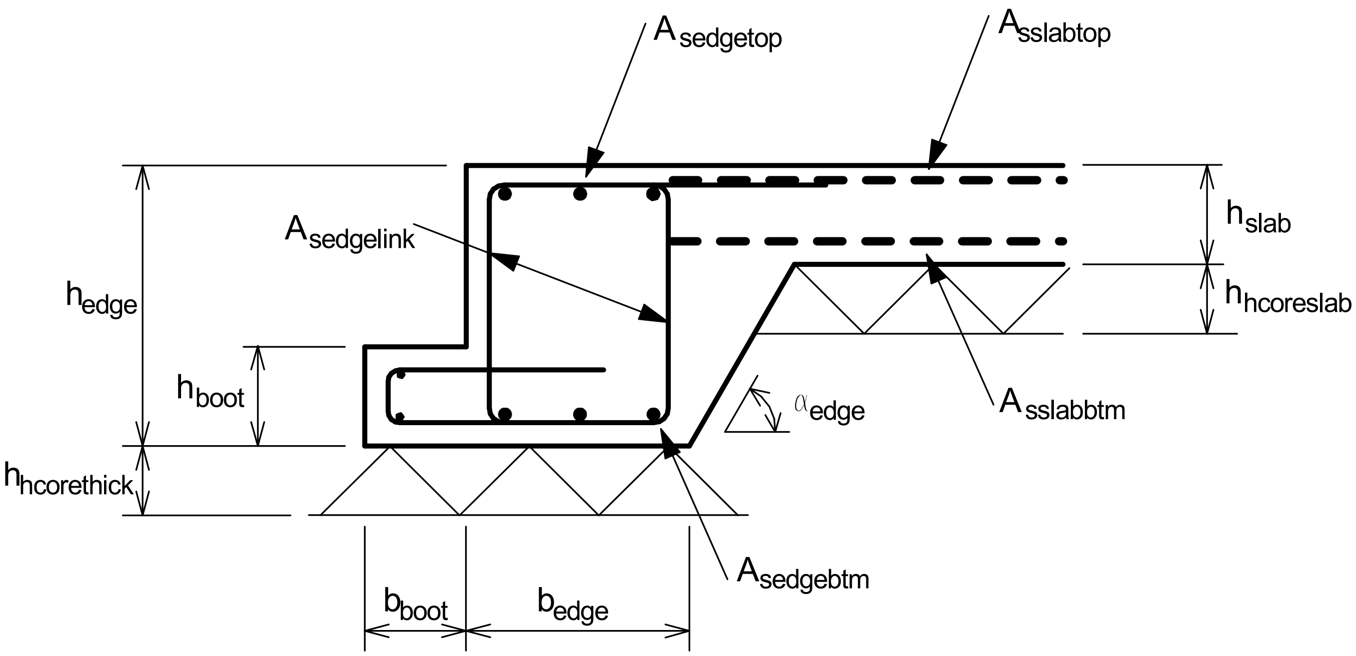
RAFT FOUNDATION DESIGN IN ACCORDANCE WITH BS8110:PART 1-1997 FOR MULTISTOREY BUILDING (BS8110 : PART 1 : 1997)



Soil and raft definition

Soil definition

Allowable bearing pressure; q_{allow} = **75.0** kN/m^2

Number of types of soil forming sub-soil; **Two or more types**

Soil density; **Firm to loose**

Depth of hardcore beneath slab; $h_{hcoreslab}$ = **200** mm; (Dispersal allowed for bearing pressure check)

Depth of hardcore beneath thickenings; $h_{hcorethick}$ = **0** mm; (Dispersal allowed for bearing pressure check)

Density of hardcore; γ_{hcore} = **20.0** kN/m^3

Basic assumed diameter of local depression; $\phi_{depbasic}$ = **3500**mm

Diameter under slab modified for hardcore; $\phi_{depslab} = \phi_{depbasic} - h_{hcoreslab}$ = **3300** mm

Diameter under thickenings modified for hardcore; $\phi_{depthick} = \phi_{depbasic} - h_{hcorethick}$ = **3500** mm

Raft slab definition

Max dimension/max dimension between joints; l_{max} = **12.000** m

Slab thickness; h_{slab} = **250** mm

Concrete strength; f_{cu} = **35** N/mm^2

Poissons ratio of concrete; ν = **0.2**

Slab mesh reinforcement strength; f_{yslab} = **500** N/mm^2

Partial safety factor for steel reinforcement; γ_s = **1.15**

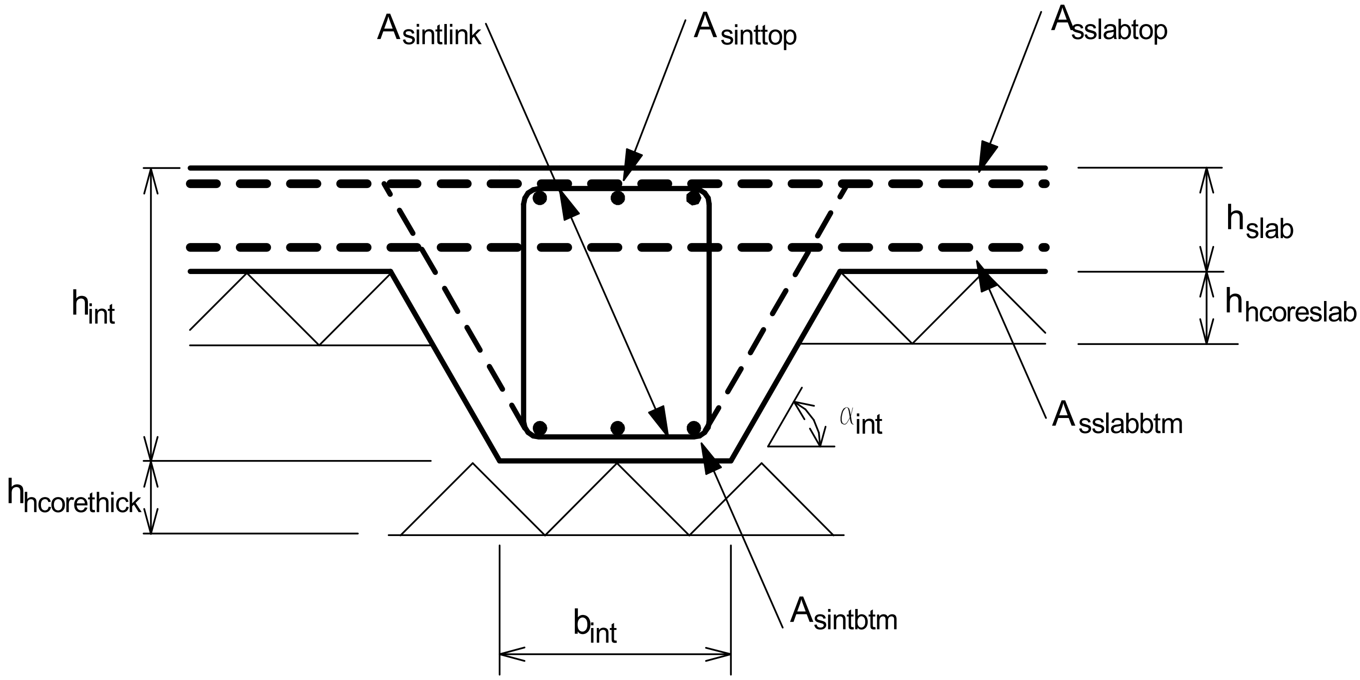
From C&CA document 'Concrete ground floors' Table 5

