

STRUCTURAL CALCULATION

8 CHERRY TREE ROAD
NZ SOL

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01/11

LOADING SCHEDULE

1 Roof:

Clay tiles on battens on 100x50 joists @ 400 c/s = 0.55 kN/m²

Imposed load = 0.75 "

1.30

Say = 1.35 kN/m²

2 Floor

225x50 joists @ 400 c/s + 25mm floor boarding + plaster = 0.4 kN/m²

Imposed load = 1.50 "

1.90 "

Say = 2.00 kN/m²

3 Walls

9" solid brick work = 4.50 kN/m²

4" solid brick work = 2.25 kN/m²

150mm studwork = 0.90 kN/m²

4 Flat roof:

150x50 joists @ 400 c/s = 0.10 kN/m²

3 layers of felt + gravels = 0.20 "

20mm ply wood = 0.14 "

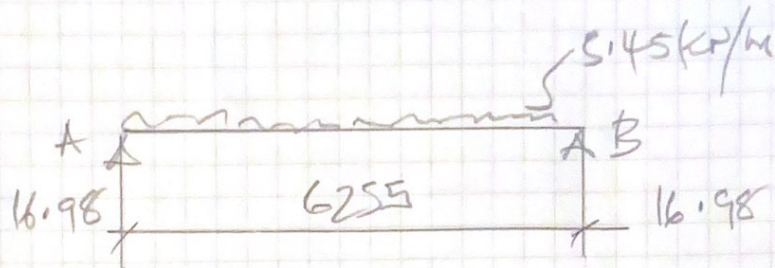
50mm insulation board = 0.25 "

0.75 "

Imposed load = 0.75 "

1.50 "

Say = 1.65 kN/m²

RIDGE BEAMLoading:

$$\begin{aligned}
 AB = \text{Plat roof} &= 1.65 \text{ kN/m}^2 \times 4.3 \frac{1}{2} = 3.55 \text{ kN/m} \\
 \text{Tiled roof} &= 1.35 \text{ kN/m}^2 \times 4.3 \frac{1}{2} = 2.90 \text{ kN/m} \\
 \hline
 &= 5.45 \text{ kN/m}
 \end{aligned}$$

$$\therefore BM = 5.45 \times 6.23 \frac{1}{8} = 26.44 \text{ kNm}$$

TRY: 203 x 203 UC 46

$$y_{ry} = 6255 / 51.1 = 122.41 \quad \frac{A}{T} = \frac{200.2}{9.5} = 21.15$$

$$\therefore \text{Allowable stress} = 155 \text{ N/mm}^2$$

$$\therefore Z \text{ req'd} = 26.44 \times 10^3 / 155 = 170.58 \text{ cm}^3 < 449.2$$

$$\text{Actual def (DL)} = \frac{5 (5.45 \times 6.23) (623)^3 \times 10}{384 \times 21000 \times 4564} = 11.10 \text{ mm}$$

$$\text{Allowable def} = 6255 / 360 = 17.38 \text{ mm} > 11.10$$

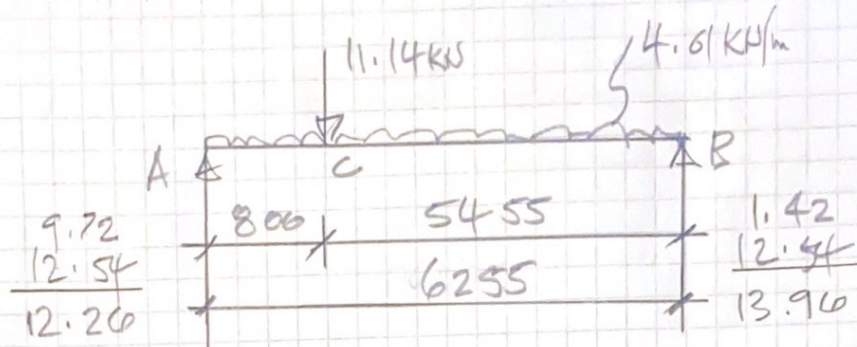
USE 203 x 203 UC 46

check on 100 x 450 x 225 dp pad stone

$$\text{Pressure} = \frac{16.98 \times 10^3}{100 \times 450} = 0.38 \text{ N/mm}^2 < 0.42$$

