

Structural Appraisal
Of
Judy Cross Barn
Watergate
Quadrant
PE11 4PY

Date: November 2018

Client: Paul Green

Engineer: STEVEN KIDD BSc, CEng, FIStructE

1.0 Synopsis and Terms of Reference

The following structural appraisal was requested by the client in view of his intention to convert the existing barn for domestic use.

The client is himself a builder/engineer and has already replaced the roof structure and deepened the foundations on the north gable prior to this structural appraisal being carried out. However he is yet to tackle underpinning on side adjacent dyke and add a mezzanine floor. The following report focuses on the structural stability of the barn in its present condition. Related issues such as damp penetration, timber rot and drainage are not covered here. Specialist advice on these matters should be sought where appropriate. Apart from some knowledge of the foundations and timber calculation results this appraisal is based on a visual inspection only. No soil/materials were tested or foundations exposed. However good access to all sections of the barn was possible.

Finally this report should not be copied without the clients permission.

2.0 **Survey**

2.1 **Introduction**

The barn which is the subject of the report is located outside the fenland village of Quadring in open countryside. Prevailing ground conditions here are known to be alluvial silts forming a crust over very soft grey clay. It dates back to late Edwardian times (1920) and was built in traditional materials, single brick walls supporting a hand made timber roof and slates/pantiles.

2.2 **Roof**

2.3 As indicated by photographs appended to this report the new roof is in keeping with traditional methods.

2.4 Member sizes are as follows:

- (a) Rafters: 150x43 at 600 centres c24
- (b) Purlins: 100x75-3000 max length c24
- (c) Ties 200x32 c24
- (d) Nominal Ridge beam.

2.5 The layout of the roof is such that rafters lean against each other above purlin level therefore a nominal outward thrust only will be experienced at plate level.

2.6 The ridge line is running straight and true indicating the supporting structure is performing satisfactorily.

2.7 **Walls**

2.8 As indicated by photographs appended to this report the walls are in hand made bricks in a lime based mortar. Generally these are 225 English bond with piers at door openings. All running straight and true.

2.9 On the dyke side the client has added an inner skin of blockwork and tied into the outer brick work, this was to stabilize this side of the barn.

2.10 There are at present, no internal walls. However external walls form a strong box 7.8x4.5 meters with no signs of distress at the corners.

2.11 On the rear gable the timber wall plate (at eaves level) is embedded in the brick work as is normal for a barn of this age. No signs of rot could be seen, but this should be checked out. Such embedded timber forms a tie into the corners, which should be maintained.

2.12 **Floors and Foundations**

2.13 Although no serious evidence of settlement was apparent the client wishes to add an internal raft which contributes to the stability of the barn. In view of movement on north wall he has already addressed the foundation issue in part with traditional underpinning.

