RCA STRUCTURES
STRUCTURAL ENGINEERING AND DESIGN

ISO 9001 REGISTERED FIRM

The Institution of StructuralEngineers

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Structural Calculations

Project:- Bowyers Cottage, Furneux Pelham, Essex.

Design:- Design of Structural Elements for Proposed Garden Room

Job No:- 24076 *Date:-* Sep-23

Prepared By:- Ian Devonshire

Basis Of Design:-

BS EN 1990	Basis of Structural Design
BS EN 1990 NA	UK National Annex for Basis of Structural Design
BS EN 1991	Actions on Structures
BS EN 1991 NA	UK National Annex for Actions on Structures
BS EN 1992	Design of Concrete Structures
BS EN 1992 NA	UK National Annex for Design of Concrete Structures
BS EN 1993	Design of Steel Structures
BS EN 1993 NA	UK National Annex for Design of Steel Structures
BS EN 1995	Design of Timber Structures
BS EN 1995 NA	UK National Annex for Design of Timber Structures
BS EN 1996	Design of Masonry Structures
BS EN 1996 NA	UK National Annex for Design of Masonry Structures

Notes:-

1. *Full building regulations and checking engineer approval must be obtained prior to installation or fabrication.*
2. *Installation to be in accordance with current codes and standards.*
3. *All lengths and dimensions in these calculations are for design purposes only and should not be used for setting out on site. Contractor/Builder must measure up lengths/heights for setting out before ordering of any materials.*
4. *All temporary works to be designed and undertaken by a suitably qualified contractor.*
5. *All loadings to existing structures have been calculated following a visual inspection on site and further investigative works may be required to verify the type of construction.*
6. *All construction work to comply with the Construction Design & Management (CDM) Regulations 2015.*
7. *All planning and other elements of Building Regulations by others.*

Revisions:-

Rev	*Date*	*Revision*

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DESIGN BRIEF/SPECIFICATION

Drawings used:-	Drawing Sheets provided by the Client

Scope of required design works:-

1) *Flitch Beam over Flat Roofed Extension*
2) *Flitch Beams over New Lounge and New Kitchen*
3) *Flat Roof Joists over Rear Extension*

Please also refer to RCA drawings and sketches where applicable.

STEELWORK SPECIFICATION

The Steelwork in the following calculations including UB & UC Sections have been designed as S355 grade in accordance with BS EN 1993. (Unless noted otherwise).
Grade of fixing, end, toe and baseplates as noted in calculations.
If cold rolled grade hollow Sections2 (2) (2) have been specified, client to be aware of increased radius sizes.
Where steelwork is to be used internally grade JR to be used and where external, grade J0 to be used to BS EN 10025:1993.
All bolts in connections to be Grade 8.8 to BS EN 1993 unless specified otherwise.
All welding to be in accordance with BS EN 1011-2:2001.
Where fillet welds are specified, these are generally to be 6mm fillet weld unless noted otherwise.
Where partial penetration fillet welds are specified, these are generally to be installed to a depth of 2mm less than the thickness of the connected part. (Minimum throat size = 2 √t)
Partial penetration butt welds to be generally a minimum of 6mm thick.
All full and partial penetration butt welds should be made using matching electrodes with a specified minimum tensile strength, yield strength, elongation at failure and Charpy impact value equivalent or better than the parent material.
Should Hollo-bolts be used, installation and detailing in accordance with Table H61 of SCI "Joints in Steel construction:Simple Joints" guidelines.
Finishes to Steel work to Architects specification.
Finishes to Steel work to provide suitable fire resistance to building regulation requirements.
All steelwork to be installed strictly in accordance with BS EN 1993.
Where steel bears on masonry, solid mass concrete padstone to be placed below. Size to RCA calculations.

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DESIGN BRIEF/SPECIFICATION (CONT.)

STEELWORK - CPR & CE Marking Compliance.

