Typical Design Calcualtion

PREAMBLE

M/s. CASAGRAND is developing Premium Residential Apartments situated at Koladi village, Poonamallee taluk, Thiruvallur district Architecture by the Casagrand in house Architect & M/s Innotech engineering consult Pvt. Ltd has been appointed as the structural consultant for this prestigious project.

The structure shall be designed according to the Limit State Method as specified in IS: 456-2000.Appropriate loads and its combinations, as per relevant clauses in Codes IS 456:2000, IS 875 (Part-5) 1987 &IS 1893 part-1 2016, for the most unfavourable effects are chosen for design.

TYPICAL FLOORS LOAD				
Load components		**Thickness (mm)**	**UDL (kN/sqm)**	**Annotations**
Entrance lobby/ Lounge/ Amenities/ Lift Lobby / Corridor	Dead load	Actuals		
	Live load	-	3.00	
	Finishes	-	1.20	50mm finishes considered
	Services	-	0.50	Service Ducts + Fire Sprinklers
Staircase	Dead load	Actuals		
	Live load	-	3.00	
	Finishes	50	3.50	50mm finishes + steps load (Finishes 1.2 kN/sqm Step load 1.8 kN/sqm)

	Services	-	-	
Toilet areas	Dead load	Actuals		
	Live load	-	2.00	
	Finishes	100	3.6	100 mm sunk + 50mm Tile load
Kitchen	Dead load	Actuals		
	Live load	-	2.00	
	Finishes	50	1.70	50mm finishes + false ceiling considered
Living room/ Bed Room	Dead load	Actuals		
	Live load	-	2.00	
	Finishes	50	1.70	50mm finishes + false ceiling considered
Balcony	Dead load	Actuals		
	Live load	-	3.00	
	Finishes	100	3.60	100 mm sunk + 50mm Finishes load

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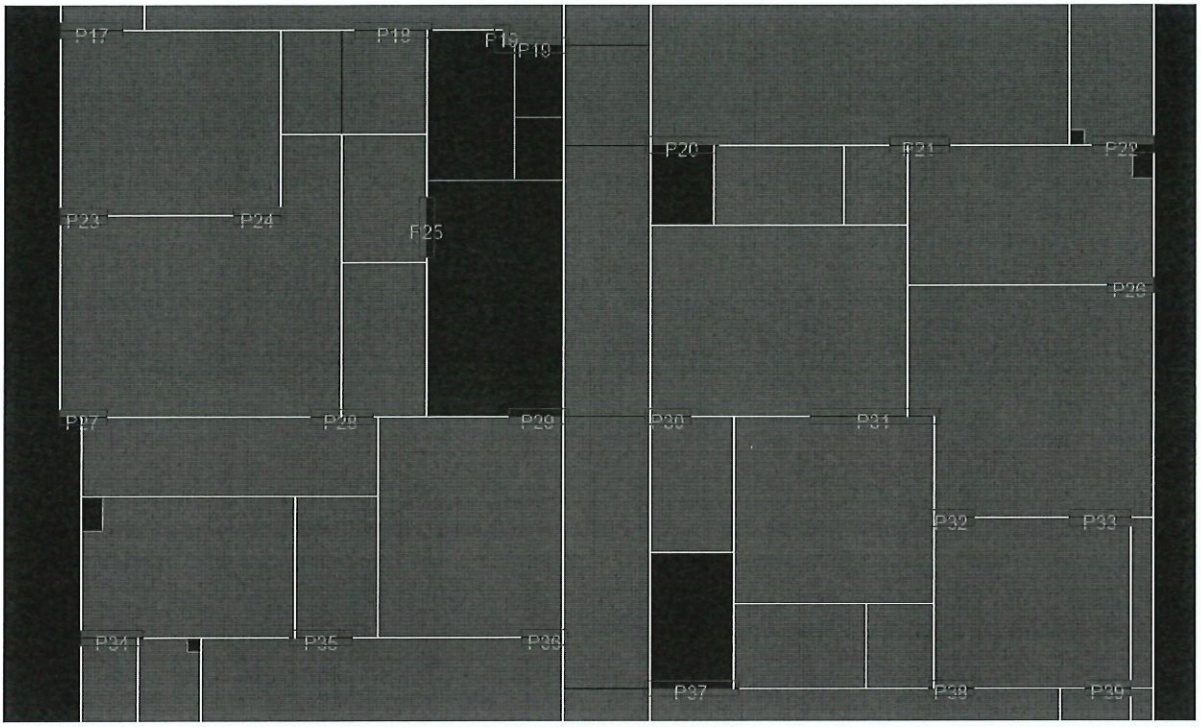
TYPICAL SHEAR WALL DETAIL



ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
F2	P28	-5986.1	38875	1200	200	0.5

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	1	550	415

Design Code Parameters

Γ_s	Γ_c	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	-6586.1	38875	-5386.1	38875	1200	200
Bottom	Leg 1	-6586.1	38875	-5386.1	38875	1200	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	8603	0.0358	0.0025	UDWalS32-1	4609.7863	198.6272	211.5892	240000
Bottom	8681	0.0362	0.0025	UDWalS32-1	4636.3363	199.2048	-212.8078	240000

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	UDWalS31-1	3561.9968	165.0799	-154.857	182.1472	355.3646
Bottom	Leg 1	500	UDWalS31-1	3588.5468	293.798	-154.857	182.1472	355.3646

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	400	UDWalS31	4665.1007	-113.6162	21.8	8
Top–Right	Leg 1	500	UDWalS31	4665.1007	165.0799	22.88	8
Bottom–Left	Leg 1	500	UDWalS31	4691.6507	-287.4566	25.54	8
Botttom–Right	Leg 1	500	UDWalS31	4691.6507	293.798	25.67	8

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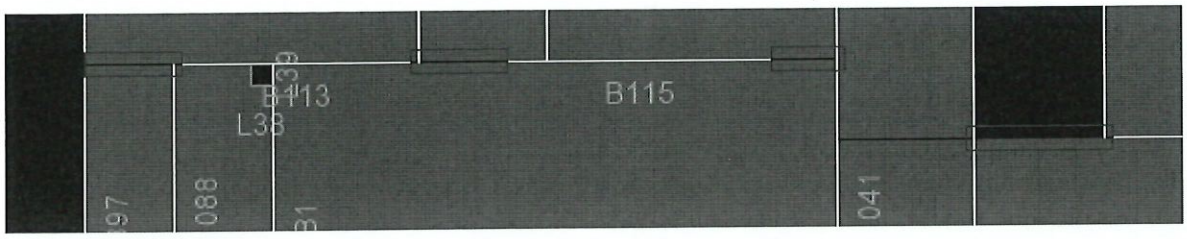
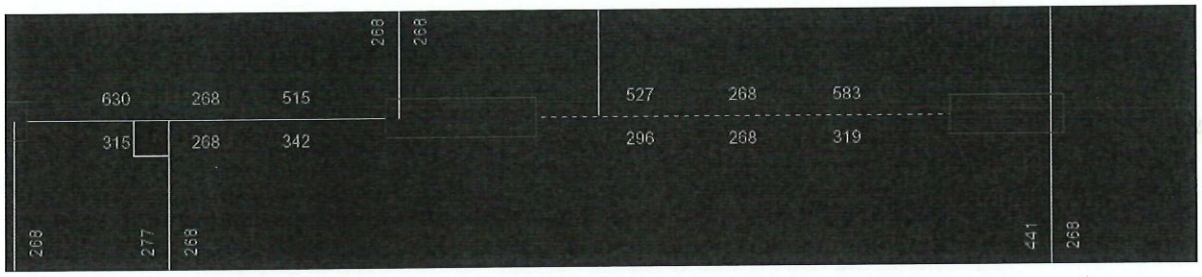
innoTECH Transform Thoughts

