

PRELIMINARY STRUCTURAL REPORT

UPON

EXISTING AGRICULTURAL BARN

AUSTENDYKE HALL,

AUSTENDYKE ROAD

WESTON HILLS

PROJECT No: 19320

DOCUMENT REF: 19320-REP-01



Mr & Mrs Tointon

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1. INTRODUCTION

At the request of Mr & Mrs Tointon, a Visual Inspection of the existing barn structure was undertaken on the 25th March 2020, the purpose being to undertake a detailed visual inspection of the barn roof and first floor structure and brief visual inspection of all other structural aspects.

The object of this report is to comment upon the structural form, arrangement, capabilities and condition of the existing barn timber roof structure.

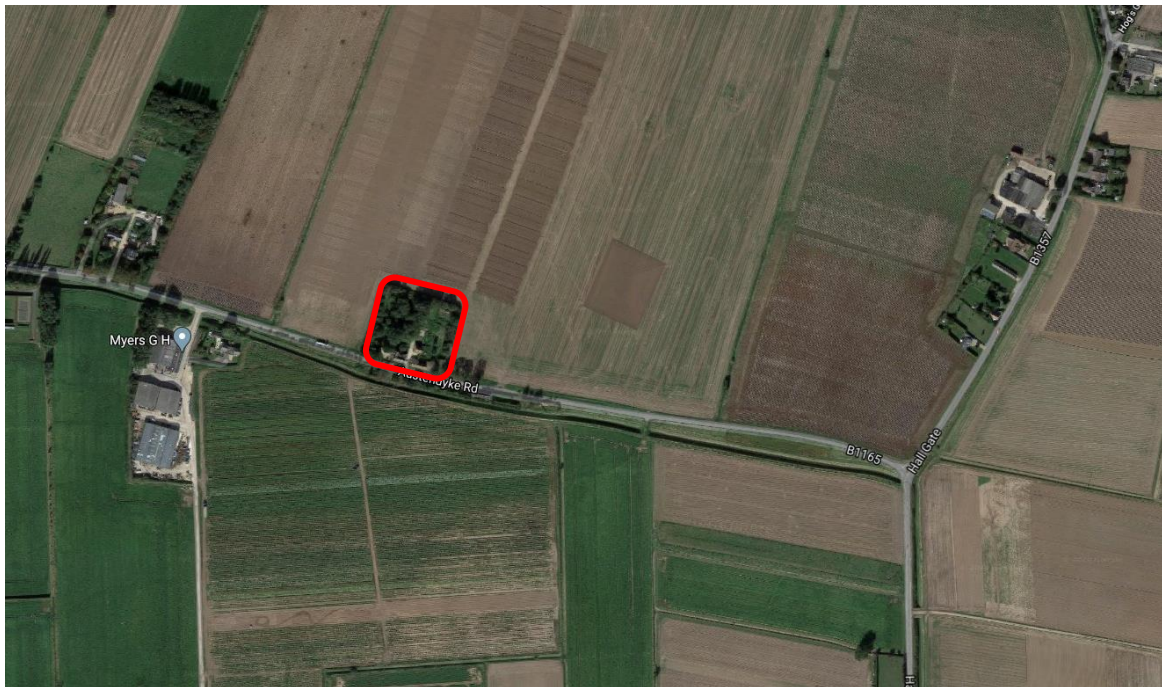
Whilst the focus of the inspection and report is to comment on the primary roof structure, observations have also been made on stability and condition of the barns general structure.

At the time of inspecting all roof finishes were removed to fully expose the bare roof structure to allow full inspection. Foundations were not exposed or inspected nor were we asked to comment.

It confines itself to the Basic Building Fabric and is not intended to comment upon non-structural items.

2. DESCRIPTION OF PROPERTY

The property is situated to the North of Austendyke Road (B1165) at its Eastern road near the junction with Hall Gate (B1357). Appropriate national grid reference TF302217.



The property forms part of the curtilage to Austendyke Hall, which is a grade II listed structure.

The barn forms part of a collection of barn structures whose original purpose would have been agricultural in nature. They are all of solid masonry construction with traditional cut timber and primary truss roofs with pantile finish.

The proposed projects involve the conversion of the complex of barns into a domestic dwelling. The proposed arrangements are illustrated on Julian Warrick architectural design drawings numbered J031.

The permanent structural arrangements for the dwelling have been provided in a report by J C Consultancy. As such we have not commented on the permanent stability of the proposed arrangements as it has been assumed that they have been adequately covered by this previously prepared document.

3. OBSERVATIONS

3.1. The small barn to the East of the curtilage is a small single storey barn with solid masonry walls and timber roof.

The pantile covering has been removed from the majority of the barn leaving the cut timber roof structure exposed.

The timbers are significantly warped and deformed in places and the trusses have spread.



The solid masonry walls have suffered a severe amount of movement and have significant cracking throughout the structure.

This is particularly evident where the flank walls are buttressed by gable walls or internal walls. As the eaves spread and movement has led to a subsequent crack which has detached the flank walls from their buttress.



This eaves spread and movement has also left many of the walls significantly out of plumb.



3.2. The main barn consists of 3 rooms, the main room which is the largest on plan and full height, and two smaller rooms one ground floor one first floor.

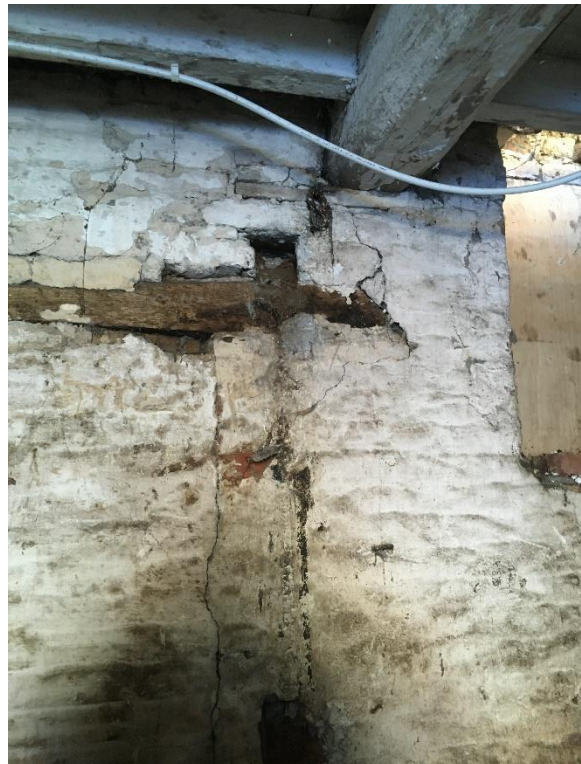
The First floor structure is formed with timber floor boards, on joists and regular centre spanning from masonry to large hardwood beams which span across the width of the structure.

The timber structure appears in relatively good condition for its age and style of construction. The floor has very little observable “bounce” and no observable bowing.

The joists and beams are generally in good condition. However, there is some evidence of previous infestation which should be checked by a specialist to ensure it is dead and if not appropriately treated.



The masonry walls have significant defects at the beam bearing locations. These occur to both bearings on the South Wall. On the northern wall one of the timber beam bearings has damp ingress and has deteriorated such that a new supporting post has been introduced.



The structure in the main full height room of the barn is in average condition for its age, with some areas of brickwork and mortar suffering from weathering.

