

DESIGN REPORT

Steel compression member - CHS 219.1 × 6

Designed in accordance with IS 800:2007 (limit state method)

Project	-
Client	-
Location	-
Member	C1 - Tubular column TC1
Designed by	-
Checked by	-
Result	All checks satisfied
Date	31 Oct 2026

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1. Design summary

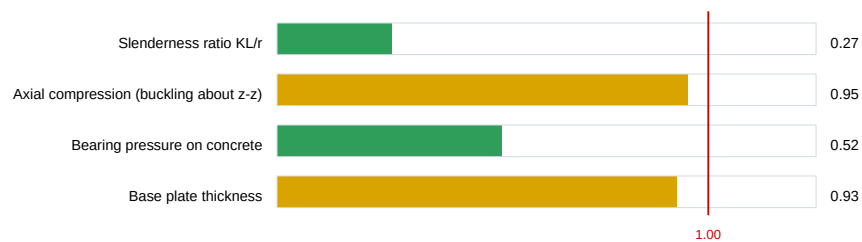
All design checks are satisfied. Maximum utilisation 0.95.

Project	-
Client / location	-
Member	C1 - Tubular column TC1
Member type	Circular hollow section (CHS)
Section	CHS 219.1 × 6
Steel	YSt 310: $f_y = 310 \text{ N/mm}^2$, $f_u = 450 \text{ N/mm}^2$
Length	4.500 m
Design axial force	902.1 kN (Factored design load (input))
Design compressive strength	$P_d = 947.6 \text{ kN}$ (buckling about z-z)
Self weight of member	31.5 kg/m - 142 kg
Report date	31 Oct 2026

Summary of design checks

Check	Clause	Demand	Capacity	Ratio	Status
Slenderness ratio KL/r	Table 3	47.78	180.00	0.265	OK
Axial compression (buckling about z-z)	7.1.2	902.09 kN	947.57 kN	0.952	OK
Bearing pressure on concrete	7.4.1	7.80 N/mm ²	15.00 N/mm ²	0.520	OK
Base plate thickness	7.4.3.1	14.82 mm	16.00 mm	0.926	OK

UTILISATION OF DESIGN CHECKS



Utilisation of each check (1.00 = capacity)

2. Design basis and material

- IS 800:2007 General construction in steel - Code of practice (limit state method).
- IS 808:1989 Dimensions for hot rolled steel beam, column, channel and angle sections.
- IS 2062:2011 Hot rolled structural steel; IS 4923:2017 Hollow steel sections.
- IS 875 (Parts 1-3) and IS 1893 for loads; IS 456:2000 for the concrete pedestal.
- Section properties are computed from the IS 808 outline (tapered flanges and root fillets of rolled shapes included); they agree with the tabulated values within about 1-3 %.

γ_{m0} - resistance governed by yielding	1.10 (Table 5)
γ_{m1} - resistance governed by ultimate stress	1.25 (Table 5)
γ_{mb} - bolts (bearing type)	1.25 (Table 5)
γ_{mw} - shop welds	1.25 (Table 5)
Modulus of elasticity E	200,000 N/mm ² (2.2.4.1)
Shear modulus G	76,900 N/mm ² (2.2.4.1)

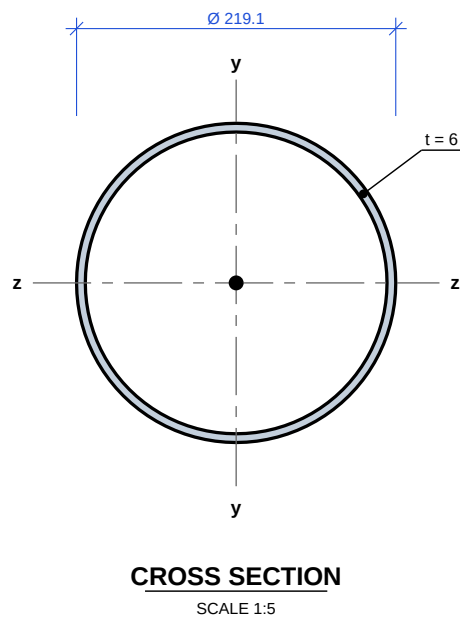
Material strength (IS 800 Table 1 / IS 2062)

OK

Reference	Description	Calculation	Result
Table 1	Steel grade	YSt 310	
	Governing thickness	maximum element thickness $t = 6 \text{ mm}$ ($t < 20 \text{ mm}$)	
Table 1	Yield stress f_y	f_y for $t < 20 \text{ mm}$	310 N/mm ²

