

Westhill Pavilion

Structural Calculations

For

Westfield Parish Council

Date: 23/02/2023

Project Reference: M2-2572 Document Reference: SE-01-A1

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M2-2572	MD	Feb-23
Doc. Ref	Chk'd by	Date
SE-01-A1	MC	Feb-23

Document Issue History and Status

	Prepared By		Checked By		Appro	ved By
Revision	Name	Date	Name	Date	Name	Date
A1	Max Day	23.02.23	Matthieu Crosnier	23.02.23	Max Day	23.02.23

General Notes:

Calculations to be checked by Building Control Authority before work commences. Client to ensure all of contractors' works on site comply with and meet Approval of the relevant British Standards and the Local Authority including Building Control and Planning Departments. All temporary works to be the responsibility of the contractor and should be in accordance with BS 5975 to ensure temporary stability during the course of the works.

Dimensions: Note that all dimensions shown on the calculations are indicative and have been used for calculation purposes only. All dimensions should be checked prior to start of the works on site. It is the responsibility of the client to notify the Engineer of any discrepancies. The same applies to the alignment of walls and general layouts. All existing foundations and lintels to be exposed to verify suitability and to be checked for adequacy and/or replaced or surrounded in 150mm concrete cover if necessary. Prior to commencement a trial hole and /or soil report/investigation and an inspection of any trees in the areas may be required.

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Introduction:

The following design calculations are for the proposed extension at Westhill Pavilion. In the absence of a formal SI the British Geological maps were consulted and a conservative bearing pressure of 100kN/m² was taken.

Design Codes - British Standards:

BS 5268:2002	"The Structural Use of Timber"
BS 5628:1992	"Code of Practice for use of Masonry"
BS 5950:2000	"The Structural Use of Steel in Building"
BS 5977:1983	"Lintels"
BS 6399:1997	"Loadings for Buildings"
BS 8004:1986	"Code of Practice for Foundations"
BS 8110:1997	"Structural Use of Concrete" 2001
BS 8500:2006	"Concrete"

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Loadings

Roof Loading (Pitched Tiled Roof)

Roof slope;			A = 30 °
Dead Load			
Tiles;	Roof _{D1}	=	0.60 kN/m ²
Felt & Battens;	Roof _{D2}	=	0.05 kN/m ²
Rafters;	Roof _{D3}	=	0.12 kN/m ²
Insulation;	Roof _{D4}	=	0.05 kN/m ²
Services;	Roof _{D5}	=	0.05 kN/m ²
Plasterboard & Skim;	Roof _{D6}	=	0.15 kN/m ²
Dead Load on slope;	$Roof_{DL_{sroof}} = sum(Roof_{D1}, Roof_{D2}, Roof_{D3}, Roof_{D4}, Roof_{D5}, Roof_{D6})$	=	1.020 kN/m ²
Total Dead Load (on plan);	$Roof_{DL} = Roof_{DL_sroof} / cos(A)$	=	1.178 kN/m ²
Imposed Load			
Roof Imposed Load (on plan);	Roof _{IL1}	=	0.60 kN/m ²
Roof Loading (Mono-pitched Tiled F	Roof)		
Roof slope;			A = 6 °
Dead Load			
Tiles;	Roof _{D1}	=	0.60 kN/m ²
Felt & Battens;	Roof _{D2}	=	0.05 kN/m ²
Rafters;	Roof _{D3}	=	0.12 kN/m ²
Insulation;	Roof _{D4}	=	0.05 kN/m ²
Services;	Roof _{D5}	=	0.05 kN/m ²
Plasterboard & Skim;	Roof _{D6}	=	0.15 kN/m ²
Dead Load on slope;	$Roof_{DL_sroof} = sum(Roof_{D1}, Roof_{D2}, Roof_{D3}, Roof_{D4}, Roof_{D5}, Roof_{D6})$	=	1.020 kN/m ²
Total Dead Load (on plan);	$Roof_{DL} = Roof_{DL_{sroof}} / cos(A)$	=	1.026 kN/m ²
Imposed Load			
Roof Imposed Load (on plan);	Roof _{IL1}	=	0.75 kN/m ²
Cavity Wall Loading			
Dead Load			
Masonry (Outer Leaf):	CW _{D1}	=	2.20 kN/m ²
Insulation;	CW _{D2}	=	0.05 kN/m ²
Masonry (Inner Leaf);	CW _{D3}	=	1.80 kN/m ²
Plasterboard & Skim;	CW _{D4}	=	0.15 kN/m ²
Total Dead Load;	$CW_{DL} = sum(CW_{D1}, CW_{D2}, CW_{D3}, CW_{D4})$	=	4.20 kN/m ²
Internal Blockwork Wall Loading			
Dead Load			
Masonry:	IW _{p1}	=	1.80 kN/m ²
Plasterboard & Skim (both sides)	IW _{D2}	=	0.30 kN/m ²
Total Dead Load;	IW _{DL} = sum(IW _{D1} ,IW _{D2})	=	2.10 kN/m ²

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Beam 1 Design:			
Loadings			
UDI from Pitched Boof			
Width of roof being carried	v. = 3.6 m		
Dead Load;	$DL_1 = 1.178 \text{ kN/m}^2 \times x_1$	=	4.241 kN/m
Imposed Load;	$IL_1 = 0.60 \text{ kN/m}^2 \times x_1$	=	2.160 kN/m
STEEL BEAM ANALYSIS & DESIGN	(BS5950)		
	(205050)		
STEEL BEAM ANALYSIS & DESIG	<u>N (BS5950)</u>	_	
In accordance with BS5950-1:20	00 incorporating Corrigendum No.1	1	coloulation version 2.0.07
		TEDDS	calculation version 5.0.07
	Load Envelope - Combination 1		
9.805			
0.0			
mm [5800	J B	
kNm	Bending Moment Envelope		
		A	
21.964–J mm	22.0 5800		
A	1	В	
kN 19.355 19.4	Shear Force Envelope		
0.0-		*	
-10.275	5000	-10.3	
A	1	B	
Support conditions			
Support A Vertically restrained			
Rotationally free			
Support P. Vertically rectrained			
Botationally free			

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Applied loading			
Beam loads Dead self weight of bu	eam × 1		
Dead full VDI 4 241 k	N/m to 0 kN/m		
Imposed full VDL 2 1F	5 kN/m to $0 kN/m$		
Load combinations			
Load combination 1 Sun	nort A Dead v 1.40		
Load combination 1 Sup			
imposed × 1.	.00		
Dead × 1.40	CO		
Imposed × 1.	.60		
Support B Dea	ld × 1.40		
Imposed \times 1.	.60		
Analysis results			
Maximum moment; M _{ma}	$_{ax} = 22 \text{ kNm}; M_{min} = 0 \text{ kNm}$		
Maximum shear; V _{max} = 19.4 k	N; V _{min} = -10.3 kN		
Deflection; $\delta_{max} = 8.7 \text{ mr}$	m; δ _{min} = 0 mm		
Maximum reaction at support	A; $R_{A_{max}} = 19.4 \text{ kN}; R_{A_{min}} = 19.4 \text{ kN};$	9.4 kN	
Unfactored dead load reaction at s	upport A; R _{A_Dead} = 9.1 kN		
Unfactored imposed load reaction	at support A; R _{A_Imposed} = 4.2 kN		
Maximum reaction at support	B; $R_{B_{max}} = 10.3 \text{ kN}; R_{B_{min}} = 10$	0.3 kN	
Unfactored dead load reaction at s	upport B; R _{B_Dead} = 5 kN		
Unfactored imposed load reaction	at support B; R _{B_Imposed} = 2.1 kN		
Section details			
Section type; UB 203x133>	x30 (BS4-1)		
Steel grade; S275			
From table 9: Design strength	р _у		
Thickness of element; max	κ(T, t) = 9.6 mm		
Design strength; p _y = 275 N/m	1m ²		
Modulus of elasticity; E = 2	205000 N/mm ²		

