PJM DESIGNS

STRUCTURAL CALCULATIONS

Job Ref:	23052
Project:	Structural alterations & extension
Site Address:	Kitts Cottage, Springfield
Client:	Mr R. Glew
Revision:	
Date:	19.05.2023

PJM Designs Limited | Suite 5, West Chevin Business Centre, West Chevin Road, Otley, LS21 3HA
Tel: 07915 214474 | email: info@pjmdesigns.co.uk

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	Project:	Structural alterations & extension
	Site Address:	Kitts Cottage, Springfield
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DEFINITIONS

Engineer:	PJM Designs Limited.
Client:	The individual or organisation that has instructed the design work.
Architect:	The individual or organisation appointed by the client to provide Architectural services (if applicable).
Contractor:	The main contractor in control of the construction phase.

DOCUMENT GUIDANCE

This document is to be read in conjunction with all relevant Architects and Engineers information. All documentation should be fully reviewed by the Contractor prior to commencement on site. Any deviations from the information provided are to be approved in writing by the Engineer.

The information provided in this document has been produced in accordance with the information provided to the Engineer. It is the responsibility of the principal designer to ensure any revised information is issued to the engineer to review and amend the structural information where necessary.

The information provided in this document should be approved by the appointed Building Control Officer prior to carrying out works on site or ordering materials. No liability is accepted for any changes that may be required as a result of work commencing on site prior to being approved.

For projects involving existing structures, a visual inspection will be carried out by the Engineer prior to works commencing. If any areas are covered with internal finishes during the inspection, certain assumptions may be made regarding the existing structure that will require confirmation when building work begins. Any such assumptions will be noted on the drawings provided. To avoid delays on site, it is advisable that existing finishes are removed as early as possible to confirm any assumptions made. Any assumptions e.g. existing floor and roof span directions, load bearing wall locations, existing foundations, or the condition of the existing structure are to be checked by a suitably qualified person on site once finishes have been removed. The engineer is to be contacted if required to review the exposed existing structure.

For new build structures, it is advised that a full ground investigation is carried out. For alterations to existing structures, where load paths are being altered, or additional loading is being applied to the existing foundations, trial holes are to be carried out to inspect the existing ground and existing footings for review by the Engineer and the Building Control Officer.

CDM 2015 REGULATIONS

The Construction Design and Management (CDM) Regulations 2015 apply in full to all construction works. On projects involving more than one contractor (including subcontractors), the client must appoint a Principle Designer and a Principle Contractor.

On projects involving an Architect, unless we are informed in writing, it is assumed the Architect is carrying out the duties of the Principal Designer. On projects not involving an Architect, PJM Designs Limited will be the Principal Designer unless informed in writing otherwise.

The Principal Contractor will be the Main Contractor appointed to carry out the construction works. The principal Contractor must produce a written Construction Phase Plan for the works, and include any method statements where appropriate. Further information on the CDM 2015 Regulations can be seen at http://www.hse.gov.uk/pubns/indg411.pdf

PARTY WALL ACT

If the project involves one of the following, it is likely that the client will need to serve a party wall notice on the adjoining owner:

- New building on or at the boundary of 2 properties
- Work to an existing party wall or party structure
- Excavation near to and below the foundation level of neighbouring buildings

Further information about the Act can be found in the explanatory booklet available to download from: https://www.gov.uk/party-wall-etc-act-1996-guidance

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HEALTH AND SAFETY

All building work can be hazardous, particularly where large structural elements, deep excavations or alterations to existing structures are involved. Typical hazards related to structural works that are present on the majority of building projects are identified below. Where uncommon hazards are present on certain projects. These are to be identified on the drawings provided.

