Wellan

Structural Appraisal

Former Agricultural Store/Workshop

at Folly Farm, Sibford Ferris

For

Mr K Bishop

June 2020

Issue 1

[redacted]

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Approved

Date 2020

Project No……..……**20/079**

Contents

1.0 Introduction

This appraisal and report has been commissioned by Mr M Blackman, acting on behalf of Mr K Bishop, who owns the building and wishes to convert it for residential use. The report will comment on the existing structural condition of the building and feasibility of the proposed conversion to residential use.

A site visit was made on 18th May 2020 by Mr M Walker, B.Sc C.Eng. M.I.C.E. Mr Walker is a Chartered Engineer with more than 30 years of experience, much of which has involved investigating buildings, identifying defects and specifying remedial/alteration measures.

An external and internal inspection of the visible parts of the buildings was carried out. Inspection of the buildings was carried out from ground level and with the aid of a 2.4 metre ladder. Close examination of the upper parts of the upper surface of the roof was, therefore, not possible.

The comments in this report are illustrated by the sketches in Appendix A together with photographs.

This report has been produced for the use of Mr K Bishop and those working on his behalf in connection with structural issues associated with proposed conversion of this barn and should not be relied upon by any other party or any other context.

2.0 Background and Form of Construction

This barn is located approximately 0.5 km to the east of the village of Sibford Ferris. It is accessed via a farm track from Grange Lane which is a minor road linking Sibford Ferris to Tadmarton. The barn being considered for residential conversion is part of a small development of redundant farm buildings which includes a second steel framed building and some silos. The farmhouse is approximately 50 metres further to the east but its use is no longer related to agriculture.

The building is towards the top a gentle slope that extends to the south. The area is relatively open but with a number of trees immediately to the east of the building.

The building is typical of relatively modern farm buildings with a steel portal frame and clad with fibre reinforced profile sheeting to the roof and profiled metal cladding on the walls. The steel frame comprises a symmetrical bay with an additional lean-to section. The building is clad on all sides with a pair of large hinged doors on the north elevation. A small door has been added beside these doors, presumably as an alteration to facilitate easier access for personnel use.

The building appears to have been used for storage purposes and, additionally, there is a workshop area. Power and light are available presumably to facilitate the maintenance activities.

3.0 Structural Condition And Load Capacity

The layout of the building and a typical section are shown in Appendix A. There are currently four frames at a spacing of approximately 4.5 metres. There are two internal columns resulting from the two bay arrangement.

A check has been carried out on the verticality of the steel frame and for settlement. The existing frame members are generally reasonably vertical but one of the internal columns is out-of-plum by approximately 1:150. It is possible that this is due to erection tolerance but is having no significant impact on the structural performance of the building. Excavation of a trial pit has demonstrated substantial concrete foundation. These bear directly on to dense Hornton stone brash at a depth of approximately 900mm. These foundations are performing satisfactorily and there is no indication of settlement or movement. The steel superstructure is also performing satisfactorily. There is minor surface corrosion on the steel framing but this can be easily dealt with as a matter of routine maintenance. The timber purlins are in good condition and there is no evidence of sagging.

Calculations are included in Appendix B and confirm adequacy of the purlins and steel frame in its current form and as proposed, all as discussed below. The calculated stresses and deflections are well within permissible values and reflect the relatively substantial nature of the building.

3.1 Proposed Conversion Work

The structure of the existing building is to be retained. There is no requirement for any alteration to the existing steel portal frames or the roof structure but some new doors and windows are expected to be introduced into the walls.

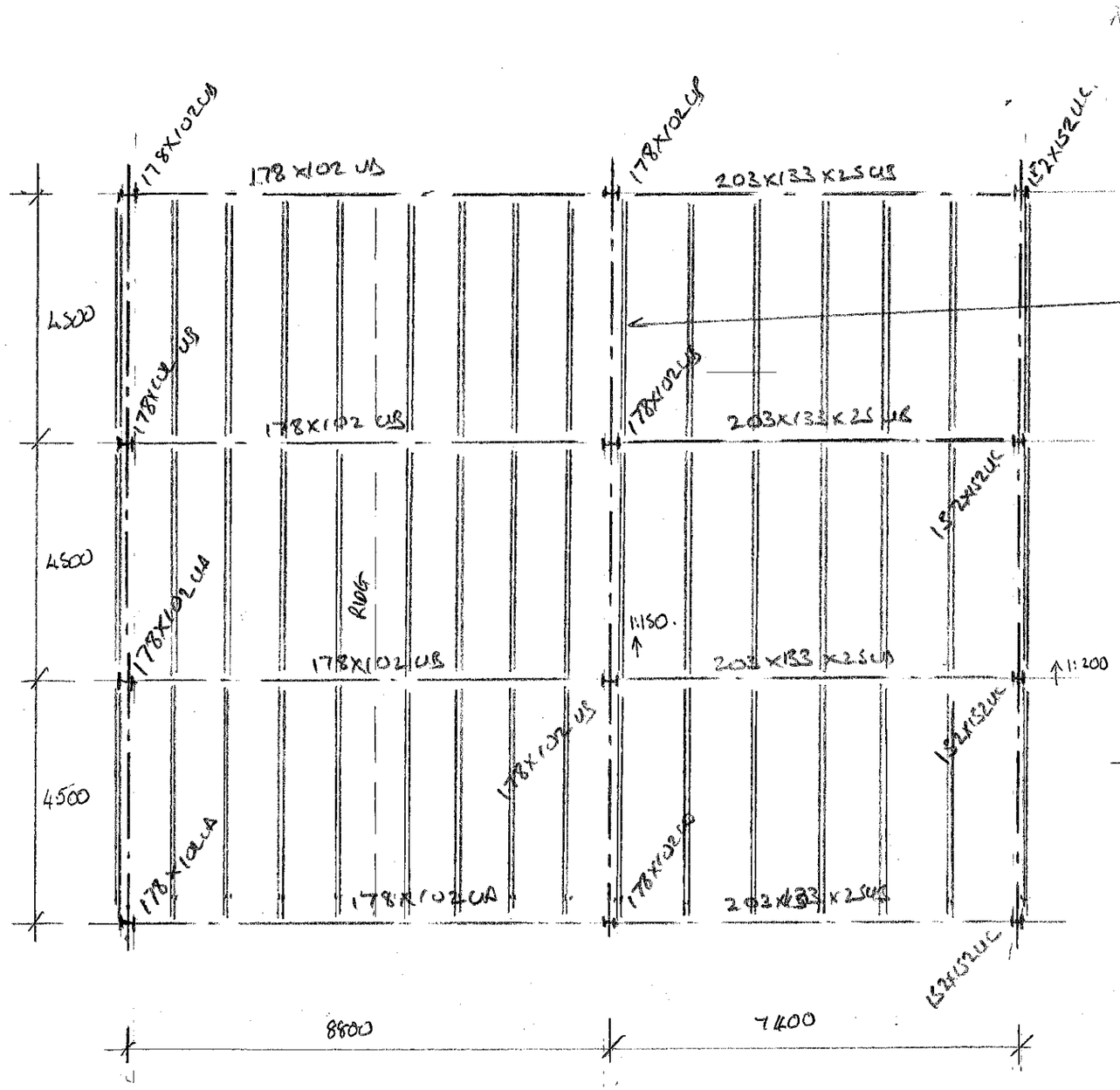
A capacity check on the existing frame members has been carried out to establish that the frame will be adequate to support the proposed building envelope using an insulated profiled composite metal cladding system (Kingspan or similar). The calculations in Appendix B consider both strength and deflection requirements. This indicates that the frame satisfactory. There is considerable spare capacity in the stanchions if a mezzanine floor is required.

4.0 Conclusion

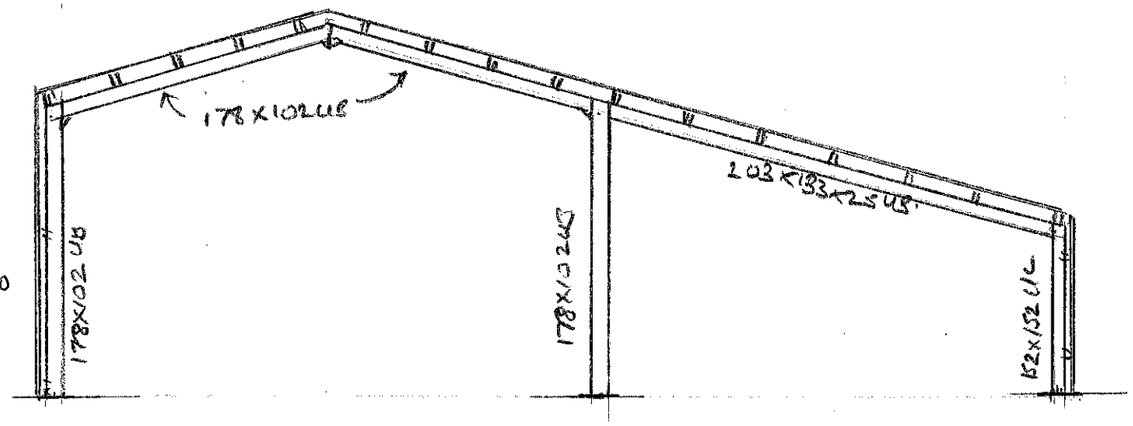
The existing building is in fair condition and is structurally suitable for conversion to residential use, as proposed, without strengthening of the existing building envelope.

