Project No: 3788
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8th December 2016

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For the attention of Ben Blackledge

Re: Tack Room Units 25/26/27 - Stables Market, Camden – Load Capacity and Structural Strengthening

Dear Ben,

Following your request, this letter outlines the maximum allowable capacity of the floor structure of units 25, 26 and 27 of the Tack Room, Stables Market, Camden. This letter also contains the necessary structural modifications in order to strengthen the structure to accommodate a total load of 5 kN/m^2.

Based on the received drawing with information regarding the dimensions of the floor joists and cast-iron beams (shown in Figure 1) and based on a condition survey done on the first floor of the Tack Room, we have back analyzed the maximum allowable loading of the floor structure of units 25, 26 and 27 inside the Tack Room.

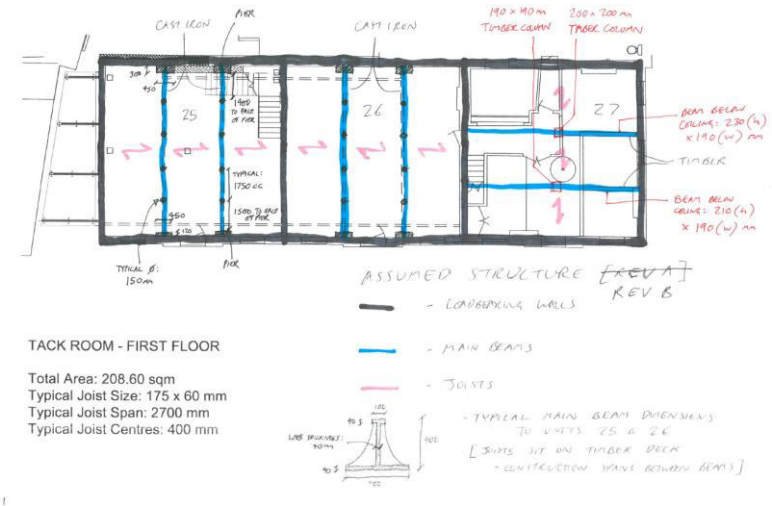


Figure 1: Tack Room – first floor – structural elements

In order to obtain the maximum allowable loading for the floor structure, we have made the following assumptions:

- Structural elements to have dimensions as shown in Figure 1;
- Floor timber joists to be softwood and grade C16, spanning 2900 mm;
- Assumed self-weight of the floor to be 0.25 kN/m^2;
- Beams supporting the joists to be cast-iron (with working stresses of 18.5 N/mm^2, based on "Historical Structural Steelwork Handbook" (Bates) for cast-iron beams before year 1900);
- Cast-iron beams to be supported by columns, spanning 1900 mm, in units 25 and 26;
- Softwood timber beams (grade C16) supporting the floor joists in unit 27, with two spans of 4300 mm;

Without any strengthening of the floor structure, we calculate the maximum capacity of the floor for unit 25 and 26 to be:

- Current allowable load to be 4 kN/m^2 subject to timber condition survey (Super imposed dead Load: 1 kN/m^2 + Imposed load: 3 kN/m^2 = 4 kN/m^2);

In order to the floor structure of units 25 and 26 be able to accommodate a total load of 5 kN/m^2 (assumed split 1 kN/m^2 of super imposed dead load + 4 kN/m^2 of live load, which is the load defined by the Eurocodes for retail shops), we recommend introducing new timber joists between the existing ones (63x175 with 400 mm spacing from center to center and grade C24). For more information please see drawing 3788/204 issued on 8Th December 2016.

Please note that the condition survey reported that several joists, in unit 25 and 26, were showing several decays, therefore we didn't assume the existing joists in the first floor of the Tack Room had any structural capacity.

Regarding unit 27, due to a different structural support for the floor joists, we calculate the maximum capacity of the floor structure of unit 27 to be:

- Current allowable load to be 1.55 kN/m^2 subject to timber condition survey (Super imposed dead Load: 0.25 kN/m^2 + Imposed load: 1.3 kN/m^2 = 1.55 kN/m^2);

In order to the floor structure of unit 27 be able to accommodate a load of 5 kN/m^2 (assumed split 1 kN/m^2 of super imposed dead load + 4 kN/m^2 of live load), we recommend introducing new timber joists between the existing ones (63x175 with 400 mm spacing from center to center and grade C24).