Hazard	Falls from Height
Risk of occurance	High
Consequences	Death/Serious Injury
Possible Mitigation Measures	Make sure ladders are in good condition, at a 1:4 angle and tied or footed. - Prevent people and materials falling from roofs, gable ends, working platforms and open edges using guardrails, midrails and toeboards. - Make sure fragile roof surfaces are covered, or secure working platforms with guard rails are used on or below the roof.
Hazard	Collapse of Excavations
Risk of occurance	High
Consequences	Death/Serious Injury
Possible Mitigation Measures	Stabilise loose earth with box shutters or raking shores. Restrict persons from accessing trenches deeper than 1.0m, or adjacent to unretained earth. Cover or barrier excavations to prevent people or vehicles from falling in.
Hazard	Underpinning works
Risk of occurance	High
Consequences	Death/Serious Injury, Damage to property
Possible Mitigation Measures	Underpinning is to be be carried out in maximum lengths of 1000mm in a 'hit and miss' sequence to be decided between contractor and engineer prior to work commencing.Full method statement to be provided.
Hazard	Collapse of structures
Risk of occurance	High
Consequences	Death/Serious Injury, Damage to property
Possible Mitigation Measures	Support structural elements (such as walls, beams, chimney breasts, floors and roofs) with props; ensure temporary props and bracing are installed by a competent person. Main contractor to allow for necessary temporary bracing and propping of the structure during erection. Main contractor to liaise with subcontractors where required. Method statements to be provided where necessary.
Hazard	Contact with live electric cables, water or gas supplies
Risk of occurance	High
Consequences	Death/Serious Injury
Possible Mitigation Measures	Utility providers to be consulted for records of any existing services on the site. Ground to be CAT scanned prior to excavations taking place. Any existing services to be marked on the proposed foundation plans and provided to all contractors working on the site.
Hazard	Damage to existing structure when installing steelwork
Risk of occurance	High
Consequences	Death/Serious Injury, Damage to property
Possible Mitigation Measures	Existing masonry to be saw cut prior to wall removals to prevent damage to remaining masonry. Steel beams installed below existing masonry to be preloaded using driven steel folding wedges to reduce the risk of cracking on release of props. Reduce imposed loading as much as possible to structure being propped.

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Hazard	Overloading of structural elements
Risk of occurance	Medium
Consequences	Death/Serious Injury, Damage to property
Possible Mitigation Measures	Maximum allowable imposed loadings to be adhered to. Refer to Design criteria. Main contractor to ensure information is provided to all subcontractors. Storage of materials on site not to exceed these limits.
Hazard	Lifting of structural elements
Risk of occurance	High
Consequences	Death/Serious Injury, Damage to property
Possible Mitigation Measures	Main contractor to ensure suitable equipement is used for lifting structural sections. Steel beams to be spliced where necessary to aid lifting and manouvering
Hazard	Exposure to building dusts
Risk of occurance	High
Consequences	Serious health issues
Possible Mitigation Measures	Prevent dust by using wet cutting and vacuum extraction on tools; use a vacuum cleaner rather than sweeping; use a suitable, well-fitting mask
Hazard	Exposure to asbestos
Risk of occurance	High
Consequences	Serious health issues
Possible Mitigation Measures	Asbestos survey to be carried out prior to opening up of existing finishes. Contractor to liaise with asbestos consultant for the safe removal of any affected areas.
Hazard	Electricity
Risk of occurance	High
Consequences	Death/Serious Injury.
Possible Mitigation Measures	Turn the electricity supply and other services off before drilling into walls. - Do not use excavators or power tools near suspected buried services
Hazard	Protecting members of the public
Risk of occurance	High
Consequences	Death/Serious Injury.
Possible Mitigation Measures	Secure the site; net scaffolds and use rubbish chutes.

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DESIGN CRITERIA

Use of Structure	Dwelling
Codes of Practice	BS EN 1990: Eurocode: Basis of Structural Design BS EN 1991: Eurocode 1: Actions on Structures BS EN 1992: Eurocode 2: Design of Concrete Structures BS EN 1993: Eurocode 3: Design of Steel Structures BS EN 1995: Eurocode 5: Design of Timber Structures BS EN 1996: Eurocode 6: Design of Masonry Structures BS EN 1997: Eurocode 7: Geotechnical Design
Allowable Imposed Loadings	Roof 0.6 kN/m^2 Floors 1.5 kN/m^2
Wind Loading	Refer to seperate wind calcuations
Steelwork	Structural Steelwork Grade S275 JR or JOH (Unless noted ortherwise on drawings)
Masonry	Load Bearing Blockwork 7.3 N/mm^2 (Unless noted ortherwise on drawings)
Timber	Grade C16 or C24 (refer to drawings)
Concrete	Mass Concrete Grade C25/30 (Unless noted ortherwise on drawings)
Ground Conditions	TBC Design ground bearing capacity 75 kN/m^2
Other	The member spans in these calculations are for design purposes only. Actual lengths must be obtained by the Contractor or Fabricator from accurate site measurements.