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Lataral roctraint			
Lateral restraint	al restraint at supports only		
Span 1 has later			
Effective length factor in	major axis: $K = 1.00$		
Effective length factor in	minor axis, $K_x = 1.00$		
Effective length factor for	$K_{y} = 1.00$	IO·	
	iaterai-torsional buckning, KLIA – 1.0	ν,	
Classification of cross cos	tions - Section 2 5		
	$\frac{2}{n} = 1.00$		
Internal compression par	/ μyj – 1.00 rts - Table 11		
Denth of section: d = 172			
d /+ - 26 0 v o /	= 80 x s: Class 1 plastic		
Outstand flanges - Table	11		
Width of section: $h = B / 2$	2 = 67 mm		
$h/T = 70 \times \varepsilon < =$	2 - 67 min		
		S	ection is class 1 p
Shear capacity - Section	4.2.3		
Design shear force;	$F_v = max(abs(V_{max}), abs(V_{min})) = 19.4$	kN	
d / t < 70 $ imes$ ϵ			
	W	eb does not need to be chec	ked for shear bud
Shear area; $A_v = t \times$	D = 1324 mm ²		
Design shear resistance;	$P_v = 0.6 \times p_y \times A_v = 218.4 \text{ kN}$		
	PASS - D	Design shear resistance exce	eds design shear
Moment capacity - Section	on 4.2.5		
Design benaing moment;	IVI = ITTAX(abs(IVIs1_max), abs(IVIs1_min)) =	= 22 KINITI	
Effective length for let	ear - CI.4.2.5.2; $IVI_c = MIN(p_V \times S_{XX})$	1.2 × p _y × ∠ _{xx}) = δδ.5 KNM	
Effective length for laters	al-torsional buckling - Section 4.3.5	200 mm	
Slondorness ratio	$11 \text{ constants} = 1.0 \times \text{Ls} = 5$		
Sienuemess ratio;	n = LE / 1yy = 102.000		
Buckling parameter	JECUUI 4.J.U./		
Torsional index: v - 21 A	u - 0.001		
Slandarness factor	$y = 1 / [1 + 0.05 = 12 / y^{2}]^{0.25} = 0.602$	•	
Ratio - cl / 2 6 0 R 1 /	ν		
Fouivalent clenderness	cl 4 3 6 7· λιτ= μ ∨ ν ∨ λ ∨ √[β] – 100	9 928	
Limiting clenderness - An	nex B 2 2: $\lambda_{10} = 0.4 \times (\pi^2 \vee F / n)^{0.5} = 3$	34 310	
Zanang sienderness - All	λιτ > λιο - ΔΙΙουν	ance should be made for late	eral-torsional hu
Bending strength - Section	on 4.3.6.5		
Robertson constant.	aut = 7.0		

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Perry factor; $\eta_{LT} = max(\alpha_{LT} \times (\lambda_{TT}))$	ι _{LT} - λ _{L0}) / 1000	0, 0) = 0.529		
Euler stress; $p_E = \pi^2 \times E / \lambda_{LT}^2 =$	= 167.4 N/mm ²	2		
$\phi_{LT} = (p_y + (\eta_{LT} + 1) \times p_E) / 2$	2 = 265.5 N/m	m²		
Bending strength - Annex B.2.1;	$p_b = p_E \times p_V / ($	(φ _{LT} + (φ _{LT} ² - p _E ×	p _y) ^{0.5}) = 109.1 N/mm ²	
Equivalent uniform moment factor	r - Section 4.3	.6.6		
Moment at quarter point of segme	nt; M2 =	18.6 kNm		
Moment at centre-line of segment;	M₃ = 21.5 kNr	n		
Moment at three quarter point of s	segment; M ₄ =	13.6 kNm		
Maximum moment in segment;	M _{abs} = 22 kNn	n		
Maximum moment governing buck	ling resistance	e; M _{LT} = M _{abs} :	= 22 kNm	
Equivalent uniform moment factor	for lateral-tor	sional buckling;		
	m _{LT} = n	nax(0.2 + (0.15	$\times M_2 + 0.5 \times M_3 + 0.15 \times N_3$	l4) / Mabs, 0.44) = 0.909
Buckling resistance moment - Sect	ion 4.3.6.4			
Buckling resistance moment;	$M_b = p_b \times S_{xx} =$	= 34.3 kNm		
M _b / m _{LT} = 37.7 kNm				
	PASS	- Buckling resis	tance moment exceeds de	esign bending moment
Check vertical deflection - Section	2.5.2			
Consider deflection due to dead an	d imposed loa	ıds		
Limiting deflection; $\delta_{\text{lim}} = L_{s1}$	/ 360 = 16.11 1	l mm		
Maximum deflection span 1;	$\delta = \max(abs(\delta$	δ_{max}), abs(δ_{min})) =	= 8.688 mm	
		PASS - Maxi	mum deflection does not	exceed deflection limit
	0)			
MASONRT BEARING DESIGN (BS562	<u>8)</u>			
MASONRY BEARING DESIGN TO BS	5628-1:2005			
				TEDDS calculation version 1.0.08
Masonry details				
Masonry type; Aggregate concre	ete blocks (259	% or less forme	d voids)	
Compressive strength; p _{unit} = 3.	6 N/mm²;	Mortar des	ignation; iii	

Compressive strength; $p_{unit} = 3.6 \text{ N/mm}^2$;Mortar designation;iiiLeast horiz dim of units; $l_{unit} = 100 \text{ mm}$;Height of units; $h_{unit} = 215 \text{ mm}$ Masonry units;Category II;Construction control;NormalPartial safety factor; $\gamma_m = 3.5$; Characteristic strength; $f_k = 3.5 \text{ N/mm}^2$ Leaf thickness;t = 100 mm;Effective wall thickness; $t_{ef} = 100 \text{ mm}$ Wall height;h = 2400 mm;Effective height of wall; $h_{ef} = 2400 \text{ mm}$

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Bearing details

Beam spanning out of plane of wall Width of bearing; B = **100** mm; Length of bearing; l_b = **100** mm Edge distance; x_{edge} = **50** mm Loading details Concentrated dead load; $G_k = 5 \text{ kN}$; Concentrated imposed load; $Q_k = 2 kN$ Design concentrated load; F = 10.4 kN Distributed dead load; g_k = **0.0** kN/m; Distributed imposed load; qk = 0.0 kN/m Design distributed load; f = 0.0 kN/m Masonry bearing type Bearing type; **Type 1**; Bearing safety factor; $\gamma_{\text{bear}} = 1.25$ Check design bearing without a spreader Design bearing stress; f_{ca} = **1.036** N/mm²; Allowable bearing stress; $f_{cp} = 1.250 \text{ N/mm}^2$ PASS - Allowable bearing stress exceeds design bearing stress Check design bearing at $0.4 \times h$ below the bearing level

Design bearing stress; $f_{ca} = 0.093 \text{ N/mm}^2$; Allowable bearing stress; $f_{cp} = 0.605 \text{ N/mm}^2$

PASS - Allowable bearing stress at 0.4 × h below bearing level exceeds design bearing stress