Minimum mesh required in top for shrinkage;	**A142**;
Actual mesh provided in top;	**A393 ($A_{sslabtop}$ = 393 mm^2/m)**
Mesh provided in bottom;	**A393 ($A_{sslabbtm}$ = 393 mm^2/m)**
Top mesh bar diameter;	$\phi_{slabtop}$ = **10** mm
Bottom mesh bar diameter;	$\phi_{slabbtm}$ = **10** mm
Cover to top reinforcement;	c_{top} = **20** mm
Cover to bottom reinforcement;	c_{btm} = **40** mm
Average effective depth of top reinforcement;	$d_{tslabav} = h_{slab} - c_{top} - \phi_{slabtop}$ = **220** mm
Average effective depth of bottom reinforcement;	$d_{bslabav} = h_{slab} - c_{btm} - \phi_{slabbtm}$ = **200** mm
Overall average effective depth;	$d_{slabav} = (d_{tslabav} + d_{bslabav})/2$ = **210** mm
Minimum effective depth of top reinforcement;	$d_{tslabmin} = d_{tslabav} - \phi_{slabtop}/2$ = **215** mm
Minimum effective depth of bottom reinforcement;	$d_{bslabmin} = d_{bslabav} - \phi_{slabbtm}/2$ = **195** mm

Edge beam definition

Overall depth;	h_{edge} = **600** mm
Width;	b_{edge} = **550** mm
Depth of boot;	h_{boot} = **250** mm
Width of boot;	b_{boot} = **250** mm
Angle of chamfer to horizontal;	α_{edge} = **60** deg
Strength of main bar reinforcement;	f_y = **500** N/mm^2
Strength of link reinforcement;	f_{ys} = **500** N/mm^2
Reinforcement provided in top;	**3 H25 bars ($A_{sedgetop}$ = 1473 mm^2)**
Reinforcement provided in bottom;	**3 H20 bars ($A_{sedgebtm}$ = 942 mm^2)**
Link reinforcement provided;	**2 H12 legs at 250 ctrs (A_{sv}/s_v = 0.905 mm)**
Bottom cover to links;	c_{beam} = **40** mm
Effective depth of top reinforcement;	$d_{edgetop} = h_{edge} - c_{top} - \phi_{slabtop} - \phi_{edgelink} - \phi_{edgetop}/2$ = **546** mm
Effective depth of bottom reinforcement;	$d_{edgebtm} = h_{edge} - c_{beam} - \phi_{edgelink} - \phi_{edgebtm}/2$ = **538** mm
Boot main reinforcement;	**H8 bars at 250 ctrs (A_{sboot} = 201 mm^2/m)**
Effective depth of boot reinforcement;	$d_{boot} = h_{boot} - c_{beam} - \phi_{boot}/2$ = **206** mm

Internal beam definition



Overall depth; h_{int} = **550** mm

Width; b_{int} = **500** mm

Angle of chamfer to horizontal; α_{int} = **60** deg

Strength of main bar reinforcement; f_y = **500** N/mm^2

Strength of link reinforcement; f_{ys} = **500** N/mm^2

Reinforcement provided in top; **3 H25 bars ($A_{sinttop}$ = 1473 mm^2)**

Reinforcement provided in bottom; **3 H25 bars ($A_{sintbtm}$ = 1473 mm^2)**

Link reinforcement provided; **2 H12 legs at 225 ctrs (A_{sv}/s_v = 1.005 mm)**

Effective depth of top reinforcement; $d_{inttop} = h_{int} - c_{top} - 2 \times \phi_{slabtop} - \phi_{inttop}/2$ = **498** mm

Effective depth of bottom reinforcement; $d_{intbtm} = h_{int} - c_{beam} - \phi_{intlink} - \phi_{intbtm}/2$ = **486** mm

Internal slab design checks

Basic loading

Slab self weight; w_{slab} = 24 kN/m^3 $\times$ h_{slab} = **6.0** kN/m^2

Hardcore; $w_{hcoreslab} = \gamma_{hcore} \times h_{hcoreslab}$ = **4.0** kN/m^2

Applied loading

Uniformly distributed dead load; w_{Dudl} = **2.0** kN/m^2

Uniformly distributed live load; w_{Ludl} = **2.5** kN/m^2

Slab load number 1

Load type;	**Line load**
Dead load;	w_{D1} = **3.0** kN/m
Live load;	w_{L1} = **2.0** kN/m
Ultimate load;	$w_{ult1} = 1.4 \times w_{D1} + 1.6 \times w_{L1}$ = **7.4** kN/m
Line load width;	b_1 = **140** mm

Internal slab bearing pressure check

Total uniform load at formation level;	$w_{udl} = w_{slab} + w_{hcoreslab} + w_{Dudl} + w_{Ludl}$ = **14.5** kN/m^2

Bearing pressure beneath load number 1

Net bearing pressure available to resist line load;	$q_{net} = q_{allow} - w_{udl}$ = **60.5** kN/m^2
Net ‘ultimate’ bearing pressure available;	$q_{netult} = q_{net} \times w_{ult1}/(w_{D1} + w_{L1})$ = **89.5** kN/m^2
Loaded width required at formation;	$l_{req1} = w_{ult1}/q_{netult}$ = **0.083** m
Effective loaded width at u/side slab;	$l_{eff1} = \max(b_1, l_{req1} - 2 \times h_{hcoreslab} \times \tan(30))$ = **0.140** m
Effective net ult bearing pressure at u/side slab;	$q_{netulteff} = q_{netult} \times l_{req1}/l_{eff1}$ = **52.9** kN/m^2
Cantilever bending moment;	$M_{cant1} = q_{netulteff} \times [(l_{eff1} - b_1)/2]^2/2$ = **0.0** kNm/m

Reinforcement required in bottom

Maximum cantilever moment;	$M_{cantmax}$ = **0.0** kNm/m
K factor;	$K_{slabbp} = M_{cantmax}/(f_{cu} \times d_{bslabmin}^2)$ = **0.000**
Lever arm;	$z_{slabbp} = d_{bslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabbp}/0.9)})$ = **185.3** mm
Area of steel required;	$A_{sslabbpreq} = M_{cantmax}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabbp})$ = **0** mm^2/m

PASS - $A_{sslabbpreq}$ <= $A_{sslabbtm}$ - Area of reinforcement provided to distribute the load is adequate

