JCP STRUCTURAL AND CIVIL ENGINEERS

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Unit 7, Boscombe Centre, Mills Way,
Amesbury, Wiltshire, SP4 7SD

Structural Design Calculations

for

Brick House, Eversley

Site address
Brick House,
Eversley

April '24
Ref: 16703/sdh/SC01

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		Project Ref:	16703
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Site Address:	Brick House, Eversley	Engineer:	sdh
Project type:	Replacement Oak beam and post	Date:	April '24

Brief:

JCP Engineers was appointed to carry out the structural design for the proposed extension of Project 16703, a domestic building located in Eversley.

Basis of the Design:

The scope of work covers the following structural design works:

Replacement beam and post using Oak

Load Paths & Lateral Stability:

Through existing traditional construction

Robustness & Avoidance of Disproportionate Collapse:

The building is classed as a Consequence Class 1 building under the Building Regulations Part A with design guidance extract as follows:

"***For Class 1 buildings – Provided the building has been designed and constructed in accordance with the rules given in this Approved Document, or other guidance referenced under Section 1, for meeting compliance with requirement A1 and A2 in normal use, no additional measures are likely to be necessary***."

Design codes used:

BS 5268: 2002 "The Structural Use of Timber"
BS 6399: 1997 "Loadings for Buildings"

Other references:

Timber Designer's Manual, 3rd Edition – E.C Ozelton & J.A. Baird

Design software used:

CADS Analysis, Modelling & Design 2022 Structural Analysis & Design

Notes:

These calculations only apply to the structural elements included in these documents; if any discrepancies are found on site, the Engineer is to be informed. All architectural and building design requirements are to be provided by others.

Dimensions in these calculations are for design purposes only, having been scaled from copies of drawings. The building contractor is to obtain detailed dimensions from site measurements and is not to rely on those provided herein for fabrication purposes or procurement of materials.

The contractor is responsible for ensuring the stability of the structure at all times and that the works are carried out in strict compliance with all relevant Codes of Practice, Building Regulations and good building practice. All temporary support works required during the course of construction are the responsibility of the contractor.

Throughout the works the contractor / client is to be responsible for ensuring that the requirements of the Construction, Design and Management Regulations are complied with. Before any demolition works are undertaken, an R&D asbestos survey is recommended.

The Engineer believes that there are no foreseeable unusual risks that may arise during construction, maintenance, or use that a competent contractor could not foresee; however, due attention is to be given to ensuring a safe method of working and risk assessment is planned.

All structural steelwork and components are to be manufactured in accordance with the requirements of execution class EXC2 to BS EN 1090-2.

Architectural drawings:

P1	-	Layouts and section

Structural drawings:

16703-100-01 (P1)	-	Structural arrangement

Pitched roof (Gk)		γ [kN/m³]	Load [kN/m²]
	Tiling, roof clay plain 100 gauge		0.700
	Felt & Battens		0.050
	Timber joists softwood 50x150 @300mm crs		0.130
20 mm	Traditional lime plaster	20.00	0.400
		Total [kN/m²]:	1.28

Pitched roof (Qk)		γ [kN/m³]	Load [kN/m²]
	Imposed load on roof with no access		0.600
		Total [kN/m²]:	0.60

Floor (Gk)		γ [kN/m³]	Load [kN/m²]
	Carpet & underlay		0.050
22 mm	Chipboard	7.00	0.154
	Timber joists softwood 50x150 @300mm crs		0.130
100 mm	Mineral wool, quilt	0.12	0.012
	Services - residential		0.050
	Plasterboard (13mm), including skim coat		0.180
		Total [kN/m²]:	0.58

Floor (Qk)		γ [kN/m³]	Load [kN/m²]
	Imposed load for residential		1.500
		Total [kN/m²]:	1.50

Floor stud allowance (Qk)		γ [kN/m³]	Load [kN/m²]
	Partitions, light		1.000
		Total [kN/m²]:	1.00

Timber stud (Gk)		γ [kN/m³]	Load [kN/m²]
	Plasterboard (13mm), including skim coat		0.180
	Timber joists softwood 50x100 @300mm crs		0.087
100 mm	Mineral wool, batt	0.25	0.025
	Plasterboard (13mm), including skim coat		0.180
		Total [kN/m²]:	0.47

CONSULTING STRUCTURAL AND CIVIL ENGINEERS		JOB NO:	16703
		PAGE:	L02
PROJECT:	**Brick Hosue, Eversley**	CALCS BY:	sdh
ELEMENT:	Loading sheet	DATE:	Mar. '24

Purlin (Gk) — both cannot be "yes"

