DESIGN BASIS REPORT

FOR

M/S. ARC DEVELOPERS

THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING WITH 30 DWELLING UNITS WITH AFFORDABLE HOUSING AT PLOT NO. 27 PART, 28 PART, 29 & 30, SWATHI NAGAR MAIN ROAD & SWATHI NAGAR ROAD, SWATHI NAGAR, NADUKUTHAGAI , CHENNAI COMPRISED IN S.NO.32/1C OF NADUKUTHAGAI VILLAGE, AVADI PAGE 1 OF 2 TALUK (PREVIOUSLY POONAMALLEE TALUK) WITHIN THE LIMITS O F POONAMALLEE PANCHAYAT UNION.

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1.0 OBJECTIVE

The Design basis covers the basic requirement that will be followed for the design of THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING WITH 30 DWELLING UNITS WITH AFFORDABLE HOUSING FOR M/S. ARC DEVELOPERS AT PLOT NO. 27 PART, 28 PART, 29 & 30, SWATHI NAGAR MAIN ROAD & SWATHI NAGAR ROAD, SWATHI NAGAR, NADUKUTHAGAI , CHENNAI COMPRISED IN S.NO.32/1C OF NADUKUTHAGAI VILLAGE, AVADI PAGE 1 OF 2 TALUK (PREVIOUSLY POONAMALLEE TALUK) WITHIN THE LIMITS O F POONAMALLEE PANCHAYAT UNION.

The building is designed for Stilt + Five Floors. The structure is supported on column in turn resting on Pile Foundation. The Structural system comprises columns, beams, slabs and wall structure.

3-D Analysis of all the building structures will be carried out using STAAD PRO software package and analysis results shall be used for designing the various elements.

2.0 DESIGN LOADS

2.1 Dead Loads

The Dead loads that are envisaged to act permanently are considered as per IS**: 875 (Part 1) – 1987 – Dead loads.** Indian Standard **"Code of Practice for Design Loads (other than earthquake) for Buildings and Structures**".

1. Slab is assumed to be 150mm thick – 3.75 KN/m^2
2. Slab is assumed to be 125mm thick – 3.125 KN/m^2
3. Floor finish – 1.5KN/m^2
4. Brick work masonry walls 230thick are proposed to be used (location of walls per Architectural drawings) Unit weight is taken as 20 KN/m^3
5. Weathering course in Terrace finish – 3 KN/m^2

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2.2 Imposed Loads

The imposed loads that are envisaged to act permanently are considered as per **IS : 875 (Part 2) – 1987** . Indian Standard **"Code of Practice for Design Loads (other than earthquake) for Buildings and Structures"**.

1. Living = 2 KN/m^2
2. Staircase = 4 KN/m^2
3. Toilets = 2 KN/m^2
4. Terrace floors = 1.5 KN/m^2

2.3 Earthquake Load

The loading due to earthquake is assessed based on the provisions of **IS: 1893-2016**. Structure with ductile detailing is considered as per **IS: 13920-2016.**

CHENNAI falls under Seismic Zone III

Zone factor = **0.16**

Response reduction factor = **5**

Importance factor = **1.0**

Structure with ductile detailing is considered as per IS: 13920-2016

2.4 Load Combinations

The various loads shall be combined in accordance with the stipulations in IS: 875 (Part 5) – 1987. Whichever combinations produced the most unfavorable effect in the building, foundations or structural member concerned shall be adopted. The various load combinations considered in the analysis are as follows:

1. 1(DL+LL)
2. 1 DL+0.8 LL+ 0.8 SQX +1
3. 1 DL+0.8 LL+ 0.8 SQX -1
4. 1 DL+0.8 LL+ 0.8 SQZ +1
5. 1 DL+0.8 LL+ 0.8 SQZ -1

6. 1.0 (DL+SQX +)
7. 1.0 (DL+SQX -1)
8. 1.0 (DL+SQZ +1)
9. 1.0 (DL+SQZ -1)
10. 1.5(DL+LL)
11. 1.5(DL+SQX +1)
12. 1.5(DL+SQX -1)
13. 1.5(DL+SQZ +1)
14. 1.5(DL+SQZ -1)
15. 1.2(DL+LL+SQX +1)
16. 1.2(DL+LL+SQX -1)
17. 1.2(DL+LL+SQZ +1)
18. 1.2(DL+LL+SQZ -1)
19. 0.9DL+1.5SQX+1
20. 0.9DL+1.5SQX -1
21. 0.9DL+1.5SQZ +1
22. 0.9DL+1.5SQZ -1

The above load combinations will be considered and effect of worst combinations Will be taken for design of various building elements.