<u>Provide 203x133x30 UB S.275 – Beam to bear onto 300x300long x 215deep x 100thick concrete corner</u> <u>padstone</u>

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Beam 2 Design: Loadings UDL from Pitched Roof Width of roof being carried; Dead Load; Imposed Load;	$x_1 = 3.5 \text{ m}$ $DL_1 = 1.178 \text{ kN/m}^2 \times x_1$ $IL_1 = 0.60 \text{ kN/m}^2 \times x_1$ IGN (BS5950)		= 4.123 kN/m = 2.100 kN/m
STEEL BEAM ANALYSIS & D	ESIGN (BS5950)		
In accordance with BS5950-1:2	000 incorporating Corrigendum No.	1	
In accordance with BS5950-1:2	000 incorporating Corrigendum No.	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No.	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No.	1	EDDS calculation version 3.0.
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In accordance with BS5950-1:2	000 incorporating Corrigendum No.	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No.	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope	1	EDDS calculation version 3.0.
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In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No.: Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1 Shear Force Envelope	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope <u>26.4</u> 4700 1 Shear Force Envelope	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No.: Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1 Shear Force Envelope	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No. Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1 Shear Force Envelope	1	EDDS calculation version 3.0.
In accordance with BS5950-1:2	000 incorporating Corrigendum No.: Load Envelope - Combination 1 4700 1 Bending Moment Envelope 26.4 4700 1 Shear Force Envelope		EDDS calculation version 3.0.

Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

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Applied loading			
Beam loads Dead self weight of beam	× 1		
Dead full UDL 4.123 kN/m			
Imposed full UDL 2.1 kN/n	ı		
Load combinations			
Load combination 1 Support	A Dead × 1.40		
Imposed $ imes$ 1.60			
Dead imes 1.40			
Imposed $ imes$ 1.60			
Support B Dead × 1	40		
Imposed $ imes$ 1.60			
Analysis results			
Maximum moment; M _{max} = 2	6.4 kNm; M _{min} = 0 kNm		
Maximum shear; V _{max} = 22.4 kN;	V _{min} = -22.4 kN		
Deflection; $\delta_{max} = 7 \text{ mm};$	$\delta_{min} = 0 \text{ mm}$		
Maximum reaction at support A;	R _{A_max} = 22.4 kN; R _{A_min} = 22.4 k	kN	
Unfactored dead load reaction at suppo	ort A; R _{A_Dead} = 10.4 kN		
Unfactored imposed load reaction at su	pport A; R _{A_Imposed} = 4.9 kN		
Maximum reaction at support B;	R _{B_max} = 22.4 kN; R _{B_min} = 22.4 k	kN	
Unfactored dead load reaction at suppo	ort B; R _{B_Dead} = 10.4 kN		
Unfactored imposed load reaction at su	pport B; R _{B_Imposed} = 4.9 kN		
Section details			
Section type; UB 203x133x30 (BS4-1) ; Steel grade; S275		
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Classification of cross sections - Section 3.5

Tensile strain coefficient; $\varepsilon = 1.00$; Section classification; Plastic

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Shear capacity - Section 4.2.3			
Design shear force; $F_v = 22.4 \text{ kN}$; Design shear resistance;	P _v = 218.4 kN	
	PASS - Design	shear resistance exceeds	design shear force
Moment capacity - Section 4.2.5			
Design bending moment; M = 26.4 kN	m; Moment capacity low she	ear; M _c = 86.5 kNm	1
Buckling resistance moment - Section 4.3.	6.4		
Buckling resistance moment; M _b	= 41.3 kNm; M _b / m _{LT} = 44.7 k	«Nm	
	PASS - Buckling resistance	e moment exceeds desig	n bending moment
Check vertical deflection - Section 2.5	.2		
Consider deflection due to dead and in	nposed loads		
Limiting deflection $\delta_{\text{lim}} = 13.056$	5 mm;Maximum deflection;	δ = 6.976 mm	
	PASS - Maximum	deflection does not exc	eed deflection limit
MASONRY BEARING DESIGN (BS5628)			
MASONRY BEARING DESIGN TO BSSG	28-1-2005		
MASONICI BEARING DESIGN TO BSSU	20-1.2005	TEDD	S calculation version 1.0.08
Masonry details			
Masonry type; Aggregate concrete	blocks (25% or less formed voi	ds)	
Compressive strength; p _{unit} = 3.6 N,	/mm ² ; Mortar designat	ion; iii	

p _{unit} = 3.6	5 N/mm²	;	Mortar o	designation	; iii
l _{unit} = 100) mm;	Height o	f units;	h _{unit} = 215	mm
y II;	Construc	tion con	trol; No	rmal	
γm = 3.5 ;	Characte	eristic stre	ength;	f _k = 3.5 N/r	nm²
mm;	Effective	wall thic	kness;	t _{ef} = 100 m	m
0 mm;	Effective	height o	f wall;	h _{ef} = 2400 i	mm
	punit = 3.(l _{unit} = 10(y II; γ _m = 3.5; mm; D mm;	$p_{unit} = 3.6 \text{ N/mm}^2$ $l_{unit} = 100 \text{ mm};$ y II ; Construct $\gamma_m = 3.5$; Character mm; Effective 0 mm; Effective	$p_{unit} = 3.6 \text{ N/mm}^2$; $l_{unit} = 100 \text{ mm}$;Height o \mathbf{y} II;Construction com $\gamma_m = 3.5$; Characteristic structuremm;Effective wall thic0 mm;Effective height o	$p_{unit} = 3.6 \text{ N/mm}^2$;Mortar of $l_{unit} = 100 \text{ mm}$;Height of units; \mathbf{y} II;Construction control;Nor $\gamma_m = 3.5$;Characteristic strength;mm;Effective wall thickness;0 mm;Effective height of wall;	$p_{unit} = 3.6 \text{ N/mm}^2$;Mortar designation; $l_{unit} = 100 \text{ mm}$;Height of units; $h_{unit} = 215 \text{ m}$ $y \text{ II}$;Construction control;Normal $\gamma_m = 3.5$; Characteristic strength; $f_k = 3.5 \text{ N/r}$ mm;Effective wall thickness; $t_{ef} = 100 \text{ m}$ 0 mm;Effective height of wall; $h_{ef} = 2400 \text{ m}$

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→ ^{Be}	eam to span out of plane of wa	II		
$\kappa \setminus$				



Bearing details

Beam spanning out of plane of wall Width of bearing; B = 100 mm; Length of bearing; l_b = **100** mm Edge distance; x_{edge} = **300** mm Loading details Concentrated dead load; $G_k = 10 \text{ kN}$; Concentrated imposed load; $Q_k = 4 kN$ Design concentrated load; F = 20.8 kN Distributed dead load; g_k = **0.0** kN/m; Distributed imposed load; qk = 0.0 kN/m Design distributed load; f = 0.0 kN/m Masonry bearing type Bearing type; Type 2; Bearing safety factor; γ_{bear} = **1.50** Check design bearing without a spreader Design bearing stress; f_{ca} = **2.080** N/mm²; Allowable bearing stress; $f_{cp} = 1.500 \text{ N/mm}^2$ FAIL - Design bearing stress exceeds allowable bearing stress, use a spreader **Spreader details** Length of spreader; hs = **215** mm ls = **440** mm; Depth of spreader; Edge distance; s_{edge} = **130** mm Spreader bearing type Bearing type; **Type 1**; Bearing safety factor; γ_{bear} = **1.25** Check design bearing with a spreader Loading acts at midpoint of spreader f_{ca} = **0.473** N/mm²; Allowable bearing stress; $f_{cp} = 1.250 \text{ N/mm}^2$ Design bearing stress; PASS - Allowable bearing stress exceeds design bearing stress

