

2 Brunel Avenue
Leicester
LE3 9BU

info@structuralcalcs.co.uk

www.structuralcalcs.co.uk

07598895578

**Wharf Farm Cottage, Shackerstone, Nuneaton CV13 6NW
Piling and Ground Beam Calculations.**

Bhavin Gulab – MSc – BEng – Civil and Structural Engineer

[Google Reviews](#)

Job No : 2826

Issue : 1

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	Item Piling and Ground Beam Calcs		Sheet No 2
	Designed By BG	Checked By BG	Date 20/06/24

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1. Basis of structural design

All design has been carried out in accordance with the current British Standards (Eurocodes):

BS EN 1990:2002 Eurocode 1: Basis of Structural Design.

BS EN 1991-1-1:2002 Eurocode 1: Actions on structures. General actions – Densities, self-weight, imposed loads

BS EN 1991-1-4:2005 Eurocode 1: Actions on structures. General actions – Wind actions

BS EN 1992-1-1:2004 Eurocode 2: Design of concrete structures

BS EN 1993-1-1:2005 Eurocode 3: Design of steel structures

BS EN 1997-1:2004 Eurocode 7: Geotechnical design

These calculations should be read in conjunction with any relevant architectural details and drawings.

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2. Standard Loadings

Walls		
Internal Stud Wall Studding 2 * Plasterboard	0.20 kN/m ² 0.30 kN/m ²	WL 0.50 kN/m²
100 Lightweight Block Wall (Internal) Blockwork 2 x Plaster	1.00 kN/m ² 0.50 kN/m ²	WL 1.50 kN/m²
140 Lightweight Block Wall (Internal) Blockwork 2 x Plaster	1.40 kN/m ² 0.50 kN/m ²	WL 1.90 kN/m²
External Tile/Stud Wall Studding Plasterboard Battens, Felt and Insulation Tile Hanging	0.10 kN/m ² 0.15 kN/m ² 0.15 kN/m ² 0.60 kN/m ²	WL 1.00 kN/m²
External Brick/Block cavity Wall Brick 100 Lightweight Block Plaster	2.10 kN/m ² 1.00 kN/m ² 0.25 kN/m ²	WL 3.35 kN/m²
215 Dense Block/Brick Wall Blockwork 2 x Plasterboard	4.30 kN/m ² 0.30 kN/m ²	WL 4.60 kN/m²
275 Lightweight Block Cavity Wall 2 x 100 Blockwork 2 x Plasterboard	2.20 kN/m ² 0.30 kN/m ²	WL 2.50 kN/m²

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Roofs and Floors		
Sloping Roofs (on plan)		
Tiles	0.85 kN/m ²	DL 1.05 kN/m ²
Battens and felt	0.10 kN/m ²	LL 0.75 kN/m ²
Rafters	0.10 kN/m ²	WL 1.80 kN/m²
Live Load	0.75 kN/m ²	
Roof Space		
Joists and Insulation	0.10 kN/m ²	DL 0.25 kN/m ²
Soffit	0.15 kN/m ²	LL 0.25 kN/m ²
Live Load	0.25 kN/m ²	WL 0.50 kN/m²
Flat Timber Roofs		
Chippings and Felt	0.40 kN/m ²	DL 1.05 kN/m ²
Boards Joists and Firings	0.45 kN/m ²	LL 0.75 kN/m ²
Soffit and Insulation	0.20 kN/m ²	WL 1.8 kN/m²
Live Load	0.75 kN/m ²	
Timber Floors		
Boards and Joists	0.30 kN/m ²	DL 1.45 kN/m ²
Soffit	0.15 kN/m ²	LL 1.50 kN/m ²
Live Load	1.50 kN/m ²	WL 2.95 kN/m²
Partitions	1.00 kN/m ²	
PC Floors		
150 PCC Slab (200)	3.10 kN/m ²	DL 4.62 kN/m ²
Screed	1.40 kN/m ²	LL 1.50 kN/m ²
Insulation	0.07 kN/m ²	WL 6.12 kN/m²
Finishes	0.05 kN/m ²	
Live Load	1.50 kN/m ²	