3.0 ANALYSIS METHODS

The analysis of the structures is carried out using the STAAD PRO. The entire super-structure is modeled using frame elements as appropriate. Beams and columns are modeled as frame elements. Appropriate loads and its combinations, as per relevant IS code clauses, for most unfavorable effects are chosen for design. Various load cases considered in the analysis are briefed above.

4.0DESIGNASSUMPTION

4.1.1 The Base of the Foundation is assumed to be FIXED.

4.1.2 All Concrete elements shall be designed in accordance with IS 456:2000 Limit State Design.

4.1.3 Appropriate loads and its combinations, as per relevant clauses, for the most unfavorable effects are chosen for design. (Refer Load Combination below).

5.0FOUNDATIONDESIGN

Type of Foundation : Pile foundation.

Depth of Foundation : 15.0 m

6.0MATERIALS

The self-weight of the various elements are computed based on the unit weight of materials as given below:

S.no	Materials	Unit weight KN/m^3
1	Reinforced Cement Concrete	25
2	Solid Block/Brick	20
3	Steel	78.50

Structural concrete shall be of grade M25 for Pile

Structural concrete shall be of grade M20 for Pile cap& Column

Structural concrete shall be of grade M20for Beam & Slab

Steel reinforcement shall be of Grade Fe500 confirming toIS:1786-2008.

7.0NOMINALCOVERTOREINFORCEMENT

From Durability requirement, exposure condition is assumed as mild for structural elements above ground level and mode rate for structural elements below ground level.

The Clear cove to reinforcement to meet durability requirement shall be as follows:

Column –40mm

Pile cap – 100mm

Beam – 25mm

Slab – 20mm

DESIGN OF BEAM: 1

Beam size: 230mm x 450mm

Bending moment at support	=	140kNm
Bending moment at mid span	=	133kNm
Shear force, Vu	=	149kN
Bending moment at support, Mu	=	140kNm
R	=	$(140 \times 10^6)/230 \times 409^2$
	=	3.64

Pt/100 =Ast/bd = fck/2fy [1-Sq.rt (1-4.598xR/fck)\

fck	=	20 N/mm^2
fy	=	500 N/mm^2
Pt	=	1.07%
Ast required	=	1013 mm^2

Provide 6nos of 16Y

Ast provided = 1206 mm^2

Hence safe.

Bending moment at mid span, Mu	=	133kNm
R	=	$(133 \times 10^6)/230 \times 409^2$
	=	3.46
Pt	=	1.0%
Ast required	=	944 mm^2

Provide 6nos of 16Y

Ast provided = 1206 mm^2

Hence it is safe

Shear force, Vu, = 149kN

τ_v = Vu/bd

= $(149 \times 10^3)/ 230 \times 409$

= $1.58\ N/mm^2$

Hence ok.

Shear capacity of concrete:

Pt = 1.0 %

τ_c = 0.62

= τ_c bd

= 0.62X 230 X 409

= 58323 N (or) 58 kN

Shear to be carried by stirrups

Vu = Vs – τ_c bd

= 149 – 58 kN

= 91kN

Therefore, provide 2 legged 10Y @ 150 mm C/C at the supports.

Provide 2 legged 10Y @ 200mm C/C at the midspan.

DESIGN OF BEAM: 2

Beam size: 230mm x 525mm

Bending moment at support = 132kNm

Bending moment at mid span = 111kNm

Shear force, Vu = 96kN

Bending moment at support, Mu = 132kNm

R = $(132 \times 10^6)/230 \times 484^2$

= 2.44

Pt/100 =Ast/bd = fck/2fy [1-Sq.rt (1-4.598xR/fck)\

fck = $20\ N/mm^2$

fy = $500\ N/mm^2$

Pt = 0.65%

Ast required = $725\ mm^2$

Provide 4nos of 16Y

Ast provided = $804\ mm^2$

Hence safe.

Bending moment at mid span, Mu = 111kNm

R = $(111 \times 10^6)/230 \times 484^2$

= 2.06

Pt = 0.53%

Ast required = $593\ mm^2$

Provide 4 nos of 16Y

Ast provided = $804\ mm^2$

Hence it is safe

Shear force, Vu, = 96kN

τv = Vu/bd

= $96 \times 10^3 / 230 \times 484$

= $0.86\ N/mm^2$

Hence ok.

