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Analysis of Post Base Hold Down

for

One Pour Nail-On Bracket

by

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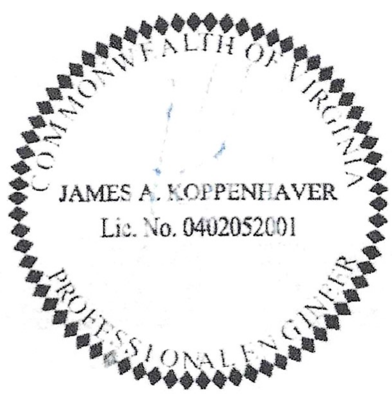
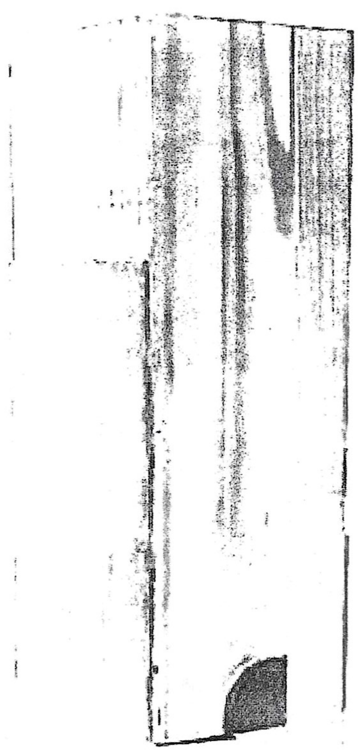
Overview

The uplift capacities of post foundation systems are required to verify compliance with Building Codes. In order to determine the capacities, the analysis takes into account various factors having to do with the wood, concrete, steel, and fasteners that may control the design. The wood calculations include a check of tension on the post section, crushing parallel to grain at rebar anchor, fastener shear with the metal side plate, and fastener shear with wood blocks. The concrete calculation of interest is the break-out of the various hold-down devices from the total resisting weight of the concrete foundation system. A steel calculation is required for the metal strap tensile strength capacity.



Description

Solid 4x6 and 6x6 posts, as well as, multi-ply 2x6 posts can be fitted with the prototype post base hold down. The post and hold down are encased in a concrete footing. The metal strap of the system is formed from a 14 gage by 5" wide strap which forms a U-shaped standoff when attached to the post bases. Several corrugations and beads are rolled into the 14 gage metal strap to increase its' stiffness, however their affect will be neglected for the purposes of this analysis. There are a total of 32 16d common nails providing strap attachment to the posts.



Assumptions

The calculations assume a nominal 3,000 psi concrete mix, and that the resisting concrete and soil cone above are sized to provide weight in excess of the maximum uplift on each post.

Capacity Calculations

Wood frame tie-down devices typically utilized for building construction include Simpson Strong-Tie® H10 Hurricane Ties. The maximum allowable uplift load for a Simpson H10 Tie is 1,070 lbs for a 5-minute duration load. For Post-Frame building construction, the typical truss spacing is 4 feet and post spacing is 8 feet. One tie is provided at each truss heal and therefore each post resists two truss uplift reactions or 2 x 1,070 lbs = 2,140 lbs maximum per post.

Post Tensile Capacity

Tension on typical 4x6 SYP#2 post section,
$A = 3.5\ (5.5) = 19.25\ in^2$
$F_t' = F_tC_DC_M = (725\ psi)(1.6)(1.0) = 1{,}160\ psi$
Post Tensile Capacity = (1,160 psi)(19.25 in^2) = ***22,330 lbs Uplift Resistance***

The allowable tension on the net section of a 4x6 #2 Southern Yellow Pine post is 22,330 pounds. Because the allowable tension stress is not the same for all timber species, the allowable tension will vary if species other than #2 SYP are used.