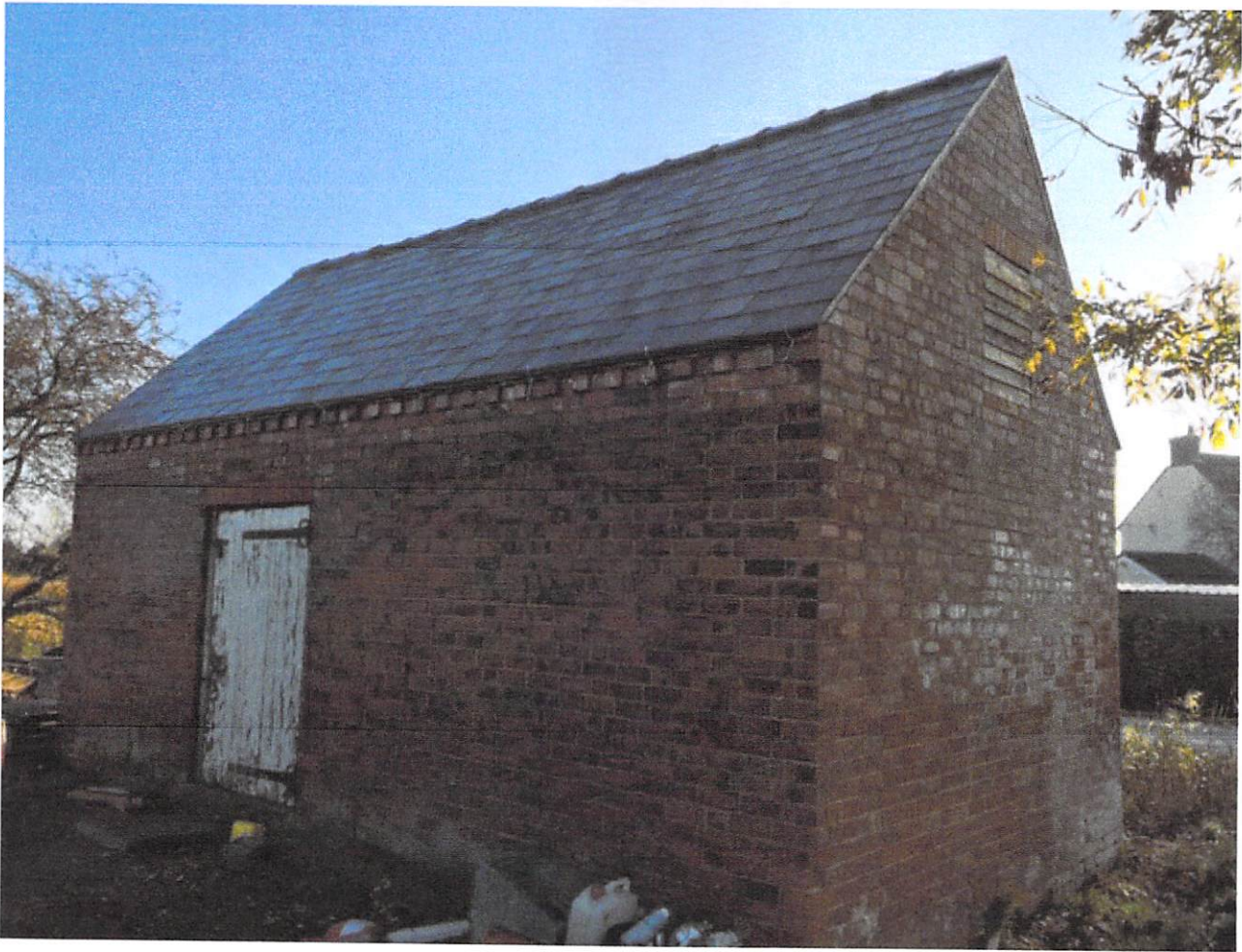
- 2.14 Details of an appropriate internal raft are given in the Appendices to this report. This effectively provides additional support to the external walls through steel dowels at 600mm centres.
- 2.15 It has already been stated that the standard corbelled brick foundations which form the original foundations to the barn replaced on the side running nearest the dyke and the door gable. These will be taken to the invert of the dyke to avoid any mutual influence. These also should be tied into the raft.
- 2.16 A new timber mezzanine is proposed which is to have the additional function of tying the structure together through external tie plates. Calculations appended to this report show a 220x47 C16 grade at 600mm centres will be satisfactory.
- 2.17 The new floor should be tied into the gable also.

3.0 **Conclusions and Recommendations**

- 3.1 From the evidence gained on site and with reference to the Institution Of Structural Engineers report "Subsidence of Low Rise Buildings" the barn may be said to be in a stable condition; satisfactory for conversion into domestic accommodation.
- 3.2 However in order to safeguard against long term movement the client proposes to underpin the side adjacent the dyke to the invert of the dyke.
- 3.3 SLC to revisit when foundation work is in progress.