The allowable bearing pressure will not be exceeded

Internal slab bending and shear check

Applied bending moments

Span of slab;	$l_{slab} = \phi_{depslab} + d_{tslabav}$ = **3520** mm
Ultimate self weight udl;	$w_{swult} = 1.4 \times w_{slab}$ = **8.4** kN/m^2
Self weight moment at centre;	$M_{csw} = w_{swult} \times l_{slab}^2 \times (1 + \nu) / 64$ = **2.0** kNm/m
Self weight moment at edge;	$M_{esw} = w_{swult} \times l_{slab}^2 / 32$ = **3.3** kNm/m
Self weight shear force at edge;	$V_{sw} = w_{swult} \times l_{slab} / 4$ = **7.4** kN/m

Moments due to applied uniformly distributed loads

Ultimate applied udl;	$w_{udlult} = 1.4 \times w_{Dudl} + 1.6 \times w_{Ludl}$ = **6.8** kN/m^2
Moment at centre;	$M_{cudl} = w_{udlult} \times l_{slab}^2 \times (1 + \nu) / 64$ = **1.6** kNm/m
Moment at edge;	$M_{eudl} = w_{udlult} \times l_{slab}^2 / 32$ = **2.6** kNm/m
Shear force at edge;	$V_{udl} = w_{udlult} \times l_{slab} / 4$ = **6.0** kN/m

Moment due to load number 1

Approximate equivalent udl;	$w_{udl1} = w_{ult1}/(2 \times 0.3 \times l_{slab})$ = **3.5** kN/m^2
Moment at centre;	$M_{c1} = w_{udl1} \times l_{slab}^2 \times (1 + \nu) / 64$ = **0.8** kNm/m
Moment at edge;	$M_{e1} = w_{udl1} \times l_{slab}^2 / 32$ = **1.4** kNm/m
Shear force at edge;	$V_1 = w_{udl1} \times l_{slab} / 4$ = **3.1** kN/m

Resultant moments and shears

Total moment at edge;	$M_{\Sigma e}$ = **7.2** kNm/m

Total moment at centre; $M_{\Sigma c}$ = **4.3** kN/m

Total shear force; V_{Σ} = **16.5** kN/m

Reinforcement required in top

K factor; $K_{slabtop} = M_{\Sigma e}/(f_{cu} \times d_{tslabav}^2)$ = **0.004**

Lever arm; $z_{slabtop} = d_{tslabav} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabtop}/0.9)})$ = **209.0** mm

Area of steel required for bending; $A_{sslabtopbend} = M_{\Sigma e}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabtop})$ = **80** mm^2/m

Minimum area of steel required; $A_{sslabmin} = 0.0013 \times h_{slab}$ = **325** mm^2/m

Area of steel required; $A_{sslabtopreq} = \max(A_{sslabtopbend}, A_{sslabmin})$ = **325** mm^2/m

PASS - $A_{sslabtopreq}$ <= $A_{sslabtop}$ - Area of reinforcement provided in top to span local depressions is adequate

Reinforcement required in bottom

K factor; $K_{slabbtm} = M_{\Sigma c}/(f_{cu} \times d_{bslabav}^2)$ = **0.003**

Lever arm; $z_{slabbtm} = d_{bslabav} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabbtm}/0.9)})$ = **190.0** mm

Area of steel required for bending; $A_{sslabbtmbend} = M_{\Sigma c}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabbtm})$ = **53** mm^2/m

Area of steel required; $A_{sslabbtmreq} = \max(A_{sslabbtmbend}, A_{sslabmin})$ = **325** mm^2/m

PASS - $A_{sslabbtmreq}$ <= $A_{sslabbtm}$ - Area of reinforcement provided in bottom to span local depressions is adequate

Shear check

Applied shear stress; $v = V_{\Sigma}/d_{tslabmin}$ = **0.077** N/mm^2

Tension steel ratio; $\rho = 100 \times A_{sslabtop}/d_{tslabmin}$ = **0.183**

From BS8110-1:1997 - Table 3.8;

Design concrete shear strength; v_c = **0.469** N/mm^2

PASS - v <= v_c - Shear capacity of the slab is adequate

Internal slab deflection check

Basic allowable span to depth ratio; $Ratio_{basic}$ = **26.0**

Moment factor; $M_{factor} = M_{\Sigma c}/d_{bslabav}^2$ = **0.109** N/mm^2

Steel service stress; $f_s = 2/3 \times f_{yslab} \times A_{sslabbtmbend}/A_{sslabbtm}$ = **44.615** N/mm^2

Modification factor; $MF_{slab} = \min(2.0, 0.55 + [(477N/mm^2 - f_s)/(120 \times (0.9N/mm^2 + M_{factor}))])$

MF_{slab} = **2.000**

Modified allowable span to depth ratio; $Ratio_{allow} = Ratio_{basic} \times MF_{slab}$ = **52.000**

Actual span to depth ratio; $Ratio_{actual} = l_{slab}/ d_{bslabav}$ = **17.600**

PASS - $Ratio_{actual}$ <= $Ratio_{allow}$ - Slab span to depth ratio is adequate

Edge beam design checks

Basic loading

Hardcore; $w_{hcorethick} = \gamma_{hcore} \times h_{hcorethick}$ = **0.0** kN/m^2

Edge beam

Rectangular beam element; $w_{beam} = 24 kN/m^3 \times h_{edge} \times b_{edge}$ = **7.9** kN/m

Boot element; $w_{boot} = 24 kN/m^3 \times h_{boot} \times b_{boot}$ = **1.5** kN/m

Chamfer element; $w_{chamfer} = 24 kN/m^3 \times (h_{edge} - h_{slab})^2/(2 \times \tan(\alpha_{edge}))$ = **0.8** kN/m

Slab element; $w_{slabelmt} = 24 kN/m^3 \times h_{slab} \times (h_{edge} - h_{slab})/\tan(\alpha_{edge})$ = **1.2** kN/m

Edge beam self weight; $w_{edge} = w_{beam} + w_{boot} + w_{chamfer} + w_{slabelmt}$ = **11.5** kN/m

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Edge load number 1

Load type; **Longitudinal line load**

Dead load; w_{Dedge1} = **13.2** kN/m

Live load; w_{Ledge1} = **0.0** kN/m

Ultimate load; $w_{ultedge1} = 1.4 \times w_{Dedge1} + 1.6 \times w_{Ledge1}$ = **18.5** kN/m

Longitudinal line load width; b_{edge1} = **102** mm

Centroid of load from outside face of raft; x_{edge1} = **51** mm

Edge load number 2

Load type; **Longitudinal line load**

Dead load; w_{Dedge2} = **16.1** kN/m

Live load; w_{Ledge2} = **5.6** kN/m

Ultimate load; $w_{ultedge2} = 1.4 \times w_{Dedge2} + 1.6 \times w_{Ledge2}$ = **31.5** kN/m

Longitudinal line load width; b_{edge2} = **100** mm

Centroid of load from outside face of raft; x_{edge2} = **230** mm

Edge beam bearing pressure check

Effective bearing width of edge beam; $b_{bearing} = b_{edge} + b_{boot} + (h_{edge} - h_{slab})/\tan(\alpha_{edge})$ = **1002** mm

