

6.0 Hinge calculation, front reversing chamber door

6.1 Front reversing chamber door

6.1.1 Weight and COG of door

Material / density of door steel	A283-C / 7.75 g/cm³		
Thermal conduc. / density of refractory	0.106 W/m°C / 0.33 g/cm³		
Door cover plate t	6.0 mm	Weight of door cover	
Door cover area	829,988.2 mm²		38.6 kg
Door side plate t	3.0 mm	Total length of side pl.	
Door side plate width	30.0 mm		4,712.9 mm
side plate length L ₁	536.9 mm	Weight of all side pl.	
side plate length L ₂	211.3 mm		3.3 kg
side plate length L ₃	1,396.0 mm		
side plate length L ₄	352.7 mm		
side plate length L ₅	2,216.0 mm		
Refractory thickness	30.0 mm	Weight of refractory	
Refractory area	829,988.2 mm²		8.2 kg
Total weight			50.1 kg

Center of gravity in vertial direction of door

Door height	1591.8 mm		
Door weight / refractory area	6.04E-05 kg/mm ²		
Segment	10	Element length	159.2 mm

	A	L	W	WxL
1	90946.1	79.59	5.5	436.9
2	94403.7	239	5.7	1360.6
3	84543.8	398	5.1	2030.8
4	78348.7	557	4.7	2634.8
5	75348.8	716	4.5	3257.8
6	75413.9	875	4.6	3985.3
7	80206.4	1035	4.8	5009.2
8	102259.9	1194	6.2	7369.0
9	104778.5	1353	6.3	8557.2
10	57842.3	1512	3.5	5279.7

$$\Sigma WxL = 39,921.3$$

$$COG = 796.9 \text{ mm}$$

Center of gravity in horizontal direction of door

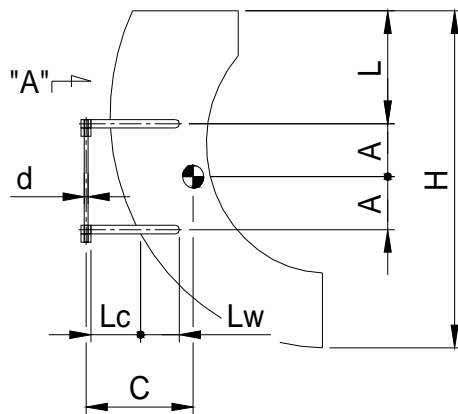
Door height **1079.5** mm
 Door weight / refractory area $6.04\text{E-}05$ kg/mm²
 Segment 10 Element length 108.0 mm

	A	L	W	WxL
1	38349.1	53.975	2.3	124.9
2	39523.5	213	2.4	508.5
3	41919.7	372	2.5	942.1
4	47045.3	532	2.8	1509.3
5	85673.4	691	5.2	3571.8
6	135157.6	850	8.2	6933.4
7	142458.1	1009	8.6	8676.7
8	130696.5	1168	7.9	9216.1
9	114514.6	1327	6.9	9175.3
10	68754.3	1487	4.2	6169.4

$$\Sigma WxL = 46,827.7$$

$$\text{COG} = 934.7 \text{ mm}$$

6.1.2 Hinge calculation



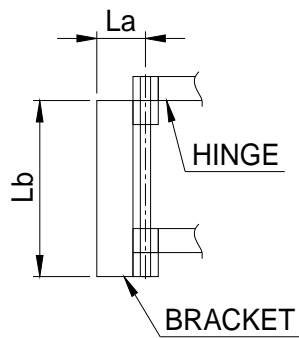
Weight of door 65.1 kg
 (Refractory anchor weight margin considered)

Safety factor **1.5**

H 1591.8 mm
 A **200.0** mm
 L 596.9 mm
 C **644.0** mm
 d, Pin dia. **10.0** mm
 Min weld length, **Lw** **140.0** mm
 Weld size, w 4 mm
 Hinge Q'ty 2 ea
 Lc **270** mm