Appendix A

Sketch SK/01 Structural Plan and Section of Former Agricultural Store/Workshop



GROUND FLOOR PLAN



TYPICAL SECTION (1:100)

Wellan Tel 01608 685753	Wellan House. Aylesmore, Warks, CV36 5EJ
Scale 1:100 @ A3 Proj No 20-079	Title STRUCTURAL PLAN & SECTION
Date JUNE '20 Drg No SK/01	Project FORMER AGRICULTURAL STORE/WORKSHOP. FOLLY FARM, SIBFORD FERRIS

Appendix B

Calculation Sheets Pages 1-24

Wellan Consulting Engineers

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Calc sheet no. 1

Prepared by MLN

Date JUNE '20

Project no. 20-079

Title of scheme: FORMER AGRICULTURAL/WORK SHOP, FOLLY FARM, SIBFORD

INTRODUCTION

THE FOLLOWING CALCULATIONS ARE TO CHECK THE STRUCTURAL CAPACITY OF AN EXISTING STEEL FRAMED BUILDING WHICH IS PROPOSED FOR CONVERSION TO RESIDENTIAL USE.

THE ROOF IS CLAD WITH FIBRE REINFORCED PROFILE SHEETING TO THE ROOF AND STEEL PROFILED SHEETING TO THE WALLS. PURLINS SPAN TO THE TO A TWO-BAY PORTAL FRAME WHICH APPEARS TO HAVE BEEN ORIGINALLY CONSTRUCTED AS A SYMMETRICAL SINGLE BAY WITH A LEAN-TO MONO-PITCH ADDED.

THE BUILDING IS GENERALLY IN FAIR CONDITION WITH NO EVIDENCE OF STRUCTURAL DISTRESS, SETTLEMENT OR EXCESSIVE DEFLECTION.

DESIGN CHECKS WILL BE CARRIED OUT IN ACCORDANCE WITH

1) LOADING — BS 6399
2) STEELWORK — BS 5950

CONCRETE ANALYSIS WILL UTILISE TEDDS BY TEKLA.

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Calc sheet no.	2
Prepared by	MW
Date	JUNE 20
Project no.	20-079.

Title of scheme: FORMER AGRICULTURAL WORKSHOP, FOLLY FARM, SIBFORD

LOADING

ROOF (AS PROPOSED).

INSULATED PROFILED SHEET	0.12 kN/m².
STEEL FRAME	0.05 kN/m².
CEILING & SERVICES	0.2 kN/m².
	0.29 kN/m².
SNOW LOAD (SEE TEDDS OUTPUT)	0.42 kN/m².

WIND LOADING

- SEE TEDDS OUTPUT.

NET ROOF PRESSURE

C = −0.44
G = −0.41. } INT PRES

C = 0.26
G = −0.07 } INT SUCTION.

INWARD.

W = 0.2
L = −0.35 } INT PRESS.

W = 0.49
L = −0.09 } INT SUCN.

SNOW LOADING TO BS6399:PART 3:1988

TEDDS calculation version 1.0.03

Site location

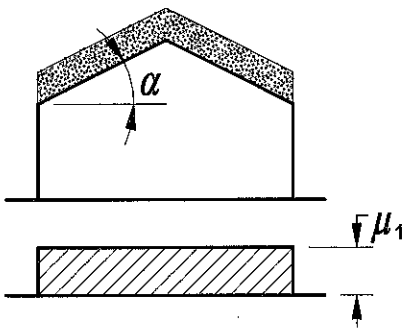
Location of site	**Oxford**
Site altitude	A = **200** m

Calculate site snow load

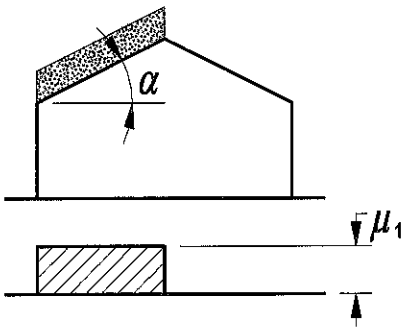
From BS6399:Part 3: 1988 - Figure 1. Basic snow load on the ground

Basic snow load	s_b = **0.40** kN/m^2
	$s_{alt} = 0.1 \times s_b + (0.09\ kN/m^2)$ = **0.13** kN/m^2
Site snow load	$s_0 = \max(s_b, s_b + s_{alt} \times (A - (100\ m)) / 100\ m)$ = **0.53** kN/m^2

BS6399:Part3:1988 Cl.6.2



Uniform loading



Asymmetric loading

Roof geometry

Roof type	**Pitched**
Distance on plan from gutter to ridge	b = **8.000** m
Angle of pitch of roof	α = **20.0** deg

Calculate uniform snow load

From BS6399:Part 3: 1988 - Figure 3. Snow load shape coefficients for pitched roofs

Snow load shape coefficient	μ_1 = **0.80**
Uniform roof snow load	$s_{d1} = \mu_1 \times s_0$ = **0.42** kN/m^2

BS6399:Part3:1988 Cl.5

Calculate asymmetric snow load

From BS6399:Part 3: 1988 - Figure 3. Snow load shape coefficients for pitched roofs

Snow load shape coefficient	$\mu_1 = 0.8 + 0.4 \times [(\alpha - 15\ deg) / 15\ deg]$ = **0.93**
Asymmetric roof snow load	$s_{d1} = \mu_1 \times s_0$ = **0.49** kN/m^2

BS6399:Part3:1988 Cl.5

Snow sliding down roof

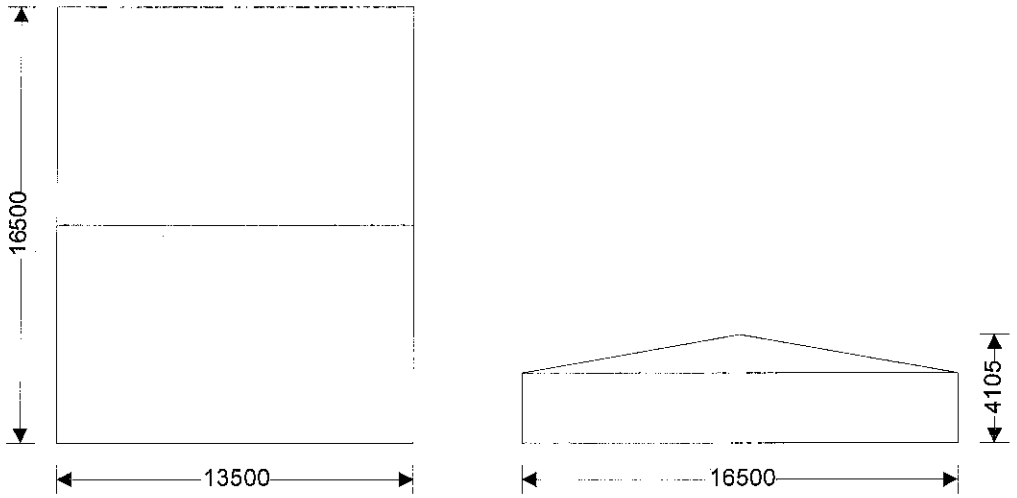
Maximum uniform snow load on roof	s_{d_max} = **0.49** kN/m^2
Force from sliding snow load	$F_s = s_{d\_max} \times b \times \sin(\alpha)$ = **1.35** kN/m

BS6399:Part3:1988 Cl.8

WIND LOADING (BS6399)

In accordance with BS6399

Tedds calculation version 3.0.17



Building data

Type of roof	Duopitch		
Length of building	L = **13500** mm	Width of building	W = **16500** mm
Pitch of roof	α_0 = **10.0** deg		
Reference height	H_r = **4105** mm		

Dynamic classification

Building type factor (table 1)	K_b = **1.0**	Dynamic augmentation factor (1.6.1)	C_r = **0.01**

