



1.0 INPUT

1.1 Column

Type	Type = Standard
Section	Section= UC 203x203x46
Overall Depth	D = 203.2mm
Flange Width	B = 203.6 mm
Flange Thickness	T = 11 mm
Web Thickness	t = 7.2 mm

1.1.1 Weld

Flange - Base Plate Weld Size	S_f = 5 mm
Web - Base Plate Weld Size	S_w = 4 mm

1.2 Base Plate & Bolts

1.2.1 Base Plate

Depth	D_{pl} = 400 mm
Width	B_{pl} = 400 mm
Thickness	t_{pl} = 20 mm

1.2.2 Holding Down Bolts

Bolt Size	d = 20 mm
Number of Bolts	N_b = 4 Nos
Gauge	S_g = 300 mm
Bolt Spacing	S_b = 300 mm
Edge Distance along Length	e_x = 50 mm
Edge Distance along Width	e_y = 50 mm

1.3 Bolt Anchorage

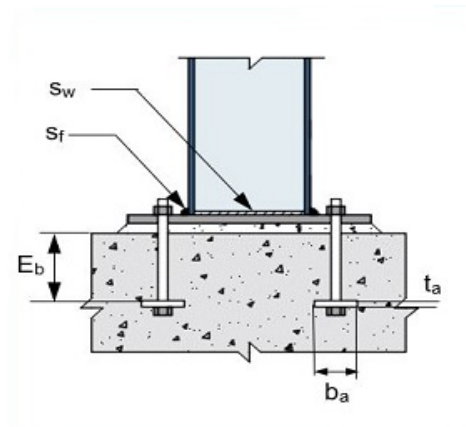
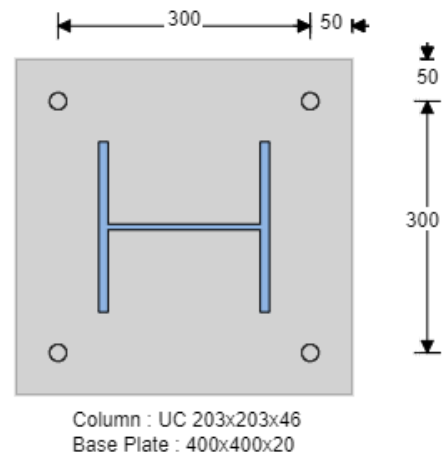
Bolt Type	Bolt with Plates
Embedment	E_b = 360 mm
Width of Square Plate	b_a = 80 mm
Thickness	t_a = 12 mm

1.4 Stiffener

Stiffener	No
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1.5 Load Combination

Axial Load	A_c = 75 kN
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Major Axis Moment	M_a	= 15 kNm
Minor Axis Moment	M_i	= 15 kNm
Resultant Shear	F_{sv}	= 20 kN

1.6 Steel Grade

Column Steel Grade	f_{yc}	= S 275
Base Plate Steel Grade	f_{yb}	= S 275
Anchor Plate Steel Grade	f_{ya}	= S 275

1.7 Bolt Property

Bolt Grade	f_b	= 4.6
Bolt Pull Out based on Concrete in		Tension

1.8 Concrete Property

Characteristic Strength of Concrete	f_{cu}	= 25 N/mm²
Tensile Strength of Concrete	f_s	= 1.15 N/mm²
Coefficient of Friction	μ	= 0.3
Electrode Classification	EC	= 35

2.0 OUTPUT

Ref: BS 5950

Plate Edge to Flange - Length Dir.	$L1$	= $(D_{pl} - D) / 2 =$ 98.4 mm
Plate Edge to Flange - Breadth Dir.	$B1$	= $(B_{pl} - B) / 2 =$ 98.2 mm
Design Base Plate Strength	p_{yp}	= 265 N/mm²
Compression Outstand	c	= $\sqrt{((p_{yp} * t_{pl}^2) / (3 * 0.6 * f_{cu})) + 0.8 * S_f} =$ 52.5 mm
Effective Length	L_e	= $D + (S_b - D) / 2 + \min(c, L1) =$ 304.1 mm
Effective Breadth	B_e	= $B + (S_g - B) / 2 + \min(c, B1) =$ 304.3 mm
Resultant Moment	M	= $M_a + M_i * (L_e / B_e) =$ 30 kNm
Effective Width of Base Plate	B_{efc}	= 400 mm
Distance from Tension Bolts to Compression Edge	h_1	= 350 mm
Depth of Compression Block	x	= 20.22 mm
Compression Force in Concrete	C_f	= $0.6 * f_{cu} * B_{efc} * x =$ 121.33 kN
Tension Force in Bolts	T_f	= $C_f - A_c =$ 46.33 kN

2.1 Base Plate Area

Provided Area of Base Plate	A_p	= $B_{pl} * D_{pl} =$ 160000 mm²
Required Area of Base Plate	A_{Reqd}	= $\text{abs}(A_c) / 0.6 * f_{cu} =$ 5000 mm²

2.2 Base Plate Thickness

Required Thickness of Base Plate	t_{Reqd}	= 11 mm
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2.3 Holding Down Bolts

Force Acting per Bolt	F_b	= $(2 * T_f) / N_b =$ 23.167 kN
Tensile Area of Bolt	A_t	= 245 mm²

Area of Bolt for Tension	$P_t = 400 \text{ N/mm}^2$
Tension Capacity of Bolts	$P_b = 0.6 * P_t * 0.875 * A_t = 51.45 \text{ kN}$