Total uniform load at formation level; $w_{udledge} = w_{Dudl}+w_{Ludl}+w_{edge}/b_{bearing}+w_{hcorethick}$ = **16.0** kN/m^2

Centroid of longitudinal and equivalent line loads from outside face of raft

Load x distance for edge load 1; $Moment_1 = w_{ultedge1} \times x_{edge1}$ = **0.9** kN

Load x distance for edge load 2; $Moment_2 = w_{ultedge2} \times x_{edge2}$ = **7.2** kN

Sum of ultimate longitud'l and equivalent line loads; ΣUDL = **50.0** kN/m

Sum of load x distances; $\Sigma Moment$ = **8.2** kN

Centroid of loads; $x_{bar} = \Sigma Moment/\Sigma UDL$ = **164** mm

Initially assume no moment transferred into slab due to load/reaction eccentricity

Sum of unfactored longitud'l and eff'tive line loads; $\Sigma UDLsls$ = **34.9** kN/m

Allowable bearing width; $b_{allow} = 2 \times x_{bar} + 2 \times h_{hcoreslab} \times \tan(30)$ = **559** mm

Bearing pressure due to line/point loads; $q_{linepoint} = \Sigma UDLsls/ b_{allow}$ = **62.5** kN/m^2

Total applied bearing pressure; $q_{edge} = q_{linepoint} + w_{udledge}$ = **78.4** kN/m^2

$q_{edge} > q_{allow}$ - The slab is required to resist a moment due to eccentricity

Now assume moment due to load/reaction eccentricity is resisted by slab

Bearing width required; $b_{req} = \Sigma UDLsls/(q_{allow} - w_{udledge})$ = **591** mm

Effective bearing width at u/s of slab; $b_{reqeff} = b_{req} - 2 \times h_{hcoreslab} \times \tan(30)$ = **360** mm

Load/reaction eccentricity; $e = b_{reqeff}/2 - x_{bar}$ = **16** mm

Ultimate moment to be resisted by slab; $M_{ecc} = \Sigma UDL \times e$ = **0.8** kNm/m

From slab bending check

Moment due to depression under slab (hogging); $M_{\Sigma e}$ = **7.2** kNm/m

Total moment to be resisted by slab top steel; $M_{slabtop} = M_{ecc} + M_{\Sigma e}$ = **8.1** kNm/m

K factor; $K_{slab} = M_{slabtop}/(f_{cu} \times d_{tslabmin}^2)$ = **0.005**

Lever arm; $z_{slab} = d_{tslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slab}/0.9)})$ = **204** mm

Area of steel required; $A_{sslabreq} = M_{slabtop}/((1.0/\gamma_s) \times 460 \text{ N/mm}^2 \times z_{slab})$ = **99** mm^2/m

PASS - $A_{sslabreq}$ <= $A_{sslabtop}$ - Area of reinforcement provided to transfer moment into slab is adequate

The allowable bearing pressure under the edge beam will not be exceeded

Edge beam bending check

Divider for moments due to udl's; β_{udl} = **12.0**

Applied bending moments

Span of edge beam; $l_{edge} = \phi_{depthick} + d_{edgetop}$ = **4045** mm

Ultimate self weight udl; $w_{edgeult} = 1.4 \times w_{edge}$ = **16.1** kN/m

Ultimate slab udl (approx); $w_{edgeslab} = \max(0\ \text{kN/m}, 1.4 \times w_{slab} \times ((\phi_{depthick}/2 \times 3/4) - (b_{edge} + (h_{edge} - h_{slab})/\tan(\alpha_{edge}))))$

$w_{edgeslab}$ = **4.7** kN/m

Self weight and slab bending moment; $M_{edgesw} = (w_{edgeult} + w_{edgeslab}) \times l_{edge}^2/\beta_{udl}$ = **28.3** kNm

Self weight shear force; $V_{edgesw} = (w_{edgeult} + w_{edgeslab}) \times l_{edge}/2$ = **42.0** kN

Moments due to applied uniformly distributed loads

Ultimate udl (approx); $w_{edgeudl} = w_{udlult} \times \phi_{depthick}/2 \times 3/4$ = **8.9** kN/m

Bending moment; $M_{edgeudl} = w_{edgeudl} \times l_{edge}^2/\beta_{udl}$ = **12.2** kNm

Shear force; $V_{edgeudl} = w_{edgeudl} \times l_{edge}/2$ = **18.1** kN

Moment and shear due to load number 1

Bending moment; $M_{edge1} = w_{ultedge1} \times l_{edge}^2/\beta_{udl}$ = **25.2** kNm

Shear force; $V_{edge1} = w_{ultedge1} \times l_{edge}/2$ = **37.4** kN

Moment and shear due to load number 2

Bending moment; $M_{edge2} = w_{ultedge2} \times l_{edge}^2/\beta_{udl}$ = **43.0** kNm

Shear force; $V_{edge2} = w_{ultedge2} \times l_{edge}/2$ = **63.7** kN

Resultant moments and shears

Total moment (hogging and sagging); $M_{\Sigma edge}$ = **108.7** kNm

Maximum shear force; $V_{\Sigma edge}$ = **161.2** kN

Reinforcement required in top

Width of section in compression zone; $b_{edgetop} = b_{edge} + b_{boot}$ = **800** mm

Average web width; $b_w = b_{edge} + (h_{edge}/\tan(\alpha_{edge}))/2$ = **723** mm

K factor; $K_{edgetop} = M_{\Sigma edge}/(f_{cu} \times b_{edgetop} \times d_{edgetop}^2)$ = **0.013**

Lever arm; $z_{edgetop} = d_{edgetop} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{edgetop}/0.9)})$ = **518** mm

Area of steel required for bending; $A_{sedgetopbend} = M_{\Sigma edge}/((1.0/\gamma_s) \times f_y \times z_{edgetop})$ = **482** mm^2

Minimum area of steel required; $A_{sedgetopmin} = 0.0013 \times 1.0 \times b_w \times h_{edge}$ = **564** mm^2

Area of steel required; $A_{sedgetopreq} = \max(A_{sedgetopbend}, A_{sedgetopmin})$ = **564** mm^2

PASS - $A_{sedgetopreq}$ <= $A_{sedgetop}$ - Area of reinforcement provided in top of edge beams is adequate

Reinforcement required in bottom

Width of section in compression zone; $b_{edgebtm} = b_{edge} + (h_{edge} - h_{slab})/\tan(\alpha_{edge}) + 0.1 \times l_{edge}$ = **1157** mm

K factor; $K_{edgebtm} = M_{\Sigma edge}/(f_{cu} \times b_{edgebtm} \times d_{edgebtm}^2)$ = **0.009**

Lever arm; $z_{edgebtm} = d_{edgebtm} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{edgebtm}/0.9)})$ = **511** mm

Area of steel required for bending; $A_{sedgebtmbend} = M_{\Sigma edge}/((1.0/\gamma_s) \times f_y \times z_{edgebtm})$ = **489** mm^2

