Our ref: Y005-LE-07

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Mr Mark Knight
Court Farm
West Woodlands
Frome
BA11 5EN

29 November 2021

Dear Mr Knight

Re: Barn at Court Farm, West Woodlands, Frome

Further to our recent review of the current state of the existing portal framed barn, I write to confirm the following:

1) The barn's condition remains unchanged and no further deterioration has occurred. We do not have any additional observations, comments, or recommendations to add.

2) Our report reference Y005 revision B, dated 18th February 2020, remains valid and we consider it to be up to date.

I trust this is of use to you with moving forward with your plans. Should you have any queries, please do not hesitate to contact us.

Yours sincerely

[redacted]

Aurimas Dubinskas

Beveridge Chartered Structural Engineers

CC Wright Consult LLP

Tom Holley MEng (Hons) CEng MIStructE   Aurimas Dubinskas BSc MSc CEng MIStructE
John Beveridge Ltd registered in England and Wales company no 4293978. Registered office: 8 Leigh Road, Street, Somerset BA16 0HA r2.2

REPORT ON VISUAL STRUCTURAL INSPECTION

AT COURT FARM

WEST WOODLANDS

FROME

REVISION B

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CLIENT Mr Mark Knight

REF Y005

[redacted]

Aurimas Dubinskas BSc MSc CEng MIStructE

18 February, 2020

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1.0 Introduction

1.1 We are instructed by Mr Mark Knight to visit Court Farm, West Woodlands, Frome and carry out a visual structural inspection of the steel portal framed barn.

1.2 This report has been prepared solely for the benefit of the above-named client. No liability is accepted to any third party.

1.3 A written report is to be provided giving the structural condition of the barn together with recommendations for structural remedial measures that may be required in order to provide for conversion to habitable accommodation.

1.4 The property was visited on 18 March 2019 and a visual inspection carried out. The weather during the visit was overcast.

2.0 Scope of Investigation

2.1 During our visit a condition survey was carried out and photographs taken. This report is based on notes taken from this visit without benefit of monitoring or previous knowledge of the building.

2.2 All external observations were made from ground level unless noted otherwise. Parts of the structure that were covered, unexposed or inaccessible could not be visually inspected and therefore cannot be reported upon.

2.3 This inspection relates to the steel portal framed barn. Other parts of the property were not inspected and do not form part of this report.

2.4 Dimensions, where given in the report, are estimated.

2.5 A trial pit was excavated to the rear of the barn, exposing the existing column pad (assumed to be typical throughout). An opening was formed in the ground bearing slab to inspect its thickness.

2.6 Underground drains were not examined.

3.0 Brief Description of Property

3.1 The property is situated in West Woodlands, to the east of B3092.

3.2 The barn is a double pitched roof steel portal frame, with a mono pitched “lean-to” to the West.

3.3 The main portal frame clear span is approximately 8.8 m, height to eaves approximately 4.35 m, ridge height approximately 5.4 m.

3.4 The “lean-to” clear span is approximately 5.9 m and height to the lower eaves is approximately 3.3 m.

3.5 The outbuilding is constructed in four bays, with the approximate equal frame spacing of 4.5 m.

3.6 The frame columns are 178 x 102 UB. The trial pit revealed the column foundation projection of 700 mm, implying approximately 1.3 m to 1.4 m square pad foundations. The pad foundation formation level was found to be approximately 600 mm to 700 mm. No holding down bolts were visible implying that the columns have been cast into the concrete pads.

3.7 The frame rafters are 152 x 89 UB.

3.8 The floor is made up of concrete. The trial pit revealed the slab thickness to be 225 mm, reinforced at bottom with H10 bars at estimated 200 mm spacing (both ways)

3.9 The walls are generally constructed with single skin sheeting on 125 x 75 timber rails. 1.7 m high 215 mm thick blockwork walls are present around the perimeter of the “lean-to”, including the dividing wall between the two parts of the outbuilding.

3.10 The roof finish is single skin sheeting on cold formed and sleeved steel purlins.

3.11 Out of plane stability of the steel frame is achieved by:

i) Steel circular hollow section roof bracing; provided in the rear end bay.

ii) Vertical (circular hollow section diagonal) bracing, provided in the second bay (from the front), and blockwork “shear walls”, built tight up against the columns. The bracing in the eastern wall is full height. The bracing within the dividing wall line and in the western wall is extended down from the eaves to the top of the blockwork.

iii) In addition, there are knee braces at top of each column.

4.0 Findings of Inspection

4.1 The slabs are generally in good condition and of substantial construction. No moderate or severe cracking was observed at the time of the visit.

4.2 No signs of distortion and no signs of overloading or buckling of steel columns and rafters were observed at the time of the inspection.

4.3 The steelwork - where visible – appeared to be in sound condition with only surface rust. Steel that has been below ground or encased in concrete was not inspected.

4.4 Blockwork walls appeared to be in sound condition. No moderate or severe cracking was observed at the time of the visit.

5.0 Conclusion and Recommendations

5.1 The barn appears to be in a suitable structural condition to allow for conversion into a habitable dwelling.

5.2 The existing primary structure is considered to be adequate to support the loads from external works, such as insulated cladding panels. Preliminary analysis has been carried out to assess this (refer to Appendix C).

5.3 The internal fit out should comprise new horizontal ceiling, supported on new internal / perimater stud walls. Such secondary framework would be kept within the confines of the existing building envelope.

5.4 The 225mm thick ground floor slab is considered to be adequate to support the loads from the new internal and perimeter stud walls, supporting the new lightweight ceiling construction over.

5.5 Steel frame surface rust will need to be mechanically removed, following which the existing steelwork will need to be descaled and coated with zinc rich primer in order to prevent further corrosion.

5.6 The bracing and blockwork walls are to remain as they provide stability. Formation of openings in the blockwork walls proposals will have to be assessed by a competent structural engineer.

5.7 Steel frames are inherently flexible. This should be considered when making the choice of the external wall construction, internal finishes and detailing the building's envelope.

Appendix A – Classification of Damage

It is common practice to categorise the structural significance of cracking damage in accordance with the classification given in Table 1 of Digest 251 produced by the Building Research Establishment.

Classification	Description	Crack Width
Category 0	Negligible	<0.1mm
Category 1	Very Slight	0.1<2mm
Category 2	Slight	2>5mm
Category 3	Moderate	5>15mm
Category 4	Severe	15>25mm
Category 5	Very Severe	>25mm