USE 100 x 450 x 225 dp PADSTONE

2 LOFT FLOOR BEAM:



Loading:

$$C = \begin{matrix} \text{Floor} & = & 2.0 \text{ kN/m}^2 \times 5.19/2 \times 3.29/2 & = & 8.54 \text{ kN} \\ \text{Stud} & = & 0.9 \text{ kN/m}^2 \times 5.19/2 \times 2.3/2 & = & 2.69 \text{ kN} \end{matrix}$$

$$AB = \begin{matrix} \text{Floor} & = & 2.0 \text{ kN/m}^2 \times 3.29/2 & = & 3.29 \text{ kN/m} \\ \text{Stud} & = & 0.9 \text{ kN/m}^2 \times 0.8 & = & 0.72 \text{ kN/m} \end{matrix}$$

BM occurs @ $13.96/4.01 = 3.40$ from B 4.01 kN/m

$$\therefore \text{BM} = 13.96 \times 3.40 - 4.01 \times 3.4^2/2 = 24.29 \text{ kNm}$$

TR4: 203x203 UC 46

$$y_{\text{reqd}} = 6255/51.1 = 122.41 \quad \#/T = 200.2/9.5 = 21.15$$

\therefore Allowable stress = 155 N/mm^2

\therefore $Z_{\text{reqd}} = 24.29 \times 10^3 / 155 = 156.71 \text{ cm} < 449.2$

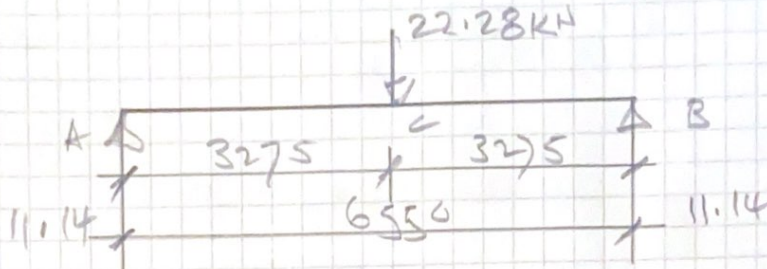
Eql UDL = $24.29 \times 8 / 6.23^2 = 4.96 \text{ kN/m}$

$$\text{Actual deft (b74)} = \frac{5}{384} \times \frac{(4.96 \times 6.23)(623)^3}{2000 \times 4564} \times 10 = 10.20 \text{ mm}$$

Allowable deft = $6255/360 = 17.38 \text{ mm} > 10.20$

USE 203x203 UC 46

3 STAIR TRIMMER BEAM



Loading :-

$C = \text{Point load from left beam} = 11.14 \times 2 = 22.28 \text{ kN}$

$\therefore BM = 11.14 \times 3.28 = 36.54 \text{ kNm}$

TRY: 203 x 203 UC 46

$y/r_{yy} = 6550/51.1 = 128 \quad D/T = 18.5$

$\therefore \text{Allowable stress} = 139 \text{ N/mm}^2$

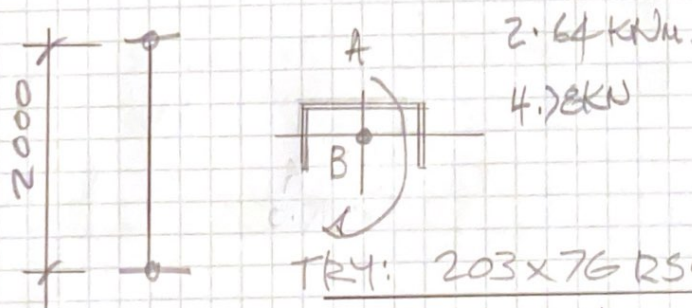
$\therefore Z_{req'd} = 36.54 \times 10^3 / 139 = 262.88 \text{ cm}^3 < 449.2$

Actual def_(b+y) = $\frac{22.28 \times (655)^2 \times 10}{48 \times 21000 \times 4564} = 13.61 \text{ mm}$