References:

BS EN 1090	The harmonized standard (hEN) covering fabricated structural steelwork : Execution of steel structures and aluminium structures. (Part 1 & 2)
BS EN 10025-1	Steel Sections and Plates
Hollow Sections:	
BS EN 10210-1	Hot finished
BS EN 10219-1	Cold formed welded
Stainless Steels:	
BS EN 10088-4	Sheet, Plate & Strip
BS EN 10088-5	Bars, Rods, Wire, Sections and Bright Products
BS EN 15088-1	Aluminium
Structural bolts:	
BS EN 15048-1	Non-preloaded structural bolting assemblies
BS EN 14399-1	High strength structural bolting assemblies for preloading
Welding:	
EN ISO 3834-2:2005	Quality requirements for fusion welding of metallic materials – Part 2: Comprehensive quality requirements.
BS EN 13479	Welding Consumables

Execution Class to BS EN 1090-2

Consequence Class from Table B1 - BS EN 1990 =
CC1 *Low Consequence for loss of human life*
Building use from BS EN 1991-1-7 :-
Agricultural Buildings, Houses less than 4 storeys.

Service Category to BS EN 1090-2 =
SC1 *Quasi static actions, low seismic activity, fatigue from crane actions.*

Production Category to BS EN 1090-2 =
PC2 *Welded components grade S355 and above,*

Execution Class from Table B.3 of BS EN 1090-2 = EXC2
Therefore, fabricator to note execution class **EXC2** **to BS EN 1090-2**

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DESIGN BRIEF/SPECIFICATION (CONT.)

TIMBER SPECIFICATION

The Timber in the following calculations has generally been designed as C16 grade in accordance with BS EN 1995. (Unless noted otherwise).
Timber has been designed as generally covered by suitable finishes such as plasterboard to give suitable fire protection. Client to advise if charring rates are to be assessed for unprotected timbers.
All timber connections to be made in accordance with BS EN 1995 / NHBC Standards.
Solid blocking to be used where joists are notched into steel beams.
Lateral Restraint straps required to walls parallel to joists and timber roof spans.
Straps to be at a maximum 1.2 c/c apart and fixed to a minimum of 3 No. Joists
All straps installed to BS EN 1995 and BS8103.
Herringbone strutting or solid blocking required perpendicular to joist spans.
2.5m - 4.5m spans, 1 row required. Over 4.5m spans, 2 rows required equally spaced.

LINTEL SPECIFICATION

All Lintels to be installed in accordance with BS5977.
Individual manufacturers literature must be referred to for installation procedure.
All Lintels to bear 150mm where possible. No steel beams must bear directly on lintels.

CONCRETE (FOUNDATIONS) SPECIFICATION

The Concrete in the foundations has generally been designed as
C20/25 grade in accordance with BS EN 1992 & BS8500. (Unless noted otherwise).
(Or equivalent RC25 designated mix to NHBC standards)
Concrete may be site mixed if in accordance with NHBC 2.1 tables 1 & 2.
All reinforcement bars are taken as "H" type bars with a yield strength of 500N/mm^2.
All concrete to be installed in accordance with BS EN 1992.

MASONRY SPECIFICATION

All masonry in the following calculations has been designed in accordance with BS EN 1996.
All blockwork below DPC level to be constructed in mortar designation (i) in accordance with BS EN 1996 part 1, Table 1. (Cement : Sand 1:3)
All load bearing masonry to be minimum 100mm wide.
Movement joints placed in accordance with BS EN 1996.
Joints every 12m (6m from corners) in brickwork and every 6m (3m from corners) in blockwork.
Wall ties to be installed and specified to DD140 & NHBC Standards.
No individual block to weigh more than 20Kg for Health & Safety purposes.
Blockwork designed to have a maximum density of 1400Kg/m^3. RCA to be advised if different.

