

Design Check for Existing RC Balcony Slabs

data
result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1330	mm		
Slab Thickness D =	150	mm		
Main Reinforcement =	6.3 AT 140	mm	Ast =	222 mm ² /m
2ndy Rft =	6.3 AT 150	mm		
Top cover c =	25	mm	(Bottom 70 mm)	

For D =	150	slab,	& top cover c =	25	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =			122	mm from underside
Adopt Lever Arm La =	0.9 x d =	0.9 x d =		110	mm

Materials

Concrete – from tests adopt	CP 114 - pcb	= 7 N/mm ² (1:2:4 mix)
	BS 8110 - fcu	= 30 N/mm ² (RC30)

Reinforcement	CP 114		BS 8110	
R = round mild steel	pst = 140	N/mm ²	Fy = 250	N/mm ²
S = High Yield (Square)	pst = 230	N/mm ²	Fy = 420	N/mm ²

Loadings

			<u>kN/m²</u>	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
150	RC slab	= D x 24 kN/m ³ =	3.60	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)
				No of Flats
				4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.28 = W
TOTAL	Factored ultimate load	BS 8110 =	10.79 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2/2 =$	5.55	kNm
Shear force	$Q = W \times L =$	8.35	kN
Shear stress	$q = Q / (b \times la) =$	0.076	N/mm²

For slab depth = D =	150	eff depth = d =	122	& La=0.90 d				
Ast =	222	mm ²	Pst =	230	N/mm ²	La =	110	mm
Moment of resistance = MR = Ast x Pst x La		Mr =	5.61	kNm	OK		99.07174	
Allowable shear stress q =			0.7	N/mm²	OK			
Deflection check: Maximum allowable span L = 12 x D =			1800	mm	OK			

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2/2 =$	9.54	kNm
Shear force	$Q = W \times L =$	14.35	kN
Shear stress	$q = Q / (b \times d) =$	0.118	N/mm²

For slab depth = D =	150	eff depth = d =	122	& La=0.90 d				
Ast =	222	mm ²	Fy =	420	N/mm ²	La =	110	mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =			9.73	kNm	OK		98.14022	
Allowable shear stress = Vc =			0.48	N/mm²	OK			
Deflection check: Maximum allowable span L = 7 x d x factor						Adopt factor = 2.0 maximum (T3.10 BS8110)		
		L =	1708	mm	OK			

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kN/m (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kN/m (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kN/m (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.11	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =	28	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =	2.23	kNm	ultimate OK

SUMMARY Slabs **PASS** 99.07 %

Design Check for Existing RC Balcony Slabs

data
result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1330	mm		
Slab Thickness D =	165	mm		
Main Reinforcement =	6.3 AT 165	mm	Ast =	189 mm ² /m
2ndy Rft =	6.3 AT 150	mm		
Top cover c =	25	mm	(Bottom 70 mm)	

For D =	165	slab,	& top cover c =	25	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =			137	mm from underside
Adopt Lever Arm La =	0.9 x d =	0.9 x d =		123	mm

Materials

Concrete – from tests adopt CP 114 - pcb = 7 N/mm² (1:2:4 mix)
 BS 8110 - fcu = 30 N/mm² (RC30)

Reinforcement	CP 114		BS 8110	
R = round mild steel	pst =	140 N/mm ²	Fy =	250 N/mm ²
S = High Yield (Square)	pst =	230 N/mm ²	Fy =	420 N/mm ²

Loadings

			<u>kN/m²</u>	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
165	RC slab	= D x 24 kN/m ³ =	3.96	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)
				No of Flats
				4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.64 = W
TOTAL	Factored ultimate load	BS 8110 =	11.30 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	5.87	kNm
Shear force	$Q = W \times L =$	8.83	kN
Shear stress	$q = Q / (b \times la) =$	0.072	N/mm²

For slab depth = D =	165	eff depth = d =	137	& La=0.90 d
Ast =	189 mm ²	Pst =	230 N/mm ²	La = 123 mm
Moment of resistance = MR = Ast x Pst x La		Mr =	5.36 kNm	FAIL 109.5692
Allowable shear stress q =			0.7 N/mm²	OK
Deflection check: Maximum allowable span L = 12 x D =			1980 mm	OK

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	9.99	kNm
Shear force	$Q = W \times L =$	15.02	kN
Shear stress	$q = Q / (b \times d) =$	0.110	N/mm²

For slab depth = D =	165	eff depth = d =	137	& La=0.90 d
Ast =	189 mm ²	Fy =	420 N/mm ²	La = 123 mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =			9.30 kNm	FAIL 107.4485
Allowable shear stress = Vc =			0.48 N/mm²	OK
Deflection check: Maximum allowable span L = 7 x d x factor				Adopt factor = 2.0 maximum (T3.10 BS8110)
		L =	1918 mm	OK