Allowable def = $6550/360 = 18.19 \text{ mm} > 13.18$

USE 203 x 203 UC 46

4 BI FOLDS COLUMN



Effective Length = $2000 \times 1.0 = 2000$

Radius of Gyration = 80.2 mm

8 CHERRY TREE ROAD

05/11

4 BI FOLDING COLUMN Con'td

$$\therefore \text{Slenderness ratio} = \frac{2000}{80.2} = 24.94 < 185$$

Loading:-

$$A = 0.7 \text{ KNm} \times \frac{2}{2} \times 1.0 = 0.7 \text{ KNm}$$

$$B = \text{Flat roof} = 1.65 \text{ KN/m}^2 \times 3.6 \times \frac{2}{2} = 2.97 \text{ KN}$$

$$\begin{aligned} \text{Bifolding door } 25 \text{ KN/m}^2 \times 0.7 \times 2 \times (0.01 \times 2)^2 &= 1.40 \text{ "} \\ 25 \text{ KN/m}^2 \times 1.0 \times \frac{2}{2} \times 0.02 &= 0.5 \text{ "} \\ \hline &= 4.87 \text{ KN} \end{aligned}$$

$$\text{BM from Bi-folding} = 1.4 \times 0.7/2 = 0.49 \text{ KNm}$$

$$\therefore \text{Total bending} = 0.49 + 0.7 = 1.19 \text{ "}$$

$$\text{BM from B} = \frac{4.78 \times 0.203}{2} + 0.1 = 0.96 \text{ "}$$

$$2.64 \text{ KNm}$$

TRY 203x76 RSC

$$\text{Allowable stress in bending} = 165 \text{ N/mm}^2$$

$$\text{Allowable stress in Compression} = 143 \text{ N/mm}^2$$

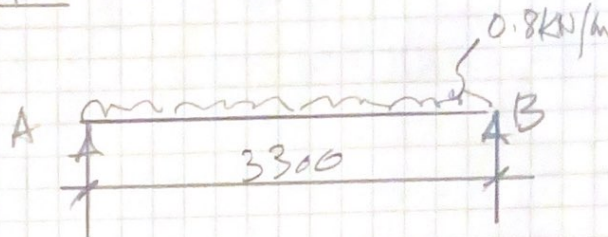
$$\text{Actual bending stress} = \frac{2.64 \times 10^3}{193} = 13.68 \text{ N/mm}^2 < 165$$

$$\text{Compression stress} = \frac{4.87 \times 10^3}{34.35 \times 10^2} = 1.42 \text{ N/mm}^2 < 143$$

$$\frac{13.68}{165} + \frac{1.42}{143} = 0.10 < 1.4$$

USE 203x76 RSC

5. FLOOR JOISTS



Loading:

$$AB = \text{Floor} = 2.0 \text{ kN/m}^2 \times 0.4 = 0.8 \text{ kN/m}$$

$$\therefore \text{BM} = 0.8 \times 3.3^2 / 8 = 1.09 \text{ kNm}$$

$$\therefore Z_{\text{req'd}} = 1.09 \times 10^6 / 5.3 \times 1.1 = 186.98 \times 10^3 \text{ mm}^3$$

$$\text{Allowable def} = 3300 \times 0.003 = 9.9 \text{ mm}$$

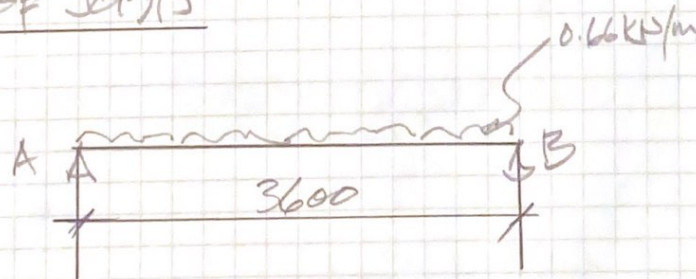
$$\therefore I_{\text{req'd}} = \frac{5}{384} \frac{(0.8 \times 3.3 \times 10^3)^2 \times (3300)^3}{9000 \times 9.9} = 13.88 \times 10^6 \text{ mm}^4$$

