

# STONE CONSULTING ENGINEERS LTD.

CONSULTING CIVIL, STRUCTURAL AND  
FOUNDATION ENGINEERS

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Job No. 1855

Date: Nov 2018

Revised: 06/02/2019

## QA INFORMATION

|                                 |                                                         |
|---------------------------------|---------------------------------------------------------|
| CLIENT:                         | Coles                                                   |
| JOB ID:                         | 48 Havant road                                          |
| SCOPE OF WORK:                  | Structural calculations                                 |
| DESIGN CODES AND<br>REFERENCES: | BS 5950 : BS 5268 : BS 5628<br>The Building Regulations |
| SOFTWARE:                       | MS EXCEL                                                |
| SUB-SOIL/<br>FOUNDATION DATA:   | N/A                                                     |

## MATERIAL DATA

|                |                               |
|----------------|-------------------------------|
| CONCRETE:      |                               |
| REINFORCEMENT: |                               |
| STEELWORK:     | Grade S355                    |
| TIMBER:        | Grades C16 & C24 as specified |
| OTHER:         | Masonry as specified          |

## OTHER INFORMATION / NOTES

This document demonstrates an adequate foundation design to meet Building Regulations requirements can be achieved with a 'no dig' Foundation Strategy. Root Protection Zones for all trees are safeguarded (particularly T3 as identified on the Arboricultural Report).

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|                          |                |                |          |                 |    |                  |   |
|--------------------------|----------------|----------------|----------|-----------------|----|------------------|---|
| <b>Project:</b>          | 48 Havant road | <b>Date:</b>   | Nov 2018 | <b>Made by:</b> | KS | <b>Sheet No.</b> | 1 |
| <b>CALCULATION SHEET</b> |                | <b>Job No.</b> | 1855     | <b>Chkd:</b>    | -  | <b>Rev.</b>      | 1 |

## Pitched Roof

|                      |             |       |
|----------------------|-------------|-------|
| Pitch =              | 15.00       | deg   |
| Plain tiles =        | 0.64        | kN/m2 |
| Battens and felt =   | 0.10        | kN/m2 |
| Rafters =            | 0.15        | kN/m2 |
| Dead load on slope = | <b>0.89</b> | kN/m2 |
| Live load on slope = | <b>0.72</b> | kN/m2 |
|                      |             |       |
| Dead load on plan =  | <b>0.92</b> | kN/m2 |
| Live load on plan =  | <b>0.75</b> | kN/m2 |

## External (timber clad)

|                  |             |       |
|------------------|-------------|-------|
| Cladding =       | 0.20        | kN/m2 |
| 50 x 100 studs = | 0.11        | kN/m2 |
| Sheathing :      | 0.31        | kN/m2 |
| Total =          | <b>0.62</b> | kN/m2 |

### General Notes:

1. These calculations relate the the structural elements of the proposed detached garage at 48 Havant road.
2. These calculations are to be read in conjunction with all relevant Architects drawings.
3. The dimensions quoted in these calculations are for calculation purposes only and are not to be used in any other capacity.
4. The Contractor is responsible for checking all dimensions on site.
5. All steel work to be hot-dipped galvanised or otherwise protected from corrosion where required.

### Root Protection Measures:

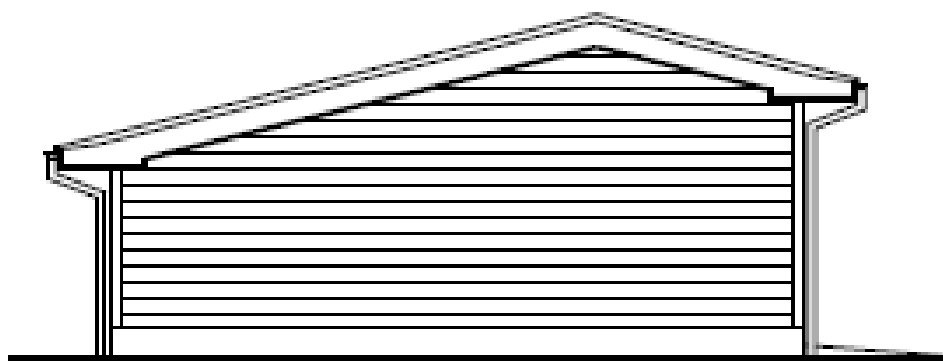
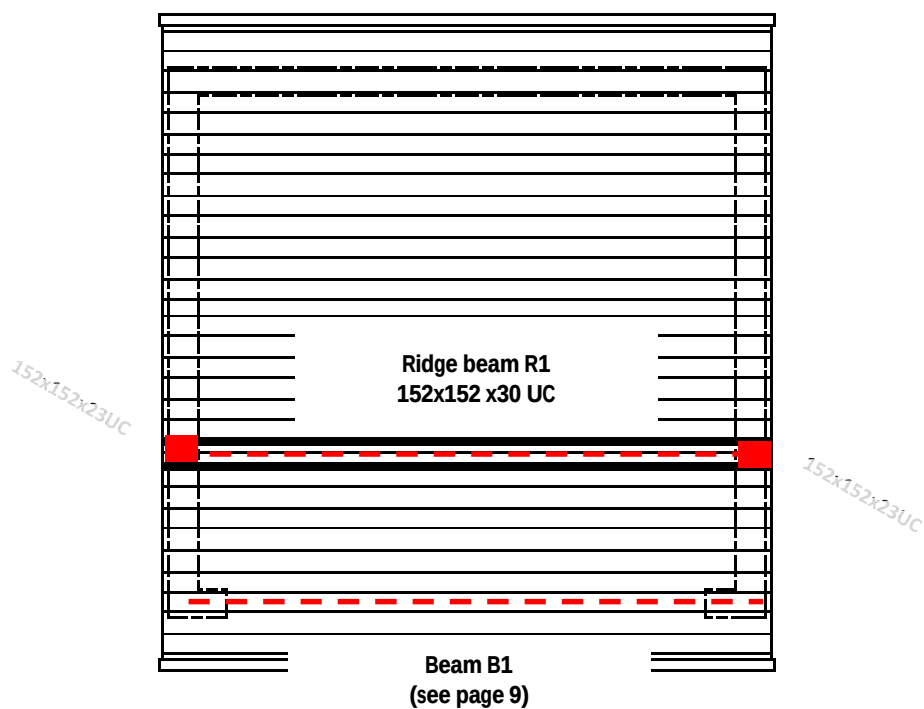
The following proposal to mitigate any disturbance and/or damage to the root structure of existing trees adjacent to or within the proposed foundations of the new garage are as follows.

