Balustrade System to 1.5kN/m

60.3 x 3.9mm stainless tube

Do not risk your professional indemnity - use appropriate materials

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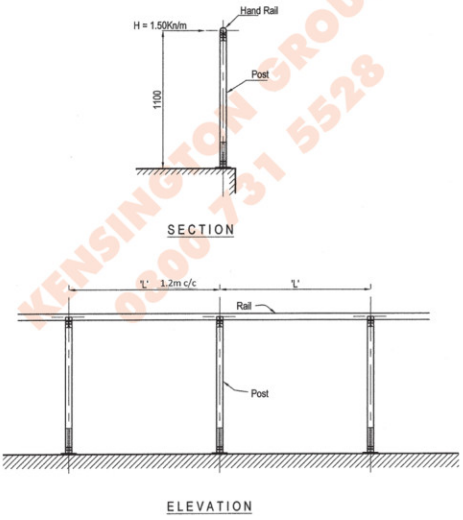
BALUSTRADING DESIGN



60.3CHS x 3.9 + 300mm high 50.8CHS x 3.0 Spiggot

HANDRAIL & POST DESIGN

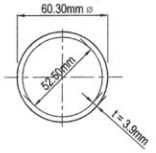
MATERIAL - stainless steel grade 1.4401 (316) [p_y = 220 N/mm^2]

Horizontal load 'H' applied at 1.10m above base plate level.

H= 1.50Kn/m

γ_f = 1.60

HANDRAIL



L = centres of posts

$I_{x-x} = \frac{\pi(60.3^4 - 52.5^4)}{64}$ = 276114.86mm^4

$Z_{x-x} = \frac{\pi(60.3^4 - 52.5^4)}{32 \times 60.3}$ = 9158.04mm^3

$S_{x-x} = 0.167[60.3^3 - (60.3 - 2x3.9)^3]$ = 12450.37mm^3

ϵ = 1.22 D/t = 15.46 = $(13.73\epsilon^2)$ section is Class1 - plastic

0.2% proof stress p_y = 220 N/mm^2

Factored lateral load applied to handrail = 1.5 x 1.6 = 2.40Kn/m

Applied M = $\frac{2.40 \times L^2}{8}$ = 0.30 L^2 Knm

Allowable M_c = $\frac{220 \times 12450.37}{10^6}$ = 2.74 Knm

or

M_c = $\frac{1.2 \times 220 \times 9158.04}{10^6}$ = 2.42 Knm

$0.30 L^2 = 2.42$

$\therefore L = \sqrt{\frac{2.42}{0.30}}$ = 2.84m

Deflection

Limiting deflection to 25mm

$L = \sqrt[4]{\frac{25 \times 384 \times 200 \times 10^3 \times 276114.86}{5 \times 1.50 \times 10^{12}}}$ = 2.90m

MAXIMUM ALLOWABLE SPAN 2.84m

HANDRAIL & POST DESIGN

(60.3 x 3.9CHS post with 50.8 x 3.0 Spiggot 300mm high)

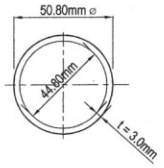
MATERIAL - stainless steel grade 1.4401 (316) [p_y = 220 N/mm^2]

Horizontal load 'H' applied at 1.10m above base plate level.

H= 1.50Kn/m

γ_f = 1.60

SPIGGOT



L = centres of posts

$I_{x-x} = \frac{\pi(50.8^4 - 44.8^4)}{64}$ = 129189.87mm^4

$Z_{x-x} = \frac{\pi(50.8^4 - 44.8^4)}{32 \times 50.8}$ = 5086.22mm^3

$S_{x-x} = 0.167[50.8^3 - 44.8^3]$ = 6877.25mm^3

ϵ = 1.22 D/t = 16.93 = $(11.37\epsilon^2)$ section is Class1 - plastic

0.2% proof stress p_y = 220 N/mm^2

Allowable M_c = $\frac{220 \times 6887.25}{10^6}$ = 1.52 Knm

or

M_c = $\frac{1.2 \times 220 \times 5086.22}{10^6}$ = 1.34 Knm

at 800mm below handrail

load resisted by post - W_1 load resisted by spiggot - W_2

$\therefore W_1 + W_2 = \frac{(1.5 \times 1.2)\,1.1}{0.3}$ = 6.60 Kn

and

$\frac{W_1}{276114.86} = \frac{W_2}{129189.87}$

$\therefore W_1$ = 4.49 Kn & W_2 = 2.11 Kn

Applied moment to post = 4.49 x 0.3 x 1.6 = 2.16 Knm

Applied moment to spiggot = 2.11 x 0.3 x 1.6 = 1.01 Knm

deflection for post at 1.20m c/c

$\delta = \frac{4.49 \times 10^3 \times 0.3^3 \times 10^9}{3 \times 200 \times 10^3 \times 279114.86}$ = 0.72mm ∴ satisfactory

