Hudds Design
Structural & Architectural Engineering
DESIGN CONSULTANTS

PLANNING AND BUILDING CONTROL; CALCULATIONS & DRAWINGS

Office: 103-105 Bradford Road
Huddersfield, HD1 6DZ
Office: 01484 941051
Web: www.huddsdesign.com
Email: eng@huddsdesign.com

STRUCTURAL CALCULATIONS

FOR

MR S. WEBBER
@

BROOMROYD, BARNSLEY, S70 5ES.

Design Summary: (See Sheet A1)

Notes:

- **Package for raft foundation only as shown in plans.**
- All Internal Walls to be timber partition only.
- Refer to SI 00237, Lyons CMC Coal Mining & Geotechnical Consultancy for soil investigation report.
- All dimensions to be confirmed and checked by builder on site prior to works commencing and materials being ordered.
- All steel to be minimum high yield grade 500N/mm^2
- Minimum C30 Concrete
- Minimum 40mm Cover to all reinforcement
- DPM to others' details
- All ground conditions to approval of local authority before foundations commence
- All temporary support works to builder/contractor's specification
- Hudds Design has not been appointed as CDM coordinator and is the responsibility of the builder.

ISSUED FOR BUILDING CONTROL APPROVAL: **16th November 2020**
HUDDS DESIGN **Ref: HD-S20-1112**

SHEET A1

Refer to sketch mark ups for references
Refer to Architects drawings for dimensions

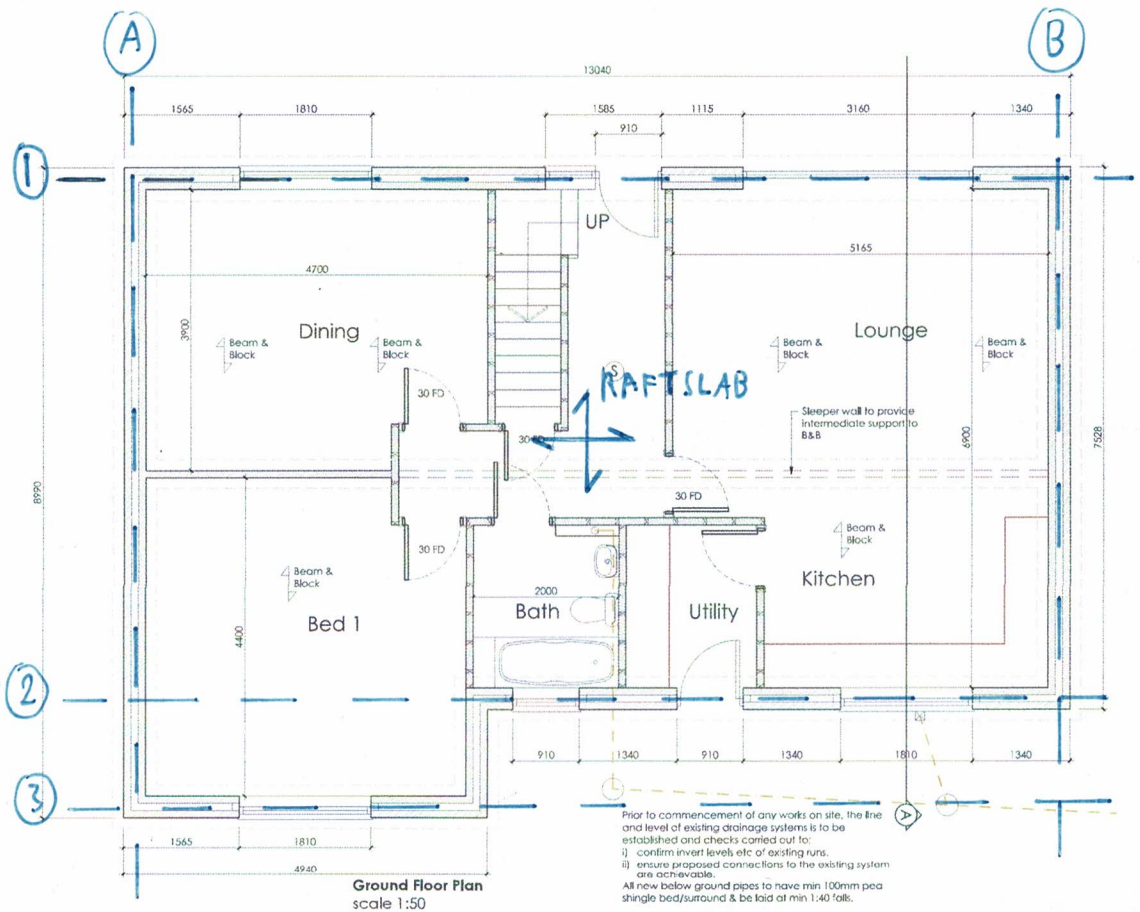
DESIGN SUMMARY

'Raft Foundation' **Refer to Sketch**
200mm Thick Reinforced Concrete Raft Slab
2 Layers A393 Mesh Top **and** Bottom (2 Top & 2 Bottom) or
Use 1 Layer B785 Mesh Top and Bottom
Min Grade C30 Concrete
Min 40mm Cover

