Jeya S Jeyalingam BSc Ceng MICE
Chartered Engineer

Orchard End,
25 Pigot Lane,
Framingham Earl,
Norwich,
NR14 7PX
Phone: 01508 494 393
Fax: 01508 494 393
Mob: 07984550035
e-mail: jsj@talktalk.net

26 March 2024

Mr A.Mitchell
Mitchell Building Services
17 Silfield Road
Wymondham
Norfolk NR18 9AU

Dear Andy

RE: PROPOSED ROOF REFURBISHMENT AT 24-28 MIDDLETON LANE WYMONDHAM NORWICH NR18 0AB
STRUCTURAL DESIGN

Thank you for your request to provide structural design for the above.

Further to our site meeting /inspection on 21 March 2024 Please find enclosed a copy of design justification and details.

If you have any queries, please let me know.

Yours sincerely

S. Jeyalingam

JSJ Structural Services **P1**
Jeya S. Jeyalingam BSc CEng MICE
Chartered Engineer
Orchard End
25 Pigot Lane
Framingham Earl
Norwich NR14 7PX
Tel: 01508 494 393
Mob: 07984550035
Email: jsj@talktalk.net

Ref: JSJ- 23/03//2024
23 March 2024

STRUCTURAL DESIGN AND DETAILS

CLIENT: Mitchell building Services

PROJECT: PROPOSED ROOF REFURBISHMENT AT 24-28 MIDDLETON LANE WYMONDHAM NORWICH NR18 0AB

DESIGN INFORMATION: Drawings: Refer
Roof layout and trusses existing and proposed sketches attached

DESCRIPTION OF WORKS: Refurbishment of existing roof structure, Renewal of rafters, new ridge beam and posts

LOADING CATEGORY: Domestic

JSJ Structural Services
Jeya S.Jeyalingam BSc CEng MICE
Chartered Engineer

STRUCTURAL DESIGN:
General and Safety Notes:

Building Regulations Approval:
Most Structural alterations will require Building Regulations approval and must be inspected by an approved building control consultancy/inspector prior to concealing or covering structural members. It is the client's and contractor's responsibility to ensure that applications and inspections have been carried out.

Planning Permission: -
Planning permission may or may not be required in connection with the work described herein, and a suitably qualified architect or planning advisor should be consulted before commencement of work.

Party Wall Agreements: -
Structural alterations to a party wall, or excavations in the vicinity of a neighbour's property, will require the adjoining owner's consent under the Party Wall Act 1996.This will require a party Wall agreement to be made before the commencement of the works. Advice may be obtained from the government planning Portal www.planningportal.gov.uk or by contacting a Chartered Building Surveyor.

Safety:
This information is provided in the expectation that those appointed to carry out the work are suitably qualified and experienced contractors. If there is any doubt about aspects of the specification and details, the engineer should be contacted before the commencement of work on site. The work described should be capable of being carried out using the normal range of skills and equipment expected of a competent general contractor.

Excavations in excess of 1.2 meters deep or in unstable ground conditions should not be entered by any person unless a system of shoring or ground support has been installed.

Any variation between the architect's drawings and specification and this information should be brought to the attention of the architect and engineer immediately.

Temporary support:
Installation of beams, lintels or supporting structures should be undertaken only with the suitable temporary support to the structure above. The attention should be paid to nature of the supported loads and the capacity of the props, shores and needle beams as appropriate. The contractor shall ensure the stability of the structural element and the overall construction until the work is complete.

General Notes:

- The Design justification and details only concern of the construction and the client which they specifically refer.
- No responsibility or liability is accepted in respect of any other element or part of the construction or any other party.
- The design brief does not include any site inspections unless specifically instructed.
- The foundation design allowable ground bearing pressure must be confirmed on site.
-
- No construction or fabrication should be carried out until all statutory approvals are obtained. - As per connection design and details – JSJ Structural Engineering Service
- The setting out dimensions and general construction details, refer to the Architect's or Clients drawings. Dimensions given on pages of design analysis are NOT for fabrication purposes. The contractor is responsible for checking all dimensions and levels for construction.
- All designs, connections, workmanship, and materials are to comply with current Building Regulations, relevant BS codes or written approval of the Engineer.
- The Proprietary structural elements, fixtures and admixtures may only be used with the Engineers approval and to manufacturer's recommendations.
- All bolted connections shall have minimum of two number of bolts.

