

**PRELIMINARY STRUCTURAL REPORT**

**UPON**

**BARN ADJACENT**

**GAIA**

**BENSGATE ROAD**

**HOLBEACH**

**PROJECT No: SW 22-113**

**DOCUMENT REF: SW 22-113-REP-01**



Status Design

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## 1. INTRODUCTION

Acting upon the instruction of Mr B Gilhams of Status Design., we attended the site in January 2022, to undertake visual inspections and basic ground investigations including inspecting the existing foundation detail.

The object of this report is to comment upon the current structural condition and viability for conversion to domestic accommodation. It confines itself to the Basic Structural Fabric and is not intended to comment upon non-structural items.

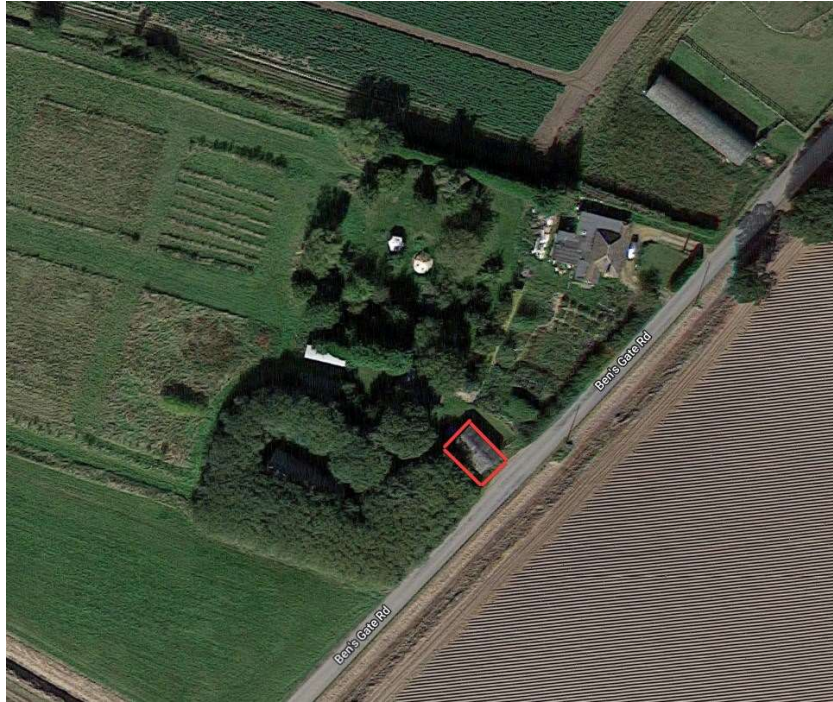
During the course of the survey and in preparation of this report no cladding, internal features or items were moved, therefore we cannot comment upon the condition of areas which were covered or inaccessible.

Comments relating to Ground Conditions are based upon previous experience in the Fenland area, and publicly available British Geological Society records.

This report has been prepared for the named client above and should not be relied upon by any other parties, except the client and their specialist third party advisors, without the express written permission of Shields Wilson Limited.

## 2. PROPERTY LOCATION & DESCRIPTION

The barn building sits to the North West of Bens Gate Road, site to the South West the dwelling located to the frontage of the plot, 92 Peters Point Road, Sutton Bridge PE12 9UX.



The building is an agricultural barn which the current residents state was erected in 1996 and originally housed

The structure of the barn takes the form of lightweight steel framing consisting of rolled steel angles, hollow sections and tubular section trusses.

The width of the structure is just over 6m which the tubular steel trusses clear span over. There are two no. central trusses the building is approximately 9.5m in length.

The roof structure is braced at eaves level using tubular hollow section steel.

The roof cladding is thought to take the form of asbestos cement roof sheets.

The walls are clad using single skin metal corrugated cladding sheets fixed to rolled steel angle rails spanning between the frame posts.

There is a 2-block course dwarf wall above slab level, the wall is 1 block thick with the lightweight steel framing fixed directly to the top of the dwarf wall. This wall appears to extend down below ground as an engineering brick wall, 1 brick thick.

There is a concrete floor within the barn structure, it appears to be of traditional ground bearing construction.

### 3. OBSERVATIONS

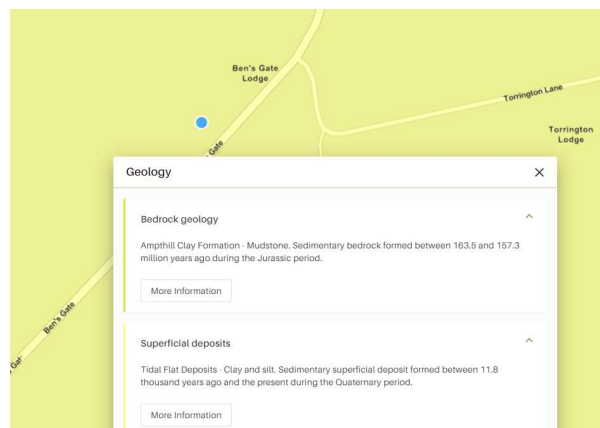
A visual inspection of the building was undertaken. Our observations are described below.

The Location of the barn and its form are illustrated on Status Design drawing SD21-024/2, a copy of which is located within Appendix A.

There is a general photographic record of our survey contained in Appendix B.

#### 3.1. Ground Conditions

Publicly available British Geological Society maps and borehole records indicate the site to be underlain with Tidal flat deposits of Clay and Silt tidal flat deposits over the Clay Formations.



Our experience over many years of work in the area would concur with the publicly available data.

The immediately sub-surface strata offered in these areas generally presents a formation suitable for traditional shallow spread foundations.

#### 3.2. Structure

The style of structure is a lightweight structure intended as a storage buildings and light workshops for agricultural use.

It is typical of the style and period that the cladding is asbestos cement cladding. This is likely to be the original cladding. The asbestos sheets should be handled appropriately by correctly trained operatives in accordance with all asbestos related legislation.

It should be noted that the rain water goods are PVC, but do not outfall to a positive drainage system

The single skin metal cladding is generally in average condition with very few gaps in the sheeting joints and only small amounts of surface corrosion.

We can state from experience that the lightweight structure is unlikely to be fully adequate to carry the required domestic loads, of cladding, services, ceiling and minimum roof imposed loads with the desired factors of safety required by current design codes.

A simplified model analysis of the frame structure was undertaken in MasterSeries frame analysis software and as expected it was found that some parts of the frame are not adequate to meet current design codes loading and standards.

The analysis model has shown that the roof framing members with appropriate detailed analysis and sympathetic detailing of the new roof construction could remain and contribute to the roof structure.

However, the frame posts are shown to be inadequate for the loads which they would attract to current standards.

Our calculation output is contained with Appendix C.

In addition, the detail between the lightweight steel frame and the dwarf wall would require strengthening as from inspection the current detail will not be adequate to be subject to loadings to current requirements.

The concrete ground floor slab is in good condition and showing few signs of distress. There is a crack running the width of the building set back from the doorway, but this appears to be a construction joint due to the very linear nature rather than a crack due to movement.

The current residents were of the opinion that the dwarf masonry wall is built off a traditional shallow strip footing. The existing structure has an inherent degree of flexibility but is not showing any signs of excessive foundation movements.

#### 4. Proposed Structure Conversion

The proposed conversion involves the replacement of the roof and wall cladding, with new materials.

The existing lightweight frame construction is in places inadequate for the proposed loads, as described in 3.2. However, the proposed new wall and roof cladding details can be configured in such a way to provide the additional load bearing capacity and structural stability required for the proposed conversion to meet current design standards.

The new can be sheathed and as such will provide additional racking stability for the proposed dwelling.

The new external walls can be designed to be suitable timber frame walls spanning from ground to head utilising the racking capacity described above to provide overall stability. They would also provide additional vertical load bearing capacity for the roof and offer additional capacity to the existing back-to-back rolled steel angle posts which are shown to have inadequate capacity.

New or additional purlin members may be required to aid the existing members with the additional loads.

The existing barn strip foundations will need to be exposed and checked during the detail design of the conversion. However, it is our opinion that the existing strip footing is likely to be suitable or readily strengthened to become suitable.

## 5. CONCLUSIONS & RECCOMENDATIONS

Generally, the condition of the structure is good for a building of this type and age.

The existing structure can be utilised in part to form the structure of the converted dwelling.

The proposed conversion layout and style has the ability to provide methods for load bearing and stability and as such will ensure that the proposed conversion can accommodate domestic loads in accordance with the modern building regulations.

The parts requiring introduction to provide additional stability are predominantly in the form of the new external wall materials.

By implementing the recommendations contained in the report above, the property should provide suitable domestic accommodation for years to come.

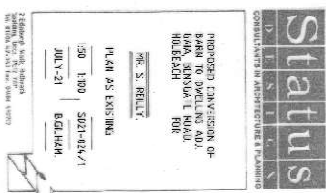
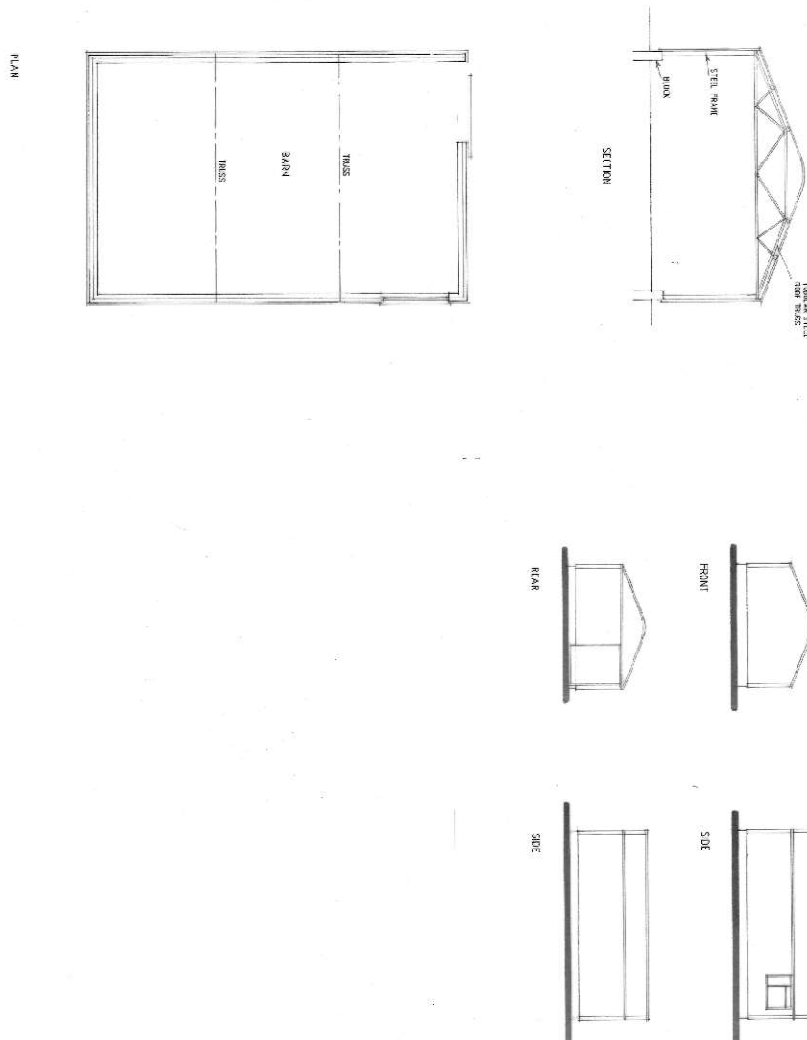
For and on behalf of **SHIELDS WILSON LIMITED**

