope Same as Transverse Brace). Strut Channel Can Be Used Per Fig. 10-11. (Longitudinal Brace at Opposite End Not Shown for Clarity)

Holdown Clamp Typical

For Pipe Size, See Table 5-8, 6-8, 7-8, or 8-8

1-3/4" (44.5 mm) SQ.

x 1-8" (3.2 mm)

L Washer

See Fig. 10-12 for Trapeze Section

Transverse Bracing Same as Other Side

Connection Type
A Thru D Bent
P[3]"x1/4" (76.2 x 6.4 mm)
E Thru H Bent
P[4]"x3/8" (101.6 x 9.5 mm)

1-1/2" (38.1 mm) Max.

1/2" (12.7 mm) Max.
FIGURE 4-21 CABLE BRACING FOR PIPE TRAPEZE

LONGITUDINAL CABLE BRACE, SEE FIG. 10-5

VA 
"B-0" (1.8 m) MAX TO SUPPORTING STRUCTURE MEMBER

VERTICAL SUPPORT SAME AS OPPOSITE SIDE

ADD VERTICAL ANGLE FROM SCHEDULE WHEN 'L' IS GREATER THAN MAXIMUM LENGTH

TRANVERSE CABLE BRACE, SEE FIG. 10-5

1 MIN. 2 MAX HANGER ROD

CONNECTION TYPE
A THRU D BENT
P 3"x1/4" (76.2 x 6.4 mm)
E THRU H BENT
P 4"x3/8" (101.6 x 9.5 mm)

SEE FIG. 10-12 FOR TRAPEZE SECTION

CONNECTION TYPE
A THRU D BENT
P 3"x1/4" (76.2 x 6.4 mm)

1-1/2" (38)

2" (5)
FIGURE 4-22 FLOOR SUPPORTED PIPES

TRAPEZE SUPPORT ANGLE
'8" x 1-5/8" x 1/8" x 1-5/8" LONG
(33.3 x 33.3 x 3.2 x 33.3 mm)

PIPE SUPPORT
SAME AS AT TRAPEZE

HOLD DOWN CLAMPS
& PIPES SAME AS
TRAPEZE

MACHINE BOLTS
SEE TABLE

LONGITUDINAL BRACE
SAME AS TRANSVERSE
BRACE

VERT. LEGS

3" (76.2 mm) MAX

1 MIN
2 MAX

DIAGONAL TRANSVERSE BRACE

CONNECTION
TYPE A & B SHOWN

CONNECTION
TYPE C, D, & E SHOWN

3" (76.2 mm) MAX
Connections to the Structure

The SMACNA Seismic Restraint Manual Contains 8 Levels for Connection into Concrete

(2) 1 Bolt Connection
(3) 2 Bolt Connections
(3) 4 Bolt Connections
Connections to the Structure

The SMACNA Manual Contains

(6) Alternative Connections to Concrete
(6) Details for Connection to Steel
(3) Details for Connections to Wood
CONNECTIONS TO STRUCTURES

1

G G

1-3/4" (44.5 mm)

1-1/2" (38.1 mm)

2

TYPE C, D, & E

ITEMS NOT NOTED SAME AS DETAIL 1

TYPE | G | in | mm
--- | --- | --- | ---
C | 3" | 76.2 |
D | 3-3/4" | 95.3 |
E | 4-1/2" | 114.3 |
CONNECTIONS TO STRUCTURES

- Anchor Bolt
- Adjustable hinged connection with overturning authority approval
- Expansion anchor bolts
- 10x bolt dia. min.
- 1 max. hinge 1 min. with authority
- 1–5/8" (41.3 mm) framing channel
CONNECTION TO STRUCTURES

SCORE THREAD TO PREVENT NUT ROTATION

2" SQ. x 1/4" PL AT TYPE A & B
3" SQ. x 3/8" PL AT TYPE C, D & E

NOTES:
RODS TO BE PLACED PRIOR TO CONCRETE FILL.
DRILL 1/16" LARGER HOLE THAN THE NOMINAL ROD DIA. THRU OPEN CELL.