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Check design bearing at $0.4 \times h$ below the bearing level

Design bearing stress;

 $f_{ca} = 0.153 \text{ N/mm}^2$; Allowable bearing stress; $f_{cp} = 0.605 \text{ N/mm}^2$

PASS - Allowable bearing stress at 0.4 × h below bearing level exceeds design bearing stress

Provide 203x133x30 UB S.275 – Beam to bear onto 440long x 215deep x 100thick concrete padstone

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<u>Beam 3 Design:</u>								
<u>Loadings</u>								
UDL from Pitched Roof								
Width of roof being carried;	x ₁ = 3.5 m							
Dead Load;	DL ₁ = 1.178 ki	N/m² ×	X ₁				=	4.123 kN/m
Imposed Load;	IL ₁ = 0.60 kN/	$m^2 \times x_1$	L				=	2.100 kN/m
Point Load from Beam 1 x 2								
Dead Load;	PL _{DL1}						=	18.200 kN
Imposed Load;							=	8.400 KN
<u>D ANALYSIS</u>								
ANALYSIS							Tedds	calculation version 1.0.
Geometry								
,								
1 &	Geometry (m) - 1.5 2 1	- Steel	(BS59)	50) - UE	3 203x133x3	80		
1 <u>*</u>	Geometry (m) -	- Steel	BS59 Por Bearn	50) - UE	3 203x133x3	80		
1 <u>Z</u> X	Geometry (m) - 1.5 2 1	- Steel	(BS59)	50) - UE	3 203x133x3	3		
Loading	Geometry (m) - 1.5 2 1	- Steel	(BS59)	50) - UE	3 203x133x3	3		
¹ ∠ Z Loading Self weight included	Geometry (m) - 1.5 2 1	- Steel	BS59	50) - UE	3 203x133x3	3		
¹ ∠ ^Z ↓ Loading Self weight included Load combination factors	Geometry (m) - 1.5 2 1	- Steel	BS59	50) - UE	3 203x133x3	3		
Load combination factors	Geometry (m) - 1.5 2 1	Self Weight	Bermanent	Imposed	3 203x133x3	3		
Loading Self weight included Load combination factors Load combination 1.4D + 1.6I + 1.6RI (Strength)	Geometry (m) -	- Steel Crank 1.40	(BS59)	50) - UE	3 203x133x3	3		

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Node loads

Node	Load case	Fo	Moment	
		Х	z	
		(kN)	(kN)	(kNm)
2	Permanent	0	18.2	0
2	Imposed	0	4.2	0

Element Loads

Element	Load case	Load Type	Orientation	Description
1	Permanent	UDL	GlobalZ	4.12 kN/m
1	Imposed	UDL	GlobalZ	2.1 kN/m

<u>Results</u>

Forces





Element results

Envelope - Strength combinations

Element	She	Shear force			nent	
	Pos (m)	Max abs (kN)	Pos (m)	Max (kNm)	Pos (m)	Min (kNm)
1	0	35.3 (max abs)	1.5	42.2 (max)	0	0 (min)
2	4.042	-11.2	0	42.2 (max)	4.042	0 (min)

Envelope - All combinations

Element	Axial force				
	Pos	Max	Pos	Min	
	(m)	(kN)	(m)	(kN)	
1	0	0 (min)	0	0 (min)	
2	4.042	6.4 (max)	0	3.9	

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Envelope - Service combinations

Element	Deflection			
	Pos	Min		
	(m)	(mm)	(m)	(mm)
1	1.5	10.1	0	0
2	0.875	10.4 (max)	4.042	-2.9 (min)

;

STEEL MEMBER DESIGN (BS5950)

STEEL MEMBER DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Section details

Section type;

UB 203x133x30 (BS4-1); Steel grade;

TEDDS calculation version 3.0.07

S275



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	DASS Comp	raccian resistance eveneds de	cian comprossion fo
Compression members with	moments - Section 4.8.3	ession resistance exceeds de	sign compression jo
Comp.and bending check:	$F_c / (A \times p_v) + M / M_c = 0.494$		
, , , , , , , , , , , , , , , , , , ,	PASS - Co	ombined bending and compre	ession check is satisf
Member buckling resistance	e - cl.4.8.3.3.2		
Buckling resistance check:	$F_{c} / P_{cx} + m_{x} \times M / M_{c} \times (1 + 0.5 \times 1)$	Ec / Pcx) = 0.497	
Bucking resistance encer,		S Mombor buckling resistor	so chocks are satisf
		S wichiber buckling resistur	ice encers are satisj
<u>Provide Cranked 203</u>	x133x30 UB S.275 – Beam to bear or	to 440long x 215deep x 100t	hick concrete padste
<u>Provide Cranked 203</u>	x133x30 UB S.275 – Beam to bear or	to 440long x 215deep x 100t	hick concrete padsta
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	to 440long x 215deep x 100tl	hick concrete padsta
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	<u>to 440long x 215deep x 100t</u>	hick concrete padsto
<u>Provide Cranked 203</u>	x133x30 UB S.275 – Beam to bear or	<u>to 440long x 215deep x 100t</u>	hick concrete padsta
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	<u>to 440long x 215deep x 100t</u>	<u>hick concrete padsta</u>
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	to 440long x 215deep x 100t	<u>hick concrete padsta</u>
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	<u>to 440long x 215deep x 100t</u>	hick concrete padsta
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	<u>to 440long x 215deep x 100t</u>	<u>hick concrete padsta</u>
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	<u>to 440long x 215deep x 100t</u>	<u>hick concrete padsta</u>
<u>Provide Cranked 203</u>	<u>x133x30 UB S.275 – Beam to bear or</u>	<u>to 440long x 215deep x 100t</u>	hick concrete padsto

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MAIN RAFTER DESIGN

TIMBER RAFTER DESIGN (BS5268-2:2002)

TEDDS calculation version 1.0.03





Rafter details

Breadth of timber section	ns;	b = 50 r	nm;	Depth o	of timber	sections;	; h = 200 n	nm
Rafter spacing; s = 400	mm;	Rafter s	ipan;	Single s	pan			
Clear length of span on sl	ope;	L _{cl} = 41 5	57 mm;	Rafter s	lope;	α = 30.	0 deg	
Timber strength class;	C24							
Section properties								
Cross sectional area of ra	fter;	A = 100	00 mm²;	Section	modulus	; Z = 333	333 mm³	
Radius of gyration;	r = 58 n	nm;	Second	moment	of area;	= 3333	33333 mmʻ	4
Loading details								
Rafter self weight;	F _j = 0.0	3 kN/m;	Dead lo	ad on slo	ope;	F _d = 1.0	2 kN/m²	
Imposed snow load on pl	an;	F _u = 0.6	0 kN/m²;	Impose	d point lo	ad;	F _p = 0.90	kN
Modification factors								
Section depth factor;	K7 = 1.0	95;	Load sh	aring fac	tor;	K ₈ = 1.1	0	
Consider long term load	conditio	<u>1</u>						
Load duration factor;	K3 = 1.0	0;	Total UI	DL perp.	to rafter;	F = 0.38	33 kN/m	
Notional bearing length;	L _b = 6 m	ım;	Effectiv	e span;	L _{eff} = 41	63 mm		
Check bending stress								
Permissible bending stres	ss;	σ_{m_adm} =	= 8.626 N	/mm²;	Applied	bending	stress;	σ _{m_max} = 2.489 N/mm ²
				PA	SS - Appl	ied bend	ing stress	within permissible limits
Check compressive stress	s paralle	to grain						
Permissible comp. stress;	$\sigma_{c_{adm}}$ =	5.038 N/	/mm²;	Applied	l compres	sive stre	ss;	$\sigma_{c_{max}}$ = 0.276 N/mm ²
				PASS -	Applied c	ompress	ive stress	within permissible limits
Check combined bending	g and cor	npressive	e stress p	arallel to	grain			
Combined loading check;	0.349 <	1						