The full height masonry has had remedial ties and pattress plates installed during its life. These are unlikely to be original as they are formed out of a chain and turfer mechanism. We have assumed for the purposes of this report that the structural calculations undertaken by J C Consultancy have considered the removal of these and the permanent stability of the masonry structure.

We noted cracking to the corners where the flank walls adjoin the Eastern Gable.





The primary timber roof construction is generally in good condition for its age. All ridge beam and purlin members appear to be sound.

The main trusses also appear to be in good condition, although there is evidence of historic infestation which should be confirmed as not active by an expert.

In one location the truss bearing has been repaired using steel plates. Whilst this repair appears to be functioning it has not been possible without undertaking destructive survey work to observe the details of the repair.



On the Southern side of the roof all the common rafters are in generally sound condition with very little significant deterioration. There is a small element of defective wall plate adjacent the central truss in the main room on this side of the roof.

On the Northern side of the roof there are damp and defect issues throughout the full length of the wall plate, with the wall plate falling away in several places along its length.

The common rafters on this side of the roof have also suffered from damp ingress and deterioration from exposure.





4. CHECKS BY CALCULATION

We have recorded the sizes of all the principle members of the roof and first floor structures in order to justify their capacities for the intended domestic reutilisation of the structure.

The calculations undertaken are appended to this report, labelled sheets C/1 to C/23.

The calculations proved that the principal members of the roof and first floor structures are adequate for modern domestic loadings and therefore adequate for re-use in the proposed conversion.

5. CONCLUSIONS & RECCOMENDATIONS

The small single storey height barn to the East of the complex has suffered from severe eaves movement and some foundation movement. The combination of which have the masonry walls in an extremely poor state. The walls to the northern end of the barn are significantly out of plumb and are likely to be experiencing a slow progressive failure as the lean will exacerbate over time.

It is our opinion that this barn is not currently stable enough to be considered safe and is beyond reasonable economic repair.

The main barn first floor structure is generally in good condition and fit for re use as part of the proposed conversion to domestic. However, the defective bearings onto the Southern wall require rebuilding.

The defective and deteriorated brickwork immediately below the beam bearings should be cut out and replaced with a minimum 3 course depth of engineering brickwork. Further defective brickwork below should be cut out and replaced with ordinary masonry units, and any further cracking to the elevation below these replacements should be stitched using crack repair methods such as helifix Heli bars.

On the northern elevation where a support post has been introduced to replace the defective beam bearing, whilst this detail does not appear distressed consideration should be given to the installation of a more robust and longer lasting bearing detail. We would recommend the introduction of a new masonry pier, tied into the existing brickwork, onto a new footing.

The Masonry around the main barn has suffered a degree of historic movement leaving a number of significant cracks to the masonry structure. A programme of crack stitching should be introduced to tie all the wall elements together ensuring that they will continue to act as a stable structure. This is of particular importance at the Eastern Gable where the cracks have left the gable wall partly detached from the flank walls.

The main barn roof structure is generally in good condition and is fit for re use as part of the proposed conversion to domestic use. There are isolated elements which require replacement due to damp ingress and weathering.

The wall plate on the Northern elevation needs replacement for significant portions of its length and as such we would recommend that the wall plate be replaced with a similar sized timber of a minimum grade C24 timber.

The common rafters on the Northern elevation are also suffering from damp ingress and many of them are now beyond serviceable life. Due to the progression of the damp and the small size of the rafters it will not be possible to install a repair detail. As such we would recommend that the bottom section of the rafter is cut out and completely replaced. Please refer to our detail on sheet REM/01 appended to this report.

For and on behalf of **SIDEBOTTOM RICHARDSON CHENG LTD**

A. Wilson CEng MStructE

21st April 2020

APPENDICES

PROJECT:

Loadings.

	SLG kN/m ²	γ_f	ULS kN/m ²
Roof - Dead - tiles	= 0.65		
- battens, insulation	= 0.15		
- s/w structure	= 0.10		
- ceiling	= 0.20		
	1.10	1.4	1.54
- Imposed - min. roof imposed 35°	= 0.50	1.6	0.80
	1.60		2.34

First Floor - Dead - Decking & Finishes	= 0.25		
- s/w joists	= 0.15		
- ceiling	= 0.20		
	0.60	1.4	0.84
- Imposed - Domestic	= 1.50	1.6	2.40
	2.10		3.24

PROJECT:

Check first floor Joists

$S_{per} = 2.2m$ Simply Supported @ 0.55m c/c.

$$w = 0.55 \times 2.1 = 1.16 \text{ kN/m}$$

$$W = 2.54 \text{ kN}$$

$$V = 1.27 \text{ kN}$$

$$M = 0.7 \text{ kNm}$$

Existing Joist size 140 x 75.

$$S_{xx} = \frac{0.7 \times 10^6}{\frac{140^2 \times 75}{6}} = 2.86 \text{ N/mm}^2$$

$$\text{Allowable} = 7.5 \text{ N/mm}^2 > 2.86 \text{ N/mm}^2 \text{ OK.}$$

check deflection, $E_{mean} = 10800 \text{ N/mm}^2$.

$$\delta = \frac{5 \times 2540 \times 2200^3}{384 \times 10800 \times \left[\frac{140^3 \times 75}{12} \right]} = 1.9 \text{ mm OK.}$$

$\therefore$ Existing timber first floor Joists OK.

PROJECT:

Check First Floor Beams

$S_{pm} = 5.6m.$ Simply Supported.

$w = 2.2m \times 2.1 = 4.62 \text{ kN/m}.$

$W = 4.62 \times 5.6 = 25.9 \text{ kN}.$

$V = 12.95 \text{ kN}$

$M = 25.9 \times 5.6 / 8 = 18.1 \text{ kNm}.$

Existing beam size , 250 x 220 oak beams .

$\sigma_{11} = 181 \times 10^6 / \frac{250^2 \times 220}{6} = 7.9 \text{ N/mm}^2.$

Allowable $\sigma_{11} = 9.0 > \sigma_{11} = 7.9 \text{ N/mm}^2$ beams OK.

Check deflection $E_{min} = 6500 \text{ N/mm}^2.$

$\delta = 5 \times 25900 \times 5600^3 / 384 \times 12600 \times \left(\frac{220 \times 250^3}{12} \right) = 16.4 \text{ mm}.$

Allowable = $5.6 \times 0.003 = 16.8 \text{ mm}.$

∴ Existing Hard Wood First Floor beams OK.

We would not recommend the use of a brittle finish ceiling such as plaster board to the u/s of the First floor as whilst the deflection of the floor structure is within allowable limits it may prove slightly too flexible to prevent cracking to a brittle finish from imposed loads above.

PROJECT:

Common rafters - 63 x 63 @ 410 c/c.

Span = 1.3m Simply Supported

$$w = 1.6 \times 0.41 = 0.66 \text{ kNm}.$$

$$W = 0.66 \times 1.3 = 0.85$$

$$V = 0.425$$

$$M = 0.14 \text{ kNm}.$$

$$G_{11} = 0.14 \times 10^6 / [63^2 \times 63 / 6] = 3.4 \text{ N/mm}^2.$$

$$\text{Allowable } G_{11} = 5.3 \text{ N/mm}^2 > 3.4 \text{ N/mm}^2 \text{ OK}.$$

Check deflection $E_{men} = 8800 \text{ N/mm}^2$

$$\delta = 5 \times 850 \times 1300^3 / 384 \times 8800 \times \left[\frac{63 \times 63^3}{12} \right] = 2.1 \text{ mm OK}.$$

∴ All Existing Common rafters OK.