Copyright

SCHEME TITLE Proposed refurbishment & existing roof at 24-28 Middleton lane, Wymondham Norwich NR18 0AB SHEET 1 OF

ELEMENT DESIGNED Timber DATE 23/03/24

REVISION

Ref.		Output
	Renew existing rafters Rafters C/SP 1.5 m Loads on rafter Imposed (Qk) m kN/m P/R 0.6 × 0.4 = 0.24 Dead (Gk) kN/m² m P/R 1.2 × 0.4 = 0.48	
	* Provide 47×75 C24 @ 400 c/c	
	(Refer Loads Smart sing a/m pages (1→5)	
	* ALTERNATIVE • 47×100 C24 (FLAT) @ 400 c/c	

Ridge beam

Worst Case OPtm 2.4 m

Loads on beam

$$Q_k = \frac{\text{Imposed kN/m}^2 \times m}{1.5} = 0.9 \text{ kN/m}$$

$$G_k = \text{Beam kN/m} \times m = 1.2 \times 1.5 = 1.8$$

- Provide Ridge beam
  - 75 x 175 C24

(Refer Cads smart eng ap^n Pages (1→)

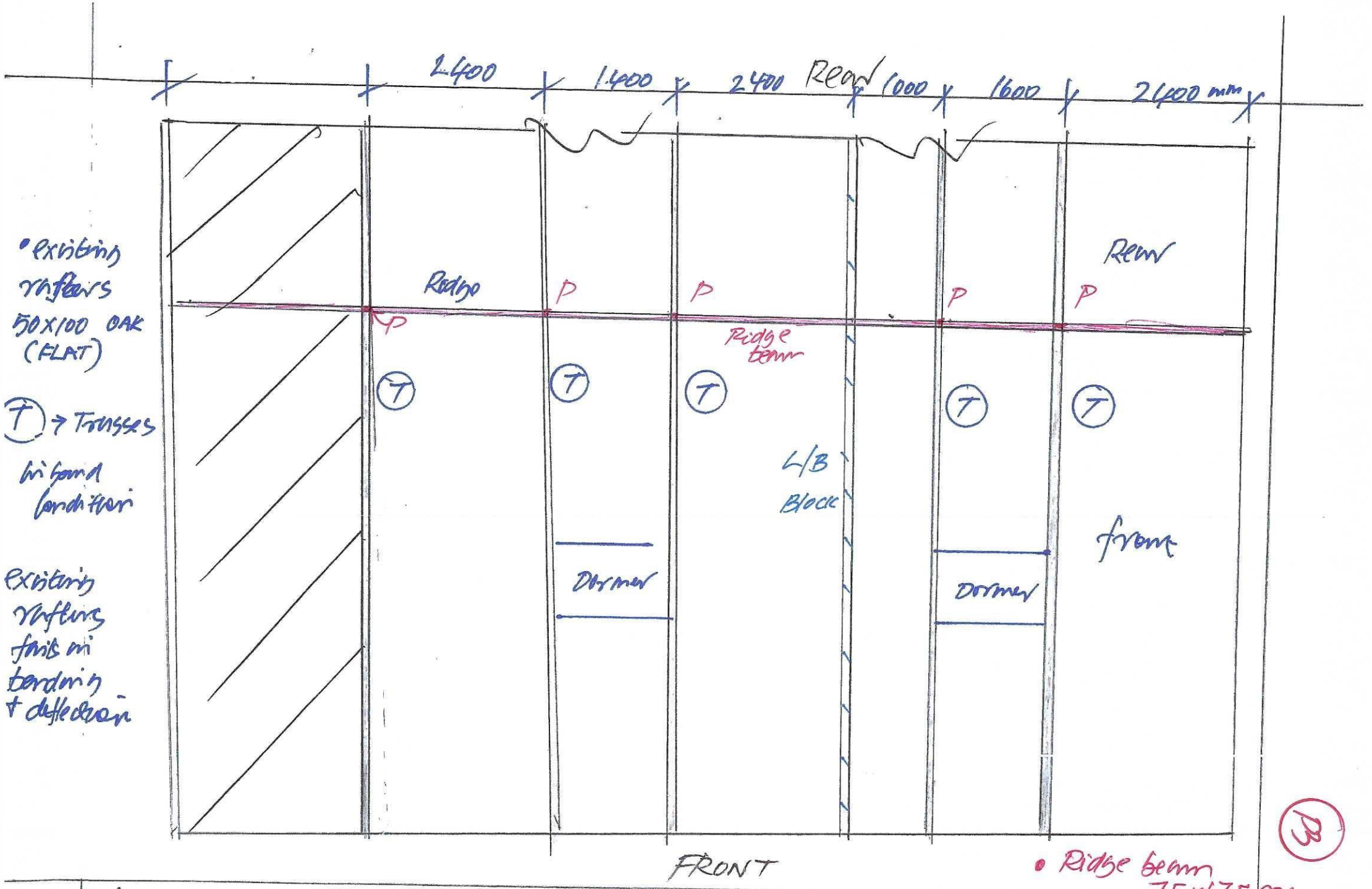
$h_t = 1.5 m$

Psf, R = Design fm = $3.2 \times 2 = 6.4$ kN

Posts

- Provide 75 x 100 C24

(Refer Cads smart eng ap^n Pages (1→2)



- Existing rafters 50x100 OAK (FLAT)

(T) → Trusses in good condition

Existing rafters fails on bending + deflection

(B)

- Ridge beam 75x175 C24
- POST 75x100 C24
- Rafters 47x75 C24 @ 400 c/c
- BR (47x100 C24 FLAT @ 400 c/c

