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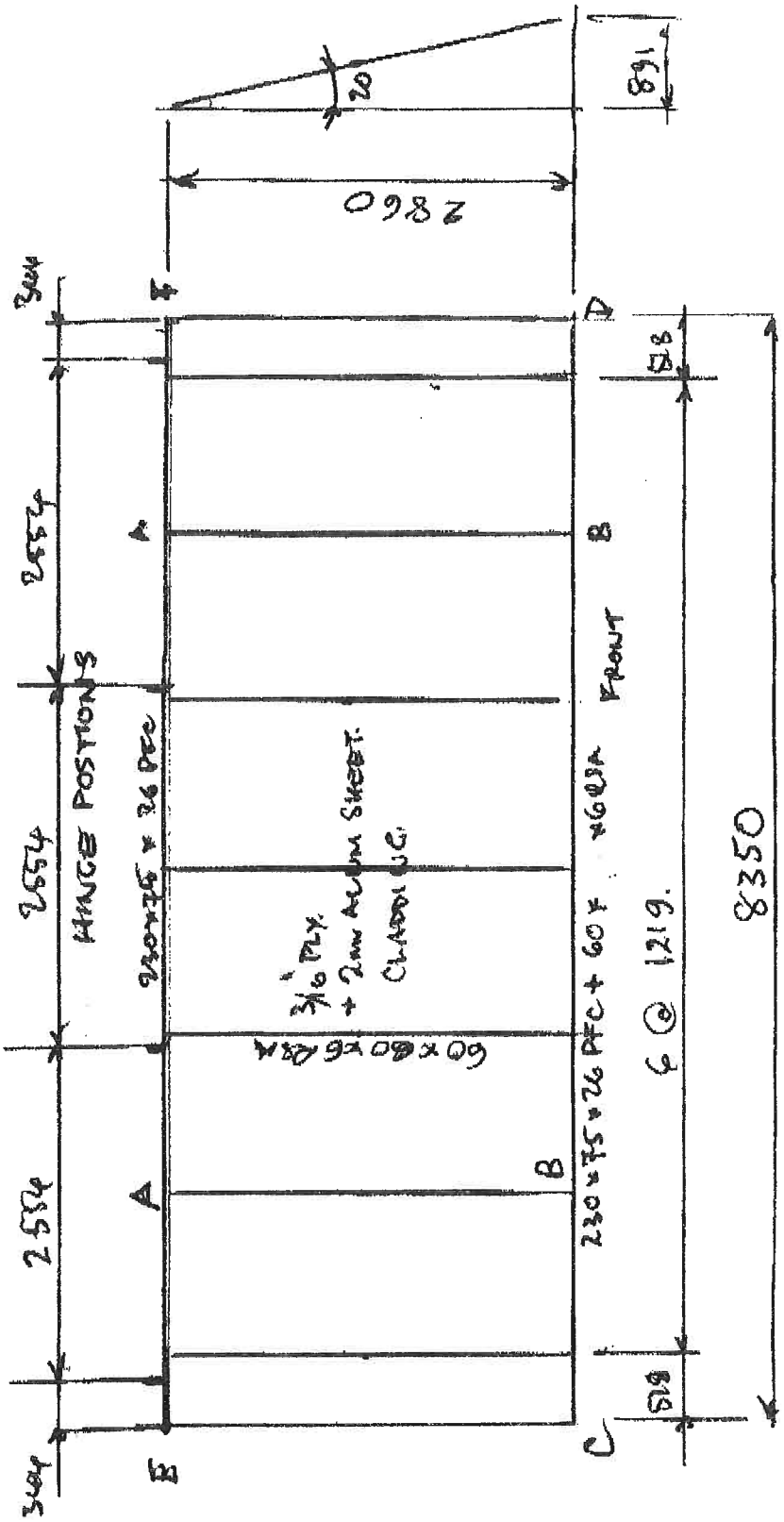

CANOPY. STEELWORK LAYOUT.

(1)

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Stage Bees. Canopy. Beam A-B.

3/16" PLY WOOD @ 6kN/M³

g x mass = $1.218 \times 2.86 \times \left(\frac{0.187 \times 25.4}{10^3}\right) \times 6 = 0.0993$ kN

2mm Alum. = $1.218 \times 2.86 \times 0.002 \times \frac{0.0078}{3} \times \frac{10^3}{10^3} \times 9.81$

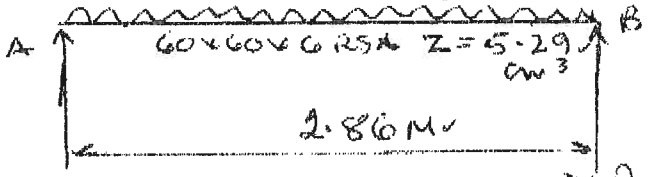
= 0.178 kN.

