BTA
STRUCTURAL DESIGN
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WINCHCOMBE FARM

LITTLE SODBURY

BS37 6QD

STRUCTURAL REPORT

ON

COW BARN

Date of inspection

30th October 2023

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JGB Birdwood MA CEng MICE MIStructE

Registered in England – number: 4605547 address: as Head Office

1. Introduction

We were appointed to report on the structural condition of an agricultural barn at the property and its suitability for conversion to residential use.

Our report is concerned only with this structural issue, all other aspects of the property are outside our report.

Our report is prepared for the use of the above named client in connection with a planning submission only and is not to be relied upon by third parties without our specific written authorisation.

A site visit was carried out by James Birdwood of BTA Structural Design Ltd on 30th October 2023. Weather conditions were dry.

No exposing work was carried out. Our report is based on a visual inspection.

Our report contains photographs of the buildings taken on the day of inspection.

Calculations to justify the steel framed roof structure are also attached.

2. General Description

The building is a single storey agricultural barn, used as a cow shed. It is about 26.5m long by 12.0m wide, with a height to eaves of about 2.8m, and 4.3m to the ridge.

The barn has a double pitch roof with steel lattice 'Double Howe' tubular trusses, supporting steel tubular purlins and a corrugated cement sheet roof.

It is orientated E-W, with gables at the east and west ends.

Walls are of 150mm concrete blockwork, with 450mm sq piers at about 3.3m c/c on the long sides, corresponding to the positions of the roof trusses.

The barn has a concrete floor, and is on a level site.

3. External Observations

The corrugated cement sheet roof is straight and level with no sign of structural movement.

External walls are of fair-faced concrete blockwork, with stiffening piers projecting out and in at about 3.3m centres to support the roof trusses.

The walls stand vertical with no significant bulges or bowing.

There are a few cracks of longstanding, some perhaps due to vehicle impact, but no evidence of significant structural movement.

There is weathering and general wear and tear particularly at corners reflecting the agricultural use of the building. There is also some eroded pointing and blockwork due to leaking or missing gutters, particularly to the external piers on the north side, where there is no gutter. The walls however remain structurally sound, requiring only localized repairs.

At the front (west) gable end there is a wide central opening between block piers, with a sliding metal door. This is almost certainly original.

At the rear (east) gable end there are two side openings with a thicker block wall between. Above this the original stiffening piers can be seen. This is a later alteration, and has been done quite crudely, but is nonetheless robust.

4. Internal Observations

The space is divided into eight equal bays of about 3.3m . There are seven ‘Double Howe’ lattice trusses dividing the bays, and steel purlins span between the trusses and gables.

The trusses are formed of tubular top and bottom chords (both approx 60mm diameter tubes, with the web members being of approximately 42mm diameter.

The purlins are also steel tubes, approx diameter 60mm. There are six purlins per slope with an average spacing of about 1.4m.

The trusses and purlins all have surface rust but this has not affected the structural performance.

Calculations for the trusses and purlins are included in the appendix of this report. For the purposes of this analysis the 60mm tubes are taken as 60.3x4 CHS and 42 diameter tubes as 42.2x2.6 CHS. These are at the lighter end of the possible sections.

The block walls are in similar condition internally as externally; with occasional vehicle of animal damage and some damp areas where gutters have been leaking, but remain sound structurally. They have sufficient thickness, combined with the stiffening piers, to ensure stability.

The concrete floor is quite uneven with steps between the cow stalls and corridors, but appears structurally sound.

5. Comments & Conclusions

Existing Structure

This is a well-built agricultural barn of substantial proportions. It has suffered from neglect with past leaking gutters etc but remains structurally sound. There are no signs of significant cracking or movement. Localized masonry repairs are needed to weathered piers particularly on the north side, and missing gutters should be reinstated in due course.

The roof structure is adequately sized for the current loadings. We have checked the trusses and purlins for the existing loading plus ceiling linings, insulation and services, and the structure is adequate for these. Calculations are attached to this report in support of this.

The steel members are affected by surface rust and would benefit from a thorough wire brushing and treatment with an effective primer, but this is not an urgent requirement.