Proposed Refurbishment & existing roof Structure

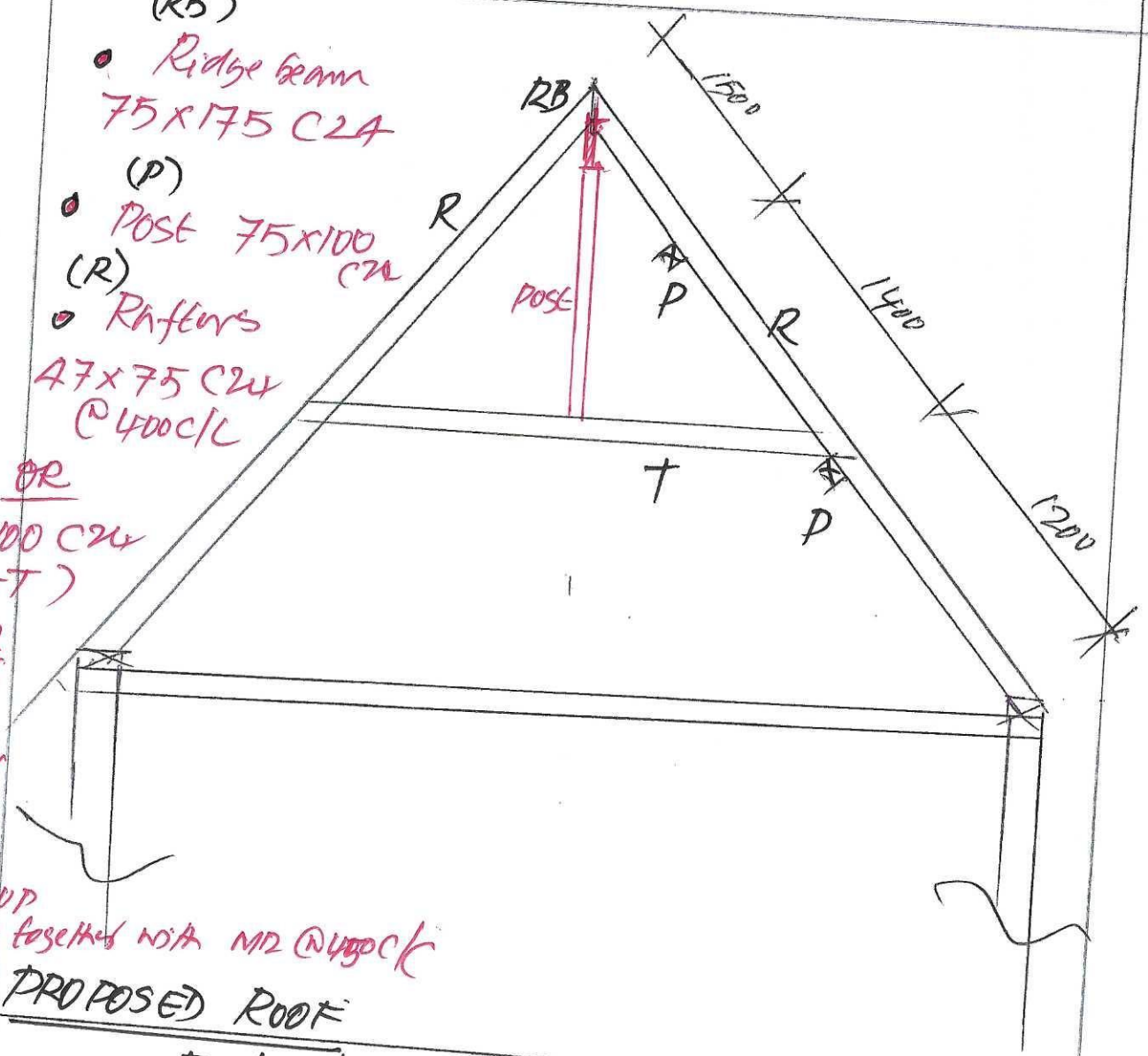
(RB)
- Ridge beam 75x175 C24

(P)
- Post 75x100 C24

(R)
- Rafters 47x75 C24 @400c/c

OR
47x100 C24 (FLAT) @ 400 c/c

- Dormer Check rafter Doubled up bolted together with M12 @450c/c



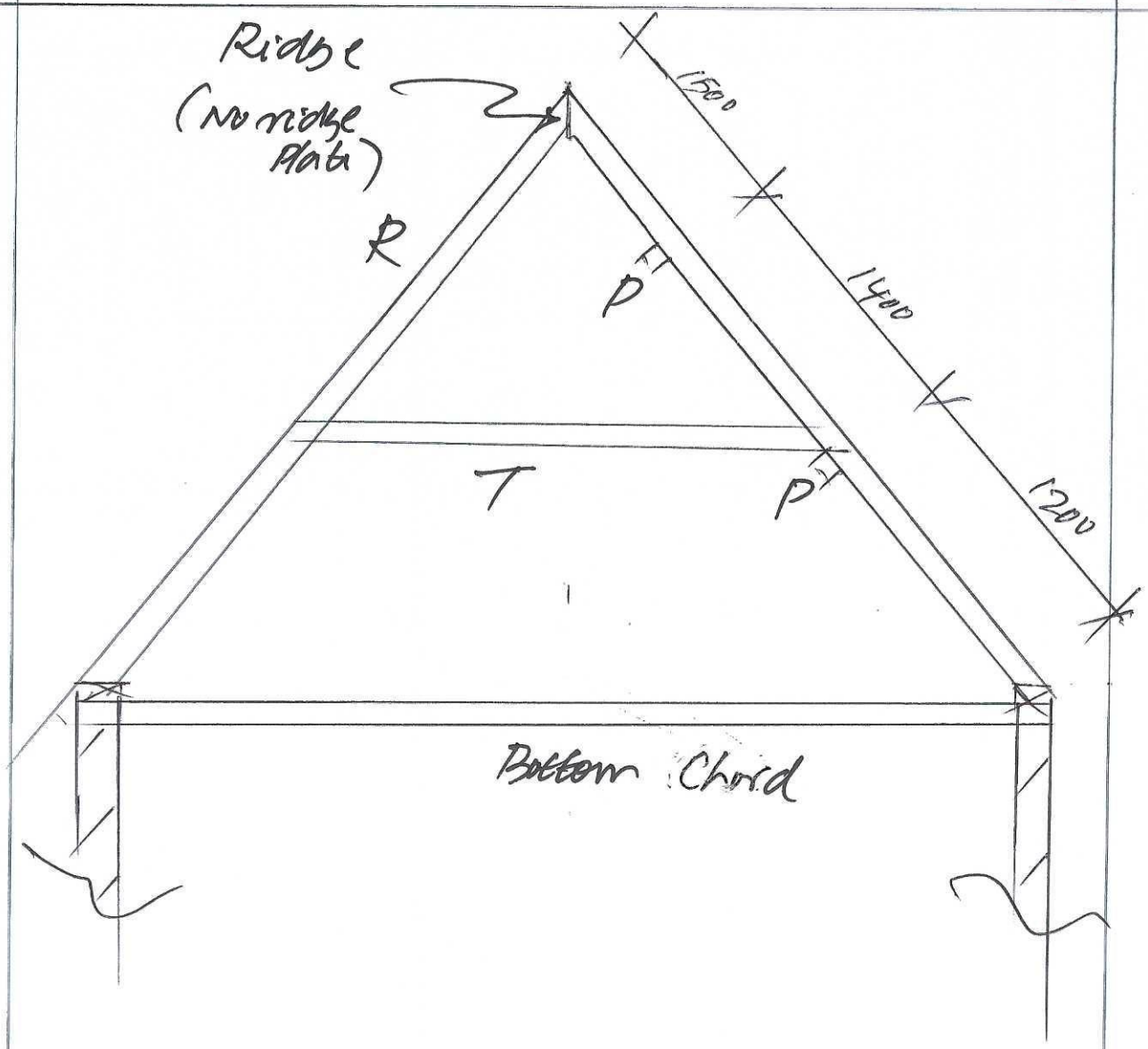
PROPOSED ROOF

Refurbishment →

Ridge beam & Posts on Trusses

PROVIDE

- New rafters → 47x75 C24 @400c/c OR 47x100 C24 (FLAT) @ 400c/c
- New Ridge beam → 75x175 C24
- Ridge posts → 75x100 C24
- Dormer Check rafters Doubled up rafters bolted together with 12 mm bolts @ 450 c/c