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kN/m (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kN/m (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kN/m (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.21	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =		28	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =		1.90	kNm	ultimate OK

SUMMARY	Slabs	FAIL	109.57 %
----------------	-------	-------------	----------

Design Check for Existing RC Balcony Slabs

data
result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1330	mm		
Slab Thickness D =	165	mm		
Main Reinforcement =	7.2 AT155	mm	Ast =	263 mm ² /m
2ndy Rft =	7.2 AT 145	mm		
Top cover c =	20	mm	(Bottom 70 mm)	

For D =	165	slab,	& top cover c =	20	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =			142	mm from underside
Adopt Lever Arm La =	0.9 x d =	0.9 x d =		128	mm

Materials

Concrete – from tests adopt	CP 114 - pcb	= 7 N/mm ² (1:2:4 mix)
	BS 8110 - fcu	= 30 N/mm ² (RC30)

Reinforcement	CP 114		BS 8110	
R = round mild steel	pst =	140 N/mm ²	Fy =	250 N/mm ²
S = High Yield (Square)	pst =	230 N/mm ²	Fy =	420 N/mm ²

Loadings

			kN/m ²	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
165	RC slab	= D x 24 kN/m ³ =	3.96	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)
				No of Flats
				4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.64 = W
TOTAL	Factored ultimate load	BS 8110 =	11.30 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	5.87	kNm
Shear force	$Q = W \times L =$	8.83	kN
Shear stress	$q = Q / (b \times la) =$	0.069	N/mm²

For slab depth = D =	165	eff depth = d =	142	& La=0.90 d
Ast =	263 mm ²	Pst =	230 N/mm ²	La = 128 mm
Moment of resistance = MR = Ast x Pst x La		Mr =	7.73 kNm	OK 75.96734
Allowable shear stress q =			0.7 N/mm²	OK
Deflection check: Maximum allowable span L = 12 x D =			1980 mm	OK

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	9.99	kNm
Shear force	$Q = W \times L =$	15.02	kN
Shear stress	$q = Q / (b \times d) =$	0.106	N/mm²

For slab depth = D =	165	eff depth = d =	142	& La=0.90 d
Ast =	263 mm ²	Fy =	420 N/mm ²	La = 128 mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =			13.41 kNm	OK 74.49695
Allowable shear stress = Vc =			0.48 N/mm²	OK
Deflection check: Maximum allowable span L = 7 x d x factor				Adopt factor = 2.0 maximum (T3.10 BS8110)
		L =	1988 mm	OK

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kN/m (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kN/m (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kN/m (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.21	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =		23	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =		2.17	kNm	ultimate OK

SUMMARY Slabs **PASS** 75.97 %

Design Check for Existing RC Balcony Slabs

data
result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1330	mm		
Slab Thickness D =	160	mm		
Main Reinforcement =	6.3 AT145	mm	Ast =	215 mm ² /m
2ndy Rft =	6.3 AT150	mm		
Top cover c =	27	mm	(Bottom 70 mm)	

For D =	160	slab,	& top cover c =	27	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =			130	mm from underside
Adopt Lever Arm La =	0.9 x d =	0.9 x d =		117	mm

Materials

Concrete – from tests adopt CP 114 - pcb = 7 N/mm² (1:2:4 mix)
BS 8110 - fcu = 30 N/mm² (RC30)

Reinforcement	CP 114		BS 8110	
R = round mild steel	pst =	140 N/mm ²	Fy =	250 N/mm ²
S = High Yield (Square)	pst =	230 N/mm ²	Fy =	420 N/mm ²

Loadings

			kN/m ²	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
160	RC slab	= D x 24 kN/m ³ =	3.84	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)
				No of Flats
				4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.52 = W
TOTAL	Factored ultimate load	BS 8110 =	11.13 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	5.77	kNm
Shear force	$Q = W \times L =$	8.67	kN
Shear stress	$q = Q / (b \times la) =$	0.074	N/mm²

For slab depth = D =	160	eff depth = d =	130	& La=0.90 d
Ast =	215 mm ²	Pst =	230 N/mm ²	La = 117 mm
Moment of resistance = MR = Ast x Pst x La		Mr =	5.79 kNm	OK 99.67098
Allowable shear stress q =			0.7 N/mm²	OK
Deflection check: Maximum allowable span L = 12 x D =			1920 mm	OK

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	9.84	kNm
Shear force	$Q = W \times L =$	14.80	kN
Shear stress	$q = Q / (b \times d) =$	0.114	N/mm²

