Job Name:	30 Hampstead High Street, NW3 1QA.
Job No:	10455
Sheet No:	1
By:	SSH
Date:	16 October 2021
Rev:	

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The following calculations have been undertaken for the proposed alterations at the above address.

All the dimensions for beams included within the calculations are to be site checked, by the building contractor prior to commencing or ordering materials. All works are to be carried out to the calculations enclosed.

If any changes are made on site, then these calculations must be checked and adjusted to suit new layouts.

The contractor is to ensure adequate temporary supports and propping is provided when the beams and structural elements are installed or removed. The contractor is to ensure overall stability of the structure is continuously maintained during the alteration works and if in doubt consult relevant parties

If any of the assumptions used for the calculations are discovered to be incorrect once work commences on site then the calculations must be amended to suit.

NOTE: CALCULATIONS ARE SUBJECT TO BUILDING CONTROL APPROVAL. ANY WORKS CARRIED OUT PRIOR TO APPROVAL OF CALCULATIONS BY BUILDING CONTROL ARE AT OWN RISK. STRONGLY SUGGEST NO MATERIALS ARE ORDERED OR WORK ARE CARRIED OUT UNTIL APPROVAL IS RECEIVED FROM BUILDING CONTROL.

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The following structural calculations consider
the proposed structural alterations at the above property.

Structural References
B.Regs Approved Doc A
BS648 - Design Weights
BS6399 - Design Superimposed Loads
BS5268 - Timber Design
BS5628 - Masonry Design
BS5950 - Steelwork Design
SCI - Steelwork Design Guide to BS5950 Part1 Vol 1

Unit Loads

			Ws	(γf)	Wu
33	Pitch Roof (kN/m^2 on Plan)				
Tiles	0.65				
Rafters, Battens & Felt	0.10				
Plaster Board & Skim	0.15				
	0.90	/ COS 33	1.07	1.4	1.50
Snow		-	0.60	1.6	0.96
			1.67	1.47	2.46
Timber Floor (kN/m^2)					
Deck		-	0.10		
Joists		-	0.10		
Plaster Board & Skim		-	0.15		
			0.35	1.4	0.49
Super Imposed Load		-	2.00	1.6	3.20
			2.35	1.57	3.69
Masonry (kN/m^3)		-	20.00	1.40	28.00
Studwall (kN/m^2)		-	0.40	1.40	0.56

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	3
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Sedium Flat Roof (kN/m^2)

3 Layers Felt & Chips	-	0.60		
Ply Deck & Furrings	-	0.15		
Joists	-	0.10		
Plaster Board & Skim	-	0.15		
Seduim Roof	-	0.37		
		1.37	1.40	1.92
Snow	-	0.60	1.60	0.96
		1.97	1.46	2.88

Ceiling (kN/m^2)

Deck	-	0.10		
Joists	-	0.10		
Plaster Board & Skim	-	0.15		
		0.35	1.4	0.49
Super Imposed Load	-	0.25	1.6	0.40
		0.60	1.48	0.89

Flat Roof (kN/m^2)

3 Layers Felt & Chips	-	0.60		
Ply Deck & Furrings	-	0.15		
Joists	-	0.10		
Plaster Board & Skim	-	0.15		
		1.00	1.40	1.40
Snow	-	0.60	1.60	0.96
		1.60	1.48	2.36

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Consider Loads on Exsiting double joists.

Max Span 3.00 m

Timber Floor = 0.35 × $\frac{3.98}{2}$ = 0.70 kN/m

2.00 × $\frac{3.98}{2}$ = 3.98 kN/m

For Calculation see Page 06 - 06

Use Existing.

Consider Loads on DJ1.

Max Span 1.70 m

Timber Floor = 0.35 × $\frac{2.91}{2}$ = 0.51 kN/m

2.00 × $\frac{2.91}{2}$ = 2.91 kN/m

For Calculation see Page 07 - 07

Use 2No. 195×47 C24
As DJ1 & DJ2.

Consider Loads on DJ3.

Max Span 2.00 m

Floor Joists = 0.35 × 0.40 = 0.14 kN/m

2.00 × 0.40 = 0.80 kN/m

For Calculation see Page 08 - 08

Use 2No. 195×47 C24
As DJ3.