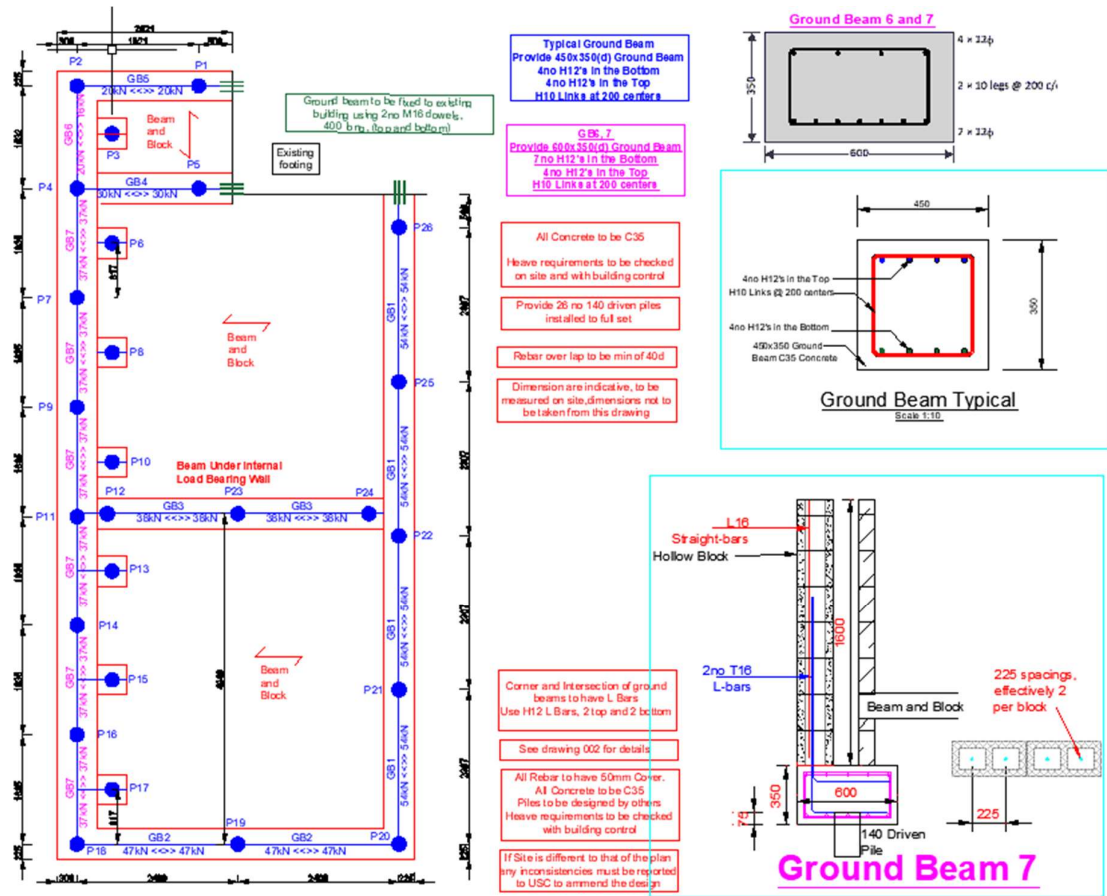
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3. Construction notes

- 1) All calculations, details & proposals must be fully checked and approved (by the Building Control Engineer) prior to starting any work, such that any errors or discrepancies can be brought to the attention of The structural engineer so that adjustments can be made prior to construction.
- 2) Any work that starts before written approval has been given from the Local Authority Building Control Department is at the contractors own risk.
- 3) Liability is limited to the cost of the work covered by this design (ie: the cost of the proposed structural work). Use of these calculations is limited to this term and condition.
- 4) It is the Pile Contractors responsibility to ensure that the ground conditions are suitable for the pile loads. Driven Piles in Clay, may require pre-boring to achieve the required pile depths.
- 5) The specification for any tree or clay heave protection requirements for the piles, ground beams & floor slab are the responsibility of the Customer.
- 6) Piles must be installed central to the ground beams and in the positions shown on the design layout; tolerance = +/- 75mm.
- 7) All setting out must be checked on site by the Main Contractor & Customer before commencement, any discrepancies should be brought to the attention of the Engineer so that adjustments can be made prior to piling.
- 8) The Customer & Contractor must ensure all existing services, sewers & drains are located and protected or moved if located near a pile positions.
- 9) The Contractor must ensure that all existing structures are adequately protected, supported and stable whilst the work is being undertaken.
- 10) Any requirements for heave protection for the Piles & Ground Beams are to be specified by the Geotechnical Engineer or others. No SI provided, tbc on site and engineer to be informed if different.
- 11) Design based on information provided

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4. Proposed plan and elevations.