<u>Shear capacity of concrete:</u>

Pt = 0.65 %

τc = 0.53

= τc bd

= 0.53 X 230 X 484

	=	58999 N (or) 59kN

Shear to be carried by stirrups

Vu	=	Vs – τc bd
	=	96 – 59 kN
	=	37kN

Therefore, provide 2 legged 8Y @ 100 mm C/C at the supports.

Provide 2 legged 8Y @ 200 mm C/C at the midspan.

Design of Pile Cap :

Safe load for 600mm Dia pile	=	1130 KN
Concrete grade for pile cap	=	M20
Un factored Column load	=	1442KN
No of piles required	=	1442/1130 = 1.28
Provide 2 nos of Pile (600Ø)		
Spacing of Piles	=	1800mm
	=	1.8m
Factored load	=	1442 x 1.5
	=	2163
Bending moment WL/4	=	2163 x 1.8 / 4
	=	973KNM
R = MU/bd^2	=	973 x 10^6 / 975 x 875^2
	=	1.3
fck	=	20N/mm^2
fy	=	500N/mm^2
Pt/100 = Ast/bd	=	fck/2fy [1-sqrt (1 - 4.598xR/20)]

Ast required = 2739 mm^2

Provide 7 nos of 25 Dia bar

Ast provided = 3437mm^2

Ast required > Ast provided

Hence it is safe.

DESIGN OF COLUMN C1

Length of column	D	450	mm
Breadth of column	b	230	mm
Unsupported length (longer direction)	L_x	2700	mm
Unsupported length (shorter direction)	L_y	2700	mm
Eff. Length (longer direction)	L_{ex}	2160	mm
Eff. Length (shorter direction)	L_{ey}	2160	mm
Factored Load	P_u	1051	kN
Factored moment (longer direction)	Mux	65	kNm
Factored moment (shorter direction)	Muz	21	kNm
Charac. comp strength of concrete	f_{ck}	20	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Dia of bar used	Φ	20	mm
Clear cover		40	mm
Effective cover	d'	50	mm
Effective depth	d	400	mm
Check for slenderness			
Longer Direction			
Slenderness ratio	L_{ex}/D	4.80	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	9.39	**short**
Additional moment due to slenderness	M_{ay}	0	kN-m
Calculation of P_{uz}			
No of bars used		8	
Area of reinforcement	Ast	2512	
Provided steel		8 nos Y20	
Percentage of reinforcement	p_t	2.427	%
Area of concrete	Ag	103500	mm^2
Ultimate axial load (without moments)	P_{uz}	1851	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.111	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.204	From Sp16
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.398	
Axial load corresponding to balanced failure	P_{bx}	523	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.217	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.179	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.143	
Axial load corresponding to balanced failure	P_{by}	406	kN
Reduction factor for additional moments	k_y	0.554	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Check for moments due to min. eccentricity			
Longer Direction			
Minimum eccentricity	e_x	20.40	mm

Moment due to min. eccentricity	M_x	21.44	kN-m
Moment in longer direction	M_{ux}	65.00	kNm
Shorter direction			
Minimum eccentricity	e_y	13.07	mm
Moment due to min. eccentricity	M_y	13.73	kN-m
Moment in shorter direction	M_{uy}	21	kNm
Final design moments			
Moment in longer direction	M_{ux}	**65.00**	kNm
Moment in shorter direction	M_{uy}	**21.00**	kNm
Check for interaction			
	d'/D	0.111	
	d'/b	0.217	
p/f_{ck}	p/f_{ck}	0.121	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.508	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD^2$	0.130	
Uniaxial moment capacity (longer direction)	M_{ux1}	**121.095**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD^2$	0.110	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**52.371**	kNm
P_u/P_{uz} ratio	P_u/P_{uz}	**0.568**	
Value of exponent		1.614	
Interaction ratio		**0.595**	
Percentage reinforcement satisfactory or not		**safe**	
b/D ratio	b/D	0.51111111	
Status of dimensions		**OK**	
Gross area	A_g	103500	mm^2
Area of core	A_k	60800	mm^2
Spacing of lateral ties	S	57.5	mm
Larger dimension of the hoop	H	230	mm
Cross sectional area of hoop	A_{sh}	66.87	mm^2