Extract from Table 1. BRE Digest 251

Classification of damage based on crack widths

Appendix B – Figures and Pictures

Figure 1: Site Aerial View

Photo 1: Main Portal

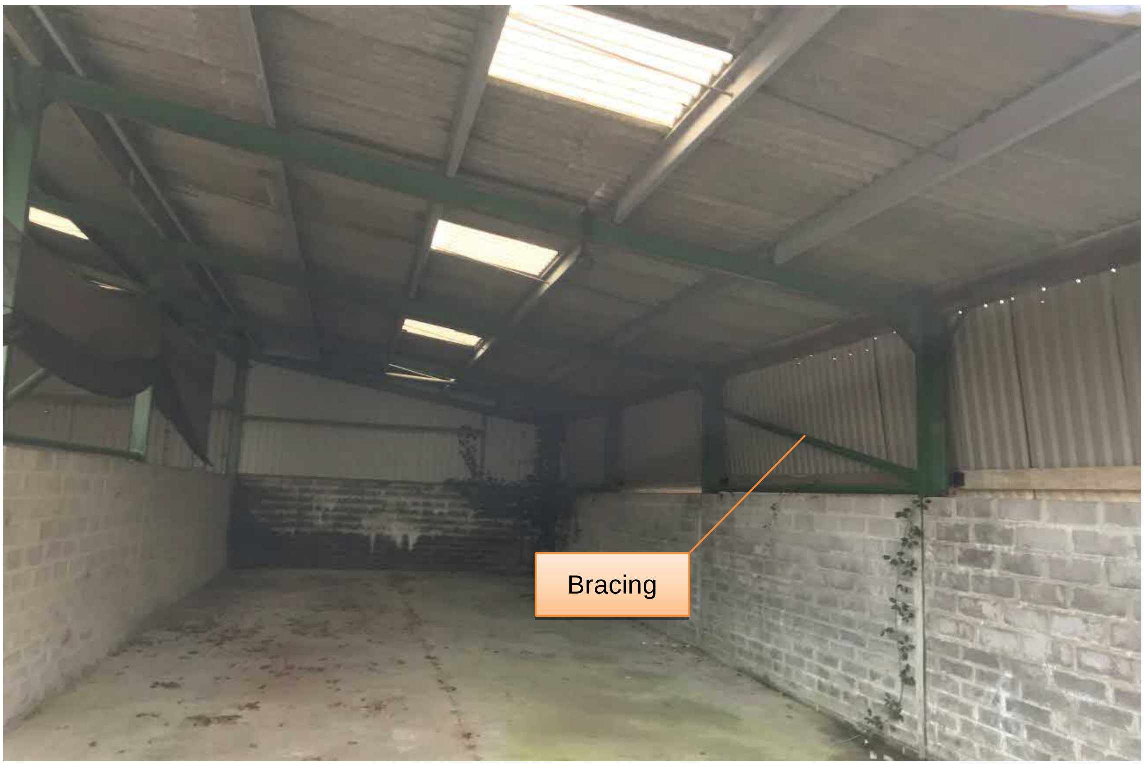


Photo 2: Lean-to

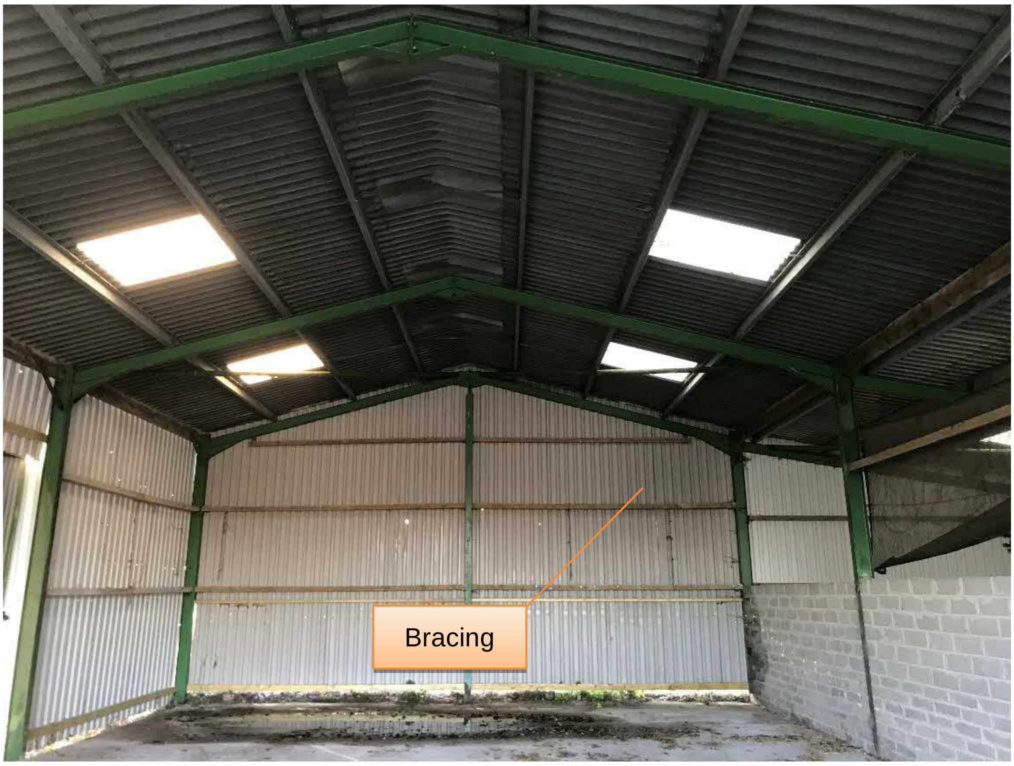


Photo 3: Roof Bracing

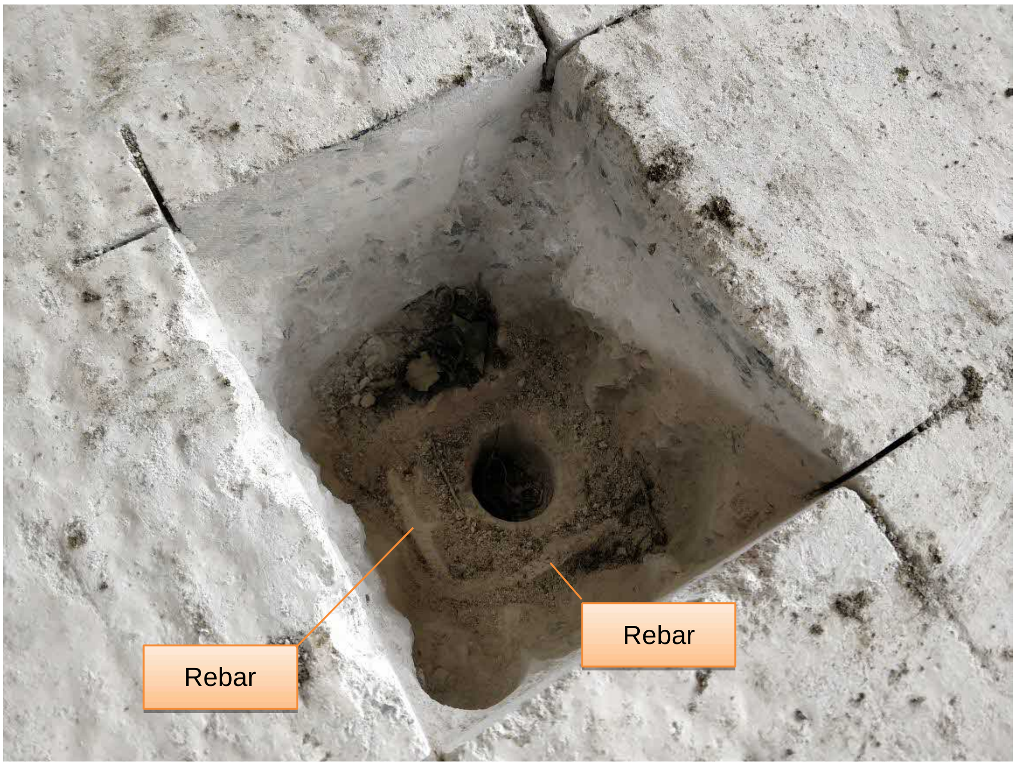


Photo 4: Slab


Photo 5: Column Pad

Photo 6: West Elevation

Appendix C – Preliminary Design Calculations

C. PRELIMINARY DESIGN CALCULATIONS

C.1 LOADINGS

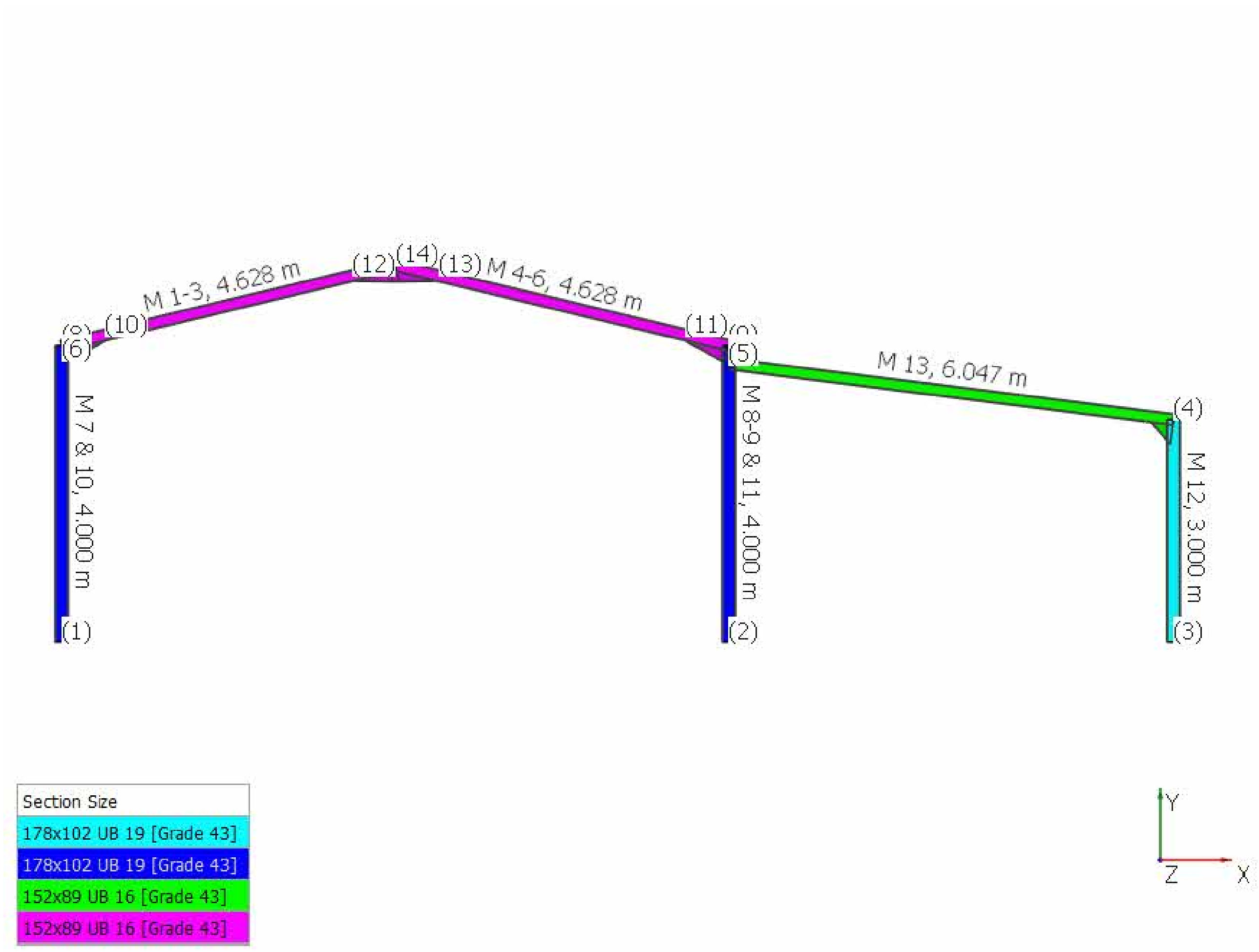
Portal Frame

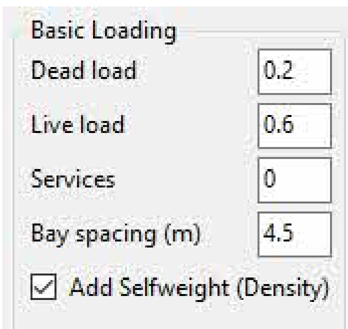
Cladding	16 kg/m2	0.16	
Purlins		0.04	
On Slope		0.20	kN/m^2
Dead (excl. rafters)	roof pitch 12.00 degrees	**0.20**	**kN/m^2**
Live		**0.60**	**kN/m^2**

C.2 FRAME ANALYSIS AND DESIGN

\Y YEAR\Y005.MP

MasterFrame : Graphics





Frame Geometry - Full Frame - Front View

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MASTERPORT 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 D2	Services
Load Group L1	Live Load

Load Case 001 : 1.4 (Dead+Services) + 1.6 Live

Load Combination + 1.00 UT + 1.40 D1 + 1.40 D2 + 1.60 L1

Load Case 002 : Dead + Services + Live (Service)

Load Combination + 1.00 UT + 1.00 D1 + 1.00 D2 + 1.00 L1

Load Case 003 : Live Only (Service)

Load Combination + 1.00 UT + 1.00 L1

Load Case 004 : (Sway Stability)

Load Combination + 1.00 UT

Notional Loads Apply horizontal notional loads at 0.0 degrees from X axis equal to 0.5% of the factored vertical loads in case 1

Level	@ (m)	F (kN)	Level	@ (m)	F (kN)	Level	@ (m)	F (kN)
0	0.000	0.007	1	3.000	0.092	2	3.750	0.087
3	3.797	0.003	4	4.000	0.019	5	4.140	0.112
6	4.940	0.112	7	5.080	0.019			

Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)
1	0.002	2	0.002	3	0.002	4	0.092
5	0.087	6	0.003	7	0.000	8	0.010
9	0.010	10	0.056	11	0.056	12	0.056
13	0.056	14	0.019				

Load Case 005 : 1.4 (Dead+Services) + 1.6 Live + Notional -->

Load Combination + 1.00 UT + 1.40 D1 + 1.40 D2 + 1.60 L1

Notional Loads Apply horizontal notional loads at 0.0 degrees from X axis equal to 0.5% of the factored vertical loads in case 1

Level	@ (m)	F (kN)	Level	@ (m)	F (kN)	Level	@ (m)	F (kN)
0	0.000	0.007	1	3.000	0.092	2	3.750	0.087
3	3.797	0.003	4	4.000	0.019	5	4.140	0.112
6	4.940	0.112	7	5.080	0.019			

Node	F (kN)	Node	F (kN)	Node	F (kN)	Node	F (kN)
1	0.002	2	0.002	3	0.002	4	0.092
5	0.087	6	0.003	7	0.000	8	0.010
9	0.010	10	0.056	11	0.056	12	0.056
13	0.056	14	0.019				

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	9.000	0.000	0.000
3	15.000	0.000	0.000	4	15.000	3.000	0.000
5	9.000	3.750	0.000	6	0.000	3.797	0.000
7	9.000	3.797	0.000	8	0.000	4.000	0.000
9	9.000	4.000	0.000	10	0.583	4.140	0.000
11	8.417	4.140	0.000	12	3.917	4.940	0.000
13	5.083	4.940	0.000	14	4.500	5.080	0.000

MEMBER PROPERTIES

```
Members 1-6   (0.600m Haunch End1 (314.6), 0.600m Haunch End2 (304.8))
MD ...  ...         152x89 UB 16 [Grade 43]
 A 20.32E-4          Ix 835.2E-8         Iy 90.6E-8          J 3.56E-8
 E 205.0E6           G 78.85E6

  Members 7-11   (0.203m Haunch at End 2, Depth 177.8mm to 355.6mm)
MH ...  ...         178x102 UB 19 [Grade 43]
 A 24.26E-4          Ix 1357E-8          Iy 137.6E-8         J 4.41E-8
 E 205.0E6           G 78.85E6

  Member 12
M  ...  ...         178x102 UB 19 [Grade 43]
 A 24.26E-4          Ix 1357E-8          Iy 137.6E-8         J 4.41E-8
 E 205.0E6           G 78.85E6

  Member 13   (0.300m Haunch End1 (416.8), 0.000m Haunch End2 (304.8))
MD ...  ...         152x89 UB 16 [Grade 43]
 A 20.32E-4          Ix 835.2E-8         Iy 90.6E-8          J 3.56E-8
 E 205.0E6           G 78.85E6
```

MEMBER LOADING

Note: Partial Fixity - Use 0% in Ultimate, 10% in Sway Stability and 20% in Serviceability Loading Cases
Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity

E kN/mm²	Density kN/m³
>= 200.00	77.01
>= 20.00	24.00
>= 2.00	10.00

Members 1-3

```
 UT Spacing 04.500 [Multiply AllLoads]
     Rafter 1 of Bay  1
 D1 UDLY -000.200             [ kN/m ]
 D2 UDLY -000.000             [ kN/m ]
 L1 UDLY -000.600             [ kN/m ]
 W1 UDLN +000.000             [ kN/m ]
 W2 UDLN +000.000             [ kN/m ]

  Members 4-6
 UT Spacing 04.500 [Multiply AllLoads]
     Rafter 2 of Bay  1
 D1 UDLY -000.200             [ kN/m ]
 D2 UDLY -000.000             [ kN/m ]
 L1 UDLY -000.600             [ kN/m ]
 W1 UDLN +000.000             [ kN/m ]
 W2 UDLN +000.000             [ kN/m ]

  Members 7 & 10
 UT Spacing 04.500 [Multiply AllLoads]
     Column  1
 UT PartFix 20.00 +++ ---    (0/10/20)
 W1 UDLX +000.000             [ kN/m ]
 W2 UDLX +000.000             [ kN/m ]

  Members 8-9 & 11
 UT Spacing 04.500 [Multiply AllLoads]
     Column  2
 UT PartFix 20.00 +++ ---    (0/10/20)
 W1 UDLX +000.000             [ kN/m ]
 W2 UDLX +000.000             [ kN/m ]

  Member 12
 UT Spacing 04.500 [Multiply AllLoads]
```

```
    Lean-To Column 2
UT PartFix 20.00 +++ ---    (0/10/20)
W1 UDLX +000.000             [ kN/m ]
W2 UDLX +000.000             [ kN/m ]

 Member 13
UT Spacing 04.500 [Multiply AllLoads]
    Lean-To Beam 2
D1 UDLY -000.200             [ kN/m ]
D2 UDLY -000.000             [ kN/m ]
L1 UDLY -000.600             [ kN/m ]
W1 UDLN +000.000             [ kN/m ]
W2 UDLN +000.000             [ kN/m ]
```

