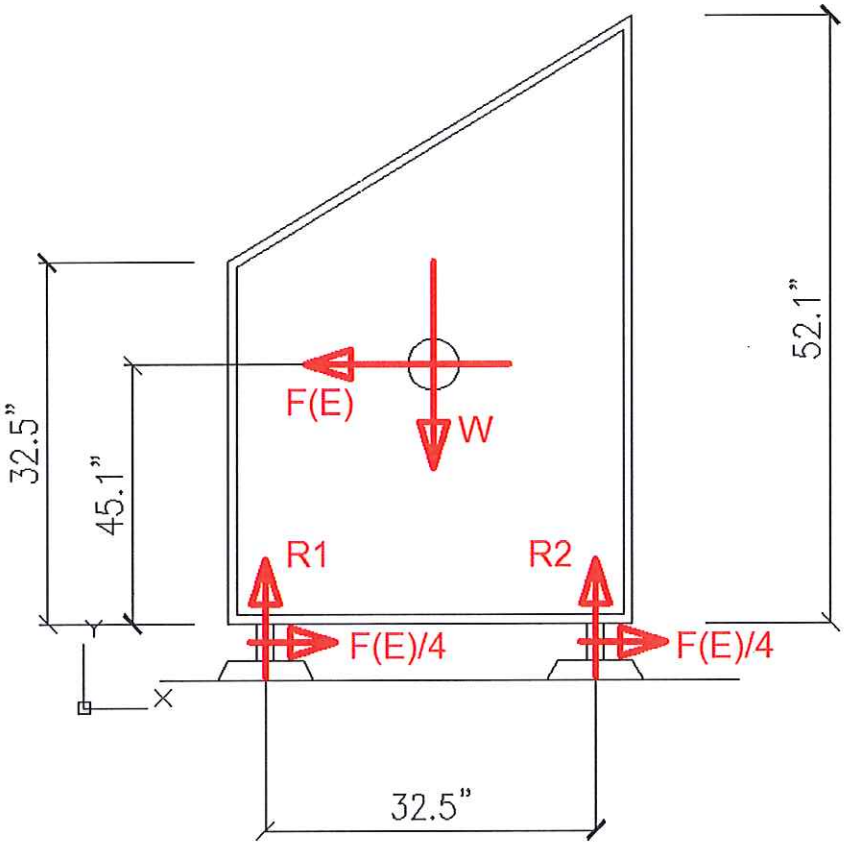
Calculation of the Anchorages for the Cabinet

1/19/17

- Estimated weights:
  - Cabinet: 500 lb
  - Contents: 500 lb
  - **TOTAL:** **1,000 lb**

- Considered earthquake:
  - The maximum base acceleration of the Response Spectra previously considered was used:
  - Design base acceleration: S_{DS} = 0.764 g



- W = 1,000 lb
- $F_E = 1{,}000\ lb \times 0.764 = 764\ lb$
- $M_E = 764\ lb \times 45.1" = 2{,}870\ lb.ft$
- $R_1 = \frac{1{,}000}{4} + \frac{2{,}870 \times 12}{2 \times 32.5} = 780\ lb$
- $R_2 = \frac{1{,}000}{4} - \frac{2{,}870 \times 12}{2 \times 32.5} = -280\ lb$

A majoration factor of 1.5x was used for design.

Case 1:

$$\begin{cases} N_1 = R_1 = -780\ lb = -3.5\ kN \\ T_1 = \dfrac{F_E}{4} = \dfrac{764}{4} = 191\ lb = 0.85\ kN \end{cases}$$

Case 2:

$$\begin{cases} N_2 = 2 = 280\ lb = 1.25\ kN \\ T_2 = \dfrac{F_E}{4} = \dfrac{764}{4} = 191\ lb = 0.85\ kN \end{cases}$$

Anchor Bolt Characteristics:

- $f'_c = 2\ ksi = 14\ MPa$
- $f_y = 40\ ksi = 276\ MPa$
- Diam. = 3/8" = 10 mm
- Embedment Length: L = 6" = 150 mm