Bracket Lb 450.0 mm Bracket, tb **8.0** mm
 La **60.0** mm Weld of bracket, wb **8** mm

Hinge & bracket material A283-C Pin material A36
 Hinge t 8.0 mm Hinge width **50.0** mm



<section "A-A">

Applied force, F = 97.7 kg

Hinge properties

Cross sec. area A 400.0 mm²

$I = t h^3 / 12 = 83333.3 \text{ mm}^4$

$S = t h^2 / 6 = 3333.3 \text{ mm}^3$

$r = (I / A)^{0.5} = 14.4 \text{ mm}$

$L / r = 18.7$

Allowable compressive stress of hinge = 13.4 kg/mm²

Reacting forces & moments

$$F_A = F_B = \frac{F \times C}{2 A} = \frac{97.7 \times 644}{2 \times 200} = 157.3 \text{ kg}$$

$$F_V = F / 2 = 48.8 \text{ kg}$$

Hinge stress

Bending moment, $M = F C / 2 = 31456.9 \text{ kgmm}$

Bending stress = $M / S = 9.44 \text{ kg/mm}^2 < 13.80 \text{ kg/mm}^2 \text{ OK}$

Shear stress = $F_V / A = 0.12 \text{ kg/mm}^2 < 8.36 \text{ kg/mm}^2 \text{ OK}$

Tension stress = $F_A / A = 0.39 \text{ kg/mm}^2 < 12.54 \text{ kg/mm}^2 \text{ OK}$

Compres. stress = $F_A / A = 0.39 \text{ kg/mm}^2 < 13.35 \text{ kg/mm}^2 \text{ OK}$

Combined Stress = 0.73 < 1.00 OK

Pin stress

Pin cross sec. area, $A_p = 78.5 \text{ mm}^2$

$$\begin{aligned}\text{Shear stress} &= \frac{(F_A^2 + F_V^2)^{0.5}}{A_p} = \frac{(157.3^2 + 48.8^2)^{0.5}}{78.5} \\ &= 2.10 \text{ kg/mm}^2 < 10.20 \text{ kg/mm}^2 \quad \text{OK}\end{aligned}$$

Weld check between door and hinges

For bending

$$6 \text{ M} / 2 \text{ L}^2 0.707 \text{ w} = 1.70 \text{ kg/mm}^2 < 9.56 \text{ kg/mm}^2 \quad \text{OK}$$

For shear

$$F_V / 2 \text{ L} 0.707 \text{ w} = 0.06 \text{ kg/mm}^2 < 9.56 \text{ kg/mm}^2 \quad \text{OK}$$

For tension or compression

$$F_A / 2 \text{ L} 0.707 \text{ w} = 0.20 \text{ kg/mm}^2 < 9.56 \text{ kg/mm}^2 \quad \text{OK}$$

$$\text{Combined stress} = 0.21 < 1.00 \quad \text{OK}$$

6.1.3 Bracket calculation

Bracket stress

$$\text{Bending moment, } Mb = F \times (C + La) = 68,775 \text{ kg mm}$$

$$\text{Bending stress} = 6 Mb / Lb^2 tb =$$

$$0.25 \text{ kg/mm}^2 < 13.80 \text{ kg/mm}^2 \text{ OK}$$

$$\text{Shear stress} = F / Lb tb =$$

$$0.03 \text{ kg/mm}^2 < 8.36 \text{ kg/mm}^2 \text{ OK}$$

$$\text{Combined stress} = 0.02 < 1.00 \text{ OK}$$

Weld stress on bracket

$$\text{Bending} = 6 Mb / 2 Lb^2 0.707 wb =$$

$$0.18 \text{ kg/mm}^2 < 9.56 \text{ kg/mm}^2 \text{ OK}$$

$$\text{Shear} = F / 2 Lb 0.707 w =$$

$$0.02 \text{ kg/mm}^2 < 9.56 \text{ kg/mm}^2 \text{ OK}$$

$$\text{Combined stress} = 0.02 < 1.00 \text{ OK}$$