USE 200 x 50 joists @ 400 CRS

$$I_{\text{prod}} = 33.3 \times 10^6 \text{ mm}^4 > 13.88 \times 10^6$$

$$Z_{\text{prod}} = 333 \times 10^3 \text{ mm}^3 > 186.98 \times 10^3$$

6. FLAT ROOF JOISTS



Loading:

$$AB = \text{Flat roof} = 1.65 \text{ kN/m}^2 \times 0.4 = 0.66 \text{ kN/m}$$

$$\therefore \text{BM} = 0.66 \times 3.6^2 / 8 = 1.07 \text{ kNm}$$

$$\therefore Z_{\text{req'd}} = 1.07 \times 10^6 / 5.3 \times 1.1 = 183.53 \times 10^3 \text{ mm}^3$$

$$\text{Allowable def} = 3600 \times 0.003 = 10.8 \text{ mm}$$

8 CHERRY TREE ROAD

07/11

6 FLAT ROOF JOIST Cont'd

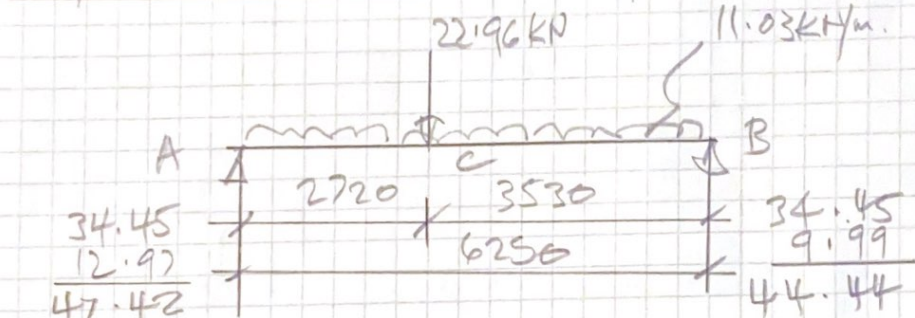
$$\therefore Z_{\text{needd}} = \frac{5}{384} \frac{(0.66 \times 3.6 \times 10^3)^2 (3600)^2}{9000 \times 10.8} = 14.25 \times 10^6 \text{ mm}^3$$

USE 150x50 @ 400 C/S

$$Z_{\text{prod}} = 188 \times 10^3 > 183.53 \times 10^3 \text{ mm}^3$$

$$I_{\text{prod}} = 14.1 \times 10^6 \approx 14.85 \times 10^6 \text{ mm}^4$$

7 EXTENSION BEAM



Loadings:

AB = 9" Wall	= 4.5 kN/m ² × 2.5 × 0.8*	= 9.00 kN/m
Roof	= 1.35 kN/m ² × 3.0/2	= 2.03 kN/m
		<hr/>
		11.03 kN/m
C = 4 1/2" Wall	= 2.25 kN/m ² × 2.5 × 3.8/2	= 10.83 kN
Floor	= 2.00 kN/m ² × 6.3/2 × 3.8/2	= 12.13 kN
		<hr/>
		22.96 kN

Beam occurs @ C

$$M_{\text{max}} = 44.44 \times 3.53 - 11.03 \times 3.53^2/2 = 88.15 \text{ kNm}$$

TRY: 203x203 UC 60

$$b/r_{yy} = 6250/51.9 = 120.43 \quad b/t = 14.8$$

$$\therefore \text{Allowable stress} = 155 \text{ N/mm}^2$$

$$\therefore Z_{\text{needd}} = 88.15 \times 10^3 / 155 = 568.71 \text{ cm}^3 < 581.1$$

$$Eq \text{ UDL} = 88.15 \times 8 / 6.25^2 = 18.05 \text{ kN/m}$$

7. EXTENSION BEAM con'd

$$\text{Actual defl (DHL)} = \frac{5}{384} \frac{(18.05 \times 6.25)(625)^2}{21000 \times 6088} \times 16 = 28.05 \text{ mm}$$

$$\text{Allowable defl} = \frac{6250}{360} \approx 17.36 \text{ mm} < 28.05$$

TRY: 254 x 254 UC73

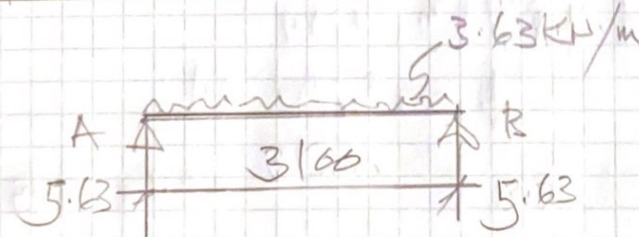
$$Z_{\text{provd}} = 894.5 \text{ cm}^3 > 568.71$$

$$\text{Actual defl} = \frac{28.05 \times 6088}{11360} = 15.03 \text{ mm} < 17.36$$