For slab depth = D =	160	eff depth = d =	130	& La=0.90 d
Ast =	215 mm ²	Fy =	420 N/mm ²	La = 117 mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =			10.04 kNm	OK 98.06029
Allowable shear stress = Vc =			0.48 N/mm²	OK
Deflection check: Maximum allowable span L = 7 x d x factor				Adopt factor = 2.0 maximum (T3.10 BS8110)
		L =	1820 mm	OK

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kNm (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kNm (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kNm (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.17	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =		30	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =		2.32	kNm	ultimate OK

SUMMARY Slabs **PASS** 99.67 %

Design Check for Existing RC Balcony Slabs

data

result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1340	mm	
Slab Thickness D =	140	mm	
Main Reinforcement =	6.3 AT155	mm	Ast = 201 mm ² /m
2ndy Rft =	6.3 AT150	mm	
Top cover c =	17	mm	(Bottom 70 mm)

For D = 140 slab, & top cover c = 17 (NB single layer only)
 Effective depth to reinforcement d = d = D - c - 3 = 120 mm from underside
 Adopt Lever Arm La = 0.9 x d = 0.9 x d = 108 mm

Materials

Concrete – from tests adopt CP 114 - pcb = 7 N/mm² (1:2:4 mix)
 BS 8110 - fcu = 30 N/mm² (RC30)

Reinforcement	CP 114	BS 8110
R = round mild steel	pst = 140 N/mm ²	Fy = 250 N/mm ²
S = High Yield (Square)	pst = 230 N/mm ²	Fy = 420 N/mm ²

Loadings

			kN/m ²	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
140	RC slab	= D x 24 kN/m ³ =	3.36	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)
				No of Flats
				4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.04 = W
TOTAL	Factored ultimate load	BS 8110 =	10.46 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	5.42	kNm
Shear force	$Q = W \times L =$	8.09	kN
Shear stress	$q = Q / (b \times la) =$	0.075	N/mm²

For slab depth = D =	140	eff depth = d =	120	& La=0.90 d
Ast =	201 mm ²	Pst =	230 N/mm ²	La = 108 mm
Moment of resistance = MR = Ast x Pst x La		Mr =	4.99 kNm	FAIL 108.6098
Allowable shear stress q =			0.7 N/mm²	OK
Deflection check: Maximum allowable span L = 12 x D =			1680 mm	OK

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	9.39	kNm
Shear force	$Q = W \times L =$	14.01	kN
Shear stress	$q = Q / (b \times d) =$	0.117	N/mm²

For slab depth = D =	140	eff depth = d =	120	& La=0.90 d
Ast =	201 mm ²	Fy =	420 N/mm ²	La = 108 mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =			8.66 kNm	FAIL 108.3808
Allowable shear stress = Vc =			0.48 N/mm²	OK
Deflection check: Maximum allowable span L = 7 x d x factor				Adopt factor = 2.0 maximum (T3.10 BS8110)
		L =	1680 mm	OK

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kNm (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kNm (ultimate)
Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kNm (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.04	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =		20	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =		1.44	kNm	ultimate OK

SUMMARY Slabs **FAIL** 108.61 %

Design Check for Existing RC Balcony Slabs

data
result

Design Codes

Original	CP 3 – Ch .V - Pt 1	Loadings
	CP 114	Concrete
Current	BS 6399 - Pt 1	Loadings
	BS 8110 - Pt 1	Concrete

Dimensions

Cantilever length L=	1340	mm		
Slab Thickness D =	140	mm		
Main Reinforcement =	6.3 AT135	mm	Ast =	230 mm ² /m
2ndy Rft =	6.3 AT150	mm		
Top cover c =	25	mm	(Bottom 70 mm)	

For D = 140 slab,	& top cover c =	25	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =	112	mm from underside
Adopt Lever Arm La =	0.9 x d =	101	mm

Materials

Concrete – from tests adopt	CP 114 - pcb	= 7 N/mm ² (1:2:4 mix)
	BS 8110 - fcu	= 30 N/mm ² (RC30)

Reinforcement	CP 114		BS 8110	
R = round mild steel	pst = 140	N/mm ²	Fy = 250	N/mm ²
S = High Yield (Square)	pst = 230	N/mm ²	Fy = 420	N/mm ²

Loadings

			kN/m ²	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
140	RC slab	= D x 24 kN/m ³ =	3.36	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)
				No of Flats
				4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.04 = W
TOTAL	Factored ultimate load	BS 8110 =	10.46 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2/2 =$	5.42	kNm
Shear force	$Q = W \times L =$	8.09	kN
Shear stress	$q = Q / (b \times la) =$	0.080	N/mm²