eng@huddsdesign.com
www.huddsdesign.com

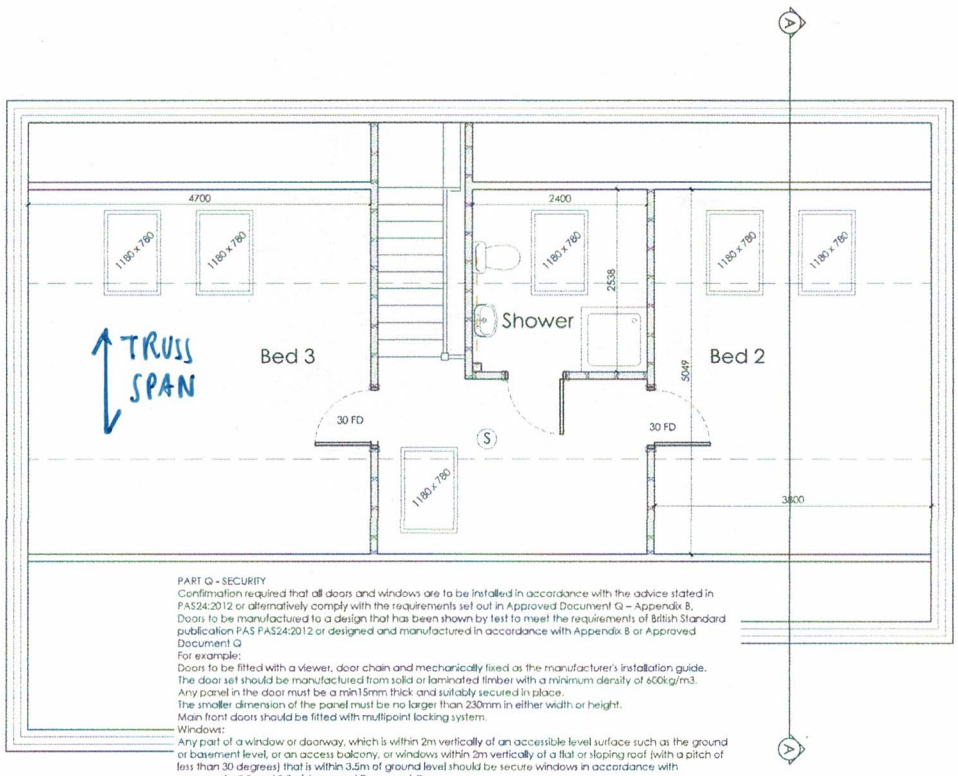
HD-520-1112 (A2)

PROPOSED FOUNDATION PLAN (NTS)



Ground Floor Plan
scale 1:50

Prior to commencement of any works on site, the line and level of existing drainage systems is to be established and checks carried out to:
i) confirm invert levels etc of existing runs.
ii) ensure proposed connections to the existing system are achievable.
All new below ground pipes to have min 100mm pea shingle bed/surround & be laid at min 1:40 falls.



First Floor Plan
scale 1:50

PART Q - SECURITY
Confirmation required that all doors and windows are to be installed in accordance with the advice stated in PAS24:2012 or alternatively comply with the requirements set out in Approved Document Q – Appendix B.
Doors to be manufactured to a design that has been shown by test to meet the requirements of British Standard publication PAS PAS24:2012 or designed and manufactured in accordance with Appendix B or Approved Document Q
For example:
Doors to be fitted with a viewer, door chain and mechanically fixed as the manufacturer's installation guide.
The door set should be manufactured from solid or laminated timber with a minimum density of 600kg/m3.
Any panel in the door must be a min15mm thick and suitably secured in place.
The smaller dimension of the panel must be no larger than 230mm in either width or height.
Main front doors should be fitted with multipoint locking system.
Windows:
Any part of a window or doorway, which is within 2m vertically of an accessible level surface such as the ground or basement level, or an access balcony, or windows within 2m vertically of a flat or sloping roof (with a pitch of less than 30 degrees) that is within 3.5m of ground level should be secure windows in accordance with paragraphs 2.2 and 2.3 of Approved Document Q.
Windows to be made to a design that has been shown by test to meet the security requirements of British Standards publication PAS 24:2012
Frames to be mechanically fixed to the structure of the building in accordance with manufacturer's installation instruction

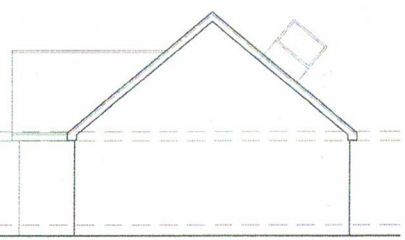
NOTE: ALL INTERNAL WALLS ARE TIMBER PARTITION ONLY

HD-S20-1112 (A3)

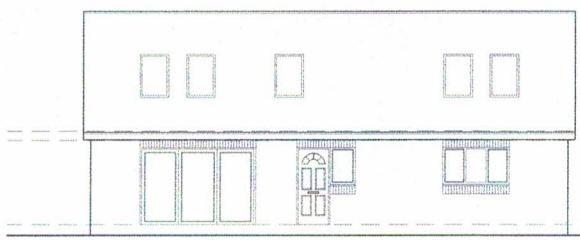
PROPOSED ELEVATIONS (NTS)



