APOLLO SCAFFOLD SERVICES LTD
TEMPORARY ROOF GUIDELINES
DESIGN CHECK CALCULATIONS

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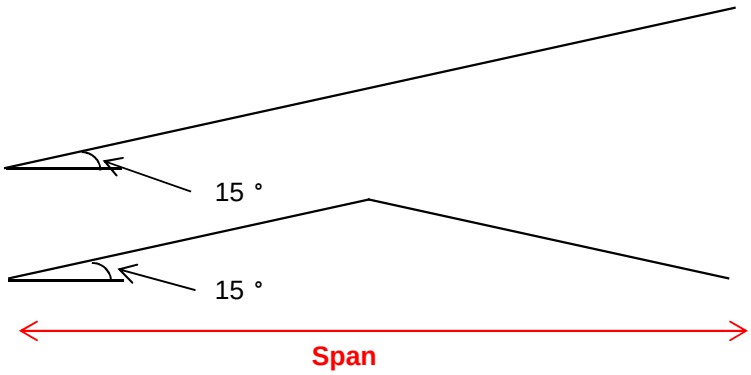
Brief

To prepare structural design calculations for four temporary roof structures, one duo pitch and one mono pitch using Apollo 450mm Lattice Beams and Apollo 750 X-Beams.

Layout



Roofs are to be sheeted and an independent scaffold system must be used at each gable wall.

Bays are to be 2.5m c/c using bracing system as per AWD R0182-001B.

The design is to incorporate snow loads and be standing for less than a year

The angle of pitch on both roofs - 15°

Apollo 450 Lattice Beam Capacities as per AWD F006/004
Apollo 450 Lattice Ridge Frame Capacaties as per AWD G0041/001

Apollo 750 X-beam Capacaties as per AWD R0076/001
Apollo 750 X-beam Ridge Frame Capacaties as per AWD R0151/001

Design

Actions on Structures - Snow EN 1991-1-3
Actions on Structures - Wind EN 1991-1-4
Temporay Demountable Structures

Assumptions

The design is to account for snow lying on the roof

It is assumed that the roof beams will be fixed to the scaffold structure at each end to allow for simply supported design .

Roof design wind speed = 22 m/s (London only)

Max roof height above sea level is 60m
Max roof eave height above ground level is 20m

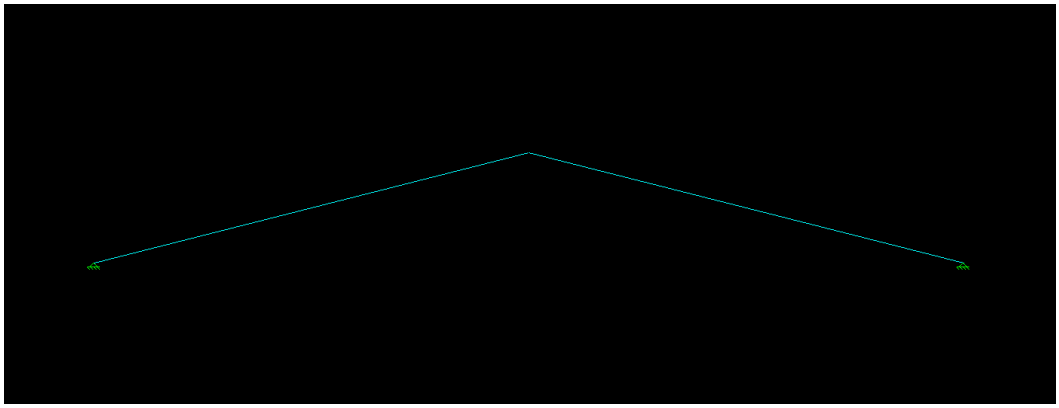
The plan brace has been designed to withstand the weight of one operative on the brace frame. Max operative and tool weight is 100kg