1. Careful removal (if necessary) of any top soil beneath the extended footprint of the proposed garage floor slab. If any roots are exposed in this process then they are to be packed with sharp sand.
2. Placement of gravel bed (10-20mm aggregate) to a minimum depth of 100mm over the prepared ground.
3. The gravel can be placed in 50mm lifts and lightly tamped with a tapping board to produce a medium dense layer, it is not necessary to mechanically compact the gravel.
4. A 200 mm reinforced concrete slab is to be poured over the gravel bed and the structure built up off of this slab.

The above proposal will negate the requirement for any extensive excavation into the ground that might disturb and damage the roots - or undermine the health - of the existing trees (particularly T3).

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## Roof Rafters

Dead load = (s)\*(0.92) = 0.32 kN/m                      Span = 3.94 m  
 Live load = (s)\*(0.75) = 0.26 kN/m                      Spacing, s = 0.35 m  
 Total ud load = 0.58 kN/m

Maximum design moment =  $(0.67 \times 3.94^2 / 8) = 1.13 \text{ kNm}$

**1 No 75 by 120 mm C24**

Max design stress =  $6M / (bd^2) = 6.30 \text{ Mpa}$  OK  
 Permissible stress =  $7.5 \times 1.1 \times (300/d)^{.11} = 9.12 \text{ Mpa}$   
 Max deflection =  $0.104 M L^2 / (EI) = 15.70 \text{ mm}$  OK

**PROVIDE 75 by 120 C24 rafters at 350 mm**

## Ridge beam

Span = 5.50 m

Dead load from rafters =  $(5.5/2) \times (0.92) = 2.53 \text{ kN/m}$   
 Live load from rafters =  $(5.5/2) \times (0.75) = 2.06 \text{ kN/m}$   
 Unfactored total udl = **4.59 kN/m**

**PROVIDE 1 No.(152 x 152 x 30 )UC for ridge beam**

## Ridge beam reactions

R(DL) = 6.96 kN  
 R(LL) = 5.67 kN  
 total = 12.63 kN

(by inspection)

**PROVIDE 1 No. (152 x 152 x 23mm) UC post to form frame**

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**Project:** 48 Havant road

**Date:** Nov 2018

**Made by:** KS

**Sheet No.** 4

**CALCULATION SHEET**

**JobNo.** 1855

**Chkd:** -

**Rev.** 0

Design in accordance with BS 5950 : Part 1 : 1990  
Simply supported beam

Span (m) 5.500

**Analysis**

Choose steel section:

152x152x30

☐ UB

☒ UC

☐ RSJ

☐ PFC

| Load Factors |     |
|--------------|-----|
| Dead         | 1.4 |
| Imposed      | 1.6 |

|                                   |        |
|-----------------------------------|--------|
| E (N/mm <sup>2</sup> )            | 205000 |
| I <sub>x</sub> (cm <sup>4</sup> ) | 1748   |

| LOADING     | Dead<br>kN | Imposed<br>kN | Position<br>m | Length<br>m |
|-------------|------------|---------------|---------------|-------------|
| UDL         | 13.915     | 11.33         | -             | -           |
| Point load  |            |               |               | -           |
| Point load  |            |               |               | -           |
| Point load  |            |               |               | -           |
| Point load  |            |               |               | -           |
| Partial UDL |            |               |               |             |
| Partial UDL |            |               |               |             |

| RESULTS      |                          |                      |            |
|--------------|--------------------------|----------------------|------------|
| M max<br>kNm | F <sub>v</sub> max<br>kN | Max. deflection (mm) |            |
|              |                          | Imposed only         | Total load |
| 27.41        | 19.94                    | -6.85                | -16.24     |

| Design Strength | py (N/mm <sup>2</sup> ) |
|-----------------|-------------------------|
| 355             |                         |