Consider Loads on Timber Post.

Max Span 3.00 m

Point Load = 4.03 kN

Bending Moment = 4.03 × 0.10 = 0.403 kNm

For Calculation see Page 09 -09

Use 100×100 C24
As Timber Post.

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Consider Loads on Beam 1.

Max Span 4.00 m

Point Load 1 =				DL	=	1.20	kN
(Existing Double Joists)				LL	=	5.97	kN
Point Load 2 =				DL	=	0.52	kN
(DJ1)				LL	=	2.47	kN
Floor Joists =	0.35	×	0.40		=	0.14	kN/m
	2.00	×	0.40		=	0.80	kN/m

For Calculation see Page 10 - 10

Use 152×152 UC23
As Beam 1.

Beam: **Existing double joists** **Span: 3.0 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.1	0		L	0.15	0.15
U	D	Timber Floor	0.70	0		L	1.05	1.05
U	L	Timber Floor	3.98	0		L	5.97	5.97
						Total load: 14.34 kN	**7.17**	**7.17**
						Dead:	*1.20*	*1.20*
						Live:	*5.97*	*5.97*

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 5.38 kNm at 1.50 m. from R1

Maximum S.F. = 7.17 kN at 0.00 m. from R1

Live load deflection = 4.20 x 10^8/EI at 1.50 m. from R1 *(E in N/mm^2, I in cm^4)*

Total deflection = 5.04 x 10^8/EI at 1.50 m. from R1

Beam: **DJ1** **Span: 1.7 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.1	0		L	0.09	0.09
U	D	Timber Floor	0.51	0		L	0.43	0.43
U	L	Timber Floor	2.91	0		L	2.47	2.47
						Total load: 5.98 kN	**2.99**	**2.99**
						Dead:	*0.52*	*0.52*
						Live:	*2.47*	*2.47*

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 1.27 kNm at 0.85 m. from R1

Maximum S.F. = 2.99 kN at 0.00 m. from R1

Live load deflection = 0.316 x 10^8/EI at 0.85 m. from R1 *(E in N/mm^2, I in cm^4)*

Total deflection = 0.383 x 10^8/EI at 0.85 m. from R1

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 2no 47 x 195 C24 *7.7 kg/m approx*

z = 595.7 cm^3 I = 5,808 cm^4

Timber grade: C24 2 members acting together: K_8 = 1.1 [§2.9]

K_3 (loading duration factor) = 1.25 (medium term)
K_7 (depth factor) = $(300/195)^{0.11}$ = 1.05 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.14 = 8,208 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $\sigma_{m,adm} = \sigma_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.25 x 1.05 x 1.1 = 10.81 N/mm^2

Applied bending stress, $\sigma_{m,a}$ = 1.27 x 1000/596 = 2.13 N/mm^2 OK

Shear

Permissible shear stress, $\tau_{adm,//} = \tau_{g,//}.K_3.K_8$ = 0.71 x 1.25 x 1.1 = 0.98 N/mm^2

Applied shear stress, τ_a = 2.99 x 1000 x 3/(2 x 94 x 195) = 0.24 N/mm^2 OK

Deflection

Bending deflection = 0.383 x 10^8/(8,208 x 5,808) = 0.80 mm

Mid-span shear deflection = 1.2 x 1.27 x 10^6/((E/16) x 94 x 195) = 0.16 mm

Total deflection = 0.80 + 0.16 = 0.97 mm (0.0006 L) <= 0.003L OK

Beam: **DJ3** **Span: 2.0 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.1	0		L	0.10	0.10
U	D	Timber Floor	0.14	0		L	0.14	0.14
U	L	Timber Floor	0.80	0		L	0.80	0.80
						Total load: 2.08 kN	**1.04**	**1.04**
						Dead:	*0.24*	*0.24*
						Live:	*0.80*	*0.80*

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 0.520 kNm at 1.00 m. from R1

Maximum S.F. = 1.040 kN at 0.00 m. from R1

Live load deflection = 0.167 x 10^8/EI at 1.00 m. from R1 *(E in N/mm^2, I in cm^4)*