At present no significant repairs are needed to maintain the building in good structural condition.

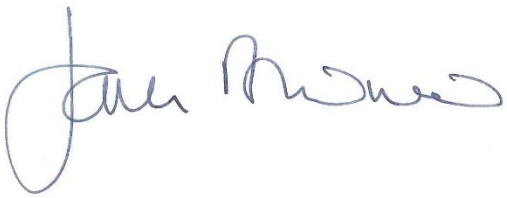
Proposed conversion

The proposed conversion will include the following elements:

- Forming of door and window openings in external blockwork walls.
- New roof cladding including insulation and ceiling finishes, to be supported on the existing roof structure. As justified in the attached calculations.
- Insulation and finishes to the external walls. This can be done from inside without removing the blockwork.
- Insulation and floor finishes. This can be done above the existing concrete slab. Additional thicknesses of insulation can be used to make up for the steps in the slab.
- Construction of non-loadbearing partitions supported on the existing floor slab.

These works can all be carried out within the existing building, and we therefore conclude that the building can be converted without the need for significant reconstruction of its structural elements.

We will be pleased to answer any questions on this report.



James Birdwood MA CEng MICE MIStructE
800/ JGBB

Photographs

View from South West

West Elevation

North Elevation

Junction with Farm Building at N-E Corner

Interior Looking West

Interior Looking East

BTA STRUCTURAL DESIGN

WWW.BTA.CO.UK

Winchcombe Farm

Little Sodbury

BS37 6QD

Appendix A

Structural Calculations

for

Existing Cow Barn

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Structural Calculations

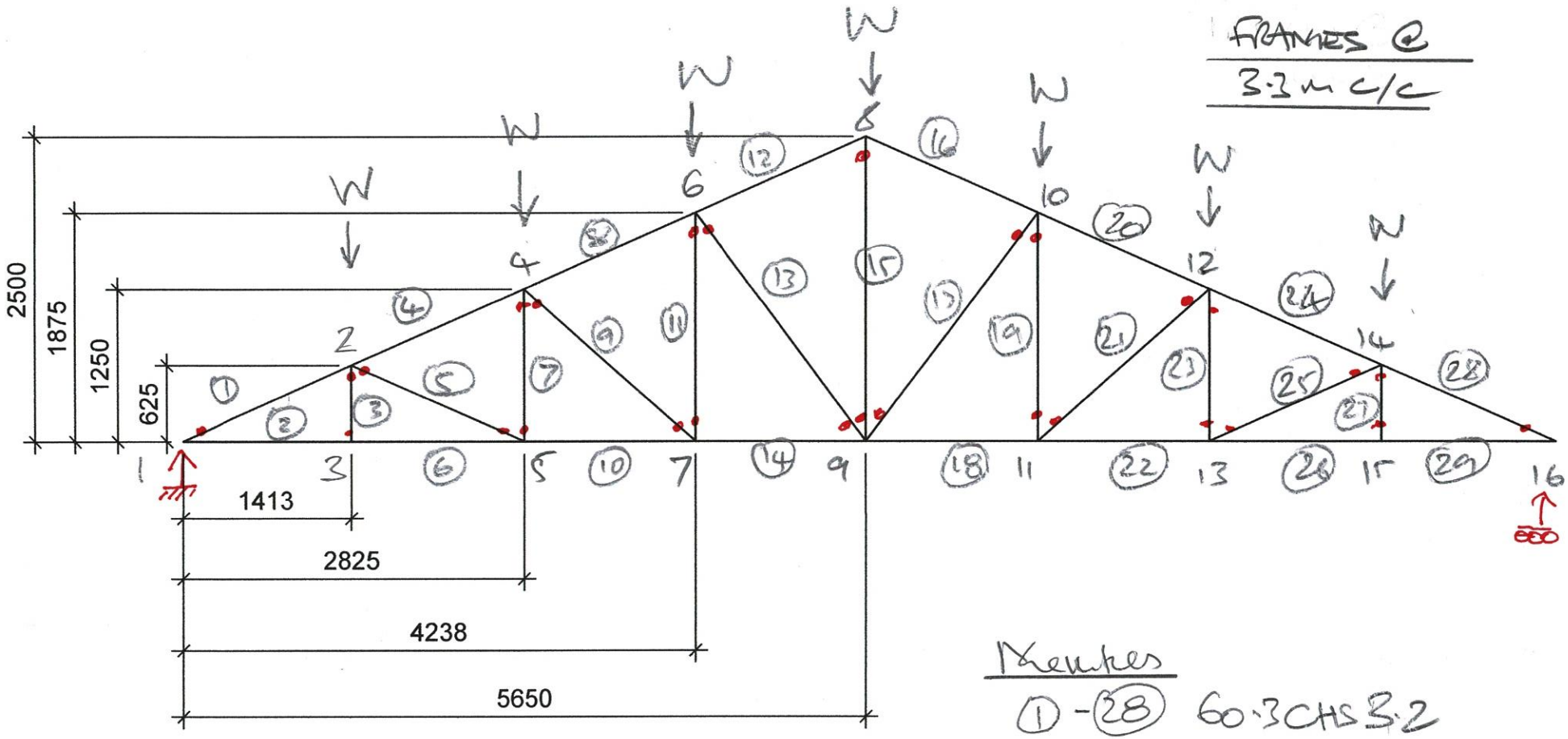
These calculations analyze the main steel trusses and purlins of the cow barn to check that they are adequately designed and capable of carrying insulation and roof finishes in addition to the existing roof sheeting.

