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6/5/2012 Original Calculations

Anchorage of Water Tanks
Location to be determined

Ref. 2010 California Building Code, 2009 International Building Code.

Ref. Plans by Free Hot Water, dated 4 - 13 - 2012

Tanks are of all steel construction, base supported. Base ring is 0.171 thick steel, 4.50 " high, 30.31 " outside diameter. Tank plus contents will weigh 30.50 kips.

Tank is 10' diameter and 7' high: Maximum water level is 6.0 ' above base.

Since the site locations will vary, Tank anchorage will be designed for hypothetical "worst case" seismic criteria. Actual site data must be compared to these calculations to ensure that no more conditions exist.

Seismic criteria:

Importance Factor	1.00	Occupancy Category II	
S_s =	2.25	G S₁ =	1.50 G
		Site Class =	D or E
		R =	3.00
Seismic Category E		Fa =	1.00
		Fv =	2.40
	Sms =	2.25 G	Sm1 =
			3.60 G
	Sds =	1.50 G	Sd1 =
			2.40 G

Tank is a non-building structure, as described in ASCE 7-05, table 15.4-2

Ref. ASCE 7-05, 15.4.1:

Cs = 0.80 S1/ (R/I) = 0.40 G > 0.03 G OKAY

Qe = V = Cs W Cs = 0.40 G x 30.5 kips = 12.2 kips

Eh = rho x Qe rho = 1.3

Eh = 1.3 x 12 kips = 15.86 kips

For load combination DL + 0.7 EQ, DL = 30.5 kips, 0.7 EQ = 11.10 kips (ASD Values)

Overtuning Moment = 11.1 kips x 3.20 ' = 36.08 foot kips
Restoring Moment = 30.5 kips x 4.5 ' = 137.25 foot kips > 36.08 foot kips

For load combination 0.6 DL + 0.7 EQ, DL = 18.3 kips, 0.7 EQ = 11.10 kips

Overtuning Moment = 11.1 kips x 3.20 ' = 35.53 foot kips
Restoring Moment = 0.6 x 30.5 kips x 4.5 ' = 82.35 foot kips > 35.53 foot kips

Tank may slide but not overturn. No holdowns required.

Tank is anchored at eight points at 45 degrees angular spread.

Shear (sliding) force of 15.86 kips will be resisted equally by three anchors (at a time).

$$\text{Shear} = 3.70 \text{ kips to each anchor}$$

Tank anchor clips are 4 " by 4 " x 4 " long angle clips, 1/4 " thick A572 steel.

Determine required tank pad dimensions. If new raised pad it to be poured over existing asphalt or portland cement pavement, make pad minimum of 6 " thick.

$$\text{Try 14' x 14' pad: weight} = 14.70 \text{ kips}$$

$$\text{tank and contents weight} = 30.50 \text{ kips}$$

$$\text{Total weight} = 45.20 \text{ kips} \times 0.25 \text{ coefficient of friction} = 11.30 \text{ kips} > 11.1 \text{ kips}$$

Okay

$$\text{Or, try 12' x 12' x 8 " pad: weight} = 14.40 \text{ kips}$$

$$\text{tank and contents weight} = 30.50 \text{ kips}$$

$$\text{Total weight} = 44.90 \text{ kips} \times 0.25 \text{ coefficient of friction} = 11.23 \text{ kips} > 11.1 \text{ kips}$$

Use either 14' x 14' x 6" tank pad, or, 12' x 12' x 8" tank pad. Reinforce pad with # 4's at 24" o.c. at top and bottom of slab.

It would be highly desirable to sawcut the pad into the existing asphaltic or portland cement concrete.

If the pad is cast in place on compacted soil, it should be embedded 4" minimum into the soil.

(Tank is not a building, so it does not require a footing as defined in Chapter 18.)

It would be desirable to provide flex connections to the tank piping.

Sometimes tanks will be mounted directly on existing concrete slabs. Slabs must be minimum of 4 " thick and reinforced with a minimum of 6 x 6 / 10 x 10 WWF. If reinforcement cannot be verified, tank may be mounted on 6" or 8" slab as described above, over existing concrete slab, with # 4 bent rebar dowels, 12 " x 6", with 3 " of embedment in Simpson SET XP epoxy at 24 " o.c around perimeter of new pad and inset 6" from pad edge and four additional dowels on a 48" circle centered on the center of the tank.

Post installed anchors can be Redhead Trubolt + anchors, 1/2" diameter, with 3 3/4" minimum effective embedment in 6" minimum thick concrete slab. Minimum edge distance of 7 1/2".

Ref. ESR 2427: No tension on anchors.

$$\text{Single anchor in seismic shear: } V_{eq} = 5.81 \text{ kips}$$

$$\text{Single Anchor shear breakout : } V_b = 7 \times (2.0/0.5)^{0.2} \times (0.5)^{0.5} \times (2500)^{0.5} \times (11.0)^{1.5} = 11.91 \text{ kips}$$

$$V_{cb} = (A_v / A_{v0}) \times (\theta_a) \times (\theta_s) \times V_b = 1.0 \times 1.0 \times 1.0 \times (11.91 \text{ kips}) = 11.91 \text{ kips}$$

Single Anchor shear pryout : $V_{cp} = k_{cp} \times N_{cb} =$ $1.0 \times 11.91 / 0.65 =$
6.15 kips

Critical shear condition = 6.15 kips

Adjust for ASD values = 4.40 kips > 3.70 kips Okay

Anchor each tank bracket to the pad with one 1/2" diameter Redhead Trubolt + with 3 3/4 " embedment.

Special inspection is required for installation of the Redhead anchors.

Other anchors of equal capacity may be substituted for the Redhead anchors.