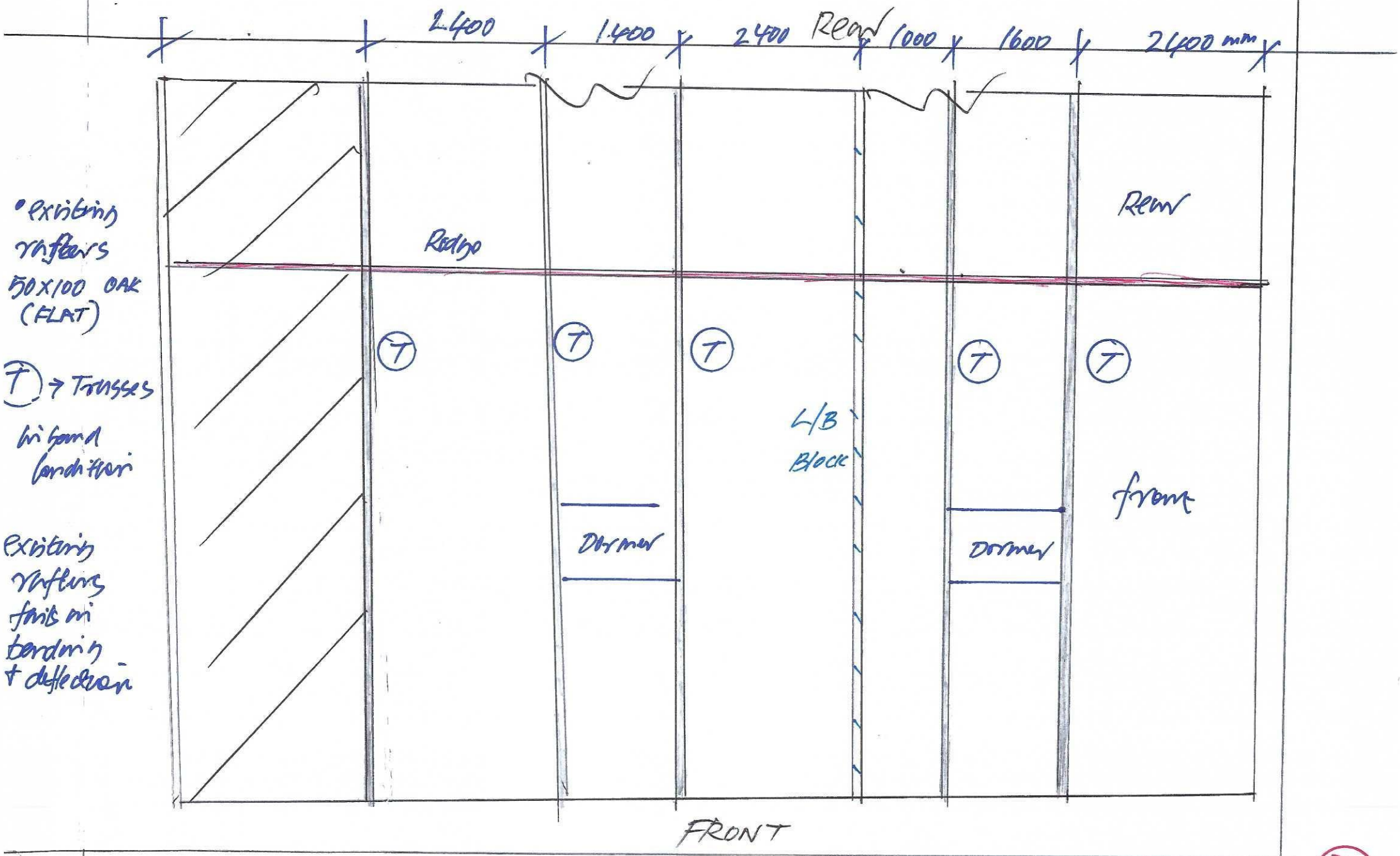


Existing Trusses (Sectional view)

- Rafters → 50x100 OAK @ 400 c/c (FLAT)
- Purlins → 65x125 OAK

(x) most of the Rafters fails in bending & deflection

(Renew existing rafters & New Ridge beam



• Existing rafters 50x100 OAK (FLAT)

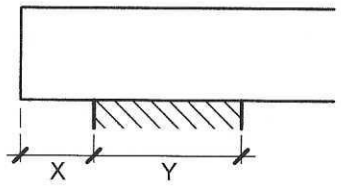
(T) → Trusses as found condition

Existing rafters fair on bearing + deflection

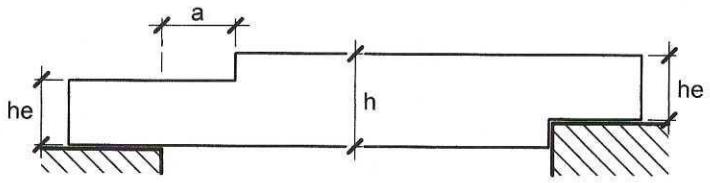
21

Beam/lintel section

Bearing position



End Notch Type



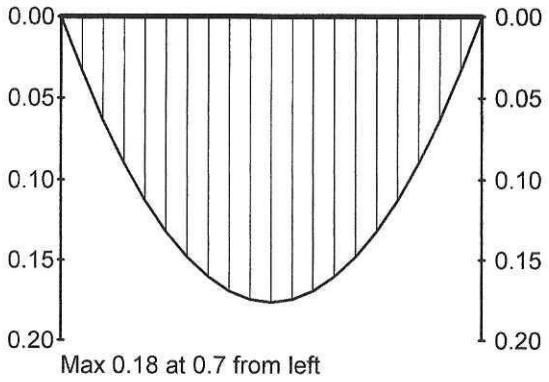
(a) (b)

Calculations for timber beams/lintels are in accordance with BS5268:Pt 2:2002

Number of parallel pieces making up beam/lintel			= 1
Section size of each timber	- 47 wide x 75 deep		
Timber type	- Sawn Softwood as Table NA.2 of BS EN 336		
Span of beam/lintel			= 1.4 m
Span type			- Simple
End bearing	- left hand end	X	= 0 mm
		Y	= 50 mm
	- right hand end	X	= 0 mm
		Y	= 50 mm
End notches	- left hand end	- none specified	
	- right hand end	- none specified	
Strength class from Table 8 (service classes 1 & 2)			- C24
Service class	- 2 (Covered and heated or unheated)		
Maximum design moment			= 0.18 kNm
Design shear force at left hand support			= 0.5 kN
Design shear force at right hand support			= 0.5 kN

