# CALCULATION SHEET

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## 1.0 Situation

Check base plate and hold downs on Te Ahi Tupua

## 2.0 Loads

Provided by Gerrit; (absolute max, Z = vert, ULS loads

Outer;

$F_x = 18.1$ kN
$F_y = 9.6$ kN
$F_z = 41.2$ kN

$M_x = 9$ kNm
$M_y = 12.2$ kN m
$M_z = 3.9$ kNm

Inner;

$F_x = 7.6$ kN
$F_y = 6.6$ kN
$F_z = 51.5$ kN

$M_x = 3.3$ kNm
$M_y = 5$ kNm
$M_z = 1.9$ kNm

## 3.0 Outer ring

### 3.1 300 min long 141 x 9.5 stub

Assume all loads concurrent (conservative).

$V^* = \sqrt{18.1 + 9.6^2} = 20.5$ kN

$M^* = 15.2$ kNm

Assume G250 - lowest.

$\phi M = 37$ kNm → tables

$\phi V = 315$ kN → "

$\phi T \Rightarrow$ fine by inspection → CHS good in torsion

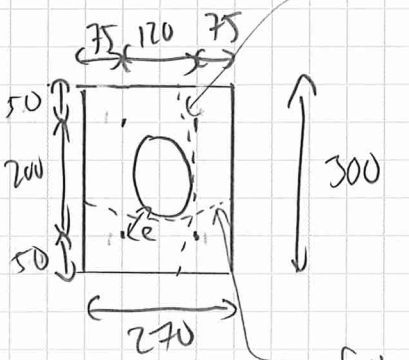
∴ ok.

### 3.2 Weld

FP BW → ok

## 3.3 Plate

Sag:




failure plane about r

failure plane about q

r → q → for the purposes of 3.3, not related to load axis

About q, w/o prying critical for plate;

$$\text{lever} \simeq \frac{200}{2} + \frac{161 - 9.5}{2} = 166\text{mm}$$

$$N^*_{bolt} = \frac{15.2}{.166} + \frac{41.2}{2} = 112.2\text{kN} \quad \text{(both bolts)}$$

Plate is 25mm outer

Take $f_y$ stainless = 210 MPa

$$\therefore \phi M = .9 \times 210 \times .27 \times \frac{.025^2}{4} = 7.97\text{kNm}$$

$$M^* = N^*_{bolt} \times e = 112.2 \times .046 = 5.16\text{kNm}$$ (e from CAD)

Calcs assume CHS is vertical → conservative.

$$\frac{D}{C} = \frac{5.16}{7.97} = .64 \rightarrow \text{ok}$$

About r, lever = 130mm

$$\therefore N^*_{bolt} = \frac{15.2}{.13} + \frac{41.2}{2} = 137\text{kN}$$

From CAD, yeild line ≃ 320mm $\therefore \phi M = .9 \times 210 \times .32 \times .025^2/4$
$= 9.6\text{kNm}$

$M^* = 6.3\text{kNm} \rightarrow$ ok.

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3.4 Bolts

- Plate doesn't yeild ∴ no prying force considered.
- Fy1t 316 Stainless = 500 MPa (anzeor.co.nz, assume class 50).

$$\phi N_{tf} = \phi A_s f_y$$
$$= .8 \times 157 \times 1000^{-2} \times 500 \times 10^3$$
$$= 58.8 \text{ kN}$$

- About q;

$$\frac{D}{C} = \frac{112.2}{58.8 \times 2} = .95 \rightarrow \text{ok.}$$

Once the load is in concrete, it's hooked onto internal frame, which loads DIGS through strut + tie. This is fine by inspection.

- About r;

$$\frac{D}{C} = \frac{137}{62.8 \times 2} = 1.09$$

→ delve deeper into combos;

From GA 0706 Hemo Gorge SPC_tool_v1.1 vec;

By inspection try LC 2000 4 Node IDs 1,154,513 and 1154519 and 1154517

ID1154513; $\frac{\sqrt{12.2^2 + 1.9^2}}{.13 \times 2} + \frac{2.2}{4} = 48.04 \text{ kN} \rightarrow \text{ok}$

ID 1154519; $\frac{\sqrt{11.4^2 + 3.1^2}}{.13 \times 2} + \frac{10.5}{4} = 48.2 \text{ kN} \rightarrow \text{ok.}$

ID 1154517; $\frac{\sqrt{8.1^2 + 4.8^2}}{.13 \times 2} + \frac{33.5}{4} = 44.6 \text{ kN} \rightarrow \text{ok.}$

$\phi V = \phi 62 \times f_{uf} A$
$= .65 \times .62 \times 500 \times 10^6 \times 164 \times 1000^{-2}$
$= 29\ kN$

Some washers have slots, no more than 1 No per location

$\therefore N^*_{unrefined} = \frac{\sqrt{18.1^2 + 9.6^2}}{3} = 6.8$

$\frac{6.8}{21} = .23$

$\therefore \frac{D}{C}_{tension} + \frac{D}{C}_{shear} < 1.2$ $\therefore$ ok.

Shear loads held in by horizontal bars $\therefore$ concrete breakout ok by inspection.

4.0 Inner ring

4.1 88.9 x 7.6 Stub

$\phi M = 11\ kN\,m$ → fine

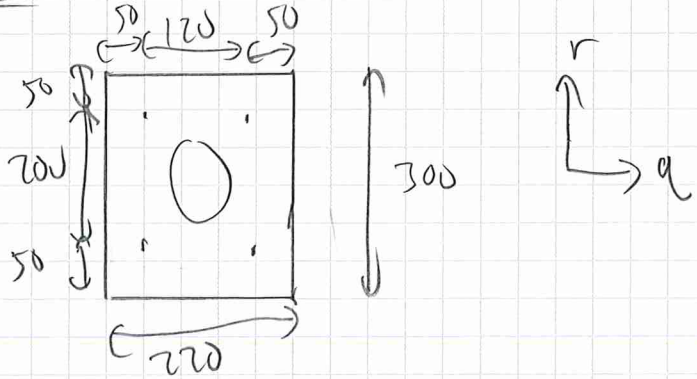
Shear/torsion fine by inspection.

4.2 Weld

FPBW → fine.

4.3 Plate

Say



About q:

lever ≈ 145mm

$N^*_{bolt} = \frac{3.6}{.145} + \frac{51.6}{2} = 50.6\ kN$

$M^* = 50.6 \times .072 = 3.6\ kNm$

$\phi M = .9 \times 210 \times 10^6 \times .27 \times \frac{.022^2}{4}$

$= 4.16\ kNm \rightarrow ok$

About r:

$N^*_{bolt} = \frac{3.6}{.105} + \frac{51.6}{2} = 60.1\ kN$

$M^* = 60.1 \times .072 = 4.3\ kNm$

$\phi M = .9 \times 210 \times 10^6 \times .3 \times \frac{.02^2}{4}$

$= 5.67\ kNm \rightarrow ok$

## 4.4 Bolts

$N^*_{bolt} = \frac{60.1}{2} = 30.1\ kN \rightarrow$ M16 SS as per 3.4

∴ fine. Not critical by inspection, shear/combo fine by inspection

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Post Script:

I considered forces acting on the system, but couldn't find an square angle to that ended up worse.