MEMBER ORIENTATION

Members 4-6, 8-9 & 11-13 ß +180.00

NODAL LOADING AND SUPPORT CONDITIONS

NODES 1-3

```
UT Rs 1 1 1 1 1 1 (20.00%  Fixity)
```

\Y YEAR\Y005.MP

Member Forces Ultimate (001 : 1.4 (Dead+Services) + 1.6 Live)

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	8	13.485C	23.104	-30.871	17.712	11.010
	10	12.690C	19.791	-18.003	@ 4.202	@ 3.068
2	10	12.688C	19.792	-18.003	17.712	11.010
	12	8.176C	0.994	17.623	@ 4.202	@ 3.068
3	12	8.176C	0.993	17.623	17.712	11.010
	14	7.380C	-2.318	17.225	@ 4.202	@ 3.068
4	9	13.733C	24.136	-35.650	17.374	8.167
	11	12.938C	20.823	-22.162	@ 4.382	@ 3.239
5	11	12.936C	20.824	-22.162	17.374	8.167
	13	8.423C	2.026	17.003	@ 4.382	@ 3.239
6	13	8.424C	2.026	17.003	17.374	8.167
	14	7.628C	-1.286	17.225	@ 4.382	@ 3.239
7	1	26.668C	-7.718	0.000		11.339
	6	25.675C	-7.718	-29.304		@ 2.316
8	2	45.923C	-3.100	0.000		4.661
	5	44.942C	-3.100	-11.625		@ 2.325
9	5	26.750C	-7.718	-33.720		4.661
	7	26.737C	-7.718	-34.083		@ 2.325
10	6	25.675C	-7.718	-29.304		11.339
	8	25.614C	-7.718	-30.871		@ 2.316
11	7	26.737C	-7.718	-34.083		4.661
	9	26.676C	-7.718	-35.650		@ 2.325
12	3	17.384C	-4.618	0.000		2.875
	4	16.599C	-4.618	-13.853		@ 1.740
13	4	6.641C	15.898	-13.853	8.282	10.592
	5	2.326C	-18.625	-22.095	@ 2.781	@ 2.781

Member Forces Ultimate (005 : 1.4 (Dead+Services) + 1.6 Live + Notional -->)

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	8	13.396C	23.043	-30.533	17.746	11.230
	10	12.601C	19.730	-17.701	@ 4.190	@ 3.068
2	10	12.654C	19.718	-17.701	17.746	11.230
	12	8.141C	0.920	17.672	@ 4.190	@ 3.068
3	12	8.195C	0.906	17.672	17.746	11.230
	14	7.400C	-2.405	17.222	@ 4.190	@ 3.068
4	9	13.917C	24.174	-35.888	17.357	8.022
	11	13.122C	20.861	-22.378	@ 4.394	@ 3.274
5	11	13.066C	20.875	-22.378	17.357	8.022
	13	8.553C	2.077	16.962	@ 4.394	@ 3.274
6	13	8.499C	2.090	16.962	17.357	8.022
	14	7.704C	-1.222	17.222	@ 4.394	@ 3.274
7	1	26.589C	-7.633	0.000		11.214
	6	25.596C	-7.633	-28.983		@ 2.316
8	2	45.822C	-3.267	0.000		4.904
	5	44.841C	-3.267	-12.251		@ 2.325
9	5	26.829C	-7.898	-33.913		4.904

Member Forces Ultimate (005 : 1.4 (Dead+Services) + 1.6 Live + Notional -->)						
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)
	7	26.817C	-7.898	-34.285		@ 2.325
10	6	25.596C	-7.636	-28.983		11.214
	8	25.534C	-7.636	-30.533		@ 2.316
11	7	26.817C	-7.897	-34.285		4.904
	9	26.756C	-7.897	-35.888		@ 2.325
12	3	17.564C	-4.809	0.000		2.994
	4	16.780C	-4.809	-14.427		@ 1.740
13	4	6.762C	16.065	-14.427	8.172	10.367
	5	2.447C	-18.458	-21.662	@ 2.842	@ 2.781

Support Reactions Serviceability (002 : Dead + Services + Live (Service))							
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	5.834	17.414	-3.246	2	-2.230	29.558	1.126
3	-3.604	11.509	1.536	Total	0.000	58.482	-0.584

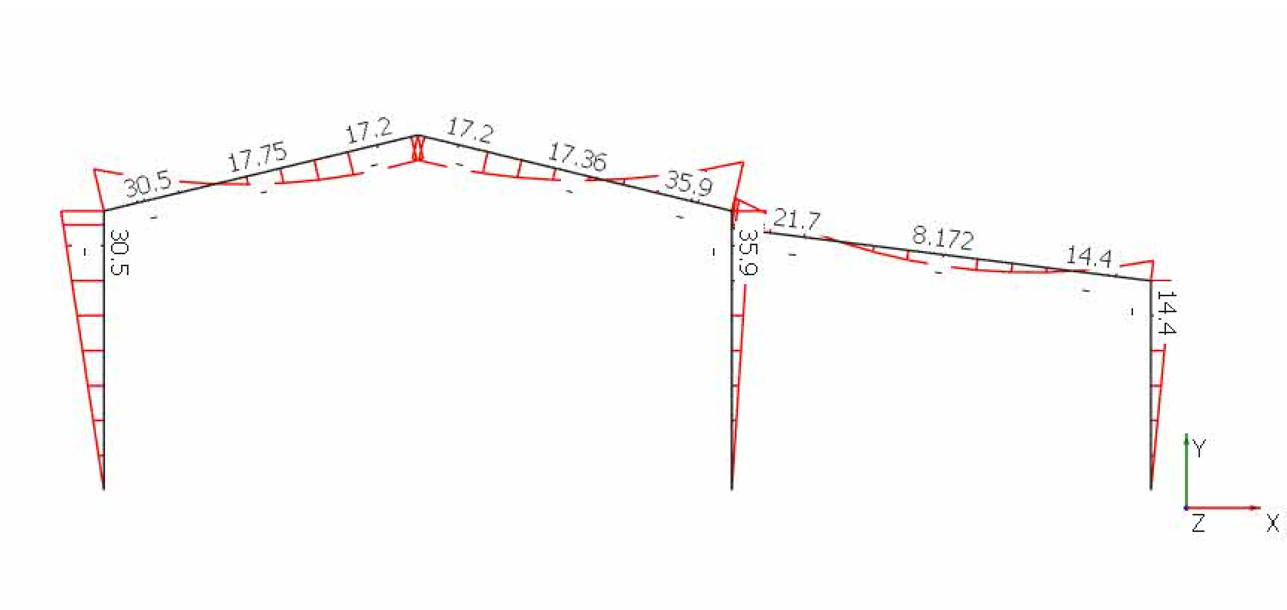
Support Reactions Serviceability (003 : Live Only (Service))							
Node	Support Reactions (kN and kN.m)			Node	Support Reactions (kN and kN.m)		
	Rx (kN)	Ry↑(kN)	Mz↗(kN.m)		Rx (kN)	Ry↑(kN)	Mz↗(kN.m)
1	4.186	11.950	-2.329	2	-1.597	20.679	0.806
3	-2.589	7.871	1.102	Total	0.000	40.500	-0.421

Support Reactions Serviceability (004 : (Sway Stability))							
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	-0.091	-0.067	0.080	2	-0.160	-0.081	0.098
3	-0.199	0.147	0.135	Total	-0.450	0.000	0.313

Beveridge Chartered Structural Engineers 8 Leigh Road, Street Somerset, BA16 0HA	Project: Portal Frame Barn at Court Farm, West Woodlands			Job Ref.: Y005	
	Section: Frame Analysis and Design			Sheet no./rev.: C-18 /	
	Calc. by: AD	Date: Jul-19	Chk'd by: TH	Date: Jul-19	App'd by:	Date:

\Y YEAR\Y005.MP

MasterFrame : Graphics

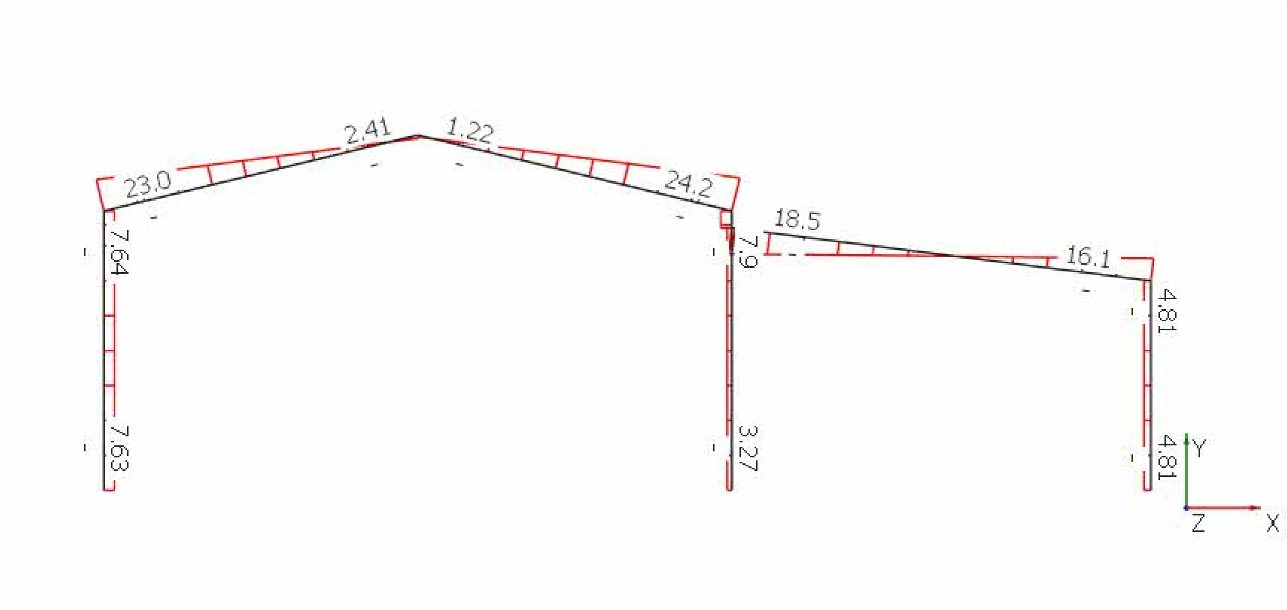


Load Case 005 : 1.4 (Dead+Services) + 1.6 Live + Notional -->
Bending Moment Diagram - Full Frame - Front View
Bending Moment Values (kN.m)
50 kN.m = 1m

Beveridge Chartered Structural Engineers, 8 Leigh Road, Street, Somerset, BA16 0HA	Project: Portal Frame Barn at Court Farm, West Woodlands				Job Ref.: Y005	
	Section: Frame Analysis and Design				Sheet no./rev.: C-19 /	
	Calc. by: AD	Date: Jul-19	Chk'd by: TH	Date: Jul-19	App'd by:	Date:

