SUBTENO Ltd

STRUCTURAL AND CIVIL ENGINEERING CONSULTANTS

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Sainsburys Hove,

Existing Basement Slab Assessment and Replacement

Report Ref S230725 - BS

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CONTENT

1. Background

Subteno Ltd were instructed by William Southern Limited to undertake a review of the existing basement slab construction information, assess its capacity for its intended future use.

Figure 1 – Existing Basement Ground Slab

5 No. concrete cores have been taken, these highlight the basement slab is constructed from 50mm unreinforced concrete screed on 65mm clay brick.

1 trial pit was dug against an existing load bearing wall, The trial pit indicates the brick wall terminates approximately 600mm below existing basement level. The trial pit highlighted the existing brickwork and screed flooring sit directly on made up ground (flint/shingle) It should be noted that no damp proof membrane is present underneath the brickwork.

Core details and trial pit results are shown below on Figure 1, 2 and 3.

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Figure 2 – Typical Concrete Slab Core Locations

Figure 3 – Concrete Slab Core Details

Figure 4 – Trial Pit Showing the Made-up Ground (Flint/Shingle)

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2. Existing Slab Assessment

The existing basement slab is a 50mm concrete screed and 65mm clay brick sitting on made up ground. Our client is planning to use this basement area for retail storage and offices etc.

Assume the concrete grade for the screed is C25/30, therefore its design compressive capacity is 13.4N/mm^2 (30N/mm^2 x 0.67 / 1.5).

Assume the brick is a 10N/mm^2 215mmx100mmx65mm clay break, therefore its design compressive capacity is 4.25N/mm^2 (10N/mm^2 x 0.85 / 3.0).

Based on the trial pits, made up ground (flint/shingle) appears under the existing slab, use modulus of subgrade reaction of 5kN/m^3 (loose sand / gravels).

Typical values of modulus of subgrade reaction (k_s) for different types of soils

Type of Soil	k_s (kN/m^3)
Loose sand	4,800–16,000
Medium dense sand	9,600–80,000
Dense sand	64,000–1,28,000
Clayey medium dense sand	32,000–80,000
Silty medium dense sand	24,000–48,000

Proposed Loading

From Eurocode EN 1991-1-1:2002 table 6.1 and table 6.2, imposed load should use Category D2.

q_k = 5.0kN/m^2 (uniformly load)
Q_k = 3.6kN (point load)

Assess Slab

Existing 50mm concrete screed without reinforcement has been assessed, under the proposed load requirement. The results show the screed failed under crack control under both uniform and point load, it also fails under punching shear capacity under point load. The assessment calculation refers to Tedds output below.

<u>CONCRETE INDUSTRIAL GROUND FLOOR SLAB DESIGN</u>

In accordance with TR34, 4th Edition 2013

Tedds calculation version 2.0.02

<u>Design summary</u>

Load 1 -UDL 5 kN/m^2

Description	Unit	Provided	Required	Utilisation	Result
Ratio of cracked to uncracked mnts of resistance < 50% (cl.7.4)					FAIL
Slab capacity in flexure	kN/m^2	12.8	5.0	0.390	PASS

Load 2 -Single internal 60 x 60 point load

Description	Unit	Provided	Required	Utilisation	Result
Ratio of cracked to uncracked mnts of resistance < 50% (cl.7.4)					FAIL
Slab capacity in flexure	kN	9.8	6.6	0.672	PASS
Shear at face	kN	19.4	6.6	0.340	PASS
Shear at 2d	kN	6.0	6.6	1.089	FAIL

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Slab details

Reinforcement type;	Fabric;	Concrete class;	C25/30
Slab thickness;	h = **50** mm		
Fabric reinforcement type;	A193;	Char. strength of reinf.;	f_{yk} = **20** N/mm^2
Area of bottom steel provided;	$A_{s,prov}$ = **193** mm^2/m;	Diameter of reinforcement;	ϕ_s = **7** mm
Nominal cover;	c_{nom_b} = **25** mm		
Eff. depth of reinforcement;	d = **18** mm		

Partial safety factors

Concrete (with or without fibre);	γ_c = **1.50**;	Reinforcement (bar or fabric);	γ_s = **1.15**
Permanent;	γ_G = **1.20**;	Variable;	γ_Q = **1.50**
Dynamic loads;	γ_D = **1.60**		

Subgrade reaction

Modulus of subgrade reaction; k = **0.005** N/mm^3

Concrete details - Table 6.1. Strength properties for concrete

Char. comp. cylinder strength;	f_{ck} = **25** N/mm^2;	Char. comp. cube strength;	f_{cu} = **30** N/mm^2
Mean comp cylinder strength;	f_{cm} = **33** N/mm^2;	Mean axial tensile strength;	f_{ctm} = **2.6** N/mm^2
Flexural tensile strength;	$f_{ctd,fl}$ = **2.7** N/mm^2;	Design conc. comp strength;	f_{cd} = **16.7** N/mm^2
Secant modulus of concrete;	E_{cm} = **31** kN/mm^2		
Poisons ratio;	ν = **0.2**;	Radius of relative stiffness;	l = **511** mm
Characteristic of system;	λ = **1.397** m^{-1}		

