

Pole Shed App Ver 01 2022

Job No.: 511-5025142

Address: 3219 Arundel Rakaia Gorge Road, Cavendish, New Zealand

Date: 25/09/2024

Latitude: -43.720174

Longitude: 171.387041

Elevation: 365.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N4	Ground Snow Load	1.68 KPa	Roof Snow Load	1.06 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	6 m
Wind Region	NZ2	Terrain Category	2.09	Design Wind Speed	50.1 m/s
Wind Pressure	1.51 KPa	Lee Zone	YES	Ultimate Snow ARI	50 Years
Wind Category	extra 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 6.05 m $C_{p,e} = -0.9$ $p_e = -1.22$ KPa $p_{net} = -1.22$ KPa

For roof $C_{p,e}$ from 6.05 m To 12.10 m $C_{p,e} = -0.5$ $p_e = -0.68$ KPa $p_{net} = -0.68$ 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 11.50 m $C_{p,e} = 0.7$ $p_e = 0.95$ KPa $p_{net} = 1.40$ KPa

For side wall $C_{p,e}$ from 0 m To 6.05 m $C_{p,e} =$ $p_e = -0.88$ KPa $p_{net} = -0.88$ KPa

Maximum Upward pressure used in roof member Design = 1.22 KPa

Maximum Downward pressure used in roof member Design = 0.59 KPa

Maximum Wall pressure used in Design = 1.40 KPa

Maximum Racking pressure used in Design = 1.36 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 5183 mm

Try Purlin 250x50 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.97

K8 Upward = 0.60 S1 Downward = 12.68 S1 Upward = 21.41

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

Capacity Checks

M _{1.35D}	1.02 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	333.33 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	4.11 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	110.22 %
M _{0.9D-W_{nUp}}	-3.01 Kn-m	Capacity	-3.51 Kn-m	Passing Percentage	116.61 %

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V _{1.35D}	0.79 Kn	Capacity	12.06 Kn	Passing Percentage	1526.58 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	3.17 Kn	Capacity	16.08 Kn	Passing Percentage	507.26 %
V _{0.9D-WnUp}	-2.32 Kn	Capacity	-20.10 Kn	Passing Percentage	866.38 %

Deflections

Modulus of Elasticity = 6700 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 = 11.19 mm	Limit by Woolcock et al, 1999 Span/240 = 21.39 mm
Deflection under Dead and Service Wind = 14.83 mm	Limit by Woolcock et al, 1999 Span/100 = 51.33 mm

Reactions

Maximum downward = 3.17 kn Maximum upward = -2.32 kn

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

Rafter Design External

External Rafter Load Width = 2666.5 mm External Rafter Span = 5743 mm Try Rafter 300x45 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 = 0.88

K₈ Upward = 0.88 S₁ Downward = 15.50 S₁ Upward = 15.50

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

Capacity Checks

M _{1.35D}	3.71 Kn-m	Capacity	13.69 Kn-m	Passing Percentage	369.00 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	14.95 Kn-m	Capacity	18.26 Kn-m	Passing Percentage	122.14 %
M _{0.9D-WnUp}	-10.94 Kn-m	Capacity	-22.82 Kn-m	Passing Percentage	208.59 %
V _{1.35D}	2.58 Kn	Capacity	23.01 Kn	Passing Percentage	891.86 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.41 Kn	Capacity	30.68 Kn	Passing Percentage	294.72 %
V _{0.9D-WnUp}	-7.62 Kn	Capacity	-38.35 Kn	Passing Percentage	503.28 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 10.22 mm	Limit by Woolcock et al, 1999 Span/240 = 23.96 mm
Deflection under Dead and Service Wind = 13.55 mm	Limit by Woolcock et al, 1999 Span/100 = 57.50 mm

Reactions

Maximum downward = 10.41 kn Maximum upward = -7.62 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts = 2

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

$K_{11} = 12.6$ fpj = 22.7 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

$K_{11} = 2.0$ 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) = -40.07 kn > -7.62 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -7.62 Kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2667 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 = 0.83 S_1 Downward = 9.63 S_1 Upward = 16.58

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

Capacity Checks

$M_{Wind+Snow}$	1.62 Kn-m	Capacity	1.75 Kn-m	Passing Percentage	108.02 %
$V_{0.9D-WnUp}$	2.43 Kn	Capacity	12.06 Kn	Passing Percentage	496.30 %

Deflections

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

Deflection under Snow and Service Wind = 22.34 mm

Limit by Woolcock et al, 1999 Span/100 = 26.66 mm

Sag during installation = 3.07 mm

Reactions

Maximum = 2.43 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2875 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 = 0.81 S_1 Downward = 9.63 S_1 Upward = 17.22

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

Capacity Checks

$M_{Wind+Snow}$	1.88 Kn-m	Capacity	1.69 Kn-m	Passing Percentage	89.89 %
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V _{0.9D-WnUp}	2.62 Kn	Capacity	12.06 Kn	Passing Percentage	460.31 %
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Deflections

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

Deflection under Snow and Service Wind = 30.19 mm

Limit by Woolcock et al. 1999 Span/100 = 28.75 mm

Sag during installation = 4.14 mm

Reactions

Maximum = 2.62 kn

End Pole Design**Geometry For End Bay Pole****Geometry**

250 SED H5 (Minimum 275 dia. at Floor Level)	Dry Use	Height	5700 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	mm c/c		

LoadsTotal Area over Pole = 15.332375 m²

Dead	3.83 Kn	Live	3.83 Kn
Wind Down	9.05 Kn	Snow	16.25 Kn
Moment Wind	16.28 Kn-m	Moment snow	4.47 Kn-m
Phi	0.8	K ₈	0.59
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

PhiN _c Wind	458.35 Kn	PhiM _n Wind	30.33 Kn-m	PhiV _n Wind	96.07 Kn
PhiN _c Dead	275.01 Kn	PhiM _n Dead	18.20 Kn-m	PhiV _n Dead	57.64 Kn
PhiN _c Snow	366.68 Kn	PhiM _n Snow	24.26 Kn-m	PhiV _n Snow	76.85 Kn

Checks $(M_x/\Phi M_n) + (N/\Phi N_c) = 0.60 < 1$ OK $(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.35 < 1$ OK

Deflection at top under service lateral loads = 38.09 mm < 59.85 mm

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Ds =	0.6 mm	Pile Diameter
L =	1700 mm	Pile embedment length
f1 =	4500 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 15.332375 m²

Moment Wind =	16.28 Kn-m	Moment Snow =	4.47 Kn-m
Shear Wind =	3.62 Kn	Shear Snow =	4.47 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.06 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	18.47 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.88 < 1 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 =	1700 mm	Pile embedment length
f1 =	4500 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	16.28 Kn-m	Moment Snow =	4.47 Kn-m
Shear Wind =	3.62 Kn	Shear Snow =	4.47 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.06 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	18.47 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.88 < 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(2000) x Ks(1.5) x 0.5 x tan(30) x π x Dia of Pile(0.6) x Height of Pile(2000)

Skin Friction = 32.31 Kn

Weight of Pile + Pile Skin Friction = 38.15 Kn

Uplift on one Pile = 30.51 Kn

Uplift is ok