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Check shear stress	PASS - Combined o	compressive an	d bending stresses are	e within permissible lir
Permissible shear stress;	τ _{adm} = 0.781 N/mm ² ;	Applied she	ar stress; τ _{max} = 0	.120 N/mm²
		PASS	5 - Applied shear stress	s within permissible lir
Check deflection				
Permissible deflection;	δ _{adm} = 12.489 mm;	Total deflec ⁴	tion; δ _{max} = 4.309 mm	
		I	PASS - Total deflectior	n within permissible lin
Consider medium term lo	oad condition			
Load duration factor;	K ₃ = 1.25 ; Total	UDL perp. to ra	fter; F = 0.563 kN/m	
Notional bearing length;	$L_b = 9 \text{ mm}; \text{ Effect}$	ive span; L _{eff}	= 4166 mm	
Check bending stress		-		
Permissible bending stres	SS;	3 N/mm ² ; Apr	olied bending stress;	σ _{m_max} = 3.664 N/ mi
-	_	PASS - /	Applied bending stress	s within permissible lii
Check compressive stress	s parallel to grain		-	
Permissible comp. stress;	σ _{c_adm} = 5.828 N/mm ² ;	Applied corr	pressive stress;	σ _{c_max} = 0.406 N/mn
		PASS - Appl	ied compressive stress	s within permissible lii
Check combined bending	g and compressive stress	parallel to grai	n	
Combined loading check;	0.418 < 1			
	PASS - Combined	compressive an	d bending stresses are	e within permissible lii
Check shear stress				
Permissible shear stress;	τ _{adm} = 0.976 N/mm ² ;	Applied shea	ar stress; τ _{max} = 0	.176 N/mm²
		PASS	- Applied shear stress	s within permissible lii
Check deflection				
Permissible deflection;	δ_{adm} = 12.497 mm;	Total deflect	tion; δ_{max} = 6.350 mm	
		I	PASS - Total deflectior	n within permissible lin
Consider short term load	condition			
Load duration factor;	K ₃ = 1.50 ; Total	UDL perp. to ra	fter; F = 0.383 kN/m	
	L _b = 9 mm; Effect	ivo coon. I		
Notional bearing length;	- ,	live span; Leff	= 4166 mm	
Notional bearing length; Check bending stress	- ,	live span; L _{eff}	= 4166 mm	
Notional bearing length; Check bending stress Permissible bending stres	s; σ _{m_adm} = 12.93	9 N/mm ² ; App	= 4166 mm blied bending stress;	თ _{m_max} = 4.928 N/mi
Notional bearing length; Check bending stress Permissible bending stres	;s; σ _{m_adm} = 12.93	9 N/mm²; App 9 A /mm²; App	= 4166 mm blied bending stress; Applied bending stres :	თ _{m_max} = 4.928 N/mi s within permissible lir
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress	s; σ _{m_adm} = 12.93 s parallel to grain	9 N/mm²; Apį <i>PASS - J</i>	= 4166 mm blied bending stress; Applied bending stres :	σ _{m_max} = 4.928 N/mi s within permissible lin
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress Permissible comp. stress;	ss; $\sigma_{m_{adm}} = 12.93$ s parallel to grain $\sigma_{c_{adm}} = 6.461 \text{ N/mm}^2;$	9 N/mm ² ; Apj PASS - J	= 4166 mm blied bending stress; Applied bending stres : hpressive stress;	σ _{m_max} = 4.928 N/mi s within permissible lin σ _{c_max} = 0.321 N/mn
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress Permissible comp. stress;	ss; $\sigma_{m_{adm}} = 12.93$ s parallel to grain $\sigma_{c_{adm}} = 6.461 \text{ N/mm}^2;$	9 N/mm ² ; Apj <i>PASS - J</i> Applied com <i>PASS - Appl</i>	= 4166 mm olied bending stress; Applied bending stress ppressive stress; ied compressive stres ;	σ _{m_max} = 4.928 N/mi s within permissible lin σ _{c_max} = 0.321 N/mn s within permissible lin
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending	ss; $\sigma_{m_{adm}} = 12.93$ s parallel to grain $\sigma_{c_{adm}} = 6.461 \text{ N/mm}^2$; ; and compressive stress	9 N/mm ² ; App PASS - , Applied com PASS - Appl parallel to grai	= 4166 mm olied bending stress; Applied bending stress opressive stress; ied compressive stress n	σ _{m_max} = 4.928 N/m s within permissible lin σ _{c_max} = 0.321 N/mr s within permissible lin
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check;	ss; $\sigma_{m_{adm}} = 12.93$ s parallel to grain $\sigma_{c_{adm}} = 6.461 \text{ N/mm}^2$; s and compressive stress 0.437 < 1	9 N/mm ² ; App PASS - 7 Applied com PASS - Appl parallel to grai	= 4166 mm olied bending stress; Applied bending stress npressive stress; ied compressive stress n	σ _{m_max} = 4.928 N/m s within permissible lin σ _{c_max} = 0.321 N/mr s within permissible lin
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress; Permissible comp. stress; Check combined bending Combined loading check;	ss; $\sigma_{m_{adm}} = 12.93$ s parallel to grain $\sigma_{c_{adm}} = 6.461 \text{ N/mm}^2$; g and compressive stress 0.437 < 1 PASS - Combined of	9 N/mm ² ; App PASS - J Applied com PASS - Appl parallel to grai	= 4166 mm blied bending stress; Applied bending stress apressive stress; ied compressive stress n d bending stresses are	σ _{m_max} = 4.928 N/mi s within permissible lin σ _{c_max} = 0.321 N/mn s within permissible lin e within permissible lin
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check; Check shear stress	ss; $\sigma_{m_adm} = 12.93$ s parallel to grain $\sigma_{c_adm} = 6.461 \text{ N/mm}^2$; g and compressive stress 0.437 < 1 PASS - Combined of	9 N/mm ² ; App PASS - 7 Applied com PASS - Appl parallel to grai	= 4166 mm olied bending stress; Applied bending stress npressive stress; ied compressive stress n d bending stresses are	σ _{m_max} = 4.928 N/mi s within permissible lin σ _{c_max} = 0.321 N/mn s within permissible lin e within permissible lin
Notional bearing length; Check bending stress Permissible bending stress Check compressive stress; Permissible comp. stress; Check combined bending Combined loading check; Check shear stress Permissible shear stress;	ss; $\sigma_{m_adm} = 12.93$ s parallel to grain $\sigma_{c_adm} = 6.461 \text{ N/mm}^2$; g and compressive stress 0.437 < 1 PASS - Combined of $\tau_{adm} = 1.172 \text{ N/mm}^2$;	9 N/mm ² ; App PASS - J Applied com PASS - Appl parallel to grai compressive an Applied shea	 = 4166 mm olied bending stress; Applied bending stress; ied compressive stress; n d bending stresses are ar stress; τ_{max} = 0 	σ _{m_max} = 4.928 N/mi s within permissible lin σ _{c_max} = 0.321 N/mn s within permissible lin e within permissible lin

