DESIGN OF GROUND FLOOR SLAB (TWO WAY SLAB)

Condition : Interior Panels

DESIGN DATA:-

Span of slab in shorter direction	l_a	=	3274	mm	3.274 m	
Span of slab in longer direction	l_b	=	4150	mm	4.150 m	
Thickness of Slab Provided	h_p	=	150	mm	0.150 m	
Clear cover to main reinf.	d'	=	30	mm		
Dia of main reinforcement	ϕ	=	12	mm	(Shorter span)	
Dia of main reinforcement	ϕ	=	12	mm	(Long span)	
Eff. depth of slab (Short span)	dsa	=	(150 - 30 - 6)	=	114 mm	Shorter span
Eff. depth of slab (Long span)	dsb	=	(150-12-30-6)	=	102 mm	Long span
Density of Concrete	γc	=	25	kN/m^3		
Compressive strength of concrete	fc'	=	35	N/mm^2		Ref.Design Basis
Yield Strength of steel	fy	=	420	N/mm^2		

LOADINGS

Dead load Considering the width of slab as b = 1000 mm

Self weight of slab = 0.15 x 25 = 3.750 kN/m^2

Dead load due to electrical accessories = 1.000 kN/m^2

Total Dead load DL = **4.75** kN/m^2

Factored dead load Wud = 1.2 x DL = 5.70 kN/m^2

LL = **9.00** kN/m^2 Ref.Design Basis

Wul = 1.6 x LL = 14.40 kN/m^2

Total Factored load RLL = 5.7 + 14.4

= 20.100 kN/m^2

DESIGN

The slab is designed using moment coefficients method.

Ratio of shorter / longer span = 3.274 / 4.15 = 0.79 Two way slab

Edge conditions of the slab **Case 1**

Moments in shorter direction Ma = Ca x W x la^2

Moments in longer direction Mb = Ca x W x lb^2

W = Uniform load on the slab ; la & lb are span in short and long directions respectively

Negative moments	M (-ve)	=	Ca x Wu x l^2	Continuous Edge
Moments due to Dead Load	M (+ve)	=	Cad x Wud x l^2	Mid spans
Moments due to Live Load	M (+ve)	=	Cal x Wul x l^2	Mid spans
Negative moments for Short span		=	1/3 x +ve Moments	Discontinuous Edge

Moments coefficients (-ve)	Ca (-ve)	=	0.0000	Cb (-ve)	=	0.0000
Moments coefficients (+ve) DL	Cad (+ve)	=	0.0571	Cbd (+v	=	0.0221
Moments coefficients (+ve) LL	Cal (+ve)	=	0.0571	Cbl (+ve	=	0.0221

Negative moments (Short Span) Ma (-ve) = 0 x 20.1 x 3.274^2 Continuous Edge

= 0.00 kN-m

Negative moments (Long Span) Mb (-ve) = 0 x 20.1 x 4.15^2 Continuous Edge

= 0.00 kN-m

Positive moments (short Span) Mad (+ve = 0.0571 x 5.7 x 3.274^2 Due to dead load

= 3.49 kN-m

Positive moments (short Span) Mal (+ve) = 0.0571 x 14.4 x 3.274^2 Due to Live load

= 8.8136531 kN-m

Total +ve moments (short Span) Ma (+ve) = 12.30 kN-m

Positive moments (Long Span) Mbd (+ve = 0.0221 x 5.7 x 4.15^2 Due to dead load

= 2.170 kN-m

Positive moments (Long Span) Mbl (+ve) = 0.0221 x 14.4 x 4.15^2 Due to Live load

		=	5.481	kN-m
Total +ve moments (Long Span)	Mb (+ve)	=	7.650	kN-m

Discontinuous edges

Negative moments for Short span = 1/3 x12.302

= 4.101 kN-m

Negative moments for Long span = 1/3 x7.65 — Discontinuous edges

= 2.6 kN-m

Main reinforcement (Shorter & Longer Span)