DL udl = $\left[\frac{(0.0993 + 0.178)}{2.86} + \left(\frac{5.43 \times 9.81}{10^3}\right)\right] = 0.15$ kN/M ✓

0.097. 0.053.

SL udl = $0.72 \times 1.218 = 0.877$ kN/M ✓

0.15 kN/M DL ✓
0.877 kN/M SL ✓



$M_V = \frac{(0.15 + 0.877)(2.86)^2}{8} = 1.05$ kNM ✓

$f_b = \frac{1.05 \times 10^3}{5.29} = 198$ N/mm² ✓ > 180.

DL $R_A = 0.2145$ kN ✓ DL $R_B = 0.2145$ kN ✓

SL $R_A = 1.254$ kN ✓ SL $R_B = 1.254$ kN ✓

$\frac{d}{b} = \frac{8.41}{2.86} = 2.94 < 4$ ignore wind drag.

Wind on facia : height = 5439 mm.

$S_1 = 1.0$, $S_2 = 0.83$ $S_3 = 0.8$. V = 52 M/sec ✓

$V_S = 1.0 \times 0.83 \times 0.8 \times 52 = 34.5$ M/sec ✓

$q = 709$ N/M² ✓

(2)

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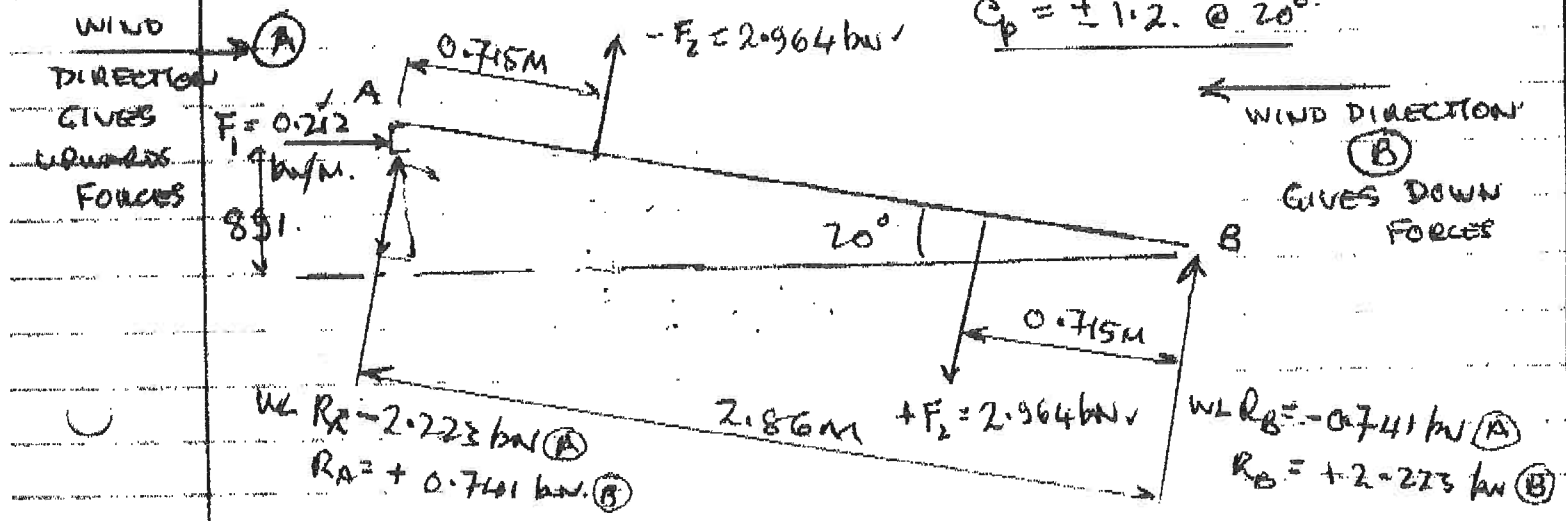
Wind on facia $F_1 = 0.709 \times 0.230 \times 1.3 = 0.212$ bw/M ✓



