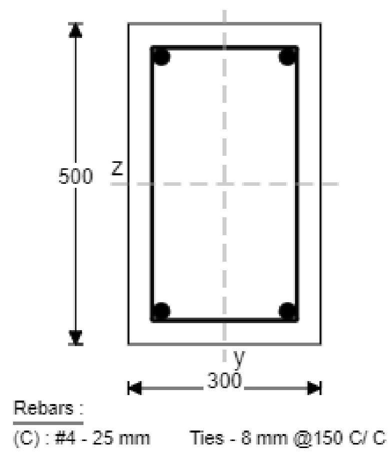
1.0 INPUT

1.1 Dimensions

Column Cross Section		**Rectangle**
Section Width	b	= **300** mm
Section Depth	h	= **500** mm



1.2 Slenderness

Type of Column		**Long**
Column Clear Height	l_o	= **3000** mm
Type of Slenderness in Z Direction	End	= **Braced**
Eff. Length Factor about Z Direction	β_z	= **0.75**
Type of Slenderness in Y Direction	End	= **Braced**
Eff. Length Factor about Y Direction	β_y	= **0.75**
Minimum Eccentricity		**Yes**

1.3 Materials

Concrete Grade	f_{cu}	= **35** N/mm^2
Main Reinforcement Grade	f_y	= **460** N/mm^2
Shear Reinforcement Grade	f_{yv}	= **460** N/mm^2
Steel Elastic Modulus	E_s	= **200000** N/mm^2

1.4 Reinforcement

Column Design Option		**Check Reinforcement Adequacy**
Area of Reinforcement Provided	A_{sp}	= **1963.5** mm^2
Clear Cover	C_c	= **35** mm

1.5 Additional Legs

Additional Legs in Z Direction	N_z	= **0**
Additional Legs in Y Direction	N_y	= **0**

1.6 Material Partial Safety Factors

Concrete in Shear	γ_{mcs}	= **1.25**
Concrete in Compression	γ_{mc}	= **1.5**
Reinforcement	γ_{ms}	= **1.15**

1.7 Design Loads

Description	N (kN)	M_{zt} (kNm)	M_{yt} (kNm)	M_{zb} (kNm)	M_{yb} (kNm)	V_z (kN)	V_y (kN)
L.Case 01	**150**	**50**	**50**	**25**	**-25**	**50**	**55**
L.Case 02	**0**	**0**	**0**	**0**	**0**	**0**	**0**

2.0 OUTPUT

Ref: BS 8110 - Part 1

Effective Cover E_c = **55.5** mm

Effective Depth Y Direction h' = $h - E_c$ = **444.5** mm

Effective Depth Z Direction b' = $b - E_c$ = **244.5** mm

2.1 Effective Height

Cl.3.2.1.2.2

Effective Height about Z Direction l_{ez} = $l_o * \beta_z$ = **2250** mm

Effective Height about Y Direction l_{ey} = $l_o * \beta_y$ = **2250** mm *Table 3.12*

2.2 Load Case 01

2.2.1 Moment Calculation

Description	Notation	Formulae	Y Direction	Z Direction
Initial Moment				
Smaller Initial End Moment (kNm)	M_1	$min(M_b, M_t)$	**25**	**25**
Larger Initial End Moment (kNm)	M_2	$max(M_b, M_t)$	**50**	**50**
Initial Middle Moment (kNm)	M_i	$max(0.4 * M_1 + 0.6 * M_2 , 0.4 * M_2)$	**20**	**40**
Minimum Eccentricity Moment (kNm)	M_{min}	$min(0.05 * h , 20) * N$	**2.2**	**3**
Slenderness Moment			**Braced**	**Braced**
Slenderness check	l_e/h		**7.5 < 15, Short**	**4.5 < 15, Short**
Additional Moment due to Slenderness				
Axial Load Capacity (kN)	N_u	$(0.67 * f_{cu} * (h * b - A_{sp}) / \gamma_{mc}) + (f_y * A_{sp} / \gamma_{ms})$	-	-
Balanced Load Capacity (kN)	N_{bal}	$0.25 * f_{cu} * h * b$	-	-
Reduction Factor	K	$min [(N_u - N) / (N_u - N_{bal}) , 1]$	-	-
Deflection of Slender Column (mm)	a_u	$(l_e^2 / (2000 * h^2) * K * h$	-	-
Additional Moment of Section (kNm)	M_{add}	$N * a_u$	**0**	**0**
Design Moment		mf = 0.5 for Braced, 1.0 for Unbraced		
Moment at Top (kNm)	M_{dtop}	$max(M_{min}, M_t + mf * M_{add})$	**50**	**50**
Moment at Middle (kNm)	M_{dmid}	$max(M_{min}, M_i + M_{add})$	**20**	**40**
Moment at Bottom (kNm)	M_{dbot}	$max(M_{min}, M_b + mf * M_{add})$	**25**	**25**

2.2.2 Moment Design Ratios

Section	Design Forces			Biaxial Capacity		
	Axial Load (kN)	Moment-Y (kNm)	Moment-Z (kNm)	Moment-Y (kNm)	Moment-Z (kNm)	Design Ratio
Top	**150**	**50**	**50**	**98**	**61.8**	**0.412**
Bottom	**150**	**25**	**25**	**99.6**	**37.2**	**0.169**
Mid	**150**	**20**	**40**	**98.8**	**52.8**	**0.153**

2.2.3 Shear Calculation

Description	Notation	Formulae	Z Direction	Y Direction
Design Moment (kNm)	M	max(M_{dtop}, M_{dbot}, M_{dmid})	**50**	**50**
Eccentricity (mm)	e	M / N	**333.3**	**333.3**
Check for Shear Reinforcement Requirement		If (e > 0.6h , Required , Not Required)	**> 180, Reqd.**	**> 300, Reqd.**
Design Shear Force (kN)	V	-	**50**	**55**
Design Shear Stress (N/mm^2)	v	V / (b * h')	**0.409**	**0.412**
Maximum Shear Stress (N/mm^2)	v_{max}	min(0.8 * $(f_{cu})^{1/2}$, 5)	**4.733**	**4.733**
Effective Tension Steel (mm^2)	A_{st}	Sharing Corner Bar area is Considered 50%	**736.3**	**736.3**
Tension Steel Percentage (%)	P_t	(A_{st} * 100) / (b * h')	**0.6**	**0.55**
Concrete Shear Stress (N/mm^2)	v_c	BS 8110 - Table 3.8	**0.675**	**0.58**
Enhanced Concrete Shear Stress (N/mm^2)	v_c'	v_c + (0.6 * N * min[(V * h) / M , 1] / (b * h))	**0.855**	**0.91**
Shear Strength Required (N/mm^2)	v_s	max(v - v_c', 0.4)	**0.4**	**0.4**
Provided Shear Reinforcement (mm^2)	A_{sv}	(N_s + 2) * π / 4 * D_s^2	**100.5**	**100.5**
Required Spacing for Ties (mm)	S	min([A_{sv} * f_{yv}] / [v_s * b * γ_{ms}], 0.75 * min(h', b'))	**183.4**	**183.4**

3.0 SUMMARY

Description	Required	Actual	Status
Moment Capacity Ratio	1.0	0.412	**PASS**
Spacing of Ties (mm)	183.4	150	**PASS**