PROJECT:

Existing Purlin

$$\text{Max. span} = 4.2 \text{ m}$$

Simply supported. inclined purlin. Hardwood.
200 x 130.

$$w = 1.3 \times 2.1 = 2.7 \text{ kN/m}$$

$$W = 2.7 \times 4.2 = 11.3 \text{ kN}$$

$$V = 5.7 \text{ kN}$$

$$M = 11.3 \times 4.2 / 6 = 6.0 \text{ kNm}$$

$$G_{11} = 6.0 \times 10^6 / \left[\frac{130 \times 200^3}{6} \right] = 14.6 \text{ N/mm}^2$$

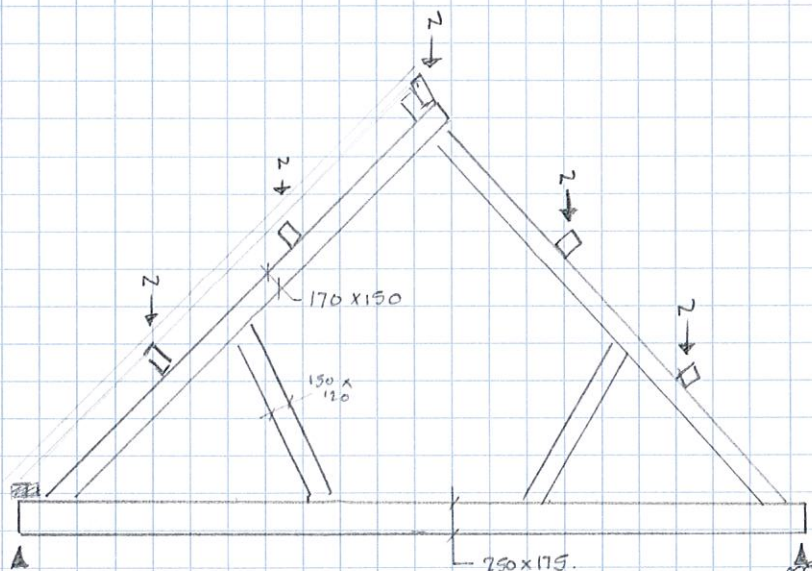
$$\text{Allowable } G_n = 12.5 \text{ N/mm}^2 > 14.6 \text{ N/mm}^2 \text{ OK}$$

$$\text{Check deflection } E_{min} = 9500 \text{ N/mm}^2$$

$$\delta = 5 \times 11300 \times 4200^3 / 384 \times 9500 \times \left[\frac{130 \times 200^3}{12} \right] = 13.2 \text{ mm}$$

∴ Existing purlins OK

PROJECT:



Typical Section through roof truss

Truss to be analysed in master series, Truss spacing max approx. 4m.

$$N = \text{Dead } 4 \times 1.1 \times 1.25 = 5.5 \text{ kN}$$

$$\text{Live } 4 \times 0.6 \times 1.25 = 3.0 \text{ kN}$$

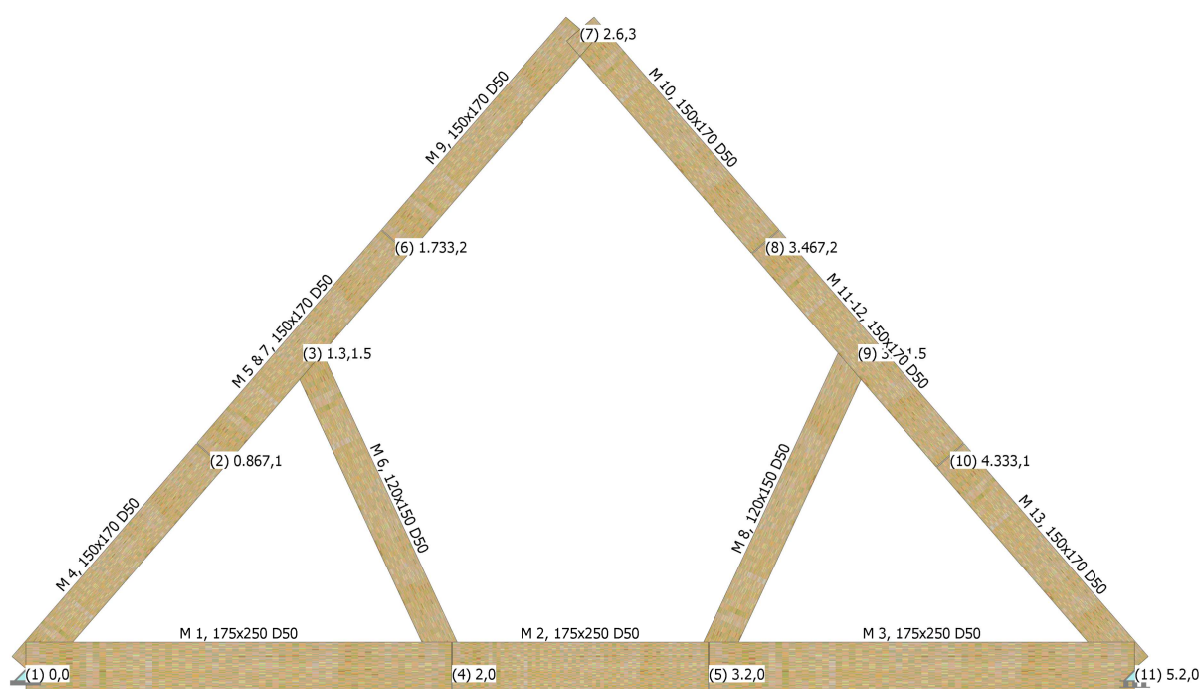
SIDEBOTTOM RICHARDSON CHENG LTD.

25548

Consulting Structural and Civil Engineers**15 High Street, Spalding****Lincolnshire PE11 1TW****Telephone: 01775 712660****Job Ref : Austendyke Hall ,Barn roof****Sheet : 19320-C/ /007****Made by : APW****Date : 20 April 2020 / Ver. 2019.15****Checked :****Approved :**

Y

Z — X

**Frame Geometry - (Full Frame) - Front View****Not to Scale**

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MasterFrame Data File

Loading Cases and Load Combination

Load Group Labels

Load Group UT	Unity Load Factor (All Cases)
Load Group D1	Dead Load
Load Group L1	Live Load

Load Case 001 : Dead plus Live (Ultimate)

Load Combination	+ 1.00 UT + 1.40 D1 + 1.60 L1
Load Duration	Long Term

Load Case 002 : Live Only (Serviceability)

Load Combination	+ 1.00 UT + 1.00 L1
Load Duration	Long Term

Load Case 003 : Dead plus Live (Serviceability)

Load Combination	+ 1.00 UT + 1.00 D1 + 1.00 L1
Load Duration	Long Term

The Nodal Co-ordinates

Node	X (m)	Y (m)	Z (m)	Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000	2	0.867	1.000	0.000
3	1.300	1.500	0.000	4	2.000	0.000	0.000
5	3.200	0.000	0.000	6	1.733	2.000	0.000
7	2.600	3.000	0.000	8	3.467	2.000	0.000
9	3.900	1.500	0.000	10	4.333	1.000	0.000
11	5.200	0.000	0.000				