WL $F_2 = 1.2 \times 2.86 \times 1.218 \times 0.709 = 2.964$ bw. ✓

WIND (A) WL $R_A = -2.964 \times \frac{2.145}{2.86} = -2.223$ bw ✓ UP ; $R_B = -0.741$ bw ✓ UP

WIND (B) WL $R_B = 2.964 \times \frac{2.145}{2.86} = 2.223$ bw. DOWN, $R_A = 0.741$ bw ✓ DOWN

Downward forces:-

(DL + SL + WL) $R_A = 0.2145 + 1.254 + 0.741 = 2.2095$ bw

(DL + SL + WL) $R_B = 0.2145 + 1.2554 + 2.223 = 3.6915$ bw.

Uplift forces:-

(DL + WL) $R_A = 0.2145 - 2.223 = -2.0085$ bw ✓

(DL + WL) $R_B = 0.2145 - 0.741 = -0.5265$ bw ✓

uplift at R_A from facia force $F_1 = 0.212$ bw/M

$1.218 \times 0.212 \times \frac{2.86 \sin 20°}{2.86 \cos 20°} = 0.258 \tan 20° = 0.094$ bw ✓

(3)

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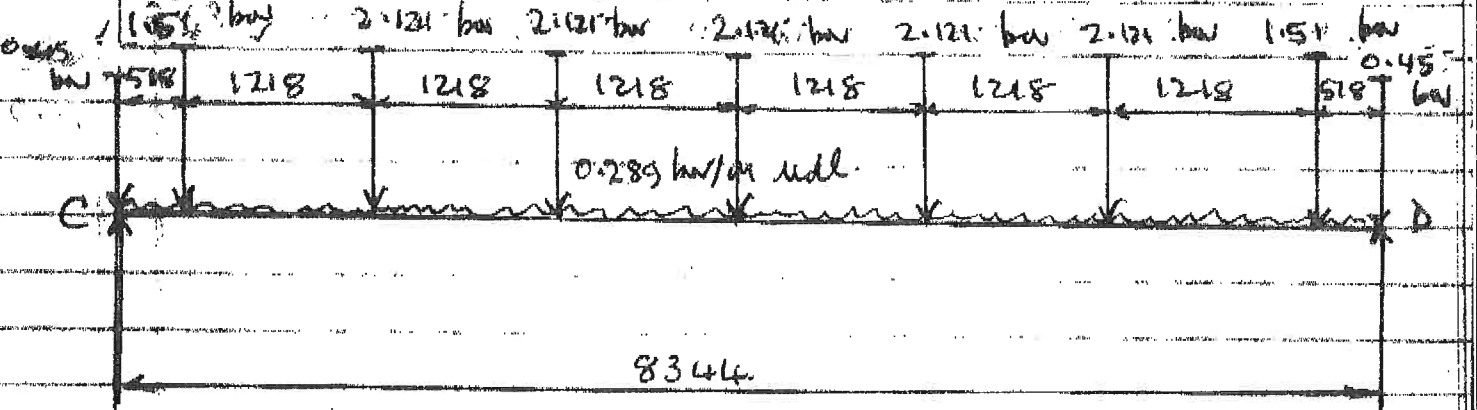
Beam C-D downward forces :- DL + SL + WL

WIND DIRECTION (B)



$R_C = 8.47$ kN $R_D = 8.47$ kN

POINT LOAD = $(0.2145 + 1.2574)\cos 20° + 0.741 = 2.121$ kN ✓
(DL + SL = 1.4685; W.L. = 1.38)

$R_C = R_D = (2.5 \times 2.121) + 1.51 + 0.45 + \left(\frac{8.344 \times 0.2896}{2}\right)$
$= 8.47$ kN ✓

udl = $\frac{(26 + 5.42)}{10^3} 9.81 \cos 20° = 2896$ kN/M ✓

$M_{@2} = \left[\left(8.47 \times \frac{8.344}{2}\right) - 2.121\left(1.128 + 2.436\right)\right.$
$\left. - \left(1.51 \times 3.652\right) - \left(0.45 \times \frac{8.344}{2}\right) - \left\{\left(\frac{4.172}{2}\right)^2 \times 0.289\right\}\right]$

$M_{@2} = 17.67$ kN M. ✓

Vertical force per front post with wind (B) = $\frac{8.47}{\cos 20°} + 0.741 \cos 20° = 9.7$ kN ↓

