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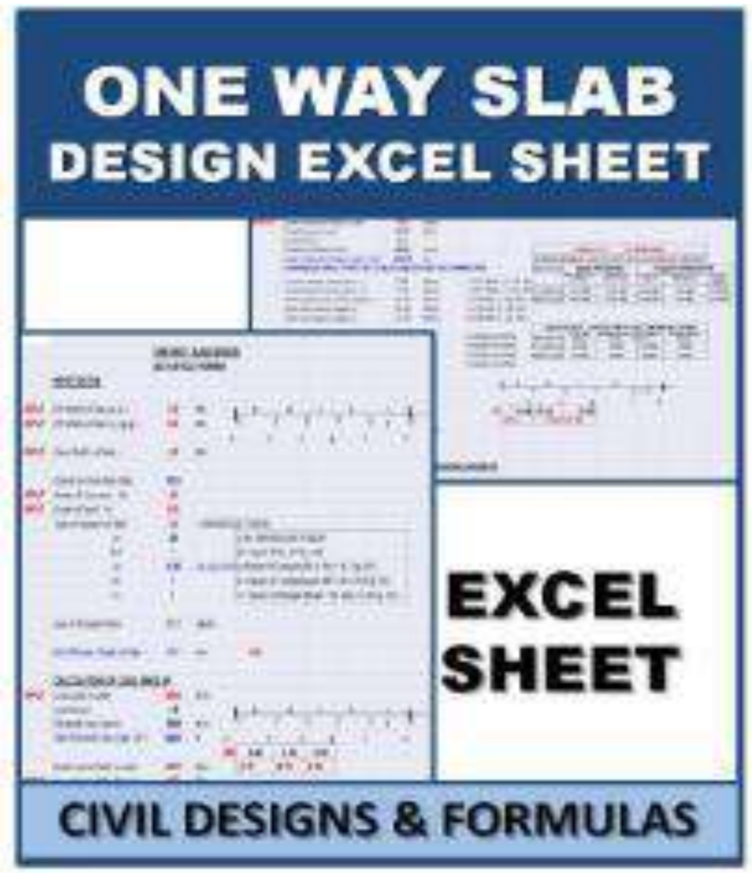
DESIGN OF RCC STRUCTURES LAB (BCV601)



DEPARTMENT OF CIVIL ENGINEERING

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Syllabus

Subject Code: BCV601 CIE Marks: 20

Syllabus

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Calculation of deflection of singly reinforced beam using Excel
2	Design of a simply supported RCC singly reinforced beam using Excel and draw the reinforcement details
3	Design of a simply supported RCC doubly reinforced beam using Excel and draw the reinforcement details
4	Design of singly reinforced beams with check for shear, check for development length and other checks using Excel.
5	Design of a cantilever beam using Excel and draw the reinforcement
6	Design a simply supported RCC one way slab with intermediate support and draw the reinforcement details
7	Design a two-way slab for the given data and prepare Bar bending schedule
8	Design a short axially loaded RC column using Excel
9	Design the reinforcement for RCC square column with isolated square footing
10	Design the reinforcement for RCC circular column with isolated square footing

INDEX

Experiment No. 1

Calculation of deflection of singly reinforced beam using Excel

1	1.A Rectangular simply supported beam of span 5m is 300mm*650mm in cross section and			
2	is reinforced with 3 bars of 20mm on tension side at an effective cover of 50mm.Determine			
3	the short term deflection due to an imposed working load of 20kN/m,(excluding self			
4	weight).Assume grade of concrete M20 and grade of steel as Fe 415.			
5				
6	Solution			
7	b,m	0.3	300	mm
8	fck,N/mm^2	20		
9	L,m	5	5000	mm
10	D,m	0.65	650	mm
11	f_y,N/mm^2	415		
12	IL,kN/m	20		
13	Cover,m	0.05		
14	d	600	m	
15	A_{st} , mm^2	942.5		
16	Self weight	4.875	kN/m	
17	Total load	24.875	kN/m	
18	max bending	77.734	kN/m	
19		77734000		
20	I_{gr}	6.87E+09	mm^4	
21	f_{cr}	3.1305	N/mm^2	
22	y_t	325	mm	
23	M_r	66131710.43	Nmm	
24	E_c	22,360.68	N/mm^2	

