

Pole Shed App Ver 01 2022

Job No.: 105 Aranui Rd - 1 **Address:** 105 Aranui Rd, Palmerston North, New Zealand **Date:** 9/14/2023
Latitude: -40.314358 **Longitude:** 175.547222 **Elevation:** 26.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N1	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.5 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	38.22 m/s
Wind Pressure	0.88 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 $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 4.50 m $C_{p,e} = -0.9$ $p_e = -0.71$ KPa $p_{net} = -0.71$ KPa

For roof $C_{p,e}$ from 4.50 m To 9.0 m $C_{p,e} = -0.5$ $p_e = -0.39$ KPa $p_{net} = -0.39$ KPa

For wall Windward $C_{p,i} = -0.3$ side Wall $C_{p,i} = -0.3$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 12 m $C_{p,e} = 0.7$ $p_e = 0.55$ KPa $p_{net} = 0.81$ KPa

For side wall $C_{p,e}$ from 0 m To 4.50 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = -0.51$ KPa

Maximum Upward pressure used in roof member Design = 0.71 KPa

Maximum Downward pressure used in roof member Design = 0.42 KPa

Maximum Wall pressure used in Design = 0.81 KPa

Maximum Racking pressure used in Design = 0.94 KPa

Design Summary

Rafter Design Internal

Internal Rafter Load Width = 4200 mm Internal Rafter Span = 11850 mm Try Rafter 2x450x63 LVL13

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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 = 6.68 S1 Upward = 6.68

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

Capacity Checks

M _{1.35D}	24.88 Kn-m	Capacity	91.56 Kn-m	Passing Percentage	368.01 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	53.08 Kn-m	Capacity	122.08 Kn-m	Passing Percentage	229.99 %
M _{0.9D-W_nUp}	-35.76 Kn-m	Capacity	-152.6 Kn-m	Passing Percentage	426.73 %
V _{1.35D}	8.40 Kn	Capacity	96.64 Kn	Passing Percentage	1150.48 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	17.92 Kn	Capacity	128.86 Kn	Passing Percentage	719.08 %
V _{0.9D-W_nUp}	-12.07 Kn	Capacity	-161.08 Kn	Passing Percentage	1334.55 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 29.09 mm Limit by Woolcock et al, 1999 Span/240 = 50.00 mm

Deflection under Dead and Service Wind = 38.25 mm Limit by Woolcock et al, 1999 Span/100 = 120.00 mm

Reactions

Maximum downward = 17.92 kn Maximum upward = -12.07 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

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$K_{11} = 2.0$ fcj = 36.1 MPa for Pole with effective thickness = 100 mm

Capacity under short term loads = 43.67 Kn > -12.07 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4200 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.91 S_1 Downward = 9.63 S_1 Upward = 14.71

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

Capacity Checks

$M_{Wind+Snow}$	1.61 Kn-m	Capacity	1.91 Kn-m	Passing Percentage	118.63 %
$V_{0.9D-WnUp}$	1.53 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	788.24 %

Deflections

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

Deflection under Snow and Service Wind = 31.35 mm Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Sag during installation = 18.87 mm

Reactions

Maximum = 1.53 kn

Girt Design Sides

Girt's Spacing = 900 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.79 S_1 Downward = 9.63 S_1 Upward = 17.59

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

Capacity Checks

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M _{Wind+Snow}	0.82 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	201.22 %
V _{0.9D-WnUp}	1.09 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	1106.42 %

Deflections

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

Deflection under Snow and Service Wind = 8.16 mm Limit by Woolcock et al. 1999 Span/100 = 30.00 mm
Sag during installation = 4.91 mm

Reactions

Maximum = 1.09 kn

Middle Pole Design

Geometry

225 SED H5 (Minimum 250 dia. at Floor Level)	Dry Use	Height	4500 mm
Area	44279 mm ²	As	33209.1796875 mm ²
I _x	156100441 mm ⁴	Z _x	1314530 mm ³
I _y	156100441 mm ⁴	Z _y	1314530 mm ³
Lateral Restraint	4500 mm c/c		

Loads

Total Area over Pole = 25.2 m²

Dead	6.30 Kn	Live	6.30 Kn
Wind Down	10.58 Kn	Snow	0.00 Kn
Moment wind	14.95 Kn-m		
Phi	0.8	K ₈	0.72
K ₁ snow	0.8	K ₁ Dead	0.6
K ₁ wind	1		

Material

Peeling	Steaming	Normal	Dry Use
f _b =	36.3 MPa	f _s =	2.96 MPa
f _c =	18 MPa	f _p =	7.2 MPa
f _t =	22 MPa	E =	9257 MPa

Capacities

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PhiNcx Wind	460.22 Kn	PhiMnx Wind	27.55 Kn-m	PhiVnx Wind	78.64 Kn
PhiNcx Dead	276.13 Kn	PhiMnx Dead	16.53 Kn-m	PhiVnx Dead	47.18 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.59 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.34 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 29.44 \text{ mm} < 45.00 \text{ mm}$$

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
K ₀ =	$(1 - \sin(30)) / (1 + \sin(30))$				
K _p =	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For Middle Bay Pole

D _s =	0.6 mm	Pile Diameter
L =	1650 mm	Pile embedment length
f ₁ =	3375 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	14.95 Kn-m
Shear Wind =	4.43 Kn

Pile Properties

Safety Factory	0.55	
H _u =	7.97 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	15.97 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.94 < 1 \text{ OK}$$

Uplift Check

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

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Density of Timber Pole = 5 Kn/m³

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

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(1650) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1650)

Skin Friction = 21.99 Kn

Weight of Pile + Pile Skin Friction = 25.77 Kn

Uplift on one Pile = 12.22 Kn

Uplift is ok