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5. Ground Conditions

No SI therefore use BGS website = <https://api.bgs.ac.uk/sobi-scans/v1/borehole/scans/items/18962988>

Heave board requirement to be determined on site by building control

C. STRATA LOG		
Description of Strata	Thickness (m)	Depth (m)
Top soil	0.5	0.5
Sandy pebbly clays	2.5	3
Red/grey mudstones	70.5	73.5

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6. Calculations

1. Load Run Down

<u>Ground Beam BM AND SF Derivations</u>					
Cavity Wall	3.4 kN/m ²				
Sleeper Wall	2.1 kN/m ²				
Ground Beam	4.9 kN/m				
Roof Load	1.8 kN/m ²				
Beam and Block	5.0 kN/m ²				
Internal Wall	2.2 kN/m ²				
1st Floor	2.5 kN/m ²				
GB1			GB2		
	m	kN/m		m	kN/m
Ground Beam		4.9	Ground Beam		4.9
Cavity Wall	4.0	13.4	Cavity Wall	5.5	18.4
Beam and Block	2.3	11.3	Beam and Block	0.4	2.0
1st Floor	2.3	5.635	1st Floor	0.4	0.98
Roof Load	1.1	2.0	Roof Load	2.5	4.5
Total		37.1	Total		30.8
Beam Length	2.3 m		Beam Length	2.4 m	
Beam Load	85.4 kN		Beam Load	73.8 kN	
Corner Load (x1.1)	47.0 kN		Corner Load (x1.1)	40.6 kN	
Intermediate Load (x1.25)	53.4 kN		Intermediate Load (x1.25)	46.1 kN	
Bending Moment (x1.45)	35.596 kNm		Bending Moment (x1.45)	32.1187 kNm	
Shear Force (x1.45)	61.906 kN		Shear Force (x1.45)	53.5311 kN	
GB3			GB4		
	m	kN/m		m	kN/m
Ground Beam		4.9	Ground Beam		4.9
Internal Wall	5.5	11.8	Cavity Wall	5.5	18.4
Beam and Block	1.0	5.0	Beam and Block	0.4	2.0
1st Floor	1.5	3.675	1st Floor	0.4	0.98
Roof Load	2.5	4.5	Roof Load	0.0	0.0
Total		29.9	Total		26.3
Beam Length	2.0 m		Beam Length	1.8 m	
Beam Load	59.7 kN		Beam Load	47.3 kN	
Corner Load (x1.1)	32.8 kN		Corner Load (x1.1)	26.0 kN	
Intermediate Load (x1.25)	37.3 kN		Intermediate Load (x1.25)	29.5 kN	
Bending Moment (x1.45)	21.649 kNm		Bending Moment (x1.45)	15.4241 kNm	
Shear Force (x1.45)	43.297 kN		Shear Force (x1.45)	34.2758 kN	

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GB5			GB6		
	m	kN/m		m	kN/m
Ground Beam		4.9	Ground Beam		4.9
Cavity Wall	3.0	10.1	Cavity Wall	3.0	10.1
Beam and Block	0.4	2.0	Beam and Block	0.4	2.0
1st Floor	0.4	0.98	1st Floor	0	0
Roof Load	0.0	0.0	Roof Load	1.0	1.8
Total		17.9	Total		18.7
Beam Length	1.8 m		Beam Length	1.5 m	
Beam Load	32.2 kN		Beam Load	28.1 kN	
Corner Load (x1.1)	17.7 kN		Corner Load (x1.1)	15.4 kN	
Intermediate Load (x1.25)	20.1 kN		Intermediate Load (x1.25)	17.5 kN	
Bending Moment (x1.45)	10.506 kNm		Bending Moment (x1.45)	7.63017 kNm	
Shear Force (x1.45)	23.346 kN		Shear Force (x1.45)	20.3471 kN	
GB7					
	m	kN/m			
Ground Beam		4.9			
Cavity Wall	4.0	13.4			
Beam and Block	2.3	11.3			
1st Floor	2.3	5.635			
Roof Load	1.1	2.0			
Total		37.1			
Beam Length	1.6 m				
Beam Load	59.4 kN				
Corner Load (x1.1)	32.7 kN				
Intermediate Load (x1.25)	37.1 kN				
Bending Moment (x1.45)	17.226 kNm				
Shear Force (x1.45)	43.065 kN				