CONNECTION TO HOLLOW CORE PLANK
TYPE A, B, C, D, & E
CONNECTIONS TO STRUCTURES

L 4” x 3-1/2” x 3/8” x 0’-5 1/2” (101.6 x 9.5 x 88.9 x 139.7 mm) TYP.
EACH END (2) 5/8” (15.9 mm) MACHINE BOLTS EA. LEG. (OR EQUIVALENT WELDED CONN.)

3 1/2” (88.9 mm)

12’-0” (3.65 m) MAXIMUM

UNDERSIDE OF SPREADER SEE SCHEDULE
MACHINE BOLT AT END OF BRACE

VERTICAL AND DIAGONAL BRACES

LONGITUDINAL BRACES AS REQUIRED (SHOWN DOTTED)

CONNECTIONS TO SPREADERS TYPE A THRU H
USE WITH VERTICAL, DIAGONAL, AND LONGITUDINAL L’S
CONNECTIONS TO STRUCTURES

2 ROWS OF 8d @ 4"
(100 mm)

2'-0" MIN. (610 mm)

MACHINE BOLT AT WOOD

WOOD MEMBER
USE 6 X MIN.

VERTICAL, DIAGONAL, OR
LONGITUDINAL BRACES

FRAMING ANCHORS EACH
END, EACH SIDE (450 lb.
CODE APPROVED VALUE)

STANDARD CUT WASHER
WOOD SHEATHING

HOLES FOR BOLTS SHALL BE
BORED 1/16" (1.59 mm)
LARGER THAN THE NOMINAL
BOLT DIAMETER

BRACE PERPENDICULAR TO
WOOD MEMBER

BRACE PARALLEL TO
WOOD MEMBER

TYPE A, B, & C
Miscellaneous Connections

The SMACNA Manual contains:

• Specific Details on Various Connections
• Bracing for Hubless Cast Iron Pipe
• Riser Bracing for Hubless Pipes
• Seismic Joints in Pipes
Miscellaneous Connections

The SMACNA Manual contains:

- Welded Tabs for Pipe Connections
- Stiffeners & Saddles at Pipe Clamps
MISCELLANEOUS CONNECTIONS

LONGITUDINAL CABLE BRACE

SEE FIGURE 10–3

DIAGONAL CABLE BRACE
SEE FIGURE 10–5
MISCELLANEOUS CONNECTIONS

2" (50.8 mm) SQ. x 1/8" (3.2 mm) P WASHED TYPICAL

BOLT

GALV. HEAVY WIRE ROPE THIMBLE

CABLE WITH WIRE ROPE CLIPS
MISCELLANEOUS CONNECTIONS

WELDED TAB FOR LONGITUDINAL BRACE

WELDED TAB FOR TRANSVERSE BRACE
The Ten Step Process

1. Get the SHL from the Designer
2. Check the structural system (*What the ducts and pipes hang from*)
3. Find the detail in Chapter 4 that corresponds to your condition
4. Determine which chapter has the correct schedule (based on SHL)
The Ten Step Process

5. Find the correct table in that chapter (see notes from detail selected in chapter 4)

6. Determine the proper row (size and weight)

7. Use the row to get information on the sizes of hangers, bolts, etc.
The Ten Step Process

8. Use the row to get the connection type (A through I)
9. Use Table 9-1 and connection type to determine the size and quantity of anchor, bolt, angle, etc.
10. Find the detail in Chapter 9 that corresponds to the connection type and the supporting structure.
Example 1

- Single run of rectangular duct
- Top of duct is 5’-8” from to supporting structure
- Duct size 58” x 24” @ 36 lb/ft
- $C_s = .80$ so SHL=A Provided by designer
Example 1

• First determine the applicable figures in Chapter 4.
  – Can not use Figures 4-2 thru 4-4
    • too far from the structure
  – Figures 4-5 thru 4-7 qualify
    • Note Figure 4-8 is for floor supports
  – Because of preference and jobsite conditions we will use Figure 4-7 which is for center bracing using cable
Example 1