| section classification |
|------------------------|
| Compact                |

| Steel grade                                 |
|---------------------------------------------|
| <input type="radio"/> grade S275            |
| <input checked="" type="radio"/> grade S355 |

| Shear Capacity                            |                                  |
|-------------------------------------------|----------------------------------|
| Area<br>A <sub>v</sub><br>mm <sup>2</sup> | capacity<br>P <sub>v</sub><br>kN |
| 1024.4                                    | 218.20                           |

cl. 4.2.3

| Moment Capacity  | Position<br>m | Moment<br>kNm | F <sub>v</sub><br>kN | M <sub>cx</sub><br>kNm | Unity<br>Factor |
|------------------|---------------|---------------|----------------------|------------------------|-----------------|
| Maximum Moment   | 2.750         | 27.41         | 0.00                 | 88.04                  | 0.31            |
| Critical section | 2.750         | 27.41         | 0.00                 | 88.04                  | 0.31            |

\* low shear

Lateral torsional buckling

| Equivalent Uniform Moment |                  | kNm   |
|---------------------------|------------------|-------|
| Maximum moment            | M <sub>A</sub>   | 27.41 |
| Uniform factor            | m                | 1.00  |
| Buckling moment           | M <sub>bar</sub> | 27.41 |

cl. 4.3.7.2

|                                   |     |
|-----------------------------------|-----|
| Z <sub>x</sub> (cm <sup>3</sup> ) | 222 |
| S <sub>x</sub> (cm <sup>3</sup> ) | 248 |

| Slenderness Ratio |         |                    |                     |             |
|-------------------|---------|--------------------|---------------------|-------------|
| Effective length  |         | radius of gyration |                     | slenderness |
| L                 | factor  | L <sub>E</sub>     | r <sub>y</sub> (cm) | λ           |
| m                 |         | m                  |                     |             |
| 5.500             | 1.2L+2D | 6.915              | 3.83                | 180.55      |

cl. 4.3.7.5

Deflection

| Deflection Limits      |     | Allowable<br>mm |
|------------------------|-----|-----------------|
| span/deflection ratios |     |                 |
| Imposed Loads          | 360 | 15.3            |
| Total Loads            | 200 | 27.5            |

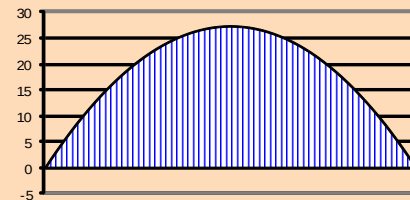
table 5

|               |    |            |
|---------------|----|------------|
| Section used: | UC | 152x152x30 |
|---------------|----|------------|

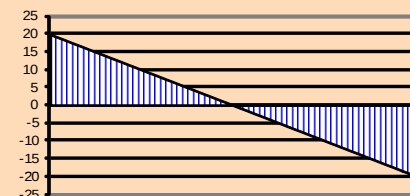
## Design Status

capacity ratio

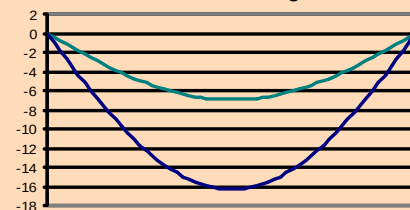
|                |      |      |
|----------------|------|------|
| Vertical shear | PASS | 0.09 |
| Moment         | PASS | 0.31 |
| Buckling       | PASS | 0.72 |
| Deflection     | PASS | 0.59 |



Bending Moment Diagram



Shear Force Diagram



Deflection Diagram

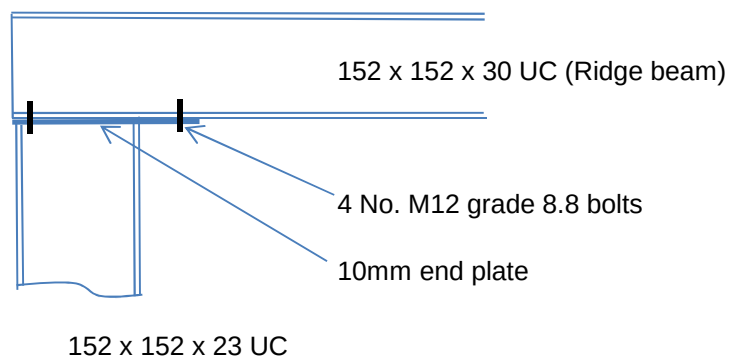
|               |                         |                 |       |
|---------------|-------------------------|-----------------|-------|
| cl. B.2.4     | limiting slenderness    | λ <sub>L0</sub> | 30.20 |
| cl. 4.3.7.6   | correction factor       | n               | 1.00  |
|               | buckling parameter      | u               | 0.849 |
|               | torsional index         | x               | 16    |
| cl. B.2.5 (d) | slenderness factor      | v               | 0.607 |
| cl. B.2.5     | equivalent slenderness  | λ <sub>LT</sub> | 93.04 |
| cl. B.2.3     | Perry coefficient       | η <sub>LT</sub> | 0.440 |
|               | Plastic moment capacity | M <sub>p</sub>  | 88.04 |
| cl. B.2.2     | Elastic critical moment | M <sub>E</sub>  | 57.96 |
|               | Buckling index          | φ <sub>B</sub>  | 85.75 |

|           |                   |                |       |
|-----------|-------------------|----------------|-------|
| cl. B.2.1 | Buckling capacity | M <sub>b</sub> | 38.31 |
|-----------|-------------------|----------------|-------|