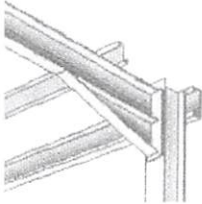


STEVEN KIDD BSc, CEng, FStructE



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Lincs.
PE11 3XA

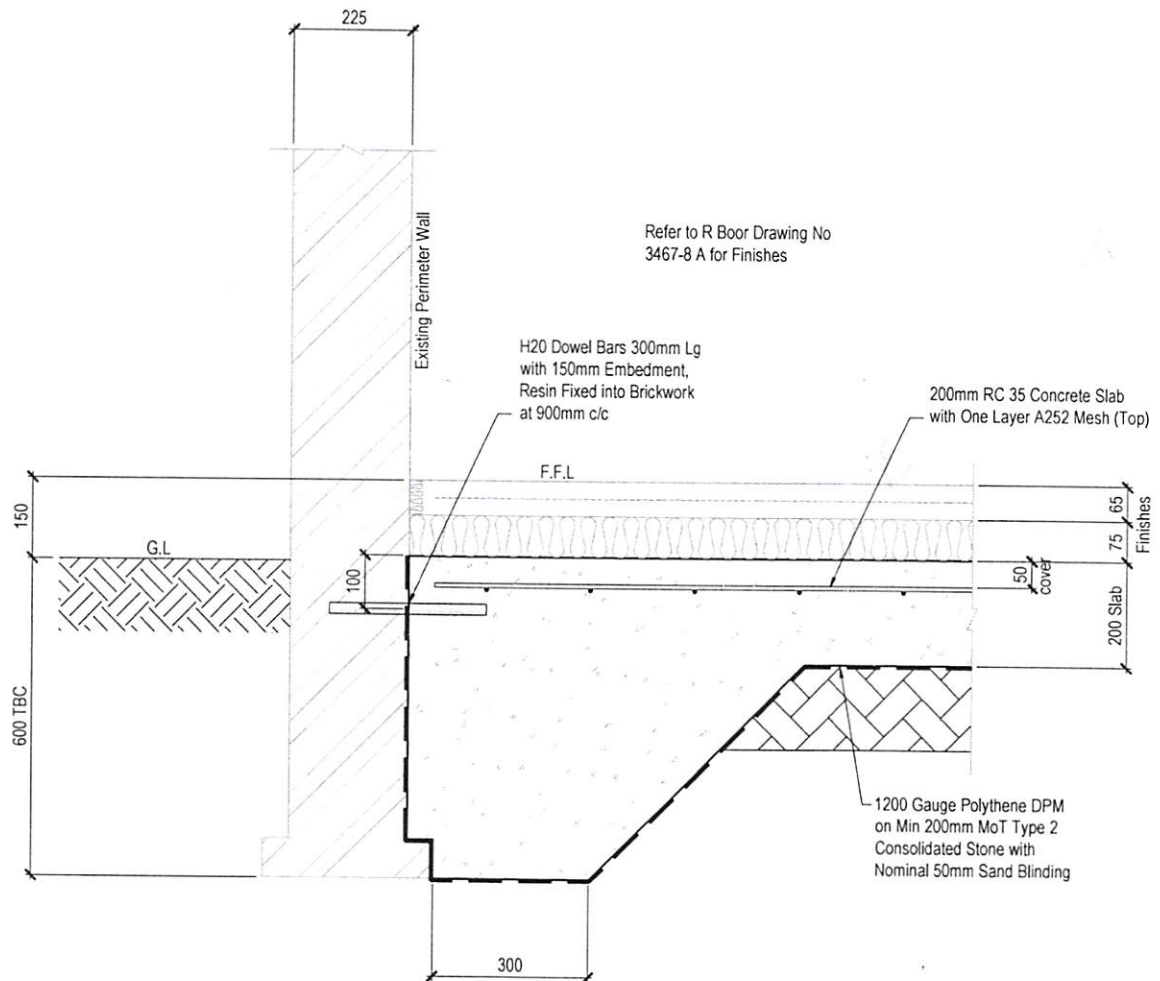
T: 01775 769 563
F: 01775 710 758

E: enquiries@southlincsconsulting.com

DETAIL OF
WALL SUPPORT.
RAFT FOUNDATION

Ref No.	18-0394
Sheet	51
By	St
Ckd.	
Date	DEC 2018

TYPICAL SECTION THROUGH BARN PERIMETER WALL



Ref No.	18-0394
Sheet	52
By	SK.
Ckd.	
Date	Dec 2018

20g Tie Bar attached to floor

18x16mm

300 dia
tie plate

Ex

www

150x90x10 L to form ledge for joints — fixed MS @ 600^{c/c} HILTI Results or similar

150x90x101 to form ledge for joints — fixes MS @ 600 $\varnothing$ HULTI RESINS OR SIMILAR