Reference	Description	Calculation	Result	
Table 1	Ultimate stress f_u		450 N/mm ²	
Table 2	ε	$\sqrt{(250 / f_y)} = \sqrt{(250 / 310)}$	0.898	
5.4.1	Design yield stress	$f_y / \gamma_{m0} = 310 / 1.1$	281.8 N/mm ²	

3. Section properties



Cross section - CHS 219.1 × 6

Area A	4,014 mm ²
Mass	31.51 kg/m
I _z (major axis)	2,278.7 cm ⁴
I _y (minor axis)	2,278.7 cm ⁴
r _z	75.3 mm
r _y	75.3 mm
Z _{ez} / Z _{ey} (elastic)	208.0 / 208.0 cm ³
Z _{pz} / Z _{py} (plastic)	272.2 / 272.2 cm ³
Torsion constant I _t	4,560.28 cm ⁴

4. Design loads

Design forces				OK
Reference	Description	Calculation	Result	
	Factored axial force	Factored design load (input)	900.0 kN	
Table 4	Factored self weight	$1.5 \times 31.51 \text{ kg/m} \times 9.81 \times 4.500 \text{ m}$	2.09 kN	
	Design axial force P	applied + self weight (at the base, conservatively over the full length)	902.1 kN	

5. Section classification

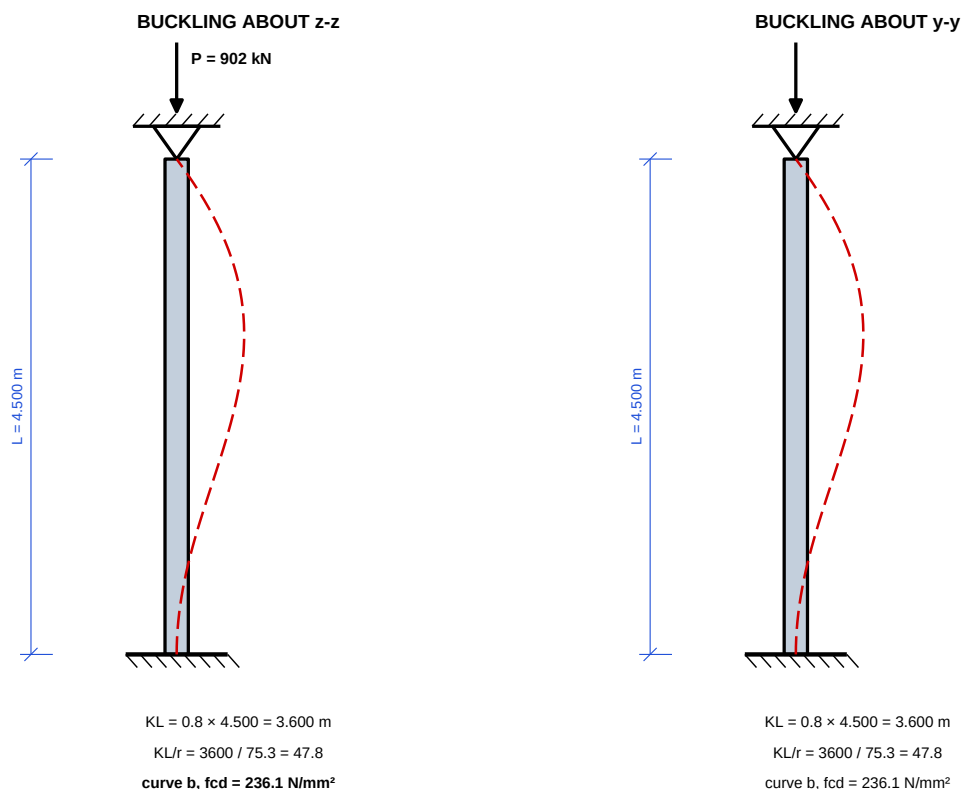
Compression elements are classified to IS 800 Table 2. Limits are shown as plastic / compact / semi-compact (multiples of ε , or ε^2 for tubes, already applied). An element beyond the semi-compact limit is slender and only its effective width is counted (Cl. 7.3.2).

