

**CONCRETE DOME WIND ANALYSIS**

**Example 1**

Commercial building 30 feet high in exposure C (most severe exposure in open flat terrain). Using design wind pressure from UBC 1985 Edition, section 2311.d, of 70 MPH.  $V = 300$  MPH.

$p = C_e C_q Q_s I$

$I = 1.0$  (Commercial Building)

$Q_s = 13$ psf (pressure from wind)

$C_e = 1.3$  (building height 30 ft. - exposure C)

$C_q = 1.3$  (method 2)

Therefore  $p = (1.3) (1.3) (13\text{psf}) (1.0) = 22\text{psf}$

**Example 2**

Assume same building and same exposure but with wind speed of 300 mph.

Preference: Finte, Mark, Handbook of Concrete Engineering; Nan Nostrand Reinhold, 1974.

$p = 1/2 C_s C_a C_g P V_h^2 (H/h)^{2/\alpha}$

Assume everything is constant except the wind speed.

$p = C V_h^2 = 22\text{psf}$  for  $V = 70$  mph (example 1).

Therefore  $C = (22) / (70)^2 = 0.00449$

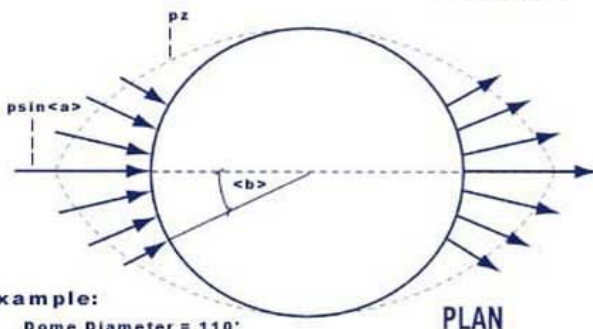
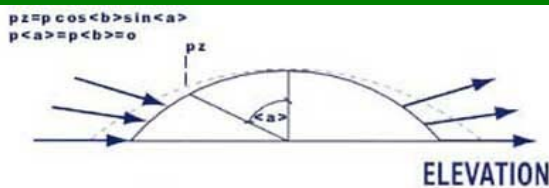
Then  $p = (0.00449) V_h^2$  for  $V = 300$  mph;  $p = 404\text{psf}$

The maximum concrete stress in dome 100 feet in diameter by 35 feet high with  $p = 400\text{psf}$  is 1,098psi compression. From the "Concrete Dome Seismic Analysis" example we see the allowable stress is significantly higher at 2,394 psi.

**Conclusion**

The forces caused by wind and earthquake on a concrete dome generally do not control the design. Domes are very strong and durable ai

**CONCRETE DOME SEISMIC ANALYSIS**



**Example:**

Dome Diameter = 110'  
Height of Dome = 37'  
Thickness = 3" @ top and 8" @ bottom  
Ref: Billington 1985 Ed., p. 55

**Membrane Forces:**

$N_{\langle a \rangle} = -apk_1 \cos \langle b \rangle$

$N_{\langle ab \rangle} = -apk_2 \sin \langle b \rangle$

$N_{\langle b \rangle} = -apk_3 \cos \langle b \rangle$

Seismic Force (UBC 1985 Edition)

$V = ZSICKW$  (Formula for the total design lateral force)

$Z = 1.0$  Zone IV (Seismic Zone Factor)

$CS = 0.14$

$I = 1.5$  (Importance Factor = Hospital)

$K = 2.0$  (Unusual building such as Dome -- conservative)

Therefore:  $V = (1.0) (1.5) (0.14) (2.0) W = 0.420W$  -- Note:  $V = 0.14W$  for normal shear wall building!

$V = (0.420) (100) = 42.0$  psf (pounds/square foot) -- one square foot of shell 8" thick weighs 100 lbs. The value of  $p = V = 42.0$  psf.

For demonstration purposes assume  $p = 60$  psf. This represents earthquake forces in excess of the most sever code requirement by a factor of 1.4.

Maximum stress due to  $N_{<b>}$  is -64.8 psi;  $N_{<a>}$  is -70.6 psi. Maximum bending moment is 909.3 lbs - ft/ft.

For a vertical live load of 40 psf in addition to the dead load of the shell the following stresses and moment are obtained. Maximum stress due to  $N_{<a>}$  = -82.5psi;  $N_{<b>}$  = -70.7 psi or .146.5 psi. The maximum bending moment is 1,588.0 lbs-ft/ft.

The maximum allowable compressive force in the concrete is:

$f_c = 1.33 (0.45) (4000\text{psi}) = -2.394\text{psi}$ . This is many times greater than the -70.6psi needed.

#### Conclusion

The forces caused by a major earthquake are considerably less than normal provided for when a dome is designed for nominal vertical loads.