2.4 Anchor Plates

2.4.1 Plate Bearing

Force Acting per Anchor Plate	$F_a = 23.167 \text{ kN}$
Bolt Hole Diameter in Anchor Plate	$d_h = 22 \text{ mm}$
Anchor Plate Bearing Area	$A_a = (b_a^2 - ((\pi / 4) * d_h^2)) = 6019.87 \text{ mm}^2$
Bearing Capacity of Plate	$P_a = 0.6 * f_{cu} * A_a = 90.298 \text{ kN}$

2.4.2 Plate Bending

Bearing Pressure on Anchor Plate	$f_a = F_a / A_a = 3.85 \text{ N/mm}^2$
Width of Bolt Head	$d_{bh} = 30 \text{ mm}$
Maximum Cantilever Length	$l_{mc} = (b_a / 2) * (2)^{0.5} - (d_{bh} / 2) = 41.56 \text{ mm}$
Bending Moment in Plate	$m_a = f_a * l_{mc}^2 / 2 = 3.324 \text{ Nm/mm}$
Design Anchor Plate Strength	$p_{yap} = 275 \text{ N/mm}^2$
Bending Capacity of Plate	$m_{ac} = p_{yap} * t_a^2 / 4 = 9.9 \text{ Nm/mm}$

2.5 Holding Down Bolt Anchorage

Spacing between Successive Bolts along	$s_{gs} = 300 \text{ mm}$
Width of Base Plate	
Effective Concrete Plan Area	$A_{planeff} = (s_{gs} * ((N_b / 2) - 1) + b_a) * (b_a + (2 * E_b)) + (\pi * E_b * E_b) + (2 * b_a * E_b) - ((N_b / 2) * b_a * b_a) = 755950.06 \text{ mm}^2$
Tension Force to be Resisted	$F_t = T_f = 46.33 \text{ kN}$
Pullout Capacity of Tension Bolts	$P_{pull} = f_s * A_{planeff} = 869.34 \text{ kN}$

2.6 Weld for Column - Base Plate

Design Strength of Weld	$p_w = 220 \text{ N/mm}^2$	<i>Cl.6.8</i>
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2.7 Flange

Design Column Strength	$p_{yc} = 275 \text{ N/mm}^2$	
Column Area	$A = 5783.84 \text{ mm}^2$	
Tension Capacity of Flange	$F_{cf} = B * T * p_{yc} = 615.89 \text{ kN}$	
Force in Tension Flange	$F_{tf} = M / (D - T) - A_c * (B * T) / A = 126.99 \text{ kN}$	
Flange Weld Design Force	$F_f = \min(F_{cf}, \max(F_{tf}, 0)) = 126.99 \text{ kN}$	
Weld Force per mm	$f_{fw} = F_f / (2 * B - t) = 0.317 \text{ kN/mm}$	
Capacity of Weld	$p_{fw} = 0.962 \text{ kN/mm}$	<i>Cl.6.8</i>

2.8 Web

Weld Force per mm due to Shear Force	$f_{ww} = F_{sv} / (2 * (D - (2 * T))) = 0.055 \text{ kN/mm}$	
Longitudinal Capacity of Weld	$p_{ww} = 0.616 \text{ kN/mm}$	<i>Cl.6.8</i>

2.9 Shear Capacity

Frictional Resistance	$P_{vc} = C_f * \mu = 36.4 \text{ kN}$
Ultimate Strength of Bolts	$f_{ub} = 400 \text{ N/mm}^2$

Shear Capacity of Bolts on Compression Side	$V_{dc} = f_{ub} / (3)^{0.5} * (\pi / 4 * d^2) * (N_b / 2) = 145.1 \text{ kN}$
Shear Capacity of Bolts on Tension Side	$V_{dt} = F_{sv} / (1 - (T_f / (P_b * (N_b / 2))))^{0.5} = 22.4 \text{ kN}$
Shear Capacity	$P_{sc1} = (P_{vc} + V_{dc} + V_{dt}) = 203.9 \text{ kN}$
Anchorage Shear Capacity	$P_{svalue} = (0.2 * f_{cu} * 0.5 * E_b * d) * N_b = 72 \text{ kN}$
Total Shear Capacity	$P_{sc} = \min(P_{sc1}, P_{svalue}) = 72 \text{ kN}$

2.10 Moment Capacity

Compression Force	$C_b = 177.9 \text{ kN}$
Neutral Axis	$x = 56.27 \text{ mm}$
Overall Moment Capacity	$M_c = 41.82 \text{ kNm}$

3.0 SUMMARY

Description	Required	Actual	Status
Base Plate			
Base Plate Area (mm ²)	$A_{Reqd} \geq 5000$	$A_p = 160000$	PASS
Base Plate Thickness (mm)	$t_{Reqd} \geq 11$	$t_{pl} = 20$	PASS
Bolt System			
Bolt Pullout Force (kN)	$F_t \geq 46.33$	$P_{pull} = 869.34$	PASS
Bolt Tension Force per Bolt (kN)	$F_b \geq 23.167$	$P_b = 51.45$	PASS
Anchor Plate - Bearing Force (kN)	$F_a \geq 23.167$	$P_a = 90.298$	PASS
Anchor Plate - Moment (Nm/mm)	$m_a \geq 3.324$	$m_{ac} = 9.9$	PASS
Stiffener - Not Provided			
Weld Force (kN/mm)			
Flange to Base Plate	$f_{fw} \geq 0.317$	$\rho_{fw} = 0.962$	PASS
Web to Base Plate - Shear	$f_{ww} \geq 0.055$	$\rho_{ww} = 0.616$	PASS
Overall Capacity			
Shear (kN)	$F_{sv} \geq 20$	$P_{sc} = 72$	PASS
Moment (kNm)	$M \geq 30$	$M_c = 41.82$	PASS