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2. Ground Beam Calculation

RC BEAM DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national annex

Tedds calculation version 3.3.00

Concrete details - Table 3.1. Strength and deformation characteristics for concrete

Concrete strength class;	C28/35
Aggregate type;	Quartzite
Aggregate adjustment factor - cl.3.1.3(2);	AAF = 1.0
Characteristic compressive cylinder strength;	$f_{ck} = 28 \text{ N/mm}^2$
Mean value of compressive cylinder strength;	$f_{cm} = f_{ck} + 8 \text{ N/mm}^2 = 36 \text{ N/mm}^2$
Mean value of axial tensile strength;	$f_{ctm} = 0.3 \text{ N/mm}^2 \times (f_{ck} / 1 \text{ N/mm}^2)^{2/3} = 2.8 \text{ N/mm}^2$
Secant modulus of elasticity of concrete;	$E_{cm} = 22 \text{ kN/mm}^2 \times [f_{cm} / 10 \text{ N/mm}^2]^{0.3} \times \text{AAF} = 32308 \text{ N/mm}^2$
Ultimate strain - Table 3.1;	$\epsilon_{cu2} = 0.0035$
Shortening strain - Table 3.1;	$\epsilon_{cu3} = 0.0035$
Effective compression zone height factor;	$\lambda = 0.80$
Effective strength factor;	$\eta = 1.00$
Coefficient k_1 ;	$k_1 = 0.40$
Coefficient k_2 ;	$k_2 = 1.0 \times (0.6 + 0.0014 / \epsilon_{cu2}) = 1.00$
Coefficient k_3 ;	$k_3 = 0.40$
Coefficient k_4 ;	$k_4 = 1.0 \times (0.6 + 0.0014 / \epsilon_{cu2}) = 1.00$
Partial factor for concrete - Table 2.1N;	$\gamma_C = 1.50$
Compressive strength coefficient - cl.3.1.6(1);	$\alpha_{cc} = 0.85$
Design compressive concrete strength - exp.3.15;	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C = 15.9 \text{ N/mm}^2$
Compressive strength coefficient - cl.3.1.6(1);	$\alpha_{ccw} = 1.00$
Design compressive concrete strength - exp.3.15;	$f_{c wd} = \alpha_{ccw} \times f_{ck} / \gamma_C = 18.7 \text{ N/mm}^2$
Maximum aggregate size;	$h_{agg} = 20 \text{ mm}$
Monolithic simple support moment factor;	$\beta_1 = 0.25$

Reinforcement details

Characteristic yield strength of reinforcement;	$f_{yk} = 500 \text{ N/mm}^2$
Partial factor for reinforcing steel - Table 2.1N;	$\gamma_S = 1.15$
Design yield strength of reinforcement;	$f_{yd} = f_{yk} / \gamma_S = 435 \text{ N/mm}^2$

Nominal cover to reinforcement

Nominal cover to top reinforcement;	$c_{nom_t} = 50 \text{ mm}$
Nominal cover to bottom reinforcement;	$c_{nom_b} = 50 \text{ mm}$
Nominal cover to side reinforcement;	$c_{nom_s} = 75 \text{ mm}$

Fire resistance

Standard fire resistance period;	$R = 60 \text{ min}$
Number of sides exposed to fire;	3
Minimum width of beam - EN1992-1-2 Table 5.5;	$b_{min} = 120 \text{ mm}$

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Section 1 - Multiple layers

Rectangular section details

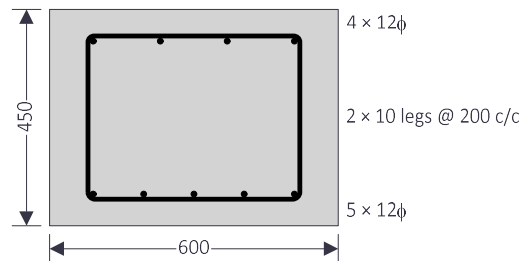
Section width;

b = 600 mm

Section depth;

h = 450 mm

PASS - Minimum dimensions for fire resistance met



Positive moment - section 6.1

Design bending moment;