Enquiries

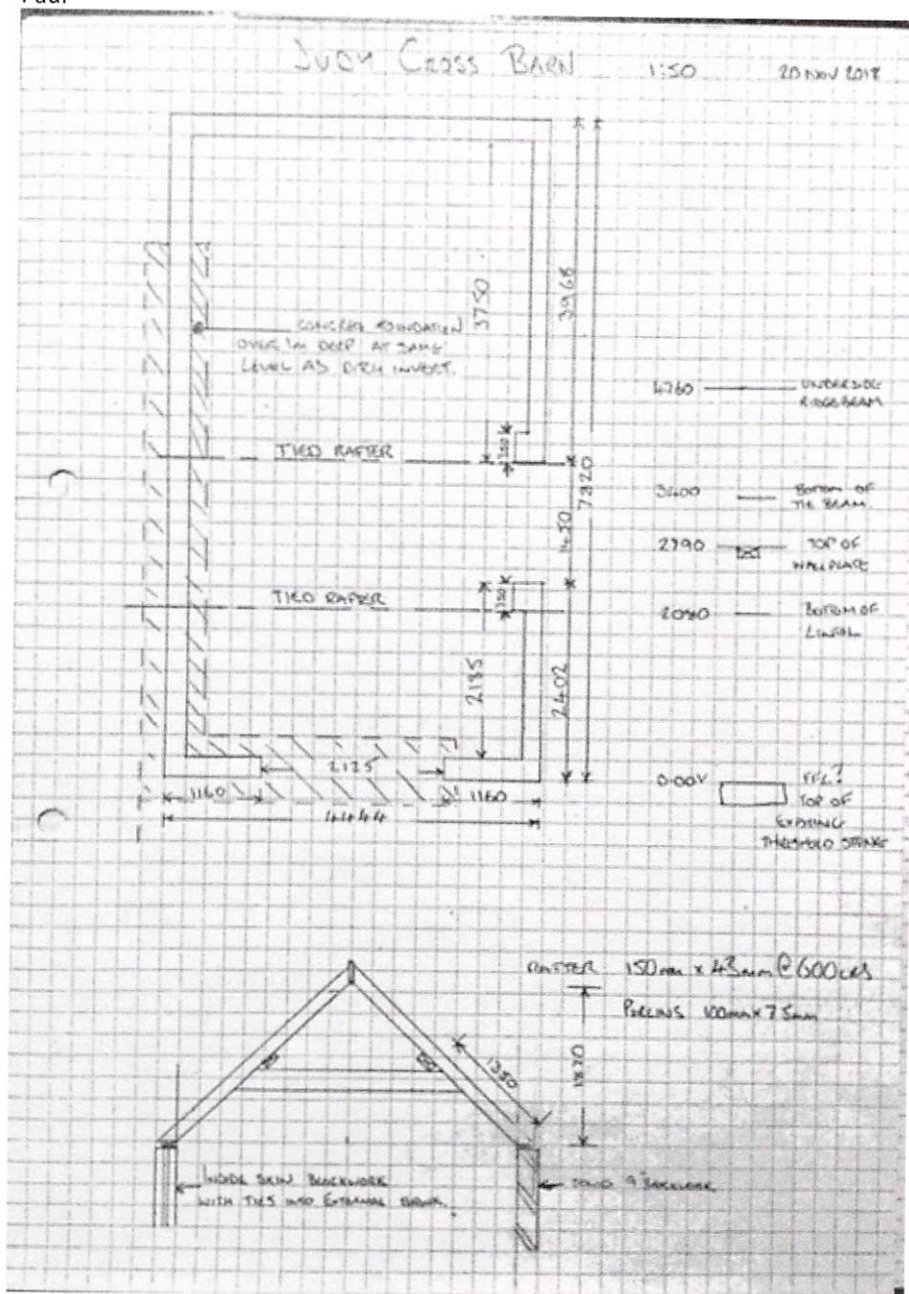
From: Paul Green <paul.green999@btinternet.com>
Sent: 28 November 2018 14:11
To: Enquiries
Subject: Judy Cross Barn Appraisal

Appraisal
+ CARS :- SHEET

Afternoon Steve

I have attached details of the barn as best I can in order for a structural appraisal. As I said I am keen to get a structural floor in to tie the barn together. Some details of mesh spec and concrete grade would be appreciated.

Many thanks
Paul

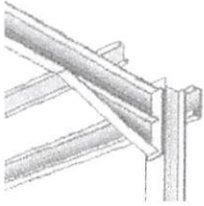


CALES INDEX

- ① Mezz Floor Beam
2-4
- ② Proof of Rafter
5-9.

Note μ_{12} acts
as restraint only.