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LOADING DATA :-

	Permanent Actions (gK,GK) (kN/m^2)	Variable Actions (qK,QK) (kN/m^2)
Pitched Roof (Pitch = 30 ^{o}approx.)		
Roofing Tiles	0.65	
Felt & Battens	0.15	
Rafters	0.15	
Imposed (Snow)		0.52 ON SLOPE
	0.95 ON SLOPE	0.52 ON SLOPE
Loft		
Ceiling Joists	0.15	
Plasterboard Ceiling	0.15	
Imposed		0.25
	0.30 kN./m^2	0.25 kN./m^2
Cavity Wall		
Brickwork outer Skin	2.00	
Blockwork inner Skin	1.35	
Plaster Internally	0.30	
	3.65 kN./m^2	
First Floor		
Boarding	0.15	
Floor Joists	0.15	
Plasterboard Ceiling	0.15	
Imposed		1.50
	0.45 kN./m^2	1.50 kN./m^2
Timber External Wall (finished in Weatherboarding)		
150mm. x 50mm. C16 timber studs	0.15	
9.5mm. thk. O.S.B. Board & Battens	0.10	
Weatherboarding	0.15	
Single face of plasterboard (Internally)	0.15	
	0.55 kN./m^2	
Flat Roof		
Zinc Covering	0.15	
Boarding	0.15	
Flat Roof Joists	0.15	
Plasterboard Ceiling	0.15	
Imposed (Slight Pitch)		0.58
	0.60 kN./m^2	0.58 kN./m^2

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Lintels over proposed Rear door openings :-

Using B.S. 5977 : Part 1 1981 :-

Taking a triangular load for the wall & half of load in Interaction Zone (as per Figure 1 of Code):-

	Perm. Load (kN/m^2)	Variable Load (kN/m^2)	Distance(m)		Permanent Load (kN/m)	Variable Load (kN/m)	
Flat Roof	0.60	0.58	3.00m./2 =	1.50	0.90	0.87	(Within Interaction Zone
Cavity Wall	3.65	-	Height	0.50	1.83	-	(Triangular load)
			TOTAL		2.73	0.87	

Therefore, TOTAL Unfactored Load = 3.60 kN./m-run

Try a Keystone S/K- 110 Lintel :-

Maximum Clear span = 3.60 m.
1.1 x Clear span = 3.96 m.

Therefore, Allowable TOTAL U.D.L. = 25.00 kN. > 14.24 kN.

Therefore, o.k.

Therefore, Use a Keystone S/K- 110 Lintel (218mm. high)

n.b. Minimum end bearings = 150mm.

(i.e. Length of Lintel needs to be clear opening + 300mm. (Minimum))

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beam across Dining/Living

Actions	Permanent Action, G_k (kN/m^2)	Leading Variable Action, Q_{k1} (kN/m^2)	Variable Action, Q_{ki} (kN/m^2)	Distance(m)	Permanent Action, G_k (kN/m)	Leading Variable Action, Q_{k1} (kN/m)	Variable Action, Q_{ki} (kN/m)
Flat roof	0.60	0.58		4.60m./2= 2.30	1.38	1.33	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
				TOTALS:	*1.38*	*1.33*	*0.00*

Clear Span = 5700 mm. Bearings = 100 mm minimum each side

Design span = **5800 mm** *(NB - Design span only - not for setting out on site)*

Conservatively, use equation 6.10 = $1.35\,G_k + 1.5\,Q_{k1} + \Sigma\,\psi_{0i}\,1.5\,Q_{ki}$

Conservatively, take ψ_{0i} = 1.00

Design UDL= 1.86 + 2.00 + 0 = 3.86 kN/m

Unfactored UDL = 2.71 kN/m

Design Point Load 1= 0.00 kN

Distance from A to point load 1= 0 mm

Distance from B to point load 1= 5800 mm

Design Point Load 2= 0.00 kN

Distance from A to point load 2= 0 mm

Distance from B to point load 2= 5800 mm

Design Point Load 3= 0.00 kN

Distance from A to point load 3= 0 mm

Distance from B to point load 3= 5800 mm

Beam analysed with simple supports:-

Design Moment =	16.25	+	0.00	+	0.00	+	0.00
Design Shear Force At A =	11.21	+	0.00	+	0.00	+	0.00
Design Shear Force At B =	11.21	+	0.00	+	0.00	+	0.00

Design Moment =	**16.25 kNm.**
Design. Shear A =	**11.21 kN.**
Design. Shear B =	**11.21 kN.**

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beam across Dining/Living

From previous calculation :-

Max. Shear = 11.21 kN Maximum Moment = 16.25 kNm

Clear Span = 5700 mm. Bearings = 100 mm minimum each side

Design span = 5.80 m = 5800 mm

Exposure condition = Service Class 1

(Intermediate Floors, Warm Roofs, internal and party timber frame walls)

