Design Check for Existing RC Balcony Slabs

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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=	1330	mm			
Slab Thickness D =	150	mm			
Main Reinforcement =	6.3 AT 140	mm	Ast =	222	mm2/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

			kN/m^2		
10	Asphalt	= A1 x 20 kN/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
150	RC slab	= D x 24 kN/m3 =	3.60		
	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 =	6.28	= 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 x L =	**8.35**	**kN**	
Shear stress	q = Q / (b x la) =	**0.076**	**N/mm²**	

For slab depth = D = 150 eff depth = d = 122 & La=0.90 d

Ast = 222 mm² Pst = 230 N/mm² 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 x L =	**14.35**	**kN**	
Shear stress	q = Q / (b x d) =	**0.118**	**N/mm²**	

For slab depth = D = 150 eff depth = d = 122 & La=0.90 d

Ast = 222 mm² Fy = 420 N/mm² 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

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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=	1330	mm			
Slab Thickness D =	165	mm			
Main Reinforcement =	6.3 AT 165	mm	Ast =	189	mm2/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/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/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
165	RC slab	= D x 24 kN/m3 =	3.96		
	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 =	6.64	= 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 x L =	**8.83**	**kN**	
Shear stress	q = Q / (b x la) =	**0.072**	**N/mm²**	

For slab depth = D =	165		eff depth = d =		137	& La=0.90 d		
Ast =	189	mm²	Pst =	230	N/mm²	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 x L =	**15.02**	**kN**	
Shear stress	q = Q / (b x d) =	**0.110**	**N/mm²**	

For slab depth = D =	165		eff depth = d =		137	& La=0.90 d		
Ast =	189	mm²	Fy =	420	N/mm²	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

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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=	1330	mm			
Slab Thickness D =	165	mm			
Main Reinforcement =	7.2 AT155	mm	Ast =	263	mm2/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/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
165	RC slab	= D x 24 kN/m3 =	3.96		
	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 =	6.64	= 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 x L =	**8.83**	**kN**	
Shear stress	q = Q / (b x la) =	**0.069**	**N/mm²**	

For slab depth = D = 165 eff depth = d = 142 & La=0.90 d

Ast = 263 mm² Pst = 230 N/mm² 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 x L =	**15.02**	**kN**	
Shear stress	q = Q / (b x d) =	**0.106**	**N/mm²**	

For slab depth = D = 165 eff depth = d = 142 & La=0.90 d

Ast = 263 mm² Fy = 420 N/mm² 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

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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=	1330	mm			
Slab Thickness D =	160	mm			
Main Reinforcement =	6.3 AT145	mm	Ast =	215	mm2/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/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/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
160	RC slab	= D x 24 kN/m3 =	3.84		
	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 =	6.52	= 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 mm² Pst = 230 N/mm² 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 mm² Fy = 420 N/mm² 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 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 $M = W \times Lb^2/8 =$ **2.17** **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

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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 AT155	mm	Ast =	201	mm2/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/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/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
140	RC slab	= D x 24 kN/m3 =	3.36		
	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 =	6.04	= 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 x L =	**8.09**	**kN**	
Shear stress	q = Q / (b x la) =	**0.075**	**N/mm²**	

For slab depth = D =	140		eff depth = d =		120	& La=0.90 d		
Ast =	201	mm²	Pst =	230	N/mm²	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 x L =	**14.01**	**kN**	
Shear stress	q = Q / (b x d) =	**0.117**	**N/mm²**	

For slab depth = D =	140		eff depth = d =		120	& La=0.90 d		
Ast =	201	mm²	Fy =	420	N/mm²	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 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	$M = W \times Lb^2/8$ =	**2.04**	**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

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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	mm2/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 =	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/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
140	RC slab	= D x 24 kN/m3 =	3.36		
	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 =	6.04	= 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 x L =	**8.09**	**kN**	
Shear stress	q = Q / (b x la) =	**0.080**	**N/mm²**	

For slab depth = D =	140		eff depth = d =		112	& La=0.90 d		
Ast =	230	mm²	Pst =	230	N/mm²	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 x L =	**14.01**	**kN**	
Shear stress	q = Q / (b x d) =	**0.125**	**N/mm²**	

For slab depth = D =	140		eff depth = d =		112	& La=0.90 d		
Ast =	230	mm²	Fy =	420	N/mm²	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 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	$M = W \times Lb^2/8$ =	**2.04**	**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 %

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 =	155	mm			
Main Reinforcement =	6.3 AT160	mm	Ast =	195	mm2/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

			kN/m^2		
10	Asphalt	= A1 x 20 kN/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
155	RC slab	= D x 24 kN/m3 =	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 mm² Pst = 230 N/mm² 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 mm² Fy = 420 N/mm² 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 %

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 =	155	mm			
Main Reinforcement =	6.3 AT150	mm	Ast =	208	mm2/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 =	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/m3 =	0.20		
20	Screed	= S1 x 24 kN/m3=	0.48		
155	RC slab	= D x 24 kN/m3 =	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 x L =	**8.58**	**kN**	
Shear stress	q = Q / (b x la) =	**0.075**	**N/mm²**	

For slab depth = D =	155	eff depth = d =	127	& La=0.90 d			
Ast = 208	mm²	Pst =	230	N/mm²	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 x L =	**14.69**	**kN**	
Shear stress	q = Q / (b x d) =	**0.116**	**N/mm²**	

For slab depth = D =	155	eff depth = d =	127	& La=0.90 d			
Ast = 208	mm²	Fy =	420	N/mm²	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 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 =		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 %