Hamilton Engineering

Innovative Hot Water Solutions

Seismic Restraint Guidelines For Model:

Vertical Glass Round Jacket Tank
HET 257–HET 1000

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Seismic Restraint Guidelines

The following information contained in this publication was developed using seismic restraint guidelines for rigid restraint as defined by the 2012 IBC (International Building Code), 2016 California Building Code and standard engineering principles. These guidelines are subject to revision as further experience and information is obtained. The calculations presented in this publication assume the following:

- Equipment installed with rigid restraint—wedge type anchors into concrete. (Hilti, Inc., Kwik Bolt TZ Carbon Steel Anchors in Concrete)
- A minimum concrete compressive strength of 2500 psi.
- All equipment (unless specified) located at ground level.
- Effects of wind forces are not included in calculations.

This information may not be valid if other restraint methods are required or if other conditions are present and not accounted for in a particular application. Please consult all federal, state, and local regulations, as well as local certified engineers for final approval of specific installations. Hamilton Engineering and other contributors assume no responsibility and accept no liability for applications contained in this publication.

Terminology

Effective Shear Force (Veff)—Maximum shear force of one seismic restraint or tie-down bolt.

Effective Tension Force (Teff)—Maximum tension force or pullout force on one seismic restraint or tie-down bolt.

Shear Force (V)—Force generated at the plane of the seismic restraints; acting to cut the restraint at the base.

Tension Force (T)—Force generated by overturning moments at the plane of the seismic restraints, acting to pull out the bolt.

Seismic Analysis

The forces acting on the equipment are the lateral and vertical forces resulting from the earthquake, the mass of the equipment, and the forces of the restraint holding the equipment in place. The forces of the restraint holding the equipment in position include shear and tension forces.

Determination of Lateral Force

The lateral force Fp for nonstructural components is defined by the 2012 IBC as:

$$F_p = (0.4a_pSDSW_p)I_p/R_p(1+2z/h) \text{ (strength based calculation)}$$

$$F_p \text{ shall not be greater than: } F_{pmax} = 1.6(W)(I_p)(S_{DS})$$

$$F_p \text{ shall not be less than: } F_{pmin} = 0.3(W)(I_p)(S_{DS})$$

If allowable stress design (ASD) data is used to size hardware, the loads may be reduced by a factor of 1.4.

$$F_{ph} = F_p/1.4 \text{ (stress based calculation)}$$

where:

F_p— Lateral Force

a_p— Component amplification factor
(set at 1.0 for boilers/water heaters)

S_{DS}— Design Spectral Response Acceleration
(where SDS = 2FaSs/3)

F_a— Site Soil Characteristics Factor
(see Table 1—Class D is soil classification default)

S_s— Mapped Spectral Response Acceleration
(set at 2.25 to cover all U.S. geographical locations

W_p— Weight of the Equipment

I_p— Importance Factor (set at 1.5)

R_p— Component Response Modification Factor (set at 1.5)

z— Height of the attachment point of the equipment in the structure
(set at 0 for ground level; set at 1.0 for rooftop)

h— Average height of the building roof above grade (set at 1.0)

Values of Site Coefficient Fa as Function of Site Class and Mapped Spectral Response Acceleration at 1s Period (Ss)

		Mapped Spectral Response Acceleration at Short Periods				
Site Class	Soil Profile Name	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	Hard Rock	0.8	0.8	0.8	0.8	0.8
B	Rock	1.0	1.0	1.0	1.0	1.0
C	Dense Soil/Soft Rock	1.2	1.2	1.1	1.0	1.0
D[c]	**Still Soil Profile**	**1.6**	**1.4**	**1.2**	**1.1**	**1.0**
E	Soft Soil Profile	2.5	1.7	1.2	0.9	b
F	See Section 11.4.7 of ASCE 7 and Note b					

[a] Use straight-line interpolation for intermediate values of mapped spectral acceleration at short period S_s

[b] Site specific geotechnical investigation and dynamic site response analyses must be performed to determine appropriate values.

[c] D is the default Site Class unless otherwise stated in the approved geotechnical report.

Determination of Vertical Force

The lateral force Fpv developed by an earthquake is determined by use of the following equation:

$$F_{pv} = (0.2\, S_{DS}\, W)/1.4$$

Determination of Effective Shear Force (Veff)

The effective shear force is calculated by the following equation:

$$V_{eff} = F_{ph} / N_{bolt}$$

where: N_{bolt}—is the number of bolts in shear.

