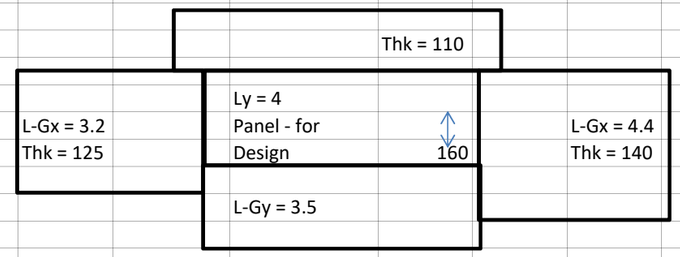
TITLE :	DESIGN OF SLAB					
SUB -TITLE :	DESIGN OF SLAB FOR FLEXURE AND SHEAR AS PER DDM METHOD					
CODE OF PRACTICE :	ACI-318M-11					
CODE TITLE :	BUILDING CODE REQUIREMENT FOR STRUCTURAL CONCRETE					
DESIGN TYPE :	ULTIMATE STATE DESIGN					
NOTE :- 1) User to Input data in cell marked as Grey.						
2) Design follows Limit State Method.						
3) Forces of one section has been considered for design						
Step 1) User Input						
PARAMETERS :		**RCDC Reference**	**USER INPUT**		**UNITS**	**Reference / Comments**
characteristic compressive strength of concrete		f'c (slab)	20			User Input
characteristic compressive strength of concrete		f'c (beams)	20			User Input
characteristic strength of reinforcement		fy	420		N/sqmm	User Input
length of slab		Ly	8.9		m	User Input
Width of slab		lx	8		m	User Input
Modulus of elasicity of beam		Ecb	21019.04		N/sqmm	clause 8.5.1
Modulus of elasicity of slab		Ecs	21019.04		N/sqmm	clause 8.5.1
Superimposed dead Load		DL	5		kN/sqm	User Input
Live load		LL	5		kN/sqm	User Input
cover		Cc	20		mm	User Input
Thickness of slab		D	275		mm	(to be assumed and iteratively checked further)
Total Factored Load,TL			22.25		kN/sqm	1.2 DL + 1.6 LL
Effective depth Along Lx		Deffx	250		mm	
Effective depth Along Ly		Deffy	240		mm	
Minimum % reinforcement		Ptmin	0.18		%	
Reinforcement detailing						
Diameter of reinforcement for bottom reinf.		d1	9.5		mm	User Input
Diameter of reinforcement for top reinf.		d2	9.5		mm	User Input
Diameter of reinforcement for distribution reinf.		d3	9.5		mm	User Input
			Short Span	**Long Span**		
Beam Data						
Beam (left side)						
Width of Beam	Long span-Side1	B3	450		mm	from analysis results
Depth of Beam		D3	800		mm	from analysis results
moment of inertia		Ib3	1.920E+10		mm^4	B3*D3^3/12
Beam (top side)						
Width of Beam	Short Span-Side1	B1	450		mm	from analysis results
Depth of Beam		D1	800		mm	from analysis results
moment of inertia		Ib1	19200000000		mm^4	B1*D1^3/12
Beam (right side)						
Width of Beam	Long span-Side2	B4	450		mm	from analysis results
Depth of Beam		D4	800		mm	from analysis results
moment of inertia		Ib4	19200000000		mm^4	B4*D4^3/12
Beam (bottom side)						
Width of Beam	Short Span-Side2	B2	450		mm	from analysis results
Depth of Beam		D2	800		mm	from analysis results
moment of inertia		Ib2	19200000000		mm^4	B2*D2^3/12
Design of slab						
Type of slab (interior,end and Simply supported)			interior	interior		
Moments along (along shorter direction)						
Clear span of slab along which moment is calculated		Ln	7550	8450	mm	clause 13.6.2.2
Clear span of slab transverse to Ln		L2	4675	4225	mm	clause 13.6.2.3 & 13.6.2.4
Effective width		Effective Width (mm)	2225	2000	mm	
Total moment		Total BM (kNm),Mo	741.17	839.04	kN-m	clause 13.6.2.2