Site wind speed

Location	Oxford	Basic wind speed	V_b = **19.7** m/s
Site altitude	Δ_S = **200** m	Upwind dist from sea to site	d_{sea} = **108** km
Direction factor	S_d =**1.00**	Seasonal factor	S_s = **1.00**
Probability factor	S_p = **1.00**	Critical gap between buidlings	g = **5000** mm
Topography not significant			
Altitude factor	S_a = **1.20**	Site wind speed	V_s = **23.6** m/s
Terrain category	Country		
Displacement height	H_d = 0mm		

The velocity pressure for the windward face of the building with a 0 degree wind is to be considered as 1 part as the height h is less than b (cl.2.2.3.2)

The velocity pressure for the windward face of the building with a 90 degree wind is to be considered as 1 part as the height h is less than b (cl.2.2.3.2)

Dynamic pressure - windward wall - Wind 0 deg and roof

Reference height	H_e = **2650** mm		
Fetch factor (Table 22)	S_c = **0.757**	Turbulence factor (Table 22)	S_t = **0.210**
Gust peak factor	g_t = **3.44**	Terrain and building factor	S_b = **1.30**
Effective wind speed	V_e = **30.8** m/s	Dynamic pressure	q_s = **0.583** kN/m^2

Dynamic pressure - windward wall - Wind 90 deg and roof

Reference height	H_e = **4105** mm

Fetch factor (Table 22)	S_c = **0.835**	Turbulence factor (Table 22)	S_t = **0.199**
Gust peak factor	g_t = **3.44**	Terrain and building factor	S_b = **1.41**
Effective wind speed	V_e = **33.2** m/s	Dynamic pressure	q_s = **0.677** kN/m^2

Size effect factors

Diag dim for gablewall	a_{eg} = **12.0** m	Exte size effect factor	C_{aeg} = **0.934**
Diag dim for side wall	a_{es} = **18.0** m	Exte size effect factor	C_{aes} = **0.903**
Diag dim for roof	a_{er} = **19.0** m	Exte size effect factor	C_{aer} = **0.899**
Volume for int size effect	V_i = **0.1** m^3	Diag dim for int size effect	a_i = **5.0** m
Internal size effect factor	C_{ai} = **1.000**		

Pressures and forces

Net pressure $p = q_s \times c_{pe} \times C_{ae} - q_s \times c_{pi} \times C_{ai}$

Net force $F_w = p \times A_{ref}$

Roof load case 1 - Wind 0, c_{pi} 0.20, -c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A (-ve)	-1.45	0.68	0.899	-1.02	6.84	-6.96
B (-ve)	-1.00	0.68	0.899	-0.74	4.41	-3.28
C (-ve)	-0.50	0.68	0.899	-0.44	101.84	-44.77
E (-ve)	-1.10	0.68	0.899	-0.80	6.84	-5.51
F (-ve)	-0.60	0.68	0.899	-0.50	4.41	-2.21
G (-ve)	-0.45	0.68	0.899	-0.41	101.84	-41.67

Total vertical net force $F_{w,v}$ = **-102.81** kN Total horizontal net force $F_{w,h}$ = **-0.98** kN

Walls load case 1 - Wind 0, c_{pi} 0.20, -c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A	-1.53	0.68	0.934	-1.11	4.59	-5.07
B	-0.88	0.68	0.934	-0.69	23.11	-15.95
C	-0.81	0.68	0.934	-0.65	28.03	-18.19
w	0.60	0.58	0.903	0.20	35.78	7.13
l	-0.50	0.58	0.903	-0.38	35.78	-13.59

Overall loading

Leeward force overall F_l = **-13.6** kN Windward force overall F_w = **7.1** kN

Overall loading overall $F_{w,w}$ = **17.0** kN

Roof load case 2 - Wind 0, c_{pi} -0.3, +c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A (+ve)	0.10	0.68	0.899	0.26	6.84	1.81
B (+ve)	0.10	0.68	0.899	0.26	4.41	1.16
C (+ve)	0.10	0.68	0.899	0.26	101.84	26.87
E (+ve)	-1.10	0.68	0.899	-0.47	6.84	-3.19
F (+ve)	-0.60	0.68	0.899	-0.16	4.41	-0.71
G (+ve)	-0.45	0.68	0.899	-0.07	101.84	-7.21

Total vertical net force $F_{w,v}$ = **18.44** kN Total horizontal net force $F_{w,h}$ = **7.11** kN

Walls load case 2 - Wind 0, c_{pi} -0.3, +c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A	-1.53	0.68	0.934	-0.77	4.59	-3.52
B	-0.88	0.68	0.934	-0.35	23.11	-8.13
C	-0.81	0.68	0.934	-0.31	28.03	-8.71
w	0.60	0.58	0.903	0.49	35.78	17.56
I	-0.50	0.58	0.903	-0.09	35.78	-3.16

Overall loading

Leeward force overall F_l = **-3.2** kN Windward force overall F_w = **17.6** kN

Overall loading overall $F_{w,w}$ = **24.0** kN

Roof load case 3 - Wind 90, c_{pi} 0.20, -c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A (-ve)	-1.80	0.68	0.899	-1.23	6.88	-8.46
B (-ve)	-1.30	0.68	0.899	-0.93	6.88	-6.37
C (-ve)	-0.60	0.68	0.899	-0.50	55.02	-27.53
D (-ve)	-0.45	0.68	0.899	-0.41	157.41	-64.41

Total vertical net force $F_{w,v}$ = **-105.15** kN Total horizontal net force $F_{w,h}$ = **0.00** kN

Walls load case 3 - Wind 90, c_{pi} 0.20, -c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A	-1.33	0.58	0.903	-0.82	2.81	-2.30
B	-0.81	0.58	0.903	-0.54	11.24	-6.11
C	-0.55	0.58	0.903	-0.40	21.73	-8.78
w	0.66	0.68	0.934	0.28	55.73	15.67
I	-0.50	0.68	0.934	-0.45	55.73	-25.15

Overall loading

Leeward force overall F_l = **-25.1** kN Windward force overall F_w = **15.7** kN

Overall loading overall $F_{w,w}$ = **35.1** kN

Roof load case 4 - Wind 90, c_{pi} -0.3, -c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A (-ve)	-1.80	0.68	0.899	-0.89	6.88	-6.14
B (-ve)	-1.30	0.68	0.899	-0.59	6.88	-4.04
C (-ve)	-0.60	0.68	0.899	-0.16	55.02	-8.92
D (-ve)	-0.45	0.68	0.899	-0.07	157.41	-11.15

Total vertical net force $F_{w,v}$ = **-29.78** kN Total horizontal net force $F_{w,h}$ = **0.00** kN

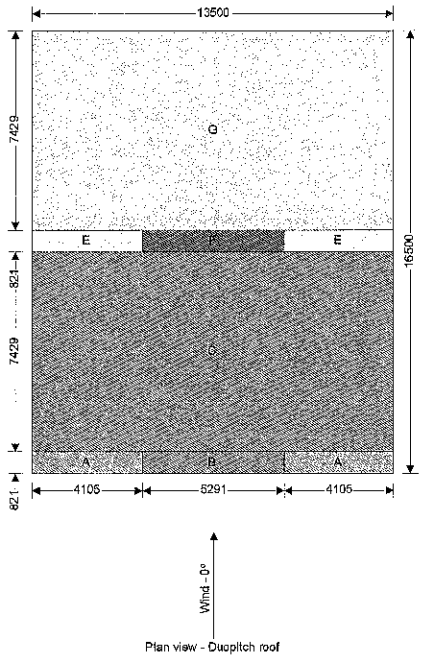
Walls load case 4 - Wind 90, c_{pi} -0.3, -c_{pe}

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A	-1.33	0.58	0.903	-0.53	2.81	-1.48
B	-0.81	0.58	0.903	-0.25	11.24	-2.84
C	-0.55	0.58	0.903	-0.11	21.73	-2.44
w	0.66	0.68	0.934	0.62	55.73	34.53
l	-0.50	0.68	0.934	-0.11	55.73	-6.29

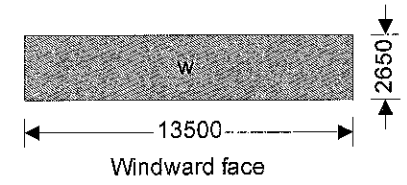
Overall loading

Leeward force overall F_l = **-6.3** kN Windward force overall F_w = **34.5** kN

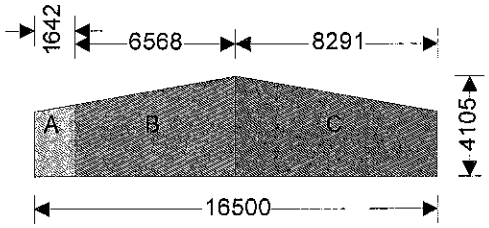
Overall loading overall $F_{w,w}$ = **35.1** kN