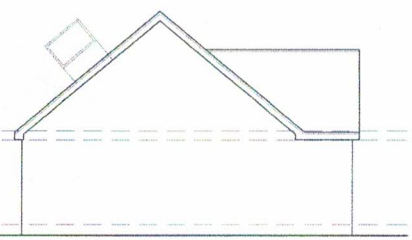
Proposed Front Elevation
scale 1:100



Proposed Side Elevation
scale 1:100



Proposed Rear Elevation
scale 1:100



Proposed Side Elevation
scale 1:100

PROVED DOCUMENT P

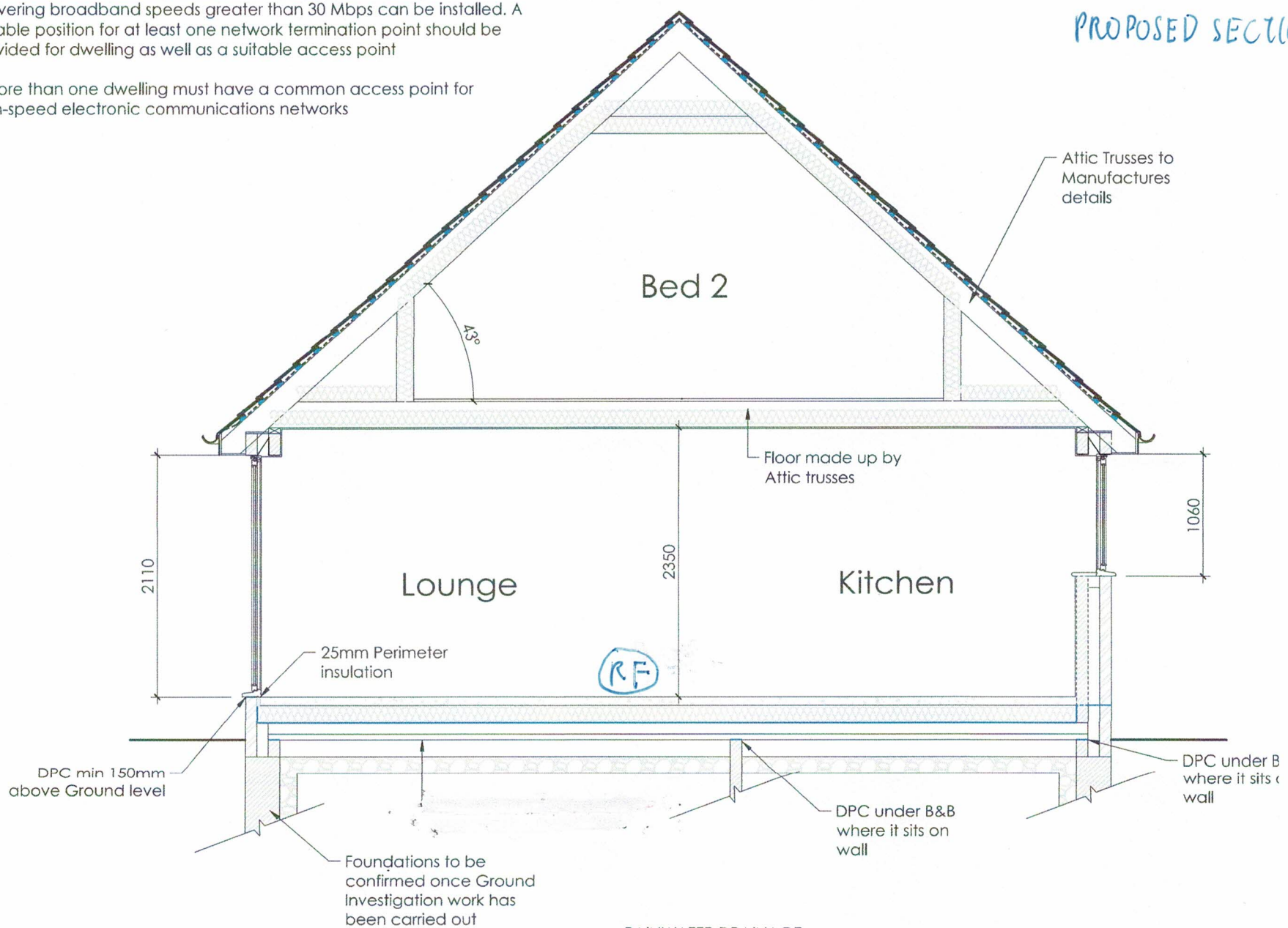
SMOKE DETECTION
Mains operated linked smoke alarm detection system to BS EN 14604 and BS 5839-6:2019 to at least a Grade D category LD3

UNDERGROUND FOUL DRAINAGE
Underground drainage to consist of 100mm diameter UPVC proprietary pipe work to give a 1:40 fall. Surround pipes in 100mm pea shingle.

infrastructure, up to a network termination point for high-speed electronic communications networks.
So that copper or fibre-optic cables or wireless devices capable of delivering broadband speeds greater than 30 Mbps can be installed. A suitable position for at least one network termination point should be provided for dwelling as well as a suitable access point

If more than one dwelling must have a common access point for high-speed electronic communications networks