Load Duration = Short Term *(Snow, Maintenance on roofs.)*

Design Timber Grade = C24 Material = Solid Timber. Treated or untreated

Bending Strength, $f_{m,k}$ = 24.0 N/mm^2 $E_{0,mean}$ = 11.00 kN/mm^2

Shear Strength, $f_{v,k}$ = 4.00 N/mm^2

Timber

Try 2 No. 200 deep x 50 wide Joists

Type of fire exposure = Not Exposed

Charring rate = General Rate = 0.60 mm/min

Required fire rating = 30 minutes

Effective size for design = 200 mm deep x 100 mm wide member

Elastic Modulus , W_{yy} = 6.7E+05 mm^3. Partial Safety factor, γ_m = 1.3

K_h Factor = 1.00 Type of Beam= Not Load Sharing k_{sys} = 1.0

k_{mod} = 0.9 k_{crit} = 1 (No LTB due to Rafters and Flat Roof Joists/ boarding

A = 20000 mm^2 I_{yy} = 66666667 mm^4

Steel Plate

Try 1 No. 200 deep x 15 mm wide steel S 275

Youngs Modulus for Steel = 205000 N/mm^2

Elastic Modulus , W_{yy} = 1.0E+05 mm^3. Modulus of Inertia, I, = 1E+07 mm^4.

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beam across Dining/Living

Modified values Modular Ratio = $\frac{205000}{11000}$ = 18.64

$I_{eff\ timber}$ = 7E+07 + (1E+07 x 18.64) = 2.5E+08 mm^4

$I_{eff\ steel}$ = 1E+07 + $\frac{7E+07}{18.64}$ = 1E+07 mm^4

$Z_{eff\ timber} = \frac{I}{y} = \frac{3E+08}{100}$ = 2530303 mm^3.

$Z_{eff\ steel} = \frac{I}{y} = \frac{1E+07}{100}$ = 135772 mm^3.

Steel plate checks

Stress to plate = $\frac{M}{Z} = \frac{1.6E+07}{135772}$ = 119.67 N/mm^2

As, 119.67 N/mm^2 < 275 N/mm^2 O.K.

Timber Checks

Bending

Design bending strength $f_{m,d}$ = $k_{mod} \cdot k_h \cdot k_{crit} \cdot k_{sys} \cdot f_{m,k} / \gamma_m$ = 16.62 N/mm^2

$M_{ult} = f_{m,d} \cdot W_{yy}$ = 42.04 kNm > 16.25 kNm O.K.

Shear k_{cr} = 0.67

Applied shear stress = $\frac{3V_d}{2bh\ k_{cr}}$ = 1.25 N/mm^2

Design shear strength $f_{v,d}$ = $k_{mod} \cdot k_{sys} \cdot f_{v,k} / \gamma_m$ = 2.77 N/mm^2

As, 2.77 N/mm^2 > 1.25 N/mm^2 O.K.

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beam across Dining/Living

Deflection A = 20000 mm^2

I_{yy} (modified) = 2.5E+08 mm^4 k_{def} = 0.6 ψ_2 = 0.0

Building use = Roofs Assume point loads approx 75 % imposed

Equivalent unfactored UDL Perm. = 1.38 kN/m M(Perm)= 5.80 kNm
Equivalent unfactored PL Perm. = 0.00 kN/m

$$w_{fin,G} = \frac{5wL^4}{384EI} + \frac{19.2\,M}{EA} \times (1 + k_{def})$$

$w_{fin,G}$ = 7.31 + 0.51 x 1.6 = 12.50 mm

Equivalent unfactored UDL Variable = 1.33 kN/m M(Variable)= 5.61 kNm
Equivalent unfactored PL Variable = 0.00 kN/m

$$w_{fin,Q} = \frac{5wL^4}{384EI} + \frac{19.2\,M}{EA} \times (1 + \psi_2\, k_{def})$$

$w_{fin,Q}$ = 7.06 + 0.49 x 1 = 7.55 mm

Final Deflection (including creep and shear) = 20.05 mm

Type of finish:- Brittle Finish Limiting value = L / 250
Allowable deflection = 22.80 mm

As, 22.80 mm > 20.05 mm **O.K.**

Therefore, use:-

2 No. 200 x 50 Joists, C24 Grade Timber
with 1 No. 200 x 15 n wide steel S 275

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beams over Knock-throughs into Main House

