A. PALMA engineering
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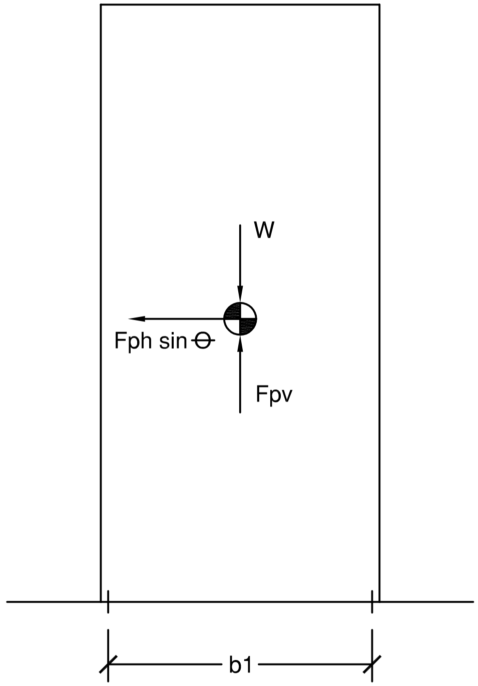
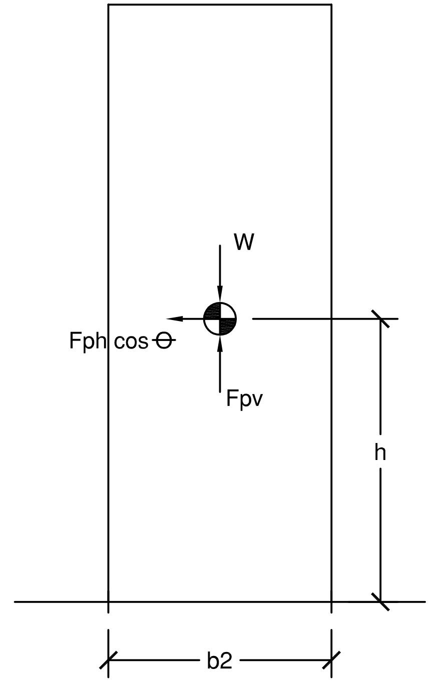
PROJECT:

TAG: 125 & 200 HP VFD

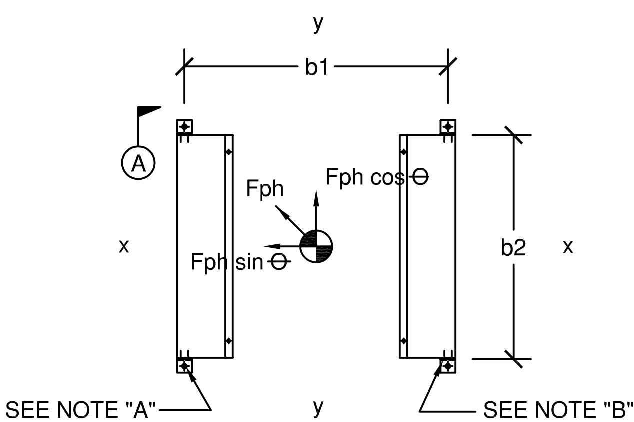
SHEET: D1 OF D1



FRONT ELEVATION

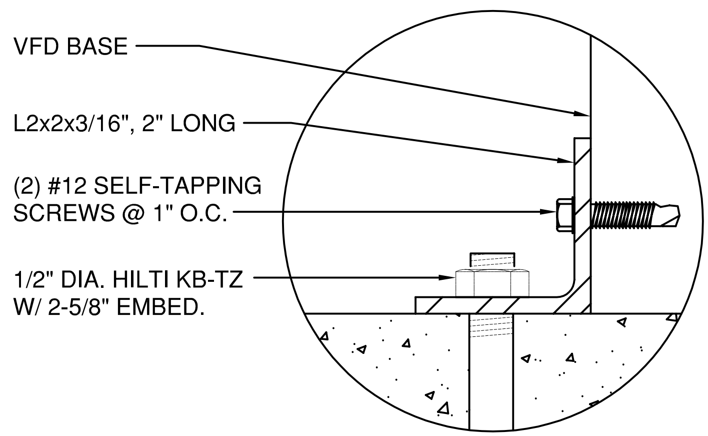


SIDE ELEVATION



PLAN VIEW OF MOUNTING HOLE LOCATION

NOTE "A": (1) 1/2" DIA. HILTI KB-TZ PER ANGLE BRACKET W/ 2-5/8" EMBED.
NOTE "B": (2) #12 SELF-TAPPING SCREW PER ANGLE @ 1" O.C.