Minimum area of steel required; $A_{sedgebtmmin} = 0.0013 \times 1.0 \times b_w \times h_{edge}$ = **564** mm^2

Area of steel required; $A_{sedgebtmreq} = \max(A_{sedgebtmbend}, A_{sedgebtmmin}) = \mathbf{564}$ mm^2

PASS - $A_{sedgebtmreq}$ <= $A_{sedgebtm}$ - Area of reinforcement provided in bottom of edge beams is adequate

Edge beam shear check

Applied shear stress; $v_{edge} = V_{\Sigma edge}/(b_w \times d_{edgetop}) = \mathbf{0.409}$ N/mm^2

Tension steel ratio; $\rho_{edge} = 100 \times A_{sedgetop}/(b_w \times d_{edgetop}) = \mathbf{0.373}$

From BS8110-1:1997 - Table 3.8

Design concrete shear strength; $v_{cedge} = \mathbf{0.509}$ N/mm^2

v_{edge} <= v_{cedge} + 0.4N/mm^2 - Therefore minimum links required

Link area to spacing ratio required; $A_{sv}\_upon\_s_{vreqedge} = 0.4\text{N/mm}^2 \times b_w/((1.0/\gamma_s) \times f_{ys}) = \mathbf{0.665}$ mm

Link area to spacing ratio provided; $A_{sv}\_upon\_s_{vprovedge} = N_{edgelink} \times \pi \times \phi_{edgelink}^2/(4 \times s_{vedge}) = \mathbf{0.905}$ mm

PASS - $A_{sv}\_upon\_s_{vreqedge}$ <= $A_{sv}\_upon\_s_{vprovedge}$ - Shear reinforcement provided in edge beams is adequate

Boot design check

Effective cantilever span; $l_{boot} = b_{boot} + d_{boot}/2 = \mathbf{353}$ mm

Approximate ultimate bearing pressure; $q_{ult} = 1.55 \times q_{allow} = \mathbf{116.3}$ kN/m^2

Cantilever moment; $M_{boot} = q_{ult} \times l_{boot}^2/2 = \mathbf{7.2}$ kNm/m

Shear force; $V_{boot} = q_{ult} \times l_{boot} = \mathbf{41.0}$ kN/m

K factor; $K_{boot} = M_{boot}/(f_{cu} \times d_{boot}^2) = \mathbf{0.005}$

Lever arm; $z_{boot} = d_{boot} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{boot}/0.9)}) = \mathbf{196}$ mm

Area of reinforcement required; $A_{sbootreq} = M_{boot}/((1.0/\gamma_s) \times f_{yboot} \times z_{boot}) = \mathbf{85}$ mm^2/m

PASS - $A_{sbootreq}$ <= A_{sboot} - Area of reinforcement provided in boot is adequate for bending

Applied shear stress; $v_{boot} = V_{boot}/d_{boot} = \mathbf{0.199}$ N/mm^2

Tension steel ratio; $\rho_{boot} = 100 \times A_{sboot}/d_{boot} = \mathbf{0.098}$

From BS8110-1:1997 - Table 3.8

Design concrete shear strength; $v_{cboot} = \mathbf{0.384}$ N/mm^2

PASS - v_{boot} <= v_{cboot} - Shear capacity of the boot is adequate

Corner design checks

Basic loading

Corner load number 1

Load type; **Line load in x direction**

Dead load; $w_{Dcorner1} = \mathbf{13.2}$ kN/m

Live load; $w_{Lcorner1} = \mathbf{0.0}$ kN/m

Ultimate load; $w_{ultcorner1} = 1.4 \times w_{Dcorner1} + 1.6 \times w_{Lcorner1} = \mathbf{18.5}$ kN/m

Centroid of load from outside face of raft; $y_{corner1} = \mathbf{51}$ mm

Corner load number 2

Load type; **Line load in x direction**

Dead load; $w_{Dcorner2} = \mathbf{16.1}$ kN/m

Live load; $w_{Lcorner2} = \mathbf{5.6}$ kN/m

Ultimate load; $w_{ultcorner2} = 1.4 \times w_{Dcorner2} + 1.6 \times w_{Lcorner2} = \mathbf{31.5}$ kN/m

Centroid of load from outside face of raft; $y_{corner2} = \mathbf{230}$ mm

Corner load number 3

Load type;	**Line load in y direction**
Dead load;	$w_{Dcorner3}$ = **14.3** kN/m
Live load;	$w_{Lcorner3}$ = **0.0** kN/m
Ultimate load;	$w_{ultcorner3} = 1.4 \times w_{Dcorner3} + 1.6 \times w_{Lcorner3}$ = **20.0** kN/m
Centroid of load from outside face of raft;	$x_{corner3}$ = **51** mm
Corner load number 4	
Load type;	**Line load in y direction**
Dead load;	$w_{Dcorner4}$ = **11.7** kN/m
Live load;	$w_{Lcorner4}$ = **0.0** kN/m
Ultimate load;	$w_{ultcorner4} = 1.4 \times w_{Dcorner4} + 1.6 \times w_{Lcorner4}$ = **16.4** kN/m
Centroid of load from outside face of raft;	$x_{corner4}$ = **230** mm
Corner load number 5	
Load type;	**Line load in y direction**
Dead load;	$w_{Dcorner5}$ = **15.0** kN/m
Live load;	$w_{Lcorner5}$ = **0.0** kN/m
Ultimate load;	$w_{ultcorner5} = 1.4 \times w_{Dcorner5} + 1.6 \times w_{Lcorner5}$ = **21.0** kN/m
Centroid of load from outside face of raft;	$x_{corner5}$ = **230** mm

Corner bearing pressure check

Total uniform load at formation level;	$w_{udlcorner} = w_{Dudl}+w_{Ludl}+w_{edge}/b_{bearing}+w_{hcorethick}$ = **16.0** kN/m^2
Net bearing press avail to resist line/point loads;	$q_{netcorner} = q_{allow} - w_{udlcorner}$ = **59.0** kN/m^2

Total line/point loads

Total unfactored line load in x direction;	$w_{\Sigma linex}$ = **34.9** kN/m
Total ultimate line load in x direction;	$w_{\Sigma ultlinex}$ =**50.0** kN/m
Total unfactored line load in y direction;	$w_{\Sigma liney}$ = **41.0** kN/m
Total ultimate line load in y direction;	$w_{\Sigma ultliney}$ = **57.4** kN/m
Total unfactored point load;	$w_{\Sigma point}$ = **0.0** kN
Total ultimate point load;	$w_{\Sigma ultpoint}$ = **0.0** kN
Length of side of sq reqd to resist line/point loads;	$p_{corner} =[w_{\Sigma linex}+w_{\Sigma liney}+\sqrt{((w_{\Sigma linex}+w_{\Sigma liney})^2+4\times q_{netcorner}\times w_{\Sigma point})}]/(2\times q_{netcorner})$
	p_{corner} = **1286** mm