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Check deflection

Permissible deflection; $\delta_{adm} = 12.498 \text{ mm};$

Total deflection; $\delta_{max} = 7.726 \text{ mm}$

PASS - Total deflection within permissible limits

Provide 50x200 C24 at max. 400mm centres

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MONOPITCH RAFTER DESIGN

TIMBER RAFTER DESIGN (BS5268-2:2002)

TEDDS calculation version 1.0.03 6 degrees 2815-**Rafter details** Breadth of timber sections; b = **50** mm; Depth of timber sections; h = 150 mm Rafter spacing; s = **400** mm; Rafter span; Single span Clear length of span on slope; L_{cl} = **2815** mm; Rafter slope; α = 6.0 deg Timber strength class; C24 Section properties A = **7500** mm²; Section modulus; Z = 187500 mm³ Cross sectional area of rafter; Radius of gyration; r = **43** mm; Second moment of area; I = 14062500 mm⁴ Loading details Rafter self weight; $F_j = 0.03 \text{ kN/m}$; Dead load on slope; $F_d = 1.02 \text{ kN/m}^2$ Imposed snow load on plan; $F_u = 0.75 \text{ kN/m}^2$; Imposed point load; F_p = **0.90** kN **Modification factors** Section depth factor; K₇ = 1.08; Load sharing factor; K₈ = 1.10 Consider long term load condition Load duration factor; K₃ = **1.00**; Total UDL perp. to rafter; F = 0.431 kN/m Notional bearing length; L_b = 5 mm; Effective span; Leff = 2820 mm **Check bending stress** Permissible bending stress; $\sigma_{m adm} = 8.904 \text{ N/mm}^2;$ Applied bending stress; $\sigma_{m max} = 2.287 \text{ N/mm}^2$ PASS - Applied bending stress within permissible limits Check compressive stress parallel to grain Permissible comp. stress; $\sigma_{c_{adm}} = 5.475 \text{ N/mm}^2$; Applied compressive stress; σ_{c_max} = **0.797** N/mm² PASS - Applied compressive stress within permissible limits Check combined bending and compressive stress parallel to grain Combined loading check; 0.415 < 1 PASS - Combined compressive and bending stresses are within permissible limits **Check shear stress** Permissible shear stress; $\tau_{adm} = 0.781 \text{ N/mm}^2$; Applied shear stress; $\tau_{max} = 0.122 \text{ N/mm}^2$ PASS - Applied shear stress within permissible limits

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	I			
Check deflection				
Permissible deflection:	δ - 8 160 mm; ⁻	Total deflection: S.		
			DASS Total doflacti	on within normissible lin
A			PASS - Total deflection	on within permissible in
Consider medium term ic				
Load duration factor;	$K_3 = 1.25;$	otal UDL perp. to r	aπer; F = 0.728 kN/m	1
Notional bearing length;	$L_b = 8 \text{ mm};$	Effective span; Le	_f = 2823 mm	
Check bending stress				
Permissible bending stres	s; $\sigma_{m_{adm}} = 1$	L 1.130 N/mm ² ; Ap	oplied bending stress;	σ _{m_max} = 3.869 N/mr
		PASS -	Applied bending stre	ss within permissible lin
Check compressive stress	s parallel to grain			
Permissible comp. stress;	$\sigma_{c_{adm}}$ = 6.440 N/m	nm ² ; Applied co	mpressive stress;	σc_max = 1.347 N/mm
		PASS - App	lied compressive stre	ess within permissible lin
Check combined bending	and compressive s	tress parallel to gra	in	-
Combined loading check:	0.584 < 1			
	PASS - Combi	ned compressive a	nd handing strasses o	re within nermissihle lin
Chack shoor stross	1 455 - Combi		ia benang stresses a	
Check shear stress	0.076 N/mm	2 Averaliantala		0 20C N /mm ²
Permissible snear stress;	τ _{adm} = 0.976 N/mm	1 ⁻ ; Applied she	ear stress; $\tau_{max} =$	0.206 N/mm ⁻
		PAS	S - Applied shear stre	ess within permissible lin
Check deflection				
Permissible deflection;	δ _{adm} = 8.470 mm; 1	Total deflection; δ_n	_{ax} = 4.138 mm	
			PASS - Total deflection	on within permissible lin
Consider short term load	condition			
Load duration factor;	K ₃ = 1.50 ;	Total UDL perp. to r	after; F = 0.431 kN/m	ı
Notional bearing length;	L _b = 8 mm; f	Effective span; L _{et}	_f = 2823 mm	
Check hending stress		•		
Permissible bending stress	s: σ _{m adm} = 1	3.355 N/mm ² · Ar	onlied bending stress:	ດ _{ຫຼາສະ} = 5.662 N/mr
Permissible bending stress	s; σ _{m_adm} = 1	L 3.355 N/mm ² ; Ap	oplied bending stress;	σ _{m_max} = 5.662 N/mr
Permissible bending stress	s; $\sigma_{m_{adm}} = 1$	L 3.355 N/mm²; Ap PASS -	oplied bending stress; Applied bending stre	σ _{m_max} = 5.662 N/mr
Permissible bending stress Check compressive stress	s; $\sigma_{m_{adm}} = 1$	L 3.355 N/mm ² ; Ap <i>PASS</i> -	oplied bending stress; Applied bending stre	σ _{m_max} = 5.662 N/mr
Permissible bending stress Check compressive stress Permissible comp. stress;	s; $\sigma_{m_{adm}} = 1$ s parallel to grain $\sigma_{c_{adm}} = 7.250 \text{ N/m}$	L 3.355 N/mm ² ; Applied con	oplied bending stress; Applied bending stree	$\sigma_{m_max} =$ 5.662 N/mr ess within permissible lin $\sigma_{c_max} =$ 0.811 N/mm
Permissible bending stress Check compressive stress Permissible comp. stress;	s; $\sigma_{m_adm} = 1$ parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$	L 3.355 N/mm ² ; Ap <i>PASS -</i> hm ² ; Applied con <i>PASS - App</i>	oplied bending stress; Applied bending stre mpressive stress; blied compressive stre	σ _{m_max} = 5.662 N/mr ess within permissible lin σ _{c_max} = 0.811 N/mm ess within permissible lin
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending	s; σ _{m_adm} = 1 s parallel to grain σ _{c_adm} = 7.250 N/m ; and compressive s	L3.355 N/mm ² ; App PASS - hm ² ; Applied con PASS - App tress parallel to gra	oplied bending stress; <i>Applied bending stre</i> mpressive stress; olied compressive stre nin	σ _{m_max} = 5.662 N/mr ess within permissible lin σ _{c_max} = 0.811 N/mm ess within permissible lin
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check;	s; $\sigma_{m_adm} = 1$ parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$ and compressive s 0.554 < 1	L 3.355 N/mm ² ; Applied con PASS - hm ² ; Applied con PASS - App tress parallel to gra	oplied bending stress; Applied bending stree mpressive stress; blied compressive stree nin	σ _{m_max} = 5.662 N/mr ess within permissible lin σ _{c_max} = 0.811 N/mm ess within permissible lin
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check;	s; $\sigma_{m_adm} = 1$ s parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$ s and compressive s 0.554 < 1 PASS - Combi	L3.355 N/mm ² ; Applied con PASS - nm ² ; Applied con PASS - App tress parallel to gra	oplied bending stress; Applied bending stree mpressive stress; olied compressive stree nin md bending stresses a	σ _{m_max} = 5.662 N/mr ess within permissible lin σ _{c_max} = 0.811 N/mm ess within permissible lin are within permissible lin
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check; Check shear stress	s; $\sigma_{m_adm} = 1$ sparallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$ and compressive s 0.554 < 1 <i>PASS - Combi</i>	L3.355 N/mm ² ; Applied con PASS - nm ² ; Applied con PASS - App tress parallel to gra ined compressive a	oplied bending stress; Applied bending stre mpressive stress; alied compressive stre nin nd bending stresses a	$\sigma_{m_max} =$ 5.662 N/mr ass within permissible lin $\sigma_{c_max} =$ 0.811 N/mr ass within permissible lin are within permissible lin
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check; Check shear stress Permissible shear stress;	s; $\sigma_{m_adm} = 1$ s parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$; and compressive s 0.554 < 1 <i>PASS - Combi</i> $\tau_{adm} = 1.172 \text{ N/mm}$	L3.355 N/mm ² ; Applied con PASS - Applied con PASS - App tress parallel to gra ined compressive an n ² ; Applied sho	oplied bending stress; Applied bending stre mpressive stress; died compressive stre in nd bending stresses a ear stress; τ _{max} =	σ _{m_max} = 5.662 N/mr ess within permissible lin σ _{c_max} = 0.811 N/mm ess within permissible lin are within permissible lin 0.301 N/mm ²
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check; Check shear stress Permissible shear stress;	s; $\sigma_{m_adm} = 1$ s parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$ s and compressive s 0.554 < 1 <i>PASS - Combi</i> $\tau_{adm} = 1.172 \text{ N/mm}$	L3.355 N/mm ² ; Applied con PASS - PASS - Applied con PASS - App tress parallel to gra ined compressive a h ² ; Applied sho PAS	pplied bending stress; Applied bending stress; ppressive stress; plied compressive stress; nd bending stresses a ear stress; τ _{max} = S - Applied shear stress;	σm_max = 5.662 N/mr ess within permissible lin σc_max = 0.811 N/mr ess within permissible lin ure within permissible lin 0.301 N/mm² ess within permissible lin
Permissible bending stress Check compressive stress Permissible comp. stress; Check combined bending Combined loading check; Check shear stress Permissible shear stress; Check deflection	s; $\sigma_{m_adm} = 1$ s parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$; and compressive s 0.554 < 1 <i>PASS - Combi</i> $\tau_{adm} = 1.172 \text{ N/mm}$	L3.355 N/mm ² ; Applied con PASS - Applied con PASS - App tress parallel to gra ined compressive an n ² ; Applied sho PAS	pplied bending stress; Applied bending stress; plied compressive stress; blied compressive stress; hin hd bending stresses a ear stress; τ _{max} = S - Applied shear stress;	σ _{m_max} = 5.662 N/mr ess within permissible lin σ _{c_max} = 0.811 N/mr ess within permissible lin ere within permissible lin 0.301 N/mm ² ess within permissible lin
Permissible bending stress Permissible bending stress Permissible comp. stress; Check combined bending Combined loading check; Check shear stress Permissible shear stress; Check deflection Permissible deflection;	s; $\sigma_{m_adm} = 1$ s parallel to grain $\sigma_{c_adm} = 7.250 \text{ N/m}$ s and compressive s 0.554 < 1 <i>PASS - Combi</i> $\tau_{adm} = 1.172 \text{ N/mm}$	L3.355 N/mm ² ; Applied con PASS - Applied con PASS - Applied con PASS - Applied to grading tress parallel to grading ined compressive and PAS Total deflection: S	pplied bending stress; Applied bending stress; pressive stress; lied compressive stres; in and bending stresses a ear stress; τ _{max} = S - Applied shear stress; and stress stress; τ _{max} =	σm_max = 5.662 N/mr ess within permissible line σc_max = 0.811 N/mr ess within permissible line inre within permissible line 0.301 N/mm² ess within permissible line