\Y YEAR\Y005.MP

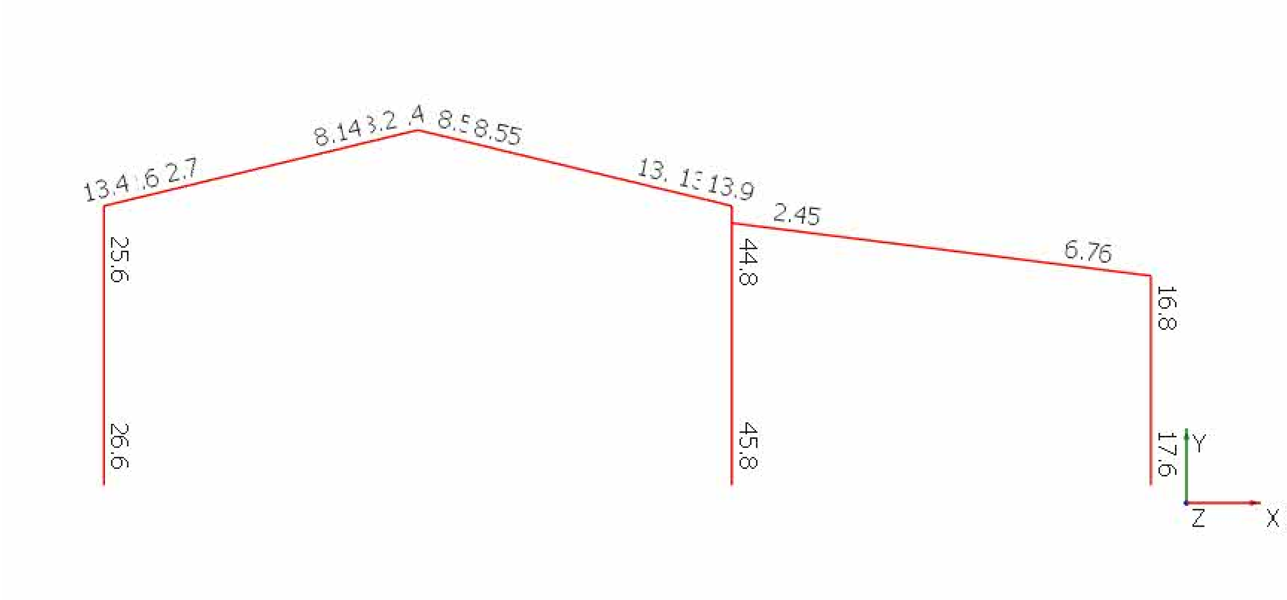
MasterFrame : Graphics



Load Case 005 : 1.4 (Dead+Services) + 1.6 Live + Notional -->
Shear Force Diagram - Full Frame - Front View
Shear Force Values (kN)
50 kN = 1m

\Y YEAR\Y005.MP

MasterFrame : Graphics



Load Case 005 : 1.4 (Dead+Services) + 1.6 Live + Notional -->
Frame Geometry - Full Frame - Front View
Axial Force (kN) - Compression Positive

Beveridge Chartered Structural Engineers, 8 Leigh Road, Street, Somerset, BA16 0HA	Project: Portal Frame Barn at Court Farm, West Woodlands			Job Ref.: Y005	
	Section: Frame Analysis and Design			Sheet no./rev.: C-21 /	
	Calc. by: AD	Date: Jul-19	Chk'd by: TH	Date: Jul-19	App'd by:	Date:

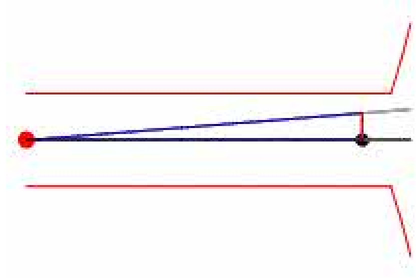
\Y YEAR\Y005.MP

AXIAL WITH MOMENTS (MEMBER)
Column 1 : Members 7 & 10 (N.1-N.8)
Between 0.000 and 3.500 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
UT PartFix 20.00 +++ ---   (Mt My Mz)
```



Member Forces in Load Case 1 and Maximum Deflection from Load Case 2						
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	26.668C	-7.718	0.000		6.289
	8	25.614C	-7.718	-30.871		@ 2.392

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 275, 26.67, 30.87, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	7.718 / 140.818 =	0.055	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 171.3≤1.2 x 275 x 152.63 =	47.108 kN.m	
Pz = Ag.py	24.26 x 275 =	667.15 kN	
n = F/Pz	26.668 / 667.15 =	0.040	OK
Srx = Fn(Sxx, n)	171.3, 0.04	170.81 cm^3	
Mrx = Srx.py	170.81 x 275	46.973 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(27.013/46.973)^2+(0)^1=$	0.331	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x4/7.48 =	53.5	OK
Pcx = Area.pcx	24.26x247.37/10 =	600.121 kN	Table 24 a
λy = Ley/ryy	100x1x3.5/2.38 =	147.1	OK
Pcy = Area.pcy	24.26x77.01/10 =	186.828 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x7+.5x14+.15x20)/27 = 0.44	0.6	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-8+.6x-15+.1x-23)/31 = .8x23/31	0.6	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 3.5 =	3.5 m	
λ = Le/ryy	3.5 / 2.38	147.06	OK
v = Fn (x,Le,ryy,λ)	22.562, 3.5, 2.38, 147.06	0.752	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.889 x 0.752 x 147.06 √ 1	98.39	
$pb = Fn (py,\lambda_{LT})$	275, 98.39	127.71 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	171.3 x 127.71 ≤ 47.108 =	21.877 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.6x-27/21.9	0.741
$r_c=F_c/P_{cy}$	26.7/186.8	0.143
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.741•98.4+0.143•147.1)/(0.741+0.143)	106.251
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.741+0.143)/(0.741+0.143)	31.530
$M_{ob}= M_b(1-F_c/P_{cy})$	21.877(1-26.7/186.8)	18.754
$M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}$	$47.108(1-26.7/186.8)^{½}$	43.616

$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	47.108(1-26.7/600.1)/(1+0.5•26.7/600.1)	44.036	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	8.973(1-26.7/186.8)/(1+1.0(26.7/186.8))	6.731	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	106.251, 31.530, 1.000, 43.616, 18.754	18.754	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	53.476, 1.000, 46.973, 44.036	45.419	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	147.059, 1.000, 8.973, 6.731	6.731	
$m_x.M_x/M_{ax}$	0.6x27/45.4	0.357	OK
$m_{LT}.M_{LT}/M_{ab}$	0.6x-27/18.8	0.864	OK
$m_x.M_x/M_{ax}$	0.6x27/45.4	0.357	OK
Compare with Simplied to 4.8.3.3	0.529, 0.884, 0.884	0.884	
Compare with MoreExact to 4.8.3.3	0.397, 0.884, 0.368	0.884	

Deflection Check - Load Case 2

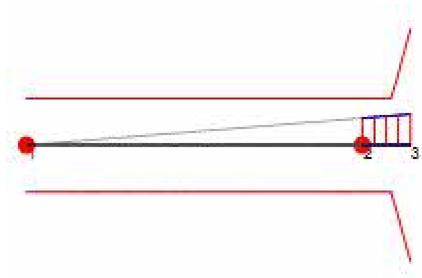
In-span δ ≤ Span/200	6.29 ≤ 4000 / 200	6.29 mm	OK

APPENDIX-G STABILITY (MEMBER) : G.2.(A).2
Column 1 : Members 7 & 10 (N.1-N.8)
Between 3.500 and 4.000 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
UT PartFix 20.00 +++ ---   (Mt My Mz)
```



Lateral and Torsional Restraints

Side rails @ 3.5 and 4 m
Stay @ 3.5 m

Member Forces in Load Case 1						
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	26.668C	-7.718	0.000		0.000
	8	25.614C	-7.718	-30.871		@ 2.392

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 275, 26.67, 30.87, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Compression Resistance Pc

λy = L/ryy	100x0.5/2.37 =	21.06	OK
y = Fn(a,hs,x,λy)	106.68, 169.9, 49.988, 21.064	0.992	G.2.3
λTC = y.λ	0.992x21.06 =	20.89	OK
Pcy = Area.pcy	24.26x271.24/10 =	658.02 kN	Table 24 b

Slenderness Correction Factor nt

$R_1=Mx_1/(py.Sxx)$	27.013/(.001x 275x171.3) = 0	0.573	
$R_2=Mx_2/(py.Sxx)$	27.978/(.001x 275x171.3) = 0	0.594	
$R_3=Mx_3/(py.Sxx)$	28.942/(.001x 275x171.3) = 0	0.614	
$R_4=Mx_4/(py.Sxx)$	29.905/(.001x 275x259.7) = 0	0.419	
$R_5=Mx_5/(py.Sxx)$	30.870/(.001x 275x424.7) = 0	0.264	
R_S-R_E	0.614 - 0.573 = 0	0.041	
R_{max}		0.614	
nt=Fn(All above)	0.573, 0.594, 0.614, 0.419, 0.264, 0.041, 0.614	0.933	G.4.3

Lateral Buckling Resistance Moment Mb

Mp = py.Sxx≤1.2 py.Zxx	275 x 171.3 ≤ 1.2 x 275 x 152.63 =	47.108 kN.m	
λy = L/ryy	100x0.5/2.37 =	21.06	OK
vt = Fn(a,x,hs,λ)	106.68, 49.988, 169.9, 21.064	0.979	G.2.4.2
c=Fn(R,q,x)	2, 0.406, 49.988	1.141	G.2.5
λTB = c.nt.vt.λy	1.141 x 0.933 x 0.979 x 21.064	21.951	G.2.4.2
pb = Fn (py,λTB)	275, 21.95	275 N/mm²	Table 16

Mb = Sxx.pb≤ Mp ≤ py.Zxx	171.3 x 275 ≤ 47.108 ≤ 275 x 152.53 =	41.946 kN.m	

Elastic Stability of Tapered Members : G.2.2

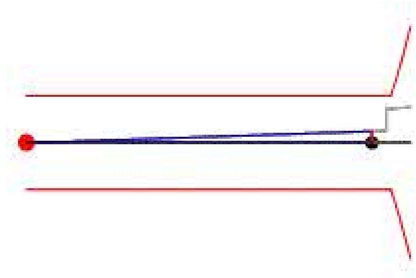
F/Pc+M/Mb	26.668 / 600.12 + 29.304 / 41.95	0.743	OK

AXIAL WITH MOMENTS (MEMBER)
Column 2 : Members 8-9 & 11 (N.2-N.9)
Between 0.000 and 3.600 m, in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
UT PartFix 20.00 +++ ---   (Mt My Mz)
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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)
	2	45.822C	-3.267	0.000		2.552
	9	26.756C	-7.897	-35.888		@ 2.400

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 275, 45.82, 35.89, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	3.267 / 140.818 =	0.023	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 171.3≤1.2 x 275 x 152.63 =	47.108 kN.m	
Pz = Ag.py	24.26 x 275 =	667.15 kN	
n = F/Pz	45.822 / 667.15 =	0.069	OK
Srx = Fn(Sxx, n)	171.3, 0.069	169.85 cm³	
Mrx = Srx.py	169.85 x 275	46.71 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(11.761/46.71)^2+(0)^1=$	0.063	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x4/7.48 =	53.5	OK
Pcx = Area.pcx	24.26x247.37/10 =	600.121 kN	Table 24 a
λy = Ley/ryy	100x1x3.6/2.38 =	151.3	OK
Pcy = Area.pcy	24.26x73.34/10 =	177.914 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x3+.5x6+.15x9)/12 = 0.44	0.6	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-3+.6x-7+.1x-10)/36 = .8x10/36	0.346	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 3.6 =	3.6 m	
λ = Le/ryy	3.6 / 2.38	151.26	OK
v = Fn (x,Le,ryy,λ)	22.562, 3.6, 2.38, 151.26	0.745	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.889 x 0.745 x 151.26 √ 1	100.23	
$pb = Fn (py,\lambda_{LT})$	275, 100.23	124.51 N/mm²	Table 16
Mb = Sxx.pb ≤ Mc	171.3 x 124.51 ≤ 47.108 =	21.329 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.6x-11.8/21.3	0.331	
$r_c=F_c/P_{cy}$	45.8/177.9	0.258	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.331•100.2+0.258•151.3)/(0.331+0.258)	122.564	

λ_{ro}=17.15 ε $(2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.331+0.258)/(0.331+0.258)	26.794	
$M_{ob}= M_b(1-F_c/P_{cy})$	21.329(1-45.8/177.9)	15.836	
$M_{xy}= M_{cx}(1-F_c/P_{cy})^{½}$	47.108(1-45.8/177.9)^{½}	40.590	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	47.108(1-45.8/600.1)/(1+0.5•45.8/600.1)	41.911	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	8.973(1-45.8/177.9)/(1+1.0(45.8/177.9))	5.297	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	122.564, 26.794, 1.000, 40.590, 15.836	15.836	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	53.476, 1.000, 46.710, 41.911	44.170	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	151.261, 1.000, 8.973, 5.297	5.297	
$m_x.M_x/M_{ax}$	0.346x11.8/44.2	0.092	OK
$m_{LT}.M_{LT}/M_{ab}$	0.6x-11.8/15.8	0.446	OK
$m_x.M_x/M_{ax}$	0.346x11.8/44.2	0.092	OK
Compare with Simplied to 4.8.3.3	0.354, 0.588, 0.588	0.588	
Compare with MoreExact to 4.8.3.3	0.166, 0.588, 0.168	0.588	