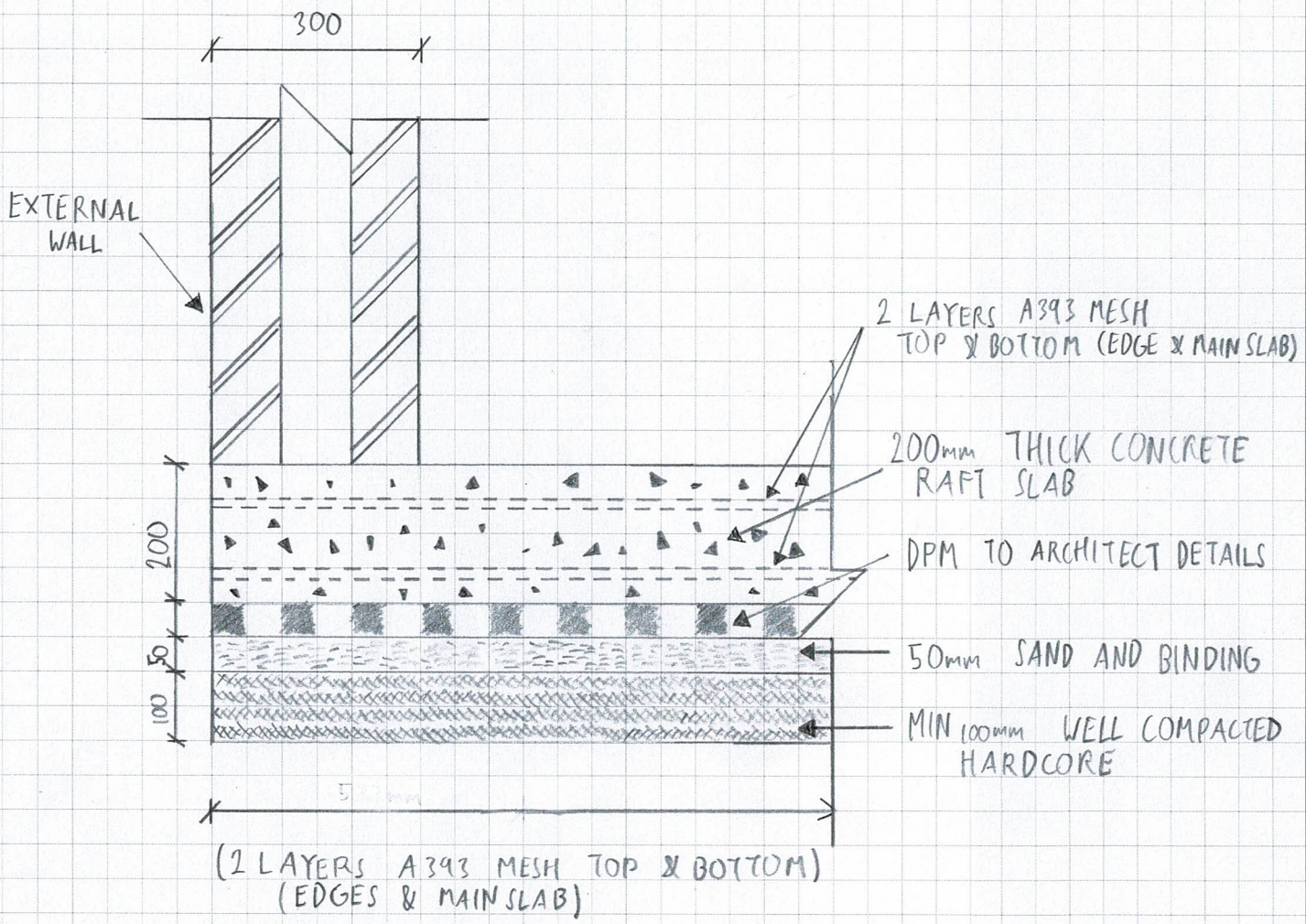
HD-S20-1112 (A4)
PROPOSED SECTION (NTS)



Section A-A
scale 1:100

RAINWATER DRAINAGE
Rainwater goods to be new 110mm UPVC half round gutters taken and connected into 68mm dia UPVC downpipes. Rainwater taken to new soakaway, situated a min distance of 5.0m away from any building, via 110mm dia UPVC pipes surrounded in 150mm granular fill. Soakaway to be min of 1 cubic metre capacity (or to depth to Local Authorities approval) with suitable granular fill with geotextile surround to prevent

RAFT FOUNDATION SKETCH (NTS)



NOTES

- ALL CONCRETE MIN C30
- ALL REINFORCEMENT HIGH YIELD 500N/mm² STEEL
- MIN 40mm COVER TO ALL REINFORCEMENTS

SECTION (NTS)

STRUCTURAL CALCULATIONS

Address: **Broomroyd, Barnsley, S70 5ES.**

Calculations for:

Raft Foundation Design.