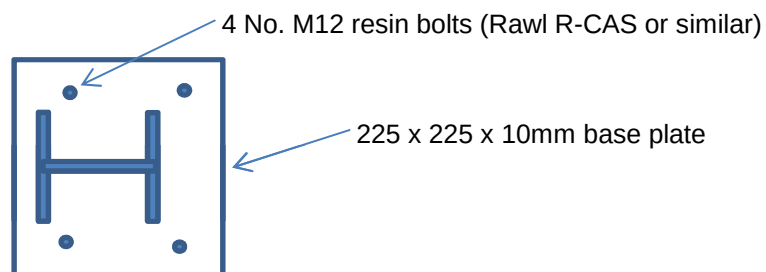
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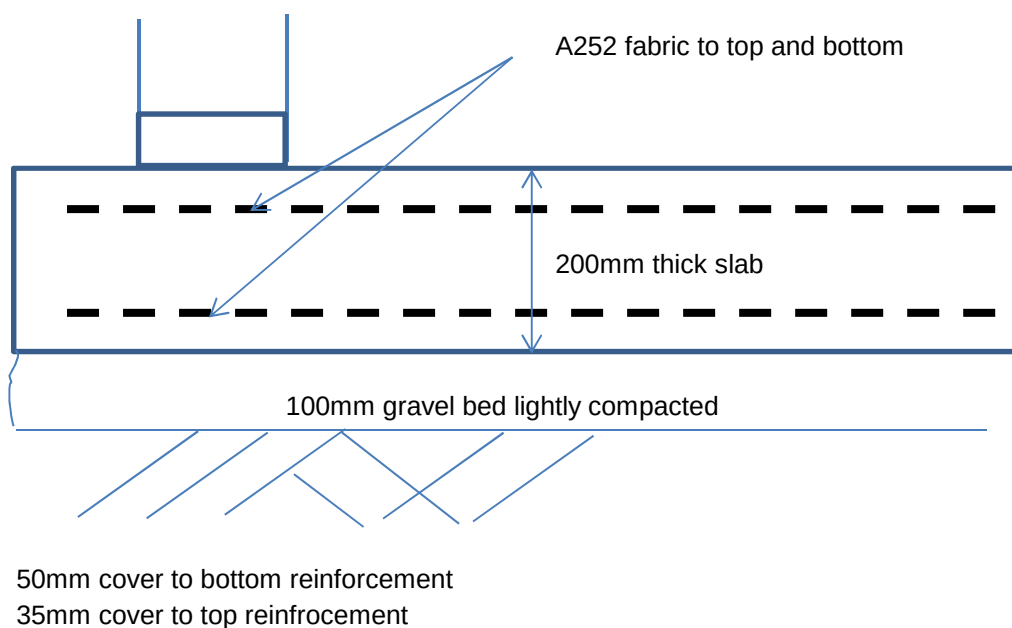
## Ridge beam to post connection



## Base plate



## Foundation slab



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|                                |                       |                    |                    |
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## Standard Wind Speeds

Design in accordance with BS 6399 : Part 2 : 1997

| Site Wind Speed, Vs |                  |       |    |    |    |           |
|---------------------|------------------|-------|----|----|----|-----------|
| Vb<br>m/s           | Site<br>Altitude | Sa    | Sd | Ss | Sp | Vs<br>m/s |
| 22                  | 3                | 1.003 | 1  | 1  | 1  | 22.066    |

☐ Significant topography ☐ Slope height > 360m equ (8)

| Effective Wind Speed, Ve |         |                |         |       |           | Dynamic Pressure                                  |
|--------------------------|---------|----------------|---------|-------|-----------|---------------------------------------------------|
| Sb                       |         |                |         |       |           |                                                   |
| Hr<br>m                  | He<br>m | Distance<br>km | Terrain | Sb    | Ve<br>m/s | qs<br>N/m <sup>2</sup>                            |
| 3.2                      | 3.2     | 6              | town    | 1.289 | 28.44     | 495.92 <span style="float: right;">equ (1)</span> |

equ (12)

## Standard Pressure Coefficients

| WIND NORMAL TO:    | LONG FACE | SHORT FACE |
|--------------------|-----------|------------|
| Breadth B (m)      | 6         | 6          |
| Inwind depth D (m) | 6         | 6          |
| D/H                | 1.88      | 1.88       |
| Scaling length, b  | 6         | 6          |

| Building Dimensions |                |                 |
|---------------------|----------------|-----------------|
| Length<br>L (m)     | Width<br>W (m) | Height<br>H (m) |
| 6                   | 6              | 3.2             |

| External pressure coefficients Cpe for vertical walls |          |        |        |        |
|-------------------------------------------------------|----------|--------|--------|--------|
| Windward (front) face                                 |          |        | 0.742  | 0.742  |
| Leeward (rear) face                                   |          |        | -0.242 | -0.242 |
| Side face                                             | Exposure | Zone A | -1.3   | -1.3   |
|                                                       | Isolated | Zone B | -0.8   | -0.8   |
|                                                       |          | Zone C |        |        |