25	E_s	2.00E+05	N/mm^2		
26	m	8.944			
27	Let x be the depth of N-A from compression flange.Equating moment of compression area to				
28	moment of equivalent tensile area about N-A,we get				
29					
30	$bx^2/2=m*A_{st}(d-x)$				
31	$300x^2/2=8.944*942.5(600-x)$				
32					
33	$x^2=56.198(600-x)$			ax^2+bx+c	
34				a	1
35	$x^2+56.198x-33718.9=0$			b	56.198
36				c	33718.9
37	x	157.67	mm		
38	I_r	2.04E+09	mm^4		
39	b_w/b	1			
40					
41	z	547.44	mm		
42					
43	I_{eff}	3.25E+09			

44			
45	Here Ir < Ieff < Igr		
46			
47	Short term deflection		
48	$a_{i(permanent)}$	2.78	mm

Experiment No. 2

Design of a simply supported RCC singly reinforced beam using Excel and draw the reinforcement details

1	1.A rectangular section of effective size 300mm*500mm is used as a simply supported		
2	beam for span 7m.What maximum udl can be allowed on the beam,if the maximum		
3	percentage of steel is provided,only on tension side? Use M20 concrete and Fe 415		
4	steel.Determine the amount of steel to be provided.		
5	**Solution**		
6	Input	Values	
7	b, mm	300	
8	d, mm	500	
9	f_{ck}, N/mm2	20	
10	f_y, N/mm^2	415	
11			
12	The maximum amount of steel permitted is provided means it is designed as a balanced se		
13			
14	$x_u/d=x_{u\ lim}/d=0.48$		
15	$X_{u\ lim}=0.48*d$	240	
16			
17	$M_u=M_{u\ lim}=0.36f_{ck}bx_{u\ lim}\ (d-0.42x_{u\ lim})$		
18	M_u , kN-m	207E+06	
19		207	
20			
21	Let w_u be the designed load in kN per meter length.Then maximum moment		
22	$= w_uL^2/8 = w_u*(7^2/8) = (49/8)w_u$ kN/m		
23	Equating it to the moment carrying capacity of the balance section $M_{u\ lim}$,we ge		
24	(49/8)8wu=207		
25	w_u , kN/m	33.80	
26	Total load carrying capacity in working condition is		
27	w, kN/m	22.53	
28			
29	Self	4.125	(assuming 50mm cover)
30	Superimposed maximum udl on the beam		
31	w, kN/m	18.406	
32			
33	Amount of steel for balanced section can be obtained by equating compressive force to		
34	tensile force as $0.36f_{ck}bx_{u\ lim} = 0.87f_yA_{st}$		
35	$0.36*20*300*0.48*500=0.87*415*A_{st}$		
36	A_{st} , mm^2	1,435.81	

Experiment No. 3

Design of a simply supported RCC doubly reinforced beam using Excel and draw the reinforcement details

DESIGN OF DOBLY REINFORCED BEAMS

INPUTS				
b	230	mm	d'	50 mm
Effective span (l)	5.5	m		
LL	33.8	kN/m		
fck	20	N/mm2		
fy	415	N/mm2		
PROCESSING				
FIXING DEPTH				
d	458.33	m		
D	508.33	m		
Tota Load (W)	36.72	kN/m		
Wu	55.08	kN/m		
Mu	208.29	kN-m		
Mulim	135.28	kN-m		
Mu>=Mulim	TRUE		DOUBLY REINFORCED	
Mu2	73.00	kN-m		
Ast2=Asc	495.18	mm2		
ptlim	0.96	%		
Ast1	1116.77	mm2		

OUTPUT		
d	458.33	mm
D	508.33	mm
As1	1116.77	mm2
Ast2	495.18	mm2
Ast	1611.94	mm2
Asc	495.18	mm2

Experiment No. 4

Design of singly reinforced beams with check for shear, check for development length and other checks using Excel.