Moment capacity

Negative moment capacity ; $M_n = M_{un}$ = **1.1** kNm/m; Positive moment capacity; $M_p = M_{pfab}$ = **0.1** kNm/m

Load 1 - UDL 5 kN/m^2

Working load capacity of UDL

UDL;	U_k = **5.0** kN/m^2		
Critical aisle width;	l_{crit} = **1124** mm;	Loaded width of single UDL;	l_{load_p} = **1124** mm
Loaded width of dual UDL;	l_{load_n} = **2248** mm;	Working load capcity of slab;	q = **12.8** kN/m^2
		Utilisation;	U_k / q = **0.390**

PASS - Total slab capacity exceeds applied load

Load 2 - Single internal 60 x 60 point load

Loading length;	l_l = **60**mm;	Loading width;	l_w = **60**mm
Permanent load;	G_k = **1.0** kN;	Variable load;	Q_k = **3.6** kN
Dynamic load;	D_k = **0.0** kN		

Contact radius ratio

Equivalent contact radius ratio; a = **33.9** mm; Radius ratio; a / l = **0.066**

Ultimate capacity under single internal concentrated loads

For a/l equal to 0;	P_{u_0} = **7.3** kN;	For a/l equal to 0.2;	$P_{u\_0.2}$ = **14.9** kN
Thus for a / l equal to 0.066;	P_u = **9.8** kN		

Check ultimate load capacity of slab

Number of loads;	N = **1**;	Loading applied to slab;	F_{uls} = **6.6** kN
		Utilisation;	F_{uls} / P_u = **0.672**

PASS - Total slab capacity exceeds applied load

Punching shear at the face of the loaded area

Shear factor;	k_2 = **0.54**		
Perimeter - face loaded area;	u_0 = **240** mm;	Shear stress;	v_{max} = **4.500** N/mm^2
Max load capacity - punching;	$P_{p,max}$ = **19.4** kN		
		Utilisation;	F_{uls} / $P_{p,max}$ = **0.340**

PASS - Total slab capacity in punching at face of loaded area exceeds applied load

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Punching shear at the critical perimeter

Shear factor;	k_s = **2.00**;	Min shear stress at 2d;	$v_{Rd,c,min}$ = **0.495** N/mm^2
Ratio of reinf. in x-direction;	ρ_x = **0.01072**;	Ratio of reinf. in y-direction;	ρ_y = **0.01072**
Reinforcement ratio;	ρ_1 = **0.01072**;	Max shear stress at 2d;	$v_{Rd,c}$ = **0.718** N/mm^2
Perimeter at 2d from face;	u_1 = **466** mm;	Max. load capacity at 2d;	P_p = **6.0** kN
Ground reaction (cl.7.10.2);	R_p = **0.0** kN;	Total imposed shear load;	F_{uls_total} = **6.6** kN
		Utilisation;	F_{uls_total} / P_p = **1.089**

FAIL - Applied loading exceeds total slab capacity in punching at 2d from face of loaded area

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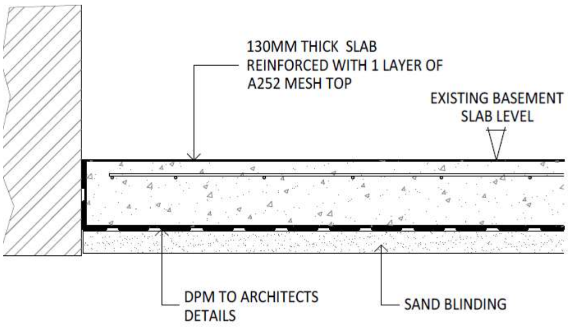
3. Design Replacement Slab

A new reinforced concrete slab will be designed to replace the existing screed and brick underlay base. Typical new basement slab construction detail is shown below.



TYPICAL BASEMENT SLAB
CONSTRUCTION DETAIL

CONCRETE INDUSTRIAL GROUND FLOOR SLAB DESIGN

In accordance with TR34, 4th Edition 2013

Tedds calculation version 2.0.02

Slab details

Reinforcement type;	Fabric;	Concrete class;	C28/35
Slab thickness;	h = **130** mm		
Fabric reinforcement type;	A252;	Char. strength of reinf.;	f_{yk} = **500** N/mm^2
Area of top steel provided;	$A_{s,prov}$ = **252** mm^2/m;	Diameter of reinforcement;	ϕ_s = **8** mm
Nominal cover;	c_{nom_b} = **30** mm		
Eff. depth of reinforcement;	d = **98** mm		