The plan brace is not designed for impact from falling objects

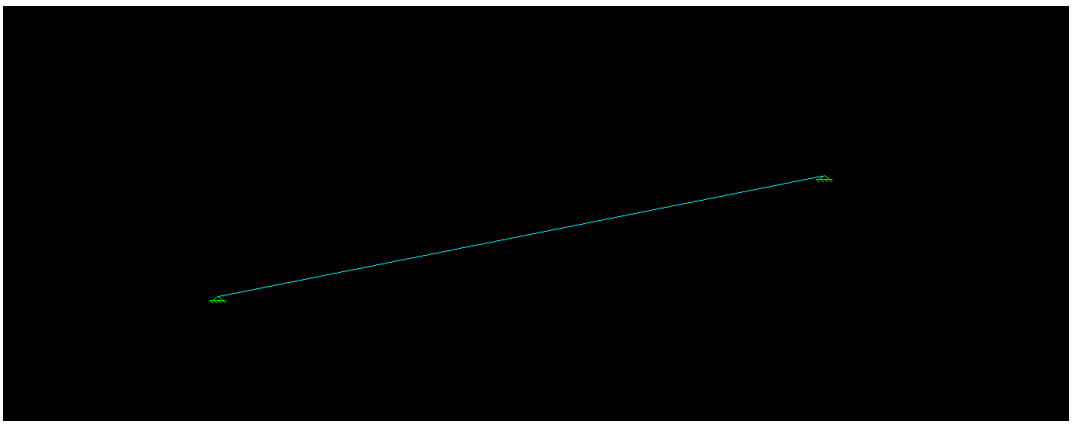
This document is for for guidance only, all temporary roof designs should be completed by a component engineer.

Analysis

Truss 1 **Duo Pitch**



Truss 2 **Mono Pitch**



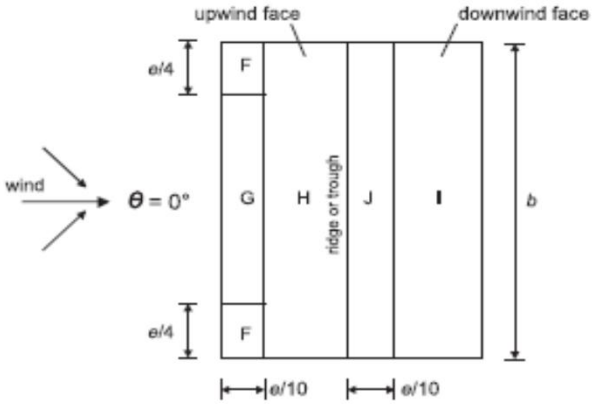
Wind Loading

Wind calculation procedures are taken from the European standards
EN 1991-1-4 Eurocode 1 Actions on structures - Wind
EN 13782 Temporary Structures -safety

Basic Wind Speed	V_b=	22	m/s	Greater London
Site Altitude	A=	60.00	m	
Site Altitude Factor	C_{alt}=	$1+0.001A*(10/z)^{0.2}$		N.A.2.5
	C_{alt}=	1.06		
Directional Factor	C_{dir}=	1.00		Tab N.A.1
Seasonal Factor	C_s=	1.00		Table N.A.2
Probability Factor	C_p=	0.85		Temp Works
Wind Speed	V_e=	$V_b*C_{alt}*C_d*C_s*C_p$		
	=	19.82	m/s	
Dynamic Wind Pressure	q_b=	$k*V_e^2$		k=0.613
	=	0.24	kN/m^2	
Effective Height	$z-h_{dis}$=	10.00	m	Assumes 15m h_{dis}
Distance to the sea from site location		80.00	km	
Site Location		Town		(Town or Country)
Distance to the edge of town		10.00		
Exposure Factor	$C_e(z)$=	2.32		Fig N.A.7
Exposure Correction	$C_e(t)$=	0.79		Fig N.A.8 (in town only)
Size Effect Factor	C_s=	0.94		Table N.A.3
Temporary Works	C_{pe}=	1.00		
Dynamic Wind Pressure	q_s=	$c_e(t)*c_e(z)*c_s*c_{pe}*q_b$		
	=	0.41	kN/m^2	

Roof Pressures - Duo Pitch

Θ= 15 °



h= 26 m
b= dependant on site

e= b or 2h (smaller of the two)
= 52 m

e/10= 5.2 m

Linear model of roof section therefore areas F & G to be averaged (conservatively).