Figure 4-7

- CONNECTION TO SUPPORTING STRUCTURAL MEMBER
- 1" (25.4 mm)
- DUCT SIZE
- 10" (3050 mm) MAX TO STRUCTURAL SUPPORTING MEMBER
- SEE FIG. 10-1 OR 10-2
- TYPICAL 4 SIDES
- 1/4" (6.4 mm) TAPPING
- SHEET METAL CONNECTION
- SPLICE, EQUALLY
- (450 mm) O.C.
- NO. 10-12 SHEET METAL SCREWS
- 7" (177 mm) MAX
- 1 MIN
- 2 MAX
- 1/2 OF BOLTS EQUAL
- 1/2 OF ANGLE
- TRANSVERSE CABLE BRACE
- LONITUDINAL CABLE BRACE
- EACH SIDE OF HANGER AND EACH SIDE OF DUCT
- SEE FIG. 9-3 OR 9-4
- 6" (150 mm) MAX
Example 1

• Figure 4-7
  – Note 3, Since L = 5’-8” we need to use table 5-3, 6-3, 7-3, or 8-3
  – In our case SHL = A (Chapter 5)
    • Use Table 5-3 because chapter 5 is for SHL A

NOTES:
1. REFER TO CHAPTER 3 FOR GENERAL REQUIREMENTS.
2. WHEN A COMBINATION OF DUCTS IS USED IN LIEU OF ONE DUCT, AT LEAST 2 SIDES OF EACH DUCT MUST BE CONNECTED TO VERTICAL OR HORIZONTAL ANGLES AND THE COMBINED WEIGHT SHALL NOT EXCEED THAT GIVEN IN THE TABLE. (ADD HORIZONTAL ANGLES IF REQUIRED.)
3. WHERE “L” IS LESS THAN 7 FEET (2134 mm), SEE TABLE 5-3, 6-3, 7-3 or 8-3; OTHERWISE SEE TABLE 5-4, 6-4, 7-4, OR 8-4 FOR VERTICAL HANGERS, DIAGONAL AND HORIZONTAL BRACES, BOLT SIZE CONNECTION TO SUPPORTING STRUCTURAL MEMBER, AND SPACING OF BRACING.
### Example 1

<table>
<thead>
<tr>
<th>Duct Size WxD (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size) (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size) (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members</th>
<th>Max. Wt. Fr (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30x30</td>
<td>L4x4x14ga (D)</td>
<td>L2x2x16ga</td>
<td>L4x4x14ga (C)</td>
<td>%</td>
<td>C</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>42x42</td>
<td>L4x4x14ga (E)</td>
<td>L2x2x16ga</td>
<td>L3x3x12ga (E)</td>
<td>%</td>
<td>C</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>54x54</td>
<td>L4x4x14ga (F)</td>
<td>L2x2x16ga</td>
<td>L4x4x12ga (F)</td>
<td>%</td>
<td>D</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>60x60</td>
<td>L4x4x14ga (G)</td>
<td>L2x2x16ga</td>
<td>L4x4x12ga (G)</td>
<td>%</td>
<td>D</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>84x84</td>
<td>L3x3x12ga (H)</td>
<td>L2.5x2.5x16ga</td>
<td>2 ½ Pipe (I)</td>
<td>%</td>
<td>E</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>96x96</td>
<td>L3x3x12ga (H)</td>
<td>L2.5x2.5x16ga</td>
<td>2 ½ Pipe (I)</td>
<td>%</td>
<td>E</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>54x28</td>
<td>L4x4x14ga (D)</td>
<td>L2x2x16ga</td>
<td>L3x3x12ga (E)</td>
<td>%</td>
<td>D</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>60x30</td>
<td>L4x4x14ga (E)</td>
<td>L2x2x16ga</td>
<td>L3x3x12ga (E)</td>
<td>%</td>
<td>D</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>84x42</td>
<td>L4x4x14ga (G)</td>
<td>L2.5x2.5x16ga</td>
<td>L4x4x12ga (H)</td>
<td>%</td>
<td>E</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>96x48</td>
<td>L4x4x14ga (G)</td>
<td>L2.5x2.5x16ga</td>
<td>2 ½ Pipe (I)</td>
<td>%</td>
<td>E</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>108x54</td>
<td>L3x3x12ga (H)</td>
<td>L3x3x16ga</td>
<td>2 ½ Pipe (J)</td>
<td>%</td>
<td>E</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>120x60</td>
<td>L3x3x12ga (H)</td>
<td>L4x4x16ga</td>
<td>2 ½ Pipe (J)</td>
<td>%</td>
<td>E</td>
<td>121</td>
<td></td>
</tr>
</tbody>
</table>