Partial safety factors

Concrete (with or without fibre);	γ_c = **1.50**;	Reinforcement (bar or fabric);	γ_s = **1.15**
Permanent;	γ_G = **1.20**;	Variable;	γ_Q = **1.50**
Dynamic loads;	γ_D = **1.60**		

Subgrade reaction

Modulus of subgrade reaction; k = **0.005** N/mm^3

Concrete details - Table 6.1. Strength properties for concrete

Char. comp. cylinder strength;	f_{ck} = **28** N/mm^2;	Char. comp. cube strength;	f_{cu} = **35** N/mm^2
Mean comp cylinder strength;	f_{cm} = **36** N/mm^2;	Mean axial tensile strength;	f_{ctm} = **2.8** N/mm^2
Flexural tensile strength;	$f_{ctd,fl}$ = **2.7** N/mm^2;	Design conc. comp strength;	f_{cd} = **18.7** N/mm^2
Secant modulus of concrete;	E_{cm} = **32** kN/mm^2		
Poisons ratio;	ν = **0.2**;	Radius of relative stiffness;	l = **1054** mm
Characteristic of system;	λ = **0.678** m^{-1}		

Moment capacity

Negative moment capacity ; $M_n = M_{un}$ = **7.6** kNm/m; Positive moment capacity; $M_p = M_{pfab}$ = **7.6** kNm/m

Load 1 - UDL 5 kN/m^2

Working load capacity of UDL

UDL;	U_k = **5.0** kN/m^2		
Critical aisle width;	l_{crit} = **2317** mm;	Loaded width of single UDL;	l_{load_p} = **2317** mm
Loaded width of dual UDL;	l_{load_n} = **4634** mm;	Working load capcity of slab;	q = **20.9** kN/m^2

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Utilisation; U_k / q = **0.239**

PASS - Total slab capacity exceeds applied load

Load 2 - Single corner 60 x 60 point load

Loading length; l_l = **60**mm; Loading width; l_w = **60**mm

Edge distance y; e_y = **100**mm

Edge distance x; e_x = **100**mm

Permanent load; G_k = **1.0** kN; Variable load; Q_k = **3.6** kN

Dynamic load; D_k = **0.0** kN

Contact radius ratio

Equivalent contact radius ratio; a = **33.9** mm; Radius ratio; a / l = **0.032**

Ultimate capacity under single corner concentrated loads

For a/l equal to 0; P_{u_0} = **15.3** kN; For a/l equal to 0.2; $P_{u\_0.2}$ = **31.6** kN

Thus for a / l equal to 0.032; P_u = **17.9** kN

Aggregate transfer percentage; P_{agg} = **15** %

Total effective edge capacity; P_{u_total} = **21.0** kN

Check ultimate load capacity of slab

Number of loads; N = **1**; Loading applied to slab; F_{uls} = **6.6** kN

Utilisation; F_{uls} / P_{u_total} = **0.314**

PASS - Total slab capacity exceeds applied load

Punching shear at the face of the loaded area

Shear factor; k_2 = **0.53**

Perimeter - face loaded area; u_0 = **240** mm; Shear stress; v_{max} = **4.973** N/mm^2

Max load capacity - punching; $P_{p,max}$ = **116.4** kN

Utilisation; F_{uls} / $P_{p,max}$ = **0.057**

PASS - Total slab capacity in punching at face of loaded area exceeds applied load

Punching shear at the critical perimeter

Shear factor; k_s = **2.00**; Min shear stress at 2d; $v_{Rd,c,min}$ = **0.524** N/mm^2

Ratio of reinf. in x-direction; ρ_x = **0.00258**; Ratio of reinf. in y-direction; ρ_y = **0.00258**

Reinforcement ratio; ρ_1 = **0.00258**; Max shear stress at 2d; $v_{Rd,c}$ = **0.524** N/mm^2

Perimeter at 2d from face; u_1 = **626** mm; Max. load capacity at 2d; P_p = **32.0** kN

Ground reaction (cl.7.10.2); R_p = **0.1** kN; Total imposed shear load; F_{uls_total} = **6.5** kN

Utilisation; F_{uls_total} / P_p = **0.202**

PASS - Total slab capacity in punching at 2d from face of loaded area exceeds applied load

Method of Slab Replacement:

- Break the existing screed, remove the screed and brick base.
- Compact the existing made-up ground.
- Lay a 50mm sand blind and damp proof membrane to architects detail.
- Cast the 130mm reinforced concrete slab.

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4. Conclusion

- Concrete cores and trial pits have been taken to show the existing basement slab construction details with no damp proof membrane.
- Assessment has been carried of the existing basement slab which fails under the required loadings in accordance with Eurocode EN 1991-1-1:2002 table 6.1 and table 6.2, imposed load should use Category D2.
- A new 130mm reinforced concrete slab has been designed and its construction details has been specified. A damp proof course should be introduced to protect the basement from damp penetration.
- It should be noted that regardless of future use it is likely the slab would need replacement in order to make the basement a habitable area.