Bending moment about x-axis due to load/reaction eccentricity

Moment due to load 1 (x line);	$M_{x1} = \max(0\text{ kNm}, w_{ultcorner1} \times p_{corner} \times (p_{corner}/2 - y_{corner1}))$ = **14.1** kNm
Moment due to load 2 (x line);	$M_{x2} = \max(0\text{ kNm}, w_{ultcorner2} \times p_{corner} \times (p_{corner}/2 - y_{corner2}))$ = **16.7** kNm
Total moment about x axis;	$M_{\Sigma x}$ = **30.8** kNm

Bending moment about y-axis due to load/reaction eccentricity

Moment due to load 3 (y line);	$M_{y3} = \max(0\text{ kNm}, w_{ultcorner3} \times p_{corner} \times (p_{corner}/2 - x_{corner3}))$ = **15.2** kNm
Moment due to load 4 (y line);	$M_{y4} = \max(0\text{ kNm}, w_{ultcorner4} \times p_{corner} \times (p_{corner}/2 - x_{corner4}))$ = **8.7** kNm
Moment due to load 5 (y line);	$M_{y5} = \max(0\text{ kNm}, w_{ultcorner5} \times p_{corner} \times (p_{corner}/2 - x_{corner5}))$ = **11.1** kNm
Total moment about y axis;	$M_{\Sigma y}$ = **35.1** kNm

Check top reinforcement in edge beams for load/reaction eccentric moment

Max moment due to load/reaction eccentricity;	$M_{\Sigma} = \max(M_{\Sigma x}, M_{\Sigma y})$ = **35.1** kNm

Assume all of this moment is resisted by edge beam

From edge beam design checks away from corners

Moment due to edge beam spanning depression; $M_{\Sigma edge}$ = **108.7** kNm

Total moment to be resisted; $M_{\Sigma cornerbp} = M_{\Sigma} + M_{\Sigma edge}$ = **143.7** kNm

Width of section in compression zone; $b_{edgetop} = b_{edge} + b_{boot}$ = **800** mm

K factor; $K_{cornerbp} = M_{\Sigma cornerbp}/(f_{cu} \times b_{edgetop} \times d_{edgetop}^2)$ = **0.017**

Lever arm; $z_{cornerbp} = d_{edgetop} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{cornerbp}/0.9)})$ = **518** mm

Total area of top steel required; $A_{scornerbp} = M_{\Sigma cornerbp} /((1.0/\gamma_s) \times f_y \times z_{cornerbp})$ = **638** mm²

PASS - $A_{scornerbp}$ <= $A_{sedgetop}$ - Area of reinforcement provided to resist eccentric moment is adequate

The allowable bearing pressure at the corner will not be exceeded

Corner beam bending check

Cantilever span of edge beam; $l_{corner} = \phi_{depthick}/\sqrt{(2)} + d_{edgetop}/2$ = **2748** mm

Moment and shear due to self weight

Ultimate self weight udl; $w_{edgeult} = 1.4 \times w_{edge}$ = **16.1** kN/m

Average ultimate slab udl (approx); $w_{cornerslab} = \max(0\ kN/m, 1.4 \times w_{slab} \times (\phi_{depthick}/(\sqrt{(2)} \times 2) - (b_{edge} + (h_{edge} - h_{slab})/\tan(\alpha_{edge}))))$

$w_{cornerslab}$ = **4.1** kN/m

Self weight and slab bending moment; $M_{cornersw} = (w_{edgeult} + w_{cornerslab}) \times l_{corner}^2/2$ = **76.1** kNm

Self weight and slab shear force; $V_{cornersw} = (w_{edgeult} + w_{cornerslab}) \times l_{corner}$ = **55.4** kN

Moment and shear due to udls

Maximum ultimate udl; $w_{cornerudl} = ((1.4 \times w_{Dudl}) + (1.6 \times w_{Ludl})) \times \phi_{depthick}/\sqrt{(2)}$ = **16.8** kN/m

Bending moment; $M_{cornerudl} = w_{cornerudl} \times l_{corner}^2/6$ = **21.2** kNm

Shear force; $V_{cornerudl} = w_{cornerudl} \times l_{corner}/2$ = **23.1** kN

Moment and shear due to line loads in x direction

Bending moment; $M_{cornerlinex} = w_{\Sigma ultlinex} \times l_{corner}^2/2$ = **188.7** kNm

Shear force; $V_{cornerlinex} = w_{\Sigma ultlinex} \times l_{corner}$ = **137.3** kN

Moment and shear due to line loads in y direction

Bending moment; $M_{cornerliney} = w_{\Sigma ultliney} \times l_{corner}^2/2$ = **216.7** kNm

Shear force; $V_{cornerliney} = w_{\Sigma ultliney} \times l_{corner}$ = **157.7** kN

Total moments and shears due to point loads

Bending moment about x axis; $M_{cornerpointx}$ = **0.0** kNm

Bending moment about y axis; $M_{cornerpointy}$ = **0.0** kNm

Shear force; $V_{cornerpoint}$ = **0.0** kN

Resultant moments and shears

Total moment about x axis; $M_{\Sigma cornerx} = M_{cornersw} + M_{cornerudl} + M_{cornerliney} + M_{cornerpointx}$ = **313.9** kNm

Total shear force about x axis; $V_{\Sigma cornerx} = V_{cornersw} + V_{cornerudl} + V_{cornerliney} + V_{cornerpoint}$ = **236.2** kN

Total moment about y axis; $M_{\Sigma cornery} = M_{cornersw} + M_{cornerudl} + M_{cornerlinex} + M_{cornerpointy}$ = **285.9** kNm

Total shear force about y axis; $V_{\Sigma cornery} = V_{cornersw} + V_{cornerudl} + V_{cornerlinex} + V_{cornerpoint}$ = **215.8** kN

Deflection of both edge beams at corner will be the same therefore design for average of these moments and shears

Design bending moment; $M_{\Sigma corner} = (M_{\Sigma cornerx} + M_{\Sigma cornery})/2$ = **299.9** kNm

Design shear force; $V_{\Sigma corner} = (V_{\Sigma cornerx} + V_{\Sigma cornery})/2 =$ **226.0** kN

Reinforcement required in top of edge beam

K factor; $K_{corner} = M_{\Sigma corner}/(f_{cu} \times b_{edgetop} \times d_{edgetop}^2) =$ **0.036**

Lever arm; $z_{corner} = d_{edgetop} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{corner}/0.9)}) =$ **518** mm

Area of steel required for bending; $A_{scornerbend} = M_{\Sigma corner}/((1.0/\gamma_s) \times f_y \times z_{corner}) =$ **1331** mm^2

Minimum area of steel required; $A_{scornermin} = A_{sedgetopmin} =$ **564** mm^2

Area of steel required; $A_{scorner} = \max(A_{scornerbend}, A_{scornermin}) =$ **1331** mm^2

PASS - $A_{scorner}$ <= $A_{sedgetop}$ - Area of reinforcement provided in top of edge beams at corners is adequate