Load Description	Type	A	B	C	Gk	Qk
	UDL	0	1.4		0.48	0.24

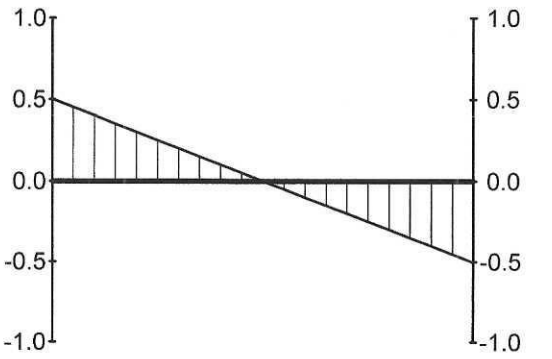
Moment (1.0Gk+1.0Qk) kNm



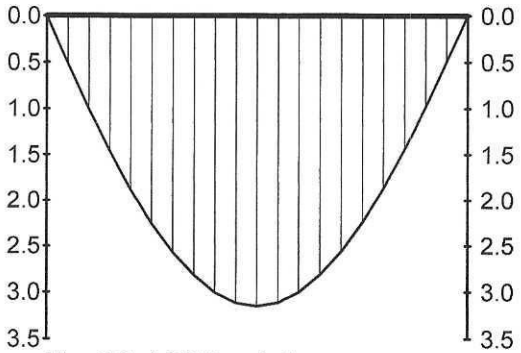
Max 0.18 at 0.7 from left

Shear (1.0Gk+1.0Qk) kN

(0.504) (-0.504)



Deflection (1.0Gk+1.0Qk) mm



Max 3.2 at 0.7 from left

Grade stresses

Bending parallel to grain	= 7.5 N/mm^2
Shear parallel to grain	= 0.71 N/mm^2
Compression perpendicular to grain (wane prohibited at bearing areas)	= 2.4 N/mm^2

Modification factors

For service class 2	- moment	K_{2M}	= 1
	- shear	K_{2V}	= 1
	- bearing	K_{2B}	= 1
	- Youngs mod	K_{2E}	= 1
	- Shear mod	K_{2E}	= 1
For load duration	- long	K_3	= 1
For end bearing	- left end	K_{4l}	= 1
	- right end	K_{4r}	= 1
For no end notch	- left end	K_{5l}	= 1
For no end notch	- right end	K_{5r}	= 1
For depth between 72 and 300mm		K_7	$= (300/h)^{0.11}$
			= 1.16
For non-load sharing system		K_8	= 1
For 1 pieces of softwood		K_9	= 1

Bending Design

The allowable bending stress is

$\sigma_{bpall} = \sigma_{bp} * K_{2M} * K_3 * K_7 * K_8$
$= 8.70\ N/mm^2$

The required section modulus is

$z_{reqd} = M * 10^6 / \sigma_{bpall}$
$= 20690\ mm^3$

The section modulus of the beam/lintel chosen is 44100 mm^3.

Shear Design

Left hand support

The allowable shear stress is

$\sigma_{cpaall} = \sigma_{cpa} * K_{2V} * K_3 * K_{5l} * K_8$
$= 0.71\ N/mm^2$

The required cross sectional area is

$A_{lreqd} = 3 * R_l * 10^3 / (2 * \sigma_{cpaall})$
$= 1056\ mm^2$

The cross sectional area of the beam/lintel chosen is

$A_{lprov} = N_{tim} * b * h$
$= 3525\ mm^2$

Right hand support

The allowable shear stress is

σ_{cpaall} = σ_{cpa}*K_{2V}*K_3*K_{5r}*K_8
= 0.71 N/mm^2

The required cross sectional area is

A_{rreqd} = 3*R_r*10^3/(2*σ_{cpaall})
= 1056 mm^2

The cross sectional area of the beam/lintel chosen is

A_{rprov} = N_{tim}*b*h
= 3525 mm^2

Bearing Design

Left hand support

The allowable bearing stress is

σ_{cpeall} = σ_{cpe}*K_{2B}*K_3*K_{4l}*K_8
= 2.40 N/mm^2

The required bearing area is

A_{blreqd} = R_l*10^3/σ_{cpeall}
= 208 mm^2

The bearing area of the beam/lintel chosen is

A_{blprov} = N_{tim}*b*Y_l
= 2350 mm^2

Right hand support

The allowable bearing stress is

σ_{cpeall} = σ_{cpe}*K_{2B}*K_3*K_{4r}*K_8
= 2.40 N/mm^2

The required bearing area is

A_{brreqd} = R_r*10^3/σ_{cpeall}
= 208 mm^2

The bearing area of the beam/lintel chosen is

A_{brprov} = N_{tim}*b*Y_r
= 2350 mm^2

Deflection check

The deflection calculated includes for shear deflection and is based on the following material properties which incorporate modification factors K_2 and K_9 as appropriate.