| Side Wall Zone Lengths (m) |              |             |
|----------------------------|--------------|-------------|
| Wind on:                   | Long         | Short       |
| Side Face:                 | (short wall) | (long wall) |
| Zone A                     | 1.2          | 1.2         |
| Zone B                     | 4.8          | 4.8         |
| Zone C                     | 0            | 0           |

| Internal pressure coefficients Cpi for enclosed buildings |           |           |
|-----------------------------------------------------------|-----------|-----------|
| Both opposite walls:                                      | Permeable | Permeable |
| Windward (front) face                                     | -0.3      | -0.3      |
| Leeward (rear) face                                       | -0.3      | -0.3      |
| Side Faces                                                | -0.3      | -0.3      |

- ☒ Internal layout generally open  
☐ Multi-room building

## Standard Wind Loads

| Size effect factor, Ca |          |          |
|------------------------|----------|----------|
| Surface:               | External | Internal |
| Site exposure type     | C        | C        |
| Diagonal dimension (m) | 6.708    | 47.622   |
| Ca                     | 0.973    | 0.798    |

| Internal Volume (m <sup>3</sup> ) |     |
|-----------------------------------|-----|
| Enter storey volume               | 108 |

| Panel Dimensions |                 |
|------------------|-----------------|
| Height<br>h (m)  | Length<br>l (m) |
| 3                | 6               |

## Net Pressures On External Walls

| Wind On Long Face      |                  |           |                |           |          |           |          |           |          |           |
|------------------------|------------------|-----------|----------------|-----------|----------|-----------|----------|-----------|----------|-----------|
| Elevation:             | Windward (front) |           | Leeward (rear) |           | Sides    |           |          |           |          |           |
|                        |                  |           |                |           | Zone A   |           | Zone B   |           | Zone C   |           |
|                        | case (i)         | case (ii) | case (i)       | case (ii) | case (i) | case (ii) | case (i) | case (ii) | case (i) | case (ii) |
| pe (N/m <sup>2</sup> ) | 358.0            | -         | -116.7         | -         | -627.5   | -         | -386.2   | -         | -        | -         |
| pi (N/m <sup>2</sup> ) | -118.7           | -         | -118.7         | -         | -118.7   | -         | -118.7   | -         | -        | -         |
| p (N/m <sup>2</sup> )  | 476.7            | -         | 2.0            | -         | -508.9   | -         | -267.5   | -         | -        | -         |

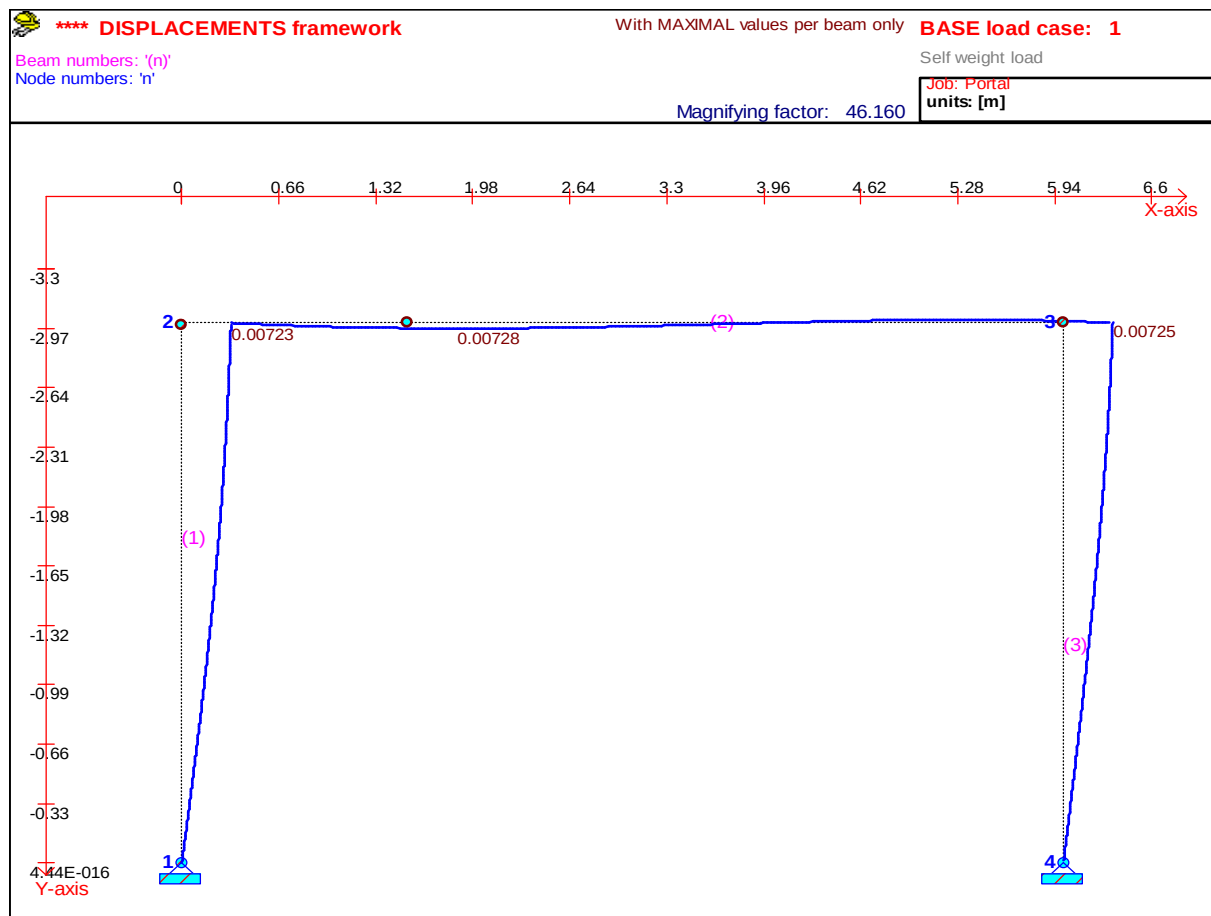
Note: -ve sign indicates suction or outw ard pressure, +ve sign indicates inw ard pressure