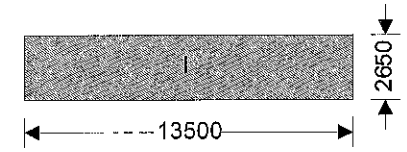
Plan view - Duopitch roof



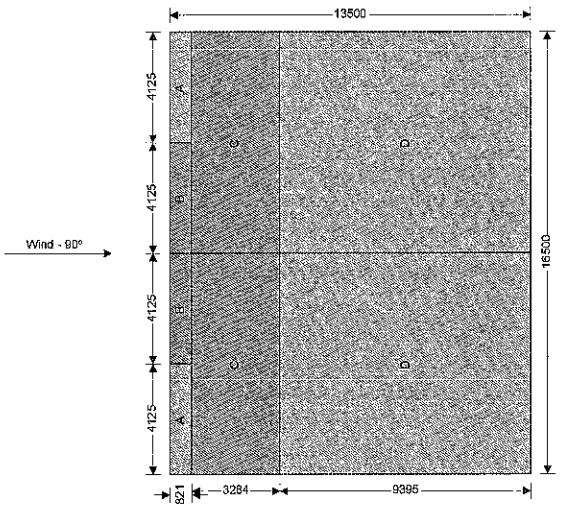
Windward face



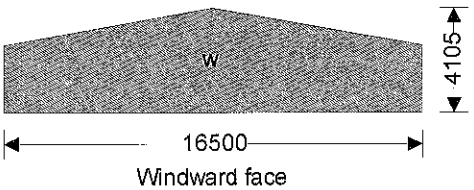
Side face



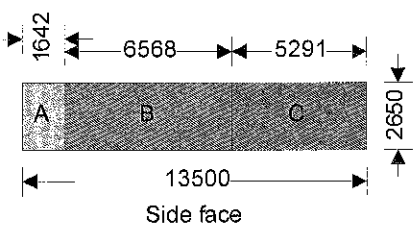
Leeward face



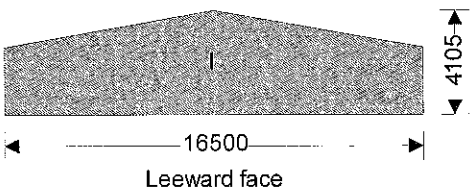
Plan view - Duopitch roof



Windward face



Side face



Leeward face

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Calc sheet no. 9
Prepared by NWJ
Date JUNE '20
Project no. 20-079

Title of scheme: FORMER AGRICULTURAL WORKSHOP, FOLLY FARM, SIBFORD

CHECK PURLINS SPAN = 4.5m.

DEAD LOAD = 0.12 kN/m²
IMPOSED = 0.42
WIND (UPLIFT) = 0.26

} 0.54 kN/m² (NO WIND) } 0.8 kN (WIND)

MAX PURLIN SPACING = 1.2m.

∴ LONG TERM LOAD = 1.2 · 0.12 = 0.14 kN/m (CLOSED)
MED " " = 1.2 · 0.54 = 0.65
SHORT " " = 1.2 · 0.8 = 0.96

DEAD TO PURLIN = 0.12 · 1.2 = 0.14 kN/m
IMP " " = 0.42 · 1.2 = 0.50
WIND " " = 0.26 · 1.2 = 0.3

} FOR COMPARISON WITH

PURLINS OK - SEE TEDDS CALCS

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Calc sheet no. 10
Prepared by NW
Date JUNE '20
Project no. 20-079

Title of scheme: FORMER AGRICULTURAL WORKSHOP, FERRY FARM, SIBFORD

MEMBER LOADS

FRAME SPACING 4.5m.

RAFTER MEMBER = 4.5 . 0.26 . = 1.17 kN/m

LEE . = 4.5 . - 0.07 = 0.32

WIND. WINDWARD = 4.5 . 0.49 = 2.21 kN/m.

LEEWARD WIND = 4.5 - 0.89 = 0.41

RAFTER DEAD = 4.5 . 0.29 = 1.31.

IMP = 4.5 . 0.42 = 1.89.

SEE ATTACHED TEDDS OUTPUT FOR RESULTS.

			CAP
WORST CASE MEMBER	1 = 24.2kN	178x102 CHS	46.0kN
" " "	2 = 24.2kN.	178x102 CHS	48.0
" "	3 = 34.7kN.	178x102 CHS	48.0
	4 = 10.2kN.	178x102 CHS	48.0
	5 = 26.8kN.	203x133x25 CA	68.0kN
	6 = 26.8kN	152x152x23UC	47.0kN.

ALL MEMBERS UNDER CAP.

DEFLECTION

WORST CASE @ AT 5 ↓ 32.6 = SPAN/276 OK.

AT 4 → 24.1 = HT/186 OK.

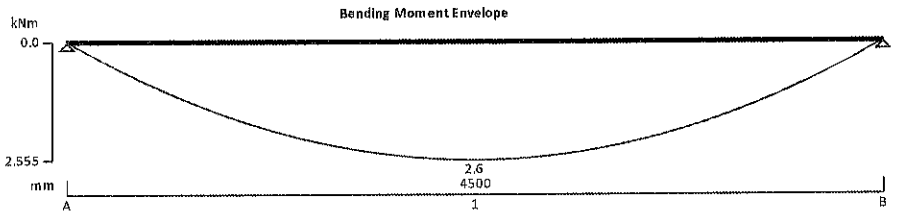
MAX REACT = 32.0 kN

∴ BASE NET AREA = 32.0/100 = 0.32 m²

MIN SIZE = 0.56 m² OK BY INSPECTION.

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.01



Applied loading

Beam loads

Dead self weight of beam × 1
Dead full UDL 0.140 kN/m
Imposed full UDL 0.500 kN/m
Wind full UDL 0.300 kN/m

Load combinations

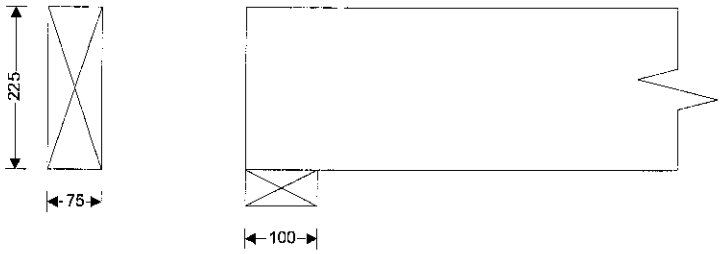
Load combination 1	Support A	Dead × 1.00
		Imposed × 1.00
		Wind × 1.00
	Span 1	Dead × 1.00
		Imposed × 1.00
		Wind × 0.00
	Support B	Dead × 1.00
		Imposed × 1.00
		Wind × 1.00
Load combination 2	Support A	Dead × 1.00
		Imposed × 1.00
		Wind × 1.00
	Span 1	Dead × 1.00
		Imposed × 1.00
		Wind × 1.00
	Support B	Dead × 1.00
		Imposed × 1.00
		Wind × 1.00

Analysis results

Design moment	M = **2.555** kNm	Design shear	F = **2.271** kN
Total load on beam	W_{tot} = **4.543** kN		
Reactions at support A	R_{A_max} = **2.271** kN	R_{A_min} = **1.596** kN	
Unfactored dead load reaction at support A	R_{A_Dead} = **0.471** kN		
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **1.125** kN		
Unfactored wind load reaction at support A	R_{A_Wind} = **0.675** kN		
Reactions at support B	R_{B_max} = **2.271** kN	R_{B_min} = **1.596** kN	
Unfactored dead load reaction at support B	R_{B_Dead} = **0.471** kN		

Unfactored imposed load reaction at support B $R_{B\_Imposed}$ = **1.125** kN

Unfactored wind load reaction at support B R_{B_Wind} = **0.675** kN



Timber section details

Breadth of section	b = **75** mm	Depth of section	h = **225** mm
Number of sections	N = **1**	Breadth of beam	b_b = **75** mm
Inclination of section	θ = **20.0** deg		
Timber strength class	**C24**		

Member details

Service class of timber	**1**	Load duration	**Medium term**
Length of span	L_{s1} = **4500** mm		
Length of bearing	L_b = **100** mm		

Lateral support - cl.2.10.8

Permiss.depth-to-breadth ratio	**6.00**	Actual depth-to-breadth ratio	**3.00**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress	σ_{c_adm} = **3.000** N/mm²	Applied bearing stress	σ_{c_a} = **0.303** N/mm²

PASS - Applied compressive stress is less than permissible compressive stress at bearing

Bending parallel to grain

Permissible bending stress	σ_{m_adm} = **9.676** N/mm²	Applied bending stress	σ_{m_a} = **7.938** N/mm²

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress	τ_{adm} = **0.888** N/mm²	Applied shear stress	τ_a = **0.202** N/mm²