DESIGN OF COLUMN C2

Length of column	D	375	mm
Breadth of column	b	300	mm
Unsupported length (longer direction)	L_x	2700	mm
Unsupported length (shorter direction)	L_y	2700	mm
Eff. Length (longer direction)	L_{ex}	2160	mm
Eff. Length (shorter direction)	L_{ey}	2160	mm
Factored Load	P_u	895	kN
Factored moment (longer direction)	Mux	41	kNm
Factored moment (shorter direction)	Muz	11	kNm
Charac. comp strength of concrete	f_{ck}	20	N/mm^2
Yield stress of steel	f_y	500	N/mm^2
Dia of bar used	Φ	16	mm
Clear cover		40	mm
Effective cover	d'	48	mm
Effective depth	d	327	mm
Check for slenderness			
Longer Direction			
Slenderness ratio	L_{ex}/D	5.76	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	7.20	**short**
Additional moment due to slenderness	M_{ay}	0	kN-m
Calculation of P_{uz}			
No of bars used		8	
Area of reinforcement	Ast	1607.68	
Provided steel		8 nos Y16	
Percentage of reinforcement	p_t	1.429	%
Area of concrete	Ag	112500	mm^2
Ultimate axial load (without moments)	P_{uz}	1601	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.128	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.200	From Sp16
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.358	
Axial load corresponding to balanced failure	P_{bx}	508	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.160	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.193	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.281	
Axial load corresponding to balanced failure	P_{by}	479	kN
Reduction factor for additional moments	k_y	0.629	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Check for moments due to min. eccentricity			
Longer Direction			
Minimum eccentricity	e_x	17.90	mm

Moment due to min. eccentricity	M_x	16.02	kN-m
Moment in longer direction	M_{ux}	41.00	kNm
Shorter direction			
Minimum eccentricity	e_y	15.40	mm
Moment due to min. eccentricity	M_y	13.78	kN-m
Moment in shorter direction	M_{uy}	13.783	kNm
Final design moments			
Moment in longer direction	M_{ux}	**41.00**	kNm
Moment in shorter direction	M_{uy}	**13.78**	kNm
Check for interaction			
	d'/D	0.128	
	d'/b	0.160	
p/f_{ck}	p/f_{ck}	0.071	
$P_u/f_{ck}bD$ value	$P_u/f_{ck}bD$	0.398	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{ux1}/f_{ck}bD^2$	0.090	
Uniaxial moment capacity (longer direction)	M_{ux1}	**75.9375**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)	$M_{uy1}/f_{ck}bD^2$	0.090	
Uniaxial moment capacity (shorter direction)	M_{uy1}	**60.75**	kNm
P_u/P_{uz} ratio	P_u/P	**0.559**	
Value of exponent		1.599	
Interaction ratio		**0.466**	
Percentage reinforcement satisfactory or not		**safe**	
b/D ratio	b/D	0.8	
Status of dimensions		**OK**	
Gross area	A_g	112500	mm^2
Area of core	A_k	70150	mm^2
Spacing of lateral ties	S	75	mm
Larger dimension of the hoop	H	230	mm
Cross sectional area of hoop	A_{sh}	74.98	mm^2

DESIGN OF SLAB S1

ROOF LEVEL SLAB

Design of two way Slab

Basic Data

Grade of concrete (fck)	=	M 20	
Grade of steel (fy)	=	Fe 500	
Thickness of slab (D)	=	125	mm
Clear cover (cc)	=	15	mm
Effective thickness of slab (deff) = 125 - 15 - 8 /2	=	106	mm
Unit weight of concrete	=	25	KN/m^3
Effective Shorter Span (Lx)	=	3.18	m
Effective Longer Span (Ly)	=	3.467	m
Aspect ratio Ly/Lx	=	1.09	**Two way slab**

Edge Condition : **Two adjacent Edges Discontinous**

Load Data

Dead Load	= 0.13 x 25	=	3.125	KN/m^2
Floor finish		=	1.50	KN/m^2
Imposed Load		=	2.00	KN/m^2
Total load		=	6.63	KN/m^2
Design load (Wu) = 1.5 x 6.625		=	**9.94**	KN/m^2