| Wind On Short Face     |                  |           |                |           |          |           |          |           |          |           |
|------------------------|------------------|-----------|----------------|-----------|----------|-----------|----------|-----------|----------|-----------|
| Elevation:             | Windward (front) |           | Leeward (rear) |           | Sides    |           |          |           |          |           |
|                        |                  |           |                |           | Zone A   |           | Zone B   |           | Zone C   |           |
|                        | case (i)         | case (ii) | case (i)       | case (ii) | case (i) | case (ii) | case (i) | case (ii) | case (i) | case (ii) |
| pe (N/m <sup>2</sup> ) | 358.0            | -         | -116.7         | -         | -627.5   | -         | -386.2   | -         | -        | -         |
| pi (N/m <sup>2</sup> ) | -118.7           | -         | -118.7         | -         | -118.7   | -         | -118.7   | -         | -        | -         |
| p (N/m <sup>2</sup> )  | 476.7            | -         | 2.0            | -         | -508.9   | -         | -267.5   | -         | -        | -         |

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## Frame analysis for racking



### FRAMEWORK program - displacement method (Statical calculation)

#### \*\*\* DATA INPUT \*\*\*

#### \*\* NODAL INPUT \*\*

| Node no. | X-coordinate [m] | Y-coordinate [m] |
|----------|------------------|------------------|
| 1        | 0.000E+00        | 0.000E+00        |
| 2        | 0.000E+00        | -3.000E+00       |
| 3        | 6.000E+00        | -3.000E+00       |
| 4        | 6.000E+00        | 0.000E+00        |

#### \*\* BEAM INPUT \*\*

| Beam no. | Active | Length [m] | Description |
|----------|--------|------------|-------------|
| 1        | Yes    | 3.000E+00  | 152x152x23  |
| 2        | Yes    | 6.000E+00  | 152x152x30  |
| 3        | Yes    | 3.000E+00  | 152x152x23  |

#### \*\* SECTION PROPERTIES \*\*

| Beam no. | Start node | End node | E-modulus [kN/m2] | Spec.mass [kg/m3] | Area [m2] | Moment of inertia [m4] |
|----------|------------|----------|-------------------|-------------------|-----------|------------------------|
| 1        | 1          | 2        | 2.100E+08         | 7.85E+03          | 2.920E-03 | 1.250E-05              |
| 2        | 2          | 3        | 2.100E+08         | 7.85E+03          | 3.830E-03 | 1.748E-05              |
| 3        | 3          | 4        | 2.100E+08         | 7.85E+03          | 2.920E-03 | 1.250E-05              |

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## \*\* P R E S C R I B E D   D I S P L A C E M E N T S \*\*

| Node no. | Ux<br>[m] | Uy<br>[m] | PHI<br>[degrees] |
|----------|-----------|-----------|------------------|
| 1        | 0.00E+00  | 0.00E+00  |                  |
| 4        | 0.00E+00  | 0.00E+00  |                  |

## \*\*\*\* L O A D S \*\*\*\*

### Base load case number 1

## \*\*\*\* B E A M   L O A D S \*\*\*\*

## \*\* S E L F   W E I G H T \*\*

Angle of the force of gravity with the X-axis of the global system is: 90.00 [degrees]

| Beam no. | Start node(1) | End node(2) | Value(1)<br>[kN/m] | Value(2)<br>[kN/m] | Total<br>[kN] |
|----------|---------------|-------------|--------------------|--------------------|---------------|
| 1        | 1             | 2           | 2.248E-01          | 2.248E-01          | 6.744E-01     |
| 2        | 2             | 3           | 2.948E-01          | 2.948E-01          | 1.769E+00     |
| 3        | 3             | 4           | 2.248E-01          | 2.248E-01          | 6.744E-01     |

Total self weight is: 3.118E+00 [kN]

## \*\* D I S T R I B U T E D   L O A D S \*\*

| Beam no. | Start node(1) | End node(2) | Angle(X-axis)<br>[degrees] | Value(1)<br>[kN/m] | Value(2)<br>[kN/m] | Gl./Loc.<br>[G/L] | Active<br>[Yes/No] |
|----------|---------------|-------------|----------------------------|--------------------|--------------------|-------------------|--------------------|
| 1        | 1             | 2           | 9.00E+01                   | 1.43E+00           | 1.43E+00           | L                 | Yes                |

