

Pole Shed App Ver 01 2022

Job No.: EHB 344 - 1

Address: 1486 Bluff Highway, Invercargill, New Zealand

Date: 2/25/2025

Latitude: -46.512308

Longitude: 168.34832

Elevation: 6.5 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	D
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.6 m
Wind Region	NZ4	Terrain Category	2.05	Design Wind Speed	42.66 m/s
Wind Pressure	1.09 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 Open

For roof $C_{p,i} = 0.6649$

For roof $C_{p,e}$ from 0 m To 3.30 m $C_{p,e} = -0.9$ $p_e = -0.46$ KPa $p_{net} = -0.87$ KPa

For roof $C_{p,e}$ from 3.30 m To 6.60 m $C_{p,e} = -0.5$ $p_e = -0.25$ KPa $p_{net} = -0.66$ KPa

For wall Windward $C_{p,i} = 0.6649$ side Wall $C_{p,i} = -0.5849$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 16.8 m $C_{p,e} = 0.7$ $p_e = 0.69$ KPa $p_{net} = 1.38$ KPa

For side wall $C_{p,e}$ from 0 m To 3.30 m $C_{p,e} =$ $p_e = -0.64$ KPa $p_{net} = 0.05$ KPa

Maximum Upward pressure used in roof member Design = 0.87 KPa

Maximum Downward pressure used in roof member Design = 0.89 KPa

Maximum Wall pressure used in Design = 1.38 KPa

Maximum Racking pressure used in Design = 1.18 KPa

Design Summary

Rafter Design Internal

Internal Rafter Load Width = 4200 mm Internal Rafter Span = 8850 mm Try Rafter 2x400x63 LVL13

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

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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 = 6.26 S1 Upward = 6.26

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

Capacity Checks

M _{1.35D}	13.88 Kn-m	Capacity	73.78 Kn-m	Passing Percentage	531.56 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	48.93 Kn-m	Capacity	98.38 Kn-m	Passing Percentage	201.06 %
M _{0.9D-W_nUp}	-26.52 Kn-m	Capacity	-122.98 Kn-m	Passing Percentage	463.73 %
V _{1.35D}	6.27 Kn	Capacity	85.9 Kn	Passing Percentage	1370.02 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	22.12 Kn	Capacity	114.54 Kn	Passing Percentage	517.81 %
V _{0.9D-W_nUp}	-11.99 Kn	Capacity	-143.18 Kn	Passing Percentage	1194.16 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 13.105 mm Limit by Woolcock et al, 1999 Span/240 = 37.50 mm

Deflection under Dead and Service Wind = 22.935 mm Limit by Woolcock et al, 1999 Span/100 = 90.00 mm

Reactions

Maximum downward = 22.12 kn Maximum upward = -11.99 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 > -11.99 Kn

Girt Design Front and Back

Girt's Spacing = 0 mm

Girt's Span = 2100 mm

Try Girt SG8 Dry

Moisture Condition = Wet (Moisture in timber is less than 18% and timber does not remain in continuous wet condition after installation)

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

K8 Upward =NaN S1 Downward =NaN S1 Upward =NaN

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	NaN Kn-m	Passing Percentage	NaN %
V _{0.9D-WnUp}	0.00 Kn	Capacity	0.00 Kn	Passing Percentage	NaN %

Deflections

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

Deflection under Snow and Service Wind = NaN mm Limit by Woolcock et al, 1999 Span/100 = 21.00 mm

Sag during installation = NaN mm

Reactions

Maximum = 0.00 kn

Girt Design Sides

Girt's Spacing = 1200 mm

Girt's Span = 3000 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 =1.00 S1 Downward =9.63 S1 Upward =10.15

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

Capacity Checks

M _{Wind+Snow}	1.86 Kn-m	Capacity	2.10 Kn-m	Passing Percentage	112.90 %
V _{0.9D-WnUp}	2.48 Kn	Capacity	12.06 Kn	Passing Percentage	486.29 %

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Deflections

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

Deflection under Snow and Service Wind = 27.00 mm Limit by Woolcock et al. 1999 Span/100 = 30.00 mm

Sag during installation = 4.91 mm

Reactions

Maximum = 2.48 kn

Middle Pole Design

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3240 mm
Area	35448 mm ²	As	26585.7421875 mm ²
Ix	100042702 mm ⁴	Zx	941578 mm ³
Iy	100042702 mm ⁴	Zx	941578 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 18.9 m²

Dead	4.72 Kn	Live	4.72 Kn
Wind Down	16.82 Kn	Snow	11.91 Kn
Moment wind	12.01 Kn-m	Moment snow	3.39 Kn-m
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

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

Capacities

PhiNcx Wind	510.45 Kn	PhiMnx Wind	27.34 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	306.27 Kn	PhiMnx Dead	16.41 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	408.36 Kn	PhiMnx Snow	21.87 Kn-m	PhiVnx Snow	50.36 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_c) = 0.49 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_c) = 0.24 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 21.26 \text{ mm} < 32.40 \text{ mm}$$

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

Assumed Soil Properties

Gamma 18 Kn/m³ Friction angle 30 deg Cohesion 0 Kn/m³

$$K_0 = (1 - \sin(30)) / (1 + \sin(30))$$

$$K_p = (1 + \sin(30)) / (1 - \sin(30))$$

Geometry For Middle Bay Pole

Ds = 0.6 mm Pile Diameter

L = 1600 mm Pile embedment length

f1 = 2700 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 12.01 Kn-m Moment Snow = Kn-m

Shear Wind = 4.45 Kn Shear Snow = 3.39 Kn

Pile Properties

Safety Factory 0.55

Hu = 8.49 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 13.91 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.86 < 1 \text{ OK}$$

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(1600) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1600)

Skin Friction = 20.68 Kn

Weight of Pile + Pile Skin Friction = 24.83 Kn

Uplift on one Pile = 12.19 Kn

Uplift is ok