Moment Factor Ru = Mu/ϕ x b x d^2 — ϕ = 0.9

Percentage of steel required pt ρ = 1 / m x (1 - sqrt(1 - (2Ru x m / fy))

m = fy / 0.85 x fc' = 14.118

But Minimum percentage of steel ρ_{min} = 0.18% — Cl 7.12.2.1.C ACI 318-14

Design of Reinforcement for Shorter Span :-

Factored Moment	Moment kN-m	Factor Ru	Reqd% of steel	Provided % of steel	Area of steel	C/C Spacing of 12 mm Dia bar
Continuous edges	0.000	0.000	0.0000	0.0018	205.200	550 mm c/c
Mid Span	12.302	1.052	0.0026	0.0026	290.715	375 mm c/c
Discontinuous edges	4.101	0.351	0.0008	0.0018	205.200	550 mm c/c

Reinforcement steel Provided = 12 mm Dia bar 200 mm c/c For Short Span

Design of Reinforcement for Long Span :-

Factored Moment	Moment kN-m	Factor Ru	Reqd% of steel	Provided % of steel	Area of steel	C/C Spacing of 12 mm Dia bar
Continuous edges	0.000	0.000	0.0000	0.0018	205.200	550 mm c/c
Mid Span	7.650	0.654	0.0016	0.0018	205.200	550 mm c/c
Discontinuous edges	2.550	0.218	0.0005	0.0018	205.200	550 mm c/c

Reinforcement steel Provided = 12 mm Dia bar 200 mm c/c For long Span

Shrinkage and Temperature Reinforcement

Effective Area of concrete = b*D = 150000 mm^2

Minimum percentage of steel = 0.18 % — Cl 7.12.2.1.C ACI 318-14

Area of steel required Ast = 270 mm^2 (For Both ways)

Assuming dia of bar dbt = 10

Spacing of 10 mm dia bar = 582 mm (For Single face)

Provide 10 dia bars @ 200 mm C/C

Check for Shear :-

Factored Shear Force Qu = 20.1 x 4.15/2

= 41.7 kN

Allowable shear force by concrete ϕVc = 0.75 x [(1/6) x sqrt (fc') x b x dsb]

ϕVc = 75.4 kN > **41.71**

Factored shear force is less than allowable shear force provided by concrete. So safe.

Required Thickness of Slab

Min thickness of Slab required = $\dfrac{ln \times (0.8 + (fy / 1400)}{36 + (9ꞵ)}$

ln = Clean Span on Longer side = 4150 mm

ϒ = Ib / Is = (300x500^3/12)/(1000*200^3/12)

= 4.6875

ꞵ = $\dfrac{4150}{3274}$ = 1.2676

Min thickness of Slab required = 4150x(0.8+(420/1400)

36+(9 x 1.268)
= 96.292 mm approx 90 mm
< 200 mm Provided slab thickness

Deflection Due to Loads:

Allowable deflection Span / 360 = 4150 / 360 = 11.528 mm — As per Table 24.2.2, ACI 318 - 19

Actual deflection in slab due to loads = $\frac{K\,w\,l^4}{384\,E\,I}$

K	=	deflection coefficient depending on support condition	=	2	
w	=	Loads acting on slab (Dead load + Live load)	=	13.75	kN/m^2
L	=	Span	=	4150	mm
E	=	$W_c^{1.5}$ x 0.043 sqrt(fc)			
	=	$2380^{1.5}$ x 0.043 x sqrt (27.6)	=	26229	kN/m^3
I	=	$(1000 \times 200^3) / 12$	=	7E+08	mm^4

As per cls. 19.2.2.1, ACI 318-19

Actual deflection in slab due to loads = $\frac{2 \times 13.75 \times 4150^4}{384 \times 26229.405 \times 666666666.67}$

= 1.215 mm

< 11.528 mm

Hence Safe