Section classification (Table 2)

Element	Table 2 row	b / t (mm)	Ratio	Limits	Class
Tube wall	Circular hollow tube	219.1 / 6.0	36.52	- / - / 71.0	Semi-compact

Classification result					OK
Reference	Description	Calculation	Result		
3.7.2	Section class	governed by the most slender element	Semi-compact		
7.3.2	Effective area	no slender element: $A_e = A$	$A_e = 4,014 \text{ mm}^2$		

6. Effective length and slenderness



End restraints, buckled shapes and effective lengths

Effective length and slenderness about z-z					OK
Reference	Description	Calculation	Result		
Table 11	End restraint	Fixed at one end, pinned at the other	$K = 0.8$		
7.2.2	Unbraced length	L	4,500 mm		
7.2.2	Effective length KL	$0.8 \times 4,500$	3,600 mm		
	Radius of gyration r_z		75.3 mm		
7.1.2	Slenderness KL/r	$3,600 / 75.3$	47.8		
Table 3	Slenderness limit	$47.8 \leq 180$ - Member carrying compressive loads from dead and imposed loads	OK		OK

Effective length and slenderness about y-y					OK
Reference	Description	Calculation	Result		
Table 11	End restraint	Fixed at one end, pinned at the other	$K = 0.8$		
7.2.2	Unbraced length	L	4,500 mm		

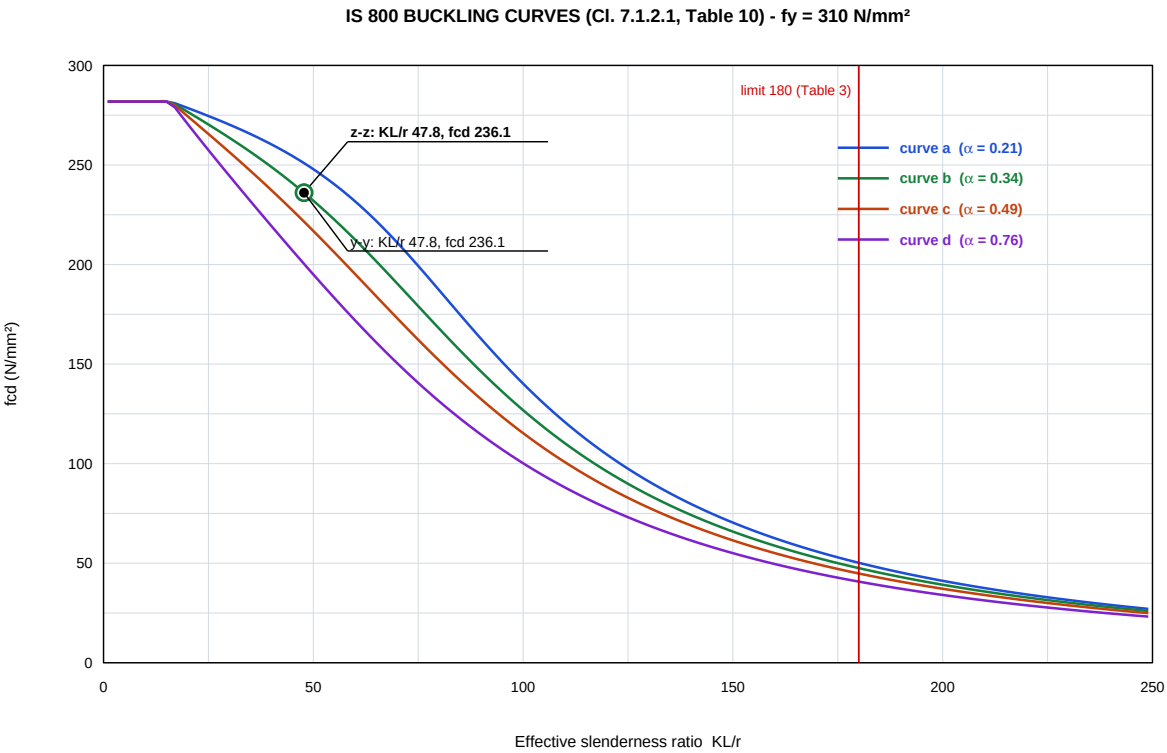
Reference	Description	Calculation	Result	
7.2.2	Effective length KL	$0.8 \times 4,500$	3,600 mm	
	Radius of gyration r_y		75.3 mm	
7.1.2	Slenderness KL/r	$3,600 / 75.3$	47.8	
Table 3	Slenderness limit	$47.8 \leq 180$ - Member carrying compressive loads from dead and imposed loads	OK	OK