Corner beam shear check

Average web width; $b_w = b_{edge} + (h_{edge}/\tan(\alpha_{edge}))/2 =$ **723** mm

Applied shear stress; $v_{corner} = V_{\Sigma corner}/(b_w \times d_{edgetop}) =$ **0.573** N/mm^2

Tension steel ratio; $\rho_{corner} = 100 \times A_{sedgetop}/(b_w \times d_{edgetop}) =$ **0.373**

From BS8110-1:1997 - Table 3.8

Design concrete shear strength; $v_{ccorner} =$ **0.471** N/mm^2

v_{corner} <= $v_{ccorner}$ + 0.4N/mm^2 - Therefore minimum links required

Link area to spacing ratio required; $A_{sv}\_upon\_s_{vreqcorner} = 0.4\text{N/mm}^2 \times b_w/((1.0/\gamma_s) \times f_{ys}) =$ **0.665** mm

Link area to spacing ratio provided; $A_{sv}\_upon\_s_{vprovedge} = N_{edgelink} \times \pi \times \phi_{edgelink}^2/(4 \times s_{vedge}) =$ **0.905** mm

PASS - $A_{sv}\_upon\_s_{vreqcorner}$ <= $A_{sv}\_upon\_s_{vprovedge}$ - Shear reinforcement provided in edge beams at corners is adequate

Corner beam deflection check

Basic allowable span to depth ratio; $Ratio_{basiccorner} =$ **7.0**

Moment factor; $M_{factorcorner} = M_{\Sigma corner}/(b_{edgetop} \times d_{edgetop}^2) =$ **1.260** N/mm^2

Steel service stress; $f_{scorner} = 2/3 \times f_y \times A_{scornerbend}/A_{sedgetop} =$ **301.285** N/mm^2

Modification factor; $MF_{corner}=\min(2.0,0.55+[(477\text{N/mm}^2-f_{scorner})/(120\times(0.9\text{N/mm}^2+M_{factorcorner}))])$

$MF_{corner} =$ **1.228**

Modified allowable span to depth ratio; $Ratio_{allowcorner} = Ratio_{basiccorner} \times MF_{corner} =$ **8.596**

Actual span to depth ratio; $Ratio_{actualcorner} = l_{corner}/ d_{edgetop} =$ **5.037**

PASS - $Ratio_{actualcorner}$ <= $Ratio_{allowcorner}$ - Edge beam span to depth ratio is adequate

Internal beam design checks

Basic loading

Hardcore; $w_{hcorethick} = \gamma_{hcore} \times h_{hcorethick} =$ **0.0** kN/m^2

Internal beam self weight; $w_{int}=24\text{ kN/m}^3\times[(h_{int}\times b_{int})+(h_{int}-h_{slab})^2/\tan(\alpha_{int})+2\times h_{slab}\times(h_{int}-h_{slab})/\tan(\alpha_{int})]$

$w_{int} =$ **9.9** kN/m

Internal beam load number 1

Load type; **Longitudinal line load**

Dead load; $w_{Dint1} =$ **15.0** kN/m

Live load; $w_{Lint1} =$ **5.3** kN/m

Ultimate load; $w_{ultint1} = 1.4 \times w_{Dint1} + 1.6 \times w_{Lint1} =$ **29.5** kN/m

Longitudinal line load width; $b_{int1} =$ **140** mm

Centroid of load from centreline of beam; $x_{int1} =$ **0** mm

Internal beam load number 2

Load type;	**Full transverse line load**;
Dead load;	w_{Dint2} = **10.0** kN/m
Live load;	w_{Lint2} = **4.0** kN/m
Ultimate load;	$w_{ultint2} = 1.4 \times w_{Dint2} + 1.6 \times w_{Lint2}$ = **20.4** kN/m
Transverse line load width;	b_{int2} = **140** mm

Internal beam bearing pressure check

Total uniform load at formation level;	$w_{udlint} = w_{DudI}+w_{LudI}+w_{hcorethick}+24kN/m^3 \times h_{int}$ = **17.7** kN/m^2

Effective point load due to transverse line/point loads

Effective point load due to load 2 (Line load);	$W_{int2} = w_{ultint2} \times [b_{int} + 2\times(h_{int} - h_{slab})/\tan(\alpha_{int})]$ = **17.3** kN
Total effective point load;	W_{int} = **17.3** kN
Minimum width of effective point load;	b_{intmin} = **140** mm

Approximate longitudinal dispersal of effective point load

Approx moment capacity of bottom steel;	$M_{intbtm} = (1.0/\gamma_s) \times f_y \times 0.9 \times d_{intbtm} \times A_{sintbtm}$ = **279.8** kNm
Max allow dispersal based on moment capacity;	$p_{intmom} = [2\times M_{intbtm} + \sqrt{(4\times M_{intbtm}^2+2\times W_{int}\times M_{intbtm}\times b_{intmin})}]/W_{int}$
	p_{intmom} = **64880** mm
Limiting max dispersal to say 5 x beam depth;	$p_{int} = \min(p_{intmom}, 5 \times h_{int})$ = 2750 mm
Total dispersal length of effective point load;	$l_{inteff} = 2 \times p_{int} + b_{intmin}$ = **5640** mm

Equivalent and total beam line loads

Equivalent ultimate udl of internal load 2;	$w_{intudl2} = W_{int2}/l_{inteff}$ = **3.1** kN/m
Equivalent unfactored udl of internal load 2;	$w_{intudl2sls} = w_{intudl2} \times (w_{Dint2} + w_{Lint2})/w_{ultint2}$ = **2.1** kN/m
Sum of factored longitud'l and eff'tive line loads;	ΣUDL_{int} = **32.5** kN/m
Sum of unfactored longitud'l and eff'tive line loads;	$\Sigma UDLsls_{int}$ = **22.4** kN/m

Centroid of loads from centreline of internal beam

Load x distance for internal load 1;	$Moment_{int1} = w_{ultint1} \times x_{int1}$ = **0.0** kN
Sum of load x distances;	$\Sigma Moment_{int}$ = **0.0** kN
Centroid of loads;	$x_{barint} = \Sigma Moment_{int}/\Sigma UDL_{int}$ = **0.0** mm
Moment due to eccentricity to be resisted by slab;	$M_{eccint} = \Sigma UDL_{int} \times abs(x_{barint})$ = **0.0** kNm/m

Assume moment due to eccentricity is resisted equally by top steel of slab on one side and bottom steel of slab on other

From slab bending check

Moment due to depression under slab (hogging);	$M_{\Sigma e}$ = **7.2** kNm/m
Total moment to be resisted by slab top steel;	$M_{slabtopint} = M_{eccint}/2 + M_{\Sigma e}$ = **7.2** kNm/m
K factor;	$K_{slabtopint} = M_{slabtopint}/(f_{cu} \times d_{tslabmin}^2)$ = **0.004**
Lever arm;	$z_{slabtopint} = d_{tslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabtopint}/0.9)})$ = **204** mm
Area of steel required;	$A_{sslabtopintreq} = M_{slabtopint}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabtopint})$ = **82** mm^2/m