DESIGN LOADINGS

Walls

Inner Skin → 0.1 x 20 kN/m^3 = 2.0 kN/m^2 – **(Block)**

Outer Skin → 0.1 x 20 kN/m^3 = 2.0 kN/m^2 – **(Brick)**

Total = 4.0 kN/m^2

Roof – (Tiles)

Dead Loads = 1.3 kN/m^2

Imposed Loads = 0.8 kN/m^2

Total = 2.1 kN/m^2

Floor – (Timber)

Dead Loads = 1.0 kN/m^2 (Allow for additional timber stud partition load)

Imposed Loads = 1.5 kN/m^2

Total = 2.5 kN/m^2

Floor – (Raft Slab)

Dead Loads = 1.2 kN/m^2 (Additional Self-Weight Included)

Imposed Loads = 1.5 kN/m^2

Total = 2.7 kN/m^2

Hudds Design
Structural Engineering Consultants
www.huddsdesign.com

Project: BROOMROYD, BARNSLEY, S70 5BS				Job No. HD-S20-1112	
Calcs for: FOUNDATION LINE LOADS				Start Page: FL-1	Rev:
Calcs by: JT	Calcs Date: 13/11/2020	Checked:	Checked Date:	Approved:	Approved Date:

FOUNDATION LINE LOADS

GRID 1/2/3 (WORST CASE)

WALL DEAD LOAD =	2.8m	×	4.0kN/m²	= 11.2kN/m	}	21.2kN/m
ROOF DEAD LOAD =	5.0m	×	1.3kN/m²	= 6.5kN/m		
FLOOR DEAD LOAD =	3.5m	×	1.0kN/m²	= 3.5kN/m		
ROOF IMPOSED LOAD =	5.0m	×	0.8kN/m²	= 4.0kN/m	}	9.3kN/m
FLOOR IMPOSED LOAD =	3.5m	×	1.5kN/m²	= 5.3kN/m		

GRID A/B

GABLE DEAD LOAD =	0.5 × 3.3m	×	4.0kN/m²	= 6.6kN/m	}	17.8kN/m
WALL DEAD LOAD =	2.8m	×	4.0kN/m²	= 11.2kN/m		

USE LOADS GRID 2/3 LOADS TO DESIGN RAFT SLAB

RAFT FOUNDATION => WORST CASE LOADING

MAX SPAN = 13300mm

LOAD ON RAFT (WORST CASE)

TOTAL DEAD LOAD = 21.2 kN/m

TOTAL IMPOSED LOAD = 9.3kN/m

SEE CALC FL-1 FOR DERIVATION OF LOADS ABOVE

USE 200mm RC RAFT SLAB

WITH 2 LAYERS A393 MESH TOP & BOTTOM

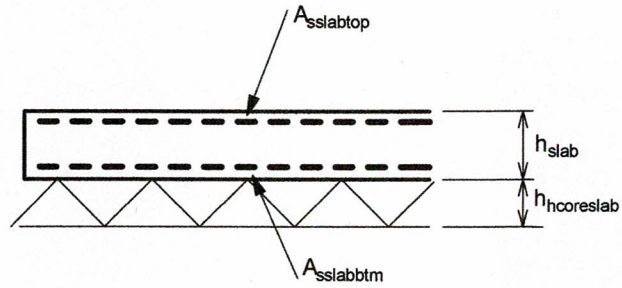
(MIN GRADE C30) => 40mm COVER

(SEE CALC RF)

PROVIDE 2 LAYERS A393 MESH TOP & BOTTOM TO EDGES

RAFT FOUNDATION DESIGN (BS8110 : PART 1 : 1997)

Tedds calculation version 1.0.12



Soil and raft definition

Soil definition

Allowable bearing pressure	q_{allow} = **25.0** kN/m^2
Number of types of soil forming sub-soil	**One type only**
Soil density	**Firm to loose**
Depth of hardcore beneath slab	$h_{hcoreslab}$ = **100** mm (Dispersal allowed for bearing pressure check)
Density of hardcore	γ_{hcore} = **20.0** kN/m^3
Basic assumed diameter of local depression	$\phi_{depbasic}$ = **2000**mm
Diameter under slab modified for hardcore	$\phi_{depslab} = \phi_{depbasic} - h_{hcoreslab}$ = **1900** mm

Raft slab definition

Max dimension/max dimension between joints	l_{max} = **13.300** m
Slab thickness	h_{slab} = **200** mm
Concrete strength	f_{cu} = **25** 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	**2 x A393 ($A_{sslabtop}$ = 786 mm^2/m)**
Mesh provided in bottom	**2 x A393 ($A_{sslabbtm}$ = 786 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} = **40** mm
Cover to bottom reinforcement	c_{btm} = **40** mm
Average effective depth of top reinforcement	$d_{tslabav} = h_{slab} - c_{top} - \phi_{slabtop}$ = **150** mm
Average effective depth of bottom reinforcement	$d_{bslabav} = h_{slab} - c_{btm} - \phi_{slabbtm}$ = **150** mm
Overall average effective depth	$d_{slabav} = (d_{tslabav} + d_{bslabav})/2$ = **150** mm
Minimum effective depth of top reinforcement	$d_{tslabmin} = d_{tslabav} - \phi_{slabtop}/2$ = **145** mm
Minimum effective depth of bottom reinforcement	$d_{bslabmin} = d_{bslabav} - \phi_{slabbtm}/2$ = **145** mm

Slab edge reinforcement

Mesh provided in top	**2 x A393 ($A_{sedgetop}$ = 786 mm^2/m)**
Mesh provided in bottom	**2 x A393 ($A_{sedgebtm}$ = 786 mm^2/m)**

Internal slab design checks

Basic loading

Slab self weight — $w_{slab} = 24\ kN/m^3 \times h_{slab} = \mathbf{4.8}\ kN/m^2$

Hardcore — $w_{hcoreslab} = \gamma_{hcore} \times h_{hcoreslab} = \mathbf{2.0}\ kN/m^2$