1	1.A Reinforced concrete beam is to be designed over an effective span of 7m with width of		
2	support 230mm.Design a beam for a servive load of 15kN/m .Use M20 concrete and Fe415		
3			
4	**Solution**		
5	Input		Values
6	Effective span, mm		7000
7	Width of support,mm		230
8	Service load,kN/m		15
9	f_{ck}, N/mm^2		20
10	f_y, N/mm^2		415
11			
12	1. Cross sectional dimension		
13			
14	Take width of beam, b,mm		250
15	Take span to depth ratio 12 to 15		
16	i.e , d = L/15 to L/12		
17	d= 7000/15 to 7000/12		
18	d	466.67	583.33
19	Therefore let us take		
20	d, mm		600
21	Consider 20mm dia bars are to be used as tension reinforcement		
22	Effective cover,d', mm		40
23	Total depth,D,mm		640
24			

25	2. Effective span,L,m	7000
26		7
27		
28	3. Load calculation	
29		
30	Self weight of beam = bdɣ	
31	Self weight of beam ,kN/m	4.00E+06
32		4
33	Service load on beam,kN/m	15
34	Total load,kN/m	19
35	New factored load/design load,W_u=1.5*19	
36	W_u,kN/m	28.5
37		
38	4. Design BM and SF	
39		
40	Design BM, kN/m M_u=$W_u L^2/8$	174.56
41		
42	Design SF,kN/m W_u*L/8	99.75
43		

5.To calculate $M_{u\,lim}$

wkt for Fe 415steel,

$M_{u\,lim}$= 0.138$f_{ck}bd^2$

$M_{u\,lim}$, kNm	248.4E+06
	248.4

Here M_u<$M_{u\,lim}$,the section is under reinforcement

Therefore Design on singly reinforcement section

6. Calculation of reinforcement details

Tension reinforcement/main reinforcement

wkt from Annex G1.1.1b pg 96 of Is 456:200(

M_u= 0.87*f_y*A_{st}*d(1-(f_y*A_{st}/(f_{ck}*b*d)))

174.5*106=0.87*415*A_{st}*600(1-(415*A_{st}/(20*250*600)))

a	b	c
29.96715	-216630	174.5E+06

A_{st},mm^2	923.50

Providing 20mm dia bars , no of bars requirec

No of bars	2.94
	3

Therefore Provide 3 bars – 20mmϕ as tension

7. Check for shear

Here V_u,kN	99.75
	99750

Nominal shear stress,τ_v,N/mm=V_u/(b*d)

τ_v,N/mm2	0.665

Shear strength of concrete,τ_c

For ,P_t =100*A_{st}/(b*d)

P_t	0.628

From Table 19,pg 73 of IS456:2000

τ_c,N/mm^2	0.52
Also $\tau_{c\,max}$,N/mm^2 for M20 concrete (from Table 20)	2.8

Here $\tau_{c\,max} > \tau_v > \tau_c$

Therefore Shear design is measured

$V_{us} = V_u – V_s$ <----- V_s=($\tau_c$bd)

V_{us} , N	2.18E+04

Selecting 8mm diameter bars – 2 legged vertical striups,

Spacing

1. S_v= 0.87$f_y A_{su}$d/V_{us}

S_v , mm	1,001.29

2.S_v = 0.87$f_y A_{sv}$/(0.4b)

S_v , mm	362.97

3. S_v=0.7d

S_v , mm	420
4. S_v , mm	300

Provide 8mm dia 2 legged stirups @ 250mm center to center as shear reinforceme

8.Check for development length (L_d)