These calculations are issued for the purposes of a planning submission. They are not intended for construction.

Design Criteria

Loading	Dead	Live	Total
Roof sheets	0.10		
Insulation	0.02		
Purlins	0.02		
Lining	0.10		
Services	0.10		
	0.40	0.60	1.00 kN/m²

The calculations show that the structure can safely carry the additional loads referred to above, and that the frames are stable under wind loading. The purlin deflections are a little higher than in a normal residential building and could cause cosmetic cracking in brittle finishes such as plasterboard. We therefore recommend that a more flexible finish is used for all ceilings, such as timber boarding, or self-finished double skin roof panels.



FRAMES @ 3.3 m c/c

Members

① - ㉘ 60.3 CHS 3.2

② - ㉙ - " -

③ - ㉗ 42.2 CHS 2.6

W = 1.413 × 3.3 × (0.40 + 0.6L)

= 4.66 kN (+ SELF WEIGHTS)

NL-STRESS MODEL

Eng/WSF/01

```
TABULATE ALL
PRINT DATA RESULTS FROM 1
TYPE PLANE FRAME
METHOD ELASTIC
NUMBER OF JOINTS 16
NUMBER OF MEMBERS 29
NUMBER OF SUPPORTS 2
NUMBER OF LOADINGS 1
JOINT COORDINATES SYMMETRY X 5.65
1 0 0 SUPPORT
2 1.413 0.625
3 1.413 0
4 2.825 1.25
5 2.825 0
6 4.238 1.875
7 4.238 0
8 5.65 2.5
9 5.65 0
10 SYMMETRY 6
11 SYMMETRY 7
12 SYMMETRY 4
13 SYMMETRY 5
14 SYMMETRY 2
15 SYMMETRY 3
16 SYMMETRY 1 SUPPORT
JOINT RELEASES
1 MOMENT Z
16 MOMENT Z
16 FORCE X
MEMBER INCIDENCES
1 1 2
2 1 3
3 2 3
4 2 4
5 2 5
6 3 5
7 4 5
8 4 6
9 4 7
10 5 7
11 6 7
12 6 8
13 6 9
14 7 9
15 8 9
16 8 10
17 9 10
18 9 11
19 10 11
20 10 12
21 11 12
22 11 13
23 12 13
24 12 14
25 13 14
26 13 15
27 14 15
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```
28 14 16
29 15 16
MEMBER RELEASES
1 START MOMENT Z
3 THRU 27 STEP 2 START MOMENT Z
3 THRU 27 STEP 2 END MOMENT Z
28 END MOMENT Z
CONSTANTS E 205E6 ALL G 79E6 ALL DENSITY 77 ALL YIEL 255000 ALL
MEMBER PROPERTIES
1 CONIC D 0.0603 T 0.004
2 THRU 26 STEP 4 AS 1
4 THRU 28 STEP 4 AS 1
3 THRU 27 STEP 2 CONIC D 0.0422 T 0.0026
29 AS 1
LOADING case 1
JOINT LOADS
2 THRU 14 STEP 2 FORCE Y -4.66
MEMBER SELF WEIGHTS
1 THRU 29 1
SOLVE
```