TYPICAL BEAM DETAIL

Beam Label :

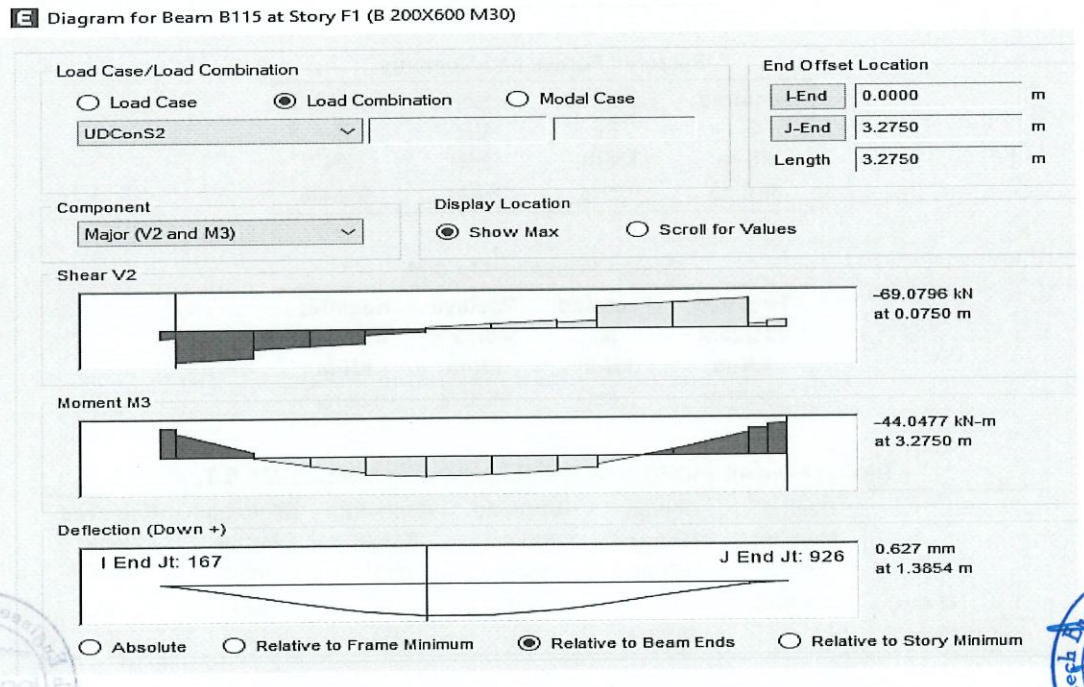


Beam Area of steel :



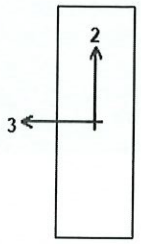
Beam Shear reinforcing :

Beam Bending Moment and Shear Force :



ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
F1	B115	2632	B 200X600 M30	UDConS29-SXN	3275	3275	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	600	200	0	40	40

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	550	550

Design Code Parameters

ɣc	ɣs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
58.2719	0.0278	26.4237	-56.6448

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
58.2719	0.0654	58.3374	-132.7345

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-132.7345		583	0	583	268
Bottom (-2 Axis)		58.3374	291	284	0	291

Shear Force and Reinforcement for Shear, V_{u2} & T_u

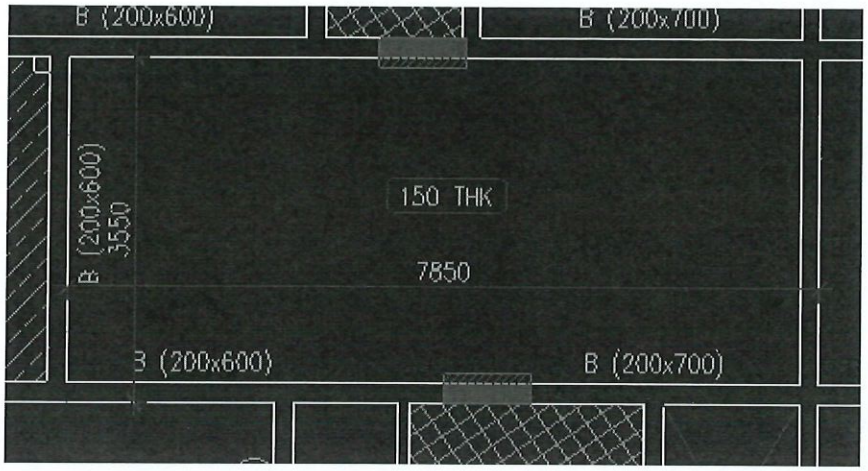
Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
107.7454	0	108.0592	94.7105	534.72