From clause 26.2.1, The development length is given by

L_d=øσ_s/4τ_{bd}

L_d ,mm	940.234

9.Check for deflection

From clause 23.2.1,pg no 34 IS456:2000

$(L/d)_{max}=(L/d)_{basic}*K_t*K_c*K_f$ (where $(L/d)_{basic}=20$)

To find K_t,

Refer fig 4 for pg 38 IS 456:2000

Pt	0.628	
$F_s=0.58f_yA_{st}$ req/A_{st} pro		
Fs ,N/mm2	236	
K_t	1.2	
K_c and K_f	1	(SSB)
$(L/d)_{max}$	24	
Now $(L/d)_{act}$	11.667	

Here

$(L/d)_{act} < (L/d)_{max}$

Therefore Safe in deflection

Experiment No. 5

Design of a cantilever beam using Excel and draw the reinforcement

1			
2	**DESIGN OF CANTILEVER BEAM**		
3			
4	**INPUTS**		
5	L = l	2.5	
6	fck in N/mm2	20	
7	fy in N/mm2	415	
8	Width (b) in Mm	250	
9	Effective cover in mm	40	
10	Bearing in mm	250	
11	LL in kN/m	10	
12	Density of RCC in kN/m3	25	
13			
14	**PRELIMINARY DESIGN**		
15	(l/d)assumed	8	
16	Effective depth in mm	312.5	
17	Overall depth in mm	352.5	
18	**LOAD CALCULATION**		
19	LL	10	
20	DL	2.20	
21	Total (W)	12.20	
22	Wu = 1.5W in kN/m2	18.305	
23	**BM & SF**		
24	Effective Span (l) in m	2.5	
25	BM (Mu) in kN-m	57.20	
26	SF (Vu) in kN	45.76	
27	Limiting BM (Mulim) in kN-m	68.36	
28	**CHECK FOR SAFE DEPTH**		
29	Mu<Mulim	TRUE	**Depth provided is safe**
30	**REINFORCEMENT**		
31	**Main Steel**		
32	**CONSTANTS OF QUA EQU**		
33	a	46823671.88	
34	b	1.76294E+11	
35	c	8.93784E+13	
36	b2-(4ac)	1.43395E+22	
37	squre root	1.19747E+11	
38	Ast IN mm2	**603.82**	
39	**Number of 12 mm dia bars**		
40	Ast/ast	1.34	
41	No of bars	2	
42	**SPACING iof 6mm dia nominal**	**300 mm**	
43			
44			
45			
46	**DESIGN DETAILS**		
47			
48	Effective depth in mm	312.5	
49	Overall depth in mm	352.5	
50	Mu in kN-m	57.20	
51	Mulim in kN-m	68.36	
52	Main Steel in mm2	603.82	
53	Spacing of stirrups	300	mm

Experiment No. 6

Design a simply supported RCC one way slab with intermediate support and draw the reinforcement details