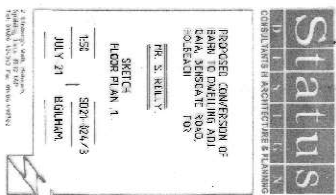
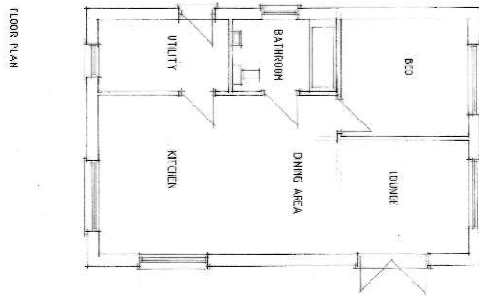
**A Wilson CEng MStructE**

**October 2022**

## APPENDIX A

[illegible]





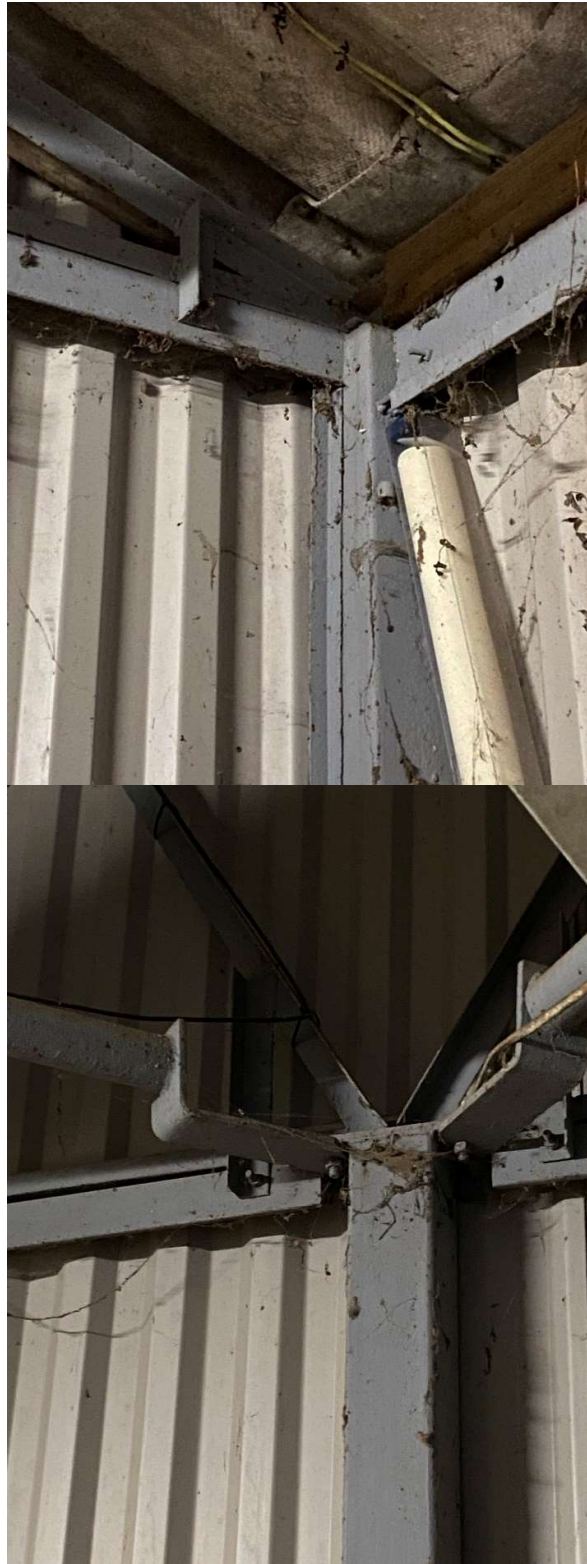
## APPENDIX B



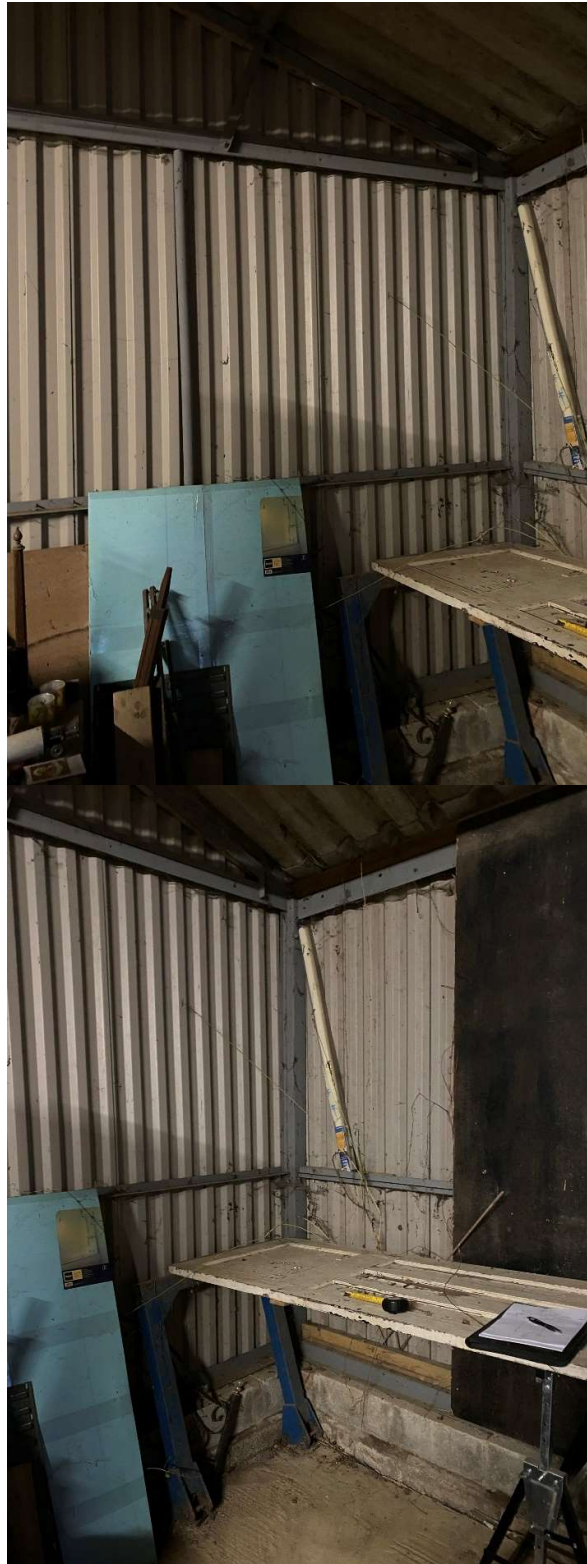


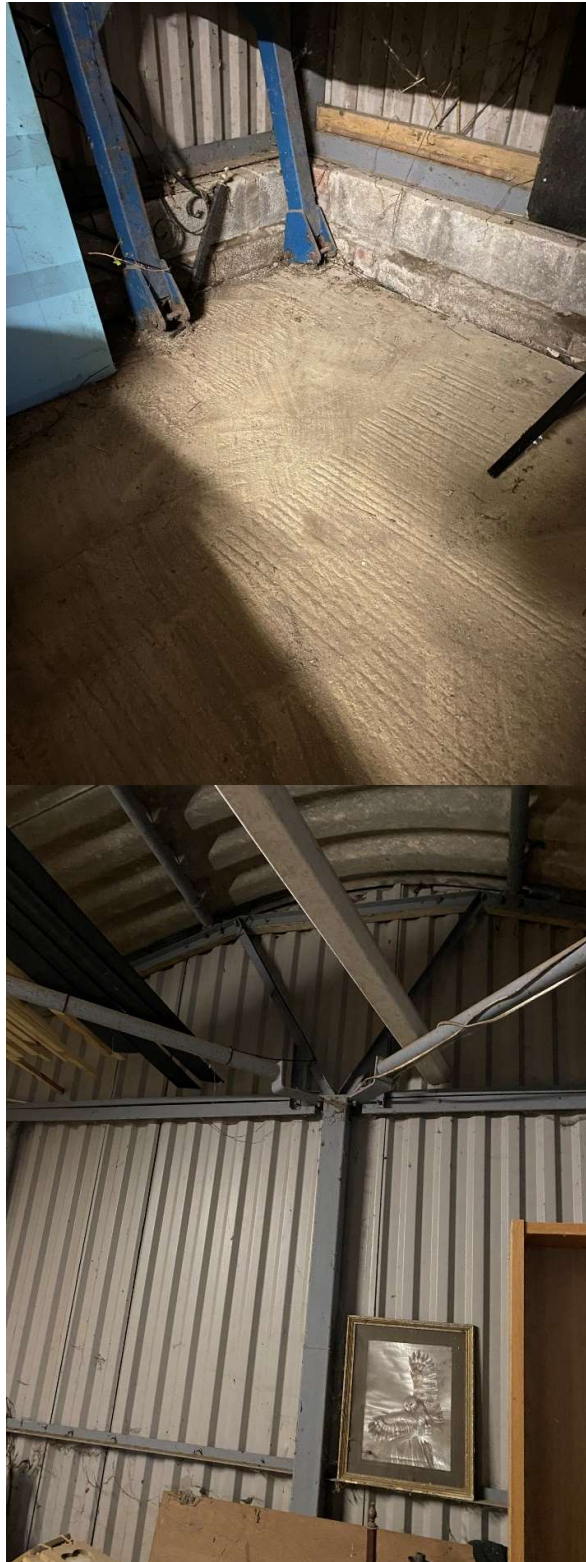




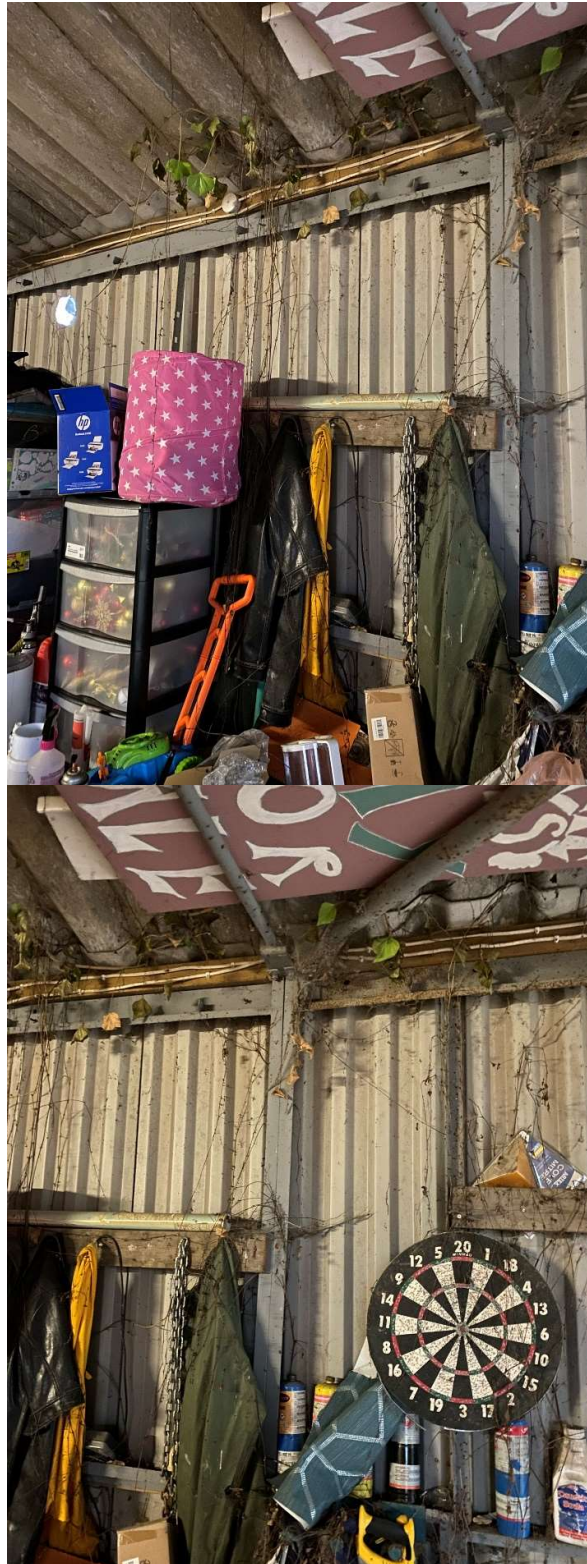




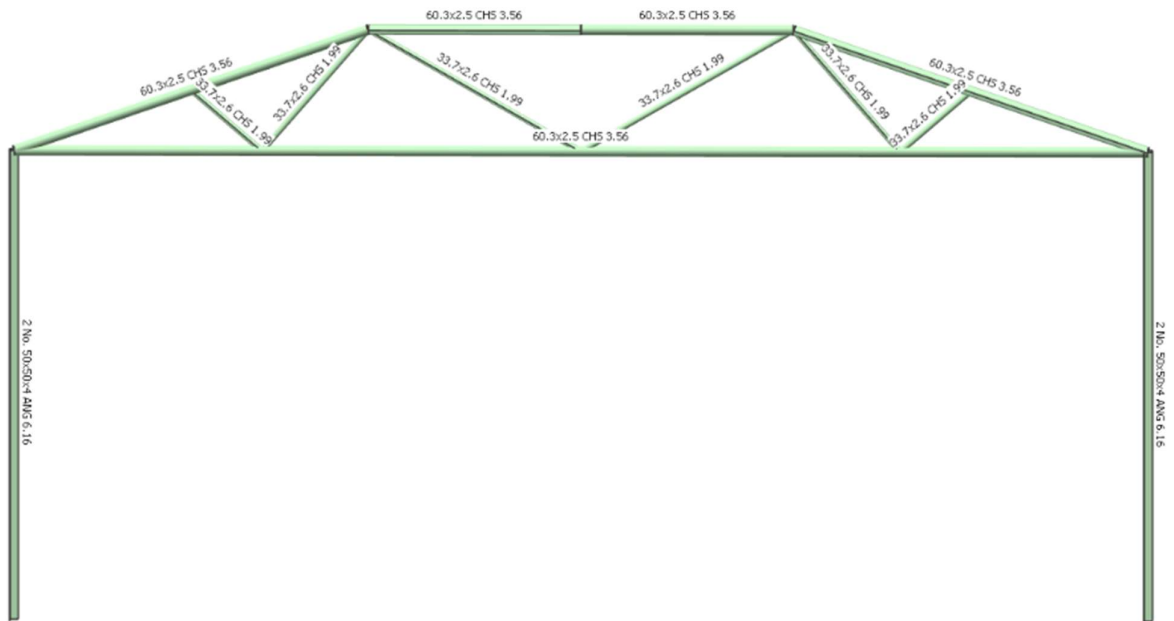








## APPENDIX C



**Frame Geometry - Full Frame - X+012 Y+000 Z+000**

**MASTERFRAME DATA FILE****LOADING CASES AND LOAD COMBINATION****Load Group Labels**

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

**Load Case 001 : Dead plus Live (Ultimate)**

Load Combination + 1.00 UT + 1.40 D1 + 1.60 L1

**Load Case 002 : Live Only (Serviceability)**

Load Combination + 1.00 UT + 1.00 L1

**Load Case 003 : Dead plus Live (Serviceability)**

Load Combination + 1.00 UT + 1.00 D1 + 1.00 L1

**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    | 6.400 | 0.000 | 0.000 |
| 3    | 0.000 | 2.700 | 0.000 | 4    | 1.400 | 2.700 | 0.000 |
| 5    | 3.200 | 2.700 | 0.000 | 6    | 5.000 | 2.700 | 0.000 |
| 7    | 6.400 | 2.700 | 0.000 | 8    | 1.000 | 3.050 | 0.000 |
| 9    | 5.400 | 3.050 | 0.000 | 10   | 3.200 | 3.400 | 0.000 |
| 11   | 4.400 | 3.400 | 0.000 | 12   | 2.000 | 3.400 | 0.000 |

**MEMBER PROPERTIES****Members 1 & 6**

|           |                                |             |           |
|-----------|--------------------------------|-------------|-----------|
| M ... ..  | 2 No. 50x50x4 ANG 6.16 [S 275] |             |           |
| A 7.84E-4 | Ix 18.32E-8                    | Iy 18.32E-8 | J 0.48E-8 |
| E 205.0E6 | G 78.85E6                      |             |           |

**Members 2-5 & 7-12**

|           |                           |             |            |
|-----------|---------------------------|-------------|------------|
| M ... ..  | 60.3x2.5 CHS 3.56 [S 275] |             |            |