8.5.1 - $E_c = 4700\sqrt{f'_c}$

13.6.2.2 $M_o = \frac{q_u \ell_2 \ell_n^2}{8}$

Distribution of moment Mo						clause 13.6.3.3
Calculation of α (for beam in direction of strip)						
slab Information						
Top Slab	Short Span-Side1	Lx1	8		m	from analysis
		S1	275		mm	from analysis
Bottom Slab	short Span-Side-2	Lx2	8		m	from analysis
		S2	275		mm	from analysis
Left Slab	Long span-Side1	Lx3	5.71		m	from analysis
		S3	200		mm	from analysis
Right Slab	Long Span-Side-2	Lx4	9.05		m	from analysis
		S4	275		mm	from analysis
Calculation of Alpha-for beam at top						
I-panel for Global-Y - for Top-beam						
Span-length-1		Lx1/2	4		m	
Span-length-Lx		Lx/2	4		m	
Moment of interia of Slab		I-slab-1	13864583333		mm4	span-length-1*D1^3/12 + span-length-Lx*D^3/12
Alpha-beam-top		αf1	1.38			I-slab-1 / Ib1
Thickness of top slab		S1	275		mm	
Thickness of slab considered for design		D	275		mm	
Calculation of Alpha-for beam at bottom						
I-panel for Global-Y - for Top-beam						
Span-length-Lx		Lx/2	4		m	
Span-length-2		Lx2/2	4		m	
Moment of interia of Slab		I-slab-2	13864583333		mm4	span-length-2*D2^3/12 + span-length-Lx*D^3/12
Alpha-beam-bottom		αf2	1.38			I-slab-2 / Ib2
Thickness of slab considered for design		D	275		mm	
Thickness of bottom slab		S2	275		mm	
Calculation of Alpha-for beam at Left						
I-panel for Global-Y - for Top-beam						
Span-length-3		L3/2	2.855		m	
Span-length-Ly		Ly/2	4.45		m	
Moment of interia of Slab		I-slab-3	9615507813		mm4	span-length-3*D3^3/12 + span-length-Ly*D^3/12
Alpha-beam-left		αf3	2.00			I-slab-3 / Ib3
Thickness of left slab		S3	200		mm	
Thickness of slab considered for design		D	275		mm	
Calculation of Alpha-for beam at Right						
I-panel for Global-Y - for Top-beam						
Span-length-Ly		Ly/2	4.45		m	
Span-length-4		L4/2	4.525		m	
I-slab-4			15554329427		mm4	span-length-4*D4^3/12 + span-length-Ly*D^3/12
Alpha-beam-right		αf4	1.23			I-slab-4 / Ib4
Thickness of slab considered for design		D	275		mm	
Thickness of right slab		S4	275		mm	
		α	1.50			(αf1+αf2+αf3+αf4)/4
Check for αf						
		Alpha-f-Ly	1.384823441			(αf1+αf2)/2
		Alpha-f-Lx	1.748487747			(αf3+αf4)/2
		fLyLx	1.562673424	1.020159663		Alpha-f-Ly*Ly^2+ Alpha-f-Lx*Lx^2
Check			ok	ok		clause 13.6.1.6
Calculation of β (for beam perpendicular to direction of strip)						Clause 13.6
		hb1	525	525	mm	D3-D
		hb2	975	975	mm	(D3-D)+B3



13.6.1.6 $0.2 \le \frac{\alpha_{f1}\ell_2^2}{\alpha_{f2}\ell_1^2} \le 5.0$

		CA	18127121094	18127121094	mm^4	1-(0.63*(D/hb1)*(D^3*hb1/3) + 1-(0.63*(B3/D3)*(B^3*D3/3)	
		CB	11309914063	11309914063	mm^4	1-(0.63*(D/hb2)*(D^3*hb2/3) + 1-(0.63*(hb1/B3)*(hb1^3*B3/3)	
		C	18127121094	18127121094	mm^4	Max (CA,CB)	
		βt	1.12	1.24		C * Ecb / (2*ECs*L2*D^3/12)	
factor for moment of column strip						13.6.4.2	
		α * Ly / Lx	1.67	1.35		α * Ly / Lx	
		Ly / Lx	1.11	0.90		Ly / Lx	
for Exterior -ve Moment factor:							
interpolation of values of β							
for βt = 0 and for Ly/lx =1			1.00	1.00		Clause 13.6.4.2	
for βt = 2.5and for Ly/lx =1			0.75	0.75		Clause 13.6.4.2	
C1, Thus for βt =	1.12		0.888	0.876			
for βt = 0 and for Ly/lx =2			1.00	1.00		Clause 13.6.4.2	
for βt = 2.5and for Ly/lx =2			0.45	0.45		Clause 13.6.4.2	
C2,Thus for βt = 0.97			0.754	0.728			
C3,for Ly/Lx=1.2			0.8730	0.8912		Interpolation of C1 and C2	
For +Ve interior momen factor							
C4,for Ly/Lx =	1.11					(clause 13.6.4.4)	Interpolation
		Moment factor for CS	0.716	0.780		add conditions	then 60
For -Ve interior moment factor						α * Ly / Lx = 0	
						α * Ly / Lx = 0 and ly/lx < 1	
C5, for Ly/Lx =	1.11					α * Ly / Lx = 0 and ly/lx > 1	
		Moment factor for CS	0.716	0.780			Interpolation
Bottom							
		Moment Co-efficent	0.35	0.35			
Bottom Moment,'Mo* bottom co-efficient		Distributed Moment (kNm)	259.41	293.66	kN-m	M0 x Moment Co-efficent	
Bottom Moment,BM1b		CS Moment (kNm)	185.80	229.16	kN-m	C4*MoB	
Bottom Moment,BM2b		MS Moment (kNm)	73.61	64.51	kN-m	MoB-BM1b	
Bottom Moment,BM3b		Moment on Beam (kNm)	157.93	194.78	kN-m	clause 13.6.5.2	
Bottom Moment,BMb final		Design Moment M1, M3 (kNm)	73.61	64.51	kN-m		
Top							
		Moment Co-efficent	0.65	0.65			
Top Moment,'Mo* top co-efficient		Distributed Moment (kNm)	481.76	545.37	kN-m	M0 x Moment Co-efficent	
Top Moment,BM1t		CS Moment (kNm)	345.06	425.57	kN-m	C5*MoT	
Top Moment,BM2t		MS Moment (kNm)	136.70	119.80	kN-m	MoT-BM1t	
Top Moment,BM3t		Moment on Beam (kNm)	293.30	361.74	kN-m	clause 13.6.5.2	
Top Moment,BMt top		Design Moment M2, M4 (kNm)	136.70	119.80	kN-m		
Design of Steel							
			M1	M3			
			73.61	64.51	kN-m		
Bottom Moment		Positive Moment At Midspan	33.08	32.25	kNm/m	M/Effective Width	
Area of reinforcement required		Area Of Reinforcement Required (BM)	356.35	347.26	sqmm/m		
Spacing Required			199	204	mm	Clause 13.3.2	
Spacing Provided			195	195	mm		
		Reinforcement Provided	363	363	sqmm/m		
Check			OK	OK			