Obviously give me a call if any queries



CHECK ON FOUNDATION BEARING

Ref No.	18-0394
Sheet	10
By	SKID
Ckd.	
Date	DEC 2018

FOUNDATION LOAD — WITH MEZZ

$$\text{Roof} = 2.0 \times 4.2 = 4.0$$

$$\text{Floor} = 2.5 \times 4.2 = 5.0$$

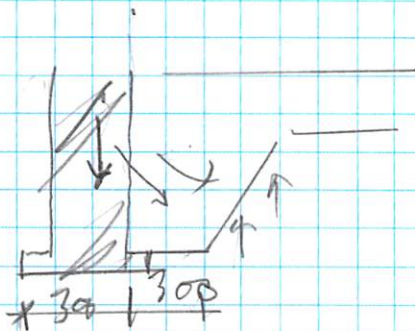
$$\text{Wall} = 4.5 \times 4.3 = 20.0$$

$$\underline{29 \text{ kN/m}}$$

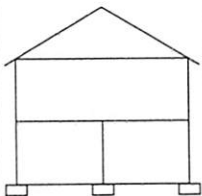
pressure under 600mm

$$= 29 / 0.6 = 48 \text{ kN/sq m}$$

$$< 50 \text{ kN/sq m}$$



∴ Proposed Foundation
Acceptable

	Timber Designers' Toolkit Timber Engineering Systems Ltd Page 2	
	Licencee: SOUTH LINGS CONSULTING	Ver: 2.10 30/11/18 16:12
	Project: Judy Cross Barn	User: sk
	Client: Paul Green	Checked:

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Author: Dr John Bellamy MSc, PhD, CEng, MICE, FISTructE, FIWSc

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phone 01638 600028 Fax 01638 600029 E-Mail jbellamy@timbersystems.co.uk
World Wide Web site www.timbersystems.co.uk

PROJECT: JUDY CROSS BARN DATA

Design Code: BS5268: Part 2: 2002 Structural use of timber

Client: Paul Green

Notes:

Mezz Floor Joist

Imposed Floor & Ceiling Loading BS 6399 : Part 1 : 1996

Ceiling: Loft usage: Domestic

Floor: Room usage: Self-contained dwelling units

CLADDING LOADING SUMMARY

Ceiling Dead Loading

1 * 12.5 mm plasterboard insulation

Dead load: 143 N/sq.m

Concentrated imposed load: 900 N

Ud imposed load: 250 N/sq.m

Lateral restraint c/c: No restraint mm

Floor Dead Loading

Chipboard flooring 22 mm

Dead load: 162 N/sq.m

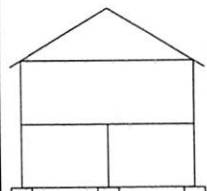
Concentrated imposed load: 1400 N

Ud imposed load: 1500 N/sq.m

Lateral restraint c/c: 300 mm

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	Project: Judy Cross Barn		User: sk
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LOAD CASES

Each structure is analysed for up to 7 separate load cases. The load cases are:

- 1: Long term Dead + Permanent
- 2: Medium term Dead + Permanent + Imposed
- 3: Short term Dead + Permanent + Concentrated load at left end
- 4: Short term Dead + Permanent + Concentrated load at mid bay
- 5: Short term Dead + Permanent + Concentrated load at right end
- 6: Very short term Dead + Permanent + Imposed + Positive wind
- 7: Very short term Dead + Negative wind

Positive wind adds to the gravitational loads.

Grade Stresses and Moduli of Elasticity

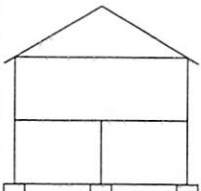
Bending	Tension	Compress	Compress	Compress	Shear	M of E	M of E	G	G	Density
//	//	//	. .*	. . .	//	Mean	Min	Mean	Min	Mean

C16 (UK sizes)

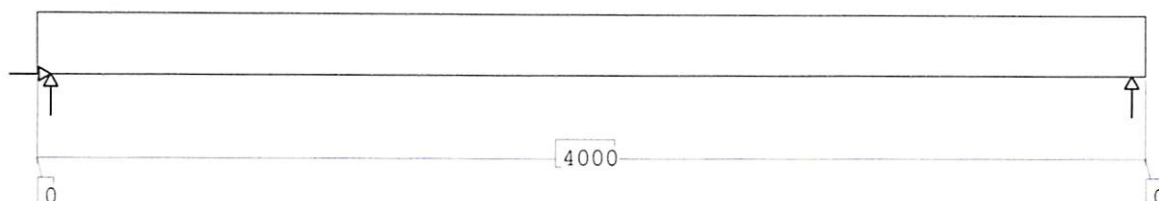
5.3	3.2	6.8	2.2	1.7	0.67	8800	5800	550	363	370
-----	-----	-----	-----	-----	------	------	------	-----	-----	-----

//: parallel to grain .|. : perpendicular to grain *: no wane at bearing surfaces

Units - Stresses and moduli: N/sq.mm Density: Kg/cu.m.