Determination of Effective Tension Force in any Direction (T_{eff})

Considering the load applied in any horizontal direction,

The Transverse Component = $F_{ph} \cos(ø)$

The Longitudinal Component = $F_{ph} \sin(ø)$

The tension load on any anchor would be:

$$P_t = ((W-F_{pv})/N) - ((F_{ph} \cos(ø)\, h_{cg}) / (2\, b_2)) - ((F_{ph} \sin(ø)\, h_{cg}) / (2\, b_1))$$

where: hcg— is the height to center of gravity

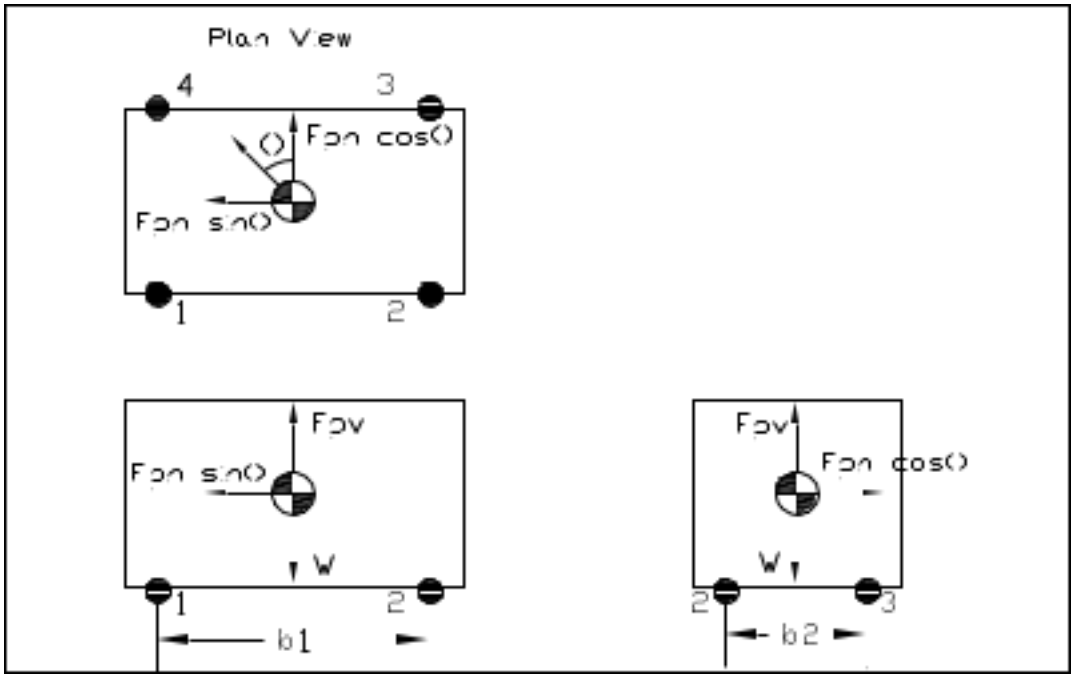
b_1— is the distance between Seismic restraints along Y-Y

b_2— is the distance between Seismic restraints along X-X

ø— $\tan\text{-}1(b_2/b_1)$

The effective tension force would be shown as :

$$T_{eff} = |P_t|$$



VERTICAL ROUND JACKET TANK—SEISMIC RESTRAINT ANALYSIS
HET 257–HET 1000 | GROUND LEVEL INSTALLATION

VERTICAL ROUND JACKET TANK—HET 257–HET 1000 | DIMENSIONS AND SPECIFICATIONS							
Model #	Capacity	Width	Depth	Height	Weight–Unit (lb)	Weight–Total (lb)	Center of Gravity
HET 257	257 gal	34.00	34.00	91.00	723	2,863	43.9
HET 275	318 gal	40.00	40.00	80.00	780	3,432	41.1
HET 432	432 gal	46.00	46.00	80.00	1,002	4,605	41.1
HET 500	504 gal	46.00	46.00	92.00	1,116	5,317	44.2
HET 650	650 gal	52.00	52.00	92.00	1,547	6,965	44.2
HET 750	752 gal	52.00	52.00	104.00	1,737	8,005	47.3
HET 1000	940 gal	52.00	52.00	128.00	2,071	9,907	53.4

VERTICAL ROUND JACKET TANK—HET 25–HET 1000 | SEISMIC CALCULATIONS							
	HET 257	HET 275	HET 432	HET 500	HET 650	HET 750	HET 1000
Lateral Force ñ Fph (lb)	1,380.4	1,654.7	2,220.3	2,563.6	3,358.1	3,859.6	4,776.6
Vertical Force ñ Fpv (lb)	613.5	735.4	986.8	1,139.4	1,492.5	1,715.4	2,122.9
Total Number of Bolts	4	4	4	4	4	4	4
No. of Bolts in Tension	2	2	2	2	2	2	2
Tension Force ñTeff (lb/blt)	565.8	420.1	386.2	557.6	507.0	732.3	1,273.5
No. of Bolts in Shear	4	4	4	4	4	4	4
Shear Force - Veff(lb/bolt)	345.1	413.7	555.1	640.9	839.5	964.9	1,194.1
Bolt Size Requirement Wedge-Type Anchor Bolt	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Minimum Bolt Length	4	4	4	4	4	4	4