For unit 27, the condition survey also indicates that the joists were showing signals of decay meaning that no structural capacity of the existing joists were taken into account for the load calculations.

We also recommend strengthening the timber beams of unit 27 by means of two steel plates (12x220 mm^2 and S275) on each side of the beams. Finally, we recommend foundations within unit 27 to be

strengthen with 1.0x1.0x1.0 m^3 reinforced concrete pads. For more information please see drawing 3788/204 issued on 8Th December 2016.

Finally, contractor must allow for propping the upper floor of unit 27 and to propose construction method for the foundations' strengthening.

Yours sincerely,

Miguel Costa
Structural Engineer

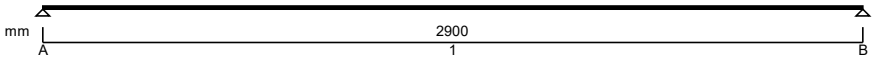
	Project				Job no.	
WALSH	Stables Market, Camden - Tack Room - Units 25, 26 and 27				3788	
	Calcs for				Start page no./Revision	
	New timber joists - units 25, 26 and 27				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	MPC	27/09/2016	PM		PM	

TIMBER JOIST DESIGN (BS5268-2:2002)

Tedds calculation version 1.1.04

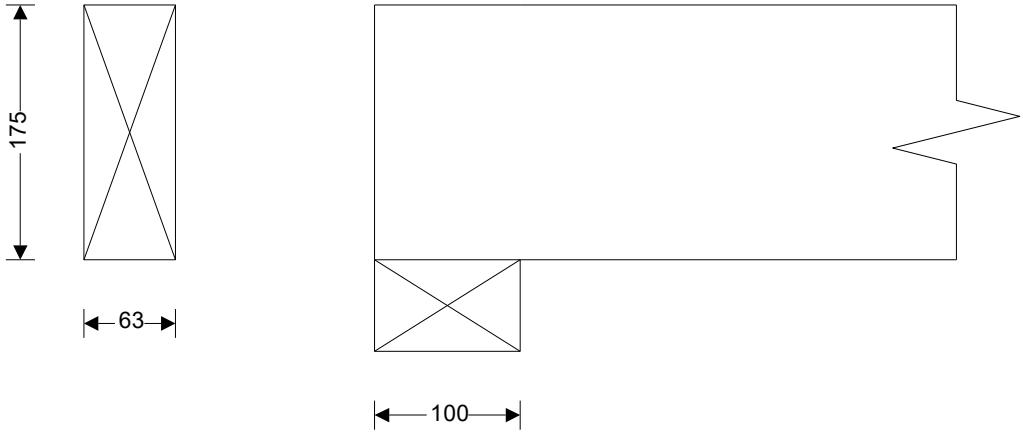
Joist details

Joist breadth	b = **63** mm
Joist depth	h = **175** mm
Joist spacing	s = **400** mm
Timber strength class	**C24**
Service class of timber	**1**



Span details

Number of spans	N_{span} = **1**
Length of bearing	L_b = **100** mm
Effective length of span	L_{s1} = **2900** mm



Section properties

Second moment of area	$I = b \times h^3 / 12$ = **28136719** mm^4
Section modulus	$Z = b \times h^2 / 6$ = **321563** mm^3

Loading details

Joist self weight	$F_{swt} = b \times h \times \rho_{char} \times g_{acc}$ = **0.04** kN/m
Dead load	F_{d_udl} = **1.00** kN/m^2
Imposed UDL(Long term)	F_{i_udl} = **4.00** kN/m^2
Imposed point load (Medium term)	F_{i_pt} = **1.40** kN

Modification factors

Service class for bending parallel to grain	K_{2m} = **1.00**
Service class for compression	K_{2c} = **1.00**
Service class for shear parallel to grain	K_{2s} = **1.00**
Service class for modulus of elasticity	K_{2e} = **1.00**

Section depth factor	K_7 = **1.06**
Load sharing factor	K_8 = **1.10**

Consider long term loads

Load duration factor	K_3 = **1.00**
Maximum bending moment	M = **2.142** kNm
Maximum shear force	V = **2.955** kN
Maximum support reaction	R = **2.955** kN
Maximum deflection	δ = **6.521** mm