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DESIGN LOADINGS

DEAD LOADS

Tiled Roof	1.2	kN/m^2
Flat Roof	0.6	kN/m^2
Timber Floor	0.5	kN/m^2
Timber Partition	0.5	kN/m^2
Block (100mm)	1.8	kN/m^2
Brick (100mm)	2.2	kN/m^2
Stone (200mm)	5.2	kN/m^2
Plaster	0.3	kN/m^2
Render	0.5	kN/m^2
Concrete	25.0	kN/m^3

LIVE LOADS

Roof	0.6	kN/m^2
Floor	1.5	kN/m^2

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BEAM LOADINGS B1

Span = 2.52m

UNIFORM LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L
Tiled Roof	1.2	0.6	1.0	1.20	0.60
Flat Roof	0.6	0.6			
Timber Floor	0.5	1.5	1.0	0.50	1.50
Timber Partition	0.5				
Block (100mm)	1.8				
Stone (200mm)	5.2		3.1	16.12	
Plaster	0.3		3.1	0.93	
Render	0.5				
TOTAL				**18.75**	**2.10**

PARTIAL LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L	X1 (m)	X2 (m)
Tiled Roof	1.2	0.6					
Flat Roof	0.6	0.6					
Timber Floor	0.5	1.5					
Timber Partition	0.5						
Block (100mm)	1.8						
Brick (100mm)	2.2						
Plaster	0.3						
Render	0.5						

POINT LOADS

Element	Load (kN) D	Load (kN) L	X (m)
Beam B3	17.7	1.1	1.7

VARIABLE

	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D (max)	Load (kN/m) L (max)	X1 (m) Max	X2 (m) Min
Stone (200mm)	5.2		1.20	6.24		0.0	2.52

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BEAM LOADINGS B2

Span = 2.2m

UNIFORM LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L
Tiled Roof	1.2	0.6	1.9	2.28	1.14
Flat Roof	0.6	0.6			
Timber Floor	0.5	1.5	1.5	0.75	2.25
Timber Partition	0.5				
Block (100mm)	1.8				
Stone (200mm)	5.2		3.1	16.12	
Plaster	0.3		3.1	0.93	
Render	0.5				
TOTAL				**20.08**	**3.39**

PARTIAL LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L	X1 (m)	X2 (m)
Tiled Roof	1.2	0.6					
Flat Roof	0.6	0.6					
Timber Floor	0.5	1.5					
Timber Partition	0.5						
Block (100mm)	1.8						
Brick (100mm)	2.2						
Plaster	0.3						
Render	0.5						

POINT LOADS

Element	Load (kN) D	Load (kN) L	X (m)

VARIABLE

	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D (max)	Load (kN/m) L (max)	X1 (m) Max	X2 (m) Min
Stone (200mm)	5.2		1.20	6.24		0.0	2.2

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BEAM LOADINGS B3

Span = 3.5m

UNIFORM LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L
Tiled Roof	1.2	0.6	1.0	1.20	0.60
Flat Roof	0.6	0.6			
Timber Floor	0.5	1.5			
Timber Partition	0.5				
Block (100mm)	1.8				
Stone (200mm)	5.2				
Plaster	0.3				
Render	0.5				
TOTAL				**1.20**	**0.60**

PARTIAL LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L	X1 (m)	X2 (m)
Tiled Roof	1.2	0.6					
Flat Roof	0.6	0.6					
Timber Floor	0.5	1.5					
Timber Partition	0.5						
Stone (200mm)	5.2		1.10	5.72		0.00	1.86
Stone (200mm)	5.2		1.20	6.24		1.86	3.50
Plaster	0.3						
Render	0.5						

POINT LOADS

Element	Load (kN) D	Load (kN) L	X (m)