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	Project: Judy Cross Barn			User: sk
	Client: Paul Green			Checked:

SUMMARY STRUCTURAL CALCULATION OUTPUT FOR FLOOR JOIST : Joist1



47 * 220 C16 (UK sizes) Regularised

Pitch: Horizontal

Supports

Left support : Built into masonry minimum bearing 60 mm on grade 2.8 N/sq.mm masonry (Minimum depth required at bearing above any notch on underside 145 mm).

Max principal reactions: + ve 2241 VShort1 - ve 0 (N)

Max secondary reactions: + ve 0 VShort1 - ve 0 Short1 (N)

Right support : Built into masonry minimum bearing 60 mm on grade 2.8 N/sq.mm masonry (Minimum depth required at bearing above any notch on underside 145 mm).

Max principal reactions: + ve 2241 VShort1 - ve 0 (N)

Cladding Cladding pitch: 0.00 deg

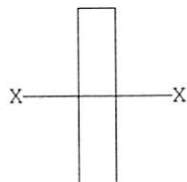
Above: Chipboard flooring 22 mm Dead load: 162 N/sq.m Restraints: 300 mm centres

Imposed loading: Room usage: Self-contained dwelling units 1500 N/sq.m or 1400 N

Beneath: 1 * 12.5 mm plasterboard + insulation Dead load: 168 N/sq.m Restraints: None

Loaded width on Joist1: 600.0 mm

Section



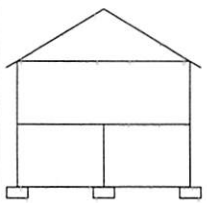
47 * 220 C16 (UK sizes) Regularised

Twist angle: Upright Spacing: 600.0 mm

End cuts: Vertical / Vertical

Length overall/ stock: 4000 / 4200 mm

Critical check: Bending (long term load case) 93.1 % of permissible. Service class 1/2 (dry timber)

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	Project: Judy Cross Barn	User: sk	
	Client: Paul Green	Checked:	

INTRODUCTION TO THE TIMBER DESIGNERS' TOOLKIT

The Timber Designers' Toolkit is a collection of computer aided design/analysis procedures for timber structures. Their aim is to reduce the costs of designing and building timber structures. In this issue procedures are provided for the racking resistance of timber frame panels and to determine the permissible shear loads on fasteners but the majority are for the selection of the most economic timber section and grade for rafters, joists, studs etc. The following notes explain the timber selection procedures and their output; the notes are intended to be issued to checkers such as Building Control Officers. Printed output from the other procedures is self contained.

INTRODUCTIONARY NOTES ON ALL TIMBER SELECTION PROCEDURES:

1. The project data printed out below apply to all beams in the project.
2. The procedures permit selection from different grades of sawn softwood, hardwood and engineered timber products such as glulam and LVL. Minimum and maximum sizes and number of ply can be set by the user.
3. To simplify and speed up the design process the user selects the cladding materials from stored lists and the program automatically applies the appropriate distributed loadings.
4. As well as cladding loads there are facilities for applying reaction loads (from beams designed previously) and user specified point loads. There are two generic beam types (Beam and Column) for which engineer users can specify their own distributed loads.
5. The analysis assumes straight uniform members of rectangular cross-section with bending only about the major axis, supported at two or more points in prescribed directions. Where minor axis bending occurs this is drawn to the attention of the user.
6. Stresses and deflections of members are calculated at up to 16 points between supports.
7. The program considers supports as being one of six different types. The safety of each support is checked and the output indicates when the supports are over loaded.
8. Utilisation values not exceeding 100% are safe, over 100% are unsafe. To avoid designs being rejected when minutely over the limits the program uses an "Engineers Fudge Factor" of 2.5%.
9. When available permissible deflections, etc are taken from Codes of Practice and Agreement Certificates, otherwise values are based on typical products and/or common practice. Some users may find some of these values unduly pessimistic and if so wished may produce supplementary calculations to justify their own alterations to the details suggested.