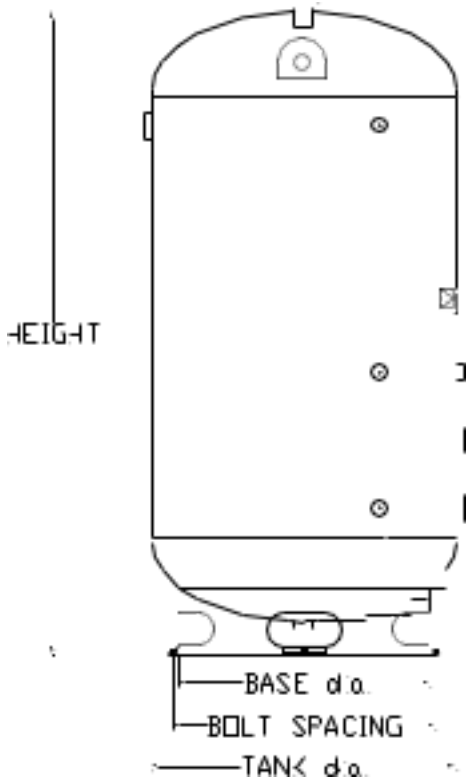
- Equipment installed with rigid restraint ñ wedge type anchors bolts into concrete. (Hilti, Inc., Kwik Bolt TZ Carbon Steel Anchors in Concrete)
- Specified bolt lengths are 8 times the bolt diameter.
- A minimum concrete compressive strength of 2500 psi.
- Calculations based upon equipment located at ground level.
- Effects of wind forces are not included in calculations.

VERTICAL ROUND JACKET TANK—SEISMIC RESTRAINT ANALYSIS
HET 257–HET 1000 | ROOFTOP INSTALLATION

VERTICAL ROUND JACKET TANK—HET 257–HET 1000 | DIMENSIONS AND SPECIFICATIONS							
Model #	Capacity	Width	Depth	Height	Weight–Unit (lb)	Weight–Total (lb)	Center of Gravity
HET 257	257 gal	34.00	34.00	91.00	723	2,863	43.9
HET 275	318 gal	40.00	40.00	80.00	780	3,432	41.1
HET 432	432 gal	46.00	46.00	80.00	1,002	4,605	41.1
HET 500	504 gal	46.00	46.00	92.00	1,116	5,317	44.2
HET 650	650 gal	52.00	52.00	92.00	1,547	6,965	44.2
HET 750	752 gal	52.00	52.00	104.00	1,737	8,005	47.3
HET 1000	940 gal	52.00	52.00	128.00	2,071	9,907	53.4

VERTICAL GLASS LINED TANK—HET 25–HET 1000 | SEISMIC CALCULATIONS							
	HET 257	HET 275	HET 432	HET 500	HET 650	HET 750	HET 1000
Lateral Force ñ Fph (lb)	3,681.0	4,412.6	5,920.7	6,836.1	8,955.0	10,292.1	12,737.6
Vertical Force ñ Fpv (lb)	613.5	735.4	986.8	1,139.4	1,492.5	1,715.4	2,122.9
Total Number of Bolts	4	4	4	4	6	6	8
No. of Bolts in Tension	2	2	2	2	3	3	4
Tension Force ñTeff (lb/blt)	2,446.2	2,243.8	2,537.5	3,227.7	2,421.5	3,048.9	3,319.6
No. of Bolts in Shear	4	4	4	4	6	6	8
Shear Force - Veff(lb/bolt)	920.3	1,103.1	1,480.2	1,709.0	1,492.5	1,715.4	1,592.2
Bolt Size Requirement Wedge-Type Anchor Bolt	5/8	5/8	5/8	3/4	3/4	3/4	3/4
Minimum Bolt Length	5	5	5	6	6	6	6

- Equipment installed with rigid restraint ñ wedge type anchors bolts into concrete. (Hilti, Inc., Kwik Bolt TZ Carbon Steel Anchors in Concrete)
- Specified bolt lengths are 8 times the bolt diameter.
- A minimum concrete compressive strength of 2500 psi.
- Calculations based upon equipment located at ground level.
- Effects of wind forces are not included in calculations.



ESTIMATED BOLT SPACING			
Model #	Capacity	Width	Depth
HET 257	257 gal	38.00	38.00
HET 275	318 gal	44.00	44.00
HET 432	432 gal	50.00	50.00
HET 500	504 gal	50.00	50.00
HET 650	650 gal	56.00	56.00
HET 750	752 gal	56.00	56.00
HET 1000	940 gal	56.00	56.00