Upwind Face(-ve)

F/G=	-0.85	(Averaged)
H=	-0.30	
I=	-0.4	
J=	-1	

Therefore applied loads for a 2.5m bay are:

F/G=	-0.88	kN/m
H=	-0.31	kN/m
I=	-0.41	kN/m
J=	-1.04	kN/m

Upwind Face(+ve)

F/G=	0.20
H=	0.20
I=	0.00
J=	0.00

Therefore applied loads for a 2.5m bay are:

F/G=	0.21	kN/m
H=	0.21	kN/m
I=	0.00	kN/m
J=	0.00	kN/m

Internal Pressure Walls

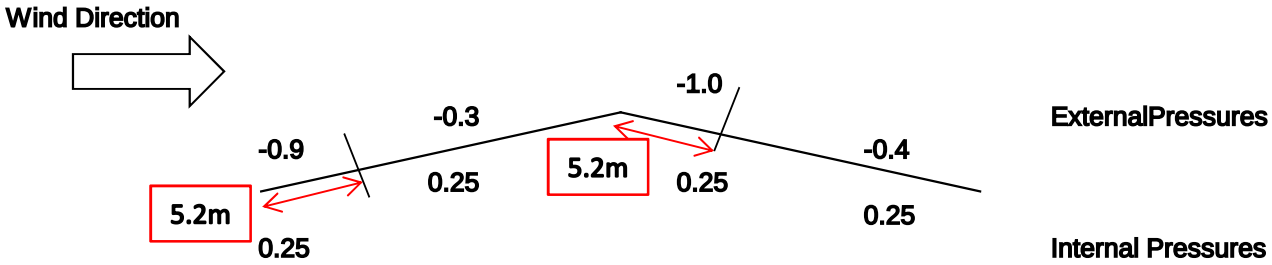
As per BS EN 1991-1-4- 7.2.9 note 5
Internal pressure coefficient is 75% of the windward face pressure due to the open face.

Internal Pressure, C_{pi} = 0.75 x C_{pe} (Vertival Wall)
= 0.25 kN/m^2 C_{pe}=0.8 * q_s

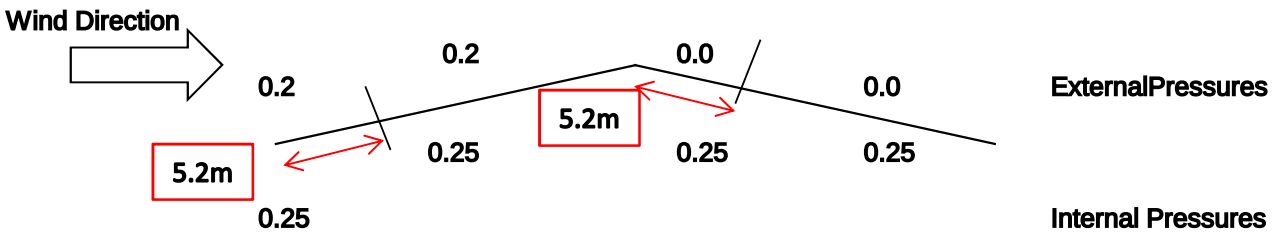
Wind Pressures

Negative External Values Indicate Uplift
All Values are in kN/m

Upwind Negative

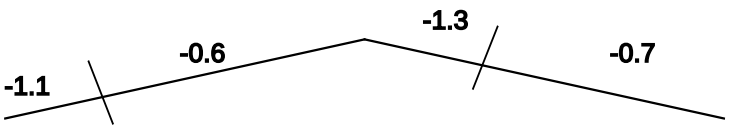


Upwind Positive

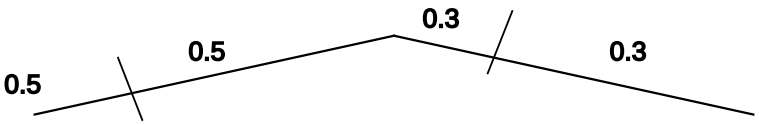


Applied Roof Load Cases Negative Values Indicate Uplift
All Values are in kN/m

Load Case 1- Upwind Negative (combined external & internal pressure)