| A 4.54E-4 | Ix 18.99E-8               | Iy 18.99E-8 | J 37.99E-8 |
| E 205.0E6 | G 78.85E6                 |             |            |

**Members 13-18**

|           |                           |            |           |
|-----------|---------------------------|------------|-----------|
| M ... ..  | 33.7x2.6 CHS 1.99 [S 275] |            |           |
| A 2.54E-4 | Ix 3.09E-8                | Iy 3.09E-8 | J 6.19E-8 |
| E 205.0E6 | G 78.85E6                 |            |           |

**MEMBER LOADING**

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

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

Members 1-18 - MasterFrame Pro

Loads

|      |         |                       |
|------|---------|-----------------------|
| D1 D | 077.010 | ( kN/m <sup>3</sup> ) |
|------|---------|-----------------------|

**MEMBER END RELEASES**

| Symbols    | End 1 torsion-minor-major | End 2 torsion-minor-major | O Released | @ Fixed |
|------------|---------------------------|---------------------------|------------|---------|
| 2 @OO @@@  | 5 @@@ @OO                 | 9 @OO @@@                 | 10 @@@ @OO |         |
| 11 @OO @@@ | 12 @@@ @OO                | 13 @OO @OO                | 14 @OO @OO |         |
| 15 @OO @OO | 16 @OO @OO                | 17 @OO @OO                | 18 @OO @OO |         |

**NODAL LOADING AND SUPPORT CONDITIONS**

NODES 8-9

D1 Ls +0000.000 -0002.240 +0000.000 +0000.000 +0000.000 +0000.000

NODES 8-9

L1 Ls +0000.000 -0001.900 +0000.000 +0000.000 +0000.000 +0000.000

NODES 11-12

D1 Ls +0000.000 -0003.810 +0000.000 +0000.000 +0000.000 +0000.000

NODES 11-12

L1 Ls +0000.000 -0003.260 +0000.000 +0000.000 +0000.000 +0000.000

## NODES 3 &amp; 7

D1 Ls +0000.000 -0001.120 +0000.000 +0000.000 +0000.000 +0000.000

## NODES 3 &amp; 7

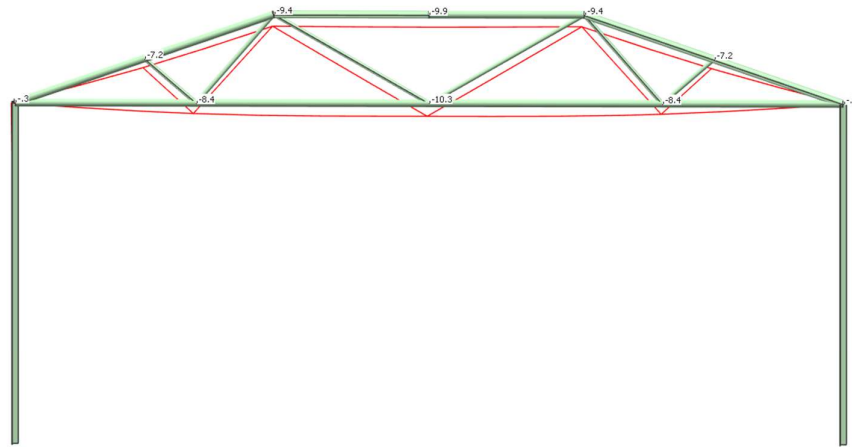
L1 Ls +0000.000 -0000.960 +0000.000 +0000.000 +0000.000 +0000.000