M = M_{pos_s1} = 63.0 kNm

Effective depth of tension reinforcement;

d = 384 mm

Redistribution ratio;

δ = min(δ_{pos_s1}, 1) = 1.000

K = M / (b × d² × f_{ck}) = 0.025

K' = (2 × η × α_{cc} / γ_c) × (1 - λ × (δ - k₁) / (2 × k₂)) × (λ × (δ - k₁) / (2 × k₂)) = 0.207

K' > K - No compression reinforcement is required

Lever arm;

z = min(0.5 × d × [1 + (1 - 2 × K / (η × α_{cc} / γ_c))^{0.5}], 0.95 × d) = 365 mm

Depth of neutral axis;

x = 2 × (d - z) / λ = 48 mm

Area of tension reinforcement required;

A_{s,req} = M / (f_{yd} × z) = 397 mm²

Tension reinforcement provided;

5 × 12φ

Area of tension reinforcement provided;

A_{s,prov} = 565 mm²

Minimum area of reinforcement - exp.9.1N;

A_{s,min} = max(0.26 × f_{ctm} / f_{yk}, 0.0013) × b × d = 331 mm²

Maximum area of reinforcement - cl.9.2.1.1(3);

A_{s,max} = 0.04 × b × h = 10800 mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width;

w_k = 0.3 mm

Design value modulus of elasticity reinf - 3.2.7(4);

E_s = 200000 N/mm²

Mean value of concrete tensile strength;

f_{ct,eff} = f_{ctm} = 2.8 N/mm²

Stress distribution coefficient;

k_c = 0.4

Non-uniform self-equilibrating stress coefficient;

k = min(max(1 + (300 mm - min(h, b)) × 0.35 / 500 mm, 0.65), 1) = 0.90

Actual tension bar spacing;

s_{bar} = (b - (2 × (C_{nom_s} + φ_{s1_v}) + φ_{s1_b_L1} × N_{s1_b_L1})) / (N_{s1_b_L1} - 1) + φ_{s1_b_L1} = 104.5 mm

Maximum stress permitted - Table 7.3N;

σ_s = 316 N/mm²

Steel to concrete modulus of elast. ratio;

α_{cr} = E_s / E_{cm} = 6.19

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Distance of the Elastic NA from bottom of beam; $y = (b \times h^2 / 2 + A_{s,prov} \times (\alpha_{cr} - 1) \times (h - d)) / (b \times h + A_{s,prov} \times (\alpha_{cr} - 1)) = 223 \text{ mm}$

Area of concrete in the tensile zone; $A_{ct} = b \times y = 133974 \text{ mm}^2$

Minimum area of reinforcement required - exp.7.1; $A_{s,min} = k_c \times k \times f_{ct,eff} \times A_{ct} / \sigma_s = 419 \text{ mm}^2$

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment; $M_{QP} = M_{pos_QP_s1} = 63.0 \text{ kNm}$

Permanent load ratio; $R_{PL} = M_{QP} / M = 1.00$

Service stress in reinforcement; $\sigma_{sr} = f_{yd} \times A_{s,req} / A_{s,prov} \times R_{PL} = 305 \text{ N/mm}^2$

Maximum bar spacing - Tables 7.3N; $s_{bar,max} = 118.3 \text{ mm}$

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $s_{top} = (b - (2 \times (C_{nom_s} + \phi_{s1_v}) + \phi_{s1_t_L1} \times N_{s1_t_L1})) / (N_{s1_t_L1} - 1) = 127.3 \text{ mm}$

Minimum allowable top bar spacing; $s_{top,min} = \max(\phi_{s1_t_L1} \times k_{s1}, h_{agg} + k_{s2}, 20 \text{ mm}) = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $s_{bot} = (b - (2 \times (C_{nom_s} + \phi_{s1_v}) + \phi_{s1_b_L1} \times N_{s1_b_L1})) / (N_{s1_b_L1} - 1) = 92.5 \text{ mm}$