USE 254 x 254 UC73

check on Dadstone 900 x 100 x 150 dp

$$\text{pressure} = \frac{42.42 \times 10^3}{900 \times 100} = 0.52 \text{ N/mm}^2 < 0.7$$

USE 900 x 100 x 150 dp pre-stressed concrete
Lintel8. ROOF LIGHT TRIMMERLoading

$$AB = \text{roof} = 1.65 \text{ kN/m}^2 \times 2.2 = 3.63 \text{ kN/m}$$

$$= 3.63 \text{ kN/m}$$

$$\therefore BM = \frac{3.63 \times 3.1^2}{8} = 4.32 \text{ kNm}$$

$$\therefore Z_{\text{req'd}} = \frac{4.32 \times 10^6}{5.3} = 815.09 \times 10^3 \text{ mm}^3$$

$$\text{Allowable defl} = 3100 \times 0.003 = 9.3 \text{ mm}$$

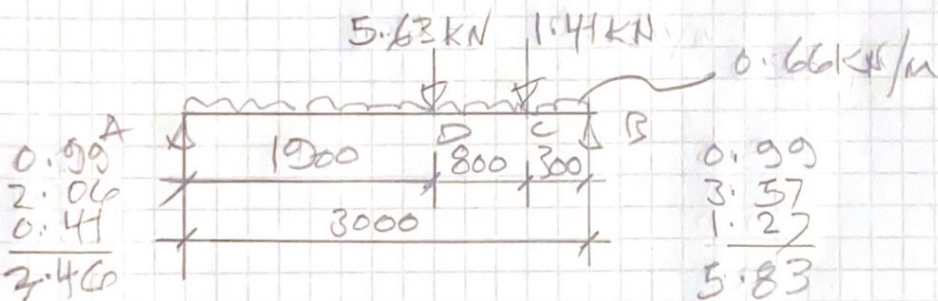
8 ROOF LIGHT TRIMMER CONT

$$I_{req'd} = \frac{5}{384} \times \frac{(3.63 \times 3.1 \times 10^3)^2 \times (3100)^3}{9000 \times 9.3} = 52.15 \times 10^6 \text{ mm}^4$$

USE 2N° 225 X 50 BOLTED TOGETHER 8mm BOLTS

$$Z_{prod} = 884 \times 10^3 \text{ mm}^3 > 815.09 \times 10^3$$

$$I_{prod} = 85.1 \times 10^6 \text{ mm}^4 > 52.15 \times 10^6$$



Loading:

$$AB = \text{roof} = 1.65 \text{ kN/m}^2 \times 0.4 = 0.66 \text{ kN/m}$$

$$D = \text{reaction} = 5.63 \text{ kN}$$

$$C = \text{reaction} = 1.65 \text{ kN/m}^2 \times 1.1 \times \frac{3.1}{2} = 1.41 \text{ kN}$$

B.M. occurs @ D

$$\therefore B.M. = 3.46 \times 1.9 - 0.66 \times 1.9^2 / 2 = 5.37 \text{ kNm}$$

$$\therefore Z_{req'd} = 5.37 \times 10^6 / 5.3 = 1013.21 \times 10^3 \text{ mm}^3$$

$$Eq \text{ VAL} = 5.37 \times 8 / 3^2 = 4.77 \text{ kN/m}$$

$$\text{Allowable def} = 3000 \times 0.003 = 9 \text{ mm}$$

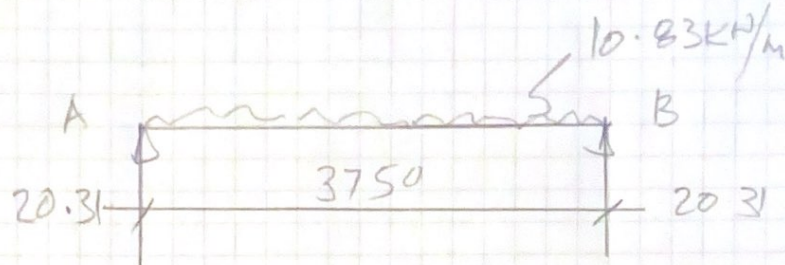
$$\therefore I_{req'd} = \frac{5}{384} \frac{(4.77 \times 3 \times 10^3)^2 (3000)^3}{9000 \times 9} = 62.11 \times 10^6 \text{ mm}^4$$