## NODE 1

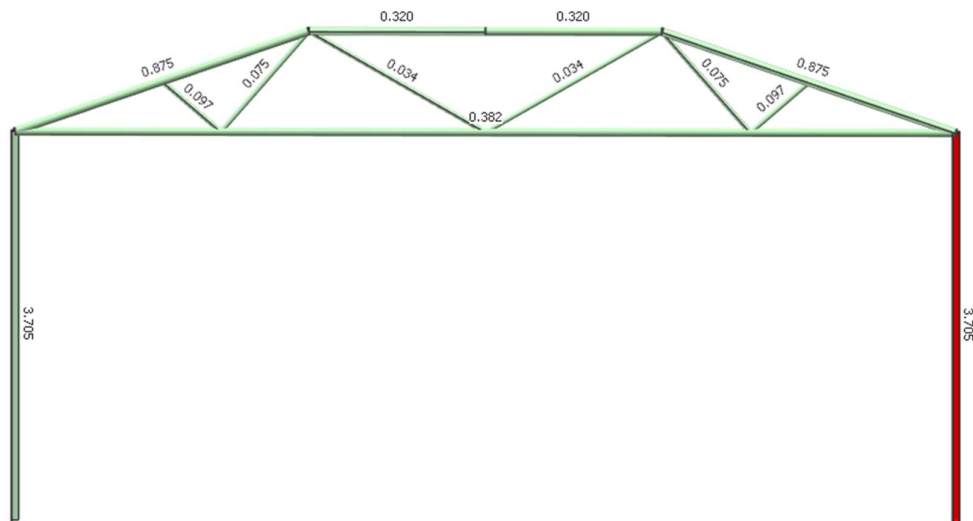
UT Rs 1 1 1 0 0 0 (Pinned)

## NODE 2

UT Rs 1 1 1 0 1 1



**Load Case 001 : Dead plus Live (Ultimate)**  
**Deflected Shape - Full Frame - X+012 Y+000 Z+000**  
**10 Magnification**



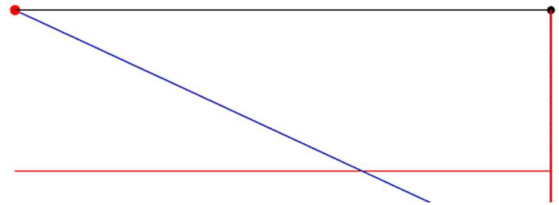
## AXIAL WITH MOMENTS (MEMBER) (FAIL)

### Member SC L1 Id 3 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 |                        |                     |                     |                            |                            |                                   |
|------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                   | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 6                            | 2                      | 20.455C             | 0.000               | 0.000                      | 0.000                      | 0.000                             |
|                              | 7                      | 20.227C             | 0.000               | 0.000                      | @ 0.000                    | @ 1.059                           |

### Additional Nominal Moments

MxUp 2.14 kN.m

### Classification and Properties (BS 5950: 2000)

Section (3.08 kg/m) 2 No. 50x50x4 ANG 6.16 [S 275]

Class = Fn(b,d,t,py) 50, 50, 4, 275

Effective Properties

Auto Design Load Cases

Area=7.53(3.92) cm², Zxx=5.04(2.52) cm³, Zyy=5.04(2.52) cm³

1

(Axial: Slender)

SemiComp

### Local Capacity Check

Fvx/Pvx 0 / 59.4 = 0

Mcx = py.Zxx 275 x 5.04 = 1.386 kN.m

Pz = Ag.py 7.53 x 275 = 206.976 kN

F/Ag.py+Mx/Mcx+My/Mcy 20.455 / 206.976 + 2.14 / 1.386 + 0 = 1.643

Low Shear

Warning

### Compression Resistance Pc

 $\lambda_x = L_{ex}/r_{vv}$  100x1x2.7/0.99 = 273.9

Pcx = Area.pcx 7.53x24.331/10 = 18.313 kN

Warning

Table 24 c

### Lateral Buckling Check Mb u-u

Mb=Zu.py (Fully Restrained) 8.2 x 275 = 2.256 kN.m

### Simplified Approach

py.Zx 275x5.04 = 1.386 kN.m

F/Pc+mx.Mx/py.Zx 20.455/18.313+1x2.1/1.4 = 2.661

WarningMajor  
and Minor Axis  
Moments

Mu = 1.513 kN.m, Mv = 1.513 kN.m

F/Pcy+mLT.MLT/Mb+mv.Mv/py.Zv 20.455/206.976+1x1.5/2.3+1x1.5/1.1 = 2.169

Warning

### Deflection Check - Load Case 0

In-span  $\delta \leq \text{Span}/360$  0  $\leq$  2700 / 360

0 mm

OK

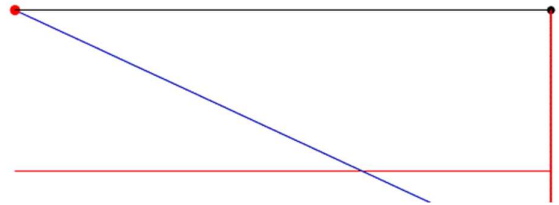
## AXIAL WITH MOMENTS (MEMBER) (FAIL)

### Member SC L1 Id 3 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 |                        |                     |                     |                            |                            |                                   |
|------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                   | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 6                            | 2                      | 20.455C             | 0.000               | 0.000                      | 0.000                      | 0.000                             |
|                              | 7                      | 20.227C             | 0.000               | 0.000                      | @ 0.000                    | @ 1.059                           |

### Additional Nominal Moments

MxUp 2.14 kN.m

### Classification and Properties (BS 5950: 2000)

Section (3.08 kg/m) 2 No. 50x50x4 ANG 6.16 [S 275]  
 Class = Fn(b,d,t,py) 50, 50, 4, 275 (Axial: Slender) SemiComp  
 Effective Properties Area=7.53(3.92) cm², Zxx=5.04(2.52) cm³, Zyy=5.04(2.52) cm³  
 Auto Design Load Cases 1

### Local Capacity Check

Fvx/Pvx 0 / 59.4 = 0 Low Shear  
 Mcx = py.Zxx 275 x 5.04 = 1.386 kN.m  
 Pz = Ag.py 7.53 x 275 = 206.976 kN  
 F/Ag.py+Mx/Mcx+My/Mcy 20.455 / 206.976 + 2.14 / 1.386 + 0 = 1.643 Warning

### Compression Resistance Pc

λx = Lex/rvx 100x1x2.7/0.99 = 273.9 Warning  
 Pcx = Area.pcx 7.53x24.331/10 = 18.313 kN Table 24 c  
 λy = Ley/rvy 100x1x2.7/0.99 = 273.9 Warning  
 Pcy = Area.pcy 7.53x24.33/10 = 18.313 kN Table 24 c

### Lateral Buckling Check Mb u-u

Le = 1.00 L 1 x 2.7 = 2.7 m  
 λv = Lev/rvv 2.7 / 0.99 = 273.87 OK < 300  
 λLT = Fn(λv,Iu,Iv,J,A,Zu) 273.87, 29, 7.6, 0.5, 7.5, 8.2  
 pb = Fn(py,λLT) 275, 84.37  
 Mb = Zu.pb 155.2 N/mm² Table 16  
 1.273 kN.m

### Simplified Approach

py.Zx 275x5.04 = 1.386 kN.m  
 F/Pc+mx.Mx/py.Zx 20.455/18.313+1x2.1/1.4 = 2.661 WarningMajor and Minor Axis Moments

Mu = 1.513 kN.m, Mv = 1.513 kN.m  
 F/Pcy+mLT.MLT/Mb+mv.Mv/py.Zv 20.455/18.313+1x1.5/1.3+1x1.5/1.1 = 3.705 Warning

### Deflection Check - Load Case 0

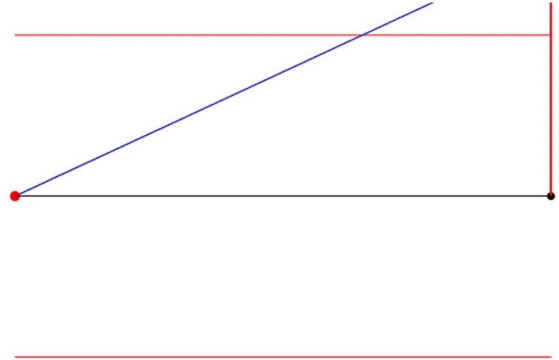
In-span δ ≤ Span/360 0 ≤ 2700 / 360 0 mm OK

## AXIAL WITH MOMENTS (MEMBER) (FAIL)

### Member SC L1 Id 1 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m<sup>3</sup>)



| Member Forces in Load Case 1 |                        |                     |                     |                            |                            |                                   |
|------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                   | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 1                            | 1                      | 20.455C             | 0.000               | 0.000                      | 0.000                      | 0.000                             |
|                              | 3                      | 20.227C             | 0.000               | 0.000                      | @ 0.000                    | @ 1.059                           |

### Additional Nominal Moments

MxUp -2.14 kN.m

### Classification and Properties (BS 5950: 2000)

Section (3.08 kg/m) 2 No. 50x50x4 ANG 6.16 [S 275]  
 Class = Fn(b,d,t,py) 50, 50, 4, 275 (Axial: Slender) SemiComp  
 Effective Properties Area=7.53(3.92) cm<sup>2</sup>, Zxx=5.04(2.52) cm<sup>3</sup>, Zyy=5.04(2.52) cm<sup>3</sup>  
 Auto Design Load Cases 1

### Local Capacity Check

Fvx/Pvx 0 / 59.4 = 0 Low Shear  
 Mcx = py.Zxx 275 x 5.04 = 1.386 kN.m  
 Pz = Ag.py 7.53 x 275 = 206.976 kN  
 F/Ag.py+Mx/Mcx+My/Mcy 20.455 / 206.976 + 2.14 / 1.386 + 0 = 1.643 Warning

### Compression Resistance Pc

λx = Lex/rvv 100x1x2.7/0.99 = 273.9 Warning  
 Pcx = Area.pcx 7.53x24.33/10 = 18.313 kN Table 24 c  
 λy = Ley/rvv 100x1x2.7/0.99 = 273.9 Warning  
 Pcy = Area.pcy 7.53x24.33/10 = 18.313 kN Table 24 c