Metal Strap Tensile Capacity

Area of metallic straps, Astrap = (2) 5" x 14 Gage = (2) 5" x 0.0593" = $0.593 in^2$
Tensile strength of metal, assumed to be Fy = 36 ksi
F't = 0.6 Fy Ag = 21.6 ksi
Maximum tensile strength of strap, P_n/Ω = F't Astrap / 1.67 = 7.67 kips = ***7,670 lb Uplift Resistance***

Metal Strap Fastener to Post Shear Capacity

Nails: 16d common nails, d = 0.162"
S.G. of wood posts = 0.55 (Southern Pine)
From Table 4 of ESR-2126, 16d nails with 14 gage metal side plates, have a strength of 147 lb.
Maximum shear uplift from fasteners, Vn = (32 nails)(147 lb) = ***4,704 lb Uplift Resistance***

Concrete Footing Calculations (3,000 psi concrete):

Conservatively neglecting cohesion of the sides of the concrete footing to the soil, the weight of soil over the footing, and floor slab or paving "break-out" resistance, find the footing size required for maximum uplift resistance:

4,704 lb Uplift Resistance / 150 lbs/ft^3 = 31.36 ft^3

Equivalent footing concrete mass required to provide 4,704 lb Uplift Resistance is -

36" diameter x 53" deep, or
30" diameter x 77" deep

Check common applications:

4x6 posts

20'x 20'x 8' high post frame building
Post spacing = 8'
110 mph wind zone, net uplift = 20 psf

Uplift force = (20'/2) (8') (20 psf) = 1,600 lbs < 4,704 lbs

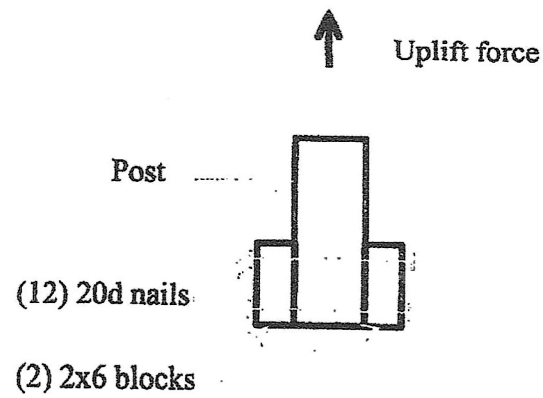
6x6 posts

30'x 30' x 10'high post frame building
Post spacing = 8'
120 mph wind zone, net uplift = 29 psf

Uplift force = (30'/2)(8')(29 psf) = 3,480 lbs < 4,704 lbs

Check alternative uplift devices:

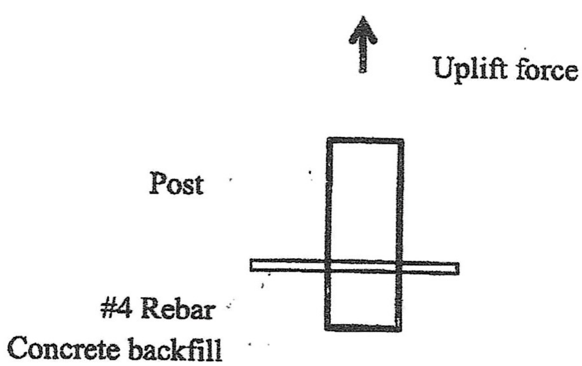
Uplift block with nails



2x6 block on both sides of post
(6) 20d galvanized nails per block (each side)
Nail capacity in shear, $z' = z\,C_D\,C_M$ = 152 lbs (1.6)(0.7) = 170 lbs

Uplift force = (12 nails)(170 lbs) = 2,040 lbs < 4,704 lbs, N.G.

Rebar through post



½" diameter (#4 rebar)
Check wood crushing
$F_c' = F_c\,C_M$ = 525 psi

Uplift force = (2 rebars)(525 psi)(2.75 in^2) = 2,888 lbs < 4,704 lbs, N.G.

Conclusion

The calculation shows that the maximum uplift capacity for the One Pour Nail-On Bracket is 4,704 lbs. Conservatively neglecting the encapsulation of the nails within the footing concrete, the capacity is controlled by shear in the nails which secure the strap to the post base. Use of this system ensures Uplift Capacity for posts and foundations in excess of the capacities of other uplift devices.