Deflection Check - Load Case 2

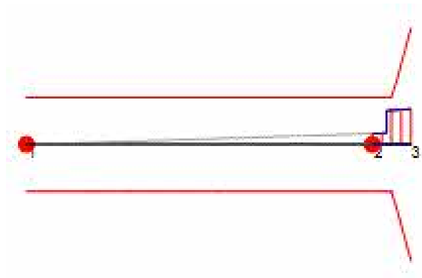
In-span δ ≤ Span/200	2.55 ≤ 4000 / 200	2.55 mm	OK

APPENDIX-G STABILITY (MEMBER) : G.2.(A).2
Column 2 : Members 8-9 & 11 (N.2-N.9)
Between 3.600 and 4.000 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
UT PartFix 20.00 +++ ---    (Mt My Mz)
```



Lateral and Torsional Restraints

Side rails @ 3.6 and 4 m
Stay @ 3.6 m

Member Forces in Load Case 1						
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)
	2	45.923C	-3.100	0.000		0.000
	9	26.676C	-7.718	-35.650		@ 2.400

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 275, 45.92, 35.65, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Compression Resistance Pc

λy = L/ryy	100x0.4/2.37 =	16.85	OK
y = Fn(a,hs,x,λy)	106.68, 169.9, 49.988, 16.851	0.995	G.2.3
λTC = y.λ	0.995x16.85 =	16.76	OK
Pcy = Area.pcy	24.26x275/10 =	667.15 kN	Table 24 b

Slenderness Correction Factor nt

$R_1=Mx_1/(py.Sxx)$	11.161/(.001x 275x171.3) = 0	0.237	
$R_2=Mx_2/(py.Sxx)$	11.470/(.001x 275x171.3) = 0	0.243	
$R_3=Mx_3/(py.Sxx)$	34.105/(.001x 275x174.5) = 0	0.711	
$R_4=Mx_4/(py.Sxx)$	34.878/(.001x 275x290.5) = 0	0.437	
$R_5=Mx_5/(py.Sxx)$	35.649/(.001x 275x424.7) = 0	0.305	
R_S-R_E	0.711 - 0.305 = 0	0.405	
R_{max}		0.711	
nt=Fn(All above)	0.237, 0.243, 0.711, 0.437, 0.305, 0.405, 0.711	0.855	G.4.3

Lateral Buckling Resistance Moment Mb

Mp = py.Sxx≤1.2 py.Zxx	275 x 171.3 ≤ 1.2 x 275 x 152.63 =	47.108 kN.m	
λy = L/ryy	100x0.4/2.37 =	16.85	OK
vt = Fn(a,x,hs,λ)	106.68, 49.988, 169.9, 16.851	0.982	G.2.4.2

c=Fn(R,q,x)	2, 0.508, 49.988	1.158	G.2.5
λTB = c.nt.vt.λy	1.158 x 0.855 x 0.982 x 16.851	16.382	G.2.4.2
pb = Fn (py,λTB)	275, 16.38	275 N/mm²	Table 16
Mb = Sxx.pb≤ Mp ≤ py.Zxx	171.3 x 275 ≤ 47.108 ≤ 275 x 152.53 =	41.946 kN.m	

Elastic Stability of Tapered Members : G.2.2

F/Pc+M/Mb	45.923 / 600.12 + 34.083 / 41.95	0.889	OK

AXIAL WITH MOMENTS (MEMBER)

Rafter 1 of Bay 1 : Members 1-3 (N.8-N.14)

Between 0.091 and 1.300 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200              [ kN/m ]
D2 UDLY -000.000              [ kN/m ]
L1 UDLY -000.600              [ kN/m ]
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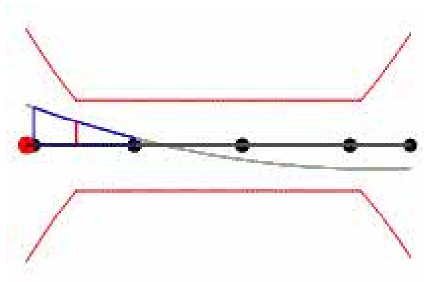


Member Forces in Load Case 1 and Maximum Deflection from Load Case 2

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)
	8	13.485C	23.104	-30.871	17.712	6.549
	14	7.380C	-2.318	17.225	@ 4.202	@ 3.102

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 13.49, 30.87, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	19.794 / 113.157 =	0.175	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.49 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	13.485 / 558.8 =	0.024	OK
Srx = Fn(Sxx, n)	123.3, 0.024	123.17 cm³	
Mrx = Srx.py	123.17 x 275	33.871 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(18.005/33.871)^2+(0)^1=$	0.283	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x4.628/6.41 =	72.2	OK
Pcx = Area.pcx	20.32x219.379/10 =	445.778 kN	Table 24 a
λy = Ley/ryy	100x1x1.209/2.1 =	57.5	OK
Pcy = Area.pcy	20.32x224.8/10 =	456.794 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x22+.5x16+.15x11)/29 = 0.44	1	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-8+.6x8+.1x16)/31 = .8x16/31	0.42	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.209 =	1.209 m	
λ = Le/ryy	1.209 / 2.1	57.51	OK
v = Fn (x,Le,ryy,λ)	19.539, 1.209, 2.1, 57.51	0.914	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_w}$	0.891 x 0.914 x 57.51 √ 1	46.82	
$pb = Fn (py,\lambda_{LT})$	275, 46.82	245.69 N/mm²	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 245.69 ≤ 33.908 =	30.293 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	1x-18/30.3	0.594	
$r_c=F_c/P_{cy}$	13.5/456.8	0.030	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.594•46.8+0.03•57.5)/(0.594+0.03)	47.323	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.594+0.03)/(0.594+0.03)	33.488	
$M_{ob}= M_b(1-F_c/P_{cy})$	30.293(1-13.5/456.8)	29.399	
$M_{xy}= M_{cx}(1-F_c/\ P_{cy})^{½}$	33.908(1-13.5/456.8)^{½}	33.403	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-13.5/445.8)/(1+0.5•13.5/445.8)	32.392	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.682(1-13.5/456.8)/(1+1.0(13.5/456.8))	6.299	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	47.323, 33.488, 1.000, 33.403, 29.399	32.688	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	72.224, 1.000, 33.871, 32.392	32.684	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	57.511, 1.000, 6.682, 6.299	6.457	
$m_x.M_x/M_{ax}$	0.42x18/32.7	0.232	OK
$m_{LT}.M_{LT}/M_{ab}$	1x-18/32.7	0.551	OK
$m_x.M_x/M_{ax}$	0.42x18/32.7	0.232	OK
Compare with Simplied to 4.8.3.3	0.282, 0.624, 0.625	0.625	
Compare with MoreExact to 4.8.3.3	0.257, 0.624, 0.556	0.624	

Deflection Check - Load Case 2

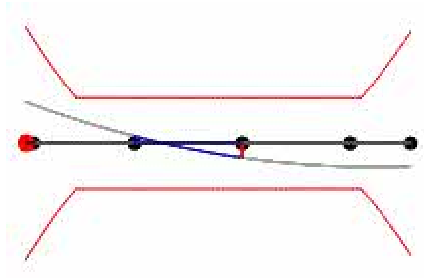
In-span δ ≤ Span/200	6.55 ≤ 4628 / 200	6.55 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Rafter 1 of Bay 1 : Members 1-3 (N.8-N.14)
Between 1.300 and 2.600 m, in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200             [ kN/m ]
D2 UDLY -000.000             [ kN/m ]
L1 UDLY -000.600             [ kN/m ]
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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)
	8	13.396C	23.043	-30.533	17.746	6.549
	14	7.400C	-2.405	17.222	@ 4.190	@ 3.102

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 13.4, 30.53, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	8.751 / 113.157 =	0.077	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.61 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	13.396 / 558.8 =	0.024	OK
Srx = Fn(Sxx, n)	123.3, 0.024	123.17 cm^3	
Mrx = Srx.py	123.17 x 275	33.871 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(10.762/33.871)^2+(0)^1$=	0.101	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x4.628/6.41 =	72.2	OK
Pcx = Area.pcx	20.32x219.429/10 =	445.880 kN	Table 24 a
λy = Ley/ryy	100x1x1.3/2.11 =	61.6	OK
Pcy = Area.pcy	20.32x217.73/10 =	442.421 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}	0.2+(.15x0+.5x4+.15x8)/11 = 0.44	0.494	Table 18
m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}	0.2+(.1x-8+.6x8+.1x16)/31 = .8x16/31	0.428	Table 26
m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.3 =	1.3 m	
λ = Le/ryy	1.3 / 2.11	61.61	OK
v = Fn (x,Le,ryy,λ)	19.589, 1.3, 2.11, 61.61	0.904	Table 19
λ_{LT}= u.v.λ.√β_W	0.892 x 0.904 x 61.61 √ 1	49.73	
pb = Fn (py,λ_{LT})	275, 49.73	238.64 N/mm²	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 238.64 ≤ 33.908 =	29.424 kN.m	

Combined Axial Compression and Bending to Annex I

r_b=m_{LT}.M_{LT}/M_b	0.494x10.8/29.4	0.181	
r_c=F_c/P_{cy}	13.4/442.4	0.030	
λ_r=($r_b\lambda_{LT}$+$r_c\lambda_y$)/(r_b+r_c)	(0.181•49.7+0.03•61.6)/(0.181+0.03)	51.436	
λ_{ro}=17.15 ε (2r_b+r_c)/(r_b+r_c)	17.15•1(2•0.181+0.03)/(0.181+0.03)	31.837	
M_{ob}= M_b(1-F_c/P_{cy})	29.424(1-13.4/442.4)	28.533	
M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}	33.908(1-13.4/442.4)^{½}	33.390	
M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})	33.908(1-13.4/445.9)/(1+0.5•13.4/445.9)	32.402	
M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))	6.742(1-13.4/442.4)/(1+1.0(13.4/442.4))	6.346	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	51.436, 31.837, 1.000, 33.390, 28.533	31.932	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	72.198, 1.000, 33.871, 32.402	32.693	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	61.611, 1.000, 6.742, 6.346	6.485	
m_x.M_x/M_{ax}	0.428x10.8/32.7	0.141	OK
m_{LT}.M_{LT}/M_{ab}	0.494x10.8/31.9	0.166	OK
m_x.M_x/M_{ax}	0.428x10.8/32.7	0.141	OK
Compare with Simplied to 4.8.3.3	0.183, 0.211, 0.211	0.211	
Compare with MoreExact to 4.8.3.3	0.168, 0.211, 0.164	0.211	

Deflection Check - Load Case 2

In-span δ ≤ Span/200	6.55 ≤ 4628 / 200	6.55 mm	OK

AXIAL WITH MOMENTS (MEMBER)

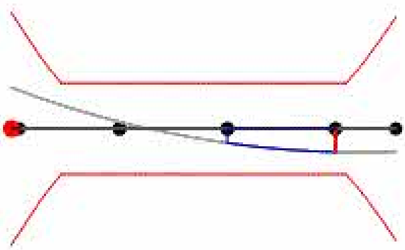
Rafter 1 of Bay 1 : Members 1-3 (N.8-N.14)

Between 2.600 and 3.900 m, in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200            [ kN/m ]
D2 UDLY -000.000            [ kN/m ]
L1 UDLY -000.600            [ kN/m ]
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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)
	8	13.396C	23.043	-30.533	17.746	6.549
	14	7.400C	-2.405	17.222	@ 4.190	@ 3.102

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 13.4, 30.53, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	1.621 / 113.157 =	0.014	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.61 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	13.396 / 558.8 =	0.024	OK
Srx = Fn(Sxx, n)	123.3, 0.024	123.17 cm^3	
Mrx = Srx.py	123.17 x 275	33.871 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(17.508/33.871)^2+(0)^1=$	0.267	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x4.628/6.41 =	72.2	OK
Pcx = Area.pcx	20.32x219.429/10 =	445.880 kN	Table 24 a
λy = Ley/ryy	100x1x1.3/2.11 =	61.6	OK
Pcy = Area.pcy	20.32x217.73/10 =	442.421 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x13+.5x15+.15x17)/18 = 0.44	0.894	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-8+.6x8+.1x16)/31 = .8x16/31	0.428	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.3 =	1.3 m	
λ = Le/ryy	1.3 / 2.11	61.61	OK
v = Fn (x,Le,ryy,λ)	19.589, 1.3, 2.11, 61.61	0.904	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.892 x 0.904 x 61.61 √ 1	49.73	
$pb = Fn (py,\lambda_{LT})$	275, 49.73	238.64 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 238.64 ≤ 33.908 =	29.424 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.894x17.5/29.4	0.532	
$r_c=F_c/P_{cy}$	13.4/442.4	0.030	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.532•49.7+0.03•61.6)/(0.532+0.03)	50.370	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.532+0.03)/(0.532+0.03)	33.376	
$M_{ob}= M_b(1-F_c/P_{cy})$	29.424(1-13.4/442.4)	28.533	
$M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}$	$33.908(1-13.4/442.4)^{½}$	33.390	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-13.4/445.9)/(1+0.5•13.4/445.9)	32.402	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.742(1-13.4/442.4)/(1+1.0(13.4/442.4))	6.346	
$M_{ab}=fn(\lambda_r, \lambda_{ro}, \varepsilon, M_{xy}, M_{ob})$	50.370, 33.376, 1.000, 33.390, 28.533	32.141	
$M_{ax}=fn(\lambda_x, \varepsilon, M_{rx}, M_{ox})$	72.198, 1.000, 33.871, 32.402	32.693	
$M_{ay}=fn(\lambda_y, \varepsilon, M_{ry}, M_{oy})$	61.611, 1.000, 6.742, 6.346	6.485	
$m_x.M_x/M_{ax}$	0.428x17.5/32.7	0.229	OK
$m_{LT}.M_{LT}/M_{ab}$	0.894x17.5/32.1	0.487	OK
$m_x.M_x/M_{ax}$	0.428x17.5/32.7	0.229	OK
Compare with Simplied to 4.8.3.3	0.279, 0.562, 0.562	0.562	
Compare with MoreExact to 4.8.3.3	0.254, 0.562, 0.483	0.562	

Deflection Check - Load Case 2

In-span δ ≤ Span/200	6.55 ≤ 4628 / 200	6.55 mm	OK

AXIAL WITH MOMENTS (MEMBER)

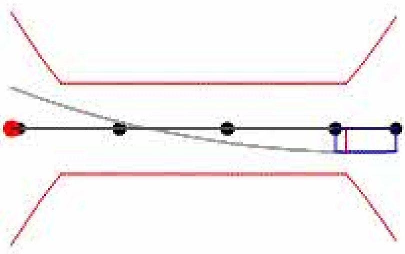
Rafter 1 of Bay 1 : Members 1-3 (N.8-N.14)

Between 3.900 and 4.628 m, in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200             [ kN/m ]
D2 UDLY -000.000             [ kN/m ]
L1 UDLY -000.600             [ kN/m ]
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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)
	8	13.396C	23.043	-30.533	17.746	6.549
	14	7.400C	-2.405	17.222	@ 4.190	@ 3.102

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 13.4, 30.53, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	0.925 / 113.157 =	0.008	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.49 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	13.396 / 558.8 =	0.024	OK
Srx = Fn(Sxx, n)	123.3, 0.024	123.17 cm^3	
Mrx = Srx.py	123.17 x 275	33.871 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(17.683/33.871)^2+(0)^1=$	0.273	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x4.628/6.41 =	72.2	OK
Pcx = Area.pcx	20.32x219.379/10 =	445.778 kN	Table 24 a
λy = Ley/ryy	100x1x0.728/2.1 =	34.6	OK
Pcy = Area.pcy	20.32x256.51/10 =	521.219 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x18+.5x18+.15x18)/18 = 0.44	1	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-8+.6x8+.1x16)/31 = .8x16/31	0.428	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 0.728 =	0.728 m	
λ = Le/ryy	0.728 / 2.1	34.62	OK
v = Fn (x,Le,ryy,λ)	19.539, 0.728, 2.1, 34.62	0.964	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.891 x 0.964 x 34.62 √ 1	29.74	
$pb = Fn (py,\lambda_{LT})$	275, 29.74	275 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 275 ≤ 33.908 =	33.908 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	1x17.7/33.9	0.522	
$r_c=F_c/P_{cy}$	13.4/521.2	0.026	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.522•29.7+0.026•34.6)/(0.522+0.026)	29.965	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.522+0.026)/(0.522+0.026)	33.494	
$M_{ob}= M_b(1-F_c/P_{cy})$	33.908(1-13.4/521.2)	33.036	
$M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}$	$33.908(1-13.4/521.2)^{½}$	33.469	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-13.4/445.8)/(1+0.5•13.4/445.8)	32.402	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.682(1-13.4/521.2)/(1+1.0(13.4/521.2))	6.347	
$M_{ab}=fn(\ \lambda_r,\ \lambda_{ro},\ \varepsilon,\ M_{xy},\ M_{ob})$	29.965, 33.494, 1.000, 33.469, 33.036	33.469	
$M_{ax}=fn(\ \lambda_x,\ \varepsilon,\ M_{rx},\ M_{ox})$	72.224, 1.000, 33.871, 32.402	32.692	
$M_{ay}=fn(\ \lambda_y,\ \varepsilon,\ M_{ry},\ M_{oy})$	34.624, 1.000, 6.682, 6.347	6.597	
$m_x.M_x/M_{ax}$	0.428x17.7/32.7	0.231	OK
$m_{LT}.M_{LT}/M_{ab}$	1x17.7/33.5	0.528	OK
$m_x.M_x/M_{ax}$	0.428x17.7/32.7	0.231	OK
Compare with Simplied to 4.8.3.3	0.281, 0.547, 0.552	0.552	
Compare with MoreExact to 4.8.3.3	0.256, 0.547, 0.546	0.547	

Deflection Check - Load Case 2

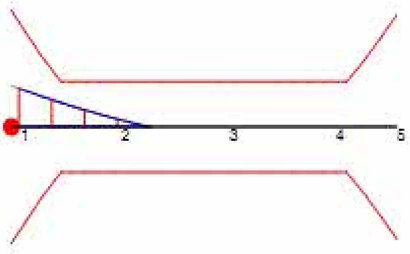
In-span δ ≤ Span/200	6.55 ≤ 4628 / 200	6.55 mm	OK

APPENDIX-G STABILITY (MEMBER) : G.2.(A).2
Rafter 1 of Bay 1 : Members 1-3 (N.8-N.14)
Between 0.091 and 1.668 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200              [ kN/m ]
D2 UDLY -000.000              [ kN/m ]
L1 UDLY -000.600              [ kN/m ]
```