Total deflection = 0.217 x 10^8/EI at 1.00 m. from R1

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 2no 47 x 195 C24 *7.7 kg/m approx*

z = 595.7 cm^3 I = 5,808 cm^4

Timber grade: C24 2 members acting together: K_8 = 1.1 [§2.9]

K_3 (loading duration factor) = 1.25 (medium term)
K_7 (depth factor) = $(300/195)^{0.11}$ = 1.05 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.14 = 8,208 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $\sigma_{m,adm} = \sigma_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.25 x 1.05 x 1.1 = 10.81 N/mm^2

Applied bending stress, $\sigma_{m,a}$ = 0.520 x 1000/596 = 0.87 N/mm^2 OK

Shear

Permissible shear stress, $\tau_{adm,//} = \tau_{g,//}.K_3.K_8$ = 0.71 x 1.25 x 1.1 = 0.98 N/mm^2

Applied shear stress, τ_a = 1.04 x 1000 x 3/(2 x 94 x 195) = 0.09 N/mm^2 OK

Deflection

Bending deflection = 0.217 x 10^8/(8,208 x 5,808) = 0.45 mm

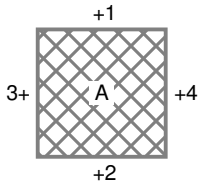
Mid-span shear deflection = 1.2 x 0.520 x 10^6/((E/16) x 94 x 195) = 0.07 mm

Total deflection = 0.45 + 0.07 = 0.52 mm (0.0003 L) <= 0.003L OK

Calculations for timber post/stud to BS5268 Part 2: 2002 using C24 timber

Location: Timber Post

Pos	Load	Dead kN	Live kN	Total kN	Offset	M_{xx}	M_{yy}
1	Beam: DJ1 : R1	[B/F] 0.52	2.47	2.99	100	0.45	
4	Beam: DJ3 : R1	[B/F] 0.24	0.80	1.04	100		-0.16
Total load		**0.76**	**3.27**	**4.03**		**0.45**	**-0.16**



Load offsets are measured in mm from faces of member; moments in kNm

Member length = 2.7m. Effective lengths: L_{Ex} = 1.0L = 2.7 m. L_{Ey} = 1.0L = 2.7 m.

Use: **100 x 100 C24**

Cross sectional area = 10,000 mm^2 Z_{xx} = 166.7 cm^3 Z_{yy} = 166.7 cm^3

K_3 (loading duration factor) = 1.00 (long term); K_8 (load sharing factor) = 1.0

Compression:

Slenderness is critical about the yy axis r_{yy} = 100/√12 = 28.9 mm

Slenderness ratio, λ_{yy} = 2.7 x 1000/28.9 = 93.5

Grade permissible compressive stress, $\sigma_{c,g}$ = 7.9 N/mm^2

Compressive stress used to determine K_{12}, $\sigma_{c,g}.K_3$ = 7.9 x 1.00 = 7.90 N/mm^2

E value used to determine K_{12} = 7,200 N/mm^2 (E_{min})

K_{12} (compression modification factor) = 0.437

Permissible compressive stress, $\sigma_{c,adm}$ = 7.90 x 0.437 = 3.45 N/mm^2

Applied compressive stress, $\sigma_{c,a}$ = 4.03 x 1000/10,000 = 0.40 N/mm^2 OK

Bending about x-x axis:

Moment = 0.449 kNm

K_3 = 1.00; K_7 (depth factor) = (300/100)^$^{0.11}$ = 1.128; K_8 = 1.0

Permissible bending stress, $\sigma_{m,adm} = \sigma_{m,g}.K_3.K_7.K_8$ = 7.500 x 1.00 x 1.128 x 1.0 = 8.46 N/mm^2

Applied bending stress, $\sigma_{m,a}$ = 0.449 x 1000/166.7 = 2.69 N/mm^2 OK

Bending about y-y axis:

Moment = 0.156 kNm

K_3 = 1.00; K_7 (depth factor) = (300/100)^$^{0.11}$ = 1.128; K_8 = 1.0

Permissible bending stress, $\sigma_{m,adm} = \sigma_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.00 x 1.128 x 1.0 = 8.46 N/mm^2

Applied bending stress, $\sigma_{m,a}$ = 0.156 x 1000/166.7 = 0.94 N/mm^2 OK

Combined compression and bending:

Ratios: Compression: 0.40/3.45 = 0.117

Bending and compression interaction adjustment factor = 1 - (1.5 $\sigma_{c.a.||}$ K_{12}/σ_e) = 0.967 (2.11.6)

Bending x-x: 2.69/(0.967 x 8.46) = 0.329 Bending y-y: 0.94/(0.967 x 8.46) = 0.114

Compression + bending stress ratio = 0.117 + 0.329 + 0.114 = **0.560** <= 1.0 OK

Beam: **Beam 1** **Span: 4.0 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.25	0		L	0.50	0.50
U	D	Timber Floor	0.14	0		L	0.28	0.28
U	L	Timber Floor		0		L	0.00	0.00
P	D	Exsiting Double Joists	1.20	0.933			0.92	0.28
P	L	Exsiting Double Joists	2.47	0.933			1.89	0.58
P	D	DJ1	0.52	2.0			0.26	0.26
P	L	DJ1	2.47	2.0			1.24	1.24
					Unfactored reactions (kN)	**Total:**	**5.09**	**3.13**
						Dead:	*1.96*	*1.32*
						Live:	*3.13*	*1.81*

Total load: 8.22/12.50 kN *Unfactored/Factored* **Factored reactions:** **7.75** **4.75**

Load types: U: UDL P: PL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. (factored) = 8.40 kNm at 2.00 m. from R1

Maximum S.F. (factored) = 7.75 kN at 0.00 m. from R1

Live load deflection = 5.44 x 10^8/EI at 1.90 m. from R1 *(E in N/mm^2, I in cm^4)*

Total deflection = 8.48 x 10^8/EI at 1.93 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **152 x 152 x 23 UC** S275 (semi-compact)

D=152.4 mm B=152.2 mm t=5.8 mm T=6.8 mm I_x=1,250 cm^4 r_y=3.70 cm S_x=182 cm^3 x=20.7

Shear

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 5.8 x 152.4/1000 = 146 kN (>=7.75) OK

Bending

Maximum moment = 8.399 kNm at 2.00 m. from R1

Moment capacity, $M_c = p_y.S_{x,\,eff}$ = 275 x 176/1000 = 48.47 kNm OK

Lateral-torsional buckling

Beam is laterally restrained at supports only
Restraint condition at R1 and R2: Compression flange laterally restrained. Nominal torsional restraint. Both flanges free to rotate on plan (1.0L) [BS5950 Table 13]
Effective length = 1.0L

Bending strength, p_b = 183.4 N/mm^2

Maximum moment within segment, M_x = 8.399 kNm

Equivalent uniform moment factor, m_{LT} = 0.907 (M_2=7.10, M_3=8.40, M_4=4.47)

Equivalent uniform moment = 0.907 x 8.399 = 7.615 kNm

Buckling resistance moment, $M_b = p_b.S_{x,eff}$ = 183.4 x 176/1000 = 32.32 kNm OK

Web capacity

Check unstiffened web capacities with loads of 7.750 kN and 4.746 kN
C1 = 45.9 kN; C2 = 1.60 kN/mm; C4 = 271; K = min{0.5+(a_e/1.4d),1.0}; p_{vw} = 275N/mm^2
(for derivation of C factors see Steelwork Design Guide to BS5950-1:2000 6th ed.)

R1: Minimum required stiff bearing length, b_1 = 0mm: a_e = 0mm; K = 0.500
Bearing capacity, $P_w = C1 + b_1.C2$ = 45.9 kN <<<
Buckling capacity, $P_x = K\sqrt{(C4.P_w)}$ = 0.500$\sqrt{}$(271 x 45.9) = 55.8 kN

R2: Minimum required stiff bearing length, b_1 = 0mm: a_e = 0mm; K = 0.500
Bearing capacity, $P_w = C1 + b_1.C2$ = 45.9 kN <<<
Buckling capacity, $P_x = K\sqrt{(C4.P_w)}$ = 0.500$\sqrt{}$(271 x 45.9) = 55.8 kN

Deflection

LL deflection = 5.44 x 1e8/205,000 x 1,250 = 2.1 mm (L/1883) OK
TL deflection = 8.48 x 1e8/205,000 x 1,250 = 3.3 mm (L/1209)