Actions	Permanent Action, G_k (kN/m^2)	Leading Variable Action, Q_{k1} (kN/m^2)	Variable Action, Q_{ki} (kN/m^2)	Distance(m)		Permanent Action, G_k (kN/m)	Leading Variable Action, Q_{k1} (kN/m)	Variable Action, Q_{ki} (kN/m)
Pitched roof	0.95	0.52		On Slope =	2.50	2.38	1.30	0.00
Loft	0.30	0.25		2.20m./2=	1.10	0.33	0.28	0.00
First Floor	0.45	1.50		2.20m./2=	1.10	0.50	1.65	0.00
Flat roof	0.60	0.58		3.00m./2=	1.50	0.90	0.87	0.00
Timber Wall	0.55			Height =	2.00	1.10	0.00	0.00
						0.00	0.00	0.00
				TOTALS:		*5.20*	*4.09*	*0.00*

Clear Span = 3420 mm. Bearings = 100 mm minimum each side

Design span = **3520 mm** *(NB - Design span only - not for setting out on site)*

Conservatively, use equation 6.10 = $1.35\ G_k + 1.5\ Q_{k1} + \Sigma\ \psi_{0i}\ 1.5\ Q_{ki}$

Conservatively, take ψ_{0i} = 1.00

Design UDL= 7.02 + 6.14 + 0 = 13.16 kN/m

Unfactored UDL = 9.29 kN/m

Design Point Load 1= 0.00 kN

Distance from A to point load 1= 0 mm

Distance from B to point load 1= 3520 mm

Design Point Load 2= 0.00 kN

Distance from A to point load 2= 0 mm

Distance from B to point load 2= 3520 mm

Design Point Load 3= 0.00 kN

Distance from A to point load 3= 0 mm

Distance from B to point load 3= 3520 mm

Beam analysed with simple supports:-

Design Moment =	20.38	+	0.00	+	0.00	+	0.00
Design Shear Force At A =	23.16	+	0.00	+	0.00	+	0.00
Design Shear Force At B =	23.16	+	0.00	+	0.00	+	0.00

Design Moment =	**20.38 kNm.**
Design. Shear A =	**23.16 kN.**
Design. Shear B =	**23.16 kN.**

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beams over Knock-throughs into Main House

From previous calculation :-

Max. Shear = 23.16 kN Maximum Moment = 20.38 kNm

Clear Span = 3420 mm. Bearings = 100 mm minimum each side

Design span = 3.52 m = 3520 mm

Exposure condition = Service Class 1

(Intermediate Floors, Warm Roofs, internal and party timber frame walls)

Load Duration = Short Term *(Snow, Maintenance on roofs.)*

Design Timber Grade = C24 Material = Solid Timber. Treated or untreated

Bending Strength, $f_{m,k}$ = 24.0 N/mm^2 $E_{0,mean}$ = 11.00 kN/mm^2

Shear Strength, $f_{v,k}$ = 4.00 N/mm^2

Timber

Try 2 No. 200 deep x 50 wide Joists

Type of fire exposure = Not Exposed

Charring rate = General Rate = 0.60 mm/min

Required fire rating = 30 minutes

Effective size for design = 200 mm deep x 100 mm wide member

Elastic Modulus , W_{yy} = 6.7E+05 mm^3. Partial Safety factor, γ_m = 1.3

K_h Factor = 1.00 Type of Beam= Not Load Sharing k_{sys} = 1.0

k_{mod} = 0.9 k_{crit} = 1 (No LTB due to Rafters and Flat Roof Joists/ boarding

A = 20000 mm^2 I_{yy} = 66666667 mm^4

Steel Plate

Try 1 No. 200 deep x 10 mm wide steel S 275

Youngs Modulus for Steel = 205000 N/mm^2

Elastic Modulus , W_{yy} = 6.7E+04 mm^3. Modulus of Inertia, I, = 7E+06 mm^4.

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TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beams over Knock-throughs into Main House

Modified values Modular Ratio = $\frac{205000}{11000}$ = 18.64

$I_{eff\ timber}$ = 7E+07 + (7E+06 x 18.64) = 1.9E+08 mm^4

$I_{eff\ steel}$ = 7E+06 + $\frac{7E+07}{18.64}$ = 1E+07 mm^4

$Z_{eff\ timber} = \frac{I}{y} = \frac{2E+08}{100}$ = 1909091 mm^3.