PASS - Applied shear stress is less than permissible shear stress

Deflection

Permissible deflection	δ_{adm} = **13.500** mm	Total deflection	δ_a = **12.140** mm

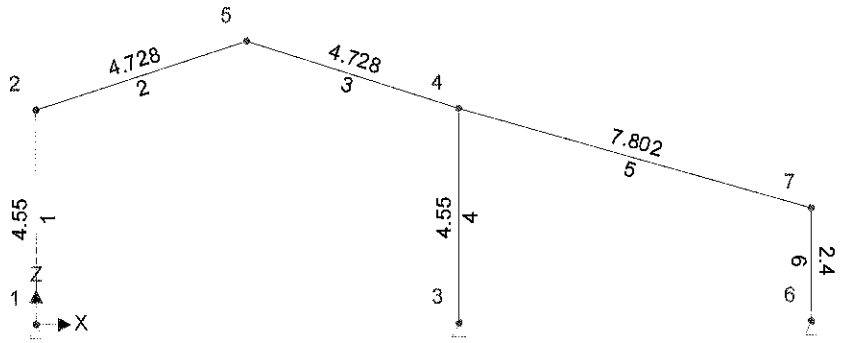
PASS - Total deflection is less than permissible deflection

ANALYSIS

Tedds calculation version 1.0.28

Geometry

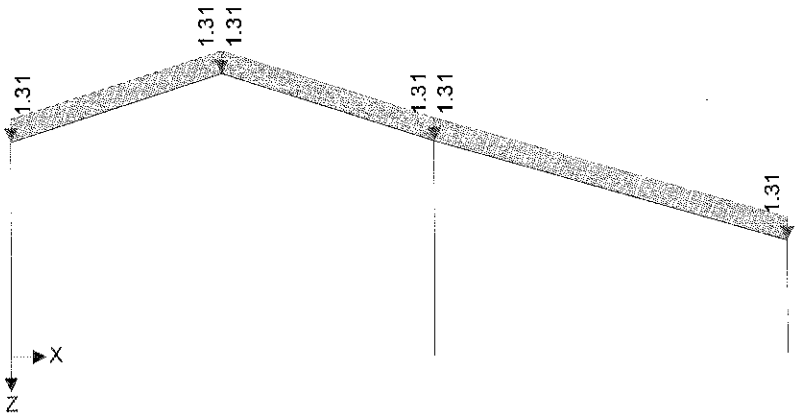
Geometry (m) - Steel (BS5950)



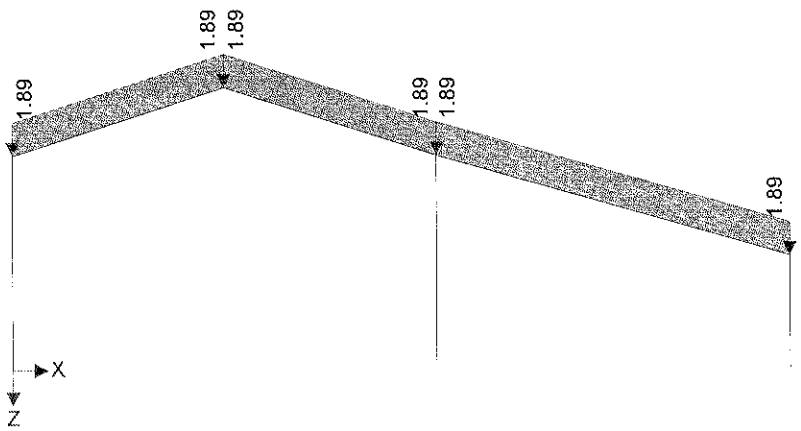
Loading

Self weight included

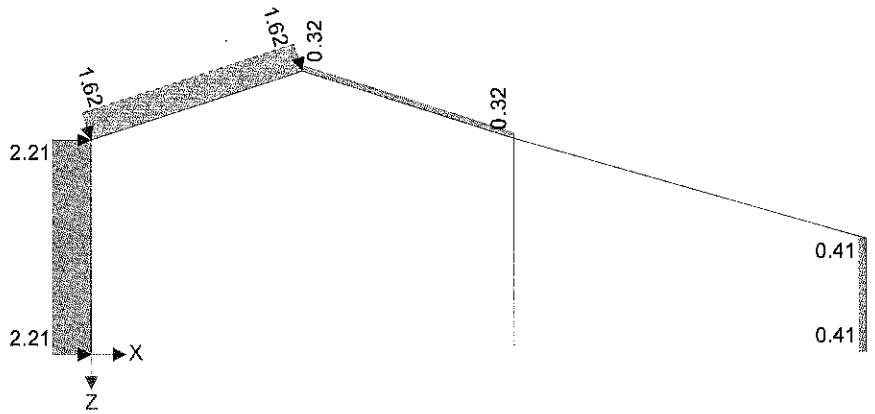
Permanent - Loading (kN/m)



Imposed - Loading (kN/m)



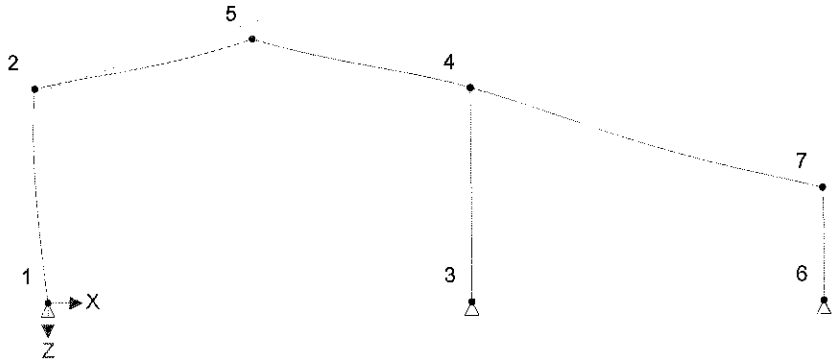
Wind - Loading (kN/m)



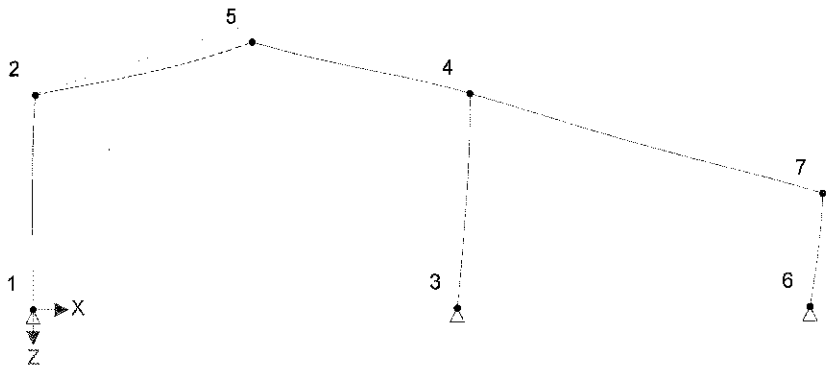
Results

Total deflection

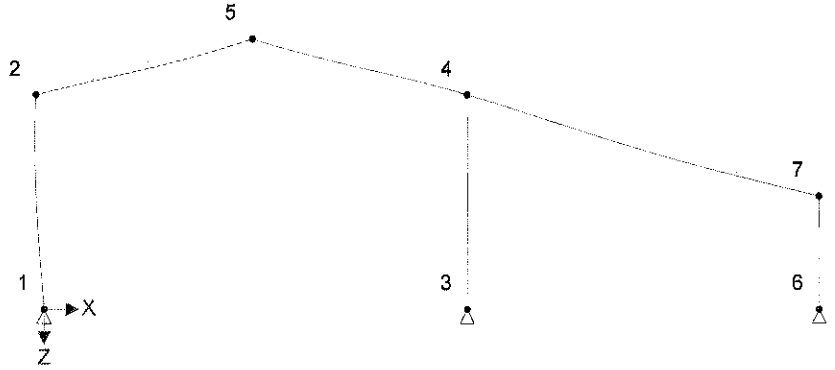
Dead and Imp (Strength) - Total deflection



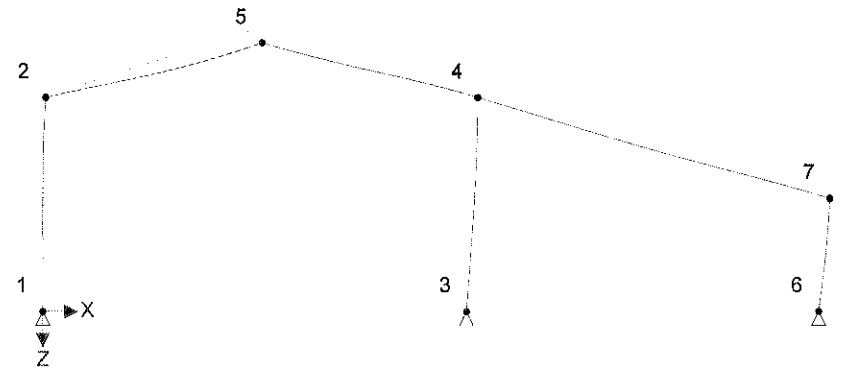
Dead Imp and wind (Strength) - Total deflection