VARIABLE

	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D (max)	Load (kN/m) L (max)	X1 (m)	X2 (m)
Tri Load						**Min**	**Max**
Stone (200mm)	5.2		1.00	5.20		0.0	1.86
Tri Load						**Max**	**Min**
Stone (200mm)	5.2		0.9	4.68		1.86	3.5

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BEAM LOADINGS — PURLIN

Span = 1.9m

UNIFORM LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L
Tiled Roof	1.2	0.6	2.4	2.88	1.44
Flat Roof	0.6	0.6			
Timber Floor	0.5	1.5			
Timber Partition	0.5				
Block (100mm)	1.8				
Stone (200mm)	5.2				
Plaster	0.3				
Render	0.5				
TOTAL				**2.88**	**1.44**

PARTIAL LOADS

Element	Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D	Load (kN/m) L	X1 (m)	X2 (m)
Tiled Roof	1.2	0.6					
Flat Roof	0.6	0.6					
Timber Floor	0.5	1.5					
Timber Partition	0.5						
Block (100mm)	1.8						
Brick (100mm)	2.2						
Plaster	0.3						
Render	0.5						

POINT LOADS

Element	Load (kN) D	Load (kN) L	X (m)

VARIABLE

Load (kN/m^2) D	Load (kN/m^2) L	B/H (m)	Load (kN/m) D (max)	Load (kN/m) L (max)	X1 (m)	X2 (m)

PJM Designs Limited
West Chevin Business Centre
West Chevin Road, Otley, LS21 3HA
Tel: 07915 214474
Email : info@pjmdesigns.co.uk

Soflock 4fa83

Job Ref : 23052
Sheet : / 007
Made by :
Date : 19 May 2023 / Ver. 2022.16.24
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Axial with Moments (Member)
Beam B1: Span 1
Span 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D1 + 1.5 L1

```
D1 UDLW -000.298                ( kN/m )
D1 UDLY -018.750                ( kN/m )
L1 UDLY -002.100                ( kN/m )
D1 PY   -017.700 1.700          ( kN,m )
L1 PY   -001.100 1.700          ( kN,m )
D1 PTRY -006.240 0.000 2.520 +000.000
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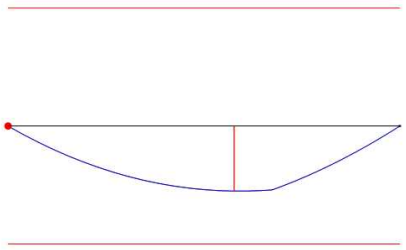

Member Forces in Load Case 1 and Maximum Deflection from Load Case 3

Span No.	Axial Force (kN)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
		End1	End2	End1	End2		
1	0.00C	51.76	-57.14	0.00	0.00	37.57 @ 1.485	4.90 @ 1.300

Classification and Effective Area (EN 1993: 2006)

Section (30.03 kg/m)	152x152 UC 30 [S 275]		
Class = Fn(b/T,d/t,f_y,N,M_y,M_z)	8.13, 19.02, 275, 0, 37.57, 0	(Axial: Non-Slender)	Class 1
Auto Design Load Cases	1		

Shear Capacity Check

$V_{y.Ed}/V_{pl.y.Rd}$	57.142 / 183.454 =	0.311	OK

Moment Capacity Check M.c.y.Rd

$V_{y.Ed}/V_{pl.y.Rd}$	1.083 / 183.454 =	0.006	Low Shear
$M_{c.y.Rd} = f_y.W_{pl.y}/\gamma_{M0}$	275 x 247.7/1	68.118 kN.m	
$M_{y.Ed}/M_{c.y.Rd}$	37.552 / 68.118 =	0.551	OK

Equivalent Uniform Moment Factor C1

C_1= fn(M_1, M_2, M_o, ψ,μ)	0.0, 0.1, 36.7, 0.845, 300.000	1.127	Uniform

Lateral Buckling Check M.b.Rd

Le = 1.0 L	1 x 2.52 =	2.52 m	
M_{cr}= Fn(C_1,L_e,I_z,I_t,I_w,E)	1.127, 2.520, 561.4, 10.52, 0.03075, 210000	207.668 kN.m	
λ_{LT}= $\sqrt{}$ W.f_y/M_{cr}	$\sqrt{}$ 247.7 x 275 / 207.668	0.573	
γ_{LT}= Fn(λ_{LT}, ϕ_{LT}, β, λ_{LT0})	0.573, 0.652, 0.750, 0.400	0.929	Curve b
γ_{LT}.mod = Fn(γ_{LT},λ_{LT},k_c,f)	0.929, 0.573, 0.942, 0.974	0.954	6.3.2.3
$M_{b.Rd} = \chi W_{pl.y}.f_y \leq M_{c.y.Rd}$	0.954 x 247.7 x 275 ≤ 68.118 =	64.989 kN.m	
$M_{y.Ed}/M_{b.Rd}$	37.569 / 64.989	0.578	OK

Deflection Check - Load Case 3

Deflection Limits (Existing Masonry)	In-span $\delta \leq$ 2520/500 = 5 mm Live (Case 2)	0.38 mm	OK
	In-span $\delta \leq$ 2520/360 = 7 mm D+L (Case 3)	4.9 mm	OK

PJM Designs Limited
West Chevin Business Centre
West Chevin Road, Otley, LS21 3HA
Tel: 07915 214474
Email : info@pjmdesigns.co.uk

Soflock 4fa83

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Axial with Moments (Member)
Beam B2: Span 1
Span 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D1 + 1.5 L1