**Table 5-3** Center Bracing For Rectangular Ducts, SHL A, L=7 ft
## Example 1

<table>
<thead>
<tr>
<th>Duct Size W×D¹ (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size)² (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size)² (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members³</th>
<th>Max. Wt. Ft⁴ (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54×28</td>
<td>L₄×4×14ga</td>
<td>L₃×3×12ga (D)</td>
<td>L₂×2×16ga</td>
<td>L₃×3×12ga (E)</td>
<td>%</td>
<td>D</td>
<td>34</td>
</tr>
<tr>
<td>60×30</td>
<td>L₄×4×14ga</td>
<td>L₃×3×12ga (E)</td>
<td>L₂×2×16ga</td>
<td>L₃×3×12ga (F)</td>
<td>%</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

**NOTES:**

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. See Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
### Example 1

<table>
<thead>
<tr>
<th>Duct Size W×D(^1) (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size)(^2) (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size)(^2) (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members(^3)</th>
<th>Max. Wt. Ft(^4) (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54×28</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (D)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (E)</td>
<td>%</td>
<td>D</td>
<td>34</td>
</tr>
<tr>
<td>60×30</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (E)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (F)</td>
<td>%</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

**NOTES:**

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. See Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
Example 1

- The vertical hangers are 4 x 4 x 14 gage angle
## Example 1

<table>
<thead>
<tr>
<th>Duct Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>W×D₁</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>(in.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vertical Hangers Angles (in.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Transverse Braces Angle Pipe (Cable Size)² (in.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Horizontal Braces Angles (in.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Longitudinal Braces Angle (Cable Size)² (in.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Bolt Size (in.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Connection Type to Structural Members³</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Max. Wt. Ft⁴ (lb)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>54×28</th>
<th>L4×4×14ga</th>
<th>L3×3×12ga (D)</th>
<th>L2×2×16ga</th>
<th>L3×3×12ga (E)</th>
<th>%</th>
<th>D</th>
<th>34</th>
</tr>
</thead>
<tbody>
<tr>
<td>60×30</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (E)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (F)</td>
<td>%</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

### NOTES:

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. See Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
Example 1

- The horizontal braces are 2 x 2 x 16 gage angle
Example 1

<table>
<thead>
<tr>
<th>Duct Size W×D&lt;sup&gt;1&lt;/sup&gt; (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size)&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size)&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Max. Wt. Ft&lt;sup&gt;4&lt;/sup&gt; (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54×28</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (D)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (E)</td>
<td>%</td>
<td>D</td>
<td>34</td>
</tr>
<tr>
<td>60×30</td>
<td>L4×4×14ga</td>
<td>L2×2×12ga (E)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (F)</td>
<td>%</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

NOTES:

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. See Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
# Example 1