Load Case 2- Upwind Positive (combined external & internal pressure)



Snow Loads

From BS EN 1991-1-3 Snow loads

The max characterisitc ground snow load to be applied anywhere in the UK

fig NA1 s_k= 0.70 kN/m^2

the snow load on the roof is

$s = \mu.C_e.C_t.s_k$

μ= shape factor
C_e= 1.0 Cl NA.2.15
C_t= 1.0 Cl Na 2.16
s_k= 0.7kN/m^2

From Table 5.2 μ= 0.80

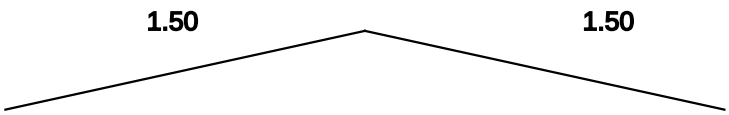
so s= 0.8*1*1*0.7
= 0.56 kN/m^2

But BS EN 1991-1-1 General actions gives that the minimum imposed load for roofs is to be
Table NA7 q_k= 0.60 kN/m^2

Applied Load= 1.50 kN/m for a 2.5m bay

Applied Roof Loads Negative Values Indicate Uplift
All Values are in kN/m

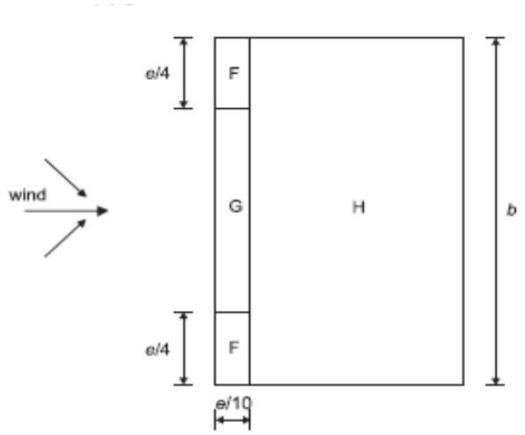
Load Case 3- Snow Loads



Load Case 2: Wind Down Force not analysed as Snow Load more onerous.

Roof Pressures - Mono Pitch 0°

Θ= 15 °



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Linear model of roof section therefore areas F & G to be averaged (conservatively).

Upwind Face(-ve)

F/G= -0.85 (Averaged)
H= -0.30

Therefore applied loads for a 2.5m bay are:

F/G= -0.88 kN/m
H= -0.31 kN/m

Upwind Face(+ve)

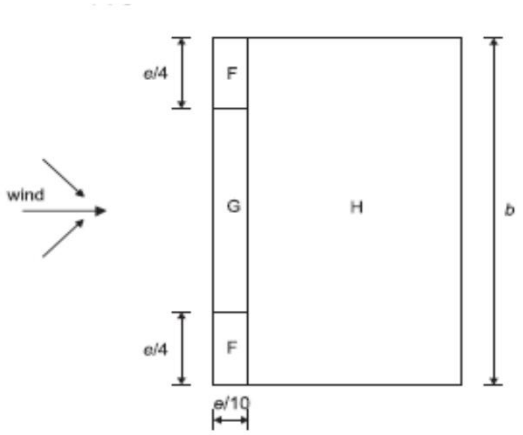
F/G= 0.20
H= 0.20

Therefore applied loads for a 2.5m bay are:

F/G= 0.21 kN/m
H= 0.21 kN/m

Roof Pressures - Mono Pitch 180°

ϴ= 15 °



h= 26 m
b= dependant on site

e= b or 2h (smaller of the two)
= 52 m

e/10= 5.2 m

Linear model of roof section therefore areas F & G to be averaged (conservatively).

<u>Upwind Face(-ve)</u>

F/G= -1.90 (Averaged)
H= -0.90

Therefore applied loads for a 2.5m bay are:

F/G= -1.97 kN/m
H= -0.93 kN/m

Internal Pressure Walls

As per BS EN 1991-1-4- 7.2.9 note 5
Internal pressure coefficient is 75% of the windward face pressure due to the open face.