Member Properties**Members 1-3**

M	175x250 D50 E 15.00E6 G .938E6 TG D50	3000000
A 437.5E-4	Ix 22786E-8	Iy 11165E-8 J 44661E-8

Members 4-5, 7 & 9-13

M	150x170 D50 E 15.00E6 G .938E6 TG D50	3000000
A 255.0E-4	Ix 6141E-8	Iy 4781E-8 J 19125E-8

Members 6 & 8

M	120x150 D50 E 15.00E6 G .938E6 TG D50	3000000
A 180.0E-4	Ix 3375E-8	Iy 2160E-8 J 8640E-8

Member Loading

Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity

E kN/mm ²	Density kN/m ³
>= 200.00	77.01
>= 20.00	24.00
>= 2.00	10.00

Members 1-13 - MasterFrame Pro Loads

D1 D	010.000	(kN/m ³)
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NODES 2, 6, 8 & 10

D1 Ls +0000.000 -0005.500 +0000.000 +0000.000 +0000.000 +0000.000

NODES 2, 6, 8 & 10

L1 Ls +0000.000 -0003.000 +0000.000 +0000.000 +0000.000 +0000.000

NODE 1

UT Rs 1 1 1 0 0 0 (Pinned)

NODE 11

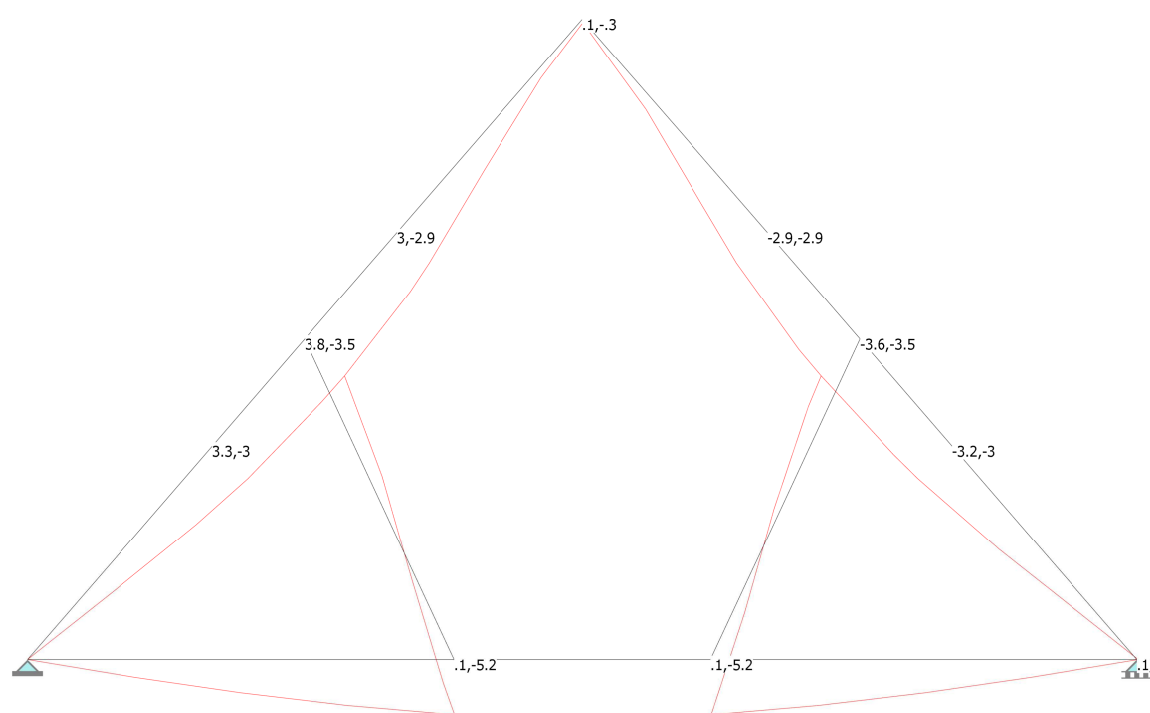
UT Rs 0 1 0 0 0 0 (Vertical Restraint)

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Y
Z — X



Load Case 001 : Dead plus Live (Ultimate)
Deflected Shape - (Full Frame) - Front View

Not to Scale**50 Magnification**

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Lincolnshire PE11 1TW

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Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /011

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

Nodal Deflections Serviceability (002 : Live Only (Serviceability))

Node	Nodal Def. (mm and Degrees)				Node	Nodal Def. (mm and Degrees)			
	$\delta X \rightarrow$	$\delta Y \uparrow$	$\Phi Z \nearrow$	δXY		$\delta X \rightarrow$	$\delta Y \uparrow$	$\Phi Z \nearrow$	δXY
2	0.70	-0.64	-0.02	0.95	3	0.79	-0.72	0.00	1.07
4	0.01	-1.08	-0.02	1.08	5	0.02	-1.08	0.02	1.08
6	0.64	-0.60	0.03	0.88	7	0.01	-0.07	0.00	0.07
8	-0.61	-0.60	-0.03	0.86	9	-0.76	-0.72	0.00	1.05
10	-0.67	-0.64	0.02	0.93					

Nodal Deflections Serviceability (003 : Dead plus Live (Serviceability))

Node	Nodal Def. (mm and Degrees)				Node	Nodal Def. (mm and Degrees)			
	$\delta X \rightarrow$	$\delta Y \uparrow$	$\Phi Z \nearrow$	δXY		$\delta X \rightarrow$	$\delta Y \uparrow$	$\Phi Z \nearrow$	δXY
2	2.28	-2.07	-0.08	3.08	3	2.58	-2.36	-0.01	3.49
4	0.04	-3.54	-0.05	3.54	5	0.05	-3.54	0.05	3.54
6	2.07	-1.95	0.12	2.85	7	0.04	-0.22	0.00	0.22
8	-1.99	-1.95	-0.12	2.79	9	-2.49	-2.36	0.01	3.43
10	-2.20	-2.07	0.08	3.02					

Member Forces Serviceability (002 : Live Only (Serviceability))

Mem ber No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	3.651T	0.335	0.408		0.109
	4	3.651T	0.335	1.078		@ 1.080
2	4	2.631T	0.000	1.648		0.087
	5	2.631T	0.000	1.648	@ 0.000	@ 0.600
3	5	3.651T	-0.335	1.078		0.109
	11	3.651T	-0.335	0.408		@ 0.920
4	1	6.672C	0.952	-0.408		0.062
	2	6.672C	0.952	0.851		@ 0.873
5	2	4.405C	-1.013	0.851		0.159
	3	4.405C	-1.013	0.181	@ 0.662	@ 0.754
6	3	0.735C	0.783	-0.725		0.094
	4	0.735C	0.783	0.570		@ 0.447
7	3	3.990C	-0.023	0.906		0.159
	6	3.990C	-0.023	0.891	@ 0.662	@ 0.754
8	5	0.735C	-0.783	0.570		0.094
	9	0.735C	-0.783	-0.725		@ 1.208
9	6	1.723C	-1.988	0.891		0.121
	7	1.723C	-1.988	-1.740		@ 0.887
10	7	1.723C	1.988	-1.740		0.121
	8	1.723C	1.988	0.891		@ 0.437
11	8	3.990C	0.023	0.891		0.159
	9	3.990C	0.023	0.906	@ 0.635	@ 0.569