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

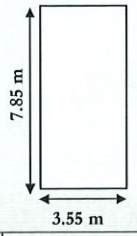
T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.0392	26.4237	140	540	0

TYPICAL SLAB DETAIL:

One way slab

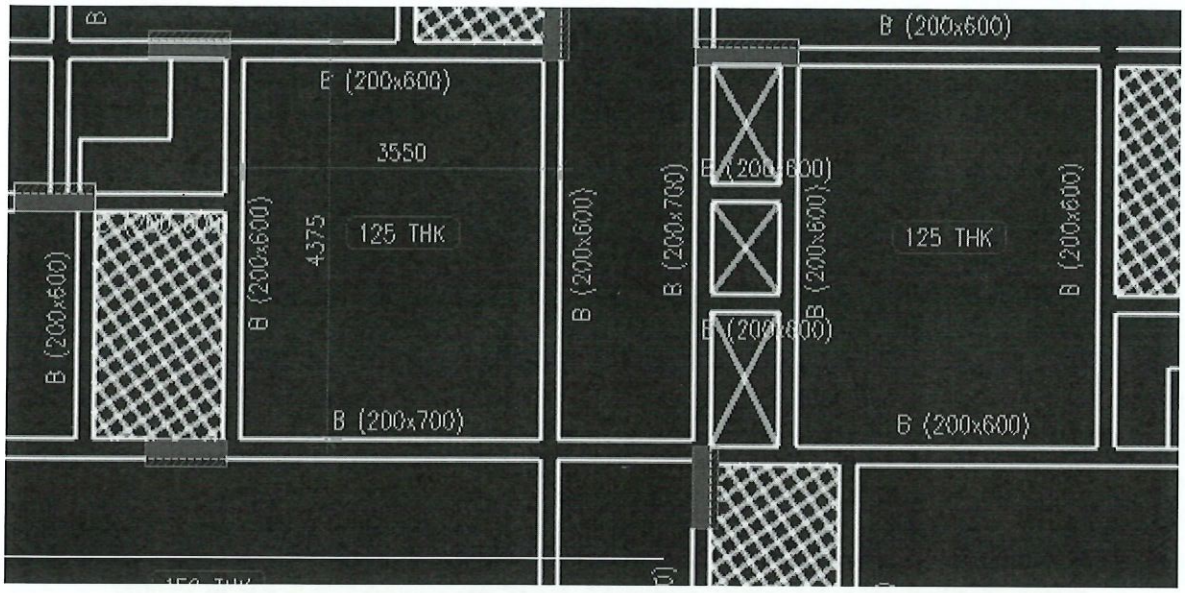


Long span	7.85 m		
Short span	3.55 m		
Aspect Ratio	2.25		
One way slab			



Long span		l_{ey}	7.98 m
Short span		l_{ex}	3.68 m
Grade of concrete		f_{ck}	30 N/sqmm
Grade of steel		f_y	550 N/sqmm
Unit weight of RCC		Yc	25.00 kN/cum
Overall depth (assumed)		D	150 mm
Effective cover		d'	20 mm
Effective depth provided		d	126 mm
Load calculations			
Self weight		W_d	3.75 kN/sqm
Floor finish		FF	2.00 kN/sqm
Miscellaneous		W	0.00 kN/sqm
Live load		LL	1.70 kN/sqm
Total load		W	7.45 kN-m
Check for depth from BM criteria			
Factored moment	$[(W_d*l_x^2)/10] + [(W_l*l_x^2)/9]$	M_u	18.88 kN-m
Effective depth required		d req	68 mm
		Depth provided is Sufficient	
Reinforcement details			
Minimum Area of steel		$A_{st\ min}$	180.00 sqmm
Shorter span (Bottom Bars)			
Area of steel		Ast $_{bot}$	330.00 sqmm
Dia of reinforcing bar		φ	8 mm
Spacing between bars		s	100 mm
Area of steel provided		$A_{st\ pro}$	502.65 sqmm
Percentage of steel	pt = 100*Ast / b*d	pt	0.399 %
Provide, parallel to shorter span (bottom)		8T @ 100 mm c/c	
Longer span (Bottom Bars)			