Internal Pressure, C_{pi} = 0.75 x C_{pe} (Vertival Wall)

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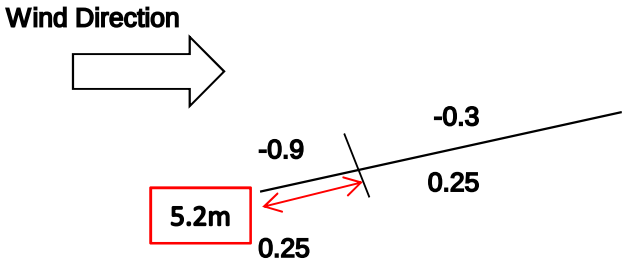
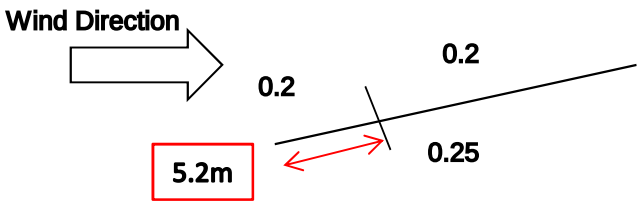


External Pressures

Internal Pressures

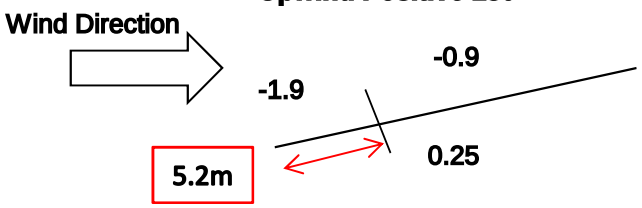
Upwind Positive 0°



External Pressures

Internal Pressures

Upwind Positive 180°

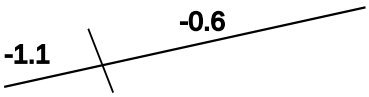


External Pressures

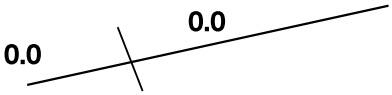
Internal Pressures

Applied Roof Loads Cases **Negative Values Indicate Uplift**
All Values are in kN/m

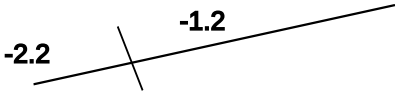
Load Case 1- **Upwind Negative 0° (combined external & internal pressure)**



Load Case 2- **Upwind Positive 0° (combined external & internal pressure)**



Load Case 3- **Upwind Negative 180° (combined external & internal pressure)**



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From Table 5.2 μ= 0.80

so s= 0.8*1*1*0.7
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But BS EN 1991-1-1 General actions gives that the minimum imposed load for roofs is to be
Table NA7 q_k= 0.60 kN/m^2

Applied Roof Loads **All Values are in kN/m**

Load Case 4- **Snow Loads**

Load Case 1: Wind Uplift 0° not analysed as Wind Uplift 180° more onerous.

Load Case 2: Wind Down Force not analysed as Snow Load more onerous.

X-Beam Check Duo Pitch

Apollo 750 X-beam Capacities as per AWD R0076/001

30m Span (2No 15m Spans):

Moment=	48.00	kNm
Shear=	39.00	kN

From STRAP analysis:

Load Case 1: Wind

Applied Moment=	19.68	kNm
Applied Shear=	7.11	kN

Load Case 2: Snow

Applied Moment=	37.93	kNm
Applied Shear=	12.71	kN

Factor of Safety on Max Value

Max Moment=	1.27	<1	Ok
Max Shear=	3.07	<1	Ok

X-Beam Check Mono Pitch

Apollo 750 X-beam Capacities as per AWD R0076/001

15m Span:

Moment=	48.00	kNm
Shear=	39.00	kN

From STRAP analysis:

Load Case 1: Wind

Applied Moment=	31.11	kNm
Applied Shear=	13.55	kN

Load Case 2: Snow

Applied Moment=	30.36	kNm
Applied Shear=	11.73	kN

Factor of Safety on Max Value

Max Moment=	1.54	<1	Ok
Max Shear=	2.88	<1	Ok

Lattice Beam Check Duo Pitch

Apollo Lattice Beam Capacities as per AWD R0076/001

18m Span (2No 9m Spans):