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Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /012

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

Member Forces Serviceability (002 : Live Only (Serviceability))

Mem ber No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
12	9	4.405C	1.013	0.181	@ 0.906	0.159
	10	4.405C	1.013	0.851		@ 0.569
13	10	6.672C	-0.952	0.851	@	0.062
	11	6.672C	-0.952	-0.408		@ 0.450

Member Forces Serviceability (003 : Dead plus Live (Serviceability))

Mem ber No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	11.512T	1.532	1.235	@	0.369
	4	11.512T	0.656	3.424		@ 1.080
2	4	8.551T	0.262	5.291	@	0.282
	5	8.551T	-0.262	5.291		@ 0.600
3	5	11.512T	-0.656	3.424	@	0.369
	11	11.512T	-1.532	1.235		@ 0.920
4	1	21.079C	3.034	-1.235	@	0.200
	2	20.824C	2.813	2.634		@ 0.873
5	2	14.400C	-2.754	2.634	@	0.541
	3	14.273C	-2.865	0.775		@ 0.748
6	3	1.340C	2.643	-2.404	@	0.307
	4	1.610C	2.517	1.867		@ 0.430
7	3	12.406C	-0.564	3.179	@	0.541
	6	12.278C	-0.674	2.770		@ 0.748
8	5	1.610C	-2.517	1.867	@	0.307
	9	1.340C	-2.643	-2.404		@ 1.225
9	6	5.855C	-6.240	2.770	@	0.395
	7	5.600C	-6.461	-5.635		@ 0.887
10	7	5.600C	6.461	-5.635	@	0.395
	8	5.855C	6.240	2.770		@ 0.437
11	8	12.278C	0.674	2.770	@	0.541
	9	12.406C	0.564	3.179		@ 0.576
12	9	14.273C	2.865	0.775	@	0.541
	10	14.400C	2.754	2.634		@ 0.576
13	10	20.824C	-2.813	2.634	@	0.200
	11	21.079C	-3.034	-1.235		@ 0.450

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Node	Support Reactions (kN and kN.m)			Node	Support Reactions (kN and kN.m)		
	Rx→ (kN)	Ry↑ (kN)	Mz↻ (kN.m)		Rx→ (kN)	Ry↑ (kN)	Mz↻ (kN.m)
1	0.000	6.000	0.000	11	0.000	6.000	0.000
Total	0.000	12.000	0.000				

Support Reactions Serviceability (003 : Dead plus Live (Serviceability))

Node	Support Reactions (kN and kN.m)			Node	Support Reactions (kN and kN.m)		
	Rx→ (kN)	Ry↑ (kN)	Mz↻ (kN.m)		Rx→ (kN)	Ry↑ (kN)	Mz↻ (kN.m)
1	0.000	19.448	0.000	11	0.000	19.448	0.000
Total	0.000	38.896	0.000				

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15 High Street, Spalding

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Telephone: 01775 712660

Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /014

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 1 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 175, h = 250, 250x175 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 437.5, Zx 1822.9, Zy 1276, rx 7.22, ry 5.05
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = -11.512 kN, L = 2.0 m, Lx = 2.0 m, Ly = 2.0 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.02 x 1.00 x 16.00	16.32 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	16.98 N/mm ²
$\sigma_{t,adm} = K_2 \cdot K_3 \cdot K_8 \cdot K_{14} \cdot \sigma_t$	1.00 x 1.00 x 1.00 x 1.02 x 9.60	9.79 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot E_{mean}$	1.00 x 15000	15000 N/mm ²

Tensile Resistance

$\sigma_{t,a} = F/Area$	11.512 / 437.5 ≤ 9.79	0.26 N/mm ²	OK
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Axial Load with Moments Check

Critical Design Location	X = 2.000		
$\sigma_{mx,a} = Mx/Zx$	3.424 / 1822.92 ≤ 16.32	1.88 N/mm ²	OK
$\sigma_t/\sigma_{t,adm} + \sigma_{mx}/\sigma_{mx,adm}$	0.26/9.79 + 1.88/16.32	0.142	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$\tau_a = 1.5 F_v / Area$	1.5 x 1.532 / 437.5 ≤ 2.20	0.05 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	1.532 / (175 x 75) ≤ 3.99	0.12 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.37 ≤ L/333	0.37 mm	OK

SIDEBOTTOM RICHARDSON CHENG LTD.

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Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /015

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 2 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 175, h = 250, 250x175 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 437.5, Zx 1822.9, Zy 1276, rx 7.22, ry 5.05
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = -8.55 kN, L = 1.199 m, Lx = 1.199 m, Ly = 1.199 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.02 x 1.00 x 16.00	16.32 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	16.98 N/mm ²
$\sigma_{t,adm} = K_2 \cdot K_3 \cdot K_8 \cdot K_{14} \cdot \sigma_t$	1.00 x 1.00 x 1.00 x 1.02 x 9.60	9.79 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot E_{mean}$	1.00 x 15000	15000 N/mm ²

Tensile Resistance

$\sigma_{t,a} = F/Area$	8.55 / 437.5 ≤ 9.79	0.20 N/mm ²	OK
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Axial Load with Moments Check

Critical Design Location	X = 0.570		
$\sigma_{mx,a} = Mx/Zx$	5.369 / 1822.92 ≤ 16.32	2.95 N/mm ²	OK
$\sigma_t/\sigma_{t,adm} + \sigma_{mx}/\sigma_{mx,adm}$	0.20/9.79 + 2.95/16.32	0.201	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$\tau_a = 1.5 F_v / Area$	1.5 x 0.262 / 437.5 ≤ 2.20	0.01 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	0.262 / (175 x 75) ≤ 3.99	0.02 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.28 ≤ L/333	0.28 mm	OK

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Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /016

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 3 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 175, h = 250, 250x175 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 437.5, Zx 1822.9, Zy 1276, rx 7.22, ry 5.05
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = -11.512 kN, L = 2.0 m, Lx = 2.0 m, Ly = 2.0 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.02 x 1.00 x 16.00	16.32 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	16.98 N/mm ²
$\sigma_{t,adm} = K_2 \cdot K_3 \cdot K_8 \cdot K_{14} \cdot \sigma_t$	1.00 x 1.00 x 1.00 x 1.02 x 9.60	9.79 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot E_{mean}$	1.00 x 15000	15000 N/mm ²

Tensile Resistance

$\sigma_{t,a} = F/Area$	11.512 / 437.5 ≤ 9.79	0.26 N/mm ²	OK
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Axial Load with Moments Check

Critical Design Location	X = 0.000		
$\sigma_{mx,a} = Mx/Zx$	3.424 / 1822.92 ≤ 16.32	1.88 N/mm ²	OK
$\sigma_t/\sigma_{t,adm} + \sigma_{mx}/\sigma_{mx,adm}$	0.26/9.79 + 1.88/16.32	0.142	OK

Shear and Bearing Check

Critical Design Location	X = 1.950		
$\tau_a = 1.5 F_v / Area$	1.5 x 1.51 / 437.5 ≤ 2.20	0.05 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	1.51 / (175 x 75) ≤ 3.99	0.12 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span $0.37 \leq L/333$	0.37 mm	OK