- Young's modulus - E = 7200 N/mm^2
- Shear modulus - G = 450 N/mm^2
- Shape factor - F = 1.2 (for rectangular sections)

and section properties of

- Area - A = 35 cm^2
- Mom. of inertia - I = 165 cm^4

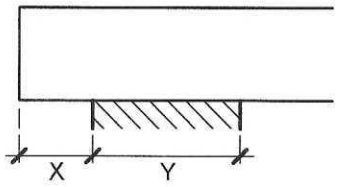
The maximum calculated deflection is 3.2 mm.

The allowable deflection in accordance with clause 2.10.7 is 4.2 mm (0.003*Span).

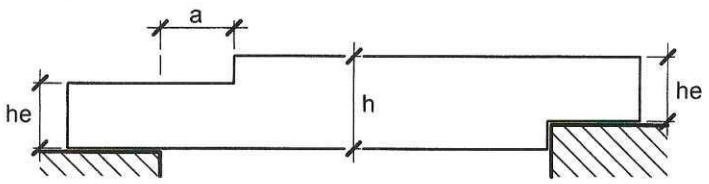
The section PASSES all the checks.

Beam/lintel section

Bearing position



End Notch Type



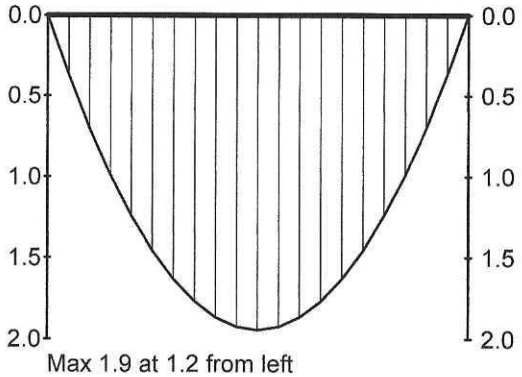
(a) (b)

Calculations for timber beams/lintels are in accordance with BS5268:Pt 2:2002

Number of parallel pieces making up beam/lintel			= 1
Section size of each timber	- 75 wide x 175 deep		
Timber type	- Sawn Softwood as Table NA.2 of BS EN 336		
Span of beam/lintel			= 2.4 m
Span type			- Simple
End bearing	- left hand end	X	= 0 mm
		Y	= 50 mm
	- right hand end	X	= 0 mm
		Y	= 50 mm
End notches	- left hand end	- none specified	
	- right hand end	- none specified	
Strength class from Table 8 (service classes 1 & 2)			- C24
Service class	- 2 (Covered and heated or unheated)		
Maximum design moment			= 1.94 kNm
Design shear force at left hand support			= 3.24 kN
Design shear force at right hand support			= 3.24 kN

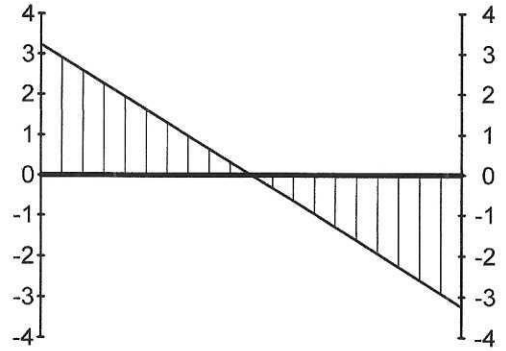
Load Description	Type	A	B	C	Gk	Qk
	UDL	0	2.4		1.8	0.9

Moment (1.0Gk+1.0Qk) kNm

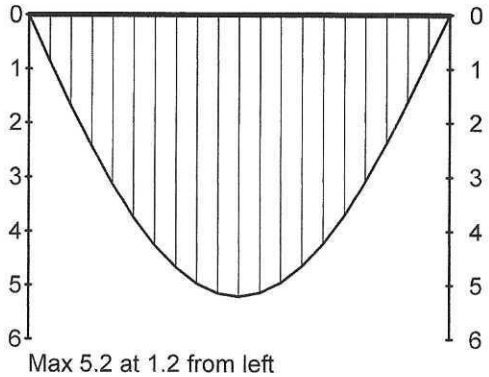


Max 1.9 at 1.2 from left

(3.24) **Shear (1.0Gk+1.0Qk) kN** (-3.24)



Deflection (1.0Gk+1.0Qk) mm



Max 5.2 at 1.2 from left

Grade stresses

Bending parallel to grain	= 7.5 N/mm^2
Shear parallel to grain	= 0.71 N/mm^2
Compression perpendicular to grain	= 2.4 N/mm^2
(wane prohibited at bearing areas)	

Modification factors

For service class 2	- moment	K_{2M}	= 1
	- shear	K_{2V}	= 1
	- bearing	K_{2B}	= 1
	- Youngs mod	K_{2E}	= 1
	- Shear mod	K_{2E}	= 1
For load duration	- long	K_3	= 1
For end bearing	- left end	K_{4l}	= 1
	- right end	K_{4r}	= 1
For no end notch	- left end	K_{5l}	= 1
For no end notch	- right end	K_{5r}	= 1
For depth between 72 and 300mm		K_7	$= (300/h)^{0.11}$
			= 1.06
For non-load sharing system		K_8	= 1
For 1 pieces of softwood		K_9	= 1

Bending Design

The allowable bending stress is

$$\sigma_{bpall} = \sigma_{bp} * K_{2M} * K_3 * K_7 * K_8$$
$$= 7.95 \text{ N/mm}^2$$

The required section modulus is

$$z_{reqd} = M * 10^6 / \sigma_{bpall}$$
$$= 244025 \text{ mm}^3$$

The section modulus of the beam/lintel chosen is 383000 mm^3.