For slab depth = D =	140	eff depth = d =	112	& La=0.90 d				
Ast =	230	mm ²	Pst =	230	N/mm ²	La =	101	mm
Moment of resistance = MR = Ast x Pst x La			Mr =	5.33	kNm	FAIL	101.6952	
Allowable shear stress q =				0.7	N/mm²	OK		
Deflection check: Maximum allowable span L = 12 x D =				1680	mm	OK		

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2/2 =$	9.39	kNm
Shear force	$Q = W \times L =$	14.01	kN
Shear stress	$q = Q / (b \times d) =$	0.125	N/mm²

For slab depth = D =	140	eff depth = d =	112	& La=0.90 d				
Ast =	230	mm ²	Fy =	420	N/mm ²	La =	101	mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =				9.25	kNm	FAIL	101.4808	
Allowable shear stress = Vc =				0.48	N/mm²	OK		
Deflection check: Maximum allowable span L = 7 x d x factor						Adopt factor = 2.0 maximum (T3.10 BS8110)		
			L =	1568	mm	OK		

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kNm (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kNm (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kNm (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2/8 =$	2.04	kNm	ultimate
-------------------------	-------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =	28	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =	2.31	kNm	ultimate OK

SUMMARY Slabs **FAIL** 101.70 %

Vaudrey Close BLOCK 43-63 FLAT 51

Design Check for Existing RC Balcony Slabs

data

result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1340	mm		
Slab Thickness D =	155	mm		
Main Reinforcement =	6.3 AT160	mm	Ast =	195 mm ² /m
2ndy Rft =	6.3 AT150	mm		
Top cover c =	35	mm	(Bottom 70 mm)	

For D =	155	slab,	& top cover c =	35	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =			117	mm from underside
Adopt Lever Arm La =	0.9 x d =	0.9 x d =		105	mm

Materials

Concrete – from tests adopt	CP 114 - pcb	= 7 N/mm ² (1:2:4 mix)
	BS 8110 - fcu	= 30 N/mm ² (RC30)

Reinforcement	CP 114		BS 8110		
R = round mild steel	pst =	140	N/mm ²	Fy =	250 N/mm ²
S = High Yield (Square)	pst =	230	N/mm ²	Fy =	420 N/mm ²

Loadings

			<u>kN/m²</u>		
10	Asphalt	= A1 x 20 kN/m ³ =	0.20		
20	Screed	= S1 x 24 kN/m ³ =	0.48		
155	RC slab	= D x 24 kN/m ³ =	3.72		
	Live load	CP 3 =	2.00	(2.0 or 3.0)	No of Flats
	Live load	BS 6399 =	3.00	(1.50 or 3.0)	4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.40 = W
TOTAL	Factored ultimate load	BS 8110 =	10.96 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	5.75	kNm
Shear force	$Q = W \times L =$	8.58	kN
Shear stress	$q = Q / (b \times la) =$	0.081	N/mm²

For slab depth = D =	155	eff depth = d =	117	& La=0.90 d
Ast =	195 mm ²	Pst =	230 N/mm ²	La = 105 mm
Moment of resistance = MR = Ast x Pst x La		Mr =	4.72 kNm	FAIL 121.6659
Allowable shear stress q =			0.7 N/mm²	OK
Deflection check: Maximum allowable span L = 12 x D =			1860 mm	OK

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	9.84	kNm
Shear force	$Q = W \times L =$	14.69	kN
Shear stress	$q = Q / (b \times d) =$	0.126	N/mm²

For slab depth = D =	155	eff depth = d =	117	& La=0.90 d
Ast =	195 mm ²	Fy =	420 N/mm ²	La = 105 mm
Moment of resistance = MR = Ast x 0.95 x Fy x La			8.19 kNm	FAIL 120.1031
Allowable shear stress = Vc =			0.48 N/mm²	OK
Deflection check: Maximum allowable span L = 7 x d x factor				Adopt factor = 2.0 maximum (T3.10 BS8110)
		L =	1638 mm	OK

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kN/m (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m, & a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kN/m (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kN/m (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.14	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =		38	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =		2.66	kNm	ultimate OK

SUMMARY	Slabs	FAIL	121.67 %
----------------	-------	-------------	----------

Vaudrey Close BLOCK 43-63 FLAT 56

Design Check for Existing RC Balcony Slabs

data

result

Design Codes

Original	CP 3 – Ch .V - Pt 1 CP 114	Loadings Concrete
Current	BS 6399 - Pt 1 BS 8110 - Pt 1	Loadings Concrete