Ref	Supported length (m)	Element of Structure	Slope angle	Imposed roof?	Applied on slope?	Load [kN/m2]	Load [kN/m]
1	**2.00**	Pitched roof (Gk)	**45**	**no**	**yes**	1.28	3.620
Length of purlin supported = 1.8m, therefore gk = 6.5kN					Total [kN/m]:		3.62

Purlin (Qk) — both cannot be "yes"

Ref	Supported length (m)	Element of Structure	Slope angle	Imposed roof?	Applied on slope?	Load [kN/m2]	Load [kN/m]
2	**2.00**	Pitched roof (Qk)	**45**	**yes**	**no**	0.60	0.600
Length of purlin supported = 1.8m, therefore gk = 1.1kN					Total [kN/m]:		0.60

Beam (Gk) — both cannot be "yes"

Ref	Supported length (m)	Element of Structure	Slope angle	Imposed roof?	Applied on slope?	Load [kN/m2]	Load [kN/m]
3	**2.00**	Floor (Gk)	**0**	**no**	**no**	0.58	1.152
Plus reactions from posts over, and stud wall (2.8kN)					Total [kN/m]:		1.15

Purlin (Qk) — both cannot be "yes"

Ref	Supported length (m)	Element of Structure	Slope angle	Imposed roof?	Applied on slope?	Load [kN/m2]	Load [kN/m]
4	**2.00**	Floor (Qk)	**0**	**no**	**no**	1.50	3.000
Plus reactions from posts over					Total [kN/m]:		3.00

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Brick House
Eversley

Replacement beam and post

Job No	:	16703
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Member Types

Reference	Shape	Material	Section
Existing members	Timber Library	Timber Oak Grade B 1#	sawnsoft 150x150
New beam	Timber Library	Timber Oak Grade B 1#	sawnsoft 300x300
New post	Timber Library	Timber Oak Grade B 1#	sawnsoft 150x150

Member Loads

Load reference	Load type	Start pos'n (m)	Start intensity (kN) & (m)	End pos'n (m)	End intensity (kN) & (m)	Direction	Category
Loads on new post (Length 2.420m)							
Horizontal impact	PL	1.100	0.250			Horiz. (+X)	Imposed
Loads on new beam (Length 0.569m)							
Beam Gk	UL		1.150			Vertical (-Y)	Dead
Beam Qk	UL		3.000			Vertical (-Y)	Imposed

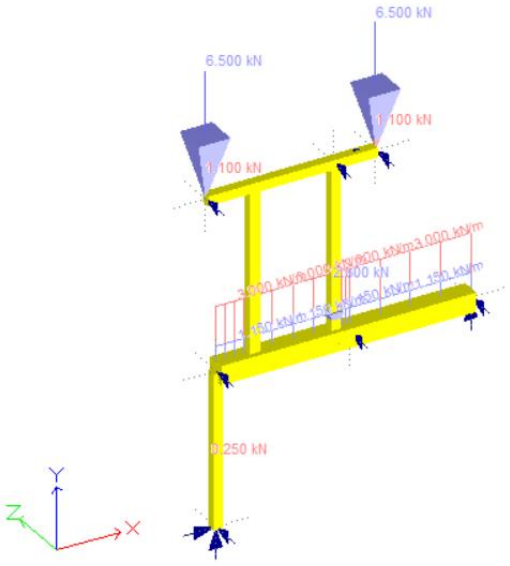
Joint Loads

Load reference	Load type	Intensity (kN) & (m)	Direction	Category (type)
Stud load	JL	2.800	Vertical (-Y)	Dead (Dead)
Purlin reaction Gk	JL	6.500	Vertical (-Y)	Dead (Dead)
Purlin reaction Qk	JL	1.100	Vertical (-Y)	Imposed (Imposed)

Load Combinations

Load Category			Partial Safety Factors				
No	Name	Type	Sub type	1	2	3	4
	Combination reference			Long Term	Medium Term	Deflection	Imp only
	Limit state			ULS	ULS	SLS	ULS
	Elastic analysis			Linear	Linear	Linear	Linear
	Plastic analysis			No	No	No	No
1	Self Weight	Permanent	Self weight	1.00	0.80	1.00	0.00
2	Dead	Permanent	Permanent	1.00	0.80	1.00	0.00
3	Imposed	Variable	Domestic	0.00	0.80	1.00	1.00