SIGN CONVENTION FOR OUTPUT:

Axial compression, anti-clockwise shears, sagging moments and downwards deflections are positive. Reactions in the directions of the arrows are also positive.

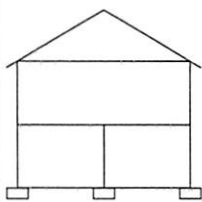
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 World Wide Web site www.timbersystems.co.uk

PROJECT: JUDY CROSS BARN DATA

Design Code: BS5268: Part 2: 2002 Structural use of timber

Client: Paul Green

Notes:

Rafter Check

Site location

County: Lincolnshire

Site altitude: 30 m

Snow Loading BS 6399 : Part 3 : 1988

Site snow load: 518 N/sq.m

Imposed snow load: 600 N/sq.m

Wind Loading BS 6399 : Part 2 : 1997 (June 2002)

Basic wind speed: 25 m/sec

Height to ridge: 8.0 m

Altitude factor: 1.03

Country terrain

Distance from sea or large lake: 0 km

Terrain and building factor: 1.73

Directional, Seasonal and Probability factors: 1.0

Dynamic pressure: 1214 N/sq.m

See beam output for pressure coefficients

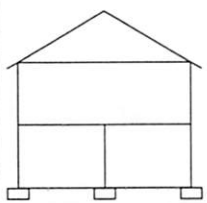
Imposed Floor & Ceiling Loading BS 6399 : Part 1 : 1996

Ceiling: Loft usage: Domestic

Floor: Room usage: Self-contained dwelling units

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CLADDING LOADING SUMMARY

Pitched Roof Dead Loading

Tiles - concrete interlocking

Dead load: 685 N/sq.m

Concentrated imposed load: 900 N

Ud imposed load: 600 N/sq.m

Lateral restraint c/c: 360 mm

Ceiling Dead Loading

1 * 12.5 mm plasterboard insulation

Dead load: 143 N/sq.m

Concentrated imposed load: 900 N

Ud imposed load: 250 N/sq.m

Lateral restraint c/c: No restraint mm

Floor Dead Loading

Chipboard flooring 22 mm

Dead load: 162 N/sq.m

Concentrated imposed load: 1400 N

Ud imposed load: 1500 N/sq.m

Lateral restraint c/c: 300 mm

LOAD CASES

Each structure is analysed for up to 7 separate load cases. The load cases are:

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- 5: Short term Dead + Permanent + Concentrated load at right end
- 6: Very short term Dead + Permanent + Imposed + Positive wind
- 7: Very short term Dead + Negative wind

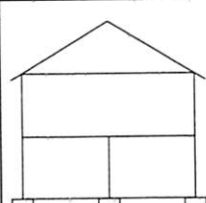
Positive wind adds to the gravitational loads.

Grade Stresses and Moduli of Elasticity

Bending	Tension	Compress	Compress	Compress	Shear	M of E	M of E	G	G	Density
//	//	//	. .*	. . .	//	Mean	Min	Mean	Min	Mean
C16 (UK sizes)										
5.3	3.2	6.8	2.2	1.7	0.67	8800	5800	550	363	370
//: parallel to grain . . : perpendicular to grain *: no wane at bearing surfaces										
Units - Stresses and moduli: N/sq.mm Density: Kg/cu.m.										

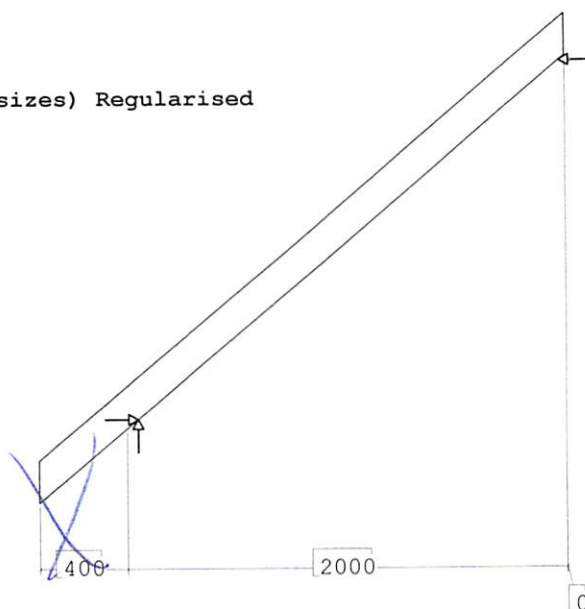
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FULL STRUCTURAL CALCULATION OUTPUT FOR ATTIC RAFTER : AtticRafter1

47 * 147 C16 (UK sizes) Regularised
Pitch: 40.000 deg



Supports

Left support : Timber wall plate minimum bearing 30 mm with two 4.5 * 100 skew nails Minimum depth required above birdsmouth 81 mm.