relative deflection at top of post $\delta = \frac{1.22 \times 10^3 \times 1.1^3 \times 10^9}{3 \times 200 \times 10^3 \times 279114.86}$ = 9.70mm

PROVIDE 60.3CHS x 3.9 POST WITH 300mm 50.8CHS x 3.0 SPIGGOT AT 1.20m c/c

HANDRAIL & POST DESIGN

(60.3 x 3.9CHS post with 50.8 x 3.0 Spiggot 300mm high)

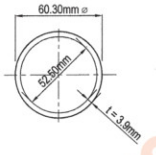
MATERIAL - stainless steel grade 1.4401 (316) [p_y = 220 N/mm^2]

Horizontal load 'H' applied at 1.10m above base plate level.

H= 1.50Kn/m

γ_f = 1.60

POST



L = centres of posts

$I_{x-x} = \frac{\pi(60.3^4 - 52.5^4)}{64}$ = 276114.86mm^4

$Z_{x-x} = \frac{\pi(60.3^4 - 52.5^4)}{32 \times 60.3}$ = 9158.04mm^3

$S_{x-x} = 0.167[60.3^3 - (60.3 - 2x3.9)^3]$ = 12450.37mm^3

ϵ = 1.22 D/t = 15.46 = $(10.39\epsilon^2)$ section is Class1 - plastic

0.2% proof stress p_y = 220 N/mm^2

Allowable M_c = $\frac{220 \times 12450.37}{10^6}$ = 2.74 Knm

or

M_c = $\frac{1.2 \times 220 \times 9158.04}{10^6}$ = 2.42 Knm

Aplied moment 800mm below handrail

M = 2.4 x L x 0.8 = 1.92 L Knm

L = $\frac{2.42}{1.92}$ = 1.26m

deflection for post at 1.20m c/c

$\delta = \frac{1.5 \times 1.2 \times 10^3 \times 0.8^3 \times 10^9}{3 \times 200 \times 10^3 \times 279114.86}$ = 5.5mm ∴ satisfactory

POST BASEPLATE

MATERIAL - stainless steel grade 1.4401

Horizontal load 'H' applied at 1.10m above base plate level.

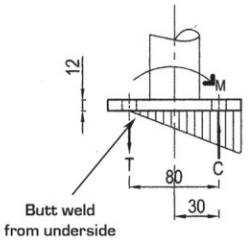
H= 1.50Kn/m (posts at 1.20m c/c)

γ_f = 1.60

M = 2.40 x 1.2 x 1.1 = 3.17 Knm

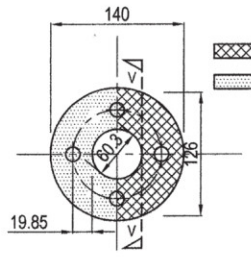
Lever Arm = 80mm

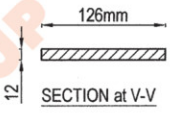
T = C = $\frac{3.17 \times 10^3}{80}$ = 39.63 Kn



i) Compression

Assuming rotation due to compression about V-V





$Z_{v-v} = \frac{126 \times 12^2}{6}$ = 3024mm^3

0.2 % proof stress p_y = 220 N/mm^2

$M_c = \frac{1.2 \times 220 \times 3024}{10^6}$ = 0.79 KNm

Moment in plate due to compression $M = \frac{39.63 \times 0.4(70 - 30.15)\,10^3}{10^6}$ = 0.63 KNm ∴ satisfactory

MAXIMUM ALLOWABLE POST CENTRES 1.20m

i) Tension

0.2 %proof stress p_y = 220 N/mm^2

Moment in plate due to bolt tension $M = \frac{39.63 \times 19.85 \times 10^3}{10^6}$ = 0.79 KNm ∴ satisfactory

MAXIMUM ALLOWABLE POST CENTRES 1.20m