Lateral and Torsional Restraints

Purlins @ 1.3, 2.6, 3.9 and 4.628 m

Stay @ 4.628 m

Member Forces in Load Case 1						
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)
	8	13.485C	23.104	-30.871	17.712	0.000
	14	7.380C	-2.318	17.225	@ 4.202	@ 3.102

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 13.49, 30.87, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Compression Resistance Pc

λy = L/ryy	100x1.577/2.05 =	77.02	OK
y = Fn(a,hs,x,λy)	91.44, 169.293, 19.539, 77.02	0.893	G.2.3
λTC = y.λ	0.893x77.02 =	68.79	OK
Pcy = Area.pcy	20.32x204.3/10 =	415.139 kN	Table 24 b

Slenderness Correction Factor nt

R_1=Mx_1/(py.Sxx)	28.790/(.001x 275x284.3) = 0	0.368	
R_2=Mx_2/(py.Sxx)	20.308/(.001x 275x155.8) = 0	0.474	
R_3=Mx_3/(py.Sxx)	12.687/(.001x 275x123.3) = 0	0.374	
R_4=Mx_4/(py.Sxx)	5.913/(.001x 275x123.3) = 0	0.174	
R_5=Mx_5/(py.Sxx)	0.000/(.001x 275x123.3) = 0	0.000	
R_S-R_E	0.474 - 0.368 = 0	0.106	
R_{max}		0.474	
nt=Fn(All above)	0.368, 0.474, 0.374, 0.174, 0.000, 0.106, 0.474	0.841	G.4.3

Lateral Buckling Resistance Moment Mb

Mp = py.Sxx≤1.2 py.Zxx	275 x 123.3 ≤ 1.2 x 275 x 109.61 =	33.908 kN.m	
λy = L/ryy	100x1.577/2.05 =	77.02	OK
vt = Fn(a,x,hs,λ)	91.44, 19.539, 169.293, 77.02	0.892	G.2.4.2
c=Fn(R,q,x)	1.903, 0.323, 19.539	1.112	G.2.5
λTB = c.nt.vt.λy	1.112 x 0.841 x 0.892 x 77.02	64.216	G.2.4.2
pb = Fn (py,λTB)	275, 64.22	202.7 N/mm²	Table 16
Mb = Sxx.pb≤ Mp ≤ py.Zxx	123.3 x 202.7 ≤ 33.908 ≤ 275 x 109.49 =	24.966 kN.m	

Elastic Stability of Tapered Members : G.2.2

F/Pc+M/Mb	13.485 / 415.14 + 18.005 / 24.97	0.754	OK

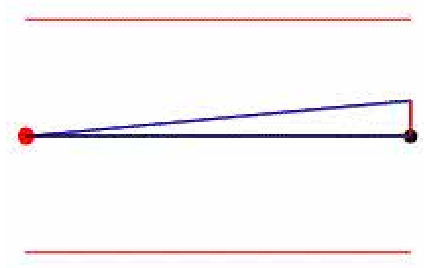
AXIAL WITH MOMENTS (MEMBER)

Lean-To Column 2 : Member 12 (N.3-N.4) in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
UT PartFix 20.00 +++ ---   (Mt My Mz)
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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	3	17.564C	-4.809	0.000		1.642
	4	16.780C	-4.809	-14.427		@ 1.800

Classification and Properties (BS 5950: 2000)

Section (19.04 kg/m)	178x102 UB 19 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	6.41, 30.58, 275, 17.56, 14.43, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	4.809 / 140.818 =	0.034	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 171.3≤1.2 x 275 x 152.63 =	47.108 kN.m	
Pz = Ag.py	24.26 x 275 =	667.15 kN	
n = F/Pz	17.564 / 667.15 =	0.026	OK
Srx = Fn(Sxx, n)	171.3, 0.026	171.09 cm^3	
Mrx = Srx.py	171.09 x 275	47.049 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(14.427/47.049)^2+(0)^1=$	0.094	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x3/7.48 =	40.1	OK
Pcx = Area.pcx	24.26x259.958/10 =	630.658 kN	Table 24 a
λy = Ley/ryy	100x1x3/2.38 =	126.1	OK
Pcy = Area.pcy	24.26x99.73/10 =	241.935 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x4+.5x7+.15x11)/14 = 0.44	0.6	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-4+.6x-7+.1x-11)/14 = .8x11/14	0.6	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 3 =	3 m	
λ = Le/ryy	3 / 2.38	126.05	OK
v = Fn (x,Le,ryy,λ)	22.562, 3, 2.38, 126.05	0.791	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.889 x 0.791 x 126.05 √ 1	88.63	
pb = Fn (py,λ_{LT})	275, 88.63	146.27 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	171.3 x 146.27 ≤ 47.108 =	25.056 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.6x-14.4/25.1	0.346	
$r_c=F_c/P_{cy}$	17.6/241.9	0.073	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.346•88.6+0.073•126.1)/(0.346+0.073)	95.131	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.346+0.073)/(0.346+0.073)	31.322	
$M_{ob}= M_b(1-F_c/P_{cy})$	25.056(1-17.6/241.9)	23.237	
$M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}$	47.108(1-17.6/241.9)^{½}	45.365	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	47.108(1-17.6/630.7)/(1+0.5•17.6/630.7)	45.167	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	8.973(1-17.6/241.9)/(1+1.0(17.6/241.9))	7.758	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	95.131, 31.322, 1.000, 45.365, 23.237	23.237	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	40.107, 1.000, 47.049, 45.167	46.420	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	126.050, 1.000, 8.973, 7.758	7.758	
$m_x.M_x/M_{ax}$	0.6x14.4/46.4	0.186	OK
$m_{LT}.M_{LT}/M_{ab}$	0.6x-14.4/23.2	0.373	OK
$m_x.M_x/M_{ax}$	0.6x14.4/46.4	0.186	OK
Compare with Simplied to 4.8.3.3	0.279, 0.418, 0.418	0.418	
Compare with MoreExact to 4.8.3.3	0.214, 0.418, 0.192	0.418	