Moment and Shear Calculations

Short Span Direction

ax for positive moment		1	→	0.035	
		1.1	→	0.04	
	for 1.09	αx	=	0.040	
Positive moment Mx	0.040 x 9.94 x	3.18 ^2	=	**3.97**	KN-m
ax for negative moment		1	→	0.047	
		1.1	→	0.053	
	for 1.09	αx	=	0.052	
Negative moment Mx :	0.052 x 9.94 x	3.18 ^2	=	**5.27**	KN-m

Long Span Direction

For positive moment		αy	=	0.035	
Positive moment My :	0.035 x 9.94 x	3.18 ^2	=	**3.52**	KN-m
For negative moment		αy	=	0.047	
Negative moment My :	0.047 x 9.94 x	3.18 ^2	=	**4.72**	KN-m

Shear force V_u = 9.94 x 3.2 x 0.5 = **15.80** KN

Check Effective Depth for Bending

Depth required = $(M_x / (0.133x \; fck \times b))^{1/2}$ = 44.50 mm

Depth provided = 125 - 15 - 8 /2 = 106 mm

Hence O.K

Reinforcement calculations

Short Span Direction @ Support

$Mu/bd^2 = \dfrac{5.27 \times 10^6}{1000 \times 106 \times 106}$ = **0.469**

Pt = **0.11** %

Area of steel Ast	= 0.00111	x	1000 x	106	=	117.55	mm^2
Minimum area of steel	0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars	50.27	x	1000 /	150.00	=	334.93	mm
Ast provided					=	335.1	mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm
2) = 300 mm
3) = 334.93 mm

Therefore provide Y **8** @ **150** mm C/C

Short Span Direction @ Mid Span

$Mu/bd^2 = \dfrac{3.97 \times 10^6}{1000 \times 106 \times 106}$ = 0.353

Pt = 0.083 %

Area of steel Ast	= 0.00083	x	1000 x	106	=	87.982	mm^2
Minimum area of steel	0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars	50.27	x	1000 /	150.00	=	334.93	mm
Ast provided					=	335.1	mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm
2) = 300 mm
3) = 334.93 mm

Therefore provide Y **8** @ **150** mm C/C 100

Provided % of Tension Reinforcement (pt) = **0.316** %

Long Span Direction @ Support

$Mu/bd^2 = \dfrac{4.72 \times 10^6}{1000 \times 106 \times 106} = 0.420$

Pt = 0.099 %

Area of steel Ast =	0.00099	x	1000 x	106	=	105.09	mm^2
Minimum area of steel	0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars	50.27	x	1000 /	150.00	=	334.93	mm
Ast provided					=	335.1	mm^2

Check for Spacing

Minimum of

1)	3d	=	318	mm
2)		=	300	mm
3)		=	334.93	mm

Therefore provide Y **8** @ **150** mm C/C

Long Span Direction @ mid Span

$Mu/bd^2 = \dfrac{3.52 \times 10^6}{1000 \times 106 \times 106} = 0.313$

Pt = 0.073 %

Area of steel Ast =	0.00073	x	1000 x	106	=	77.742	mm^2
Minimum area of steel	0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars	50.27	x	1000 /	150.00	=	334.93	mm
Ast provided					=	335.1	mm^2

Check for Spacing

Minimum of

1)	3d	=	318	mm
2)		=	300	mm
3)		=	334.93	mm

Therefore provide Y **8** @ **150** mm C/C

<u>Check for Deflection:</u>

Basic Span/depth Ratio	=	22	
% of Tension Reinforcement provided (pt)	=	0.316	%
Service stress of steel (fs) : 0.58fy(Ast_r/Ast_p)	=	76.14	N/mm^2
Modification Factor for Tension Reinforcement (F1)	=	2.00	
Allowable Span/Eff Depth Ratio	=	44	
Actual Span/Eff Depth Ratio = 3.18 x 1000 / 106	=	30.00	

Hence O.K

DESIGN OF SLAB S2

ROOF LEVEL SLAB

Design of two way Slab

Basic Data

Grade of concrete (fck)		=	M 20	
Grade of steel (fy)		=	Fe 500	
Thickness of slab (D)		=	125	mm
Clear cover (cc)		=	15	mm
Effective thickness of slab (deff)	= 125 - 15 - 8 /2	=	106	mm
Unit weight of concrete		=	25	KN/m^3
Effective Shorter Span (Lx)		=	3.35	m
Effective Longer Span (Ly)		=	3.467	m
Aspect ratio Ly/Lx		=	1.03	**Two way slab**