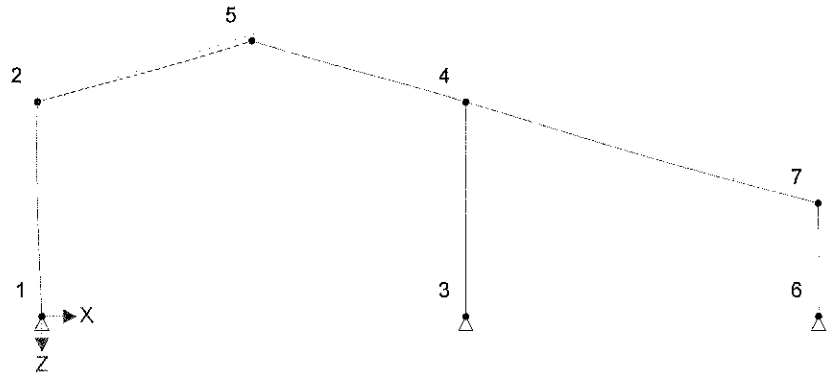
Dead and Imposed (Service) - Total deflection



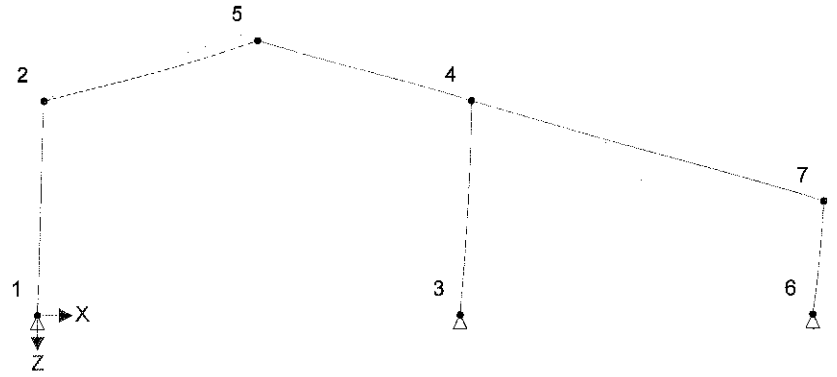
Dead Imposed and Wind (Service) - Total deflection



Imposed (Service) - Total deflection



Imposed and Wind (Service) - Total deflection



Node deflections

Load combination: Dead and Imp (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	-0.71917	
2	-27.5	0.2	0.41492	
3	0	0	-0.0071	
4	-2.2	0.4	-0.06882	
5	-14.8	39.8	-0.08302	
6	0	0	0.05287	
7	-2.1	0.1	-0.27083	

Load combination: Dead Imp and wind (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	-0.01456	
2	6.3	0.2	0.49397	
3	0	0	0.54202	
4	28	0.3	-0.03151	
5	17.2	34.5	-0.14911	
6	0	0	0.90435	
7	28	0.1	0.17363	

Load combination: Dead and Imposed (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	-0.48328	
2	-18.5	0.1	0.27802	
3	0	0	-0.00655	
4	-1.5	0.3	-0.04495	
5	-10	26.7	-0.0559	

δ@5 = 26.7 (Z) mm
10.0 (X)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
6	0	0	0.03431	
7	-1.5	0.1	-0.18391	

Load combination: Dead Imposed and Wind (Service)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	-0.01681	
2	5.1	0.2	0.41393	
3	0	0	0.45077	
4	23.3	0.3	-0.02607	
5	14.2	28.9	-0.12485	
6	0	0	0.75337	
7	23.3	0.1	0.142	

6 x ⑥ 4 = 23.3 m.
6 & ⑥ 5 = 28 m.

Load combination: Imposed (Service)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	-0.26889	
2	-10.2	0.1	0.15607	
3	0	0	-0.00063	
4	-0.7	0.2	-0.02722	
5	-5.5	15	-0.03091	
6	0	0	0.02116	
7	-0.7	0	-0.09909	

Load combination: Imposed and Wind (Service)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.19759	
2	13.3	0.1	0.29198	
3	0	0	0.45669	
4	24.1	0.1	-0.00834	
5	18.7	17.2	-0.09986	
6	0	0	0.74022	
7	24	0	0.22682	

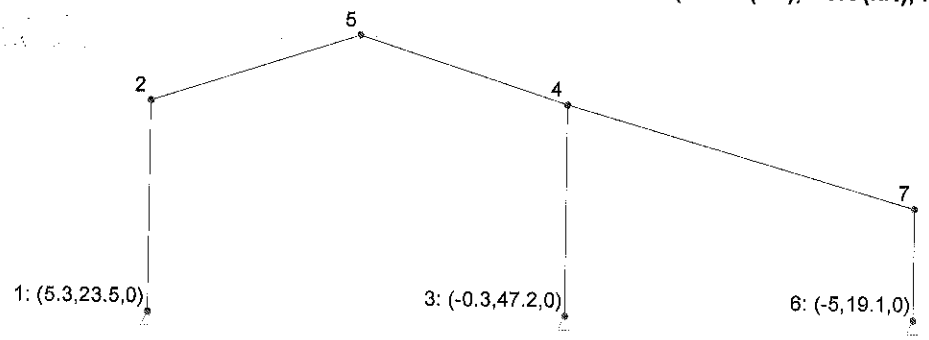
Total base reactions

Load case/combination	Force FX (kN)	Force FZ (kN)
Dead and Imp (Strength)	0	89.8
Dead Imp and wind (Strength)	-16.1	82.8

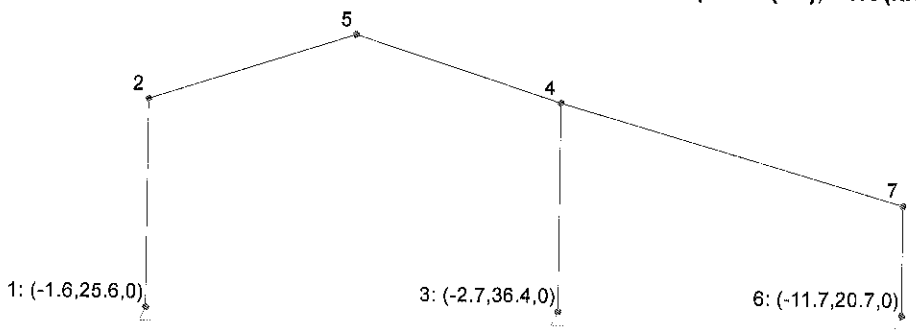
Load case/combination	Force	
	FX (kN)	FZ (kN)
Dead and Imposed (Service)	0	61.2
Dead Imposed and Wind (Service)	-13.4	70
Imposed (Service)	0	32.6
Imposed and Wind (Service)	-13.4	41.4

Reactions

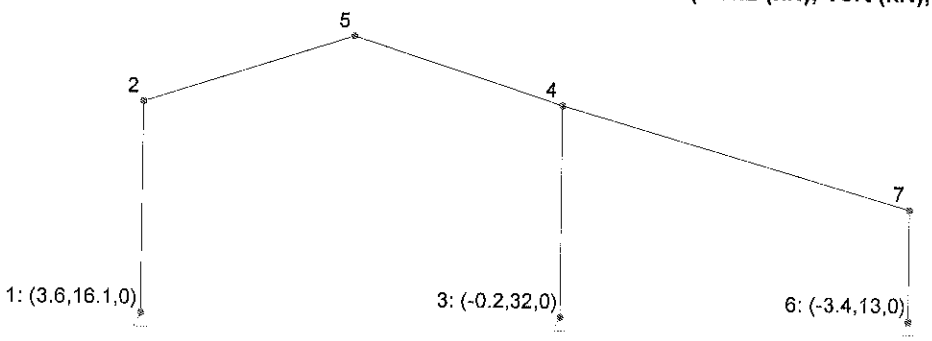
Dead and Imp (Strength) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