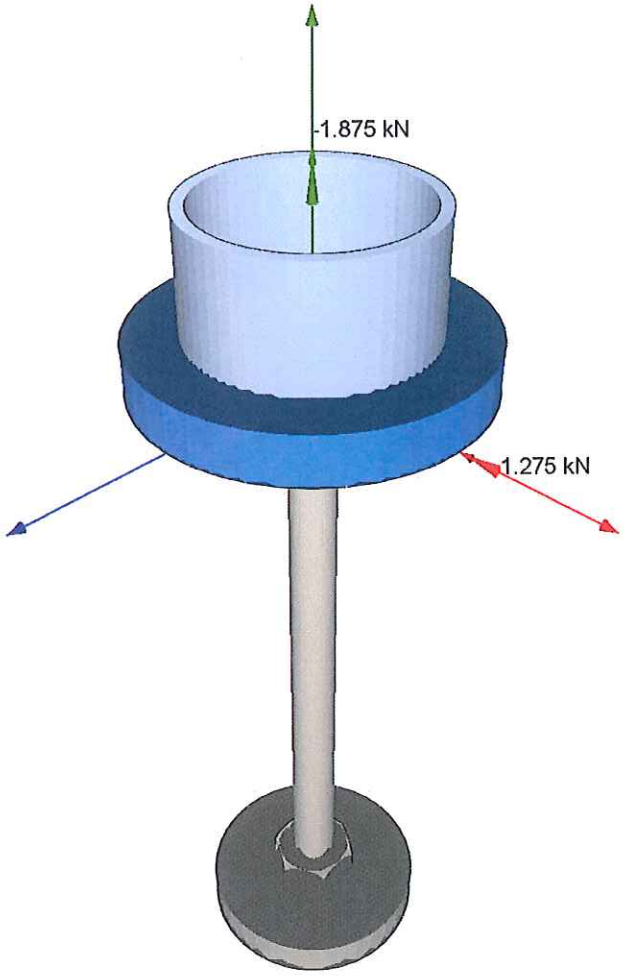
Following are the analysis program (PROKON - BasePlate) results.

PROKON Software Consultants (Pty) Ltd Internet: http://www.prokon.com E-Mail : mail@prokon.com	Job Number		Sheet
	Job Title		
	Client		
	Calcs by	Checked by	Date

Holding-down Bolt Design - SANS 10162 - 2005

Calculation Sheet for Load Case : 2

P : **-1.875 kN**
Vx : **1.275 kN**



Material Strength Properties

fcu : **14 MPa**
fu Bolt : **400 MPa**
fy Base Plate : **260 MPa**

Column Section

O1 48.4x2.5

Bolt Resistance Forces

Bolt Diameter : 10 mm

Bolt Netto Cross Section

$$A_n = \frac{0.75 \cdot \pi \cdot d^2}{4}$$
$$= \frac{0.75 \times \pi \times 10^2}{4}$$
$$= 58.905 \text{ mm}^2$$

Tension Resistance 25.2.2.1

$$T_r = \frac{0.67 \cdot A_n \cdot f_u}{1000}$$
$$= \frac{0.67 \times 58.905 \times 400}{1000}$$
$$= 15.787 \text{ kN}$$

Shear Resistance 25.2.3.3

$$V_r = \frac{0.6 \cdot 0.67 \cdot 0.7 \cdot A_n \cdot f_u}{1000}$$
$$= \frac{0.6 \times 0.67 \times 0.7 \times 58.905 \times 400}{1000}$$
$$= 6.630 \text{ kN}$$

Compression Resistance

$$C_r = \frac{0.75 \cdot 0.67 \cdot A_n \cdot f_u}{1000}$$
$$= \frac{0.75 \times 0.67 \times 58.905 \times 400}{1000}$$
$$= 11.840 \text{ kN}$$

Factors Affecting Bolt Pull-Out Area

cBolt = Anchorage lenght of bolt
cBolt = 150 mm

End Type Used is a Circular Plate
Circular Plate diameter is 50 mm
Circular Plate thickness is 8 mm

