

Pole Shed App Ver 01 2022

Job No.: 51 SH51 Waipatu **Address:** 51 State Highway 51, Waipatu 4172, New Zealand **Date:** 27/11/2024
Latitude: -39.629922 **Longitude:** 176.869473 **Elevation:** 8.5 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	3.6 m
Wind Region	NZ2	Terrain Category	2.83	Design Wind Speed	35.42 m/s
Wind Pressure	0.75 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Medium	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 2.70 m $C_{p,e} = -0.9$ $p_e = -0.61$ KPa $p_{net} = -0.61$ KPa

For roof $C_{p,e}$ from 2.70 m To 5.40 m $C_{p,e} = -0.5$ $p_e = -0.34$ KPa $p_{net} = -0.34$ 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 7 m $C_{p,e} = 0.7$ $p_e = 0.47$ KPa $p_{net} = 0.70$ KPa

For side wall $C_{p,e}$ from 0 m To 2.70 m $C_{p,e} =$ $p_e = -0.44$ KPa $p_{net} = -0.44$ KPa

Maximum Upward pressure used in roof member Design = 0.61 KPa

Maximum Downward pressure used in roof member Design = 0.37 KPa

Maximum Wall pressure used in Design = 0.70 KPa

Maximum Racking pressure used in Design = 0.81 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 3850 mm Try Purlin 190x45 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.98

K8 Upward = 0.46 S1 Downward = 12.23 S1 Upward = 25.13

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

Capacity Checks

M _{1.35D}	0.56 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	319.64 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.56 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	152.56 %
M _{0.9D-W_nUp}	-0.64 Kn-m	Capacity	-1.39 Kn-m	Passing Percentage	126.36 %
V _{1.35D}	0.58 Kn	Capacity	8.25 Kn	Passing Percentage	1422.41 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.17 Kn	Capacity	11.00 Kn	Passing Percentage	940.17 %
V _{0.9D-W_nUp}	-0.67 Kn	Capacity	-13.75 Kn	Passing Percentage	2052.24 %

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 = 8.51 mm Limit by Woolcock et al, 1999 Span/240 = 15.83 mm

Deflection under Dead and Service Wind = 9.71 mm Limit by Woolcock et al, 1999 Span/100 = 38.00 mm

Reactions

Maximum downward = 1.17 kn Maximum upward = -0.67 kn

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

Rafter Design Internal

Internal Rafter Load Width = 4000 mm Internal Rafter Span = 3350 mm Try Rafter 2x240x45 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 1.00 S1 Downward = 6.71 S1 Upward = 6.71

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

Capacity Checks

M _{1.35D}	1.89 Kn-m	Capacity	5.8 Kn-m	Passing Percentage	306.88 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.79 Kn-m	Capacity	7.74 Kn-m	Passing Percentage	204.22 %

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M _{0.9D-WnUp}	-2.16 Kn-m	Capacity	-9.68 Kn-m	Passing Percentage	448.15 %
V _{1.35D}	2.26 Kn	Capacity	20.84 Kn	Passing Percentage	922.12 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	4.52 Kn	Capacity	27.78 Kn	Passing Percentage	614.60 %
V _{0.9D-WnUp}	-2.58 Kn	Capacity	-34.74 Kn	Passing Percentage	1346.51 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 3.77 mm Limit by Woolcock et al, 1999 Span/240 = 14.58 mm

Deflection under Dead and Service Wind = 4.78 mm Limit by Woolcock et al, 1999 Span/100 = 35.00 mm

Reactions

Maximum downward = 4.52 kn Maximum upward = -2.58 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 = J5 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 = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

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

Capacity under short term loads = 19.50 Kn > -2.58 Kn

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 3313 mm Try Rafter 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 K₁ Medium term = 0.8 K₁ Long term = 0.6 K₄ = 1 K₅ = 1 K₈ Downward = 0.94

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K8 Upward =0.94 S1 Downward =13.82 S1 Upward =13.82