Applied loading

Uniformly distributed dead load — $w_{Dudl} = \mathbf{1.2}\ kN/m^2$

Uniformly distributed live load — $w_{Ludl} = \mathbf{1.5}\ kN/m^2$

Internal slab bearing pressure check

Total uniform load at formation level — $w_{udl} = w_{slab} + w_{hcoreslab} + w_{Dudl} + w_{Ludl} = \mathbf{9.5}\ kN/m^2$

PASS - w_{udl} <= q_{allow} - Applied bearing pressure is less than allowable

Internal slab bending and shear check

Applied bending moments

Span of slab — $l_{slab} = \phi_{depslab} + d_{tslabav} = \mathbf{2050}\ mm$

Ultimate self weight udl — $w_{swult} = 1.4 \times w_{slab} = \mathbf{6.7}\ kN/m^2$

Self weight moment at centre — $M_{csw} = w_{swult} \times l_{slab}^2 \times (1 + \nu) / 64 = \mathbf{0.5}\ kNm/m$

Self weight moment at edge — $M_{esw} = w_{swult} \times l_{slab}^2 / 32 = \mathbf{0.9}\ kNm/m$

Self weight shear force at edge — $V_{sw} = w_{swult} \times l_{slab} / 4 = \mathbf{3.4}\ kN/m$

Moments due to applied uniformly distributed loads

Ultimate applied udl — $w_{udlult} = 1.4 \times w_{Dudl} + 1.6 \times w_{Ludl} = \mathbf{4.1}\ kN/m^2$

Moment at centre — $M_{cudl} = w_{udlult} \times l_{slab}^2 \times (1 + \nu) / 64 = \mathbf{0.3}\ kNm/m$

Moment at edge — $M_{eudl} = w_{udlult} \times l_{slab}^2 / 32 = \mathbf{0.5}\ kNm/m$

Shear force at edge — $V_{udl} = w_{udlult} \times l_{slab} / 4 = \mathbf{2.1}\ kN/m$

Resultant moments and shears

Total moment at edge — $M_{\Sigma e} = \mathbf{1.4}\ kNm/m$

Total moment at centre — $M_{\Sigma c} = \mathbf{0.9}\ kNm/m$

Total shear force — $V_{\Sigma} = \mathbf{5.5}\ kN/m$

Reinforcement required in top

K factor — $K_{slabtop} = M_{\Sigma e}/(f_{cu} \times d_{tslabav}^2) = \mathbf{0.003}$

Lever arm — $z_{slabtop} = d_{tslabav} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabtop}/0.9)}) = \mathbf{142.5}\ mm$

Area of steel required for bending — $A_{sslabtopbend} = M_{\Sigma e}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabtop}) = \mathbf{23}\ mm^2/m$

Minimum area of steel required — $A_{sslabmin} = 0.0013 \times h_{slab} = \mathbf{260}\ mm^2/m$

Area of steel required — $A_{sslabtopreq} = \max(A_{sslabtopbend}, A_{sslabmin}) = \mathbf{260}\ mm^2/m$

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

Reinforcement required in bottom

K factor — $K_{slabbtm} = M_{\Sigma c}/(f_{cu} \times d_{bslabav}^2) = \mathbf{0.002}$

Lever arm — $z_{slabbtm} = d_{bslabav} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabbtm}/0.9)}) = \mathbf{142.5}\ mm$

Area of steel required for bending — $A_{sslabbtmbend} = M_{\Sigma c}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabbtm}) = \mathbf{14}\ mm^2/m$

Area of steel required — $A_{sslabbtmreq} = \max(A_{sslabbtmbend}, A_{sslabmin}) = \mathbf{260}\ mm^2/m$

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

Shear check

Applied shear stress — $v = V_{\Sigma}/d_{tslabmin} = \mathbf{0.038}\ N/mm^2$

Tension steel ratio — $\rho = 100 \times A_{sslabtop}/d_{tslabmin} = \mathbf{0.542}$

From BS8110-1:1997 - Table 3.8

Design concrete shear strength — v_c = **0.664** N/mm²

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 — $M_{factor} = M_{\Sigma c}/d_{bslabav}^2$ = **0.038** N/mm²

Steel service stress — $f_s = 2/3 \times f_{yslab} \times A_{sslabbtmbend}/A_{sslabbtm}$ = **5.825** N/mm²

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 — $Ratio_{actual} = l_{slab}/ d_{bslabav}$ = **13.667**

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

Slab edge design checks

Basic loading

Hardcore — $w_{hcoreslab} = \gamma_{hcore} \times h_{hcoreslab}$ = **2.0** kN/m²

Slab self weight — w_{slab} = 24 kN/m³ × h_{slab} = **4.8** kN/m²

Edge load number 1

Load type — **Longitudinal line load**

Dead load — w_{Dedge1} = **21.2** kN/m

Live load — w_{Ledge1} = **9.3** kN/m

Ultimate load — $w_{ultedge1} = 1.4 \times w_{Dedge1} + 1.6 \times w_{Ledge1}$ = **44.6** kN/m

Longitudinal line load width — b_{edge1} = **300** mm

Centroid of load from outside face of raft — x_{edge1} = **150** mm

Slab edge bearing pressure check

Total uniform load at formation level — $w_{udledge} = w_{Dudl} + w_{Ludl} + w_{slab} + w_{hcoreslab}$ = **9.5** kN/m²