```
D1 UDLW -000.228                ( kN/m )
D1 UDLY -020.080                ( kN/m )
L1 UDLY -003.390                ( kN/m )
D1 PTRY -006.240 0.000 2.200 +000.000
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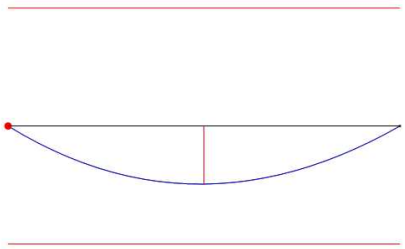

Member Forces in Load Case 1 and Maximum Deflection from Load Case 3							
Span No.	Axial Force (kN)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
		End1	End2	End1	End2		
1	0.00C	41.93	-38.84	0.00	0.00	22.22 @ 1.089	3.11 @ 1.089

Classification and Effective Area (EN 1993: 2006)

Section (22.95 kg/m)	152x152 UC 23 [S 275]		
Class = Fn(b/T,d/t,f_y,N,M_y,M_z)	11.19, 21.31, 275, 0, 22.22, 0	(Axial: Non-Slender)	Class 3
Effective Properties	Area=29.24 cm², $W_{pl.y}$=179.39(182) cm³, $W_{pl.z}$=76.18(80.2) cm³		
Auto Design Load Cases	1		

Shear Capacity Check

$V_{y.Ed}/V_{pl.y.Rd}$	41.928 / 158.276 =	0.265	OK

Moment Capacity Check M.c.y.Rd

$V_{y.Ed}/V_{pl.y.Rd}$	0.777 / 158.276 =	0.005	Low Shear
$M_{c.y.Rd} = f_y.W_{el.y}/\gamma_{M0}$	275 x 164.13/1 =	45.136 kN.m	
$M_{y.Ed}/M_{c.y.Rd}$	22.21 / 45.136 =	0.492	OK

Equivalent Uniform Moment Factor C1

C_1= fn(M_1, M_2, M_o, ψ,μ)	0.0, 0.0, 22.2, 1.000, 300.000	1.127	Uniform

Lateral Buckling Check M.b.Rd

Le = 1.0 L	1 x 2.2 =	2.2 m	
M_{cr}= Fn(C_1,L_e,I_z,I_t,I_w,E)	1.127, 2.200, 400.8, 4.635, 0.02118, 210000	167.122 kN.m	
λ_{LT}= √ $W_{.el.y}/M_{cr}$	√ 164.1 x 275 / 167.122	0.520	
γ_{LT}= Fn(λ_{LT}, ϕ_{LT}, β, λ_{LT0})	0.520, 0.622, 0.750, 0.400	0.952	Curve b
γ_{LT}.mod = Fn(γ_{LT}.λ_{LT},k_c,f)	0.952, 0.520, 0.942, 0.976	0.976	6.3.2.3
$M_{b.Rd} = \chi\ W_{el.y}.f_y \leq M_{c.y.Rd}$	0.976 x 164.1 x 275 ≤ 45.136 =	44.047 kN.m	
$M_{y.Ed}/M_{b.Rd}$	22.217 / 44.047	0.504	OK