## \*\*\*\* O U T P U T   calculation results   (base) \*\*\*\*

### Base load case no. 1

**\*\* The self-weight is included in this base load case.**

## \*\* Nodal displacements with respect to the global system of axes \*\*

| Node no. | Ux<br>[m] | Uy<br>[m] | fi<br>[degrees] |
|----------|-----------|-----------|-----------------|
| 1        | 0.000E+00 | 0.000E+00 | 1.996E-01       |
| 2        | 7.257E-03 | 7.153E-07 | 5.169E-02       |
| 3        | 7.246E-03 | 1.124E-05 | 4.924E-02       |
| 4        | 0.000E+00 | 0.000E+00 | 1.830E-01       |

## \*\* Beam actions with respect to the local system of axes \*\*

| Beam no. | Node no. | Normal force<br>[kN] | Shear force<br>[kN] | Moment<br>[kN.m] |
|----------|----------|----------------------|---------------------|------------------|
| 1        | 1        | 4.834E-01            | -2.940E+00          | 2.598E-16        |
|          | 2        | 1.910E-01 tension    | -1.362E+00          | -2.368E+00       |
| 2        | 2        | 1.362E+00            | 1.910E-01           | 2.368E+00        |
|          | 3        | -1.362E+00 compr.    | -1.960E+00          | 4.085E+00        |
| 3        | 3        | 1.960E+00            | -1.362E+00          | -4.085E+00       |
|          | 4        | -2.634E+00 compr.    | 1.362E+00           | -2.238E-16       |

## \*\* Support forces of the nodes with prescribed deformations (Global) \*\*

| Node no. | Fx<br>[kN] | Fy<br>[kN] | M<br>[kN.m] |
|----------|------------|------------|-------------|
| 1        | -2.940E+00 | -4.834E-01 | 0.000E+00   |
| 4        | -1.362E+00 | -2.634E+00 | 0.000E+00   |

## \*\* Equilibrium check nodal forces (incl. prescribed nodal forces) \*\*

| Node no. | Sum-Fx<br>[kN] | Sum-Fy<br>[kN] | Sum-M<br>[kN.m] |
|----------|----------------|----------------|-----------------|
| 1        | -2.940E+00     | -4.834E-01     | 2.598E-16       |
| 2        | 2.642E-14      | 1.110E-16      | 0.000E+00       |
| 3        | 7.727E-14      | -2.220E-16     | -8.882E-16      |

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|                                |                       |                    |                    |
|--------------------------------|-----------------------|--------------------|--------------------|
| <b>Project:</b> 48 Havant road | <b>Date:</b> Nov 2018 | <b>Made by:</b> KS | <b>Sheet No.</b> 9 |
| <b>CALCULATION SHEET</b>       | <b>JobNo.</b> 1855    | <b>Chkd:</b> -     | <b>Rev.</b> 0      |

## Beam B1

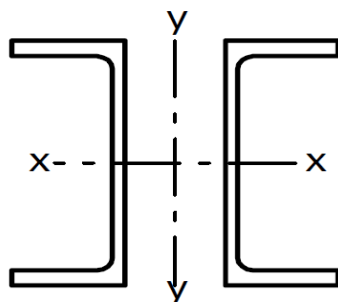
Reaction from rafters

|           |                           |           |
|-----------|---------------------------|-----------|
| $w(dl) =$ | $(1.3/2) \times (0.92) =$ | 0.60 kN/m |
| $w(ll) =$ | $(1.3/2) \times (0.75) =$ | 0.49 kN/m |
| Span =    | 5.00 m                    |           |

## Beam options

**1 No. (125 x 65 x 15) PFC**

or **2 No. (100 x 50 x 10) PFC back to back**



or **1 No. (102 x 102 x 23) RSJ**

Reaction at end of beams

$$R(dl+ll) = (5/2) \times (0.6 + 0.49) = 2.73 \text{ kN}$$

(by inspection) **100 x 100 C24 studs to support beam are satisfactory**

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|                                |                       |                    |                     |
|--------------------------------|-----------------------|--------------------|---------------------|
| <b>Project:</b> 48 Havant road | <b>Date:</b> Nov 2018 | <b>Made by:</b> KS | <b>Sheet No.</b> 10 |
| <b>CALCULATION SHEET</b>       | <b>JobNo.</b> 1855    | <b>Chkd:</b> -     | <b>Rev.</b> 0       |

## Beam B1

Design in accordance with BS 5950 : Part 1 : 1990  
Simply supported beam

Span (m) 5.000

Choose steel section:

125x65x15

☒ UB  
☐ UC  
☐ RSJ  
☐ PFC

| Load Factors |     |
|--------------|-----|
| Dead         | 1.4 |
| Imposed      | 1.6 |

|                                   |        |
|-----------------------------------|--------|
| E (N/mm <sup>2</sup> )            | 205000 |
| I <sub>x</sub> (cm <sup>4</sup> ) | 483    |

| Design Status  |      | capacity ratio |
|----------------|------|----------------|
| Vertical shear | PASS | 0.03           |
| Moment         | PASS | 0.18           |
| Buckling       | PASS | 0.57           |
| Deflection     | PASS | 0.41           |

| LOADING     | Dead<br>kN | Imposed<br>kN | Position<br>m | Length<br>m |
|-------------|------------|---------------|---------------|-------------|
| UDL         | 3          | 2.45          | -             | -           |
| Point load  |            |               |               | -           |
| Point load  |            |               |               | -           |
| Point load  |            |               |               | -           |
| Point load  |            |               |               | -           |
| Partial UDL |            |               |               |             |
| Partial UDL |            |               |               |             |

| RESULTS |                    |                      |            |
|---------|--------------------|----------------------|------------|
| M max   | F <sub>v</sub> max | Max. deflection (mm) |            |
| kNm     | kN                 | Imposed only         | Total load |
| 5.71    | -4.57              | -4.03                | -10.15     |

| Design Strength                      |
|--------------------------------------|
| p <sub>y</sub> N/mm <sup>2</sup> 355 |

| section classification |
|------------------------|
| Plastic                |

Steel grade  
☐ grade S275  
☒ grade S355

| Shear Capacity  |                |
|-----------------|----------------|
| Area            | capacity       |
| A <sub>v</sub>  | P <sub>v</sub> |
| mm <sup>2</sup> | kN             |
| 687.5           | 146.44         |

cl. 4.2.3

| Moment Capacity  | Position<br>m | Moment<br>kNm | F <sub>v</sub><br>kN | M <sub>cx</sub><br>kNm | Unity<br>Factor |
|------------------|---------------|---------------|----------------------|------------------------|-----------------|
| Maximum Moment   | 2.500         | 5.71          | 0.00                 | 31.91                  | 0.18            |
| Critical section | 2.500         | 5.71          | 0.00                 | 31.91                  | 0.18            |

\* low shear

| Lateral torsional buckling |                  |      |
|----------------------------|------------------|------|
| Equivalent Uniform Moment  |                  | kNm  |
| Maximum moment             | M <sub>A</sub>   | 5.71 |
| Uniform factor             | m                | 1.00 |
| Buckling moment            | M <sub>bar</sub> | 5.71 |

cl. 4.3.7.2

|                                   |      |
|-----------------------------------|------|
| Z <sub>x</sub> (cm <sup>3</sup> ) | 77.3 |
| S <sub>x</sub> (cm <sup>3</sup> ) | 89.9 |

| Slenderness Ratio |         |                    |                     |             |
|-------------------|---------|--------------------|---------------------|-------------|
| Effective length  |         | radius of gyration |                     | slenderness |
| L                 | factor  | L <sub>E</sub>     | r <sub>y</sub> (cm) | λ           |
| m                 |         | m                  |                     |             |
| 5.000             | 1.2L+2D | 6.250              | 2.06                | 303.40      |

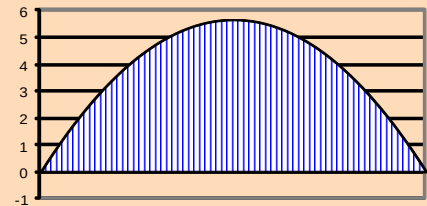
cl. 4.3.7.5

## Deflection

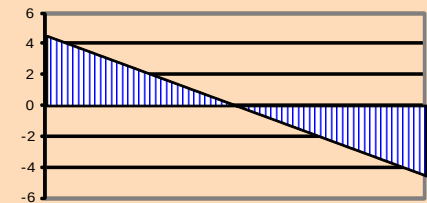
| Deflection Limits      |     | Allowable |
|------------------------|-----|-----------|
| span/deflection ratios |     | mm        |
| Imposed Loads          | 360 | 13.9      |
| Total Loads            | 200 | 25.0      |

table 5

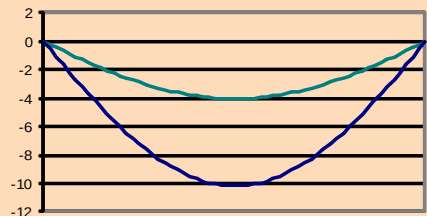
|               |     |           |
|---------------|-----|-----------|
| Section used: | PFC | 125x65x15 |
|---------------|-----|-----------|



Bending Moment Diagram



Shear Force Diagram



Deflection Diagram

|               |                         |                 |        |
|---------------|-------------------------|-----------------|--------|
| cl. B.2.4     | limiting slenderness    | λ <sub>LO</sub> | 30.20  |
| cl. 4.3.7.6   | correction factor       | n               | 1.00   |
|               | buckling parameter      | u               | 0.942  |
|               | torsional index         | x               | 11.1   |
| cl. B.2.5 (d) | slenderness factor      | v               | 0.402  |
| cl. B.2.5     | equivalent slenderness  | λ <sub>LT</sub> | 114.84 |
| cl. B.2.3     | Perry coefficient       | η <sub>LT</sub> | 0.593  |
|               | Plastic moment capacity | M <sub>p</sub>  | 31.91  |
| cl. B.2.2     | Elastic critical moment | M <sub>E</sub>  | 13.79  |
|               | Buckling index          | φ <sub>B</sub>  | 26.94  |
| cl. B.2.1     | Buckling capacity       | M <sub>b</sub>  | 10.04  |