Moment=	15.70	kNm
Shear=	13.90	kN

From STRAP analysis:

Load Case 1: Wind

Applied Moment=	8.55	kNm
Applied Shear=	4.90	kN

Load Case 2: Snow

Applied Moment=	13.45	kNm
Applied Shear=	7.58	kN

Factor of Safety on Max Value

Max Moment=	1.17	<1	Ok
Max Shear=	1.83	<1	Ok

Lattice Beam Check Mono Pitch

Apollo Lattice beam Capacities as per AWD R0076/001

9m Span:

Moment=	15.70	kNm
Shear=	13.90	kN

From STRAP analysis:

Load Case 1: Wind

Applied Moment=	13.59	kNm
Applied Shear=	9.25	kN

Load Case 2: Snow

Applied Moment=	10.93	kNm
Applied Shear=	7.039	kN

Factor of Safety on Max Value

Max Moment=	1.16	<1	Ok
Max Shear=	1.50	<1	Ok

X-Beam Check Duo Pitch

Allowable Deflection=	L/250	
L=	30000	
Allowable Deflection=	120	mm
Span Deflection=	19.74	mm from STRAP analysis
Ridge Deflection=	27.33	mm from STRAP analysis

X-Beam Check Mono Pitch

Allowable Deflection=	L/250	
L=	15000	
Allowable Deflection=	60	mm
Calculated Deflection=	17.26	mm from STRAP analysis

Lattice Beam Check Duo Pitch

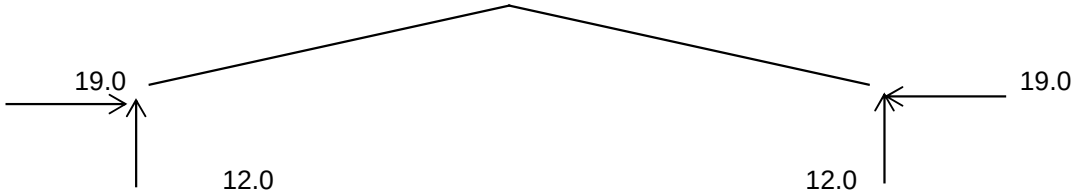
Allowable Deflection=	L/250	
L=	18000	
Allowable Deflection=	72	mm
Span Deflection=	7.75	mm from STRAP analysis
Ridge Deflection=	9.91	mm from STRAP analysis

Lattice Beam Check Mono Pitch

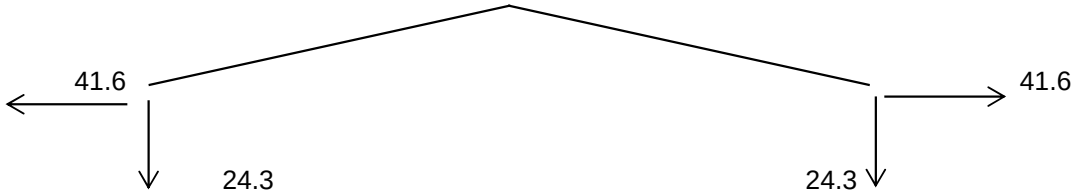
Allowable Deflection=	L/250	
L=	9000	
Allowable Deflection=	36	mm
Calculated Deflection=	8.69	mm from STRAP analysis

X-Beam Check Duo Pitch (all values in kN)

