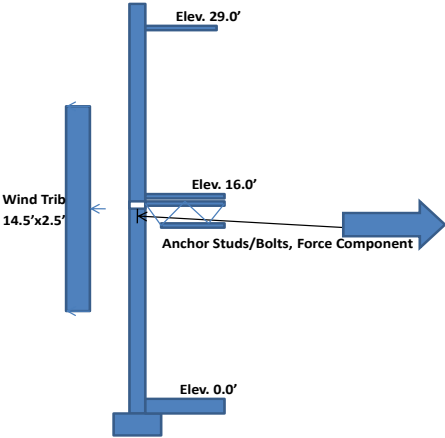
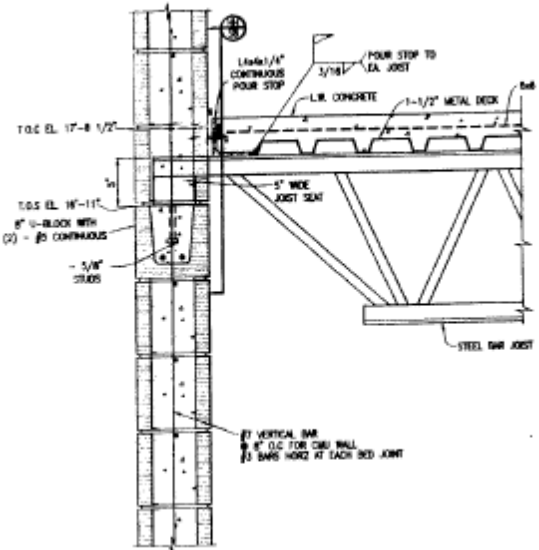


Trial Design Problem – Wall to 2nd Floor Anchorage in Masonry Construction per ACI 530-08

You are designing a new concrete block masonry wall Fire Station in New Orleans, Louisiana that is approximately 100'x100' in plan and in a flat urban area. You need to determine the component wind lateral out-of-plane wall force based on the Code required 150 mph basic wind speed. The second floor open web joist framing will be anchored to the grouted 8-inch, $f'_m = 2000$ psi reinforced concrete block masonry wall at joist pockets every 2.5' feet on center. The tributary height contributing to the 2nd floor wind out of plane load is 14.5 feet so the out of plane wind load area is 2.5' x 14.5' to be attached to the floor framing. The Roof is at elevation 29 feet as shown in the wall section below.



WALL SECTION



DETAIL AT SECOND FLOOR

Determine the wind out-of-plane lateral force (leeward side) and the proposed number of 5/8-inch diameter anchors connecting the joist bearing plate to the masonry wall for the force. The governing Building Codes are IBC 2009, ASCE 7-05 and ACI 530-08.

Solution

Answer Summary

Time to Complete: **30 minutes**

Wind Resultant Force Component: **2016#**

Anchor Type, Grade, Material: **Cast-in-Place Headed Stud (Nelson Stud), ASTM A108**
(e.g. Headed Anchor Stud, cast-in-place 'J' bolt, post-installed expansion anchor, A307 Anchor Bolt, etc.)

Anchor Capacity Sources: **ACI 530-08/ASCE 7-05**
(e.g. Code, Bolt Vendor Information, etc.)

Number of 5/8" diameter anchors per attachment: **2 @ 5/8" diameter**

Bolt Embedment and Spacing: **7" embedment and 8 inch spacing**

Solution

Wind Resultant Force Component for lateral out-of plane load.

ASCE 7-05 Wind Components (ASCE 7-05 6.4.2.2)

- $p_{net} = \lambda K_{zt} I p_{net30}$ (EQ 6-2)
- In the City of New Orleans, Exposure B, Urban Area, $\lambda = 1.0$ for Urban Area
- Topographic Factor K_{zt} for the flat site is 1.0
- Fire station is an Occupancy Category IV structure per ASCE 7-05 Table 1-1
- Importance Factor per ASCE 7-05 Table 6-1 for Category IV in Hurricane Prone regions is 1.15
- End Wall Zone 5 used as 10% of the building length is = 100' (0.10) = 10'
- Tributary Wind Area on each joist anchor location component = 2.5' x 14.5' = 36 ft²
- p_{net30} from ASCE 7-05, Figure 6-3, Components and Cladding, Wall, End Zone 5, Greater than 20ft² but less than 50ft²,
Straight line Interpolate between the value for 20ft² of 50.5 psf and 50ft² of 45.7 psf for 36 ft².
- $(50.5 \text{ psf} - 45.7 \text{ psf}) / 50\text{ft}^2 - 20\text{ft}^2 = 4.8 \text{ psf/ft}^2$

- $(4.8 \text{ psf/ft}^2) (36\text{ft}^2 - 20\text{ft}^2 / 50\text{ft}^2 - 20\text{ft}^2) = 2.56 \text{ psf}$
- $p_{net30} = 45.7 \text{ psf} + 2.56 \text{ psf} = 48.26 \text{ psf}$
- $p_{net} = 1.0 (1.0) (1.15) 48.26\text{psf} = 56 \text{ psf}$
- Wind Resultant Force Component = $56 \text{ psf} (36\text{ft}^2) = 2016 \text{ \#}$

ACI 530-08 Shear Design (ACI 2.1.4.3)

- Use 5/8" diameter A307 Headed Anchor Bolts
- $L_{bc} = 7.625/2 = 3.81''$ which is governed by half the thickness of the 8" inch thick CMU wall
- $A_{pv} = \pi L_{bc}^2 / 2 = \pi 3.81^2 / 2 = 22.8 \text{ sq. in.}$
- $A_{pt} = \pi L_{bc}^2 = \pi 3.81^2 = 45.6 \text{ sq. in}$
- B_v is the lesser of $B_{vb} = 1.25 A_{pv} \sqrt{f'm}$ (Eq. 2-6)
-or-
 $B_{vc} = 350 \sqrt[4]{f'm A_b}$ (Eq. 2-7)
-or-
 $B_{vpry} = 2.0 B_{ab} = 2.5 A_{pt} \sqrt{f'm}$ (Eq. 2-8)
-or-
 $B_{vs} = 0.36 A_b f_y$ (Eq. 2-9)
- $B_{vb} = 1.25 A_{pv} \sqrt{f'm} = 1.25 (22.8) \sqrt{2000} = 1275\#$ GOVERNS
- $B_{vc} = 350 \sqrt[4]{(2000\text{psi})(0.3 \text{ lin}^2)} = 1746\#$
- $B_{vpry} = 2.0 B_{ab} = 2.5 A_{pt} \sqrt{f'm} = 2.5 (45.6) \sqrt{2000} = 5100\#$
- $B_{vs} = 0.36 (0.31) 30,000 = 3350 \text{ \#}$
- B_{vb} Masonry breakout controls
- Check overlap if bolts spaced at 8 inches on center.
 $A_{pv} = 22.8 + 8'' \times 3.81'' = 53.2 \text{ sq. in.}$
 $B_{vb} = 1.25 (53.2) \sqrt{2000} = 2974\#$ OK
- Number of 5/8" diameter Anchors Needed = $2016\# / 1275\#$ per anchor = 1.6 anchors
 - Use 2 anchors spaced beneath the joist @ 8" OC (one anchor in each cell)

Final Selection

- Use (2) 5/8" diameter cast-in-place headed anchor bolts located in the center of the wall with 7" embedment spaced at 8" on center (12 bolt diameters on center for the anchors.)