7. Design compressive strength

Buckling about z-z				OK
Reference	Description	Calculation	Result	
Table 10	Buckling class	cold formed hollow section	b	
Table 7	Imperfection factor α		0.34	
7.1.2.1	Euler buckling stress f_{cc}	$\pi^2 E / (KL/r)^2 = \pi^2 \times 200,000 / 47.8^2$	864.6 N/mm ²	
7.1.2.1	Non-dimensional slenderness λ	$\sqrt{f_y / f_{cc}} = \sqrt{(310 / 864.6)}$	0.599	
7.1.2.1	ϕ	$0.5 [1 + \alpha (\lambda - 0.2) + \lambda^2] = 0.5 [1 + 0.34 (0.599 - 0.2) + 0.599^2]$	0.747	
7.1.2.1	Stress reduction factor χ	$1 / [\phi + \sqrt{(\phi^2 - \lambda^2)}]$	0.838	
7.1.2.1	Design compressive stress f_{cd}	$\chi f_y / \gamma_{m0} = 0.838 \times 310 / 1.1 (\leq f_y / \gamma_{m0})$	236.1 N/mm ²	
7.1.2	Design compressive strength P_d	$A_e f_{cd} = 4,014 \times 236.1 / 1000$	947.6 kN	

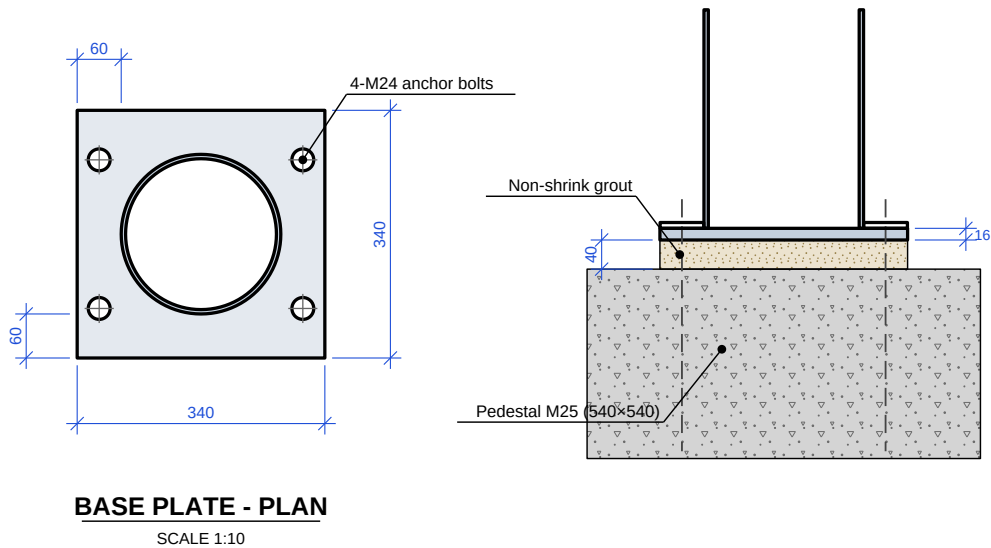
Buckling about y-y				OK
Reference	Description	Calculation	Result	
Table 10	Buckling class	cold formed hollow section	b	
Table 7	Imperfection factor α		0.34	
7.1.2.1	Euler buckling stress f_{cc}	$\pi^2 E / (KL/r)^2 = \pi^2 \times 200,000 / 47.8^2$	864.6 N/mm ²	
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7.1.2	Design compressive strength P_d	$A_e f_{cd} = 4,014 \times 236.1 / 1000$	947.6 kN	

Axial compression check				OK
Reference	Description	Calculation	Result	
7.1.2	Governing strength	minimum of the axes - buckling about z-z	$P_d = 947.6 \text{ kN}$	
7.1.2	Design axial force		$P = 902.1 \text{ kN}$	
7.1.2	$P \leq P_d$	$902.1 \leq 947.6$ (ratio 0.952)	OK	OK



Design compressive stress against slenderness for the four buckling curves, with the design points of this member