Wind Uplift

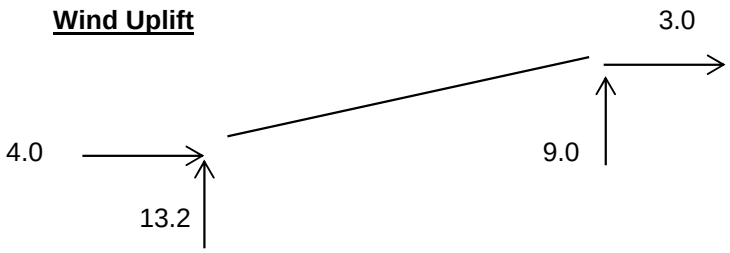


Snow

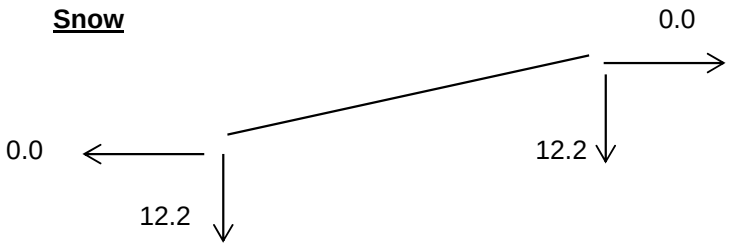


X-Beam Check Mono Pitch (all values in kN)

Wind Uplift

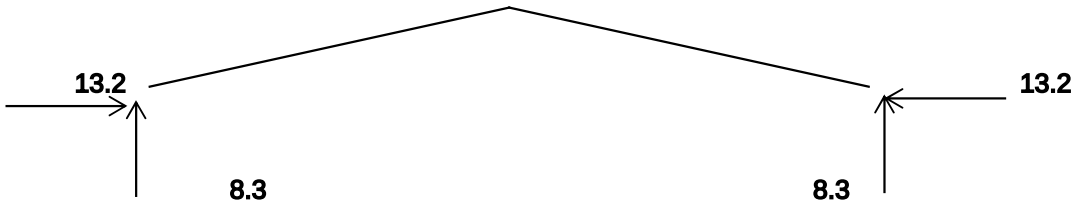


Snow

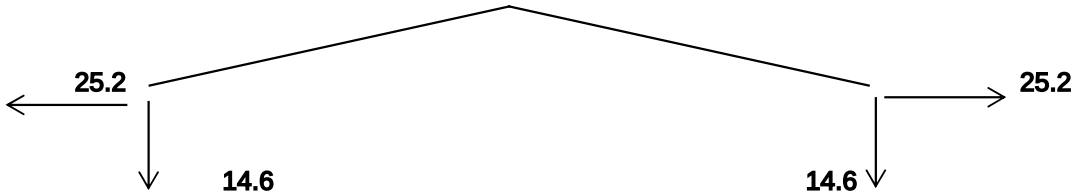


Lattice Beam Check Duo Pitch (all values in kN)

Wind Uplift

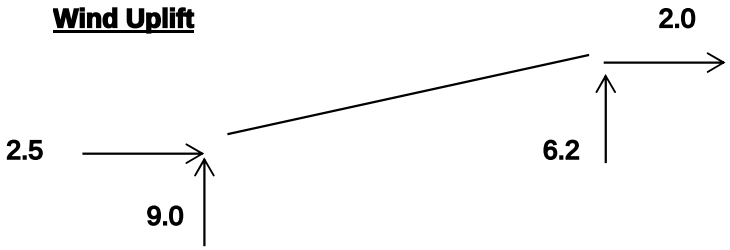


Snow

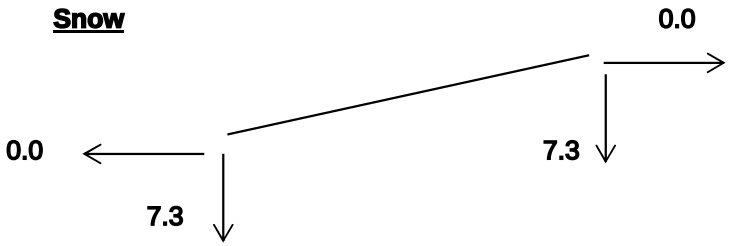


Lattice Beam Check Mono Pitch (all values in kN)

Wind Uplift



Snow



Summary

The roof beam passes design checks for specified loading.

Roof Type	Max Span(m)
X-Beam Mono Pitch	15.0
X-Beam Duo Pitch	30.0
Lattice Beam Mono Pitch	9.0
Lattice Beam Duo Pitch	18.0

This document is for guidance only, all temporary roof designs should be completed by a component engineer.

Guidelines Based On:

- Structure located in London, United Kingdom
- Maximum Wind Speed - 22m/s
- Maximum roof height above sea level - 60m
- Max eave height above ground level - 20m