POST CRITICAL UPLIFT :- Beam C-D wind (A)

wind on fascia = 0.212 kN/M. uplift = $0.212 \times \frac{891}{2860 \cos 20°} = 0.07$ kN/m

uplift per post = $0.07 \times \frac{8135}{2} = 0.3$ kN ↑

VERTICAL POINT LOADS = $0.2145 + 2.123 \cos 20°$ (DL) $- 1.87$ kN ↑ ✓

TOTAL UPLIFT PER POST = $\left\{\left(2.5 \times \frac{1.87}{0.675}\right) + 1.33 + 0.4\right\} \times 0.3 = 6.7$ kN ↑

(4)

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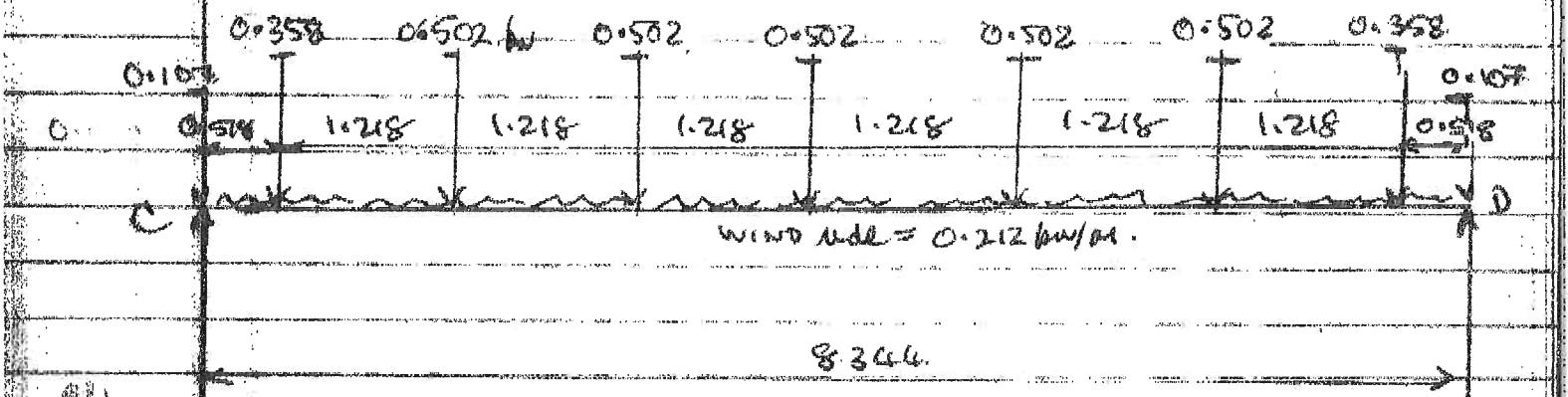
Horizontal forces. Beam C – D. WIND DIRECTION (B)



$R_{HC} = 2.606$ kN

R_{HD}. 2.604 kN

POINT LOAD ON FACIA $= (1.4685 \sin 20°) = 0.502$ kN. ✓

$$R_{HC} = R_{HD} = \left[\left(2.5 \times \underset{0.502}{0.502}\right) + 0.358 + 0.107 + \left(\frac{0.212 \times 8.344}{2}\right)\right]$$

$$= 2.604 \text{ kN}. \checkmark$$

$$M_{H\ell} = \left[\left(2.604 \times \frac{8.344}{2}\right) - 0.502\left(1.218 + 2.436\right) - \left(0.358 \times 3.654\right) - \left(0.107 \times \frac{8.344}{2}\right) - \left\{\frac{(4.172)^2}{2} \times 0.212\right\}\right]$$

(10.864 ✓; 1.834 ✓; 1.308 ✓; 0.446 ✓; 1.845 ✓)

$$M_{H\ell} = 5.431 \text{ kN m} \checkmark$$

(5)

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230 × 75 × 26 PFC.

$\frac{L}{r_y} = \frac{1.218 \times 10^2}{2.35} = 52$ $\frac{D}{T} = 18.4$

$p_c = 180 \text{ N/mm}^2$.