8. Column base



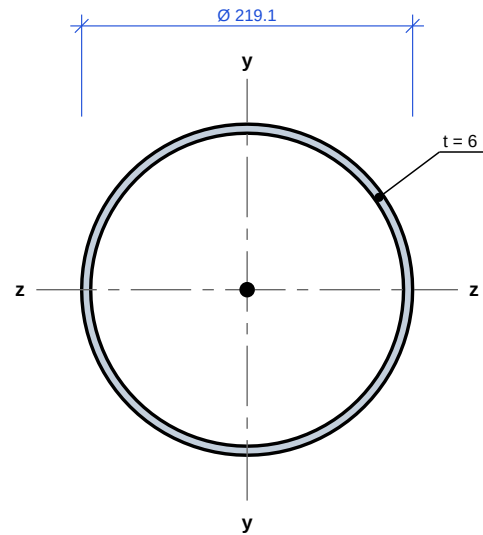
Slab base - plan and section

Slab base design (Cl. 7.4)				OK
Reference	Description	Calculation	Result	
7.4.1	Bearing strength of concrete	$0.6 f_{ck} = 0.6 \times 25$	15.0 N/mm ²	
7.4.1	Area required	$P / (0.6 f_{ck}) = 902,086 / 15.0$	60,139 mm ²	
	Projection beyond the column	required 13; min. for anchors $2.5 d = 60$	60 mm	

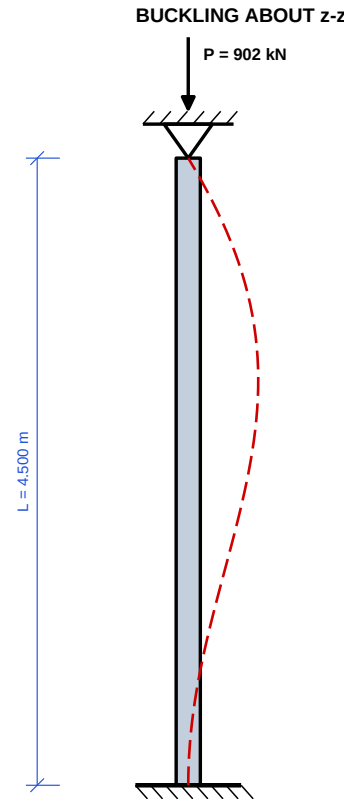
Reference	Description	Calculation	Result	
	Plate size L × B	column 219.1 × 219 + projections	340 × 340 mm	
7.4.1	Bearing pressure w	$P / (L B) = 902,086 / (340 \times 340)$	7.80 N/mm²	OK
7.4.3.1	Projections a, b	larger / smaller projection beyond the column	60 / 60 mm	
7.4.3.1	Thickness required ts	$\sqrt{[2.5 w (a^2 - 0.3 b^2) \gamma m_0 / f_y]}$ with $f_y = 250$	14.8 mm	
7.4.3.1	ts ≥ flange thickness	$t_f = 6 \text{ mm}$		
	Plate provided	E250 plate	16 mm	OK
	Anchor bolts (nominal, axial load)	4-M24 grade 4.6, 500 mm embedment		
7.4.3	Column to base connection	column end machined for full bearing; 6 mm fillet weld all round		
	Pedestal	M25, 540 × 540 mm, 40 mm non-shrink grout		

9. Detailing notes

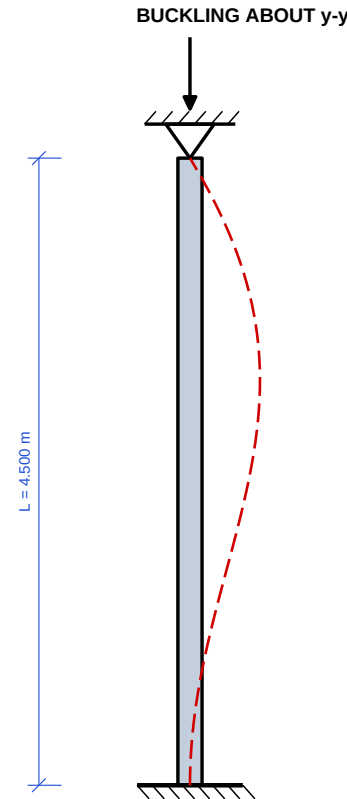
- Fabrication, erection and tolerances to IS 800 Sections 15 and 17; out-of-plumb not to exceed H/1000.
- Bolts to IS 1364 / IS 1367 with washers; holes drilled or sub-punched and reamed.
- Welding to IS 816 with E41 electrodes; minimum fillet size per IS 800 Table 21.
- Surface preparation and painting per the project specification (IS 800 Section 15).