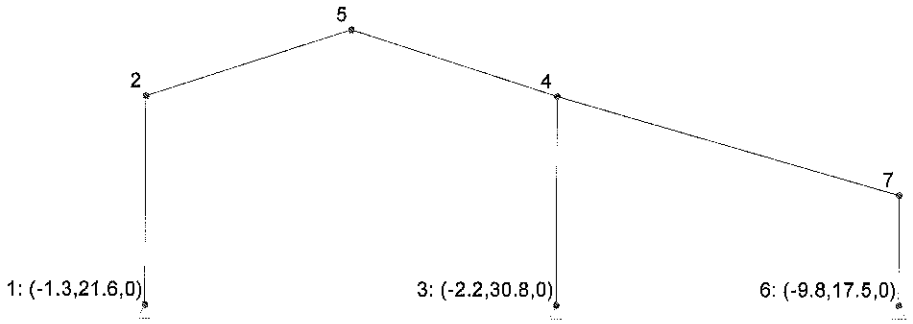
Dead Imp and wind (Strength) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



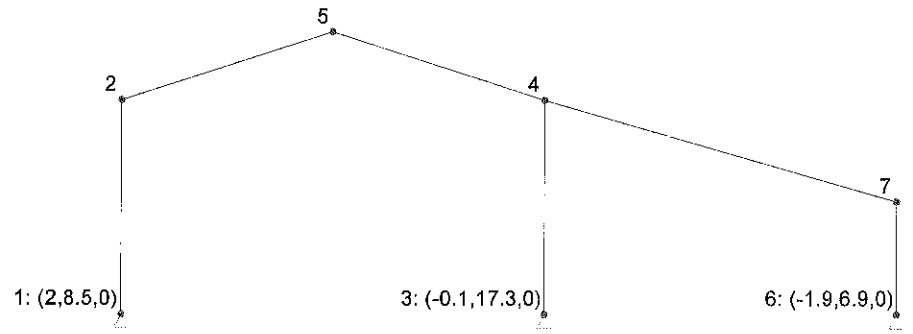
Dead and Imposed (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



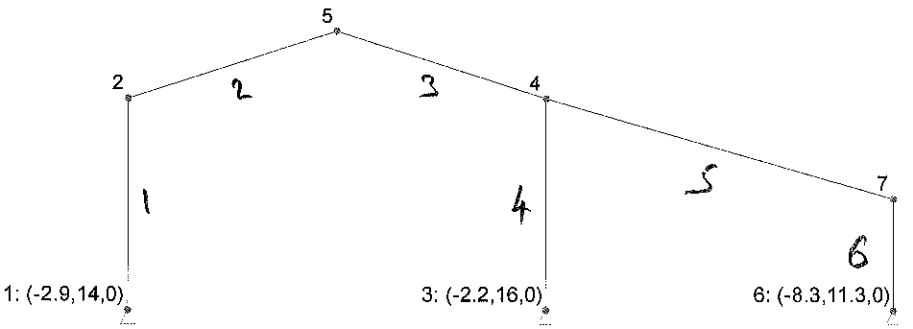
Dead Imposed and Wind (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



Imposed (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



Imposed and Wind (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



Element end forces

Load combination: Dead and Imp (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.55	1	-23.5	5.3	0
		2	22.7	-5.3	-24.2
2	4.728	2	-12	-20	24.2
		5	4.7	-2.7	16.5
3	4.728	5	-5.4	-0.5	-16.5
		4	12.7	-22.2	-34.7
4	4.55	3	-47.2	-0.3	0
		4	46.3	0.3	1.3
5	7.802	4	1	-21.9	33.4

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
		7	9.9	-16.4	-12.1
6	2.4	7	-18.5	-5	12.1
		6	19.1	5	0

Load combination: Dead Imp and wind (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.55	1	-25.6	-1.6	0
		2	24.7	-10.4	-20
2	4.728	2	-17.5	-20.4	20
		5	11.7	-7	11.7
3	4.728	5	-13.5	-1.2	-11.7
		4	19.9	-18.7	-29.7
4	4.55	3	-36.4	-2.7	0
		4	35.6	2.7	12.2
5	7.802	4	-6.9	-14.1	17.5
		7	15.7	-16.5	-26.8
6	2.4	7	-20.2	-10.6	26.8
		6	20.7	11.7	0

Load combination: Dead and Imposed (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.55	1	-16.1	3.6	0
		2	15.2	-3.6	-16.2
2	4.728	2	-8.1	-13.4	16.2
		5	3.2	-1.8	11.1
3	4.728	5	-3.6	-0.3	-11.1
		4	8.5	-14.9	-23.3
4	4.55	3	-32	-0.2	0
		4	31.2	0.2	0.8
5	7.802	4	0.7	-14.8	22.5
		7	6.7	-11.1	-8.1
6	2.4	7	-12.5	-3.4	8.1
		6	13	3.4	0

Load combination: Dead Imposed and Wind (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.55	1	-21.6	-1.3	0
		2	20.8	-8.7	-16.8
2	4.728	2	-14.7	-17.1	16.8
		5	9.8	-5.8	9.8
3	4.728	5	-11.3	-1	-9.8
		4	16.7	-15.7	-25
4	4.55	3	-30.8	-2.2	0
		4	30	2.2	10.2
5	7.802	4	-5.8	-12	14.8

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
		7	13.2	-13.9	-22.4
6	2.4	7	-17	-8.8	22.4
		6	17.5	9.8	0

Load combination: Imposed (Service)

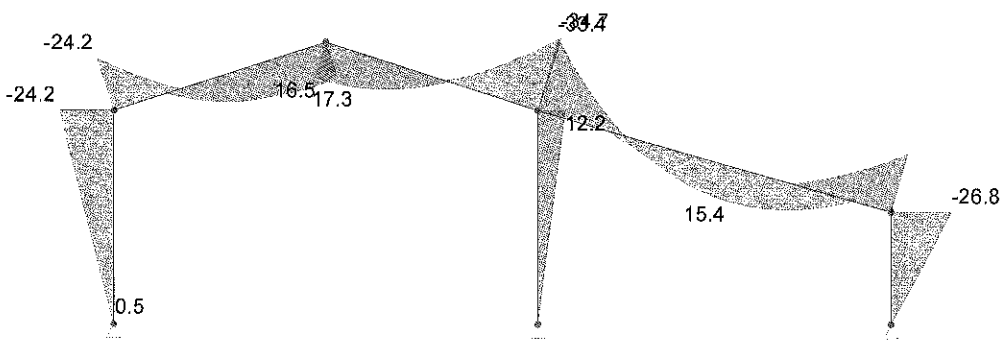
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.55	1	-8.5	2	0
		2	8.5	-2	-9.1
2	4.728	2	-4.5	-7.5	9.1
		5	1.8	-1	6.2
3	4.728	5	-2	-0.2	-6.2
		4	4.8	-8.3	-13
4	4.55	3	-17.3	-0.1	0
		4	17.3	0.1	0.6
5	7.802	4	0.4	-8.1	12.4
		7	3.7	-6.1	-4.5
6	2.4	7	-6.9	-1.9	4.5
		6	6.9	1.9	0

Load combination: Imposed and Wind (Service)

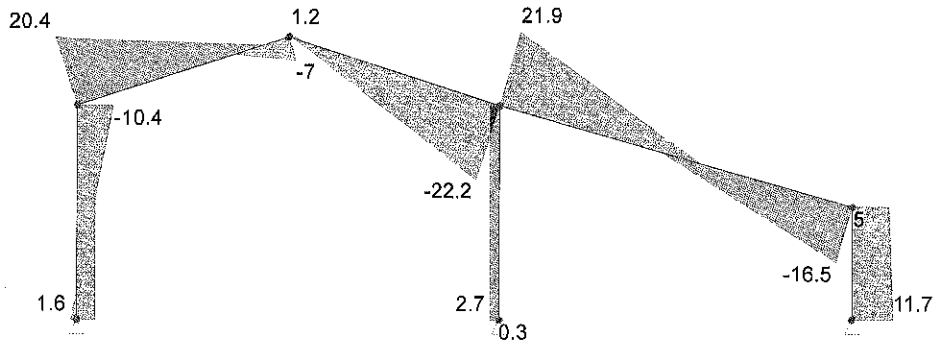
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.55	1	-14	-2.9	0
		2	14	-7.1	-9.6
2	4.728	2	-11.1	-11.2	9.6
		5	8.4	-5	4.9
3	4.728	5	-9.7	-0.8	-4.9
		4	12.9	-9.1	-14.7
4	4.55	3	-16	-2.2	0
		4	16	2.2	9.9
5	7.802	4	-6.1	-5.3	4.7
		7	10.2	-8.9	-18.7
6	2.4	7	-11.3	-7.3	18.7
		6	11.3	8.3	0