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	West	nill Pavilion	24
1 12	Job Ref.	Calc. by	Date
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	0***	vide F0v1F0 C24 refters a	t may 100mm control
	<u>F10</u>	vide 50x150 C24 rujters d	t max. 400mm centres

Project		Sheet no./rev.
Westhill F	avilion	25
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Doc. Ref	Chk'd by	Date
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Foundation Design:

Loadings

UDL from Pitched Roof			
Width of roof being carried;	x ₁ = 2.0 m		
Dead Load;	$DL_1 = 1.178 \text{ kN/m}^2 \times x_1$	=	2.356 kN/m
Imposed Load;	$IL_1 = 0.60 \text{ kN/m}^2 \times x_1$	=	1.200 kN/m
UDL from Mono-pitched Roof			
Width of roof being carried;	x ₂ = 1.4 m		
Dead Load;	$DL_2 = 1.026 \text{ kN/m}^2 \times x_2$	=	1.436 kN/m
Imposed Load;	$IL_2 = 0.75 \text{ kN/m}^2 \times x_2$	=	1.050 kN/m
UDL from Masonry Wall			
Height of wall being carried;	x ₃ = 3.0 m		
Dead Load (Inner Leaf);	$DL_{3a} = 2.00 \text{ kN/m}^2 \times x_3$	=	6.000 kN/m
Dead Load (Outer Leaf);	DL_{3b} = 2.20 kN/m ² × x ₃	=	6.600 kN/m
UDL from Beam and Block Floor			
Width of roof being carried;	x ₄ = 1.4 m		
Dead Load;	$DL_4 = 4.50 \text{ kN/m}^2 \times x_4$	=	6.300 kN/m
Imposed Load;	$IL_4 = 2.50 \text{ kN/m}^2 \times x_4$	=	3.500 kN/m
Total UDL			
Total Dead UDL;	$DL_T = sum(DL_1, DL_2, DL_{3a}, DL_{3b}, DL_4)$	=	22.692 kN/m
Total Imposed UDL;	$IL_T = sum(IL_1, IL_2, IL_4)$	=	5.750 kN/m
Total UDL;	$w_T = DL_T + IL_T$	=	28.442 kN/m

STRIP FOOTING ANALYSIS & DESIGN (BS8110)

STRIP FOOTING ANALYSIS AND DESIGN (BS8110-1:1997)