Deflection Check - Load Case 2

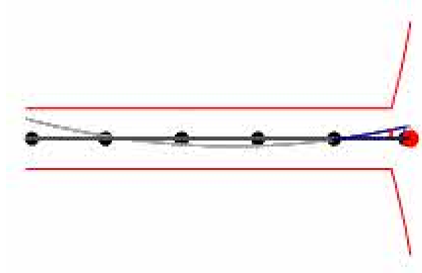
In-span δ ≤ Span/360	1.64 ≤ 3000 / 360	1.64 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Lean-To Beam 2 : Member 13 (N.4-N.5)
Between 0.090 and 1.200 m, in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200            [ kN/m ]
D2 UDLY -000.000            [ kN/m ]
L1 UDLY -000.600            [ kN/m ]
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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)
13	4	6.762C	16.065	-14.427	8.172	6.996
	5	2.447C	-18.458	-21.662	@ 2.842	@ 2.781

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 6.76, 21.66, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	14.352 / 113.157 =	0.127	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.49 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	6.762 / 558.8 =	0.012	OK
Srx = Fn(Sxx, n)	123.3, 0.012	123.27 cm^3	
Mrx = Srx.py	123.27 x 275	33.898 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(9.863/33.898)^2+(0)^1=$	0.085	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x6.047/6.41 =	94.4	OK
Pcx = Area.pcx	20.32x170.213/10 =	345.872 kN	Table 24 a
λy = Ley/ryy	100x1x1.11/2.1 =	52.8	OK
Pcy = Area.pcy	20.32x232.36/10 =	472.149 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x9+.5x5+.15x2)/13 = 0.44	1	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-3+.6x-8+.1x0)/22 = .8x8/22	0.437	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.11 =	1.11 m	
λ = Le/ryy	1.11 / 2.1	52.8	OK
v = Fn (x,Le,ryy,λ)	19.539, 1.11, 2.1, 52.8	0.925	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.891 x 0.925 x 52.8 √ 1	43.51	
$pb = Fn (py,\lambda_{LT})$	275, 43.51	253.59 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 253.59 ≤ 33.908 =	31.268 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	1x9.9/31.3	0.315
$r_c=F_c/P_{cy}$	6.8/472.1	0.014
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.315•43.5+0.014•52.8)/(0.315+0.014)	43.913
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.315+0.014)/(0.315+0.014)	33.555

$M_{ob}= M_b(1-F_c/P_{cy})$	31.268(1-6.8/472.1)	30.820	
$M_{xy}= M_{cx}(1-F_c/\ P_{cy})^{½}$	$33.908(1-6.8/472.1)^{½}$	33.664	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-6.8/345.9)/(1+0.5•6.8/345.9)	32.923	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.682(1-6.8/472.1)/(1+1.0(6.8/472.1))	6.493	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	43.913, 33.555, 1.000, 33.664, 30.820	33.288	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	94.367, 1.000, 33.898, 32.923	32.923	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	52.802, 1.000, 6.682, 6.493	6.584	
$m_x.M_x/M_{ax}$	0.437x9.9/32.9	0.131	OK
$m_{LT}.M_{LT}/M_{ab}$	1x9.9/33.3	0.296	OK
$m_x.M_x/M_{ax}$	0.437x9.9/32.9	0.131	OK
Compare with Simplied to 4.8.3.3	0.163, 0.33, 0.335	0.335	
Compare with MoreExact to 4.8.3.3	0.148, 0.33, 0.3	0.33	

Deflection Check - Load Case 2

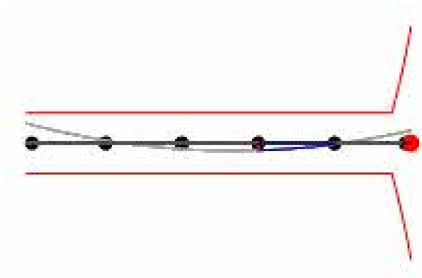
In-span δ ≤ Span/200	7 ≤ 6047 / 200	7 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Lean-To Beam 2 : Member 13 (N.4-N.5)
Between 1.200 and 2.400 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200            [ kN/m ]
D2 UDLY -000.000            [ kN/m ]
L1 UDLY -000.600            [ kN/m ]
```



Member Forces in Load Case 1 and Maximum Deflection from Load Case 2						
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)
13	4	6.641C	15.898	-13.853	8.282	6.996
	5	2.326C	-18.625	-22.095	@ 2.781	@ 2.781

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 6.64, 22.1, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	2.196 / 113.157 =	0.019	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.61 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	6.641 / 558.8 =	0.012	OK
Srx = Fn(Sxx, n)	123.3, 0.012	123.27 cm^3	
Mrx = Srx.py	123.27 x 275	33.899 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(7.857/33.899)^2+(0)^1$=	0.054	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x6.047/6.41 =	94.3	OK
Pcx = Area.pcx	20.32x170.292/10 =	346.034 kN	Table 24 a
λy = Ley/ryy	100x1x1.2/2.11 =	56.9	OK
Pcy = Area.pcy	20.32x225.86/10 =	458.949 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x4+.5x6+.15x7)/8 = 0.44	0.752	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-4+.6x-8+.1x0)/22 = .8x8/22	0.435	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.2 =	1.2 m	
λ = Le/ryy	1.2 / 2.11	56.87	OK
v = Fn (x,Le,ryy,λ)	19.589, 1.2, 2.11, 56.87	0.916	Table 19
λ_{LT}= u.v.λ.$\sqrt{\beta_W}$	0.892 x 0.916 x 56.87 $\sqrt{1}$	46.48	
pb = Fn (py,λ_{LT})	275, 46.48	246.49 N/mm²	Table 16
Mb = Sxx.pb $\leq$ Mc	123.3 x 246.49 $\leq$ 33.908 =	30.392 kN.m	

Combined Axial Compression and Bending to Annex I

r_b=m_{LT}.M_{LT}/M_b	0.752x-7.9/30.4	0.194	
r_c=F_c/P_{cy}	6.6/458.9	0.014	
λ_r=($r_b\lambda_{LT}$+$r_c\lambda_y$)/(r_b+r_c)	(0.194•46.5+0.014•56.9)/(0.194+0.014)	47.204	
λ_{ro}=17.15 ε (2r_b+r_c)/(r_b+r_c)	17.15•1(2•0.194+0.014)/(0.194+0.014)	33.111	
M_{ob}= M_b(1-F_c/P_{cy})	30.392(1-6.6/458.9)	29.952	
M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}	33.908(1-6.6/458.9)^{½}	33.661	
M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})	33.908(1-6.6/346)/(1+0.5•6.6/346)	32.941	
M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))	6.742(1-6.6/458.9)/(1+1.0(6.6/458.9))	6.550	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	47.204, 33.111, 1.000, 33.661, 29.952	32.843	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	94.332, 1.000, 33.899, 32.941	32.941	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	56.872, 1.000, 6.742, 6.550	6.631	
m_x.M_x/M_{ax}	0.435x7.9/32.9	0.104	OK
m_{LT}.M_{LT}/M_{ab}	0.752x-7.9/32.8	0.180	OK
m_x.M_x/M_{ax}	0.435x7.9/32.9	0.104	OK
Compare with Simplied to 4.8.3.3	0.133, 0.209, 0.213	0.213	
Compare with MoreExact to 4.8.3.3	0.121, 0.209, 0.179	0.209	

Deflection Check - Load Case 2

In-span $\delta \leq$ Span/200	7 $\leq$ 6047 / 200	7 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Lean-To Beam 2 : Member 13 (N.4-N.5)
Between 2.400 and 3.600 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200              [ kN/m ]
D2 UDLY -000.000              [ kN/m ]
L1 UDLY -000.600              [ kN/m ]
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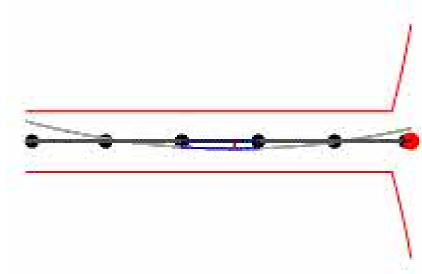


Member Forces in Load Case 1 and Maximum Deflection from Load Case 2						
Mem ber No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
13	4	6.641C	15.898	-13.853	8.282	6.996
	5	2.326C	-18.625	-22.095	@ 2.781	@ 2.781

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 6.64, 22.1, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	0.087 / 113.157 =	0.001	Low Shear
Mcx = py.Sxx$\leq$1.2 py.Zxx	275 x 123.3$\leq$1.2 x 275 x 109.61 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	6.641 / 558.8 =	0.012	OK
Srx = Fn(Sxx, n)	123.3, 0.012	123.27 cm³	

Mrx = Srx.py	123.27 x 275	33.899 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(8.279/33.899)^2+(0)^1$=	0.06	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x6.047/6.41 =	94.3	OK
Pcx = Area.pcx	20.32x170.292/10 =	346.034 kN	Table 24 a
λy = Ley/ryy	100x1x1.2/2.11 =	56.9	OK
Pcy = Area.pcy	20.32x225.86/10 =	458.949 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x8+.5x8+.15x8)/8 = 0.44	0.978	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-4+.6x-8+.1x0)/22 = .8x8/22	0.435	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.2 =	1.2 m	
λ = Le/ryy	1.2 / 2.11	56.87	OK
v = Fn (x,Le,ryy,λ)	19.589, 1.2, 2.11, 56.87	0.916	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.892 x 0.916 x 56.87 √ 1	46.48	
$pb = Fn (py,\lambda_{LT})$	275, 46.48	246.49 N/mm²	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 246.49 ≤ 33.908 =	30.392 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.978x-8.3/30.4	0.266	
$r_c=F_c/P_{cy}$	6.6/458.9	0.014	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.266•46.5+0.014•56.9)/(0.266+0.014)	47.019	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.266+0.014)/(0.266+0.014)	33.416	
$M_{ob}= M_b(1-F_c/P_{cy})$	30.392(1-6.6/458.9)	29.952	
$M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}$	33.908(1-6.6/458.9)½	33.661	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-6.6/346)/(1+0.5•6.6/346)	32.941	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.742(1-6.6/458.9)/(1+1.0(6.6/458.9))	6.550	
$M_{ab}=fn(\lambda_r, \lambda_{ro}, \varepsilon, M_{xy}, M_{ob})$	47.019, 33.416, 1.000, 33.661, 29.952	32.874	
$M_{ax}=fn(\lambda_x, \varepsilon, M_{rx}, M_{ox})$	94.332, 1.000, 33.899, 32.941	32.941	
$M_{ay}=fn(\lambda_y, \varepsilon, M_{ry}, M_{oy})$	56.872, 1.000, 6.742, 6.550	6.631	
$m_x.M_x/M_{ax}$	0.435x8.3/32.9	0.109	OK
$m_{LT}.M_{LT}/M_{ab}$	0.978x-8.3/32.9	0.246	OK
$m_x.M_x/M_{ax}$	0.435x8.3/32.9	0.109	OK
Compare with Simplied to 4.8.3.3	0.139, 0.281, 0.286	0.286	
Compare with MoreExact to 4.8.3.3	0.126, 0.281, 0.246	0.281	

Deflection Check - Load Case 2

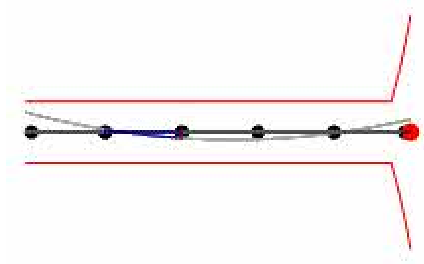
In-span δ ≤ Span/200	7 ≤ 6047 / 200	7 mm	OK

AXIAL WITH MOMENTS (MEMBER)
Lean-To Beam 2 : Member 13 (N.4-N.5)
Between 3.600 and 4.800 m, in Load Case 5

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200              [ kN/m ]
D2 UDLY -000.000              [ kN/m ]
L1 UDLY -000.600              [ kN/m ]
```