PASS - $A_{sslabtopintreq}$ <= $A_{sslabtop}$ - Area of reinforcement in top of slab is adequate to transfer moment into slab

Mt to be resisted by slab btm stl due to load ecc'ty;	$M_{slabbtmint} = M_{eccint}/2$ = **0.0** kNm/m
K factor;	$K_{slabbtmint} = M_{slabbtmint}/(f_{cu} \times d_{bslabmin}^2)$ = **0.000**
Lever arm;	$z_{slabbtmint} = d_{bslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25-K_{slabbtmint}/0.9)})$ = **185** mm
Area of steel required in bottom;	$A_{sslabbtmintreq} = M_{slabbtmint}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabbtmint})$ = **0** mm^2/m

PASS - $A_{sslabbtmintreq}$ <= $A_{sslabbtm}$ - Area of reinforcement in bottom of slab is adequate to transfer moment into slab

Bearing pressure

Initially check bearing pressure based on beam soffit/chamfer width only

Allowable bearing width; $b_{bearint} = b_{int} + 2 \times (h_{int} - h_{slab})/\tan(\alpha_{int})$ = **846** mm

Bearing pressure due to line/point loads; $q_{linepointint} = \Sigma UDLsls_{int}/b_{bearint}$ = **26.5** kN/m^2

Total applied bearing pressure; $q_{int} = q_{linepointint} + w_{udlint}$ = **44.2** kN/m^2

PASS - q_{int} <= q_{allow} - Allowable bearing pressure is not exceeded

Internal beam bending check

Divider for moments due to udl's; β_{udl} = **12.0**

Divider for moments due to point loads; β_{point} = **7.0**

Applied bending moments

Span of internal beam; $l_{int} = \phi_{depthick} + d_{inttop}$ = **3998** mm

Ultimate self weight udl; $w_{intult} = 1.4 \times w_{int}$ = **13.9** kN/m

Ultimate slab udl (approx); $w_{intslab} = \max(0\ \text{kN/m}, 1.4 \times w_{slab} \times ((\phi_{depthick} \times 3/4) - (b_{int} + 2 \times (h_{int} - h_{slab})/\tan(\alpha_{int}))))$

$w_{intslab}$ = **14.9** kN/m

Self weight and slab bending moment; $M_{intsw} = (w_{intult} + w_{intslab}) \times l_{int}^2/\beta_{udl}$ = **38.4** kNm

Self weight shear force; $V_{intsw} = (w_{intult} + w_{intslab}) \times l_{int}/2$ = **57.6** kN

Moments due to applied uniformly distributed loads

Ultimate udl (approx); $w_{intudl} = w_{udlult} \times \phi_{depthick} \times 3/4$ = **17.9** kN/m

Bending moment; $M_{intudl} = w_{intudl} \times l_{int}^2/\beta_{udl}$ = **23.8** kNm

Shear force; $V_{intudl} = w_{intudl} \times l_{int}/2$ = **35.7** kN

Moment and shear due to load number 1

Bending moment; $M_{int1} = w_{ultint1} \times l_{int}^2/\beta_{udl}$ = **39.3** kNm

Shear force; $V_{int1} = w_{ultint1} \times l_{int}/2$ = **58.9** kN

Moment and shear due to load number 2

Ultimate point load; $W_{int2} = w_{ultint2} \times \phi_{depthick} \times 3/4$ = **53.6** kN

Bending moment; $M_{int2} = W_{int2} \times l_{int}/\beta_{point}$ = **30.6** kNm

Shear force; $V_{int2} = W_{int2}$ = **53.6** kN

Resultant moments and shears

Total moment (hogging and sagging); $M_{\Sigma int}$ = **132.0** kNm

Maximum shear force; $V_{\Sigma int}$ = **205.8** kN

Reinforcement required in top

Width of section in compression zone; $b_{inttop} = b_{int}$ = **500** mm

Average web width; $b_{wint} = b_{int} + h_{int}/\tan(\alpha_{int})$ = **818** mm

K factor; $K_{inttop} = M_{\Sigma int}/(f_{cu} \times b_{inttop} \times d_{inttop}^2)$ = **0.030**

Lever arm; $z_{inttop} = d_{inttop} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{inttop}/0.9)})$ = **473** mm

Area of steel required for bending; $A_{sinttopbend} = M_{\Sigma int}/((1.0/\gamma_s) \times f_y \times z_{inttop})$ = **642** mm^2

Minimum area of steel; $A_{sinttopmin} = 0.0013 \times b_{wint} \times h_{int}$ = **585** mm^2

Area of steel required; $A_{sinttopreq} = \max(A_{sinttopbend}, A_{sinttopmin})$ = **642** mm^2

PASS - $A_{sinttopreq}$ <= $A_{sinttop}$ - Area of reinforcement provided in top of internal beams is adequate

Reinforcement required in bottom

Width of section in compression zone; $b_{intbtm} = b_{int} + 2 \times (h_{int} - h_{slab})/\tan(\alpha_{int}) + 0.2 \times l_{int}$ = **1646** mm

K factor; $K_{intbtm} = M_{\Sigma int}/(f_{cu} \times b_{intbtm} \times d_{intbtm}^2)$ = **0.010**

Lever arm; $z_{intbtm} = d_{intbtm} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{intbtm}/0.9)})$ = **461** mm

Area of steel required for bending; $A_{sintbtmbend} = M_{\Sigma int}/((1.0/\gamma_s) \times f_y \times z_{intbtm})$ = **658** mm^2

Minimum area of steel required; $A_{sintbtmmin} = 0.0013 \times 1.0 \times b_{wint} \times h_{int}$ = **585** mm^2

Area of steel required; $A_{sintbtmreq} = \max(A_{sintbtmbend}, A_{sintbtmmin})$ = **658** mm^2

PASS - $A_{sintbtmreq}$ <= $A_{sintbtm}$ - Area of reinforcement provided in bottom of internal beams is adequate

Internal beam shear check

Applied shear stress; $v_{int} = V_{\Sigma int}/(b_{wint} \times d_{inttop})$ = **0.506** N/mm^2

Tension steel ratio; $\rho_{int} = 100 \times A_{sinttop}/(b_{wint} \times d_{inttop})$ = **0.362**

From BS8110-1:1997 - Table 3.8

Design concrete shear strength; v_{cint} = **0.477** N/mm^2

v_{int} <= v_{cint} + 0.4N/mm² - Therefore minimum links required

Link area to spacing ratio required; $A_{sv\_upon\_s_{vreqint}} = 0.4N/mm^2 \times b_{wint}/((1.0/\gamma_s) \times f_{ys})$ = **0.752** mm

Link area to spacing ratio provided; $A_{sv\_upon\_s_{vprovint}} = N_{intlink} \times \pi \times \phi_{intlink}^2/(4 \times s_{vint})$ = **1.005** mm

PASS - $A_{sv\_upon\_s_{vreqint}}$ <= $A_{sv\_upon\_s_{vprovint}}$ - Shear reinforcement provided in internal beams is adequate

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