Loaded Model



New support frame.a3m

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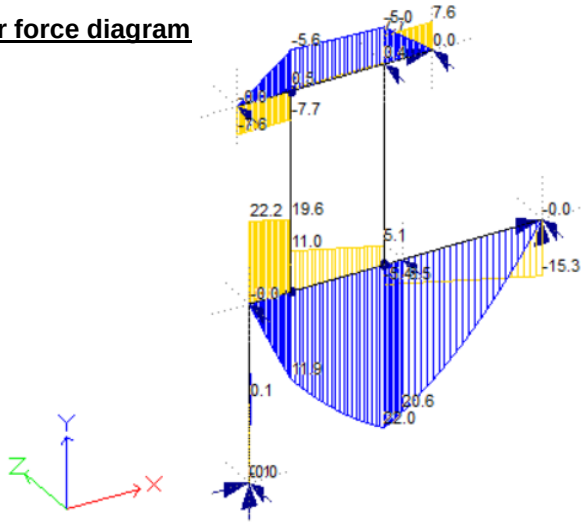
Bending moment and shear force diagram



Max Member Stresses for Combination Long Term

Member reference	Axial stresses (N/mm²)		Bending stresses (N/mm²)			
			Normal		Lateral	
	Compression	Tension	Positive	Negative	Positive	Negative
1	0.7	-0.0	0.0	-0.0	0.0	-0.0
2	0.3	-0.0	-0.0	0.0	0.0	-0.0
3	0.3	-0.0	-0.0	0.0	0.0	-0.0
4	0.0	-0.0	0.0	8.5	0.0	-0.0
5	0.0	0.0	0.0	8.5	0.0	-0.0
6	0.0	0.0	0.0	7.6	0.0	-0.0
7	0.0	-0.0	1.8	0.0	-0.0	0.0
8	0.0	-0.0	3.3	0.0	0.0	-0.0
9	0.0	-0.0	3.0	0.0	0.0	-0.0
10	0.0	-0.0	3.3	0.0	0.0	-0.0

Stresses within permissible therefore okay

Max Member Stresses for Combination Medium Term

Member reference	Axial stresses (N/mm²)		Bending stresses (N/mm²)			
			Normal		Lateral	
	Compression	Tension	Positive	Negative	Positive	Negative
1	0.8	-0.0	0.2	-0.0	0.0	-0.0
2	0.3	-0.0	-0.0	0.0	0.0	-0.0
3	0.3	-0.0	-0.0	0.0	0.0	-0.0
4	0.0	-0.0	0.0	7.9	0.0	-0.0
5	0.0	0.0	0.0	7.9	0.0	-0.0
6	0.0	0.0	0.0	7.1	0.0	-0.0
7	0.0	-0.0	2.1	0.0	-0.0	0.0
8	0.0	-0.0	3.9	0.0	0.0	-0.0
9	0.0	-0.0	3.7	-0.0	0.0	-0.0
10	0.0	-0.0	3.9	0.0	0.0	-0.0

Stresses within permissible therefore okay

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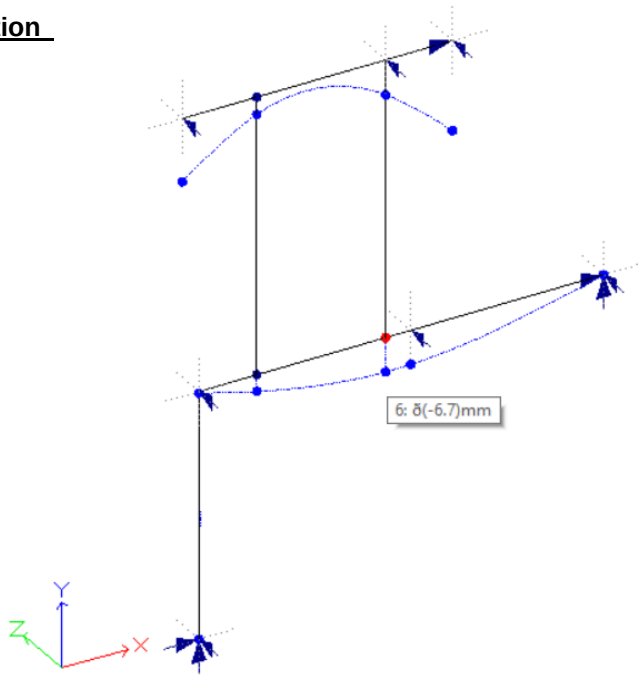
Worst case beam deflection