Secondary support: Fixing to be designed by structural engineer

Strength long term 2865 Uplift 234 Shear 1162 (N)

Right support : Structural prop/ tie fixing to be designed by job structural engineer.

Cladding Cladding pitch: 40.00 deg Site snow load: 518 N/sq.m Wind dynamic pressure: 1214 N/sq.m

Above: Tiles - concrete interlocking Dead load: 685 N/sq.m Restraints: 360 mm centres

Imposed loading: Pitched roof 600 N/sq.m or 900 N

Wind pressure coefficients: External 0.60 Internal -0.30

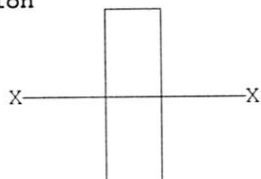
Beneath: 1 * 12.5 mm plasterboard + insulation Dead load: 168 N/sq.m Restraints: None

Wind pressure coefficients: External -0.60 Internal 0.20

Distance to previous beam: 600.0 Loaded width on AtticRafter1: $600.0 * 0.500 = 300.0$ (mm)

Distance to next beam: 600.0 Loaded width on AtticRafter1: $600.0 * 0.500 = 300.0$ (mm)

Section

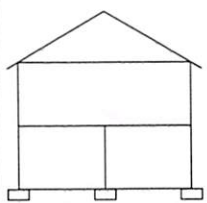


47 * 147 C16 (UK sizes) Regularised

Twist angle: Upright Spacing: 600.0 mm

End cuts: Vertical / Vertical

Length overall/ stock: 3256 / 3600 mm

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Calculations Output

Critical check: Bending (vshort1 term load case) 49.6 % of permissible. Service class 1/2 (dry timber)

Permissible deflections (per span) 7.539 (Left tip 3.525) mm (Double these deflections are permitted for short and very short term load cases)

Load cases	Long	Medium	Short	Short	Short	VShort	VShort
LOADING							
ud perpendicular	0.400	0.546	0.400	0.400	0.400	1.201	-0.183
ud parallel	0.335	0.458	0.335	0.335	0.335	0.458	0.335
MAXIMA RESULTS							
Max tension	197	269	775	197	197	269	255
Max compression	1435	1959	1243	2424	2846	2913	588
Max shear force	-529	-723	924	-874	-702	-1590	242
Max moment	282	385	-473	682	270	846	-129
Max csi	0.292	0.320	0.411	0.466	0.215	0.496	0.071
At position	1941	1941	586	1747	1941	1941	1941
Max deflection	1.761	2.404	0.852	3.970	1.717	5.271	-0.788
At position	1941	1941	0	1941	1941	1941	1941
Left tip deflection	-1.102	-1.504	0.827	-2.570	-1.068	-3.302	0.496
Right tip deflection	-0.017	-0.024	0.023	-0.062	0.067	-0.089	0.041
LEFT SUPPORT							
Reaction	1635	2232	2535	2535	2535	3805	237
Reaction(Shear)	759	1036	508	1295	1846	961	826
Axial force (Left)	-197	-269	-775	-197	-197	-269	-197
Axial force (Right)	1435	1959	1243	2424	2846	2913	588
Shear force (Left)	234	320	924	234	234	704	-107
Shear force (Right)	-529	-723	-690	-874	-520	-1590	242
Moment at support	-69	-94	-474	-69	-69	-207	32
RIGHT SUPPORT							
Reaction	759	1036	508	1295	1846	2281	-347
Reaction(Shear)							
Axial force (Left)	593	809	401	1004	2004	1763	-255
Axial force (Right)	11	14	11	11	589	14	11
Shear force (Left)	475	648	313	819	483	1426	-217
Shear force (Right)	-13	-17	-13	-13	-702	-38	6
Moment at support	0	0	0	0	-23	-1	0

Units: Reactions, axial forces, shear forces : N; Bending moments : Nm; Distances, deflections: mm

The short term load cases include a concentrated load of 900 N at 0 ,1844 ,3133 mm along beam.