$Z_{eff\ steel} = \frac{I}{y} = \frac{1E+07}{100}$ = 102439 mm^3.

Steel plate checks

Stress to plate = $\frac{M}{Z} = \frac{2.0E+07}{102439}$ = 198.98 N/mm^2

As, 198.98 N/mm^2 < 275 N/mm^2 O.K.

Timber Checks

Bending

Design bending strength $f_{m,d}$ = $k_{mod} \cdot k_h \cdot k_{crit} \cdot k_{sys} \cdot f_{m,k} / \gamma_m$ = 16.62 N/mm^2

$M_{ult} = f_{m,d} \cdot W_{yy}$ = 31.72 kNm > 20.38 kNm O.K.

Shear k_{cr} = 0.67

Applied shear stress = $\frac{3V_d}{2bh\ k_{cr}}$ = 2.59 N/mm^2

Design shear strength $f_{v,d}$ = $k_{mod} \cdot k_{sys} \cdot f_{v,k} / \gamma_m$ = 2.77 N/mm^2

As, 2.77 N/mm^2 > 2.59 N/mm^2 O.K.

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Title of Scheme *Bowyers Cottage, Furneux Pelham, Essex.* Job No. *24076*

TIMBER FLITCH BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flitch Beams over Knock-throughs into Main House

Deflection A = 20000 mm^2

I_{yy} (modified) = 1.9E+08 mm^4 k_{def} = 0.6 ψ_2 = 0.0

Building use = Roofs Assume point loads approx 75 % imposed

Equivalent unfactored UDL Perm. = 5.20 kN/m M(Perm)= 8.05 kNm
Equivalent unfactored PL Perm. = 0.00 kN/m

$$w_{fin,G} = \frac{5wL^4}{384EI} + \frac{19.2\,M}{EA} \times (1 + k_{def})$$

$w_{fin,G}$ = 4.95 + 0.70 x 1.6 = 9.04 mm

Equivalent unfactored UDL Variable = 4.09 kN/m M(Variable)= 6.34 kNm
Equivalent unfactored PL Variable = 0.00 kN/m

$$w_{fin,Q} = \frac{5wL^4}{384EI} + \frac{19.2\,M}{EA} \times (1 + \psi_2\, k_{def})$$

$w_{fin,Q}$ = 3.90 + 0.55 x 1 = 4.45 mm

Final Deflection (including creep and shear) = 13.49 mm

Type of finish:- Brittle Finish Limiting value = L / 250
Allowable deflection = 13.68 mm

As, 13.68 mm > 13.49 mm **O.K.**

Therefore, use:-

2 No. 200 x 50 Joists, C24 Grade Timber
with 1 No. 200 x 10 n wide steel S 275

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TIMBER BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flat Roof Joists over New Extension

Actions	Permanent Action, G_k (kN/m^2)	Leading Variable Action, Q_{k1} (kN/m^2)	Variable Action, Q_{ki} (kN/m^2)	Distance(m)	Permanent Action, G_k (kN/m)	Leading Variable Action, Q_{k1} (kN/m)	Variable Action, Q_{ki} (kN/m)
Flat Roof	0.60	0.58		Centres = 0.40	0.24	0.23	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
					0.00	0.00	0.00
				TOTALS:	*0.24*	*0.23*	*0.00*

Clear Span = 2750 mm. Bearings = 100 mm minimum each side

Design span = **2850 mm** *(NB - Design span only - not for setting out on site)*

Conservatively, use equation 6.10 = $1.35\,G_k + 1.5\,Q_{k1} + \Sigma\,\psi_{0i}\,1.5\,Q_{ki}$