LOADING case 1
JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z ROTATION
1	0.000000000	0.000000000	-0.004037341
2	0.001654589	-0.004846705	-0.002161257
3	0.000373902	-0.004845830	-0.002315263
4	0.001975411	-0.006527622	-0.000564557
5	0.000747540	-0.006574567	-0.000662074
6	0.001870624	-0.007088721	0.000262725
7	0.001071684	-0.007229464	-0.000106855
8	0.001341302	-0.006531956	0.000000000
9	0.001341302	-0.007086752	0.000000000
10	0.000811981	-0.007088721	-0.000262725
11	0.001610921	-0.007229464	0.000106855
12	0.000707193	-0.006527622	0.000564557
13	0.001935065	-0.006574567	0.000662074
14	0.001028016	-0.004846705	0.002161257
15	0.002308702	-0.004845830	0.002315263
16	0.002682605	0.000000000	0.004037341

7-2MM

3MM

LOADING case 1
MEMBER FORCES

MEMBER	JOINT	AXIAL FORCE	SHEAR FORCE	BENDING MOMENT
1	1	42.0145	0.1115	0.0000
	2	-41.9805	-0.0345	0.1128
2	1	-38.3785	0.1253	0.0000
	3	38.3785	-0.0483	0.1226
3	2	0.0850	0.0000	0.0000
	3	-0.1006	0.0000	0.0000
4	2	36.3657	-0.0431	-0.1128
	4	-36.3317	0.1200	-0.0131

MEMBER	JOINT	AXIAL FORCE	SHEAR FORCE	BENDING MOMENT
5	2	5.5775	0.0176	0.0000
	5	-5.5931	0.0176	0.0000
6	3	-38.3785	-0.0523	-0.1226
	5	38.3785	0.1292	-0.0055
7	4	-2.5059	0.0000	0.0000
	5	2.4747	0.0000	0.0000
8	4	30.3189	0.0827	0.0131
	6	-30.2848	-0.0057	0.0551
9	4	7.4306	0.0176	0.0000
	7	-7.4617	0.0176	0.0000
10	5	-33.2711	0.0656	0.0055
	7	33.2711	0.0114	0.0328
11	6	-5.0007	0.0000	0.0000
	7	4.9540	0.0000	0.0000
12	6	24.3129	-0.0585	-0.0551
	8	-24.2788	0.1354	-0.0946
13	6	9.0166	0.0176	0.0000
	9	-9.0633	0.0176	0.0000
14	7	-27.6941	-0.0146	-0.0328
	9	27.6941	0.0915	-0.0421
15	8	-14.7463	0.0000	0.0000
	9	14.6841	0.0000	0.0000
16	8	24.2788	0.1354	0.0946
	10	-24.3129	-0.0585	0.0551
17	9	9.0633	0.0176	0.0000
	10	-9.0166	0.0176	0.0000
18	9	-27.6941	0.0915	0.0421
	11	27.6941	-0.0146	0.0328
19	10	-5.0007	0.0000	0.0000
	11	4.9540	0.0000	0.0000
20	10	30.2848	-0.0057	-0.0551
	12	-30.3189	0.0827	-0.0131
21	11	7.4617	0.0176	0.0000
	12	-7.4306	0.0176	0.0000
22	11	-33.2711	0.0114	-0.0328
	13	33.2711	0.0656	-0.0055
23	12	-2.5059	0.0000	0.0000
	13	2.4747	0.0000	0.0000
24	12	36.3317	0.1200	0.0131
	14	-36.3657	-0.0431	0.1128
25	13	5.5931	0.0176	0.0000
	14	-5.5775	0.0176	0.0000
26	13	-38.3785	0.1292	0.0055
	15	38.3785	-0.0523	0.1226
27	14	0.0850	0.0000	0.0000
	15	-0.1006	0.0000	0.0000
28	14	41.9805	-0.0345	-0.1128
	16	-42.0145	0.1115	0.0000
29	15	-38.3785	-0.0483	-0.1226
	16	38.3785	0.1253	0.0000