Deflection Check - Load Case 3

Deflection Limits (Existing Masonry)	In-span $\delta \leq$ 2200/500 = 4.4 mm Live (Case 2)	0.39 mm	OK
	In-span $\delta \leq$ 2200/360 = 6.1 mm D+L (Case 3)	3.11 mm	OK

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Email : info@pjmdesigns.co.uk

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Axial with Moments (Member)
Beam B3: Span 1
Span 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D1 + 1.5 L1

```
D1 UDLW -000.298                ( kN/m )
D1 UDLY -001.200                ( kN/m )
L1 UDLY -000.600                ( kN/m )
D1 PDLY -010.639 0.000 1.860 (kN,m,m)
D1 PDLY -010.234 1.860 3.500 (kN,m,m)
D1 PTRY +000.000 0.000 1.860 -005.200
D1 PTRY -004.680 1.860 3.500 +000.000
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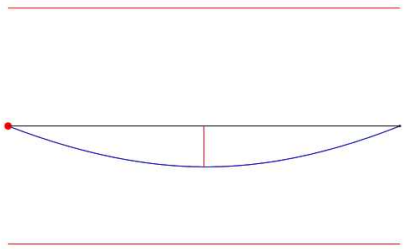

Member Forces in Load Case 1 and Maximum Deflection from Load Case 3

Span No.	Axial Force (kN)	Shear Force (kN)		Bending Moment (kN.m)		Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
		End1	End2	End1	End2		
1	0.00C	24.73	-25.38	0.00	0.00	23.61 @ 1.750	5.97 @ 1.750

Classification and Effective Area (EN 1993: 2006)

Section (30.03 kg/m)	152x152 UC 30 [S 275]		
Class = Fn(b/T,d/t,f_y,N,M_y,M_z)	8.13, 19.02, 275, 0, 23.61, 0	(Axial: Non-Slender)	Class 1
Auto Design Load Cases	1		

Shear Capacity Check

$V_{y.Ed}/V_{pl.y.Rd}$	25.386 / 183.454 =	0.138	OK

Moment Capacity Check M.c.y.Rd

$V_{y.Ed}/V_{pl.y.Rd}$	0.327 / 183.454 =	0.002	Low Shear
$M_{c.y.Rd} = f_y.W_{pl.y}/\gamma_{M0}$	275 x 247.7/1	68.118 kN.m	
$M_{y.Ed}/M_{c.y.Rd}$	23.61 / 68.118 =	0.347	OK

Equivalent Uniform Moment Factor C1

C_1= fn(M_1, M_2, M_o, ψ,μ)	0.0, 0.0, 23.6, 0.759, 300.000	1.127	Uniform

Lateral Buckling Check M.b.Rd

Le = 1.0 L	1 x 3.5 =	3.5 m	
M_{cr}= Fn(C_1,L_e,I_z,I_t,I_w,E)	1.127, 3.500, 561.4, 10.52, 0.03075, 210000	128.552 kN.m	
λ_{LT}= $\sqrt{}$ W.f_y/M_{cr}	$\sqrt{}$ 247.7 x 275 / 128.552	0.728	
γ_{LT}= Fn(λ_{LT}, ϕ_{LT}, β, λ_{LT0})	0.728, 0.754, 0.750, 0.400	0.855	Curve b
γ_{LT}.mod = Fn(γ_{LT},λ_{LT},k_c,f)	0.855, 0.728, 0.942, 0.971	0.881	6.3.2.3
$M_{b.Rd} = \chi W_{pl.y}.f_y \leq M_{c.y.Rd}$	0.881 x 247.7 x 275 ≤ 68.118 =	59.996 kN.m	
$M_{y.Ed}/M_{b.Rd}$	23.61 / 59.996	0.394	OK

Deflection Check - Load Case 3

Deflection Limits (Existing Masonry)	In-span $\delta \leq$ 3500/500 = 7 mm Live (Case 2)	0.32 mm	OK
	In-span $\delta \leq$ 3500/360 = 9.7 mm D+L (Case 3)	5.97 mm	OK

PJM Designs Limited