<table>
<thead>
<tr>
<th>ID</th>
<th>Nominal Size</th>
<th>Breaking Strength</th>
<th>Design Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
<td>mm</td>
<td>lbf</td>
</tr>
<tr>
<td>A</td>
<td>1/8</td>
<td>3.2</td>
<td>1,330</td>
</tr>
<tr>
<td>B</td>
<td>5/32</td>
<td>4.0</td>
<td>2,140</td>
</tr>
<tr>
<td>C</td>
<td>3/16</td>
<td>4.8</td>
<td>2,850</td>
</tr>
<tr>
<td>D</td>
<td>7/32</td>
<td>5.6</td>
<td>3,850</td>
</tr>
<tr>
<td>E</td>
<td>1/4</td>
<td>6.4</td>
<td>4,750</td>
</tr>
<tr>
<td>F</td>
<td>5/32</td>
<td>7.1</td>
<td>6,400</td>
</tr>
<tr>
<td>G</td>
<td>5/32</td>
<td>7.9</td>
<td>8,000</td>
</tr>
<tr>
<td>H</td>
<td>3/16</td>
<td>9.5</td>
<td>10,800</td>
</tr>
<tr>
<td>I</td>
<td>7/32</td>
<td>11.1</td>
<td>14,500</td>
</tr>
<tr>
<td>J</td>
<td>1/2</td>
<td>12.7</td>
<td>18,800</td>
</tr>
<tr>
<td>K</td>
<td>9/32</td>
<td>14.3</td>
<td>24,100</td>
</tr>
<tr>
<td>L</td>
<td>5/16</td>
<td>15.9</td>
<td>29,600</td>
</tr>
<tr>
<td>M</td>
<td>3/4</td>
<td>19.1</td>
<td>40,800</td>
</tr>
<tr>
<td>N</td>
<td>7/8</td>
<td>22.2</td>
<td>55,800</td>
</tr>
<tr>
<td>O</td>
<td>1</td>
<td>25.4</td>
<td>71,900</td>
</tr>
</tbody>
</table>

Table 3-2

Safety factor ~ 2.85
Example 1

- The transverse brace cables are a class E per Table 3-2 (nominal ¼” diameter)
- The transverse brace spacing is 30 ft.
Example 1

- Figures 10-1 and 10-2 cable connection to duct frame
# Example 1

<table>
<thead>
<tr>
<th>Duct Size W×D&lt;sup&gt;1&lt;/sup&gt; (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size)&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size)&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Max. Wt. Ft&lt;sup&gt;4&lt;/sup&gt; (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54×28</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (D)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (E)</td>
<td>%</td>
<td>D</td>
<td>34</td>
</tr>
<tr>
<td>60×30</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (E)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (F)</td>
<td>%</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

**NOTES:**

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. *See* Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
### Example 1

#### Cable Design Strength

<table>
<thead>
<tr>
<th>ID</th>
<th>Nominal Size</th>
<th>Breaking Strength</th>
<th>Design Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
<td>mm</td>
<td>lbf</td>
</tr>
<tr>
<td>A</td>
<td>¹/₈</td>
<td>3.2</td>
<td>1,330</td>
</tr>
<tr>
<td>B</td>
<td>¹/₂₂</td>
<td>4.0</td>
<td>2,140</td>
</tr>
<tr>
<td>C</td>
<td>¹/₆</td>
<td>4.8</td>
<td>2,850</td>
</tr>
<tr>
<td>D</td>
<td>¹/₃₂</td>
<td>5.6</td>
<td>3,850</td>
</tr>
<tr>
<td>E</td>
<td>¹/₄</td>
<td>6.4</td>
<td>4,750</td>
</tr>
<tr>
<td>F</td>
<td>¹/₂₂</td>
<td>7.1</td>
<td>6,400</td>
</tr>
<tr>
<td>G</td>
<td>¹/₆</td>
<td>7.9</td>
<td>8,000</td>
</tr>
<tr>
<td>H</td>
<td>¹/₆</td>
<td>9.5</td>
<td>10,800</td>
</tr>
<tr>
<td>I</td>
<td>¹/₆</td>
<td>11.1</td>
<td>14,500</td>
</tr>
<tr>
<td>J</td>
<td>¹/₂</td>
<td>12.7</td>
<td>18,800</td>
</tr>
<tr>
<td>K</td>
<td>¹/₆</td>
<td>14.3</td>
<td>24,100</td>
</tr>
<tr>
<td>L</td>
<td>¹/₆</td>
<td>15.9</td>
<td>29,600</td>
</tr>
<tr>
<td>M</td>
<td>¹/₄</td>
<td>19.1</td>
<td>40,800</td>
</tr>
<tr>
<td>N</td>
<td>¹/₆</td>
<td>22.2</td>
<td>55,800</td>
</tr>
<tr>
<td>O</td>
<td>¹</td>
<td>25.4</td>
<td>71,900</td>
</tr>
</tbody>
</table>

