

**NAI**

Novia Associates,  
Inc.

1 Northwestern Drive  
Salem, NH 03079  
Phone 603-898-8600  
Fax 603-898-2755  
info@noviaassociates.com

**SSD-2000**

**SEISMIC ANALYSIS  
TYPE 1,2,3,4,5,6,7,8, AND 9  
SEISMIC RESTRAINTS**

BY: RN | CHKD: RR | DATE: 12/06/06

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## INTRODUCTION

The following calculations will certify and establish the capacity of our Type 1 through 9 Seismic Restraints for suspended equipment.

Specific references to these nine restraint types will be made in subsequent submittals and marked up coordinated drawings for equipment, pipe, conduit, cable tray, etc.

The spreadsheet that will accompany the marked up coordinated drawings will determine the specific restraint type required for each particular location. This spreadsheet takes the seismic acceleration and calculates the horizontal force, and the weight at the support being restrained. Knowing the horizontal force the Type Restraint can be determined by Table 1 or 2, depending upon the specified minimum angle of installation.

The values shown in Table 1 are maximum horizontal forces based on the following:

- \* An installation angle of  $30^{\circ}$  from the vertical for all Type Restraint connections to ceiling.
- \* An angle of  $90^{\circ}$  from the vertical for Type 1,2,3,7,8,9 Restraint connections to the wall.
- \* An angle of  $30^{\circ}$  and  $150^{\circ}$  from the vertical for Type 4,5 and 6 Restraint connections to the wall.

The values shown in Table 2 are maximum horizontal forces based on the following:

- \* An installation angle of  $45^{\circ}$  from the vertical for all Type Restraint connections to ceiling.
- \* An angle of  $90^{\circ}$  from the vertical for Type 1,2,3,7,8,9 Restraint connections to the wall.
- \* An angle of  $45^{\circ}$  and  $135^{\circ}$  from the vertical for Type 4,5 and 6 Restraint connections to the wall.

From here the compressive force ( if any ) in the support rod can be determined from the known horizontal force for various angles. These angles shall be  $30^{\circ}$ ,  $45^{\circ}$ ,  $60^{\circ}$ , and  $89^{\circ}$  angles from the vertical for ceiling connections and  $30^{\circ}$ ,  $45^{\circ}$ ,  $60^{\circ}$ , and  $0^{\circ}$  from the horizontal for wall connections. Once the compressive force is determined, the maximum braced and unbraced rod lengths can be determined at each of the various angles.

The clip and the angle attachments to structure for cable restraints ( Type 1,2,3,7,8 and 9 ) will experience a prying action. This prying action will vary upon the installed angle of the restraint. In addition to this, the support rods of the equipment may need to be braced to prevent buckling. The reactions at structure on the clips and angles for the cable restraints will be based on the horizontal force, prying action, and the angle the cable is installed.

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The clip and angle attachments to the structure for the single arm brace restraints are assumed to have no prying action. This condition will be evident due to the rigidity of the single arm brace to prevent prying. In addition to this, the support rods of the equipment may need to be braced to prevent buckling. With these conditions in place, the reactions at structure on the clips and angles for the single arm brace restraints will be based on the anticipated horizontal force and the angle brace member is installed.

Specific references to these nine restraint types will be made in subsequent submittals and /or marked-up coordinated drawings for equipment, pipe, duct, conduit, cable tray, etc.

The Type 1 restraint consists of two 1/8" 7 x 19 steel cable restraints that are connected to Unistrut P-1546 angular fittings ( or equivalent ) anchored to ceiling deck with one 3/8" diameter Hilti Kwik Bolt II anchor with 2-1/2" embedment.

The Type 2 restraint consists of two 1/8" 7 x 19 steel cable restraints that are connected to Unistrut P-1546 angular fittings ( or equivalent ) anchored to ceiling deck with one 5/8" diameter Hilti Kwik Bolt II anchor with 4" embedment.

The Type 3 restraint consists of two 1/4" 7 x 19 steel cable restraints that are connected to 3" x 3" x 1/2" angular fittings ( or equivalent ) anchored to ceiling deck with two 5/8" diameter Hilti Kwik Bolt II anchor with 4" embedment.

The Type 4 restraint consists of one P-1000 Unistrut Single Arm Brace that is connected to Unistrut P-1546 angular fittings ( or equivalent ) anchored to ceiling deck with one 3/8" diameter Hilti Kwik Bolt II anchor with 2-1/2" embedment.

The Type 5 restraint consists of one P-1000 Unistrut Single Arm Brace that is connected to Unistrut P-1546 angular fittings ( or equivalent ) anchored to ceiling deck with one 5/8" diameter Hilti Kwik Bolt II anchor with 4" embedment.