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Sheet : 19320-C/ /017

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 4 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 150, h = 170, 170x150 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 255, Zx 722.5, Zy 637.5, rx 4.91, ry 4.33
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 21.079 kN, L = 1.323 m, Lx = 1.323 m, Ly = 1.323 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	17.03 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}$ (Compression)	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}$ (Deflection)	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(\lambda_x/r_x, \lambda_y/r_y)$	Max(132/4.907, 132/4.330) ≤ 180	30.6	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	30.55, 15.20, 12600	0.848	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.848 x 15.20	12.90 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	21.079 / 255 ≤ 12.90	0.83 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 1.323		
$\sigma_{mx,a} = M_x/Z_x$	2.634 / 722.5 ≤ 17.03	3.65 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.03 (1 - 1.5 x 0.848 x 0.83 / 133.21)	16.90 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.83 / 12.90 + 3.65 / 16.90	0.280	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 3.034 / 255 ≤ 2.20	0.18 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	3.034 / (150 x 75) ≤ 3.99	0.27 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.20 ≤ L/333	0.20 mm	OK

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Sheet : 19320-C/ /018

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 5 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 150, h = 170, 170x150 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 255, Zx 722.5, Zy 637.5, rx 4.91, ry 4.33
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 14.4 kN, L = 1.323 m, Lx = 1.323 m, Ly = 1.323 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	17.03 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}$ (Compression)	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}$ (Deflection)	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(\lambda_x/r_x, \lambda_y/r_y)$	Max(132/4.907, 132/4.330) ≤ 180	30.6	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	30.55, 15.20, 12600	0.848	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.848 x 15.20	12.90 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	14.4 / 255 ≤ 12.90	0.56 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 0.662		
$\sigma_{mx,a} = M_x/Z_x$	3.179 / 722.5 ≤ 17.03	4.40 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.03 (1 - 1.5 x 0.848 x 0.56 / 133.21)	16.94 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.56 / 12.90 + 4.40 / 16.94	0.304	OK

Shear and Bearing Check

Critical Design Location	X = 0.314		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 2.807 / 255 ≤ 2.20	0.17 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	2.807 / (150 x 75) ≤ 3.99	0.25 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.54 ≤ L/333	0.54 mm	OK

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Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /019

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Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 6 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 120, h = 150, 150x120 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 180, Zx 450, Zy 360, rx 4.33, ry 3.46
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 1.61 kN, L = 1.655 m, Lx = 1.655 m, Ly = 1.655 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.11 x 1.00 x 16.00	17.70 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}$ (Compression)	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}$ (Deflection)	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(\lambda_x/r_x, \lambda_y/r_y)$	$\text{Max}(166/4.330, 166/3.464) \leq 180$	47.8	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	47.78, 15.20, 12600	0.743	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.743 x 15.20	11.29 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	1.61 / 180 $\leq$ 11.29	0.09 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 0.000		
$\sigma_{mx,a} = M_x/Z_x$	2.404 / 450 $\leq$ 17.27	5.34 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.27 (1 - 1.5x0.743x0.09/54.48)	17.24 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.09/11.29 + 5.34/17.24	0.318	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 2.643 / 180 $\leq$ 2.20	0.22 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	2.643 / (120 x 75) $\leq$ 3.99	0.29 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.31 $\leq$ L/333	0.31 mm	OK

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Sheet : 19320-C/ /020

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Date : 20 April 2020 / Ver. 2019.15

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MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 7 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 120, h = 150, 150x120 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 180, Zx 450, Zy 360, rx 4.33, ry 3.46
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 1.61 kN, L = 1.655 m, Lx = 1.655 m, Ly = 1.655 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.11 x 1.00 x 16.00	17.70 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}$ (Compression)	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}$ (Deflection)	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(\lambda_x/r_x, \lambda_y/r_y)$	$\text{Max}(166/4.330, 166/3.464) \leq 180$	47.8	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	47.78, 15.20, 12600	0.743	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.743 x 15.20	11.29 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	1.61 / 180 $\leq$ 11.29	0.09 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 1.655		
$\sigma_{mx,a} = M_x/Z_x$	2.404 / 450 $\leq$ 17.27	5.34 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.27 (1 - 1.5 x 0.743 x 0.09 / 54.48)	17.24 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.09 / 11.29 + 5.34 / 17.24	0.318	OK

Shear and Bearing Check

Critical Design Location	X = 0.848		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 2.581 / 180 $\leq$ 2.20	0.22 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	2.581 / (120 x 75) $\leq$ 3.99	0.29 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.31 $\leq$ L/333	0.31 mm	OK

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Telephone: 01775 712660

Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /021

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 8 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 150, h = 170, 170x150 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 255, Zx 722.5, Zy 637.5, rx 4.91, ry 4.33
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 5.855 kN, L = 1.323 m, Lx = 1.323 m, Ly = 1.323 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	17.03 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}$ (Compression)	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}$ (Deflection)	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(L_{ex}/r_x, L_{ey}/r_y)$	Max(132/4.907, 132/4.330) ≤ 180	30.6	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	30.55, 15.20, 12600	0.848	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.848 x 15.20	12.90 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	5.855 / 255 ≤ 12.90	0.23 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 1.323		
$\sigma_{mx,a} = M_x/Z_x$	5.635 / 722.5 ≤ 17.03	7.80 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.03 (1 - 1.5 x 0.848 x 0.23 / 133.21)	16.99 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.23 / 12.90 + 7.80 / 16.99	0.477	OK

Shear and Bearing Check

Critical Design Location	X = 0.811		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 6.376 / 255 ≤ 2.20	0.38 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	6.376 / (150 x 75) ≤ 3.99	0.57 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.39 ≤ L/333	0.39 mm	OK

SIDEBOTTOM RICHARDSON CHENG LTD.

25548

Consulting Structural and Civil Engineers

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Telephone: 01775 712660

Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /022

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 9 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 150, h = 170, 170x150 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 255, Zx 722.5, Zy 637.5, rx 4.91, ry 4.33
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 5.855 kN, L = 1.323 m, Lx = 1.323 m, Ly = 1.323 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	17.03 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}$ (Compression)	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}$ (Deflection)	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(L_{ex}/r_x, L_{ey}/r_y)$	Max(132/4.907, 132/4.330) ≤ 180	30.6	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	30.55, 15.20, 12600	0.848	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.848 x 15.20	12.90 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	5.855 / 255 ≤ 12.90	0.23 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 0.000		
$\sigma_{mx,a} = M_x/Z_x$	5.635 / 722.5 ≤ 17.03	7.80 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.03 (1 - 1.5 x 0.848 x 0.23 / 133.21)	16.99 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.23 / 12.90 + 7.80 / 16.99	0.477	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 6.461 / 255 ≤ 2.20	0.38 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	6.461 / (150 x 75) ≤ 3.99	0.57 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.39 ≤ L/333	0.39 mm	OK

SIDEBOTTOM RICHARDSON CHENG LTD.

