

Pole Shed App Ver 01 2022

Job No.: 2409031-1
Latitude: -40.884582

Address: 21 Hill View Road, Motupipi, New Zealand
Longitude: 172.839328

Date: 18/12/2024
Elevation: 113.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N0	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	5 m
Wind Region	NZ2	Terrain Category	2.26	Design Wind Speed	44.12 m/s
Wind Pressure	1.17 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Very 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 2.15 m $C_{p,e} = -0.93$ $p_e = -0.98$ KPa $p_{net} = -0.98$ KPa

For roof $C_{p,e}$ from 2.15 m To 4.30 m $C_{p,e} = -0.88$ $p_e = -0.93$ KPa $p_{net} = -0.93$ 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 8 m $C_{p,e} = 0.7$ $p_e = 0.74$ KPa $p_{net} = 1.09$ KPa

For side wall $C_{p,e}$ from 0 m To 4.30 m $C_{p,e} =$ $p_e = -0.68$ KPa $p_{net} = -0.68$ KPa

Maximum Upward pressure used in roof member Design = 0.98 KPa

Maximum Downward pressure used in roof member Design = 0.46 KPa

Maximum Wall pressure used in Design = 1.09 KPa

Maximum Racking pressure used in Design = 1.27 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 9850 mm

Try Purlin 360x45 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 = 0.81

K8 Upward = 0.28 S1 Downward = 17.01 S1 Upward = 32.41

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

Capacity Checks

M _{1.35D}	3.68 Kn-m	Capacity	17.70 Kn-m	Passing Percentage	480.98 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	8.3 Kn-m	Capacity	23.60 Kn-m	Passing Percentage	284.34 %
M _{0.9D-W_nUp}	-8.24 Kn-m	Capacity	-10.11 Kn-m	Passing Percentage	122.69 %
V _{1.35D}	1.50 Kn	Capacity	27.61 Kn	Passing Percentage	1840.67 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.37 Kn	Capacity	36.82 Kn	Passing Percentage	1092.58 %
V _{0.9D-W_nUp}	-3.35 Kn	Capacity	-46.02 Kn	Passing Percentage	1373.73 %

Deflections

Modulus of Elasticity = 12100 MPa NZS3603 Amt 4, Table 2.3 considering at least 4 members acting together

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 30.63 mm Limit by Woolcock et al, 1999 Span/240 = 40.83 mm

Deflection under Dead and Service Wind = 37.27 mm Limit by Woolcock et al, 1999 Span/100 = 98.00 mm

Reactions

Maximum downward = 3.37 kn Maximum upward = -3.35 kn

Number of Blocking = 2 if 0 then no blocking required, if 1 then one midspan blocking required

Rafter Design External

External Rafter Load Width = 5000 mm External Rafter Span = 7922 mm Try Rafter 450x63 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 = 0.95

K8 Upward = 0.95 S1 Downward = 13.57 S1 Upward = 13.57

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

Capacity Checks

M _{1.35D}	13.24 Kn-m	Capacity	43.42 Kn-m	Passing Percentage	327.95 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	29.81 Kn-m	Capacity	57.89 Kn-m	Passing Percentage	194.20 %

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M _{0.9D-WnUp}	-29.61 Kn-m	Capacity	-72.37 Kn-m	Passing Percentage	244.41 %
V _{1.35D}	6.68 Kn	Capacity	48.32 Kn	Passing Percentage	723.35 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	15.05 Kn	Capacity	64.43 Kn	Passing Percentage	428.11 %
V _{0.9D-WnUp}	-14.95 Kn	Capacity	-80.54 Kn	Passing Percentage	538.73 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 15.20 mm Limit by Woolcock et al, 1999 Span/240= 33.33 mm

Deflection under Dead and Service Wind = 18.50 mm Limit by Woolcock et al, 1999 Span/100 = 80.00 mm

Reactions

Maximum downward = 15.05 kn Maximum upward = -14.95 kn

Rafter to Pole Connection check

Bolt Size = M16 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

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 63 mm

For Parallel to grain loading

K₁₁ = 2.0 fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

V = $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$ (Eq 4.12) = -86.48 kn > -14.95 Kn

Single Shear Capacity under short term loads = -38.81 Kn > -14.95 Kn

Intermediate Design Front and Back

Intermediate Spacing = 5000 mm Intermediate Span = 3449 mm Try Intermediate 2x240x45 SG8

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 K4 =1 K5 =1 K8 Downward =0.94