2	**DESIGN OF ONE WAY SLAB**		
4	**INPUTS**		
5	Lx in m	3	
6	Ly in m	7	
7	fck in N/mm2	20	
8	fy in N/mm2	415	
9	Width (b) in m for design	1	
10	Effective cover in mm	25	
11	Bearing in mm	250	
12	LL in kN/m2	3	
13	Density of RCC in kN/m3	25	
14	Finishing Load in kN/m2	1	
16	**SLAB TYPE**		
17	Ly > 2Lx ONE WAY SLAB	TRUE	
18	**PRELIMINARY DESIGN**		
19	(l/d)assumed	25	
20	Effective depth in mm	120	
21	Overall depth in mm	145	
22	**LOAD CALCULATION**		
23	LL	3	
24	DL	3.625	
25	FL	1	
26	Total (W)	7.625	
27	Wu = 1.5W in kN/m2	11.438	
28	**BM & SF**		
29	Effective Span (l) in m	3.12	
30	BM (Mu) in kN-m	13.92	
31	SF (Vu) in kN	17.84	
32	Limiting BM (Mulim) in kN-m	40.32	
33	**CHECK FOR SAFE DEPTH**		
34	Mu<Mulim	TRUE	**Depth provided is safe**
35	**REINFORCEMENT**		
36	**Main Steel**		
37	**CONSTANTS OF QUA EQU**		
38	a	17980290	
39	b	1.03982E+11	
40	c	3.34012E+13	
41	b2-(4ac)	8.41009E+21	
42	squre root	91706539228	
43	Ast IN mm2	**341.37**	
44	**Spacing of 10mm dia bars**		
45	1000ast/Ast	229.96	
46	3d	360	
47	300mm	300	
48	**SPACING in mm**	**229.96**	
49	**DISTRIBUTION STEEL**		
50	Ast IN mm2	**174**	

48	**SPACING in mm**	**229.96**
49	**DISTRIBUTION STEEL**	
50	Ast IN mm2	**174**
51	**Spacing of 8mm dia bars**	
52	1000ast/Ast	288.74
53	5d	600
54	450 mm	450
55	**SPACING in mm**	**288.74**

DESIGN DETAILS

61	**Effective depth in mm**	**120**
62	**Overall depth in mm**	**145**
63	**Mu in kN-m**	**13.92**
64	**Mulim in kN-m**	**40.32**
65	**Main Steel in mm2**	**341.37**
66	**Disrtbution Steel in mm2**	**174**
67	**Spacing of 10mm dia main bars**	**229.96**
68	**Spacing of 8mm dia dist bars**	**288.74**

Experiment No. 7

Design a two-way slab for the given data and prepare Bar bending schedule

DESIGN OF TWO WAY SLAB

INPUTS				
Lx	4.5	m	l/d(Lx/d)	28
Ly	5.5	m	b	1000
LL	3	kN/m2		
FFL	0.6	kN/m2		
CFL	0.4	kN/m2		
fck	20	N/mm2		
fy	415	N/mm2		
PROCESSING				
Type of Slab	TWO WAY SLAB)			
PRELIMINARY DESIGN				
d=Lx/28	160.71			
D=d+25	185.71			
Effective span (lx)=Lx+d			4.66	m
Effective span (ly)=Lx+d			5.66	m
LOAD CALCULATION				
TOTAL LOAD(LL+FFL+CFL+DL)			8.64	kN/m2
Wu= 1.5W			12.96	kN/m2
BM'S				
Mux=αx*Wu*lx^2	23.66			kN-m
Muy=αy*Wu*lx^2	16.62			kN-m
Mulim=k*fck*b*d^2	72.32			kN-m

Mu<Mulim	**Depth provided is okay**			
Reinfocement for shorter span				
			a	24080745.54
			b	-1.86512E+11
			c	7.60357E+13
		Inside SQRT		2.74627E+22
Astx		***431.74***	***mm2***	
Reinfocement for longer span				
			a	24080745.54
			b	-1.86512E+11
			c	5.3406E+13
		Inside SQRT		2.96424E+22
Asty		***297.79***	***mm2***	
Spacing of 10 mm dia bars				
along shorter span is least of	181.823			
	482.14			
	300			
SPACING	**181.82**		**mm c/c**	
Spacing of 8 mm dia bars				
along longer span is least of	168.71			
	482.14			
	300			
SPACING	**168.71**		**mm c/c**	

OUTPUT		
EFFECTIVE DEPTH	160.71	mm
OVERALL DEPTH	185.71	mm
Mux	23.66	kN-m
Muy	16.62	kN-m
Mulim	72.32	kN-m
Astx	431.74	mm2
Spacing if 10mm main bars	181.82	mm
Asty	297.79	mm2
Spacing if 8mm dist bars	168.71	mm