13.6.4.2 — Column strips shall be proportioned to resist the following portions in percent of exterior negative factored moments:

ℓ_2/ℓ_1		0.5	1.0	2.0
$(\alpha_{f1}\ell_2/\ell_1) = 0$	$\beta_t = 0$	100	100	100
	$\beta_t \geq 2.5$	75	75	75
$(\alpha_{f1}\ell_2/\ell_1) \geq 1.0$	$\beta_t = 0$	100	100	100
	$\beta_t \geq 2.5$	90	75	45

13.6.4.4 — Column strips shall be proportioned to resist the following portions in percent of positive factored moments:

ℓ_2/ℓ_1	0.5	1.0	2.0
$(\alpha_{f1}\ell_2/\ell_1) = 0$	60	60	60
$(\alpha_{f1}\ell_2/\ell_1) \geq 1.0$	90	75	45

Linear interpolations shall be made between values shown.

13.6.3.3 — In an end span, total factored static moment, M_o, shall be distributed as follows:

	(1)	(2)	(3)	(4)	(5)
	Exterior edge unrestrained	Slab with beams between all supports	Slab without beams between interior supports: Without edge beam	Slab without beams between interior supports: With edge beam	Exterior edge fully restrained
Interior negative factored moment	0.75	0.70	0.70	0.70	0.65
Positive factored moment	0.63	0.57	0.52	0.50	0.35
Exterior negative factored moment	0	0.16	0.26	0.30	0.65

end slab

interior slab

13.6.4.1 — Column strips shall be proportioned to resist the following portions in percent of interior negative factored moments:

ℓ_2/ℓ_1	0.5	1.0	2.0
$(\alpha_{f1}\ell_2/\ell_1) = 0$	75	75	75
$(\alpha_{f1}\ell_2/\ell_1) \geq 1.0$	90	75	45

Linear interpolations shall be made between values shown.

			M2	M4			
			136.70	119.80	kN-m		
Top Moment		Negative Moment At Continuous Support	61.44	59.90	kNm/m	M/Effective Width	
Area of reinforcement required		Area Of Reinforcement Required (BM)	672.48	684.37	sqmm/m		
Spacing Required			105	104	mm	Clause 13.3.2	
Spacing Provided			105	100	mm		
		Reinforcement Provided	675	709	sqmm/m		
Check			OK	OK			
Distribution Reinforcement 0.18%							
Area of reinforcement required		Area Of Reinforcement Required	450.00	sqmm/m			
Spacing Required			157.52	mm			
Spacing Provided			155.00	mm			
		Reinforcement Provided	457.30	sqmm/m			
Check			OK				
Shear Design							
shear along short span		Vsx (TL(ultimate) x Lx / 4)	44.50	kN			
ϕVc		Nominal Shear, ΦVc	142.55	kN		Clause 11.11.2.1	
check			Slab Safe In Shear				
shear along Long span		Vsy (TL(ultimate) x Lx / 2 x (1 - (Lx / (2 x Ly))))	49.00	kN			
ϕVc		Nominal Shear, ΦVc	136.85	kN		Clause 11.11.2.1	
check			Slab Safe In Shear				

13.6.5.2 — For values of $\alpha_{f1}\ell_2/\ell_1$ between 1.0 and zero, proportion of column strip moments resisted by beams shall be obtained by linear interpolation between 85 and zero percent.

11.11.2.1 $V_c = 0.17\left(1 + \frac{2}{\beta}\right)\lambda\sqrt{f'_c}\,b_o d$

11.11.2.1 $V_c = 0.17\left(1 + \frac{2}{\beta}\right)\lambda\sqrt{f'_c}\,b_o d$