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

Load x distance for edge load 1 — $Moment_1 = w_{ultedge1} \times x_{edge1}$ = **6.7** kN

Sum of ultimate longitud'l and equivalent line loads — ΣUDL = **44.6** kN/m

Sum of load x distances — ΣMoment = **6.7** kN

Centroid of loads — x_{bar} = ΣMoment/ΣUDL = **150** mm

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

Sum of unfactored longitud'l and eff'tive line loads — ΣUDLsls = **30.5** kN/m

Allowable bearing width — $b_{allow} = 2 \times x_{bar} + 2 \times h_{hcoreslab} \times \tan(30)$ = **415** mm

Bearing pressure due to line/point loads — $q_{linepoint} = \Sigma UDLsls/ b_{allow}$ = **73.4** kN/m²

Total applied bearing pressure — $q_{edge} = q_{linepoint} + w_{udledge}$ = **82.9** kN/m²

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 — $b_{req} = \Sigma UDLsls/(q_{allow} - w_{udledge})$ = **1968** mm

Effective bearing width at u/s of slab — $b_{reqeff} = b_{req} - 2 \times h_{hcoreslab} \times \tan(30)$ = **1852** mm

Load/reaction eccentricity — $e = b_{reqeff}/2 - x_{bar}$ = **776** mm

Ultimate moment to be resisted by slab — $M_{ecc} = \Sigma UDL \times e$ = **34.6** kNm/m

From slab bending check

Moment due to depression under slab (hogging) — $M_{\Sigma e}$ = **1.4** kNm/m

Total moment to be resisted by slab top steel — $M_{slabtop} = M_{ecc} + M_{\Sigma e}$ = **36.0** kNm/m

K factor — $K_{slab} = M_{slabtop}/(f_{cu} \times d_{tslabmin}^2)$ = **0.068**

Lever arm	$z_{slab} = d_{tslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slab}/0.9)}) =$ **133** mm
Area of steel required	$A_{sslabreq} = M_{slabtop}/((1.0/\gamma_s) \times f_y \times z_{slab}) =$ **623** mm²/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

Library item - B pressure with moment transfer

Slab edge bending check

Considering a 1.0m width of slab

Divider for moments due to udl's	$\beta_{udl} =$ **10.0**

Applied bending moments

Span of slab	$l_{edge} = \phi_{depslab} + d_{tslabmin} =$ **2045** mm
Ultimate self weight udl	$w_{edgeult} = 1.4 \times w_{slab} =$ **6.7** kN/m²
Self weight bending moment	$M_{edgesw} = w_{edgeult} \times l_{edge}^2/10 =$ **2.8** kNm/m
Self weight shear force	$V_{edgesw} = w_{edgeult} \times l_{edge}/2 =$ **6.9** kN/m

Moments due to applied uniformly distributed loads

Ultimate udl	$w_{edgeudl} = w_{udlult} =$ **4.1** kN/m²
Bending moment	$M_{edgeudl} = w_{edgeudl} \times l_{edge}^2/\beta_{udl} =$ **1.7** kNm/m
Shear force	$V_{edgeudl} = w_{edgeudl} \times l_{edge}/2 =$ **4.2** kN/m

Moment and shear due to load number 1

Effective slab width	$b_{eff1} = \min(x_{edge1}, b_{edge1}/2 + 0.3 \times l_{edge}) + b_{edge1}/2 + 0.3 \times l_{edge} =$ **914** mm
Bending moment	$M_{edge1} = w_{ultedge1} \times l_{edge}^2/(\beta_{udl} \times b_{eff1}) =$ **20.4** kNm/m
Shear force	$V_{edge1} = w_{ultedge1} \times l_{edge}/(2 \times b_{eff1}) =$ **49.9** kN/m

Resultant moments and shears

Total moment (hogging and sagging)	$M_{\Sigma edge} =$ **24.9** kNm/m
Maximum shear force	$V_{\Sigma edge} =$ **60.9** kN/m

Reinforcement required in top

K factor	$K_{edgetop} = M_{\Sigma edge}/(f_{cu} \times d_{tslabmin}^2) =$ **0.047**
Lever arm	$z_{edgetop} = d_{tslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{edgetop}/0.9)}) =$ **137** mm
Area of steel required for bending	$A_{sedgetopbend} = M_{\Sigma edge}/((1.0/\gamma_s) \times f_{yslab} \times z_{edgetop}) =$ **419** mm²/m
Area of steel required	$A_{sedgetopreq} = \max(A_{sedgetopbend}, A_{sslabmin}) =$ **419** mm²/m

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

Reinforcement required in bottom

K factor	$K_{edgebtm} = M_{\Sigma edge}/(f_{cu} \times d_{bslabmin}^2) =$ **0.047**
Lever arm	$z_{edgebtm} = d_{bslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{edgebtm}/0.9)}) =$ **137** mm
Area of steel required for bending	$A_{sedgebtmbend} = M_{\Sigma edge}/((1.0/\gamma_s) \times f_{yslab} \times z_{edgebtm}) =$ **419** mm²/m
Area of steel required	$A_{sedgebtmreq} = \max(A_{sedgebtmbend}, A_{sslabmin}) =$ **419** mm²/m