Area of steel		$A_{st\ min}$	180.00 sqmm
Dia of reinforcing bar		ϕ	8 mm
Spacing between bars		s	200 mm
Area of steel provided		$A_{st\ pro}$	251.33 sqmm
Percentage of steel	pt = 100*Ast / b*d	pt	0.168 %
Provide, parallel to longer span (bottom)		8T @ 200 mm c/c	
Check for shear			
Design shear force	$[(1.5*0.6)*(W_d+W_l)*l_x]$	V_u	18.031 kN
Design shear stress	(Vu /bd)	τ_v	0.14 N/sqmm
$\beta = [(0.8*fck)/(6.89*pt)$	(from SP:24)	β	8.732
Shear resisted by concrete	(from SP:24)	τ_c	0.45 N/sqmm
		Safe under shear	
Check for Deflection			
Basic span to effective depth ratio		$(l/d)_{basic}$	20
Modification factor for compression reinforcement		K_c	1
Reduction factor		K_f	1
Stress in reinforcement	$[(0.58 \times f_y \times A_{st})/ A_{st\ pro}]$	f_s	209.43 N/sqmm
Modification factor for tensile reinforcement		K_t	1.54
Maximum span to effective depth ratio	$[(l/d)basic*K_c*K_f*K_t]$	$(l/d)_{max}$	30.800
Actual span to effective depth ratio		$(l/d)_{actual}$	29.175
		Safe under Deflection	
Summary			
Shorter span (bottom) reinforcement		8T @ 100 mm c/c	
Longer span (bottom) reinforcement		8T @ 200 mm c/c	

Two way slab

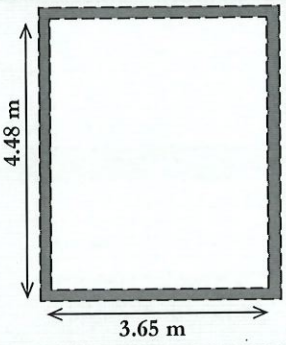

B (200x600)
B (200x600)
3550
4375
125 THK
B (200x600)
B (200x700)
B (200x600)
B (200x600)
B (200x600)
B (200x600)
125 THK
B (200x600)
B (200x600)