Check bending stress

Bending stress	σ_m = **7.500** N/mm^2
Permissible bending stress	$\sigma_{m\_adm} = \sigma_m \times K_{2m} \times K_3 \times K_7 \times K_8$ = **8.754** N/mm^2
Applied bending stress	σ_{m_max} = M / Z = **6.662** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Shear stress	τ = **0.710** N/mm^2
Permissible shear stress	$\tau_{adm} = \tau \times K_{2s} \times K_3 \times K_8$ = **0.781** N/mm^2
Applied shear stress	τ_{max} = 3 × V / (2 × b × h) = **0.402** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Compression perpendicular to grain (no wane)	σ_{cp1} = **2.400** N/mm^2
Permissible bearing stress	$\sigma_{c\_adm} = \sigma_{cp1} \times K_{2c} \times K_3 \times K_8$ = **2.640** N/mm^2
Applied bearing stress	σ_{c_max} = R / (b × L_b) = **0.469** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection	δ_{adm} = min(L_{s1} × 0.003, 14 mm) = **8.700** mm
Bending deflection (based on E_{mean})	$\delta_{bending}$ = **6.176** mm
Shear deflection	δ_{shear} = **0.345** mm
Total deflection	$\delta = \delta_{bending} + \delta_{shear}$ = **6.521** mm

PASS - Actual deflection within permissible limits

Consider medium term loads

Load duration factor	K_3 = **1.25**
Maximum bending moment	M = **1.475** kNm
Maximum shear force	V = **2.035** kN
Maximum support reaction	R = **2.035** kN
Maximum deflection	δ = **3.906** mm

Check bending stress

Bending stress	σ_m = **7.500** N/mm^2
Permissible bending stress	$\sigma_{m\_adm} = \sigma_m \times K_{2m} \times K_3 \times K_7 \times K_8$ = **10.942** N/mm^2
Applied bending stress	σ_{m_max} = M / Z = **4.588** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Shear stress	τ = **0.710** N/mm^2
Permissible shear stress	$\tau_{adm} = \tau \times K_{2s} \times K_3 \times K_8$ = **0.976** N/mm^2
Applied shear stress	τ_{max} = 3 × V / (2 × b × h) = **0.277** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Compression perpendicular to grain (no wane) σ_{cp1} = **2.400** N/mm^2

Permissible bearing stress $\sigma_{c\_adm} = \sigma_{cp1} \times K_{2c} \times K_3 \times K_8$ = **3.300** N/mm^2

Applied bearing stress $\sigma_{c\_max} = R / (b \times L_b)$ = **0.323** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection $\delta_{adm} = \min(L_{s1} \times 0.003, 14\ mm)$ = **8.700** mm

Bending deflection (based on E_{mean}) $\delta_{bending}$ = **3.668** mm

Shear deflection δ_{shear} = **0.238** mm

Total deflection $\delta = \delta_{bending} + \delta_{shear}$ = **3.906** mm

PASS - Actual deflection within permissible limits

Unit 25 and 26								
Main Beam (cast-iron)	Dimensions							
	sw (kN/m)	D (mm)	Bottom flange (mm)	Top flange (mm)	tf (mm)	tw (mm)	xg (mm)	I (mm4)
	2.57	400	400	100	40	40	134.1	617649430.9
	c1 (mm)	c2 (mm)	W (mm3)	Mrd (kNm)	Fy (Mpa)	18		
	134.1	265.9	2323268.502	41.82	E (Mpa)	210000		
	Length (m)							
	1.9							
	Working stresses							
	Dead (kN/m2)	Live (kN/m2)	L (m)	P/joist (kN)	F (kN/m)	Med (kNm)	δ (mm)	L/500 (mm)
	1.25	3.0	1.9	7.18	12.33	5.56	0.011	3.8

TACK ROOM - UNIT 25/26
CAST-IRON BEAMS

3788/SK/160915/MPC/01

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Unit 27			
Timber Beam			
b (mm)	h (mm)	E (MPa)	F (Mpa)
190	230	8000	8.6
Steel Plates			
b (mm)	h (mm)	E (Mpa)	F (Mpa)
12	220	210000	235
Mrd (kNm)			
54.5			
Dead load (kN/m)	Live load (kN/m)	L1/L2 (m)	Med (kNm)
2.9	11.6	4.3	49.3

TACK ROOM - UNIT 27 - STRENGTHENING OF MAIN TIMBER BEAMS
3788/SW/161208/MPC/01

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