Shear Design

Left hand support

The allowable shear stress is

$$\sigma_{cpaall} = \sigma_{cpa} * K_{2V} * K_3 * K_{5l} * K_8$$
$$= 0.71 \text{ N/mm}^2$$

The required cross sectional area is

$$A_{lreqd} = 3 * R_l * 10^3 / (2 * \sigma_{cpaall})$$
$$= 6845 \text{ mm}^2$$

The cross sectional area of the beam/lintel chosen is

$$A_{lprov} = N_{tim} * b * h$$
$$= 13125 \text{ mm}^2$$

Right hand support

The allowable shear stress is

σ_{cpaall} = σ_{cpa}*K_{2V}*K_3*K_{5r}*K_8
= 0.71 N/mm^2

The required cross sectional area is

A_{rreqd} = 3*R_r*10^3/(2*σ_{cpaall})
= 6845 mm^2

The cross sectional area of the beam/lintel chosen is

A_{rprov} = N_{tim}*b*h
= 13125 mm^2

Bearing Design

Left hand support

The allowable bearing stress is

σ_{cpeall} = σ_{cpe}*K_{2B}*K_3*K_{4l}*K_8
= 2.40 N/mm^2

The required bearing area is

A_{blreqd} = R_l*10^3/σ_{cpeall}
= 1350 mm^2

The bearing area of the beam/lintel chosen is

A_{blprov} = N_{tim}*b*Y_l
= 3750 mm^2

Right hand support

The allowable bearing stress is

σ_{cpeall} = σ_{cpe}*K_{2B}*K_3*K_{4r}*K_8
= 2.40 N/mm^2

The required bearing area is

A_{brreqd} = R_r*10^3/σ_{cpeall}
= 1350 mm^2

The bearing area of the beam/lintel chosen is

A_{brprov} = N_{tim}*b*Y_r
= 3750 mm^2

Deflection check

The deflection calculated includes for shear deflection and is based on the following material properties which incorporate modification factors K_2 and K_9 as appropriate.

- Young's modulus	- E	= 7200 N/mm^2
- Shear modulus	- G	= 450 N/mm^2
- Shape factor	- F	= 1.2 (for rectangular sections)

and section properties of

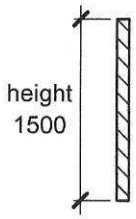
- Area	- A	= 131 cm^2
- Mom. of inertia	- I	= 3350 cm^4

The maximum calculated deflection is 5.2 mm.

The allowable deflection in accordance with clause 2.10.7 is 7.2 mm (0.003*Span).

The section PASSES all the checks.

Column section



Calculations for timber columns in accordance with BS5268:Pt 2:2002

Column shaft - 75 wide x 100 deep
Timber type - Sawn Softwood as Table NA.2 of BS EN 336

Height of single column shaft = 1500 mm

Strength class from Table 8 (service classes 1 & 2) - C24

Service class - 2 (Covered and heated or unheated)

Design axial compression = 6.4 kN

Grade stresses - from Tables 8 and 9

Compression parallel to grain = 7.9 N/mm^2
Minimum modulus of elasticity = 7200 N/mm^2

Modification factors

For service class 2 K_2 = 1
For load duration - long K_3 = 1
For load sharing system K_8 = 1.1
Determine modification factor K_{12} from the column slenderness for each axis, where:

The effective length of the column for the x-x axis is

L_{ex} = H_o*F_{lex}
= 1500 mm

and the effective length of the column for the y-y axis is

L_{ey} = H_o*F_{ley}
= 1500 mm

Hence, the slenderness ratio for the x-x axis is

λ_x = L_{ex}/i_{xx}
= 51.9

and for the y-y axis is

λ_y = L_{ey}/i_{yy}
= 69.1

and from Table 22 for compression members

- x-x axis K_{12x} = 0.722
- y-y axis K_{12y} = 0.601

The maximum slenderness ratio does not exceed 180. The section can be used for members complying with clause 2.11.4(a),(b),(c) and (d).

Axial Load Design

The minimum value of K_{12} is for the y-y axis, hence, the allowable compressive stress is

σ_{cpaall} = σ_{cpa}*K_2*K_3*K_8*K_{12}
= 5.22 N/mm^2

giving the required cross sectional area of the column as

A_{reqd} = N*10^3/σ_{cpaall}
= 1226 mm^2

The sectional area of the column chosen is 7500 mm^2, this is more than the area required.