TWO WAY SLAB

ALL CALCULATIONS ARE PER SQM AREA OF SLAB

Preliminary Data

Long span	4.38 m
Short span	3.55 m
Aspect Ratio	1.25
Hence Two way slab	



Effective Long span		l_{ey}	4.48 m
Effective Short span		l_{ex}	3.65 m
Grade of concrete		f_{ck}	30 N/sqmm
Grade of steel		f_y	550 N/sqmm
Unit weight of RCC		Υc	25.00 kN/cum
Overall depth (assumed)		D	125 mm
Effective cover		d'	20 mm
Effective depth provided		d	101 mm
Load calculations			
Self weight of slab		DL	3.13 kN/sqm
Floor finish		FF	2.00 kN/sqm
Miscellaneous		W	0.00 kN/sqm
Live load		LL	1.70 kN/sqm
Total Factored load		W_u	10.24 kN/sqm
Edge condition :	**Two adjacent sides discontinuous**		
Bending Moment calculations			
Shorter span			
+ve moment coefficient at mid span		α_x	0.047
Factored moment (Bottom - Mid span)	$[\alpha_x * W * l_x^2]$	M_{ux}	6.41 kN-m
-ve moment at coefficient continuous edge		α_x	0.063
Factored moment (Top - At Supports)	$[\alpha_x * W * l_x^2]$	M_{ux}	8.60 kN-m
Longer span			
+ve moment coefficient at mid span		α_y	0.035
Factored moment (Bottom - Mid span)	$[\alpha_x * W * l_x^2]$	M_{uy}	4.78 kN-m
-ve moment at coefficient continuous edge		α_y	0.047
Factored moment (Top - At Supports)	$[\alpha_x * W * l_x^2]$	M_{uy}	6.41 kN-m
Check for depth from BM criteria			
Effective depth required		d req	46 mm
		Depth provided is Sufficient	
Reinforcement details			
Minimum Area of steel		$A_{st\ min}$	150.00 sqmm

Shorter span (Bottom Bars)			
Area of steel		Ast	150.00 sqmm
Dia of reinforcing bar		φ	8 mm
Spacing between bars		s	200 mm
Area of steel provided		$A_{st\ pro}$	251.33 sqmm
Percentage of steel	pt = 100*Ast / b*d	pt	0.249 %
Provide, parallel to shorter span (bottom)		8T @ 200 mm c/c	
Longer span (Bottom Bars)			
Area of steel		Ast	150.00 sqmm
Dia of reinforcing bar		φ	8 mm
Spacing between bars		s	200 mm
Area of steel provided		$A_{st\ pro}$	251.33 sqmm
Percentage of steel	pt = 100*Ast / b*d	pt	0.249 %
Provide, parallel to longer span (bottom)		8T @ 200 mm c/c	
Shorter span (Top Bars)			
Area of steel		Ast	190.00 sqmm
Dia of reinforcing bar		φ	8 mm
Spacing between bars		s	200 mm
Area of steel provided		$A_{st\ pro}$	251.33 sqmm
Percentage of steel	pt = 100*Ast / b*d	pt	0.249 %
Provide, parallel to shorter span (top)		8T @ 200 mm c/c	
Longer span (Top Bars)			
Area of steel		Ast	150.00 sqmm
Dia of reinforcing bar		φ	8 mm
Spacing between bars		s	200 mm
Area of steel provided		$A_{st\ pro}$	251.33 sqmm
Percentage of steel	pt = 100*Ast / b*d	pt	0.249 %
Provide, parallel to longer span (top)		8T @ 200 mm c/c	
Check for shear			
Design shear force	(Wu*l/2)	V_u	9.344 kN
Design shear stress	(Vu /bd)	τ_v	0.09 N/sqmm
β = [(0.8*fck)/(6.89*pt)	(from SP:24)	β	13.998
Shear resisted by concrete	(from SP:24)	τ_c	0.37 N/sqmm
		Safe under shear	
Check for Deflection			
Basic span to effective depth ratio		$(l/d)_{basic}$	26
Modification factor for compression reinforcement		K_c	1.00
Reduction factor		K_f	1.00
Stress in reinforcement	$[(0.58 \times f_y \times A_{st})/ A_{st\ pro}]$	f_s	190.39 N/sqmm
Modification factor for tensile reinforcement		K_t	2.00
Maximum span to effective depth ratio	$[(l/d)basic*K_c*K_f*K_t]$	$(l/d)_{max}$	52.000
Actual span to effective depth ratio		$(l/d)_{actual}$	36.149
		Safe under Deflection	

Summary		
Shorter span (bottom) reinforcement	A	8T @ 200 mm c/c
Longer span (bottom) reinforcement	B	8T @ 200 mm c/c
Shorter span (top) reinforcement	C	8T @ 200 mm c/c
Longer span (top) reinforcement	D	8T @ 200 mm c/c