### Lateral Buckling Check Mb u-u

Le = 1.00 L 1 x 2.7 = 2.7 m  
 λv = Lev/rvv 2.7 / 0.99 = 273.87 OK < 300  
 λLT = Fn(λv,Iu,Iv,J,A,Zu) 273.87, 29, 7.6, 0.5, 7.5, 8.2  
 pb = Fn(py,λLT) 275, 84.37  
 Mb = Zu.pb 155.2 N/mm<sup>2</sup> Table 16  
 1.273 kN.m

### Simplified Approach

py.Zx 275x5.04 = 1.386 kN.m  
 F/Pc+mx.Mx/py.Zx 20.455/18.313+1x2.1/1.4 = 2.661 WarningMajor and Minor Axis Moments

Mu = 1.513 kN.m, Mv = 1.513 kN.m  
 F/Pcy+mLT.MLT/Mb+mv.Mv/py.Zv 20.455/18.313+1x1.5/1.3+1x1.5/1.1 = 3.705 Warning

### Deflection Check In-Span - Load Case 0

δ ≤ Span/360 0 ≤ 2700 / 360 = 0 mm OK

### Deflection Check Lateral Sway - Load Case 3

δ ≤ Span/200 1.99 ≤ 2700 / 200 = 1.99 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 2 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m<sup>3</sup>)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| -                                                                    | 3                      | 47.683T             | 0.152               | 0.000                      | 0.165                      | 6.681                             |
|                                                                      | 7                      | 47.683T             | -0.152              | 0.000                      | @ 1.400                    | @ 3.668                           |

### Classification and Properties (BS 5950: 2000)

Section (3.56 kg/m) 60.3x2.5 CHS 3.56 [S 275]  
Class = Fn(D/t,py) 24.12, 275 (Axial: Non-Slender) Plastic  
Auto Design Load Cases 1

### Shear Capacity Check

Fvx/Pvx 0.155 / 44.946 = 0.003 OK

### Local Capacity Check

Fvx/Pvx 0.084 / 44.946 = 0.002 Low Shear  
M<sub>cx</sub> = p<sub>y</sub>.S<sub>xx</sub> ≤ 1.2 x 275 x 6.3 = 2.079 kN.m  
A<sub>e</sub> = F<sub>n</sub>(A<sub>g</sub>, A<sub>net</sub>, p<sub>y</sub>, U<sub>s</sub>) 4.54, 4.54, 275, 410 4.54 cm<sup>2</sup>  
P<sub>z</sub> = A<sub>e</sub>.p<sub>y</sub> 4.54x275 124.85 kN  
n = F/P<sub>z</sub> -47.683 / 124.85 = 0.382 OK  
S<sub>rx</sub> = F<sub>n</sub>(S<sub>xx</sub>,) 8.36, 0.382 6.9 cm<sup>3</sup>  
M<sub>rx</sub> = S<sub>rx</sub>.p<sub>y</sub> 6.9 x 275 1.898 kN.m  
(M<sub>x</sub>/M<sub>rx</sub>)<sup>2.1</sup> + (M<sub>y</sub>/M<sub>ry</sub>)<sup>2.2</sup> = (0.165/1.898)<sup>2</sup> + (0)<sup>2</sup> = 0.008 OK

### Equivalent Uniform Moment Factors m<sub>LT</sub>, m<sub>x</sub>, m<sub>y</sub> and m<sub>yx</sub>

m<sub>LT</sub> = 0.2 + (.15M<sub>2</sub> + .5M<sub>3</sub> + .15M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44 0.57 Table 18  
m<sub>y</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26  
m<sub>x</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 0.742 Table 26  
m<sub>yx</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26

### Lateral Buckling Check Mb

M<sub>b</sub> = M<sub>c</sub> Section not susceptible to lateral torsional buckling 2.079 kN.m

### Simplified Approach

p<sub>y</sub>.Z<sub>x</sub> 275x6.3 1.733 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/p<sub>y</sub>.Z<sub>x</sub> 0 + 0.742x0.2/1.7 0.071 OK  
F/P<sub>c</sub> + m<sub>LT</sub>.M<sub>LT</sub>/M<sub>b</sub> 0 + 0.57x0.2/2.1 0.045 OK

### More Exact Approach

M<sub>ax</sub> = M<sub>cx</sub>/(1 + .5F/P<sub>c</sub>) 2.1/(1 + .5x0/9) 2.079 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/M<sub>ax</sub> 0/9 + 0.742x0.2/2.1 0.059 OK  
F/P<sub>c</sub> + .5m<sub>LT</sub>.M<sub>LT</sub>/M<sub>cx</sub> 0/9 + .50.57x0.2/2.1 0.023 OK

### Deflection Check - Load Case 3

In-span δ ≤ Span/360 6.68 ≤ 6400 / 360 6.68 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 2 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| -                                                                    | 3                      | 47.683T             | 0.152               | 0.000                      | 0.165                      | 6.681                             |
|                                                                      | 7                      | 47.683T             | -0.152              | 0.000                      | @ 1.400                    | @ 3.668                           |

### Classification and Properties (BS 5950: 2000)

Section (3.56 kg/m) 60.3x2.5 CHS 3.56 [S 275]  
Class = Fn(D/t,py) 24.12, 275 (Axial: Non-Slender) Plastic  
Auto Design Load Cases 1

### Shear Capacity Check

Fvx/Pvx 0.155 / 44.946 = 0.003 OK

### Local Capacity Check

Fvx/Pvx 0.084 / 44.946 = 0.002 Low Shear  
M<sub>cx</sub> = p<sub>y</sub>.S<sub>xx</sub> ≤ 1.2 x 275 x 6.3 = 2.079 kN.m  
A<sub>e</sub> = F<sub>n</sub>(A<sub>g</sub>, A<sub>net</sub>, p<sub>y</sub>, U<sub>s</sub>) 4.54, 4.54, 275, 410 4.54 cm²  
P<sub>z</sub> = A<sub>e</sub>.p<sub>y</sub> 4.54x275 124.85 kN  
n = F/P<sub>z</sub> -47.683 / 124.85 = 0.382 OK  
S<sub>rx</sub> = F<sub>n</sub>(S<sub>xx</sub>,) 8.36, 0.382 6.9 cm³  
M<sub>rx</sub> = S<sub>rx</sub>.p<sub>y</sub> 6.9 x 275 1.898 kN.m  
(M<sub>x</sub>/M<sub>rx</sub>)<sup>2.1</sup> + (M<sub>y</sub>/M<sub>ry</sub>)<sup>2.2</sup> = (0.165/1.898)<sup>2</sup> + (0)<sup>2</sup> = 0.008 OK

### Equivalent Uniform Moment Factors m<sub>LT</sub>, m<sub>x</sub>, m<sub>y</sub> and m<sub>yx</sub>

m<sub>LT</sub> = 0.2 + (.15M<sub>2</sub> + .5M<sub>3</sub> + .15M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44 0.57 Table 18  
m<sub>y</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26  
m<sub>x</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 0.742 Table 26  
m<sub>yx</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26

### Lateral Buckling Check Mb

M<sub>b</sub> = M<sub>c</sub> Section not susceptible to lateral torsional buckling 2.079 kN.m

### Simplified Approach

p<sub>y</sub>.Z<sub>x</sub> 275x6.3 1.733 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/p<sub>y</sub>.Z<sub>x</sub> 0 + 0.742x0.2/1.7 0.071 OK  
F/P<sub>c</sub> + m<sub>LT</sub>.M<sub>LT</sub>/M<sub>b</sub> 0 + 0.57x0.2/2.1 0.045 OK

### More Exact Approach

M<sub>ax</sub> = M<sub>cx</sub>/(1 + .5F/P<sub>c</sub>) 2.1/(1 + .5x0/9) 2.079 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/M<sub>ax</sub> 0/9 + 0.742x0.2/2.1 0.059 OK  
F/P<sub>c</sub> + .5m<sub>LT</sub>.M<sub>LT</sub>/M<sub>cx</sub> 0/9 + .50.57x0.2/2.1 0.023 OK

### Deflection Check - Load Case 3

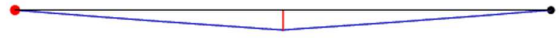
In-span δ ≤ Span/360 6.68 ≤ 6400 / 360 6.68 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 6 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m<sup>3</sup>)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| -                                                                    | 3                      | 50.613C             | 0.266               | 0.000                      | 0.256                      | 1.691                             |
|                                                                      | 12                     | 45.476C             | -0.266              | 0.000                      | @ 1.059                    | @ 1.059                           |

### Classification and Properties (BS 5950: 2000)

Section (3.56 kg/m) 60.3x2.5 CHS 3.56 [S 275]  
Class = Fn(D/t,py) 24.12, 275 (Axial: Non-Slender) Plastic

Auto Design Load Cases 1

### Shear Capacity Check

$F_{vx}/P_{vx}$  0.266 / 44.946 = 0.006 OK

### Local Capacity Check

$F_{vx}/P_{vx}$  0.217 / 44.946 = 0.005 Low Shear  
 $M_{cx} = p_y.S_{xx} \leq 1.2 \times p_y.Z_{xx}$  275 x 8.36 ≤ 1.2 x 275 x 6.3 = 2.079 kN.m  
 $P_z = A_g.p_y$  4.54 x 275 = 124.85 kN  
 $n = F/P_z$  50.613 / 124.85 = 0.405 OK  
 $S_{rx} = F_n(S_{xx})$  8.36, 0.405 6.72 cm<sup>3</sup>  
 $M_{rx} = S_{rx}.p_y$  6.72 x 275 1.848 kN.m  
 $(M_x/M_{rx})^{2.1} + (M_y/M_{ry})^{2.2}$  (0.256/1.848)<sup>2.1</sup> + (0)<sup>2.2</sup> = 0.019 OK

### Compression Resistance $P_c$

$\lambda_x = L_{ex}/r_{xx}$  100x1x2.119/2.05 = 103.4 OK  
 $P_{cx} = A_{area}.p_{cx}$  4.54x150.121/10 = 68.155 kN Table 24 a  
 $\lambda_y = L_{ey}/r_{yy}$  100x1x2.119/2.05 = 103.4 OK  
 $P_{cy} = A_{area}.p_{cy}$  4.54x150.12/10 = 68.155 kN Table 24 a

### Equivalent Uniform Moment Factors $m_{LT}$ , $m_x$ , $m_y$ and $m_{yx}$

$m_{LT} = 0.2 + (.15M_2 + .5M_3 + .15M_4)/M_{max}$  0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44 0.853 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 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 0.899 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 $M_b$