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Telephone: 01775 712660

Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /023

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 10 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 150, h = 170, 170x150 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 255, Zx 722.5, Zy 637.5, rx 4.91, ry 4.33
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 14.4 kN, L = 1.323 m, Lx = 1.323 m, Ly = 1.323 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	17.03 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}(\text{Compression})$	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}(\text{Deflection})$	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(\lambda_x/r_x, \lambda_y/r_y)$	Max(132/4.907, 132/4.330) ≤ 180	30.6	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	30.55, 15.20, 12600	0.848	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.848 x 15.20	12.90 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	14.4 / 255 ≤ 12.90	0.56 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 0.662		
$\sigma_{mx,a} = M_x/Z_x$	3.179 / 722.5 ≤ 17.03	4.40 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.03 (1 - 1.5 x 0.848 x 0.56 / 133.21)	16.94 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.56 / 12.90 + 4.40 / 16.94	0.304	OK

Shear and Bearing Check

Critical Design Location	X = 0.662		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 2.866 / 255 ≤ 2.20	0.17 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	2.866 / (150 x 75) ≤ 3.99	0.25 N/mm ²	OK

Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.54 ≤ L/333	0.54 mm	OK

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Job Ref : Austendyke Hall ,Barn roof

Sheet : 19320-C/ /024

Made by : APW

Date : 20 April 2020 / Ver. 2019.15

Checked :

Approved :

MasterKey : Timber Design
Axial Load With Moment Design to BS 5268 : Part 2
Member TB L1 Id 11 @ Level 1

Summary Design Data

Design Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Deflection Cases Covered	1.0 L1, 1.0 D1 + 1.0 L1
Section Size	b = 150, h = 170, 170x150 in Strength Class D50
Section Properties (cm ² ,cm ³ ,cm)	Area 255, Zx 722.5, Zy 637.5, rx 4.91, ry 4.33
Specification	1 : Internal use in continuously heated building Long term loading
Integrated Design Critical Case	: Dead plus Live (Serviceability)
Member Details	F = 21.079 kN, L = 1.323 m, Lx = 1.323 m, Ly = 1.323 m, Lex = 1.0 Lx, Ley = 1.0 Ly Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class D50)

$\sigma_{mx,adm} = K_2 \cdot K_3 \cdot K_{7x} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.06 x 1.00 x 16.00	17.03 N/mm ²
$\sigma_{my,adm} = K_2 \cdot K_3 \cdot K_{7y} \cdot K_8 \cdot \sigma_m$	1.00 x 1.00 x 1.08 x 1.00 x 16.00	17.27 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.00 x 15.20	15.20 N/mm ²
$\sigma_{c,adm} = K_2 \cdot K_3 \cdot K_4 \cdot K_8 \cdot \sigma_c$	1.00 x 1.00 x 1.14 x 1.00 x 3.50	3.99 N/mm ²
$\tau_{adm} = K_2 \cdot K_3 \cdot K_8 \cdot \tau$	1.00 x 1.00 x 1.00 x 2.20	2.20 N/mm ²
$E = K_2 \cdot K_9 \cdot E_{min}(\text{Compression})$	1.00 x 1.00 x 12600	12600 N/mm ²
$E = K_2 \cdot E_{mean}(\text{Deflection})$	1.00 x 15000	15000 N/mm ²

Compression Resistance

$\lambda = \text{Max}(\lambda_x/r_x, \lambda_y/r_y)$	Max(132/4.907, 132/4.330) ≤ 180	30.6	OK
$K_{12} = \text{fn}(\lambda, K_3, \sigma_c, E)$	30.55, 15.20, 12600	0.848	
$\sigma_{c,adm} = K_{12} \cdot \sigma_{c,adm}$	0.848 x 15.20	12.90 N/mm ²	
$\sigma_{c,a} = F/\text{Area}$	21.079 / 255 ≤ 12.90	0.83 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 0.000		
$\sigma_{mx,a} = M_x/Z_x$	2.634 / 722.5 ≤ 17.03	3.65 N/mm ²	OK
$\sigma_{mx,adm} = \sigma_{mx,adm} (1 - 1.5 K_{12} \cdot \sigma_{c,a} / \sigma_c)$	17.03 (1 - 1.5 x 0.848 x 0.83 / 133.21)	16.90 N/mm ²	
$\sigma_c / \sigma_{c,adm} + \sigma_{mx} / \sigma_{mx,adm}$	0.83 / 12.90 + 3.65 / 16.90	0.280	OK

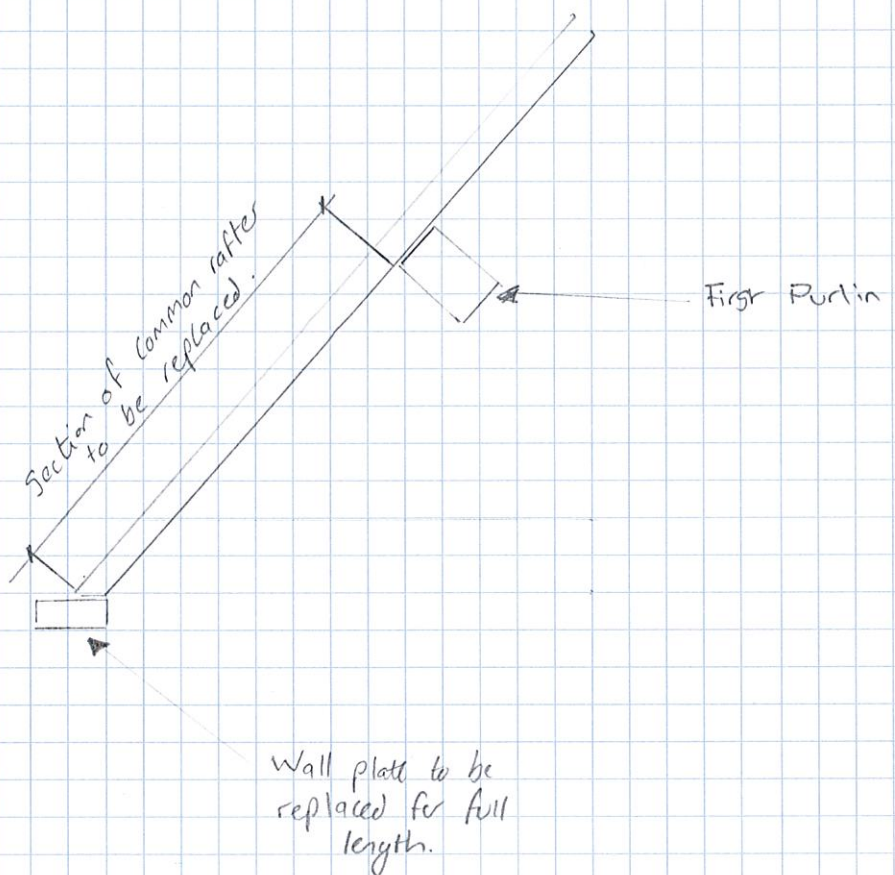
Shear and Bearing Check

Critical Design Location	X = 0.976		
$\tau_a = 1.5 F_v / \text{Area}$	1.5 x 2.976 / 255 ≤ 2.20	0.18 N/mm ²	OK
$\sigma_{cax} = F_v x / (b \cdot B_x)$	2.976 / (150 x 75) ≤ 3.99	0.26 N/mm ²	OK