Tedds calculation version 2.0.07

	Project		Sheet no./rev.
		Westhill Pavilion	
	Job Ref.	Calc. by	Date
	M	2-2572 MD	Feb-23
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	700		
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	68.5 kN/m ²	68.5 kN/m ²	
Strip footing details			
Strip footing details Width of strip footing;	B = 600 mm;	Depth of strip footing;	h = 300 mm
Strip footing details Width of strip footing; Depth of soil over strip footir	B = 600 mm; ng; h _{soil} = 700 mm;	Depth of strip footing; Density of concrete;	h = 300 mm ρ _{conc} = 23.6 kN/m³
Strip footing details Width of strip footing; Depth of soil over strip footin Load details	B = 600 mm; ng; h _{soil} = 700 mm;	Depth of strip footing; Density of concrete;	h = 300 mm ρ _{conc} = 23.6 kN/m³
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width;	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm;	Depth of strip footing; Density of concrete; Load eccentricity;	h = 300 mm ρ _{conc} = 23.6 kN/m ³ e _P = 0 mm
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm;	Depth of strip footing; Density of concrete; Load eccentricity;	h = 300 mm ρ _{conc} = 23.6 kN/m ³ e _P = 0 mm
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm;	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil;	h = 300 mm ρ _{conc} = 23.6 kN/m ³ e _P = 0 mm ρ _{soil} = 20.0 kN/m ³
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure;	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; P _{bearing} = 100 kN/m ²	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil;	h = 300 mm ρ _{conc} = 23.6 kN/m ³ e _P = 0 mm ρ _{soil} = 20.0 kN/m ³
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; P _{bearing} = 100 kN/m ²	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil;	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e_P = 0 mm ρ_{soil} = 20.0 kN/m ³
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load;	B = 600 mm; hg; $h_{soil} = 700$ mm; b = 300 mm; g; $h_{soil} = 700$ mm; $P_{bearing} = 100$ kN/m ² g $P_G = 22.7$ kN/m;	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load;	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e_P = 0 mm ρ_{soil} = 20.0 kN/m ³ P_Q = 5.8 kN/m
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load;	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; Pbearing = 100 kN/m ² G P _G = 22.7 kN/m; P _W = 0.0 kN/m;	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load;	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e_P = 0 mm ρ_{soil} = 20.0 kN/m ³ P_Q = 5.8 kN/m P = 28.4 kN/m
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; P _{bearing} = 100 kN/m ² G P _G = 22.7 kN/m; P _W = 0.0 kN/m;	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load;	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load:	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; P _{bearing} = 100 kN/m ² G P _G = 22.7 kN/m; P _W = 0.0 kN/m; F _{GSUF} = 0.000 kN/m ² :	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load;	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Osur} = 0.000 kN/m ²
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight:	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; Pbearing = 100 kN/m ² G P _G = 22.7 kN/m; P _W = 0.0 kN/m; F _{Gsur} = 0.000 kN/m ² ; F _{swt} = 7.080 kN/m ² :	Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight:	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ²
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load:	B = 600 mm; $h_{soil} = 700 \text{ mm};$ b = 300 mm; $g; h_{soil} = 700 \text{ mm};$ $P_{bearing} = 100 \text{ kN/m}^2$ $F_{G} = 22.7 \text{ kN/m};$ $P_{W} = 0.0 \text{ kN/m};$ $F_{Gsur} = 0.000 \text{ kN/m}^2;$ $F_{swt} = 7.080 \text{ kN/m}^2;$ F = 12.6 kN/m	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ²
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load;	H = 600 mm; H = 600 mm; H = 700 mm; H = 300 mm; H = 300 mm; H = 300 mm; $H = 100 \text{ kN/m^2};$ H = 100 kN/m; $H = 100 \text{ kN/m^2};$ H = 12.6 kN/m;	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ²
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load; Calculate base reaction	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; Pbearing = 100 kN/m ² $P_{G} = 22.7 \text{ kN/m};$ $P_{W} = 0.0 \text{ kN/m};$ $F_{Gsur} = 0.000 \text{ kN/m}^{2};$ $F_{Swt} = 7.080 \text{ kN/m}^{2};$ F = 12.6 kN/m T = 41.1 kN/m;	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ²
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load; Calculate base reaction Total base reaction;	B = 600 mm; $h_{soil} = 700 \text{ mm};$ b = 300 mm; $g; h_{soil} = 700 \text{ mm};$ $P_{bearing} = 100 \text{ kN/m}^2$ $F_{G} = 22.7 \text{ kN/m};$ $P_{W} = 0.0 \text{ kN/m};$ $F_{Gsur} = 0.000 \text{ kN/m}^2;$ $F_{swt} = 7.080 \text{ kN/m}^2;$ F = 12.6 kN/m T = 41.1 kN/m;	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; Eccentricity of base reaction Base reaction acts 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ² n; e _T = 0 mm within middle third of base
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load; Calculate base reaction Total base reaction;	B = 600 mm; ng; h _{soil} = 700 mm; b = 300 mm; g; h _{soil} = 700 mm; Pbearing = 100 kN/m ² P _G = 22.7 kN/m; P _W = 0.0 kN/m; F _{Gsur} = 0.000 kN/m ² ; F _{swt} = 7.080 kN/m ² ; F = 12.6 kN/m T = 41.1 kN/m;	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; Eccentricity of base reaction Base reaction acts 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ² n; e _T = 0 mm within middle third of bass
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load; Calculate base reaction Total base reaction;	$H = 600 \text{ mm};$ $hg; h_{soil} = 700 \text{ mm};$ $b = 300 \text{ mm};$ $g; h_{soil} = 700 \text{ mm};$ $P_{bearing} = 100 \text{ kN/m}^2$ $F_G = 22.7 \text{ kN/m};$ $P_W = 0.0 \text{ kN/m};$ $F_{Gsur} = 0.000 \text{ kN/m}^2;$ $F_{swt} = 7.080 \text{ kN/m}^2;$ $F = 12.6 \text{ kN/m}$ $T = 41.1 \text{ kN/m};$ $F_{Gsur} = 68.482 \text{ kN/m}^2;$	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; Eccentricity of base reaction Base reaction acts 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ $e_P = 0$ mm ρ_{soil} = 20.0 kN/m ³ $P_Q = 5.8 kN/m$ P = 28.4 kN/m $F_{Qsur} = 0.000 kN/m2$ $F_{soil} = 14.000 kN/m2$ n; $e_T = 0$ mm within middle third of bass
Strip footing details Width of strip footing; Depth of soil over strip footin Load details Load width; Soil details Depth of soil over pad footing Allowable bearing pressure; Axial loading on strip footing Dead axial load; Wind axial load; Foundation loads Dead surcharge load; Strip footing self weight; Total foundation load; Calculate base reaction Total base reaction; Calculate pad base pressures; Base pressures;	$H = 600 \text{ mm};$ $h_{soil} = 700 \text{ mm};$ $h = 300 \text{ mm};$ $h = 300 \text{ mm};$ $h_{soil} = 700 \text{ mm};$ $P_{bearing} = 100 \text{ kN/m}^2$ $P_{G} = 22.7 \text{ kN/m};$ $P_{W} = 0.0 \text{ kN/m};$ $F_{Gsur} = 0.000 \text{ kN/m}^2;$ $F_{swt} = 7.080 \text{ kN/m}^2;$ $F = 12.6 \text{ kN/m}$ $T = 41.1 \text{ kN/m};$ $q_1 = 68.483 \text{ kN/m}^2;$ $q_1 = 68.483 \text{ kN/m}^2;$	 Depth of strip footing; Density of concrete; Load eccentricity; Density of soil; Imposed axial load; Total axial load; Imposed surcharge load; Soil self weight; Eccentricity of base reaction Base reaction acts q₂ = 68.483 kN/m² Maximum base reaction 	h = 300 mm ρ_{conc} = 23.6 kN/m ³ e _P = 0 mm ρ_{soil} = 20.0 kN/m ³ P _Q = 5.8 kN/m P = 28.4 kN/m F _{Qsur} = 0.000 kN/m ² F _{soil} = 14.000 kN/m ² n; e _T = 0 mm within middle third of bas

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		I	
Material details			
	$f = 20 \text{N} / \text{mm}^2$		

Ave.pressure to left of footing; $q_L = 68.483 \text{ kN/m}^2$;

Ave.pressure to right of footing;

footing; h_{Rmin} = **150** mm

Min.depth unreinforced footing;

h_{min} = **300** mm

q_R = **68.483** kN/m²;

PASS - Unreinforced strip footing depth is greater than minimum

Min.depth to left of footing; $h_{Lmin} = 150 \text{ mm}$

Min.depth to right of

Provide 600w x 300thk GEN3 mass concrete foundation