$M_b = M_c$  Section not susceptible to lateral torsional buckling 2.079 kN.m

### Simplified Approach

$p_y.Z_x$  275x6.3 1.733 kN.m  
 $F/P_c + m_x.M_x/p_y.Z_x$  50.613/68.155 + 0.899x0.3/1.7 0.875 OK  
 $F/P_{cy} + m_{LT}.M_{LT}/M_b$  50.613/68.155 + 0.853x0.3/2.1 0.848 OK

### More Exact Approach

$M_{ax} = M_{cx}/(1 + .5F/P_{cx})$  2.1/(1 + .5x50.6/68.2) 1.516 kN.m  
 $F/P_{cx} + m_x.M_x/M_{ax}$  50.6/68.2 + 0.899x0.3/1.5 0.894 OK  
 $F/P_{cy} + .5m_{LT}.M_{LT}/M_{cx}$  50.6/68.2 + .5x0.853x0.3/2.1 0.795 OK

### Deflection Check - Load Case 3

In-span  $\delta \leq \text{Span}/360$  1.69 ≤ 2119 / 360 1.69 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 8 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 ( kN/m³)



| Member Forces in Load Case 1 |                        |                     |                     |                            |                            |                                   |
|------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                   | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 13                           | 4                      | 6.213C              | -0.005              | 0.000                      |                            | 0.000                             |
|                              | 8                      | 6.204C              | 0.005               | 0.000                      |                            | @ 1.059                           |

### Classification and Properties (BS 5950: 2000)

Section (1.99 kg/m)

33.7x2.6 CHS 1.99 [S 275]

Class = Fn(D/t,py)

12.96, 275

(Axial: Non-  
Slender)

Plastic

Auto Design Load Cases

1

### Local Capacity Check

Pz = Ag.py

2.54 x 275 =

69.85 kN

OK

F/Ag.py

6.213 / 69.85 =

0.089

OK

### Compression Resistance Pc

 $\lambda_x = L_{ex}/r_{xx}$ 

100x1x0.532/1.1 =

48.3

OK

Pcx = Area.pcx

2.54x252.759/10 =

64.201 kN

Table 24 a

 $\lambda_y = L_{ey}/r_{yy}$ 

100x1x0.532/1.1 =

48.3

OK

Pcy = Area.pcy

2.54x252.76/10 =

64.201 kN

Table 24 a

### Simplified Approach

F/Pc

6.213/64.201

0.097

OK

F/Pcy

6.213/64.201

0.097

OK

### More Exact Approach

F/Pcx

6.2/64.2

0.097

OK

F/Pcy

6.2/64.2

0.097

OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 9 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 14                                                                   | 4                      | 5.203T              | 0.008               | 0.000                      | 0.002                      | 0.019                             |
|                                                                      | 12                     | 5.222T              | -0.008              | 0.000                      | @ 0.000                    | @ 0.461                           |

### Classification and Properties (BS 5950: 2000)

Section (1.99 kg/m) 33.7x2.6 CHS 1.99 [S 275]  
 Class = Fn(D/t,py) 12.96, 275 (Axial: Non-Slender) Plastic  
 Auto Design Load Cases 1

### Local Capacity Check

Ae = Fn(Ag,A.net,py,Us) 2.54,2.54,275,410 2.54 cm²  
 Pz = Ae.py 2.54x275 69.85 kN OK  
 F/Ae.py -5.222 / 69.85 = 0.075 OK

### Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT} = 0.2 + (.15M_2 + .5M_3 + .15M_4) / M_{max}$   $0.2 + (.15 \times 0 + .5 \times 0 + .15 \times 0) / 0 = 0.44$  0.925 Table 18  
 $m_y = 0.2 + (.1M_2 + .6M_3 + .1M_4) / M_{max}$   $0.2 + (.1 \times 0 + .6 \times 0 + .1 \times 0) / 0 = .8 \times 0 / 0$  1 Table 26  
 $m_x = 0.2 + (.1M_2 + .6M_3 + .1M_4) / M_{max}$   $0.2 + (.1 \times 0 + .6 \times 0 + .1 \times 0) / 0 = .8 \times 0 / 0$  0.95 Table 26  
 $m_{yx} = 0.2 + (.1M_2 + .6M_3 + .1M_4) / M_{max}$   $0.2 + (.1 \times 0 + .6 \times 0 + .1 \times 0) / 0 = .8 \times 0 / 0$  1 Table 26

### Lateral Buckling Check Mb

Mb = Mc Section not susceptible to lateral torsional buckling 0.604 kN.m

### Deflection Check - Load Case 3

In-span  $\delta \leq \text{Span}/360$   $0.02 \leq 922 / 360$  0.02 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 10 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 15                                                                   | 5                      | 0.336T              | -0.016              | 0.000                      | -0.005                     | 0.129                             |
|                                                                      | 12                     | 0.355T              | 0.016               | 0.000                      | @ 0.500                    | @ 0.695                           |

### Classification and Properties (BS 5950: 2000)

Section (1.99 kg/m) 33.7x2.6 CHS 1.99 [S 275]  
Class = Fn(D/t,py) 12.96, 275 (Axial: Non-Slender) Plastic  
Auto Design Load Cases 1

### Shear Capacity Check

Fvx/Pvx 0.016 / 25.146 = 0.001 OK

### Local Capacity Check

Fvx/Pvx 0 / 25.146 = 0 Low Shear  
M<sub>cx</sub> = p<sub>y</sub>.S<sub>xx</sub> ≤ 1.2 p<sub>y</sub>.Z<sub>xx</sub> 275 x 2.52 ≤ 1.2 x 275 x 1.83 = 0.604 kN.m  
A<sub>e</sub> = F<sub>n</sub>(A<sub>g</sub>, A<sub>net</sub>, p<sub>y</sub>, U<sub>s</sub>) 2.54, 2.54, 275, 410 2.54 cm²  
P<sub>z</sub> = A<sub>e</sub>.p<sub>y</sub> 2.54 x 275 69.85 kN  
n = F/P<sub>z</sub> -0.355 / 69.85 = 0.005 OK  
S<sub>rx</sub> = F<sub>n</sub>(S<sub>xx</sub>,) 2.52, 0.005 2.52 cm³  
M<sub>rx</sub> = S<sub>rx</sub>.p<sub>y</sub> 2.52 x 275 0.604 kN.m  
(M<sub>x</sub>/M<sub>rx</sub>)<sup>2.1</sup> + (M<sub>y</sub>/M<sub>ry</sub>)<sup>2.2</sup> (0.005/0.604)² + (0)² = 0 OK

### Equivalent Uniform Moment Factors m<sub>LT</sub>, m<sub>x</sub>, m<sub>y</sub> and m<sub>yx</sub>

m<sub>LT</sub> = 0.2 + (.15M<sub>2</sub> + .5M<sub>3</sub> + .15M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44 0.88 Table 18  
m<sub>y</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26  
m<sub>x</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 0.92 Table 26  
m<sub>yx</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26

### Lateral Buckling Check Mb

M<sub>b</sub> = M<sub>c</sub> Section not susceptible to lateral torsional buckling 0.604 kN.m

### Simplified Approach

p<sub>y</sub>.Z<sub>x</sub> 275x1.83 0.503 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/p<sub>y</sub>.Z<sub>x</sub> 0 + 0.92x0/0.5 0.009 OK  
F/P<sub>c</sub> + m<sub>LT</sub>.M<sub>LT</sub>/M<sub>b</sub> 0 + 0.88x0/0.6 0.007 OK

### More Exact Approach

Max = M<sub>cx</sub>/(1 + .5F/P<sub>c</sub>) 0.6/(1 + .5x0/27.6) 0.604 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/Max 0/27.6 + 0.92x0/0.6 0.008 OK  
F/P<sub>c</sub> + .5m<sub>LT</sub>.M<sub>LT</sub>/M<sub>cx</sub> 0/27.6 + .50.88x0/0.6 0.004 OK

### Deflection Check - Load Case 3

In-span δ ≤ Span/360 0.13 ≤ 1389 / 360 0.13 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 5 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 8                                                                    | 10                     | 39.917C             | 0.000               | -0.035                     |                            | 0.083                             |
|                                                                      | 12                     | 39.917C             | 0.059               | 0.000                      |                            | @ 0.540                           |

### Classification and Properties (BS 5950: 2000)

Section (3.56 kg/m)

60.3x2.5 CHS 3.56 [S 275]

Class = Fn(D/t,py)

24.12, 275

(Axial: Non-Slender)

Plastic

Auto Design Load Cases

1

### Shear Capacity Check

Fvx/Pvx

0.059 / 44.946 =

0.001

OK

### Local Capacity Check

Fvx/Pvx

0 / 44.946 =

0

Low Shear

M<sub>cx</sub> = p<sub>y</sub>.S<sub>xx</sub> ≤ 1.2 x p<sub>y</sub>.Z<sub>xx</sub>

275 x 8.36 ≤ 1.2 x 275 x 6.3 =

2.079 kN.m

P<sub>z</sub> = A<sub>g</sub>.p<sub>y</sub>

4.54 x 275 =

124.85 kN

n = F/P<sub>z</sub>

39.917 / 124.85 =

0.320

OK

S<sub>rx</sub> = F<sub>n</sub>(S<sub>xx</sub>)

8.36, 0.32

7.33 cm³

M<sub>rx</sub> = S<sub>rx</sub>.p<sub>y</sub>

7.33 x 275

2.015 kN.m

(M<sub>x</sub>/M<sub>rx</sub>)<sup>2.1</sup> + (M<sub>y</sub>/M<sub>ry</sub>)<sup>2.2</sup>(0.035/2.015)<sup>2</sup> + (0)<sup>2</sup> =

0

OK

### Compression Resistance P<sub>c</sub>

λ<sub>x</sub> = L<sub>ex</sub>/r<sub>xx</sub>

100x1x1.2/2.05 =

58.5

OK

P<sub>cx</sub> = Area.p<sub>cx</sub>

4.54x241.242/10 =

109.524 kN

Table 24 a

λ<sub>y</sub> = L<sub>ey</sub>/r<sub>yy</sub>

100x1x1.2/2.05 =

58.5

OK

P<sub>cy</sub> = Area.p<sub>cy</sub>

4.54x241.24/10 =

109.524 kN

Table 24 a

### Equivalent Uniform Moment Factors m<sub>LT</sub>, m<sub>x</sub>, m<sub>y</sub> and m<sub>yx</sub>

m<sub>LT</sub> = 0.2 + (.15M<sub>2</sub> + .5M<sub>3</sub> + .15M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44