The Type 6 restraint consists of one P-1000 Unistrut Single Arm Brace that is connected to 3" x 3" x 1/2" angular fittings ( or equivalent ) anchored to ceiling deck with two 5/8" diameter Hilti Kwik Bolt II anchor with 4" embedment.

The Type 7 restraint consists of four 1/8" 7 x 19 steel cable restraints that are connected to Unistrut P-1546 angular fittings ( or equivalent ) anchored to ceiling deck with one 3/8" diameter Hilti Kwik Bolt II anchor with 2-1/2" embedment.

The Type 8 restraint consists of four 1/8" 7 x 19 steel cable restraints that are connected to Unistrut P-1546 angular fittings ( or equivalent ) anchored to ceiling deck with one 5/8" diameter Hilti Kwik Bolt II anchor with 4" embedment.

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The Type 9 restraint consists of four 1/4" 7 x 19 steel cable restraints that are connected to 3" x 3" x 1/4" x 9" angular fittings ( or equivalent ) anchored to ceiling deck with two 5/8" diameter Hilti Kwik Bolt II anchor with 4" embedment.

**TABLE 1 ( Hilti 3000 psi Lightweight Concrete Ratings )**

Maximum Horizontal Force on Type Restraints 1,2,3,4,5,6,7,8 &amp; 9 @ 30°

| TYPE | ANGLE<br>(DEGREES) | MAXIMUM<br>HORIZONTAL<br>FORCE COMPONENT<br>IN THE SEISMIC<br>BRACE ( LBS. ) | ATTACHMENT<br>LOCATION<br>CEILING<br>OR WALL |
|------|--------------------|------------------------------------------------------------------------------|----------------------------------------------|
| 1    | 30                 | 155                                                                          | CEILING                                      |
| 1    | 90                 | 233                                                                          | WALL                                         |
| 2    | 30                 | 389                                                                          | CEILING                                      |
| 2    | 90                 | 573                                                                          | WALL                                         |
| 3    | 30                 | 1283                                                                         | CEILING                                      |
| 3    | 90                 | 1990                                                                         | WALL                                         |
| 4    | 30 AND 50          | 328                                                                          | CEILING                                      |
| 4    | 30                 | 356                                                                          | WALL                                         |
| 5    | 30 AND 50          | 840                                                                          | CEILING                                      |
| 5    | 30                 | 946                                                                          | WALL                                         |
| 6    | 30 AND 50          | 1680                                                                         | CEILING                                      |
| 6    | 30                 | 1892                                                                         | WALL                                         |
| 7    | 30                 | 155                                                                          | CEILING                                      |
| 7    | 90                 | 233                                                                          | WALL                                         |
| 8    | 30                 | 389                                                                          | CEILING                                      |
| 8    | 90                 | 573                                                                          | WALL                                         |
| 9    | 30                 | 1283                                                                         | CEILING                                      |
| 9    | 90                 | 1990                                                                         | WALL                                         |

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Maximum Horizontal Force on Type Restraints 1,2,3,4,5,6,7,8 &amp; 9 @ 45°

| TYPE | ANGLE<br>(DEGREES) | MAXIMUM<br>HORIZONTAL<br>FORCE COMPONENT<br>IN THE SEISMIC<br>BRACE ( LBS. ) | ATTACHMENT<br>LOCATION<br>CEILING<br>OR WALL |
|------|--------------------|------------------------------------------------------------------------------|----------------------------------------------|
| 1    | 45                 | 302                                                                          | CEILING                                      |
| 2    | 45                 | 770                                                                          | CEILING                                      |
| 3    | 45                 | 2430                                                                         | CEILING                                      |
| 4    | 45                 | 466                                                                          | CEILING                                      |
| 5    | 45                 | 1990                                                                         | CEILING                                      |
| 6    | 45                 | 2430                                                                         | CEILING                                      |
| 7    | 45                 | 302                                                                          | CEILING                                      |
| 8    | 45                 | 770                                                                          | CEILING                                      |
| 9    | 45                 | 2430                                                                         | CEILING                                      |

**NOTES:**

Allowable shear and tensile values for anchors are based on page 46 of the Hilti Technical Fastening Guide. Anchors must be installed in strict accordance with Hilti's installation instructions.

Anchor values for conditions other than 3000 psi lightweight concrete may be used if the actual job conditions warrant. This will be indicated on the **SEISMIC RESTRAINT WORK SHEET** which may be included as part of this or subsequent submissions.

**CONCLUSION**

Seismic restraint Types 1 through 9, which are selected in accordance with the values shown in table 1 and 2, will withstand calculated horizontal forces shown on the spreadsheet. The seismic acceleration, which determines the horizontal force on each restraint type is job specific.

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