LOADING case 1
ELASTIC STRESSES: POSITIVE≡COMPRESSION FOR AXIAL AND Y POSITIVE BENDING

MEMBER	JOINT	AXIAL STRESS	AV.SHEAR STRESS	BENDING STRESS
1	1	59385.6406	315.1201	0.0000

60N/mm² 12N/mm²

	2	59337.5156	-97.5181	12067.7731
2	1	-54246.2578	354.1750	0.0000
	3	-54246.2578	-136.5730	13125.4576
3	2	262.9340	0.0000	0.0000
	3	311.0590	0.0000	0.0000
4	2	51401.2768	-121.7360	12067.7731
	4	51353.1518	339.1840	-1404.0413
5	2	17243.4699	108.7240	0.0000
	5	17291.5949	108.7240	0.0000
6	3	-54246.2578	-147.8554	13125.4576
	5	-54246.2578	365.3034	-589.6834
7	4	-7747.0865	0.0000	0.0000
	5	-7650.8365	0.0000	0.0000
8	4	42854.3308	233.7030	-1404.0413
	6	42806.2058	-16.1010	5901.5807
9	4	22972.2280	108.8010	0.0000
	7	23068.4780	108.8010	0.0000
10	5	-47027.2354	185.3862	-589.6834
	7	-47027.2354	32.2158	3506.9854
11	6	-15460.0944	0.0000	0.0000
	7	-15315.7194	0.0000	0.0000
12	6	34365.1423	-165.4115	5901.5807
	8	34317.0173	382.8595	-10123.3350
13	6	27875.5071	108.7240	0.0000
	9	28019.8821	108.7240	0.0000
14	7	-39144.3342	-41.2323	3506.9854
	9	-39144.3342	258.6803	-4508.7461
15	8	-45589.5350	0.0000	0.0000
	9	-45397.0350	0.0000	0.0000
16	8	34317.0173	382.8595	-10123.3350
	10	34365.1423	-165.4115	5901.5807
17	9	28019.8821	108.7240	0.0000
	10	27875.5071	108.7240	0.0000
18	9	-39144.3342	258.6803	-4508.7461
	11	-39144.3342	-41.2323	3506.9854
19	10	-15460.0944	0.0000	0.0000
	11	-15315.7194	0.0000	0.0000
20	10	42806.2058	-16.1010	5901.5807
	12	42854.3308	233.7030	-1404.0413
21	11	23068.4780	108.8010	0.0000
	12	22972.2280	108.8010	0.0000
22	11	-47027.2354	32.2158	3506.9854
	13	-47027.2354	185.3862	-589.6834

MEMBER	JOINT	AXIAL STRESS	AV.SHEAR STRESS	BENDING STRESS
23	12	-7747.0865	0.0000	0.0000
	13	-7650.8365	0.0000	0.0000
24	12	51353.1518	339.1840	-1404.0413
	14	51401.2768	-121.7360	12067.7731
25	13	17291.5949	108.7240	0.0000
	14	17243.4699	108.7240	0.0000
26	13	-54246.2578	365.3034	-589.6834
	15	-54246.2578	-147.8554	13125.4576
27	14	262.9340	0.0000	0.0000
	15	311.0590	0.0000	0.0000
28	14	59337.5156	-97.5181	12067.7731
	16	59385.6406	315.1201	0.0000
29	15	-54246.2578	-136.5730	13125.4576
	16	-54246.2578	354.1750	0.0000