USE 2N° 225 X 63 BOLTED TOGETHER 8mm BOLTS

$$Z_{prod} = 1124 \times 10^3 \text{ mm}^3 > 1013.21 \times 10^3$$

$$I_{prod} = 419.6 \times 10^6 \text{ mm}^4 > 62.11 \times 10^6$$

9) ENTRANCE HALL BEAM



Loading:

$$\begin{aligned}
 AB \cdot 4\frac{1}{2} \text{ Wall} &= 2.25 \text{ kN/m} \times 2.5 &= 5.63 \text{ kN/m} \\
 \text{Floor} &= 2.00 \text{ kN/m} \times 5.2 / 2 &= 5.20 \\
 \hline
 &&= 10.83 \text{ kN/m}
 \end{aligned}$$

$$BM = 10.83 \times 3.75^2 / 8 = 19.03 \text{ kNm}$$

TRY: 203 x 133 UB 30

$$y/r_{yy} = 3750 / 87.2 = 43 \quad D/t = 21.5$$

$$\text{Allowable stress} = 165 \text{ N/mm}^2$$

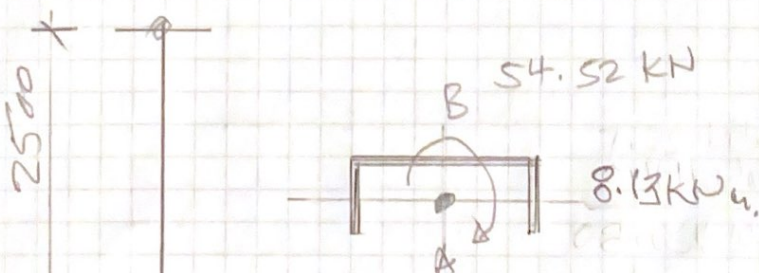
$$\therefore 2 \text{ req'd} = 19.03 \times 10^3 / 165 = 115.33 \text{ cm}^3 < 275.3 \text{ cm}^3$$

$$\Delta \text{ actual def} = \frac{5}{384} \times \frac{(10.83 \times 3.75) \times (375)^3 \times 10}{21000 \times 2887} = 4.60 \text{ mm}$$

$$\text{Allowable def} = 3750 / 360 = 10.41 \text{ mm} > 4.60$$

USE 203 x 133 UB 30

10) ENTRANCE HALL COLUMN



TRY 203 x 76 RS

$$\text{Effective length} = 2500 \times 1.0 = 2500$$

8 CHERRY TREE ROAD

14/11

10 ENTRANCE WALL COLUMN Cont'd

Radius of Gyration = 80.2

\therefore Slenderness ratio = $2500/80.2 = 31.17 < 180$

Loading

A = Beam reaction = 20.31×0.38

$4\frac{1}{2}$ Wall = $2.25 \text{ kN/m}^2 \times 2.5 \times 0.38/2$

= 7.72 kNm

= 0.4 "

8.13 kNm

B = $4\frac{1}{2}$ Wall = $2.25 \text{ kN/m}^2 \times 2.5 \times 4\frac{1}{2}$

Beam reaction

Beam reaction

= 11.25 kNm

= 22.96 "

= 20.31 "

54.52 kN

Allowable stress in bending = 165 N/mm^2

Allowable stress in Compression = 142 N/mm^2

Actual bending = $(22.96 - 20.31) \times (0.203/2) + 0.1 = 13.15 \text{ kNm}$

Actual bending stress = $13.15 \times 10^3 / 192 = 68.49 \text{ N/mm}^2 < 165$

Actual Compressive stress = $54.52 \times 10^3 / 34.35 \times 10^2 = 15.8 \text{ N/mm}^2 < 142$

$$\frac{68.49}{165} + \frac{15.8}{142} = 0.53 < 1.4$$

USE 203 x 76 RSC

11. COLUMN FOOTING

TRY: $800 \times 800 \times 1000 \text{ dp}$

\therefore Ground Pressure = $54.52 / 0.8^2 = 85.19 \text{ kN/m}^2 < 100$

USE 800 x 800 x 1000 dp FOOTING