

Pole Shed App Ver 01 2022

Job No.: James - 1 **Address:** 1070 Makino Rd / Fry Rd, Feilding, New Zealand **Date:** 14/12/2023
Latitude: -40.13759 **Longitude:** 175.609699 **Elevation:** 157 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	2	Ultimate wind & Earthquake ARI	500 Years	Max Height	3.6 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	40.95 m/s
Wind Pressure	1.01 KPa	Lee Zone	NO	Ultimate Snow ARI	150 Years
Wind Category	High	Earthquake ARI	500		

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 $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 4.20 m $C_{p,e} = -0.9$ $p_e = -0.81$ KPa $p_{net} = -0.810$ KPa

For roof $C_{p,e}$ from 4.20 m To 8.40 m $C_{p,e} = -0.5$ $p_e = -0.45$ KPa $p_{net} = -0.45$ 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 $C_{p,e} = 0.7$ $p_e = 0.63$ KPa $p_{net} = 0.93$ KPa

For side wall $C_{p,e}$ from 0 m To 4.20 m $C_{p,e} =$ $p_e = -0.59$ KPa $p_{net} = -0.59$ KPa

Maximum Upward pressure used in roof member Design = 0.81 KPa

Maximum Downward pressure used in roof member Design = 0.48 KPa

Maximum Wall pressure used in Design = 0.93 KPa

Maximum Racking pressure used in Design = 0.90 KPa

Design Summary

Rafter Design Internal

Internal Rafter Load Width = 4800 mm Internal Rafter Span = 11850 mm Try Rafter 2x610x45 LVL11

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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 = 11.05 S1 Upward = 11.05

Shear Capacity of timber = 5 MPa Bending Capacity of timber = 38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	28.44 Kn-m	Capacity	90.18 Kn-m	Passing Percentage	317.09 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	65.72 Kn-m	Capacity	120.24 Kn-m	Passing Percentage	182.96 %
M _{0.9D-W_nUp}	-49.29 Kn-m	Capacity	-150.28 Kn-m	Passing Percentage	304.89 %
V _{1.35D}	9.60 Kn	Capacity	88.28 Kn	Passing Percentage	919.58 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	22.18 Kn	Capacity	117.7 Kn	Passing Percentage	530.66 %
V _{0.9D-W_nUp}	-16.64 Kn	Capacity	-147.14 Kn	Passing Percentage	884.25 %

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 20.765 mm Limit by Woolcock et al, 1999 Span/360 = 33.33 mm

Deflection under Dead and Service Wind = 28.455 mm Limit by Woolcock et al, 1999 Span/250 = 80.00 mm

Reactions

Maximum downward = 22.18 kn Maximum upward = -16.64 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts = 4

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 = 90 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 = 58.22 Kn > -16.64 Kn

Girt Design Front and Back

Girt's Spacing = 650 mm

Girt's Span = 4800 mm

Try Girt 200x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and timber 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 = 0.75 S_1 Downward = 11.27 S_1 Upward = 18.41

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

Capacity Checks

$M_{Wind+Snow}$	1.74 Kn-m	Capacity	2.79 Kn-m	Passing Percentage	160.34 %
$V_{0.9D-WnUp}$	1.45 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	1108.97 %

Deflections

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

Deflection under Snow and Service Wind = 18.71 mm Limit by Woolcock et al, 1999 Span/250 = 19.20 mm

Sag during installation = 32.19 mm

Reactions

Maximum = 1.45 kn

Girt Design Sides

Girt's Spacing = 1200 mm

Girt's Span = 3000 mm

Try Girt 200x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and timber 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 = 0.64 S_1 Downward = 11.27 S_1 Upward = 20.58

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}	1.26 Kn-m	Capacity	2.40 Kn-m	Passing Percentage	190.48 %
V _{0.9D-WnUp}	1.67 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	962.87 %

Deflections

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

Deflection under Snow and Service Wind = 5.27 mm Limit by Woolcock et al. 1999 Span/100 = 12.00 mm
Sag during installation = 4.91 mm

Reactions

Maximum = 1.67 kn

Middle Pole Design

Geometry

250 SED H5 (Minimum 275 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	54091 mm ²	As	40568.5546875 mm ²
I _x	232952248 mm ⁴	Z _x	1774874 mm ³
I _y	232952248 mm ⁴	Z _y	1774874 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 28.8 m²

Dead	7.20 Kn	Live	7.20 Kn
Wind Down	13.82 Kn	Snow	0.00 Kn
Moment wind	10.47 Kn-m		
Phi	0.8	K ₈	1.00
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	778.92 Kn	PhiMnx Wind	51.54 Kn-m	PhiVnx Wind	96.07 Kn
PhiNcx Dead	467.35 Kn	PhiMnx Dead	30.93 Kn-m	PhiVnx Dead	57.64 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.24 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.08 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 8.11 \text{ mm} < 22.00 \text{ mm}$$

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 =	1550 mm	Pile embedment length
f ₁ =	2700 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	10.47 Kn-m
Shear Wind =	3.88 Kn

Pile Properties

Safety Factory	0.55	
H _u =	7.81 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	12.75 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.82 < 1 \text{ OK}$$

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(1550) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1550)

Skin Friction = 19.40 Kn

Weight of Pile + Pile Skin Friction = 22.52 Kn

Uplift on one Pile = 16.85 Kn

Uplift is ok