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

Capacity Checks

M _{1.35D}	0.93 Kn-m	Capacity	2.73 Kn-m	Passing Percentage	293.55 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.85 Kn-m	Capacity	3.64 Kn-m	Passing Percentage	196.76 %
M _{0.9D-W_nUp}	-1.06 Kn-m	Capacity	-4.55 Kn-m	Passing Percentage	429.25 %
V _{1.35D}	1.12 Kn	Capacity	10.42 Kn	Passing Percentage	930.36 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.24 Kn	Capacity	13.89 Kn	Passing Percentage	620.09 %
V _{0.9D-W_nUp}	-1.28 Kn	Capacity	-17.37 Kn	Passing Percentage	1357.03 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.19 mm Limit by Woolcock et al, 1999 Span/240= 14.58 mm

Deflection under Dead and Service Wind = 4.78 mm Limit by Woolcock et al, 1999 Span/100 = 35.00 mm

Reactions

Maximum downward =2.24 kn Maximum upward = -1.28 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 =J5 Joint Group for Pole = J5

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 14.9 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

V = phi x k₁ x k₄ x k₅ x f_s x b x d_s (Eq 4.12) = -17.01 kn > -1.28 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -1.28 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4000 mm

Try Girt 140x45 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 =1.00

K8 Upward =0.88 S1 Downward =10.36 S1 Upward =15.45

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

Capacity Checks

M _{Wind+Snow}	1.26 Kn-m	Capacity	1.45 Kn-m	Passing Percentage	115.08 %
V _{0.9D-WnUp}	1.26 Kn	Capacity	10.13 Kn	Passing Percentage	803.97 %

Deflections

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

Deflection under Snow and Service Wind = 30.46 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Sag during installation = 19.16 mm

Reactions

Maximum = 1.26 kn

Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 3500 mm

Try Girt 140x45 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 =1.00

K8 Upward =0.65 S1 Downward =10.36 S1 Upward =20.44

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

Capacity Checks

M _{Wind+Snow}	0.96 Kn-m	Capacity	1.07 Kn-m	Passing Percentage	111.46 %
V _{0.9D-WnUp}	1.10 Kn	Capacity	10.13 Kn	Passing Percentage	920.91 %

Deflections

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

Deflection under Snow and Service Wind = 17.86 mm Limit by Woolcock et al. 1999 Span/100 = 35.00 mm

Sag during installation = 11.23 mm

Reactions

Maximum = 1.10 kn

Middle Pole Design

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3350 mm
Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zy	421056 mm ³
Lateral Restraint	3350 mm c/c		

Loads

Total Area over Pole = 14 m²

Dead	3.50 Kn	Live	3.50 Kn
Wind Down	5.18 Kn	Snow	0.00 Kn
Moment wind	5.24 Kn-m		
Phi	0.8	K8	0.64
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	191.05 Kn	PhiMnx Wind	7.83 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	114.63 Kn	PhiMnx Dead	4.70 Kn-m	PhiVnx Dead	22.09 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.73 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.51 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 28.01 \text{ mm} < 33.50 \text{ mm}$$

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 = 1300 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 = 5.24 Kn-m
Shear Wind = 1.94 Kn

Pile Properties

Safety Factory 0.55
Hu = 4.89 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 7.84 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.67 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level) Dry Use Height 3400 mm

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Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zy	421056 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 7 m²

Dead	1.75 Kn	Live	1.75 Kn
Wind Down	2.59 Kn	Snow	0.00 Kn
Moment Wind	2.62 Kn-m		
Phi	0.8	K8	0.63
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	186.72 Kn	PhiMnx Wind	7.65 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	112.03 Kn	PhiMnx Dead	4.59 Kn-m	PhiVnx Dead	22.09 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.37 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.15 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 15.02 \text{ mm} < 35.91 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1300 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

Total Area over Pole = 7 m²

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Moment Wind = 2.62 Kn-m
Shear Wind = 0.97 Kn

Pile Properties

Safety Factory 0.55
Hu = 4.89 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 7.84 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.33 < 1 OK

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

Assumed Soil Properties

Gamma 18 Kn/m³ Friction angle 30 deg Cohesion 0 Kn/m³
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 = 1300 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 = 2.62 Kn-m
Shear Wind = 0.97 Kn

Pile Properties

Safety Factory 0.55
Hu = 4.89 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 7.84 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.33 < 1 OK

Uplift Check

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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(1300) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.91 Kn

Uplift on one Pile = 5.39 Kn

Uplift is ok