Minimum allowable bottom bar spacing; $s_{bot,min} = \max(\phi_{s1_b_L1} \times k_{s1}, h_{agg} + k_{s2}, 20 \text{ mm}) = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

Section in shear (section 6.2)

Angle of comp. shear strut for maximum shear; $\theta_{max} = 45 \text{ deg}$

Strength reduction factor - cl.6.2.3(3); $v_1 = 0.6 \times (1 - f_{ck} / 250 \text{ N/mm}^2) = 0.533$

Compression chord coefficient - cl.6.2.3(3); $\alpha_{cw} = 1.00$

Minimum area of shear reinforcement - exp.9.5N; $A_{sv,min} = 0.08 \text{ N/mm}^2 \times b \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / f_{yk} = 508 \text{ mm}^2/\text{m}$

Design shear force at support ; $V_{Ed,max} = V_{Ed,max_s1} = 66 \text{ kN}$

Min lever arm in shear zone; $z = 365 \text{ mm}$

Maximum design shear resistance - exp.6.9; $V_{Rd,max} = \alpha_{cw} \times b \times z \times v_1 \times f_{cwd} / (\cot(\theta_{max}) + \tan(\theta_{max})) = 1088 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force ; $V_{Ed} = 66 \text{ kN}$

Design shear stress; $v_{Ed} = V_{Ed} / (b \times z) = 0.302 \text{ N/mm}^2$

Angle of concrete compression strut - cl.6.2.3; $\theta = \min(\max(0.5 \times \text{Asin}(\min(2 \times v_{Ed} / (\alpha_{cw} \times f_{cwd} \times v_1), 1)), 21.8 \text{ deg}), 45 \text{ deg}) = 21.8 \text{ deg}$

Area of shear reinforcement required - exp.6.8; $A_{sv,des} = V_{Ed} \times b / (f_{yd} \times \cot(\theta)) = 166 \text{ mm}^2/\text{m}$

Area of shear reinforcement required; $A_{sv,req} = \max(A_{sv,min}, A_{sv,des}) = 508 \text{ mm}^2/\text{m}$

Shear reinforcement provided; $2 \times 10 \text{ legs @ } 200 \text{ c/c}$

Area of shear reinforcement provided; $A_{sv,prov} = 785 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing - exp.9.6N; $s_{vl,max} = 0.75 \times d = 288 \text{ mm}$

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

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3. Pile Load Summation

Unfactored Pile Loads Summation									
Pile Loads Summation									
P1	20	kN	+		kN	+		kN	= 20 kN
P2	20	kN	+	16	kN	+		kN	= 36 kN
P3	50	kN	+		kN	+		kN	= 50 kN
P4	20	kN	+	37	kN	+	30	kN	= 87 kN
P5	30	kN	+		kN	+		kN	= 30 kN
P6	50	kN	+		kN	+		kN	= 50 kN
P7	37	kN	+	37	kN	+		kN	= 74 kN
P8	50	kN	+		kN	+		kN	= 50 kN
P9	37	kN	+	37	kN	+		kN	= 74 kN
P10	50	kN	+		kN	+		kN	= 50 kN
P11	37	kN	+	37	kN	+		kN	= 74 kN
P12	38	kN	+		kN	+		kN	= 38 kN
P13	50	kN	+		kN	+		kN	= 50 kN
P14	37	kN	+	37	kN	+		kN	= 74 kN
P15	50	kN	+		kN	+		kN	= 50 kN
P16	37	kN	+	37	kN	+		kN	= 74 kN
P17	50	kN	+		kN	+		kN	= 50 kN
P18	37	kN	+	47	kN	+		kN	= 84 kN
P19	47	kN	+	47	kN	+		kN	= 94 kN
P20	47	kN	+	54	kN	+		kN	= 101 kN
P21	54	kN	+	54	kN	+		kN	= 108 kN
P22	54	kN	+	54	kN	+		kN	= 108 kN
P23	38	kN	+	38	kN	+		kN	= 76 kN
P24	38	kN	+		kN	+		kN	= 38 kN
P25	54	kN	+	54	kN	+		kN	= 108 kN
P26	54	kN	+		kN	+		kN	= 54 kN