Table 3–2

Safety factor ~ 2.85
Example 1

- The longitudinal brace cables are a class F per Table 3-2
  - (nominal 9/32” diameter)
- The longitudinal brace spacing is 60 ft.
- Longitudinal cable bracing is on each side of the hanger and on each side of the duct (4)
Example 1

- Figures 10-3 and 10-4 cable connection to duct hanger
Example 1

- Figure 10-5 Cable End Connections

2" (50.8 mm) SQ. x 1/8" (3.2 mm)
R. WASHER TYPICAL

GALV. HEAVY WIRE
ROPE THIMBLE

BOLT

CABLE WITH WIRE ROPE CLIPS
# Example 1

<table>
<thead>
<tr>
<th>Duct Size W×D&lt;sup&gt;1&lt;/sup&gt; (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size)&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size)&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Max. Wt. Ft&lt;sup&gt;4&lt;/sup&gt; (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54×28</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (D)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (E)</td>
<td>¾</td>
<td>D</td>
<td>34</td>
</tr>
<tr>
<td>60×30</td>
<td>L4×4×14ga</td>
<td>L3×3×12ga (E)</td>
<td>L2×2×16ga</td>
<td>L3×3×12ga (F)</td>
<td>¾</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

**NOTES:**

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. See Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
Example 1

- Connection bolts are 3/8 inch diameter
# Example 1

<table>
<thead>
<tr>
<th>Duct Size W×D¹ (in.)</th>
<th>Vertical Hangers Angles (in.)</th>
<th>Transverse Braces Angle Pipe (Cable Size)² (in.)</th>
<th>Horizontal Braces Angles (in.)</th>
<th>Longitudinal Braces Angle (Cable Size)² (in.)</th>
<th>Bolt Size (in.)</th>
<th>Connection Type to Structural Members³</th>
<th>Max. Wt. Ft⁴ (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54×28</td>
<td>L₄×4×14ga</td>
<td>L₃×3×12ga (D)</td>
<td>L₂×2×16ga</td>
<td>L₃×3×12ga (E)</td>
<td>%</td>
<td>D</td>
<td>34</td>
</tr>
<tr>
<td>60×30</td>
<td>L₄×4×14ga</td>
<td>L₃×3×12ga (E)</td>
<td>L₂×2×16ga</td>
<td>L₃×3×12ga (F)</td>
<td>%</td>
<td>D</td>
<td>39</td>
</tr>
</tbody>
</table>

**NOTES:**

1. The ducts' maximum dimensions will govern what bracing is required. Example: A 72 × 30 in. duct will be braced like an 84 × 42 in. duct.

2. Provide transverse bracing at 30 ft and longitudinal bracing at 60 ft. See Table 3-2 for cable size.

3. See Table 9-1 for “Connection Type” to structural supporting members.

4. Maximum weight of duct or combinations of ducts is per linear foot. For ducts weighing more than the maximum weight per foot, use the next higher duct size.
### Example 1

