

Job No.: EHB 169 - 1**Address:** 17 Calder Way, Invercargill, New Zealand**Date:** 15/05/2024**Latitude:** -46.403107**Longitude:** 168.429637**Elevation:** 18 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N5	Ground Snow Load	0.9 KPa	Roof Snow Load	0.63 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.2 m
Wind Region	NZ4	Terrain Category	2.2	Design Wind Speed	39.92 m/s
Wind Pressure	0.96 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	High	Earthquake ARI	100		

Note: Wind lateral loads are governing over Earthquake loads, So only wind loads are considered in calculations

Pressure Coefficients and Pressures

Shed Type = Mono Enclosed

For roof $C_{p,i} = 0.938$

For roof $C_{p,e}$ from 0 m To 3.6 m $C_{p,e} = -0.9$ $p_e = -0.48$ KPa $p_{net} = -0.93$ KPa

For roof $C_{p,e}$ from 3.6 m To 7.2 m $C_{p,e} = -0.5$ $p_e = -0.27$ KPa $p_{net} = -0.72$ KPa

For wall Windward $C_{p,i} = 0.6983$ side Wall $C_{p,i} = -0.6467$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 13.2 m $C_{p,e} = 0.7$ $p_e = 0.6$ KPa $p_{net} = 1.27$ KPa

For side wall $C_{p,e}$ from 0 m To 3.6 m $C_{p,e} =$ $p_e = -0.56$ KPa $p_{net} = 0.11$ KPa

Maximum Upward pressure used in roof member Design = 0.93 KPa

Maximum Downward pressure used in roof member Design = 0.84 KPa

Maximum Wall pressure used in Design = 1.27 KPa

Maximum Racking pressure used in Design = 1.03 KPa

Design Summary**Rafter Design Internal**

Internal Rafter Load Width = 4800 mm

Internal Rafter Span = 8850 mm

Try Rafter 2x360x63 LVL13

Moisture Condition = Dry (Moisture in timber is less than 16% and timber does not remain in continuous wet condition after installation)

K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 1.00 S1 Downward = 5.90 S1 Upward = 5.90

Shear Capacity of timber = 5.3 MPa Bending Capacity of timber = 48 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	15.86 Kn-m	Capacity	60.82 Kn-m	Passing Percentage	383.48 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	53.57 Kn-m	Capacity	81.1 Kn-m	Passing Percentage	151.39 %
M _{0.9D-W_nUp}	-33.13 Kn-m	Capacity	-101.38 Kn-m	Passing Percentage	306.01 %
V _{1.35D}	7.17 Kn	Capacity	77.32 Kn	Passing Percentage	1078.38 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	24.21 Kn	Capacity	103.08 Kn	Passing Percentage	425.77 %
V _{0.9D-WnUp}	-14.97 Kn	Capacity	-128.86 Kn	Passing Percentage	860.79 %

Deflections

Modulus of Elasticity = 11000 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 20.545 mm

Limit by Woolcock et al, 1999 Span/240 = 37.50 mm

Deflection under Dead and Service Wind = 35.005 mm

Limit by Woolcock et al, 1999 Span/100 = 90.00 mm

Reactions

Maximum downward = 24.21 kn Maximum upward = -14.97 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts = 3

Calculations as per NZS 3603:1993 Amend 2005 clause 4.4

Joint Group for Rafters = J2 Joint Group for Pole = J5

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 12.6 f_{pj} = 22.7 Mpa for Rafter with effective thickness = 126 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 43.67 Kn > -14.97 Kn

Girt Design Front and Back

Girt's Spacing = 0 mm

Girt's Span = 2400 mm

Try Girt 150x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and does not remain in continuous wet condition after installation)

K₁ Short term = 1 K₄ = 1 K₅ = 1 K₈ Downward = 1.00

K₈ Upward = 0.87 S₁ Downward = 9.63 S₁ Upward = 15.73

Shear Capacity of timber = 3 MPa Bending Capacity of timber = 14 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{Wind+Snow}	0.00 Kn-m	Capacity	1.83 Kn-m	Passing Percentage	Infinity %
V _{0.9D-WnUp}	0.00 Kn	Capacity	12.06 Kn	Passing Percentage	Infinity %

Deflections

Modulus of Elasticity = 6700 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 0.00 mm

Limit by Woolcock et al, 1999 Span/100 = 24.00 mm

Sag during installation = 2.01 mm

Reactions

Maximum = 0.00 kn

Girt Design Sides

Girt's Spacing = 0 mm

Girt's Span = 2250 mm

Try Girt 150x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and does not remain in continuous wet condition after installation)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =0.89 S1 Downward =9.63 S1 Upward =15.23

Shear Capacity of timber =3 MPa Bending Capacity of timber =14 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{Wind+Snow}	0.00 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	Infinity %
V _{0.9D-WnUp}	0.00 Kn	Capacity	12.06 Kn	Passing Percentage	Infinity %

Deflections

Modulus of Elasticity = 6700 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 0.00 mm

Limit by Woolcock et al. 1999 Span/100 = 22.50 mm

Sag during installation =1.55 mm

Reactions

Maximum = 0.00 kn

Middle Pole Design

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3840 mm
Area	35448 mm ²	As	26585.7421875 mm ²
I _x	100042702 mm ⁴	Z _x	941578 mm ³
I _y	100042702 mm ⁴	Z _y	941578 mm ³
Lateral Restraint	3840 mm c/c		

Loads

Total Area over Pole = 21.6 m²

Dead	5.40 Kn	Live	5.40 Kn
Wind Down	18.14 Kn	Snow	13.61 Kn
Moment wind	16.31 Kn-m	Moment snow	4.52 Kn-m
Phi	0.8	K8	0.76
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Peeling	Steaming	Normal	Dry Use
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fb =	36.3 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	22 MPa	E =	9257 MPa

Capacities

PhiNcx Wind	390.28 Kn	PhiMnx Wind	20.91 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	234.17 Kn	PhiMnx Dead	12.54 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	312.23 Kn	PhiMnx Snow	16.73 Kn-m	PhiVnx Snow	50.36 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.85 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.68 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 39.91 \text{ mm} < 38.40 \text{ mm}$$

Drained Lateral Strength of Middle pile in cohesionless soils Free Head short pile

Assumed Soil Properties

Gamma	18 Kn/m ³	Friction angle	30 deg	Cohesion	0 Kn/m ³
K0 =	$(1 - \sin(30)) / (1 + \sin(30))$				
Kp =	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1700 mm	Pile embedment length
f1 =	3150 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	16.31 Kn-m	Moment Snow =	Kn-m
Shear Wind =	5.18 Kn	Shear Snow =	4.52 Kn

Pile Properties

Safety Factory	0.55	
Hu =	9.03 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	17.07 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.96 < 1 \text{ OK}$$

Uplift Check

$$\text{Density of Concrete} = 24 \text{ Kn/m}^3$$

$$\text{Density of Timber Pole} = 5 \text{ Kn/m}^3$$

Due to cast in place pile, the surface interaction between soil and pile will be rough thus angle of friction between both is taken equal to soil angle of internal friction

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Ks (Lateral Earth Pressure Coefficient) for cast into place concrete piles = 1.5

Formula to calculate Skin Friction = Safety factor (0.55) x Density of Soil(18) x Height of Pile(1700) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1700)

Skin Friction = 23.34 Kn

Weight of Pile + Pile Skin Friction = 27.76 Kn

Uplift on one Pile = 15.23 Kn

Uplift is ok