Find Effective Compression Area

Calculate Zpl

$$Z_{pl} = \frac{b \cdot t_p^2}{4}$$

$$= \frac{1 \times 10^2}{4}$$

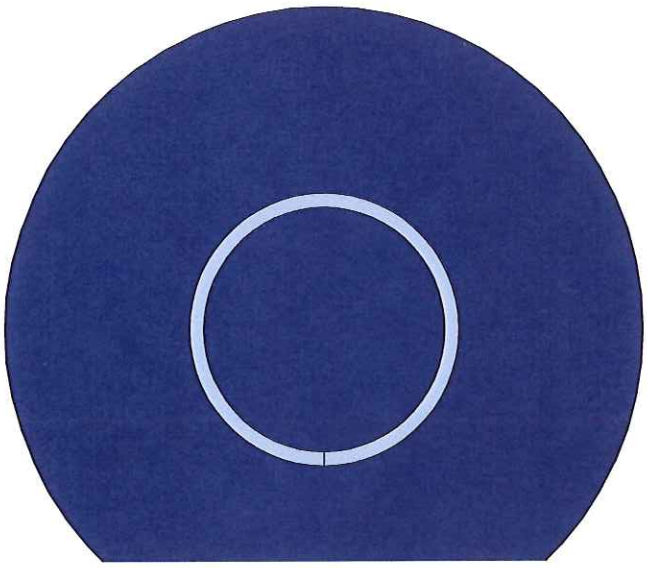
$$= 25.000$$

Effective Distance from Edge of Section

$$c_{Mx} = \sqrt{\frac{Z_{pl} \cdot 2 \cdot 0.9 \cdot \frac{f_y}{1.15}}{b \cdot \frac{f_{cu}}{1.5}}}$$

$$= \sqrt{\frac{25 \times 2 \times 0.9 \times \frac{260}{1.15}}{1 \times \frac{14}{1.5}}}$$

$$= 33.016 \text{ mm}$$



Find Equilibruim

The indicated plane represents strain resulting in force equilibrium

The actual number of Grid Point used for calculation is 1068

Moment balancing

Sum Of Moments around X-axis = 0.000
Sum Of Moments around Y-axis = 0.000

Axial Force balancing

Sum Of Forces in Z-direction = 0.010

The Shear Resisitance in the Bolts Resists the Following Forces:

Forces in X-direction
Forces in Y-direction
Moments around Z-axis

Thus:

Bolt 1 Shear Force is 1.205 kN

The maximum Shear Force being 1.205 kN

Calculating Factors of Safety in Critical Bolt

Tension in Bolts

$$FOS = \frac{T_r}{T_{ension}}$$
$$= \frac{15.708}{1.865}$$
$$= 8.423$$

Shear in Bolts

$$FOS = \frac{V_r}{S_{hear}}$$
$$= \frac{6.5973}{1.2052}$$
$$= 5.474$$

Bolt BasePlate interaction

$$FOS = \frac{Resistance}{Force}$$

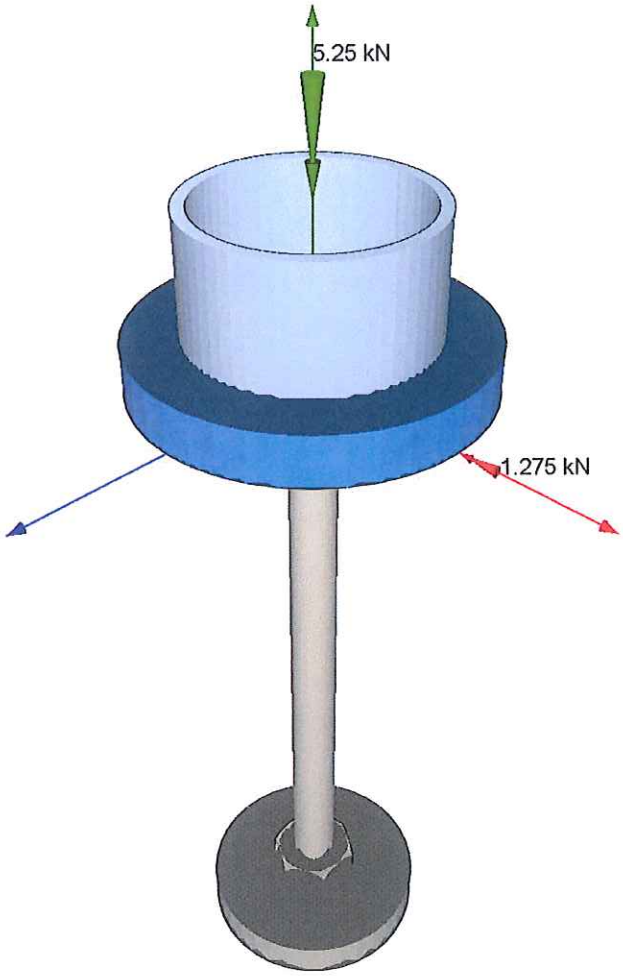
$$= \frac{29.361}{1.865}$$

$$= 15.743$$

Holding-down Bolt Design - SANS 10162 - 2005

Calculation Sheet for Load Case : 1

P : **5.25 kN**
Vx : **1.275 kN**



Material Strength Properties

fcu : **14 MPa**
fu Bolt : **400 MPa**
fy Base Plate : **260 MPa**

Column Section

O1 48.4x2.5

Bolt Resistance Forces

Bolt Diameter : 10 mm

Bolt Netto Cross Section

$$A_n = \frac{0.75 \cdot \pi \cdot d^2}{4}$$
$$= \frac{0.75 \times \pi \times 10^2}{4}$$
$$= 58.905 \text{ mm}^2$$