0.79

Table 18

m<sub>ly</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0

1

Table 26

m<sub>x</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0

0.78

Table 26

m<sub>lyx</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0

1

Table 26

### Lateral Buckling Check M<sub>b</sub>

M<sub>b</sub> = M<sub>c</sub>

Section not susceptible to lateral torsional buckling

2.079 kN.m

### Combined Axial Compression and Bending to Annex I

r<sub>b</sub> = m<sub>LT</sub>.M<sub>LT</sub>/M<sub>b</sub>

0.79x0/2.1

0.013

r<sub>c</sub> = F<sub>d</sub>/P<sub>cy</sub>

39.9/109.5

0.364

λ<sub>r</sub> = (r<sub>b</sub> λ<sub>LT</sub> + r<sub>c</sub> λ<sub>y</sub>)/(r<sub>b</sub> + r<sub>c</sub>)

(0.013•0 + 0.364•58.5)/(0.013 + 0.364)

56.533

λ<sub>r</sub> = 17.15 ε (2r<sub>b</sub> + r<sub>c</sub>)/(r<sub>b</sub> + r<sub>c</sub>)

17.15•1(2•0.013 + 0.364)/(0.013 + 0.364)

17.737

M<sub>ob</sub> = M<sub>b</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)

2.079(1 - 39.9/109.5)

1.321

M<sub>xy</sub> = 2M<sub>cx</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)

2•2.079(1 - 39.9/109.5)

2.643

M<sub>ox</sub> = M<sub>cx</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)/(1 + 0.5F<sub>d</sub>/P<sub>cx</sub>)

2.079(1 - 39.9/109.5)/(1 + 0.5•39.9/109.5)

1.118

M<sub>oy</sub> = M<sub>cy</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)/(1 + k<sub>y</sub>(F<sub>d</sub>/P<sub>cy</sub>))

2.079(1 - 39.9/109.5)/(1 + 0.5(39.9/109.5))

1.118

M<sub>ab</sub> = fn( λ<sub>r</sub>, λ<sub>r</sub> O, ε<sub>r</sub>, M<sub>xy</sub>, M<sub>ob</sub>)

56.533, 17.737, 1.000, 2.643, 1.321

1.620

M<sub>ax</sub> = fn( λ<sub>r</sub>, ε<sub>r</sub>, M<sub>ox</sub>, M<sub>oy</sub>)

58.537, 1.000, 2.015, 1.118

1.474

|                                               |                             |         |    |
|-----------------------------------------------|-----------------------------|---------|----|
| $M_{ay}=fn(\lambda_y, \epsilon, M_y, M_{oy})$ | 58.537, 1.000, 2.015, 1.118 | 1.474   |    |
| $m_x.M_x/M_{ax}$                              | 0.78x0/1.5                  | 0.019   | OK |
| $m_{LT}.M_{LT}/M_{ab}$                        | 0.79x0/1.6                  | 0.017   | OK |
| $m_x.M_x/M_{ax}$                              | 0.78x0/1.5                  | 0.018   | OK |
| Compare with Simplified to 4.8.3.3            | 0.38, 0.377, 0.377          | 0.38    |    |
| Compare with MoreExact to 4.8.3.3             | 0.38, 0.371, 0.024          | 0.38    |    |
| <b>Deflection Check - Load Case 3</b>         |                             |         |    |
| In-span $\delta \leq \text{Span}/360$         | $0.08 \leq 1200 / 360$      | 0.08 mm | OK |

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 11 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 16                                                                   | 5                      | 0.336T              | 0.016               | 0.000                      | 0.005                      | 0.129                             |
|                                                                      | 11                     | 0.355T              | -0.016              | 0.000                      | @ 0.500                    | @ 0.695                           |

### Classification and Properties (BS 5950: 2000)

Section (1.99 kg/m) 33.7x2.6 CHS 1.99 [S 275]  
Class = Fn(D/t,py) 12.96, 275 (Axial: Non-Slender) Plastic  
Auto Design Load Cases 1

### Shear Capacity Check

Fvx/Pvx 0.016 / 25.146 = 0.001 OK

### Local Capacity Check

Fvx/Pvx 0 / 25.146 = 0 Low Shear  
M<sub>cx</sub> = p<sub>y</sub>.S<sub>xx</sub> ≤ 1.2 p<sub>y</sub>.Z<sub>xx</sub> 275 x 2.52 ≤ 1.2 x 275 x 1.83 = 0.604 kN.m  
A<sub>e</sub> = F<sub>n</sub>(A<sub>g</sub>, A<sub>net</sub>, p<sub>y</sub>, U<sub>s</sub>) 2.54, 2.54, 275, 410 2.54 cm²  
P<sub>z</sub> = A<sub>e</sub>.p<sub>y</sub> 2.54 x 275 69.85 kN  
n = F/P<sub>z</sub> -0.355 / 69.85 = 0.005 OK  
S<sub>rx</sub> = F<sub>n</sub>(S<sub>xx</sub>,) 2.52, 0.005 2.52 cm³  
M<sub>rx</sub> = S<sub>rx</sub>.p<sub>y</sub> 2.52 x 275 0.604 kN.m  
(M<sub>x</sub>/M<sub>rx</sub>)<sup>2.1</sup> + (M<sub>y</sub>/M<sub>ry</sub>)<sup>2.2</sup> (0.005/0.604)<sup>2</sup> + (0)<sup>2</sup> = 0 OK

### Equivalent Uniform Moment Factors m<sub>LT</sub>, m<sub>x</sub>, m<sub>y</sub> and m<sub>yx</sub>

m<sub>LT</sub> = 0.2 + (.15M<sub>2</sub> + .5M<sub>3</sub> + .15M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44 0.88 Table 18  
m<sub>y</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26  
m<sub>x</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 0.92 Table 26  
m<sub>yx</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub> 0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 1 Table 26

### Lateral Buckling Check Mb

M<sub>b</sub> = M<sub>c</sub> Section not susceptible to lateral torsional buckling 0.604 kN.m

### Simplified Approach

p<sub>y</sub>.Z<sub>x</sub> 275x1.83 0.503 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/p<sub>y</sub>.Z<sub>x</sub> 0 + 0.92x0/0.5 0.009 OK  
F/P<sub>c</sub> + m<sub>LT</sub>.M<sub>LT</sub>/M<sub>b</sub> 0 + 0.88x0/0.6 0.007 OK

### More Exact Approach

Max = M<sub>cx</sub>/(1 + .5F/P<sub>c</sub>) 0.6/(1 + .5x0/27.6) 0.604 kN.m  
F/P<sub>c</sub> + m<sub>x</sub>.M<sub>x</sub>/Max 0/27.6 + 0.92x0/0.6 0.008 OK  
F/P<sub>c</sub> + .5m<sub>LT</sub>.M<sub>LT</sub>/M<sub>cx</sub> 0/27.6 + .50.88x0/0.6 0.004 OK

### Deflection Check - Load Case 3

In-span δ ≤ Span/360 0.13 ≤ 1389 / 360 0.13 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 4 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 7                                                                    | 10                     | 39.917C             | 0.000               | 0.035                      |                            | 0.083                             |
|                                                                      | 11                     | 39.917C             | -0.059              | 0.000                      |                            | @ 0.540                           |

### Classification and Properties (BS 5950: 2000)

Section (3.56 kg/m)

60.3x2.5 CHS 3.56 [S 275]

Class = Fn(D/t,py)

24.12, 275

(Axial: Non-Slender)

Plastic

Auto Design Load Cases

1

### Shear Capacity Check

Fvx/Pvx

0.059 / 44.946 =

0.001

OK

### Local Capacity Check

Fvx/Pvx

0 / 44.946 =

0

Low Shear

M<sub>cx</sub> = p<sub>y</sub>.S<sub>xx</sub> ≤ 1.2 x p<sub>y</sub>.Z<sub>xx</sub>

275 x 8.36 ≤ 1.2 x 275 x 6.3 =

2.079 kN.m

P<sub>z</sub> = A<sub>g</sub>.p<sub>y</sub>

4.54 x 275 =

124.85 kN

n = F/P<sub>z</sub>

39.917 / 124.85 =

0.320

OK

S<sub>rx</sub> = F<sub>n</sub>(S<sub>xx</sub>)

8.36, 0.32

7.33 cm³

M<sub>rx</sub> = S<sub>rx</sub>.p<sub>y</sub>

7.33 x 275

2.015 kN.m

(M<sub>x</sub>/M<sub>rx</sub>)<sup>2.1</sup> + (M<sub>y</sub>/M<sub>ry</sub>)<sup>2.2</sup>(0.035/2.015)<sup>2</sup> + (0)<sup>2</sup> =

0

OK

### Compression Resistance P<sub>c</sub>

λ<sub>x</sub> = L<sub>ex</sub>/r<sub>xx</sub>

100x1x1.2/2.05 =

58.5

OK

P<sub>cx</sub> = Area.p<sub>cx</sub>

4.54x241.242/10 =

109.524 kN

Table 24 a

λ<sub>y</sub> = L<sub>ey</sub>/r<sub>yy</sub>

100x1x1.2/2.05 =

58.5

OK

P<sub>cy</sub> = Area.p<sub>cy</sub>

4.54x241.24/10 =

109.524 kN

Table 24 a

### Equivalent Uniform Moment Factors m<sub>LT</sub>, m<sub>x</sub>, m<sub>y</sub> and m<sub>yx</sub>

m<sub>LT</sub> = 0.2 + (.15M<sub>2</sub> + .5M<sub>3</sub> + .15M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44

0.79

Table 18

m<sub>ly</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0

1

Table 26

m<sub>x</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0

0.78

Table 26

m<sub>lyx</sub> = 0.2 + (.1M<sub>2</sub> + .6M<sub>3</sub> + .1M<sub>4</sub>)/M<sub>max</sub>

0.2 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0

1

Table 26

### Lateral Buckling Check M<sub>b</sub>

M<sub>b</sub> = M<sub>c</sub>

Section not susceptible to lateral torsional buckling

2.079 kN.m

### Combined Axial Compression and Bending to Annex I

r<sub>b</sub> = m<sub>LT</sub>.M<sub>LT</sub>/M<sub>b</sub>

0.79x0/2.1

0.013

r<sub>c</sub> = F<sub>d</sub>/P<sub>cy</sub>

39.9/109.5

0.364

λ<sub>r</sub> = (r<sub>b</sub> λ<sub>LT</sub> + r<sub>c</sub> λ<sub>y</sub>)/(r<sub>b</sub> + r<sub>c</sub>)

(0.013•0 + 0.364•58.5)/(0.013 + 0.364)

56.533

λ<sub>r0</sub> = 17.15 ε (2r<sub>b</sub> + r<sub>c</sub>)/(r<sub>b</sub> + r<sub>c</sub>)