Edge Condition : **Two adjacent Edges Discontinous**

Load Data

Dead Load	= 0.13 x 25	=	3.125	KN/m^2
Floor finish		=	1.50	KN/m^2
Imposed Load		=	2.00	KN/m^2
Total load		=	6.63	KN/m^2
Design load (Wu) = 1.5 x 6.625		=	**9.94**	KN/m^2

Moment and Shear Calculations

Short Span Direction

ax for positive moment	1	→	0.035	
	1.1	→	0.04	
	for 1.03 αx	=	0.037	
Positive moment Mx	0.037 x 9.94 x 3.35 ^2	=	**4.10**	KN-m
ax for negative moment	1	→	0.047	
	1.1	→	0.053	
	for 1.03 αx	=	0.049	
Negative moment Mx :	0.049 x 9.94 x 3.35 ^2	=	**5.48**	KN-m

Long Span Direction

For positive moment	αy	=	0.035	
Positive moment My :	0.035 x 9.94 x 3.35 ^2	=	**3.90**	KN-m
For negative moment	αy	=	0.047	
Negative moment My :	0.047 x 9.94 x 3.35 ^2	=	**5.24**	KN-m

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Shear force V_u = 9.94 x 3.4 x 0.5 = **16.65** KN

Check Effective Depth for Bending

Depth required = $(M_x / (0.133x\ fck \times b))^{1/2}$ = 45.37 mm

Depth provided = 125 - 15 - 8 /2 = 106 mm

Hence O.K

Reinforcement calculations

Short Span Direction @ Support

$Mu/bd^2 = \dfrac{5.48 \times 10^6}{1000 \times 106 \times 106}$ = **0.487**

Pt = **0.12** %

Area of steel Ast	= 0.00115	x	1000 x	106	=	122.33	mm^2
Minimum area of steel	0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars	50.27	x	1000 /	150.00	=	334.93	mm
Ast provided					=	402.12	mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm
2) = 300 mm
3) = 334.93 mm

Therefore provide Y **8** @ **125** mm C/C

Short Span Direction @ Mid Span

$Mu/bd^2 = \dfrac{4.10 \times 10^6}{1000 \times 106 \times 106}$ = 0.365

Pt = 0.086 %

Area of steel Ast	= 0.00086	x	1000 x	106	=	90.868	mm^2
Minimum area of steel	0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars	50.27	x	1000 /	150.00	=	334.93	mm
Ast provided					=	402.12	mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm
2) = 300 mm
3) = 334.93 mm

Therefore provide Y **8** @ **125** mm C/C 100

Provided % of Tension Reinforcement (pt) = **0.379** %

Long Span Direction @ Support

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$Mu/bd^2 = \dfrac{5.24 \times 10^6}{1000 \times 106 \times 106} = 0.467$

Pt = 0.110 %

Area of steel Ast	=	0.00110	x	1000 x	106	=	116.96	mm^2
Minimum area of steel		0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars		50.27	x	1000 /	150.00	=	334.93	mm
Ast provided						=	335.1	mm^2

Check for Spacing

Minimum of

1)	3d	=	318	mm
2)		=	300	mm
3)		=	334.93	mm

Therefore provide Y **8** @ **150** mm C/C

Long Span Direction @ mid Span

$Mu/bd^2 = \dfrac{3.90 \times 10^6}{1000 \times 106 \times 106} = 0.347$

Pt = 0.082 %

Area of steel Ast	=	0.00082	x	1000 x	106	=	86.458	mm^2
Minimum area of steel		0.0012	x	1000 x	125	=	150.00	mm^2
Spacing of Y **8** bars		50.27	x	1000 /	150.00	=	334.93	mm
Ast provided						=	335.1	mm^2

Check for Spacing

Minimum of

1)	3d	=	318	mm
2)		=	300	mm
3)		=	334.93	mm

Therefore provide Y **8** @ **150** mm C/C

Check for Deflection:

Basic Span/depth Ratio	=	22	
% of Tension Reinforcement provided (pt)	=	0.379	%
Service stress of steel (fs) : 0.58fy(Ast_r/Ast_p)	=	65.53	N/mm^2
Modification Factor for Tension Reinforcement (F1)	=	2.00	
Allowable Span/Eff Depth Ratio	=	44	
Actual Span/Eff Depth Ratio = 3.35 x 1000 / 106	=	31.60	

Hence O.K

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