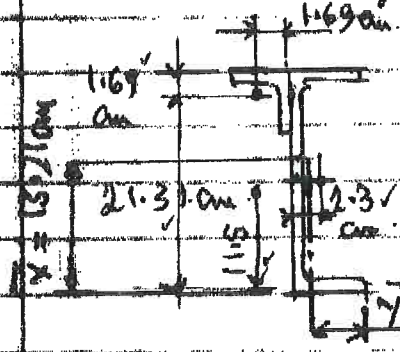
$I_x = 2748 \text{ cm}^4$.
$I_y = 181 \text{ cm}^4$.
$Z_x = 239 \text{ cm}^3$
$Z_y = 34.9 \text{ cm}^3$.
$D = 230 \text{ mm}$
$T = 12.5 \text{ mm}$.
$r_y = 2.35 \text{ cm}$

$f_{bcx} = \frac{17.47 \times 10^3}{239} = 73.93 \text{ N/mm}^2$ ✓

$f_{bcy} = \frac{5.431 \times 10^3}{34.8} = 156.063 \text{ N/mm}^2$ ✓

230 N/mm² ✓ > 1.25 × 180 = 225 N/mm² ✓
inadequate.

Section with 60 × 60 × 6 ESA added as shown on drg.



$A\bar{x} = \Sigma ax$.

$(32.7 + 6.91)\bar{x} = \{(32.7 \times 11.5) + (6.91 \times 21.3)\}$ (39.61)

$\therefore \bar{x} = 13.21$ cm ✓

$A\bar{y} = \Sigma ay = 39.61\,\bar{y} = \{(32.7 \times 5.2) + (6.91 \times 9.19)\}$

$\therefore \bar{y} = 5.89$ cm ✓

$I_{xx} = \Sigma(I_{GG} + AR^2) = \left[2748 + \{32.7(1.71)^2\} + 22.8 + \{6.91(8.1)^2\}\right]$ (95.62, 453.36)

$= 3319.84 \text{ cm}^4$ ✓

$Z_{cx} = \frac{3319.84}{9.79} = 339 \text{ cm}^3$ ✓

$Z_{Tx} = \frac{3319.84}{13.21} = 251.32 \text{ cm}^3$ ✓

(6)

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$$I_{YY} = \sum(I_{cc} + Ah^2) = \left[\{32.7(0.69)^2\} + 181 + 22.8 + \{6.91(3.3)^2\}\right]$$

(15.57 ✓, 75.25 ✓)

$$= 294.62 \text{ cm}^4$$

$$Z_{YYc} = \frac{294.62}{7.61} = 33.71 \text{ cm}^3$$

$$Z_{YYT} = \frac{294.62}{5.89} = 50 \text{ cm}^3$$

$$f_{bcH} + f_{bcV} = \left\{\left(\frac{5.431 \times 10^3}{33.71}\right) + \left(\frac{17.67 \times 10^3}{339}\right)\right\} = 213.23 \text{ N/mm}^2 \checkmark$$

(161.11, 52.12)

$< 1.25 \times 180 = 225 \text{ N/mm}^2$ (ADEQUATE)

FRONT PROPS. 2 No – ϕ 88.9 × 5 CHS. @ 10.3 kg/M

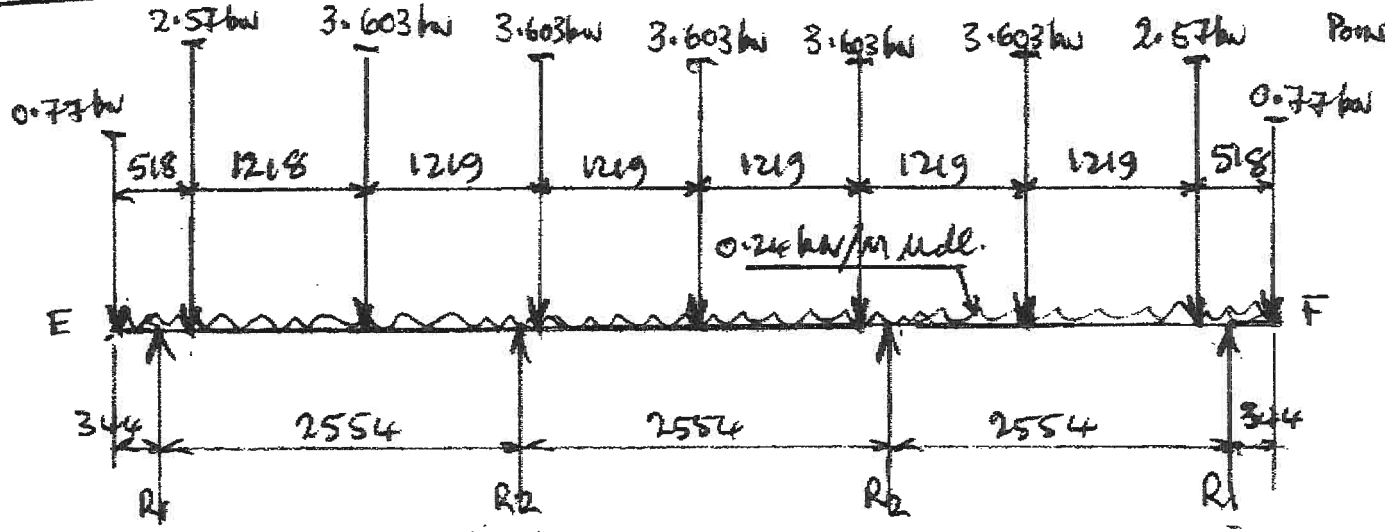
$$l/r = \frac{544}{2.97} = 183 \qquad p_{ac} = 28 \text{ N/mm}^2$$