LOADING case 1
SUPPORT REACTIONS

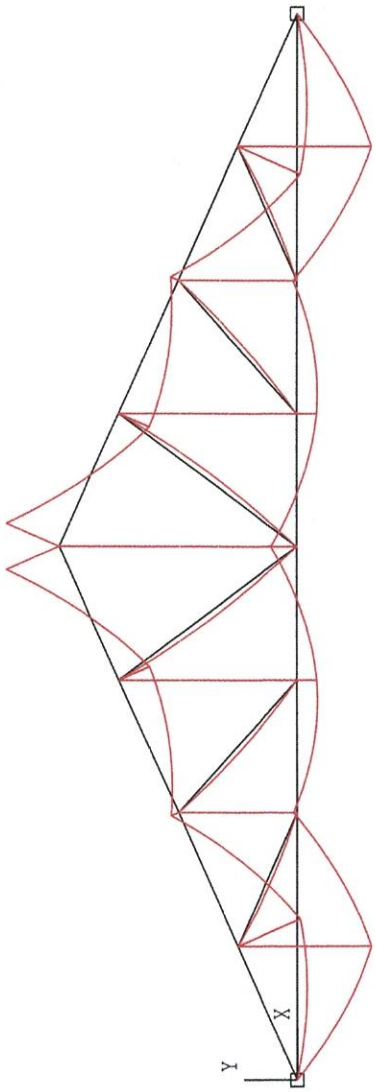
JOINT	X FORCE	Y FORCE	Z MOMENT
1	0.0000	17.2228	0.0000
16	0.0000	17.2228	0.0000

EQUILIBRIUM CHECK	SUM OF FORCES	REACTION
FORCES IN DIRECTION X	0.0000	0.0000
FORCES IN DIRECTION Y	-34.4456*	34.4456
MOMENTS ABOUT AXIS Z	-194.6639	194.6639

(7x4.66 = 32kN *
+SELF WEIGHT - OK)

Structure scale 1 cm = 0.800 □ = supports

Moment Z scale 1 cm = 0.12 LOADING case 1

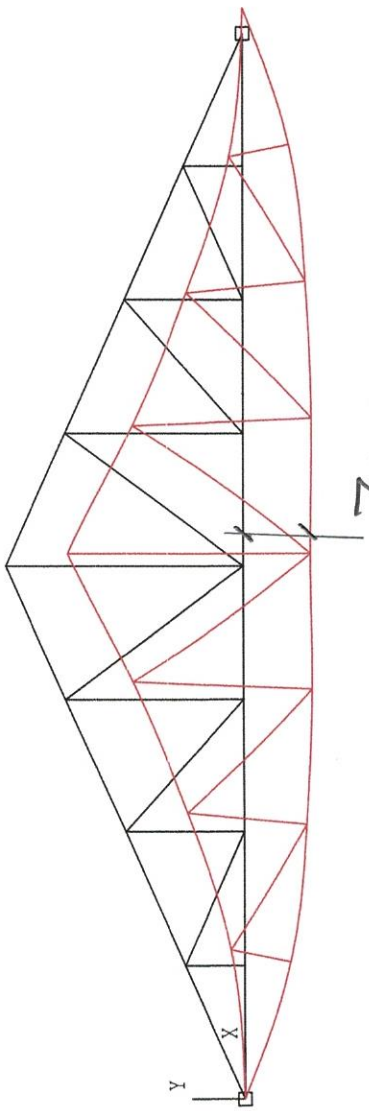


BENDING MOMENTS

0.113kNm (13 kNm)

Structure scale 1 cm = 0.800 □ = supports

Deflectn scale 1 cm = 0.00800 LOADING case 1



7mm (Span / 1600)

DEFLECTIONS

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JOB NO		
SHEET NO WF109		REV
DRG REF	MADE BY JR	CHD
PROJECT WINCHCOMBE FARM	LOCATION COW BARN	DATE 10/23

Purlins

Span. 3.27m

Spacing. 1.4m

M. $1.4 \times 1.0 \times 3.27^2/8$. 1.87kNm

60.3 CHS 3.2 Z. 7.78 fy. 240 N/mm².

(Cantilever $\Rightarrow WL^3/12 \Rightarrow$ 160 ok

Δ_{ss}. $5 \times 1.4 \times 3.274 \times 10^5 / 384 \times 205 \times 23.5$

43 mm (Simply supported)

But purlins are continuous over supports

$\therefore \Delta$. $WL^3/384EI$ = 43/5² 8.6mm

(Span/380) ok.

603 x 3.2 CHS PURLINS @ 1.4m c/c OK