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

Applied shear stress	$v_{edge} = V_{\Sigma edge} \times 1.0m/(1000mm \times d_{tslabmin}) =$ **0.420** N/mm²
Tension steel ratio	$\rho_{edge} = 100 \times A_{sedgetop} \times 1.0m/(1000mm \times d_{tslabmin}) =$ **0.542**
From BS8110-1:1997 - Table 3.8	
Design concrete shear strength	$v_{cedge} =$ **0.664** N/mm²

PASS - v_{edge} <= v_{cedge} - Shear capacity of the slab is not exceeded

Slab edge deflection check

Basic allowable span to depth ratio	$Ratio_{basicedge} =$ **26.0**
Moment factor	$M_{factoredge} = M_{\Sigma edge}/d_{bslabmin}^2 =$ **1.185** N/mm²
Steel service stress	$f_{sedge} = 2/3 \times f_{yslab} \times A_{sedgebtmbend}/A_{sedgebtm} =$ **177.512** N/mm²

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

MF_{edge} = **1.747**

Modified allowable span to depth ratio $Ratio_{allowedge} = Ratio_{basicedge} \times MF_{edge}$ = **45.421**

Actual span to depth ratio $Ratio_{actualedge} = l_{edge}/ d_{tslabmin}$ = **14.103**

PASS - $Ratio_{actualedge}$ <= $Ratio_{allowedge}$ - Slab span to depth ratio is adequate

Corner design checks

Basic loading

Corner bearing pressure check

Total uniform load at formation level $w_{udlcorner} = w_{Dudl} + w_{Ludl} + w_{slab} + w_{hcoreslab}$ = **9.5** kN/m²

PASS - $w_{udlcorner}$ <= q_{allow} - Applied bearing pressure is less than allowable

Slab corner bending check

Cantilever span of slab at corner $l_{corner} = \phi_{depslab}/\sqrt{(2)} + d_{tslabav}/2$ = **1419** mm

Moment and shear due to self weight

Considering triangular loading

Maximum ultimate self weight udl $w_{swult} = 1.4 \times w_{slab} \times \phi_{depslab}/\sqrt{(2)}$ = **9.0** kN/m

Self weight bending moment $M_{cornersw} = w_{swult} \times l_{corner}^2/(6 \times \phi_{depslab}/\sqrt{(2)})$ = **2.3** kNm/m

Self weight shear force $V_{cornersw} = w_{swult} \times l_{corner}/(2 \times \phi_{depslab}/\sqrt{(2)})$ = **4.8** kN/m

Moment and shear due to udls

Maximum ultimate udl $w_{cornerudl} = ((1.4\times w_{Dudl})+(1.6\times w_{Ludl})) \times \phi_{depslab}/\sqrt{(2)}$ = **5.5** kN/m

Bending moment $M_{cornerudl} = w_{cornerudl} \times l_{corner}^2/(6 \times \phi_{depslab}/\sqrt{(2)})$ = **1.4** kNm/m

Shear force $V_{cornerudl} = w_{cornerudl} \times l_{corner}/(2 \times \phi_{depslab}/\sqrt{(2)})$ = **2.9** kN/m

Resultant moments and shears

Total design moment $M_{\Sigma corner} = M_{cornersw} + M_{cornerudl}$ = **3.6** kNm/m

Total design shear force $V_{\Sigma corner} = V_{cornersw} + V_{cornerudl}$ = **7.7** kN/m

Reinforcement required in top of slab at corners

K factor $K_{corner} = M_{\Sigma corner}/(f_{cu} \times d_{tslabmin}^2)$ = **0.007**

Lever arm $z_{corner} = d_{tslabmin} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{corner}/0.9)})$ = **138** mm

Area of steel required for bending $A_{scornerbend} = M_{\Sigma corner}/((1.0/\gamma_s) \times f_{yslab} \times z_{corner})$ = **60** mm²/m

Area of steel required $A_{scorner} = \max(A_{scornerbend}, A_{sslabmin})$ = **260** mm²/m

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

Applied shear stress $v_{corner} = V_{\Sigma corner}/d_{tslabmin}$ = **0.053** N/mm²

Tension steel ratio $\rho_{corner} = 100 \times A_{sedgetop}/d_{tslabmin}$ = **0.542**

From BS8110-1:1997 - Table 3.8

Design concrete shear strength $v_{ccorner}$ = **0.664** N/mm²

Pass - v_{corner} <= $v_{ccorner}$ - Shear capacity of the slab is not exceeded

Slab corner deflection check

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

Moment factor $M_{factorcorner} = M_{\Sigma corner}/d_{tslabmin}^2$ = **0.172** N/mm²

Steel service stress $f_{scorner} = 2/3 \times f_{yslab} \times A_{scornerbend}/A_{sedgetop}$ = **25.646** N/mm²

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

MF_{corner} = **2.000**

Modified allowable span to depth ratio $Ratio_{allowcorner} = Ratio_{basiccorner} \times MF_{corner}$ = **14.000**

Actual span to depth ratio $Ratio_{actualcorner} = l_{corner}/ d_{tslabmin}$ = **9.783**

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

Hudds Design
Structural Engineering Consultants
Hudds Design
103-105 Bradford Rd
Huddersfield
HD1 6DZ

Project				Job no.	
Broomroyd, Barnsley, S70 5ES				HD-S20-1112	
Calcs for				Start page no./Revision	
Raft Foundation				RF- 7	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
JT	16/11/2020	JA	13/11/2020		