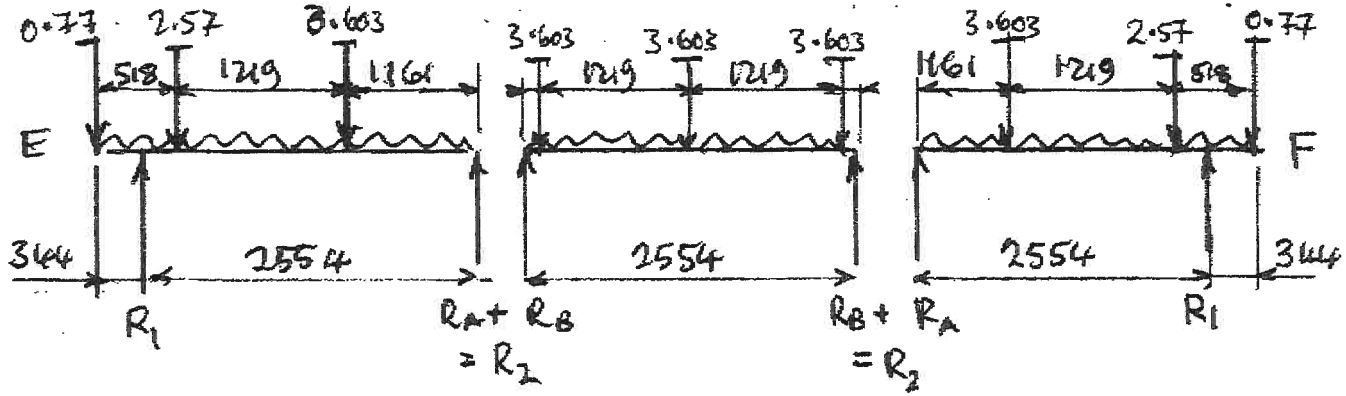
$$f_{ac} = \frac{9.7 \times 10}{13.2} = 7.35 \text{ N/mm}^2$$

$< p_{ac} = 28 \text{ N/mm}^2$ ✓

$I = 116 \text{ cm}^4$
$Z = 26.2 \text{ cm}^3$
$r = 2.97 \text{ cm}$
$A = 13.2 \text{ cm}^2$

VERTICAL FORCES WIND DIRECTION (B) BEAM E–F.





Point loads = 1.4685 Cos 20° + 2.223 = 3.603 kN.

$$R_1 = \frac{\left[(3.603 \times 1.161) + (2.57 \times 2.379) + (0.77 \times 2.898) + \left\{\frac{2.898^2}{2} \times 0.24\right\}\right]}{2.554} = 5.3\text{ kN}. \quad R_A = 2.34\text{ kN}$$

$$R_B = \frac{(3 \times 3.603) + (0.24 \times 2.554)}{2} = 5.71\text{ kN} \quad R_2 = R_A + R_B = 2.34 + 5.71 = 8.05\text{ kN}$$

$$M_{3.603} = \left[\left(0.77 \times 1.737\right) + \left(2.57 \times 1.219\right) + \left\{\frac{1.737^2}{2} \times 0.24\right\} - \left(5.3 \times 1.393\right)\right] = -2.55\text{ kNm} \checkmark$$