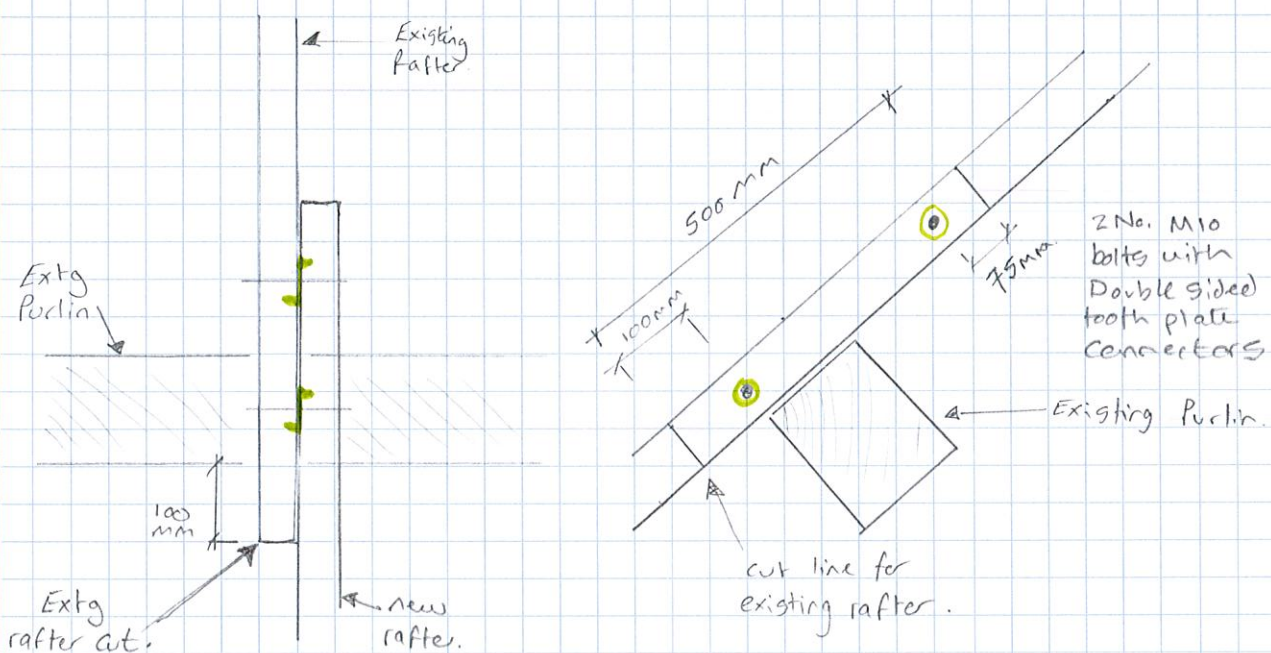
Deflection Check (Shear Deflection NOT Included)

Critical Load Case 003 : Dead plus Live (Serviceability)			
$\delta = \delta_m$	In-span 0.20 ≤ L/333	0.20 mm	OK

PROJECT:



Remedial Common rafter replacement.

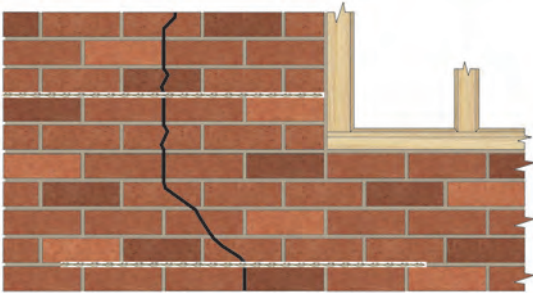


Crack Stitching

A reliable and cost-effective means of repairing and stabilising cracked masonry

Applications

- Rapid and permanent solution to cracked masonry
- Suitable for all forms of masonry structure



Over 100 standard repair specifications are available online, covering all common structural faults.
Relevant Repair Details: RDs CS01 to CS14



For full Product Information, Case Studies and downloadable Repair Details go to:

www.helifix.co.uk/products/remedial-products/crack-stitching/



Features

- Fully concealed, non-disruptive repair solution
- More reliable than crack injection methods
- HeliBond cementitious grout is injectable and rapidly produces high compressive strength
- HeliBars and HeliBond grout combine to create excellent tensile strength within the masonry
- No additional stresses are introduced during installation
- Masonry remains flexible enough to accommodate normal building movement
- Tensile loads are redistributed
- Reduces likelihood of further cracking nearby
- Avoids costly and disruptive taking down and rebuilding



HeliBar is inserted into HeliBond grout within a cut slot

Installation Procedures

1. HeliBar to be long enough to extend a minimum of 500mm either side of the crack or 500mm beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.
2. Where a crack is less than 500mm from the end of a wall or an opening, the HeliBar is to be continued for at least 200mm around the corner and bonded into the adjoining wall or bent back and fixed into the reveal, avoiding any DPC.
3. For solid masonry in excess of 300mm thick and in a cavity wall where both leaves are cracked, the wall must be crack stitched on both sides.
4. If there is render, this thickness must be added to the depth of slot. Crack stitching must be installed in the masonry and never in the render.
5. Ensure the masonry is well wetted or primed to prevent premature drying of the HeliBond due to rapid de-watering, especially in hot conditions. Ideally additional wetting of the slot should be carried out 1 to 2 minutes prior to injecting the HeliBond grout.
6. Do not use HeliBond when the air temperature is +4°C and falling or apply over ice. In all instances the slot must be thoroughly damp or primed prior to injection of the HeliBond grout.



1. Rake out or cut slots into the horizontal mortar beds, a minimum of 500mm either side of the crack



4. Using the HeliBar Insertion Tool, push one HeliBar into the grout to obtain good coverage



2. Clean out slots and flush with clean water and thoroughly soak the substrate within the slot



5. Insert a further bead of HeliBond over the exposed HeliBar, finishing 12mm from the face, and 'iron' firmly into the slot using the HeliBar Insertion Tool



3. Using the Helifix Pointing Gun, inject a bead of HeliBond along the back of the slot



6. Re-point the mortar bed and make good the vertical crack with CrackBond TE3

Slot Depth and Spacing

	Single skin/ Cavity wall	Solid Masonry		
		Up to 102.5mm	102.5mm to 225mm	Over 225mm
Depth of slot	25 – 35mm	25 – 40 mm	25 – 40 mm	25 – 40mm On both sides
Vertical Spacing	Every 4 – 6 courses, 300 – 450mm			

Technical Specifications

Material:	Austenitic stainless steel Grade 304 (1.4301) or 316 (1.4401)
Diameter:	6mm (or 4.5mm for thin mortar joints)
Tensile strength (6mm HeliBar):	10 kN
0.2% Proof stress (6mm HeliBar):	900 N/mm ²
Length:	To extend 500mm either side of the crack or outer cracks, if more than one
Standard lengths:	1m, 1.5m and 2m – in packs of 10. May be cut to length on site
Height of slot:	Full height of mortar bed or approx. 10mm if cut through the masonry unit
Bonding agent:	HeliBond cementitious grout. 1 x 3ltr HeliBond = 10 linear metres of crack stitching
RECOMMENDED TOOLING	
For cutting slot up to 40mm deep:	Twin-bladed cutter with vacuum attachment or angle grinder or hammer and mortar chisel
For mixing HeliBond grout:	3-jaw-chuck drill with mixing paddle
For injection of HeliBond into slots:	Helifix Pointing Gun CS with mortar nozzle
For smoothing pointing:	Standard finger trowel
For inserting HeliBar:	HeliBar Insertion Tool