DETAIL A

Equipment overturning calculations based on seismic load applied at a critical angle:

OPERATING WEIGHT: $\mathbf{W} := 900 \cdot \mathbf{lb}$

The following plan dimensions are as follows. Refer to attach plan view and elevation drawings.

$\mathbf{b1} := 34.00 \cdot \mathbf{in}$

$\mathbf{b2} := 30.00 \cdot \mathbf{in}$

$\mathbf{h_{cg}} := 46.00 \cdot \mathbf{in}$

$\mathbf{N} := 4$ *Number of angle brackets.*

SEISMIC CRITERIA PER 2007 CBC & ASCE 7-05: *Occupancy Category III, Site Class D*

$\mathbf{S_s} := 1.50$	*Mapped spectral accelerations for short periods*
$\mathbf{F_a} := 1.00$	*Site coefficient*
$\mathbf{S_{MS}} := \mathbf{F_a} \cdot \mathbf{S_s}$	*MCE spectral response acceleration for short periods*
$\mathbf{S_{DS}} := \frac{2}{3} \cdot \mathbf{S_{MS}}$	*Spectral acceleration, short period*
$\mathbf{z} := 0.0$	*Height in structure of point of attachment of component w/ respect to the base*
$\mathbf{h} := 1.0$	*Average roof height of structure w/ respect to base*
$\mathbf{I_p} := 1.0$	*Component importance factor*
$\mathbf{a_p} := 2.5$	*Component amplification factor*
$\mathbf{R_p} := 6.0$	*Component response modification factor*

$$\mathbf{F_p} := \frac{0.4 \cdot \mathbf{a_p} \cdot \mathbf{S_{DS}} \cdot \mathbf{W}}{\frac{\mathbf{R_p}}{\mathbf{I_p}}} \cdot \left(1 + 2 \cdot \frac{\mathbf{z}}{\mathbf{h}}\right) \qquad \mathbf{F_p} = 150\,\mathbf{lb}$$

shall not be greater than:

$$\mathbf{F_{pmax}} := 1.6 \cdot \mathbf{W} \cdot \mathbf{I_p} \cdot \mathbf{S_{DS}} \qquad \mathbf{F_{pmax}} = 1440\,\mathbf{lb}$$

and shall not be less than:

$$\mathbf{F_{pmin}} := 0.3 \cdot \mathbf{W} \cdot \mathbf{I_p} \cdot \mathbf{S_{DS}} \qquad \mathbf{F_{pmin}} = 270\,\mathbf{lb}$$

Governs!

$$F_{ph} := \frac{F_{pmin}}{1.4} \qquad F_{ph} = 193\,\mathbf{lb}$$

Vertical seismic load:

$$F_{pv} := 0.2 \cdot S_{DS} \cdot W \qquad F_{pv} = 180\,\text{lb}$$

Consider the load applied in any horizontal direction. Refer to elevation drawing attached.

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

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

The uplift load on angle no. 4:

$$P_t = \frac{0.9W - F_{pv}}{N} - \frac{F_{ph} \cdot \cos(\theta) \cdot h_{cg} \cdot \frac{b2}{2}}{I_{yy}} - \frac{F_{ph} \cdot \sin(\theta) \cdot h_{cg} \cdot \frac{b1}{2}}{I_{xx}}$$

The compressive load on angle no. 1:

$$P_c = \frac{0.9W + F_{pv}}{N} - \frac{F_{ph} \cdot \cos(\theta) \cdot h_{cg} \cdot \frac{b2}{2}}{I_{yy}} + \frac{F_{ph} \cdot \sin(\theta) \cdot h_{cg} \cdot \frac{b1}{2}}{I_{xx}}$$

where,

$$I_{xx} := \frac{N \cdot (N + 2) \cdot b1^2}{12 \cdot (N - 2)}$$

$$I_{xx} = 1156\,\mathbf{in}^2$$

$$I_{yy} := \frac{N \cdot b2^2}{4}$$

$$I_{yy} = 900\,\mathbf{in}^2$$

To maximize the values,

$$\frac{dP_t}{d\theta} = 0 \qquad \textbf{and} \qquad \frac{dP_c}{d\theta} = 0$$

will yield a condition:

$$\theta := \mathbf{atan}\left(\frac{\mathbf{I_{yy}} \cdot \mathbf{b1}}{\mathbf{I_{xx}} \cdot \mathbf{b2}}\right)$$