Member Forces in Load Case 5 and Maximum Deflection from Load Case 2						
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)
13	4	6.762C	16.065	-14.427	8.172	6.996
	5	2.447C	-18.458	-21.662	@ 2.842	@ 2.781

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 6.76, 21.66, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	4.49 / 113.157 =	0.04	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.61 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	6.762 / 558.8 =	0.012	OK
Srx = Fn(Sxx, n)	123.3, 0.012	123.27 cm^3	
Mrx = Srx.py	123.27 x 275	33.898 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(6.406/33.898)^2+(0)^1=$	0.036	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x6.047/6.41 =	94.3	OK
Pcx = Area.pcx	20.32x170.292/10 =	346.034 kN	Table 24 a
λy = Ley/ryy	100x1x1.2/2.11 =	56.9	OK
Pcy = Area.pcy	20.32x225.86/10 =	458.949 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x5+.5x3+.15x0)/6 = 0.44	0.523	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-3+.6x-8+.1x0)/22 = .8x8/22	0.437	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.2 =	1.2 m	
λ = Le/ryy	1.2 / 2.11	56.87	OK
v = Fn (x,Le,ryy,λ)	19.589, 1.2, 2.11, 56.87	0.916	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.892 x 0.916 x 56.87 √ 1	46.48	
$pb = Fn (py,\lambda_{LT})$	275, 46.48	246.49 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 246.49 ≤ 33.908 =	30.392 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.523x-6.4/30.4	0.110	
$r_c=F_c/P_{cy}$	6.8/458.9	0.015	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.11•46.5+0.015•56.9)/(0.11+0.015)	47.708	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.11+0.015)/(0.11+0.015)	32.279	
$M_{ob}= M_b(1-F_c/P_{cy})$	30.392(1-6.8/458.9)	29.944	
$M_{xy}= M_{cx}(1-F_c/ P_{cy})^{½}$	$33.908(1-6.8/458.9)^{½}$	33.657	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-6.8/346)/(1+0.5•6.8/346)	32.923	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.742(1-6.8/458.9)/(1+1.0(6.8/458.9))	6.546	
$M_{ab}=fn(\lambda_r, \lambda_{ro}, \varepsilon, M_{xy}, M_{ob})$	47.708, 32.279, 1.000, 33.657, 29.944	32.758	
$M_{ax}=fn(\lambda_x, \varepsilon, M_{rx}, M_{ox})$	94.332, 1.000, 33.898, 32.923	32.923	
$M_{ay}=fn(\lambda_y, \varepsilon, M_{ry}, M_{oy})$	56.872, 1.000, 6.742, 6.546	6.629	
$m_x.M_x/M_{ax}$	0.437x6.4/32.9	0.085	OK
$m_{LT}.M_{LT}/M_{ab}$	0.523x-6.4/32.8	0.102	OK
$m_x.M_x/M_{ax}$	0.437x6.4/32.9	0.085	OK
Compare with Simplied to 4.8.3.3	0.112, 0.125, 0.13	0.13	
Compare with MoreExact to 4.8.3.3	0.103, 0.125, 0.102	0.125	

Deflection Check - Load Case 2

In-span δ ≤ Span/200	7 ≤ 6047 / 200	7 mm	OK

AXIAL WITH MOMENTS (MEMBER)

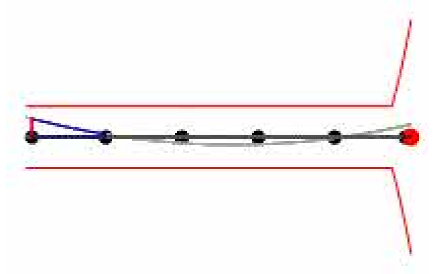
Lean-To Beam 2 : Member 13 (N.4-N.5)

Between 4.800 and 5.957 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200             [ kN/m ]
D2 UDLY -000.000             [ kN/m ]
L1 UDLY -000.600             [ kN/m ]
```



Member Forces in Load Case 1 and Maximum Deflection from Load Case 2						
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)
13	4	6.641C	15.898	-13.853	8.282	6.996
	5	2.326C	-18.625	-22.095	@ 2.781	@ 2.781

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 6.64, 22.1, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Local Capacity Check

Fvx/Pvx	18.113 / 113.157 =	0.16	Low Shear
Mcx = py.Sxx≤1.2 py.Zxx	275 x 123.3≤1.2 x 275 x 109.61 =	33.908 kN.m	
Pz = Ag.py	20.32 x 275 =	558.8 kN	
n = F/Pz	6.641 / 558.8 =	0.012	OK
Srx = Fn(Sxx, n)	123.3, 0.012	123.27 cm^3	
Mrx = Srx.py	123.27 x 275	33.899 kN.m	
$(Mx/Mrx)^{Z1}+(My/Mry)^{Z2}$	$(20.447/33.899)^2+(0)^1=$	0.364	OK

Compression Resistance Pc

λx = Lex/rxx	100x1x6.047/6.41 =	94.3	OK
Pcx = Area.pcx	20.32x170.292/10 =	346.034 kN	Table 24 a
λy = Ley/ryy	100x1x1.157/2.11 =	54.8	OK
Pcy = Area.pcy	20.32x229.17/10 =	465.672 kN	Table 24 b

Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT}=0.2+(.15M_2+.5M_3+.15M_4)/M_{max}$	0.2+(.15x7+.5x11+.15x15)/20 = 0.44	0.631	Table 18
$m_y=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26
$m_x=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x-4+.6x-8+.1x0)/22 = .8x8/22	0.435	Table 26
$m_{yx}=0.2+(.1M_2+.6M_3+.1M_4)/M_{max}$	0.2+(.1x0+.6x0+.1x0)/0 = .8x0/0	1	Table 26

Lateral Buckling Check Mb

Le = 1.00 L	1 x 1.157 =	1.157 m	
λ = Le/ryy	1.157 / 2.11 =	54.83	OK
v = Fn (x,Le,ryy,λ)	19.589, 1.157, 2.11, 54.83	0.921	Table 19
$\lambda_{LT}= u.v.\lambda.\sqrt{\beta_W}$	0.892 x 0.921 x 54.83 √ 1	45.06	
pb = Fn (py,λ_{LT})	275, 45.06	249.91 N/mm^2	Table 16
Mb = Sxx.pb ≤ Mc	123.3 x 249.91 ≤ 33.908 =	30.814 kN.m	

Combined Axial Compression and Bending to Annex I

$r_b=m_{LT}.M_{LT}/M_b$	0.631x20.4/30.8	0.419	
$r_c=F_c/P_{cy}$	6.6/465.7	0.014	
$\lambda_r=(r_b\lambda_{LT}+r_c\lambda_y)/(r_b+r_c)$	(0.419•45.1+0.014•54.8)/(0.419+0.014)	45.377	
$\lambda_{ro}=17.15\ \varepsilon\ (2r_b+r_c)/(r_b+r_c)$	17.15•1(2•0.419+0.014)/(0.419+0.014)	33.735	
$M_{ob}= M_b(1-F_c/P_{cy})$	30.814(1-6.6/465.7)	30.375	
$M_{xy}= M_{cx}(1-F_c/\ P_{cy})^{½}$	$33.908(1-6.6/465.7)^{½}$	33.665	
$M_{ox}= M_{cx}(1-F_c/P_{cx})/(1+0.5F_c/P_{cx})$	33.908(1-6.6/346)/(1+0.5•6.6/346)	32.941	
$M_{oy}= M_{cy}(1-F_c/P_{cy})/(1+k_y(F_c/P_{cy}))$	6.742(1-6.6/465.7)/(1+1.0(6.6/465.7))	6.552	
M_{ab}=fn(λ_r, λ_{ro}, ε, M_{xy}, M_{ob})	45.377, 33.735, 1.000, 33.665, 30.375	33.111	
M_{ax}=fn(λ_x, ε, M_{rx}, M_{ox})	94.332, 1.000, 33.899, 32.941	32.941	
M_{ay}=fn(λ_y, ε, M_{ry}, M_{oy})	54.834, 1.000, 6.742, 6.552	6.638	
$m_x.M_x/M_{ax}$	0.435x20.4/32.9	0.270	OK
$m_{LT}.M_{LT}/M_{ab}$	0.631x20.4/33.1	0.390	OK
$m_x.M_x/M_{ax}$	0.435x20.4/32.9	0.270	OK
Compare with Simplied to 4.8.3.3	0.314, 0.433, 0.438	0.438	
Compare with MoreExact to 4.8.3.3	0.284, 0.433, 0.392	0.433	

Deflection Check - Load Case 2

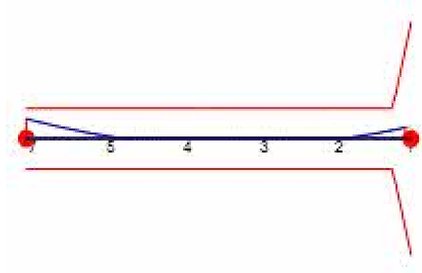
In-span δ ≤ Span/200	7 ≤ 6047 / 200	7 mm	OK

APPENDIX-G STABILITY (MEMBER) : G.2.(A).2
Lean-To Beam 2 : Member 13 (N.4-N.5)
Between 0.090 and 6.047 m, in Load Case 1

Member Loading and Member Forces

```
Loading Combination : 1 UT + 1.4 D1 + 1.4 D2 + 1.6 L1

UT Spacing 04.500 [Multiply AllLoads]
D1 UDLY -000.200              [ kN/m ]
D2 UDLY -000.000              [ kN/m ]
L1 UDLY -000.600              [ kN/m ]
```



Lateral and Torsional Restraints

Purlins @ 1.2, 2.4, 3.6, 4.8, 5.957 and 6.047 m
Stay @ 6.047 m

Member Forces in Load Case 1						
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)
13	4	6.641C	15.898	-13.853	8.282	0.000
	5	2.326C	-18.625	-22.095	@ 2.781	@ 2.781

Classification and Properties (BS 5950: 2000)

Section (15.95 kg/m)	152x89 UB 16 [Grade 43]		
Class = Fn(b/T,d/t,py,F,Mx,My)	5.76, 27.07, 275, 6.64, 22.1, 0	(Axial: Non-Slender)	Plastic
Auto Design Load Cases	1 & 5		

Compression Resistance Pc

λy = L/ryy	100x5.957/1.94 =	307.24	OK
y = Fn(a,hs,x,λy)	91.44, 224.024, 19.539, 307.238	0.512	G.2.3
λTC = y.λ	0.512x307.24 =	157.39	OK
Pcy = Area.pcy	20.32x68.4/10 =	138.999 kN	Table 24 b

Slenderness Correction Factor nt

R_1=Mx_1/(py.Sxx)	12.444/(.001x 275x349.9) = 0	0.129	
R_2=Mx_2/(py.Sxx)	0.000/(.001x 275x123.3) = 0	0.000	
R_3=Mx_3/(py.Sxx)	0.000/(.001x 275x123.3) = 0	0.000	
R_4=Mx_4/(py.Sxx)	0.692/(.001x 275x123.3) = 0	0.020	
R_5=Mx_5/(py.Sxx)	22.095/(.001x 275x123.3) = 0	0.652	
R_S-R_E	0.652 - 0.652 = 0	0.000	
R_{max}		0.652	
nt=Fn(All above)	0.129, 0.000, 0.000, 0.020, 0.652, 0.000, 0.652	0.328	G.4.3

Lateral Buckling Resistance Moment Mb

Mp = py.Sxx≤1.2 py.Zxx	275 x 123.3 ≤ 1.2 x 275 x 109.61 =	33.908 kN.m	
λy = L/ryy	100x5.957/1.94 =	307.24	OK
vt = Fn(a,x,hs,λ)	91.44, 19.539, 224.024, 307.238	0.507	G.2.4.2
c=Fn(R,q,x)	2.215, 0.035, 19.539	1.028	G.2.5
λTB = c.nt.vt.λy	1.028 x 0.328 x 0.507 x 307.238	52.568	G.2.4.2
pb = Fn (py,λTB)	275, 52.57	231.68 N/mm²	Table 16
Mb = Sxx.pb≤ Mp ≤ py.Zxx	123.3 x 231.68 ≤ 33.908 ≤ 275 x 109.49 =	28.559 kN.m	

Elastic Stability of Tapered Members : G.2.2

F/Pc+M/Mb	6.641 / 139 + 22.091 / 28.56	0.821	OK