Deflection okay

New support frame.a3m

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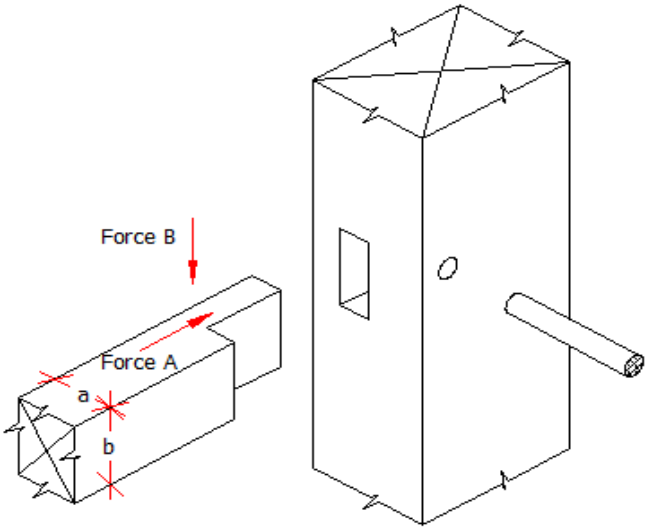
JOB NO:	16703		
PAGE:	01		
PROJECT:	Brick House, Eversley	CALCS BY:	sdh
ELEMENT:	Traditional Timber Joint Design	DATE:	April '24
Joint detail:	Beam to post		



Grade of timber selected: Oak Grade B

Allowable material stresses (N/mm²) to BS 5268-2

Compression perpendicular to grain =	3.29	N/mm²
Compression parallel to grain =	7.43	N/mm²
Shear stress =	1.43	N/mm²

Joint geometry

A	=	300 mm	Width of tenon	=	100 mm	Height of tenon	=	275 mm
B	=	300 mm	Length of tenon	=	125 mm			

Forces - taken from frame analysis

Force A =	0.00	kN
Force B =	22.20	kN

Check bearing for force A

Contact area =	62500	mm²	
Bearing stress =	0.00	N/mm²	
Allowable bearing stress on strut =	7.43	N/mm³	
Allowable bearing stress on post =	3.29	N/mm⁴	**Stresses OK**

Check bearing for force B

Contact area =	12500	mm²	
Bearing stress =	1.78	N/mm²	
Allowable bearing stress on strut =	3.29	N/mm³	
Allowable bearing stress on post =	7.43	N/mm³	**Stresses OK**

Check shear stress for force B

Shear area =	27500	mm²	
Shear stress =	1.21	N/mm²	**Stress OK**

Joint Geometry and Stresses within Allowable Limits

CONSULTING STRUCTURAL AND CIVIL ENGINEERS		JOB NO:	16703
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PROJECT:	**Brick House, Eversley**	CALCS BY:	sdh
ELEMENT:	Timber post check	DATE:	Mar. '24

Member:	Post supporting new beam

Design parameters to BS 5268-2

Load duration (k_3)	Medium Term (dead+snow, dead+temporary imposed)
Grade of timber selected	Oak Grade B
Multiple timbers (k_9)	Single Oak grade B timber
Load sharing systems (k_8)	Not a Load Sharing System
End conditions	
Restrained at both ends in position but not in direction	

Member properties and loading

Axial load	=	**22.60**	kN	Bending moment	=	**0.15**	kNm
Depth (d)	=	**150**	mm	Breadth (b)	=	**150**	mm
				Post height (L)	=	**2450**	mm

Area of section	=	22500	mm^2				
'I' value	=	42187500	mm^4	'Z' value	=	562500	mm^3
Applied axial stress	=	1.00	N/mm^2	Applied bending stress	=	0.27	N/mm^2
Effective height (L_{eff})	=	1.00	x 2450		=	2450	mm
Radius of gyration (i)	=	43.3	mm	Slenderness ratio	=	56.6	

$\sigma_{m,gl\ l}$	=	9.2	N/mm^2	k_3	=	1.25
$E_{min.}$	=	5960	N/mm^2 (conservative)	k_7	=	1.079
$\sigma_{c,g,perp}$	=	2.1	N/mm^2	k_8	=	1.00
$\sigma_{c,g,par'l}$	=	7.4	N/mm^2	k_9	=	1.00

Check axial loading capacity

$E/\sigma_{c,g,par'l}$	=	802	with $E/\sigma_{c,g,par'l}$	=	853	K_{12}	= 0.686
$\sigma_{c,g,par'l,adm}$	=	6.88	N/mm^2			Axial capacity of post	= 154.8 kN

POST 'OK' IN AXIAL LOADING

Check combined bending and axial loading capacity

$\sigma_{m,adm}$ = 12.37 N/mm^2 Euler critical stress, σ_e = 18.37 N/mm^2

$$\frac{\sigma_{m,a,II}}{\sigma_{m,adm,II}(1-(1.5\ \sigma_{c,a,II}/\sigma_e)K_{12})} + \frac{\sigma_{c,a,II}}{\sigma_{c,adm,II}} \leq 1$$

$$= 0.02 + 0.15 = 0.17$$

POST 'OK' IN AXIAL COMPRESSION & BENDING