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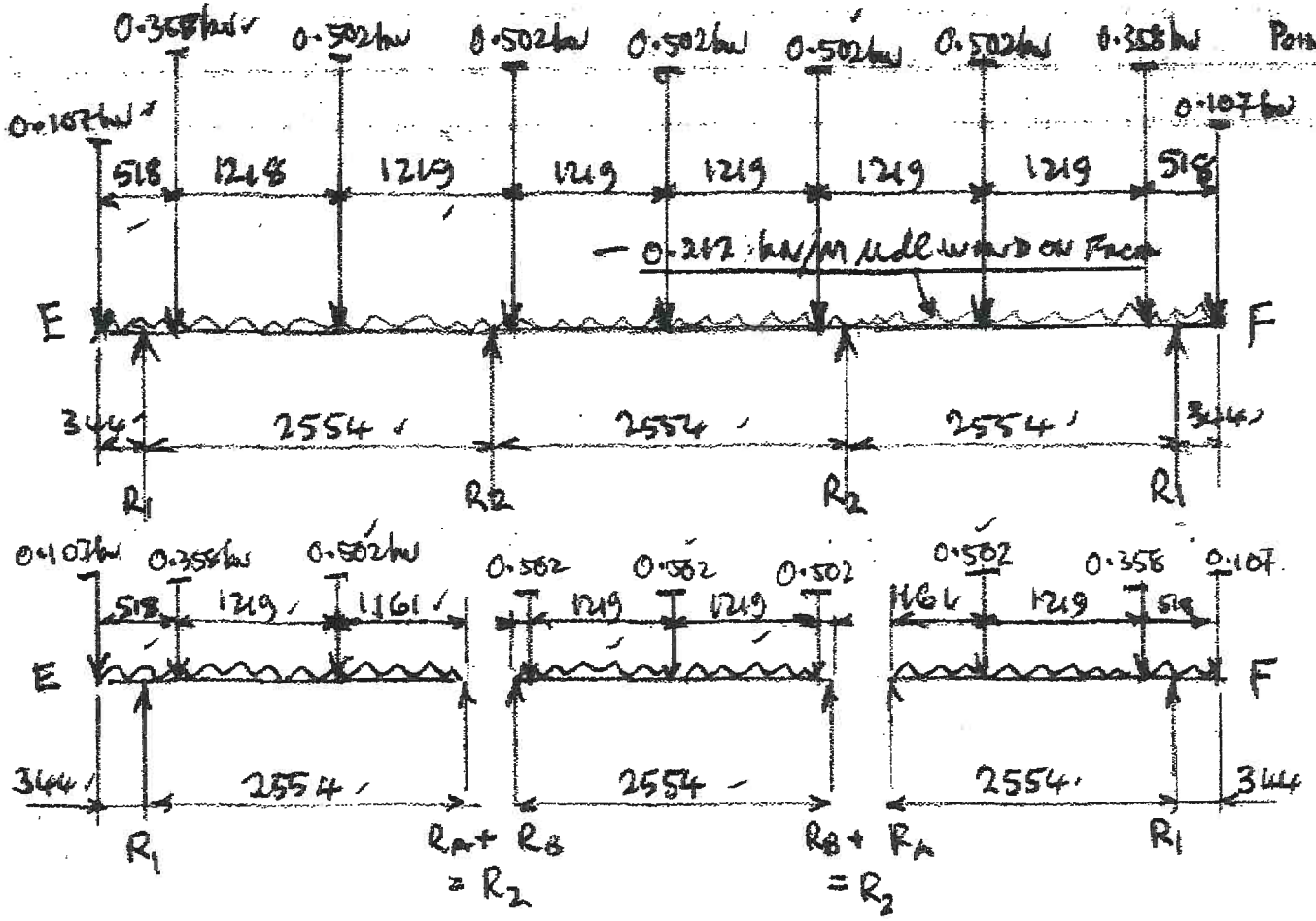
HORIZONTAL FORCES WIND DIRECTION (8) BEAM E-F



$$R_1 = \frac{\left[(0.502 \times 1.161) + (0.358 \times 2.379) + (0.107 \times 2.898) - \left\{\left(\frac{2.898^2}{2} \times 0.212\right)\right\}\right]}{2.554} = 0.335\ \text{kN} \qquad R_A = 0.018\ \text{kN}$$

$$R_B = \frac{(3 \times 0.502) - (2.554 \times 0.212)}{2} = 0.482\ \text{kN} \qquad R_2 = R_A + R_B = 0.018 + 0.482 = 0.5\ \text{kN}$$