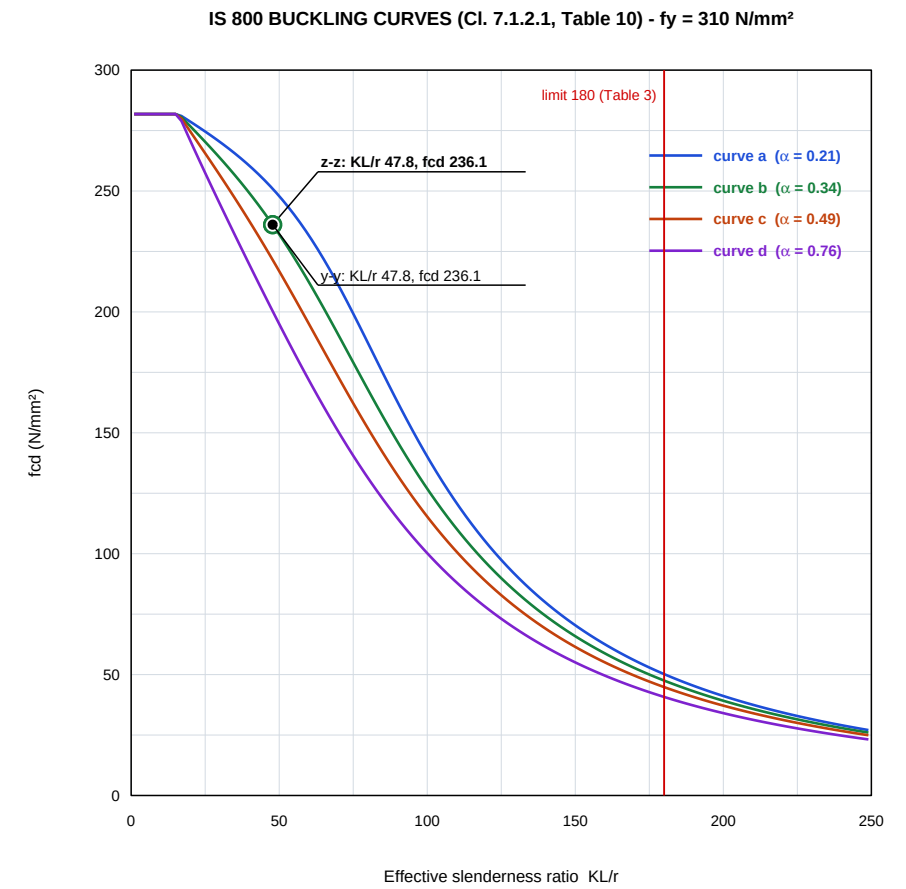
CROSS SECTION
SCALE 1:5



$KL = 0.8 \times 4500 = 3600 \text{ m}$
 $KL/r = 3600 / 75.3 = 47.8$
curve b, $f_{cd} = 236.1 \text{ N/mm}^2$



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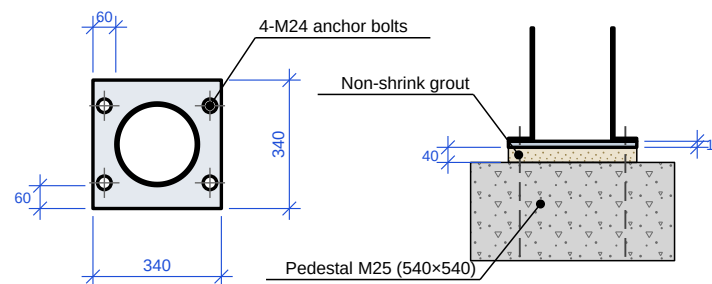
DESIGN SUMMARY (IS 800:2007)

Section	CHS 219.1 × 6
Mass	31.5 kg/m
Steel	YSt 310 ($f_y = 310$, $f_u = 450 \text{ N/mm}^2$)
Section class	Semi-compact
Design load P	902.1 kN
Governing axis	z-z ($KL/r = 47.8$, buckling class b)
f_{cd}	236.1 N/mm ²
Pd	947.6 kN
Base plate	340 × 340 × 16 mm

Result: **ALL CHECKS SATISFIED**

NOTES

- All dimensions are in mm unless noted otherwise.
- Structural steel YSt 310 to IS 2062 / IS 4923; bolts to IS 1367, grade 4.6.
- Welding to IS 816 with E41 electrodes; fillet welds 6 mm min.
- Holes drilled, $d_0 = d + 2 \text{ mm}$ ($d + 3 \text{ mm}$ above M24).
- Erect plumb within $H/1000$; grout base plates before loading.



BASE PLATE - PLAN
SCALE 1:20

SECTION
SCALE 1:20

Tubular column TC1

Member C1 · CHS 219.1 × 6

Designed: - Checked: -

Date: 31 Oct 2026 Scale: as shown Sheet 1 of 1