Conservatively, take ψ_{0i} = 1.00

Design UDL= 0.32 + 0.35 + 0 = 0.67 kN/m

Unfactored UDL = 0.47 kN/m

Design Point Load 1= 0.00 kN

Distance from A to point load 1= 0 mm

Distance from B to point load 1= 2850 mm

Design Point Load 2= 0.00 kN

Distance from A to point load 2= 0 mm

Distance from B to point load 2= 2850 mm

Design Point Load 3= 0.00 kN

Distance from A to point load 3= 0 mm

Distance from B to point load 3= 2850 mm

Beam analysed with simple supports:-

Design Moment =	0.68	+	0.00	+	0.00	+	0.00
Design Shear Force At A =	0.96	+	0.00	+	0.00	+	0.00
Design Shear Force At B =	0.96	+	0.00	+	0.00	+	0.00

Design Moment =	**0.68 kNm.**
Design. Shear A =	**0.96 kN.**
Design. Shear B =	**0.96 kN.**

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TIMBER BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flat Roof Joists over New Extension

From previous calculation :-

Max. Shear = 0.96 kN Maximum Moment = 0.68 kNm

Clear Span = 2750 mm. Bearings = 100 mm minimum each side
Design span = 2.85 m = 2850 mm

Exposure condition = Service Class 1
(Intermediate Floors, Warm Roofs, internal and party timber frame walls)
Load Duration = Short Term *(Snow, Maintenance on roofs.)*

Design Timber Grade = C24 Material = Solid Timber. Treated or untreated
Bending Strength, $f_{m,k}$ = 24.0 N/mm^2
Shear Strength, $f_{v,k}$ = 4.00 N/mm^2

Try 1 No. 150 deep x 50 wide Joists
Type of fire exposure = Not Exposed
Charring rate = General Rate = 0.60 mm/min
Required fire rating = 30 minutes
Effective size for design = 150 mm deep x 50 mm wide member
Elastic Modulus , W_{yy} = 1.9E+05 mm^3. Partial Safety factor, γ_m = 1.3
K_h Factor = 1.00 Type of Beam= Not Load Sharing k_{sys} = 1.0
k_{mod} = 0.9 k_{crit} = 1 (No LTB due to boarding)

Bending

Design bending strength $f_{m,d}$ = $k_{mod} \cdot k_h \cdot k_{crit} \cdot k_{sys} \cdot f_{m,k} / \gamma_m$ = 16.62 N/mm^2

$M_{ult} = f_{m,d} \cdot W_{yy}$ = 3.12 kNm > 0.68 kNm **O.K.**

Shear k_{cr} = 0.67

Applied shear stress = $\frac{3V_d}{2bh\,k_{cr}}$ = 0.29 N/mm^2

Design shear strength $f_{v,d}$ = $k_{mod} \cdot k_{sys} \cdot f_{v,k} / \gamma_m$ = 2.77 N/mm^2

As, 2.77 N/mm^2 > 0.29 N/mm^2 **O.K.**

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TIMBER BEAM DESIGN to BS EN 1995-1-1

Beam Reference = Flat Roof Joists over New Extension

Deflection A = 7500 mm^2 $E_{0,mean}$ = 11.00 kN/mm^2

I_{yy} = 1.4E+07 mm^4 k_{def} = 0.6 ψ_2 = 0.0

Building use = Roofs Assume point loads approx 75 % imposed

Equivalent unfactored UDL Perm. = 0.24 kN/m M(Perm)= 0.24 kNm
Equivalent unfactored PL Perm. = 0.00 kN/m

$$w_{fin,G} = \frac{5wL^4}{384EI} + \frac{19.2\,M}{EA} \times (1 + k_{def})$$

$w_{fin,G}$ = 1.33 + 0.06 x 1.6 = 2.22 mm

Equivalent unfactored UDL Variable = 0.23 kN/m M(Variable)= 0.24 kNm
Equivalent unfactored PL Variable = 0.00 kN/m

$$w_{fin,Q} = \frac{5wL^4}{384EI} + \frac{19.2\,M}{EA} \times (1 + \psi_2\, k_{def})$$

$w_{fin,Q}$ = 1.29 + 0.05 x 1 = 1.34 mm

Final Deflection (including creep and shear) = 3.57 mm

Type of finish:- Brittle Finish Limiting value = L / 250

Allowable deflection = 11 mm

NB Deflection not checked in a fire situation as serviceability only.

As, 11 mm > 3.57 mm O.K.

Therefore, use:-

1 No. 150 x 50 Joists, C24 Grade Timber Joists at 400 mm. centres