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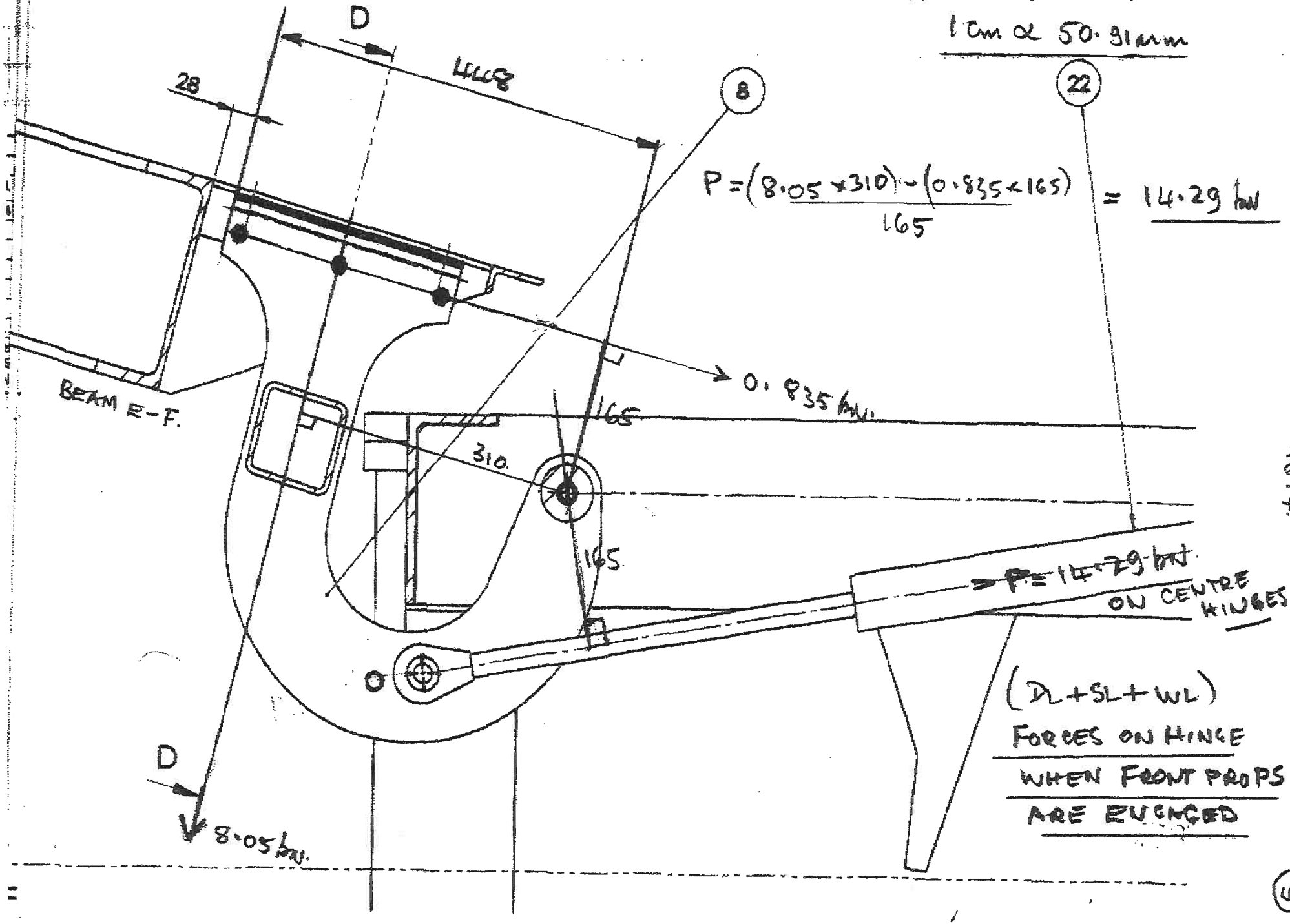

448 @ 8·8 cm.

1 cm @ 50·91 mm

$$P = \frac{(8.05 \times 310) - (0.835 \times 165)}{165} = 14.29 \text{ kN}$$

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~~P = 14·29 kN~~ ON CENTRE HINGES

(DL + SL + WL)

FORCES ON HINGE WHEN FRONT PROPS ARE EVINCED

9

(10)

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Summary :-

60×60×6 RSA possibly overstressed by approximately 10% with S.L and D.L.

Front and rear 230×75×26 PFC beams are adequate with DL+SL+downward WL.

Downward Vert. reac force on each front prop. = 9.7 kN.

Uplift on each front prop with DL+WL↑ = 6.7 kN upwards.

Forces on centre position hinges on p.9 with front props in engaged position