West Chevin Business Centre
West Chevin Road, Otley, LS21 3HA
Tel: 07915 214474
Email : info@pjmdesigns.co.uk

Soflock 4fa83

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Made by :
Date : 19 May 2023 / Ver. 2022.16.24
Checked :
Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS EN 1995-1-1:2004 + A1:2008
Purlin: Span 1

Summary Design Data

Eurocode National Annex	Using UK values
Strength class code	BS EN 338:2009
Design Cases Covered	1-3
Deflection Cases Covered	1.0 L1 + 1.0 L2, 1.0 D1 + 1.0 D2 + 1.0 L1 + 1.0 L2
Section Size	b = 72, h = 195, 195x72 in Strength Class C24
Section Properties (cm²,cm³,cm)	Area 140.4, $W_{el.y}$ 456.3, $W_{el.z}$ 168.5, i_y 5.63, i_z 2.08
Specification	1 : Internal use in continuously heated building Long Term loading
Integrated Design Critical Case	: All Spans Loaded (Ultimate: 1.35D1+1.35D2+1.5L1+1.5L2)
Member Details	N_{Ed} = 0.0 kN, L = 1.9 m, L_y = 1.9 m, L_z = 1.9 m, $L_{cr.y}$ = 1.0 L_y, $L_{cr.z}$ = 1.0 L_z Bearing length 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class C24)

$f_{m.y.d} = K_{mod}.K_{hy}.K_{sys}.f_{m.k}/\gamma_m$	0.70 x 1.00 x 1.00 x 24.00/1.3	12.92 N/mm²	
$f_{m.z.d} = K_{mod}.K_{hz}.K_{sys}.f_{m.k}/\gamma_m$	0.70 x 1.16 x 1.00 x 24.00/1.3	14.97 N/mm²	
$f_{c.90.d} = K_{mod}.K_{c.90}.K_{sys}.f_{c.90.k}/\gamma_m$	0.70 x 1.50 x 1.00 x 2.50/1.3	2.02 N/mm²	
$f_{v.d} = K_{mod}.K_{sys}.f_{v.k}/\gamma_m$	0.70 x 1.00 x 4.00/1.3	2.15 N/mm²	
E_{mean}	Instantaneous Deflection	11000 N/mm²	Deflection

Axial Load with Moments Check

Critical Design Location	X = 0.950		
$\sigma_{m.y.d} = M_y/W_{el.y}$	2.728 / 456.3 ≤ 12.92	5.98 N/mm²	OK
$U_{m.y} = \sigma_{m.y.d}/f_{m.y.d}$	5.980/12.923	0.463	OK
$U_{m.y}$	0.463	0.463	OK
$L_{eff}=L.K_{LTB}$	1.900x1.000	1.900	
$\sigma_{mcrit}=\pi\sqrt{(E_{05}.I_z.G_{05}.J)/(L_{eff}.W_y)}$	$\pi\sqrt{(7.40x606.53x0.46x1862.64)/(1.900x456.30)}$	71.383	
$\lambda_{r,elm}=\sqrt{(f_{mk}/\sigma_{mcrit})}$	√(24.00/71.38)	0.580	
k_{Crit}	$\lambda_{r,elm} < 0.75$	1.000	
$\sigma_{m.y.d}/(k_{Crit} \bullet f_{m.y.d})$	5.980/(1.000x12.923)	0.463	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$\tau_a = 1.5\ V_{y.Ed}$ / Area / k_{cr}	1.5 x 5.746 / 140.4 / 0.67 ≤ 2.15	0.92 N/mm²	OK
$\sigma_{cax} = V_{y.Ed}$ / (b.l_y)	5.746 / (72 x 75) ≤ 2.02	1.06 N/mm²	OK

Deflection Check

Critical Load Case 005 : All Spans Loaded (Serviceability: 1.0D1+1.0D2+1.0L1+1.0L2)

$\delta = \delta_m + \delta_s$	In-span 1.74 ≤ L/250	1.74 mm	OK