K8 Upward =1.00 S1 Downward =13.82 S1 Upward =0.86

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

Capacity Checks

M _{Wind+Snow}	8.11 Kn-m	Capacity	9.68 Kn-m	Passing Percentage	119.36 %
V _{0.9D-WnUp}	9.40 Kn	Capacity	-34.74 Kn	Passing Percentage	369.57 %

Deflections

Modulus of Elasticity = 5400 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 17.945 mm Limit by Woolcock et al, 1999 Span/100 = 34.49 mm

Reactions

Maximum = 9.40 kn

Intermediate Design Sides

Intermediate Spacing = 4000 mm Intermediate Span = 4150 mm Try Intermediate 2x290x45 SG8 Dry

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 K4 =1 K5 =1 K8 Downward =0.89

K8 Upward =1.00 S1 Downward =15.23 S1 Upward =1.03

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

Capacity Checks

M _{Wind+Snow}	4.69 Kn-m	Capacity	14.12 Kn-m	Passing Percentage	301.07 %
V _{0.9D-WnUp}	4.52 Kn	Capacity	41.96 Kn	Passing Percentage	928.32 %

Deflections

Modulus of Elasticity = 5400 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 17.045 mm Limit by Woolcock et al, 1999 Span/100 = 41.50 mm

Reactions

Maximum = 4.52 kn

Girt Design Front and Back

Girt's Spacing = 700 mm

Girt's Span = 5000 mm

Try Girt 240x45 SG8

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 K4 =1 K5 =1 K8 Downward =0.94

K8 Upward =0.53 S1 Downward =13.82 S1 Upward =23.03

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

Capacity Checks

M _{Wind+Snow}	2.38 Kn-m	Capacity	2.57 Kn-m	Passing Percentage	107.98 %
V _{0.9D-WnUp}	1.91 Kn	Capacity	17.37 Kn	Passing Percentage	909.42 %

Deflections

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

Deflection under Snow and Service Wind = 17.88 mm Limit by Woolcock et al, 1999 Span/100 = 50.00 mm

Sag during installation = 46.79 mm

Reactions

Maximum = 1.91 kn

Girt Design Sides

Girt's Spacing = 700 mm

Girt's Span = 4000 mm

Try Girt 240x45 SG8

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 K4 =1 K5 =1 K8 Downward =0.94

K8 Upward =0.34 S1 Downward =13.82 S1 Upward =29.13

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

Capacity Checks

M _{Wind+Snow}	1.53 Kn-m	Capacity	1.66 Kn-m	Passing Percentage	108.50 %
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V _{0.9D-WnUp}	1.53 Kn	Capacity	17.37 Kn	Passing Percentage	1135.29 %
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Deflections

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

Deflection under Snow and Service Wind = 7.32 mm Limit by Woolcock et al. 1999 Span/100 = 40.00 mm
Sag during installation = 19.16 mm

Reactions

Maximum = 1.53 kn

End Pole Design

Geometry For End Bay Pole

Geometry

275 SED H5 (Minimum 300 dia. at Floor Level)	Dry Use	Height	4800 mm
Area	64885 mm ²	As	48663.8671875 mm ²
I _x	335197731 mm ⁴	Z _x	2331810 mm ³
I _y	335197731 mm ⁴	Z _y	2331810 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 40 m²

Dead	10.00 Kn	Live	10.00 Kn
Wind Down	18.40 Kn	Snow	0.00 Kn
Moment Wind	29.69 Kn-m		
Phi	0.8	K ₈	0.83
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	774.82 Kn	PhiMnx Wind	56.15 Kn-m	PhiVnx Wind	115.24 Kn
PhiNcx Dead	464.89 Kn	PhiMnx Dead	33.69 Kn-m	PhiVnx Dead	69.14 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.58 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.33 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 33.53 \text{ mm} < 49.88 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	2100 mm	Pile embedment length
f1 =	3750 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

$$\text{Total Area over Pole} = 40 \text{ m}^2$$

Moment Wind =	29.69 Kn-m
Shear Wind =	7.92 Kn

Pile Properties

Safety Factory	0.55	
Hu =	14.11 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	31.89 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.93 < 1 \text{ OK}$$

Drained Lateral Strength of End 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 End Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	2100 mm	Pile embedment length

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f1 = 3750 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 29.69 Kn-m
Shear Wind = 7.92 Kn

Pile Properties

Safety Factory 0.55
Hu = 14.11 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 31.89 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.93 < 1 OK

Uplift Check

Density of Concrete = 24 Kn/m³

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(2100) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(2100)

Skin Friction = 35.62 Kn

Weight of Pile + Pile Skin Friction = 39.84 Kn

Uplift on one Pile = 30.20 Kn

Uplift is ok