Forces

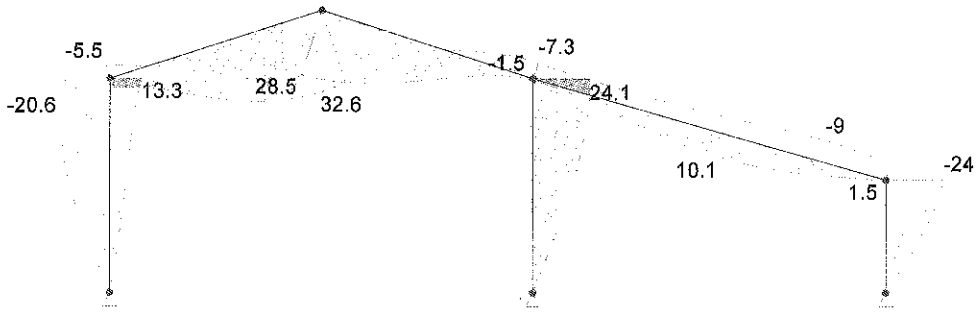
Strength combinations - Moment envelope (kNm)



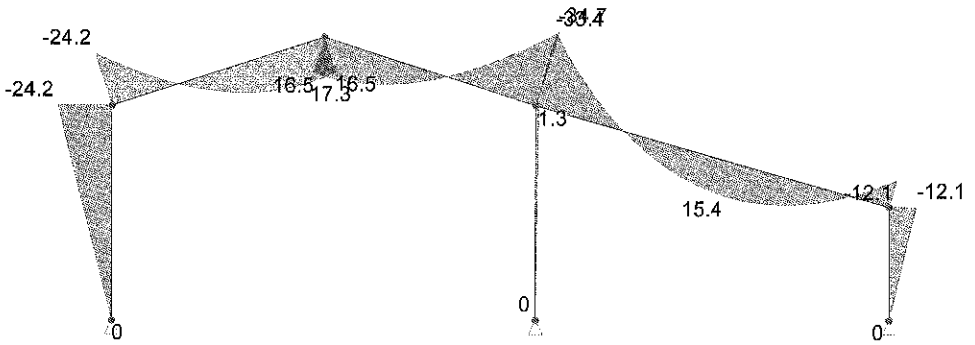
Strength combinations - Shear envelope (kN)



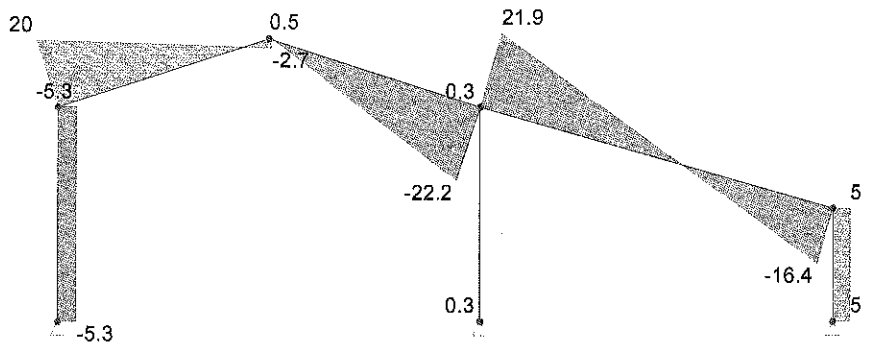
Service combinations - Deflection envelope (mm)



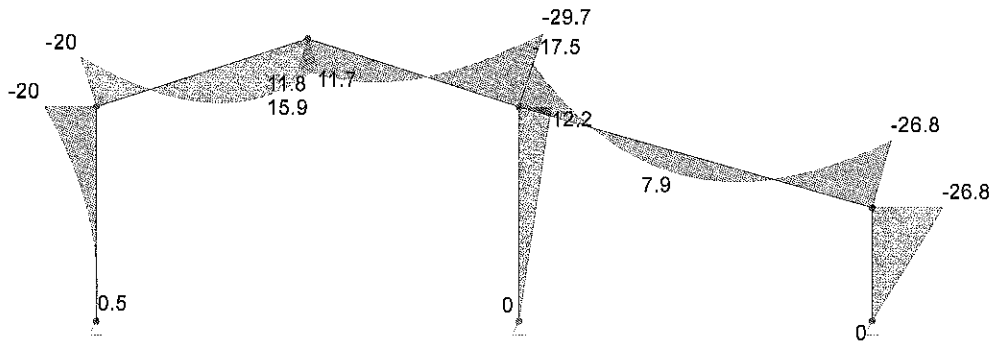
Dead and Imp (Strength) - Moment (kNm)



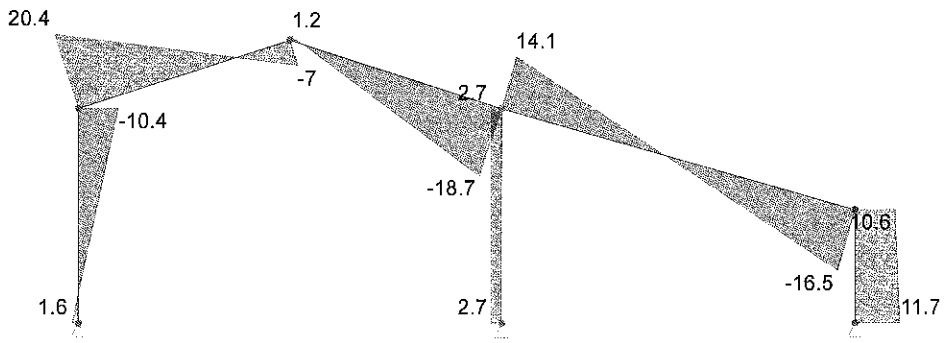
Dead and Imp (Strength) - Shear (kN)



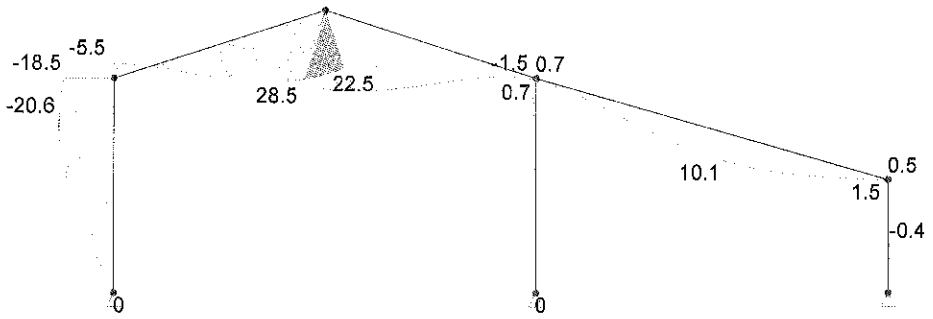
Dead Imp and wind (Strength) - Moment (kNm)



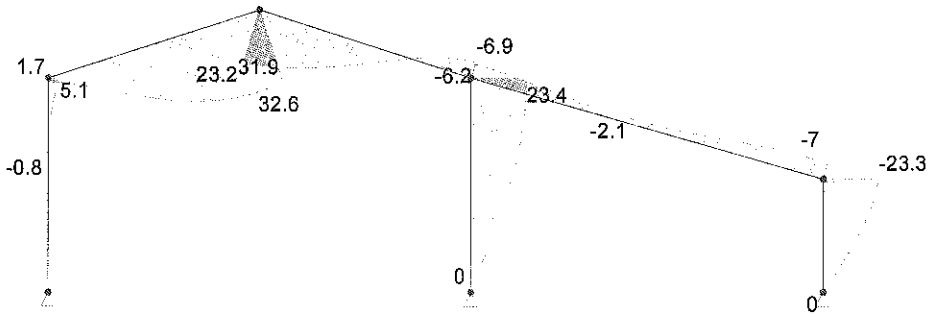
Dead Imp and wind (Strength) - Shear (kN)



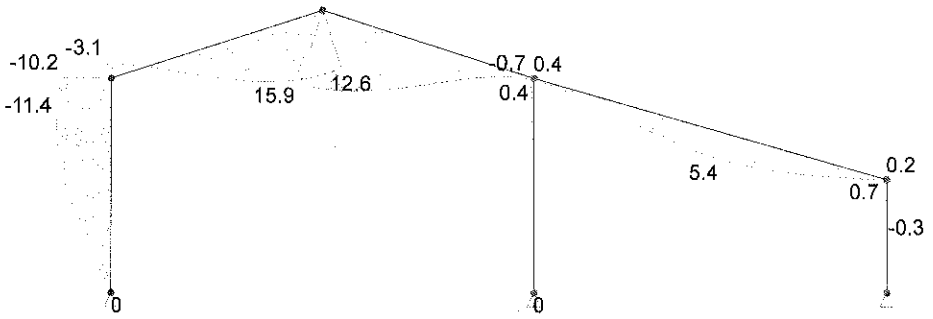
Dead and Imposed (Service) - Deflection (mm)



Dead Imposed and Wind (Service) - Deflection (mm)



Imposed (Service) - Deflection (mm)



Imposed and Wind (Service) - Deflection (mm)