Dimensions

Cantilever length L=	1340	mm		
Slab Thickness D =	155	mm		
Main Reinforcement =	6.3 AT150	mm	Ast =	208 mm ² /m
2ndy Rft =	6.3 AT150	mm		
Top cover c =	25	mm	(Bottom 70 mm)	

For D = 155 slab,	& top cover c =	25	(NB single layer only)
Effective depth to reinforcement d =	d = D - c - 3 =	127	mm from underside
Adopt Lever Arm La =	0.9 x d =	114	mm

Materials

Concrete – from tests adopt	CP 114 - pcb	= 7 N/mm ² (1:2:4 mix)
	BS 8110 - fcu	= 30 N/mm ² (RC30)

Reinforcement	CP 114		BS 8110	
R = round mild steel	pst =	140 N/mm ²	Fy =	250 N/mm ²
S = High Yield (Square)	pst =	230 N/mm ²	Fy =	420 N/mm ²

Loadings

			kN/m ²	
10	Asphalt	= A1 x 20 kN/m ³ =	0.20	
20	Screed	= S1 x 24 kN/m ³ =	0.48	
155	RC slab	= D x 24 kN/m ³ =	3.72	
	Live load	CP 3 =	2.00	(2.0 or 3.0)
	Live load	BS 6399 =	3.00	(1.50 or 3.0)

No of Flats

4

(NB BS 6399 Live load for access to not more than 4 flats = 1.5 kN/m²)

(NB BS 6399 Live load for access to more than 4 flats = 3.0 kN/m²) (= 2.0 for CP3 Ch 5 Pt 1)

TOTAL	Unfactored service load	CP 114 =	6.40 = W
TOTAL	Factored ultimate load	BS 8110 =	10.96 = W

Design

For CP 114 (service loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	5.75	kNm
Shear force	$Q = W \times L =$	8.58	kN
Shear stress	$q = Q / (b \times la) =$	0.075	N/mm²

For slab depth = D =	155	eff depth = d =	127	& La=0.90 d				
Ast =	208	mm ²	Pst =	230	N/mm ²	La =	114	mm
Moment of resistance = MR = Ast x Pst x La		Mr =	5.47	kNm	FAIL	105.0805		
Allowable shear stress q =			0.7	N/mm²	OK			
Deflection check: Maximum allowable span L = 12 x D =			1860	mm	OK			

For BS 8110 (ultimate loads & stresses etc)

Cantilever bending moment	$M = W \times L^2 / 2 =$	9.84	kNm
Shear force	$Q = W \times L =$	14.69	kN
Shear stress	$q = Q / (b \times d) =$	0.116	N/mm²

For slab depth = D =	155	eff depth = d =	127	& La=0.90 d				
Ast =	208	mm ²	Fy =	420	N/mm ²	La =	114	mm
Moment of resistance = MR = Ast x 0.95 x Fy x La =			9.49	kNm	FAIL	103.7308		
Allowable shear stress = Vc =			0.48	N/mm²	OK			
Deflection check: Maximum allowable span L = 7 x d x factor					Adopt factor = 2.0 maximum (T3.10 BS8110)			
		L =	1778	mm	OK			

Handrails

Consider also additional moment due to handrail loads:

From CP 3 adopt horizontal load H = 0.36 kN/m at a height H = 1.1 m

For CP 114: Additional moment Ma = H x L = 0.36 x 1.1 = 0.40 kNm (service)

From BS 6399 Pt 1 adopt horizontal load F = 0.74 kN/m at a height H = 1.1 m,
& a vertical load of V = 0.6 kN/m or 1.0 kN

For BS 8110: Additional moment Ma 1 = F x H x 1.6 = 0.74 x 1.1 x 1.6 = 1.30 kNm (ultimate)

Ma 2 = V x L x 1.6 = 0.6 x 1.35 x 1.6 = 1.30 kNm (ultimate)

Propping

Where deflection has occurred or reinforcement is considered inadequate to allow the slab to act as a cantilever, consider propping the edge of the slab at Lb = 1.25 m from face of building.

For simplicity, check bending of balcony (conservatively) as a simply supported spanning slab

Check to current standards only, ie for BS 8110:

Spanning bending moment	$M = W \times Lb^2 / 8 =$	2.14	kNm	ultimate
-------------------------	---------------------------	-------------	------------	----------

For the top reinforcement (NB single layer only, placed approximately centrally)

Effective depth to reinforcement = d2 = c+3 =	28	mm from top	la2 = 0.9x d2
Moment of resistance Mr = Ast x 0.95 x fy x la2 =	2.09	kNm	ultimate OK

SUMMARY Slabs **FAIL** 105.08 %