Tension Resistance 25.2.2.1

$$T_r = \frac{0.67 \cdot A_n \cdot f_u}{1000}$$
$$= \frac{0.67 \times 58.905 \times 400}{1000}$$
$$= 15.787 \text{ kN}$$

Shear Resistance 25.2.3.3

$$V_r = \frac{0.6 \cdot 0.67 \cdot 0.7 \cdot A_n \cdot f_u}{1000}$$
$$= \frac{0.6 \times 0.67 \times 0.7 \times 58.905 \times 400}{1000}$$
$$= 6.630 \text{ kN}$$

Compression Resistance

$$C_r = \frac{0.75 \cdot 0.67 \cdot A_n \cdot f_u}{1000}$$
$$= \frac{0.75 \times 0.67 \times 58.905 \times 400}{1000}$$
$$= 11.840 \text{ kN}$$

Factors Affecting Bolt Pull-Out Area

cBolt = Anchorage lenght of bolt
cBolt = 150 mm

End Type Used is a Circular Plate
Circular Plate diameter is 50 mm
Circular Plate thickness is 8 mm

Find Effective Compression Area

Calculate Zpl

$$Z_{pl} = \frac{b \cdot t_p^2}{4}$$

$$= \frac{1 \times 10^2}{4}$$

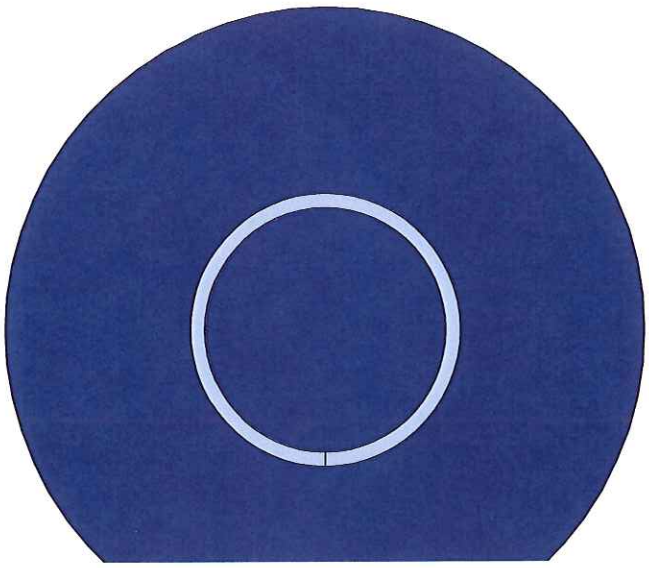
$$= 25.000$$

Effective Distance from Edge of Section

$$c_{Mxx} = \sqrt{\frac{Z_{pl} \cdot 2 \cdot 0.9 \cdot \frac{f_y}{1.15}}{b \cdot \frac{f_{cu}}{1.5}}}$$

$$= \sqrt{\frac{25 \times 2 \times 0.9 \times \frac{260}{1.15}}{1 \times \frac{14}{1.5}}}$$

$$= 33.016 \text{ mm}$$



Find Equilibruim

The indicated plane represents strain resulting in force equilibrium

The actual number of Grid Point used for calculation is 1068

Moment balancing

Sum Of Moments around X-axis = 0.000
Sum Of Moments around Y-axis = 0.000

Axial Force balancing

Sum Of Forces in Z-direction = 0.009

The Shear Resisitance in the Bolts Resists the Following Forces:

Forces in X-direction
Forces in Y-direction
Moments around Z-axis

Thus:

Bolt 1 Shear Force is 1.205 kN

The maximum Shear Force being 1.205 kN

Calculating Factors of Safety in Critical Bolt

Compression in Bolts

$$FOS = \frac{C_r}{C_{compression}}$$
$$= \frac{15.708}{.84741}$$
$$= 18.536$$

Shear in Bolts

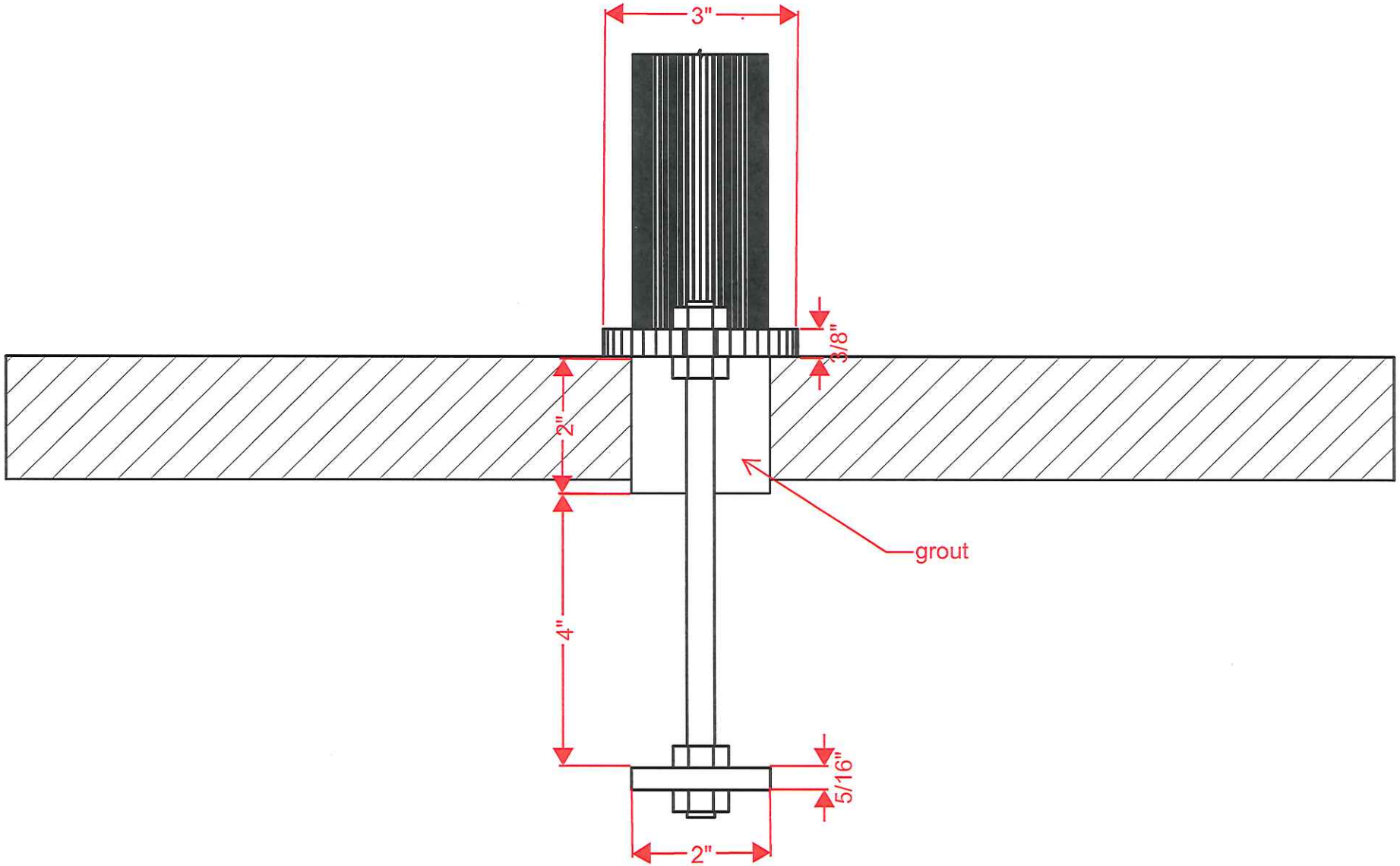
$$FOS = \frac{V_r}{S_{hear}}$$
$$= \frac{6.5973}{1.2052}$$
$$= 5.474$$

Concrete

$$FOS = \frac{StrainMax}{Strain}$$
$$= \frac{.0035}{.00007}$$
$$= 50.000$$

Bolt BasePlate interaction

$$FOS = \frac{Resistance}{Force}$$
$$= \frac{29.361}{.84741}$$
$$= 34.648$$


3"
3/8"
2"
grout
4"
5/16"
2"