17.15•1(2•0.013 + 0.364)/(0.013 + 0.364)

17.737

M<sub>ob</sub> = M<sub>b</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)

2.079(1 - 39.9/109.5)

1.321

M<sub>xy</sub> = 2M<sub>cx</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)

2•2.079(1 - 39.9/109.5)

2.643

M<sub>ox</sub> = M<sub>cx</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)/(1 + 0.5F<sub>d</sub>/P<sub>cx</sub>)

2.079(1 - 39.9/109.5)/(1 + 0.5•39.9/109.5)

1.118

M<sub>oy</sub> = M<sub>cy</sub>(1 - F<sub>d</sub>/P<sub>cy</sub>)/(1 + k<sub>y</sub>(F<sub>d</sub>/P<sub>cy</sub>))

2.079(1 - 39.9/109.5)/(1 + 0.5(39.9/109.5))

1.118

M<sub>ab</sub> = fn( λ<sub>r</sub>, λ<sub>r0</sub>, ε<sub>r</sub>, M<sub>xy</sub>, M<sub>ob</sub>)

56.533, 17.737, 1.000, 2.643, 1.321

1.620

M<sub>ax</sub> = fn( λ<sub>x</sub>, ε<sub>r</sub>, M<sub>ox</sub>, M<sub>oy</sub>)

58.537, 1.000, 2.015, 1.118

1.474

|                                                   |                             |       |    |
|---------------------------------------------------|-----------------------------|-------|----|
| $M_{ay}=fn(\lambda_y, \epsilon_r, M_r y, M_{oy})$ | 58.537, 1.000, 2.015, 1.118 | 1.474 |    |
| $m_{x.}M_x/M_{ax}$                                | 0.78x0/1.5                  | 0.019 | OK |
| $m_{LT.}M_{LT}/M_{ab}$                            | 0.79x0/1.6                  | 0.017 | OK |
| $m_{x.}M_x/M_{ax}$                                | 0.78x0/1.5                  | 0.018 | OK |
| Compare with Simplified to 4.8.3.3                | 0.38, 0.377, 0.377          | 0.38  |    |
| Compare with MoreExact to 4.8.3.3                 | 0.38, 0.371, 0.024          | 0.38  |    |

**Deflection Check - Load Case 3**

|                                       |                        |         |    |
|---------------------------------------|------------------------|---------|----|
| In-span $\delta \leq \text{Span}/360$ | $0.08 \leq 1200 / 360$ | 0.08 mm | OK |
|---------------------------------------|------------------------|---------|----|

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 12 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 17                                                                   | 6                      | 5.205T              | -0.008              | 0.000                      | 0.000                      | 0.019                             |
|                                                                      | 11                     | 5.225T              | 0.008               | 0.000                      | @ 0.000                    | @ 0.461                           |

### Classification and Properties (BS 5950: 2000)

Section (1.99 kg/m) 33.7x2.6 CHS 1.99 [S 275]  
 Class = Fn(D/t,py) 12.96, 275 (Axial: Non-Slender) Plastic  
 Auto Design Load Cases 1

### Local Capacity Check

Ae = Fn(Ag,A.net,py,Us) 2.54,2.54,275,410 2.54 cm²  
 Pz = Ae.py 2.54x275 69.85 kN OK  
 F/Ae.py -5.225 / 69.85 = 0.075 OK

### Equivalent Uniform Moment Factors mLT, mx, my and myx

$m_{LT} = 0.2 + (.15M_2 + .5M_3 + .15M_4) / M_{max}$   $0.2 + (.15 \times 0 + .5 \times 0 + .15 \times 0) / 0 = 0.44$  0.925 Table 18  
 $m_y = 0.2 + (.1M_2 + .6M_3 + .1M_4) / M_{max}$   $0.2 + (.1 \times 0 + .6 \times 0 + .1 \times 0) / 0 = .8 \times 0 / 0$  1 Table 26  
 $m_x = 0.2 + (.1M_2 + .6M_3 + .1M_4) / M_{max}$   $0.2 + (.1 \times 0 + .6 \times 0 + .1 \times 0) / 0 = .8 \times 0 / 0$  0.95 Table 26  
 $m_{yx} = 0.2 + (.1M_2 + .6M_3 + .1M_4) / M_{max}$   $0.2 + (.1 \times 0 + .6 \times 0 + .1 \times 0) / 0 = .8 \times 0 / 0$  1 Table 26

### Lateral Buckling Check Mb

Mb = Mc Section not susceptible to lateral torsional buckling 0.604 kN.m

### Deflection Check - Load Case 3

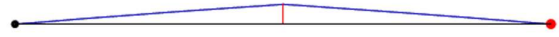
In-span  $\delta \leq \text{Span}/360$   $0.02 \leq 922 / 360$  0.02 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 7 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 (kN/m³)



| Member Forces in Load Case 1 and Maximum Deflection from Load Case 3 |                        |                     |                     |                            |                            |                                   |
|----------------------------------------------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                                                           | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| -                                                                    | 7                      | 50.613C             | -0.266              | 0.000                      | -0.256                     | 1.691                             |
|                                                                      | 11                     | 45.479C             | 0.266               | 0.000                      | @ 1.059                    | @ 1.059                           |

### Classification and Properties (BS 5950: 2000)

Section (3.56 kg/m) 60.3x2.5 CHS 3.56 [S 275]  
Class = Fn(D/t,py) 24.12, 275 (Axial: Non-Slender) Plastic

Auto Design Load Cases 1

### Shear Capacity Check

$F_{vx}/P_{vx}$  0.266 / 44.946 = 0.006 OK

### Local Capacity Check

$F_{vx}/P_{vx}$  0.217 / 44.946 = 0.005 Low Shear  
 $M_{cx} = p_y.S_{xx} \leq 1.2 \times p_y.Z_{xx}$  275 x 8.36 ≤ 1.2 x 275 x 6.3 = 2.079 kN.m  
 $P_z = A_g.p_y$  4.54 x 275 = 124.85 kN  
 $n = F/P_z$  50.613 / 124.85 = 0.405 OK  
 $S_{rx} = F_n(S_{xx})$  8.36, 0.405 6.72 cm³  
 $M_{rx} = S_{rx}.p_y$  6.72 x 275 1.848 kN.m  
 $(M_x/M_{rx})^{2.1} + (M_y/M_{ry})^{2.2}$  (0.256/1.848)² + (0)² = 0.019 OK

### Compression Resistance $P_c$

$\lambda_x = L_{ex}/r_{xx}$  100x1x2.119/2.05 = 103.4 OK  
 $P_{cx} = A_{area}.p_{cx}$  4.54x150.121/10 = 68.155 kN Table 24 a  
 $\lambda_y = L_{ey}/r_{yy}$  100x1x2.119/2.05 = 103.4 OK  
 $P_{cy} = A_{area}.p_{cy}$  4.54x150.12/10 = 68.155 kN Table 24 a

### Equivalent Uniform Moment Factors $m_{LT}$ , $m_x$ , $m_y$ and $m_{yx}$

$m_{LT} = 0.2 + (.15M_2 + .5M_3 + .15M_4)/M_{max}$  0.2 + (.15x0 + .5x0 + .15x0)/0 = 0.44 0.851 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 + (.1x0 + .6x0 + .1x0)/0 = .8x0/0 0.897 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 $M_b$

$M_b = M_c$  Section not susceptible to lateral torsional buckling 2.079 kN.m

### Simplified Approach

$p_y.Z_x$  275x6.3 1.733 kN.m  
 $F/P_c + m_x.M_x/p_y.Z_x$  50.613/68.155 + 0.897x0.3/1.7 0.875 OK  
 $F/P_{cy} + m_{LT}.M_{LT}/M_b$  50.613/68.155 + 0.851x0.3/2.1 0.847 OK

### More Exact Approach

$M_{ax} = M_{cx}/(1 + .5F/P_{cx})$  2.1/(1 + .5x50.6/68.2) 1.516 kN.m  
 $F/P_{cx} + m_x.M_x/M_{ax}$  50.6/68.2 + 0.897x0.3/1.5 0.894 OK  
 $F/P_{cy} + .5m_{LT}.M_{LT}/M_{cx}$  50.6/68.2 + .50.851x0.3/2.1 0.795 OK

### Deflection Check - Load Case 3

In-span  $\delta \leq \text{Span}/360$  1.69 ≤ 2119 / 360 1.69 mm OK

## AXIAL WITH MOMENTS (MEMBER)

### Member SB L1 Id 13 @ Level 1 in Load Case 1

Member Loading and Member Forces  
Loading Combination : 1 UT + 1.4 D1 + 1.6 L1

D1 D 077.010 ( kN/m³)



| Member Forces in Load Case 1 |                        |                     |                     |                            |                            |                                   |
|------------------------------|------------------------|---------------------|---------------------|----------------------------|----------------------------|-----------------------------------|
| Member No.                   | Node<br>End 1<br>End 2 | Axial Force<br>(kN) | Shear Force<br>(kN) | Bending<br>Moment<br>(kNm) | Maximum<br>Moment<br>(kNm) | Maximum<br>Deflection<br>(mm @ m) |
| 18                           | 6                      | 6.212C              | 0.005               | 0.000                      | 0.001                      | 0.000                             |
|                              | 9                      | 6.202C              | -0.005              | 0.000                      | @ 0.000                    | @ 1.059                           |

### Classification and Properties (BS 5950: 2000)

Section (1.99 kg/m) 33.7x2.6 CHS 1.99 [S 275]  
 Class = Fn(D/t,py) 12.96, 275 (Axial: Non-Slender) Plastic  
 Auto Design Load Cases 1

### Local Capacity Check

Pz = Ag.py 2.54 x 275 = 69.85 kN OK  
 F/Ag.py 6.212 / 69.85 = 0.089 OK

### Compression Resistance Pc

$\lambda_x = L_{ex}/r_{xx}$  100x1x0.531/1.1 = 48.3 OK  
 $P_{cx} = \text{Area.pcx}$  2.54x252.779/10 = 64.206 kN Table 24 a  
 $\lambda_y = L_{ey}/r_{yy}$  100x1x0.531/1.1 = 48.3 OK  
 $P_{cy} = \text{Area.pcy}$  2.54x252.8/10 = 64.212 kN Table 24 a

### Simplified Approach

F/Pc 6.212/64.206 0.097 OK  
 F/Pcy 6.212/64.212 0.097 OK

### More Exact Approach

F/Pcx 6.2/64.2 0.097 OK  
 F/Pcy 6.2/64.2 0.097 OK