$$\theta = 41.42\,\mathbf{deg}$$

<u>CHECK ANCHOR ATTACHMENTS</u>

Maximum Tension per angle:

$$\mathbf{P_t} := \frac{\mathbf{0.9W} - \mathbf{F_{pv}}}{\mathbf{N}} - \frac{\mathbf{F_{ph}} \cdot \mathbf{cos}(\theta) \cdot \mathbf{h_{cg}} \cdot \frac{\mathbf{b2}}{2}}{\mathbf{I_{yy}}} - \frac{\mathbf{F_{ph}} \cdot \mathbf{sin}(\theta) \cdot \mathbf{h_{cg}} \cdot \frac{\mathbf{b1}}{2}}{\mathbf{I_{xx}}}$$

$\mathbf{P_t} = -40\,\mathbf{lb}$ **UPLIFT**

Maximum Shear per angle:

$$\mathbf{P_s} := \frac{\mathbf{F_{ph}}}{\mathbf{N}}$$

$$\mathbf{P_s} = 48\,\mathbf{lb}$$

Allowable load for #12 self tapping screw attached to min. 18 ga. enclosure per ICBO Report ER-5202:

$\mathbf{n_s} := 2$ *Number of screws per angle bracket.*

$\mathbf{T_s} := \frac{\mathbf{P_s}}{\mathbf{n_s}}$ *Tension per screw.*

$\mathbf{V_s} := \frac{|\mathbf{P_s}|}{\mathbf{n_s}}$ *Shear per screw.*

$\mathbf{V_{allow}} := 326 \cdot \mathbf{lb}$ > $\mathbf{V_s} = 24\,\mathbf{lb}$ ***<u>Okay!</u>***

$\mathbf{T_{allow}} := 141 \cdot \mathbf{lb}$ > $\mathbf{T_s} = 24\,\mathbf{lb}$ ***<u>Okay!</u>***

Consider L2"x2"x3/16", 2" long:

$\mathbf{b} := 2.00\mathbf{in}$	*Length of angle.*
$\mathbf{d} := 0.1875\mathbf{in}$	*Thickness of angle.*
$\mathbf{w_a} := 2.00\mathbf{in}$	*Width of angle.*
$\mathbf{h_a} := 2.00\mathbf{in}$	*Height of angle.*
$\mathbf{M} := \mathbf{P_s} \cdot \mathbf{h_a}$	*Max. bending moment.*
$\mathbf{s} := \frac{\mathbf{b} \cdot \mathbf{d}^2}{6}$	*Section modulus.*
$\mathbf{f_b} := \frac{\mathbf{M}}{\mathbf{s}}$	*Bending stress.*
$\mathbf{F_y} := 36000\mathbf{lb} \cdot \mathbf{in}^{-2}$	*Yield stress.*
$\mathbf{F_b} := 0.66 \cdot \mathbf{F_y}$	*Allowable stress.*

$\mathbf{F_b} = 23760\,\mathbf{lb} \cdot \mathbf{in}^{-2}$ $>$ $\mathbf{f_b} = 8229\,\mathbf{lb} \cdot \mathbf{in}^{-2}$ ***Okay!***

Transfer load to anchors:

$$\mathbf{T_a} := \frac{\left|\mathbf{P_t}\right| \cdot \mathbf{w_a} + \mathbf{P_s} \cdot \mathbf{h_a}}{\frac{\mathbf{w_a}}{2}}$$ *Tension per anchor.*

$\mathbf{T_a} = 176\,\text{lb}$

$\mathbf{V_a} := \mathbf{P_s}$ *Shear per anchor.*

$\mathbf{V_a} = 48\,\text{lb}$

CHECK ANCHORS: *Calculation per Tables 9 & 10 in ICC ES Report ESR-1917.*

Consider 1/2" dia. Carbon Steel Hilti KB-TZ anchor w/ 2-5/8" embedment into 3000psi normal weight concrete.

Assumptions:

Edge Distance *= 5.5" Minimum*

Anchor Spacing *= 5.75" Minimum*

Concrete Thickness *= 4.0" Minimum*

CHECK COMBINED LOADING

$$T_{allow} := 1167\,\mathbf{lb}$$

$$V_{allow} := 2839\,\mathbf{lb}$$

$$\frac{T_a}{T_{allow}} + \frac{V_a}{V_{allow}} = 0.17 \qquad < \qquad 1.2$$

Okay!