Experiment No. 8

Design a short axially loaded RC column using Excel

DESIGN OF SQUARE SHORT COLUMN

INPUTS		
Axial load (P) in kN	1000	
fck in N/mm2	25	
fy in N/mm2	415	
Dia of Longitudinal bars in mr	16	
Dia of Lateral ties in mm	8	
Percentage of steel in %	1.5	
DESIGN		
Factored Load	1500	
Asc in terms of A	0.015	A
Ac in terms of A	0.985	A
Area of C/S of Column (A)-mr	106984.29	
Side of the square column-m	327.08	
Asc - mm2	1604.76	
Area of one bar-mm2	200.96	
Number of 16 mm dia bars	7.99	
Least lateral dimension	327.08	
16 time dia of longitudinal bar	256.00	
48 times dia of lateral ties	384	
Spacing of lateral ties in mm	256.00	

Experiment No. 9

Design the reinforcement for RCC square column with isolated square footing

DESIGN OF ISOLATED SQUARE FOOTING

INPUTS		
Column size x & y	300	mm
	300	mm
Factored Load Pu	1500	kN
SBC	185	kN/m2
fck	20	N/mm2
fy	415	N/mm2
PROCESSING		
FIXING DIMENSION OF FOOTING		
Arequired= (1.1P/SBC)	5.95	m2
TO FIX B&L OF FOOTING		
L=SQRT(A/(x/y))	2.44	m
B=(A/L)	2.44	m
ULTIMATE SOIL PRESSURE		
qu=Pu/A	252.27	kN/m2
FIX DEPTH BY SINGLE SHEAR		
NR	539.46783	
DR	1.1445455	
d	471.34	mm
D=d+50	521.34	mm
CHECK DEPTH FOR BM		

(L-y)/2	1.07		
Mu	144.20	kN-m	
Mulim	622.05	kN-m	
Mu<Mulim	TRUE		Depth provided is OKAY
CHECK DEPTH FOR PUNCHING SHEAR			
Vu	1349.91		
τv	0.93	N/mm2	
τc	1.12	N/mm2	
τv<τc	TRUE	Depth provided is OKAY	

OUTPUT	
LENGTH OF FOOTING	2.44 m
WIDTH OF FOOTING	2.44 m
EFFECTIVE DEPTH	471.34 mm
OVERALL DEPTH	521.34 mm

Experiment No. 10

Design the reinforcement for RCC Rectangular column with isolated rectangular footing

DESIGN OF ISOLATED RECTANGULAR FOOTING

INPUTS		
Column size x & y	300	mm
	500	mm
Factored Load Pu	1500	kN
SBC	185	kN/m2
fck	20	N/mm2
fy	415	N/mm2
PROCESSING		
FIXING DIMENSION OF FOOTING		
Arequired= (1.1P/SBC)	5.95	m2
TO FIX B&L OF FOOTING		
L=SQRT(A/(x/y))	3.15	m
B=(A/L)	1.89	m
ULTIMATE SOIL PRESSURE		
qu=Pu/A	252.27	kN/m2
FIX DEPTH BY SINGLE SHEAR		
NR	668.01842	
DR	1.1445455	
d	583.65	mm
D=d+50	633.65	mm

CHECK DEPTH FOR BM			
(L-y)/2	1.32		
Mu	221.11	kN-m	
Mulim	953.83	kN-m	
Mu<Mulim	TRUE		Depth provided is OKAY
CHECK DEPTH FOR PUNCHING SHEAR			
Vu	1258.43		
τv	0.55	N/mm2	
τc	1.12	N/mm2	
τv<τc	TRUE	Depth provided is OKAY	

OUTPUT	
LENGTH OF FOOTING	3.15 m
WIDTH OF FOOTING	1.89 m
EFFECTIVE DEPTH	583.65 mm
OVERALL DEPTH	633.65 mm