<table>
<thead>
<tr>
<th>Type</th>
<th><strong>Maximum Load Capacity</strong>&lt;sup&gt;1&lt;/sup&gt; (lb)</th>
<th><strong>Expansion Anchors to Concrete</strong>&lt;sup&gt;2&lt;/sup&gt; (in.)</th>
<th><strong>Machine Bolt End of Brace</strong> (in.)</th>
<th><strong>Spreader Size</strong> (in. × lb/ft)</th>
<th><strong>Machine Bolt at Wood</strong> (in.)</th>
<th><strong>Hollow Core Plank Rod</strong></th>
<th><strong>Angle Supporting Structural Member</strong>&lt;sup&gt;3&lt;/sup&gt; (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1040</td>
<td>½</td>
<td>¾</td>
<td>C4×5.4</td>
<td>½</td>
<td>¾</td>
<td>3½×2½×¾×0 ft, 3 in. LLH</td>
</tr>
<tr>
<td>B</td>
<td>1415</td>
<td>¾</td>
<td>¾</td>
<td>C4×5.4</td>
<td>¾</td>
<td>¾</td>
<td>5×3×¾×0 ft, 3 in. LLH</td>
</tr>
<tr>
<td>C</td>
<td>1586</td>
<td>(2) ½</td>
<td>½</td>
<td>C5×6.7</td>
<td>¾</td>
<td>¾</td>
<td>(2) 4×3×¾×0 ft, 4 in. LLH</td>
</tr>
<tr>
<td>D</td>
<td>2020</td>
<td>(2) ¾</td>
<td>½</td>
<td>C6×8.2</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>½</td>
<td>(2) 5×3×¾×0 ft, 4 in. LLH</td>
</tr>
<tr>
<td>E</td>
<td>2870</td>
<td>(2) ¾</td>
<td>¾</td>
<td>C8×11.5</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>½</td>
<td>(2) 6×3½×¾×0 ft, 4 in. LLH</td>
</tr>
<tr>
<td>F</td>
<td>4600</td>
<td>(4) ¾</td>
<td>¾</td>
<td>C9×13.4</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>(2) 5×3×¾×0 ft, 10 in. LLH</td>
</tr>
<tr>
<td>G</td>
<td>7040</td>
<td>(4) ¾</td>
<td>¾</td>
<td>C10×15.3</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>(2) 6×3½×¾×0 ft, 11½ in. LLH</td>
</tr>
<tr>
<td>H</td>
<td>9240</td>
<td>(4) ¾</td>
<td>¾</td>
<td>C12×20.7</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>(2) 8×4×¾×1 ft, 1½ in. LLH</td>
</tr>
<tr>
<td>I</td>
<td>15,680</td>
<td>(6) ¾</td>
<td>1</td>
<td>C12×30</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Note&lt;sup&gt;6&lt;/sup&gt;</td>
<td>(2) 8×4×¾×2 ft, 2½ in. LLH</td>
</tr>
</tbody>
</table>

**Table 9–1 Schedule for Typical Connections to Structural Supporting Members**<sup>1</sup>  

*NOTES:*
Example 1

NOTES:

1. Maximum load capacity is for general information only and the maximum member force in the bracing system used in this manual. A designer may use this force to design a special connection if required.

2. Expansion anchors will be installed per the requirements given in the latest ICC report for the specific anchor. Also, see the requirements and general notes in Chapter 3.

3. Machine bolts into 6x wood members unless shown otherwise on the details.

4. LLH = long leg horizontal.

5. Must be engineered individually.

6. Numbers in parentheses are the quantity required. (2) $\frac{3}{4}$ is two $\frac{3}{4}$ in. diameter anchors.
Example 1

- Chapter 9 has other “typical” connections including:
  - Steel
    - Web
    - I BEAMS (SPREADERS)
  - concrete decking
  - hollow core plank
$C_s > 1.00$

- What happens if $C_s$ is greater than 1?

- Appendix A
  - $C_s = 1.15$
    - Use SHL A where $C_s = 1.00$ and adjust spacing accordingly.
\( C_s > 1.00 \)

- Spacing for SHL A = 30 ft.
  - Reduce the spacing by
    - \( \frac{C_s A}{C_s X} \)
    - \( \frac{1.00}{1.15} = 0.87 \)
  - \( 0.87 \times 30 \text{ ft} = 26 \text{ ft.} \)
  - Brace using SHL A but use 26 ft. spacing
Questions

The Photo section of this presentation has been removed as it makes the file very large. There are approximately 15 slides that are photographs of installed bracing at the end of this presentation.

For the latest version of this presentation please follow the link below: www.Smacna.org/downloads/TECH/SMACNAseismic.pdf