

Pole Shed App Ver 01 2022

Job No.: Loveridge - 668
Oruanui Road Oruanui 3384

Address: 668 Oruanui Road, Oruanui 3384, New Zealand

Date: 10/11/2023

Latitude: -38.570448

Longitude: 176.036076

Elevation: 549 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	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.6 m
Wind Region	NZ2	Terrain Category	2.34	Design Wind Speed	45.98 m/s
Wind Pressure	1.27 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 1.65 m $C_{p,e} = -0.94$ $p_e = -1.07$ KPa $p_{net} = -1.07$ KPa

For roof $C_{p,e}$ from 1.65 m To 3.30 m $C_{p,e} = -0.88$ $p_e = -1.0$ KPa $p_{net} = -1.0$ 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 6 m $C_{p,e} = 0.7$ $p_e = 0.80$ KPa $p_{net} = 1.18$ KPa

For side wall $C_{p,e}$ from 0 m To 3.30 m $C_{p,e} =$ $p_e = -0.74$ KPa $p_{net} = -0.74$ KPa

Maximum Upward pressure used in roof member Design = 1.07 KPa

Maximum Downward pressure used in roof member Design = 0.61 KPa

Maximum Wall pressure used in Design = 1.18 KPa

Maximum Racking pressure used in Design = 1.37 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3450 mm

Try Purlin 200x50 SG8 Dry

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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 = 0.58 S1 Downward = 11.27 S1 Upward = 21.91

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

Capacity Checks

M _{1.35D}	0.45 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	495.56 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.35 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	220.00 %
M _{0.9D-W_nUp}	-1.13 Kn-m	Capacity	-2.16 Kn-m	Passing Percentage	191.15 %
V _{1.35D}	0.52 Kn	Capacity	9.65 Kn	Passing Percentage	1855.77 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.41 Kn	Capacity	12.86 Kn	Passing Percentage	912.06 %
V _{0.9D-W_nUp}	-1.31 Kn	Capacity	-16.08 Kn	Passing Percentage	1227.48 %

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 = 4.21 mm Limit by Woolcock et al, 1999 Span/240 = 14.17 mm

Deflection under Dead and Service Wind = 5.64 mm Limit by Woolcock et al, 1999 Span/100 = 34.00 mm

Reactions

Maximum downward = 1.41 kn Maximum upward = -1.31 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 = 3600 mm Internal Rafter Span = 5850 mm Try Rafter 2x300x50 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 = 1.00

K8 Upward = 1.00 S1 Downward = 6.81 S1 Upward = 6.81

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 _{1.35D}	5.20 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	193.85 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	14.01 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	95.93 %
M _{0.9D-WnUp}	-13.01 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	129.13 %
V _{1.35D}	3.55 Kn	Capacity	28.94 Kn	Passing Percentage	815.21 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.58 Kn	Capacity	38.6 Kn	Passing Percentage	402.92 %
V _{0.9D-WnUp}	-8.90 Kn	Capacity	-48.24 Kn	Passing Percentage	542.02 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 13.5 mm Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 20.125 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 9.58 kn Maximum upward = -8.90 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 = 100 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 = 21.67 Kn > -8.90 Kn

Rafter Design External

External Rafter Load Width = 1800 mm External Rafter Span = 5830 mm Try Rafter 300x50 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 = 0.94

K8 Upward = 0.94 S1 Downward = 13.93 S1 Upward = 13.93

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

Capacity Checks

M _{1.35D}	2.58 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	182.95 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	6.96 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	90.52 %
M _{0.9D-W_nUp}	-6.46 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	121.83 %
V _{1.35D}	1.77 Kn	Capacity	14.47 Kn	Passing Percentage	817.51 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.77 Kn	Capacity	19.30 Kn	Passing Percentage	404.61 %
V _{0.9D-W_nUp}	-4.43 Kn	Capacity	-24.12 Kn	Passing Percentage	544.47 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 15.00 mm Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 20.13 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 4.77 kn Maximum upward = -4.43 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 = 50 mm

For Parallel to grain loading

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

Eccentric Load check

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$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -25.20 kn > -4.43 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.43 Kn

Intermediate Design Sides

Intermediate Spacing = 3000 mm Intermediate Span = 3150 mm Try Intermediate 2x150x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and does not remain in continuous wet condition after installation)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =1.00 S1 Downward =9.63 S1 Upward =0.57

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

Capacity Checks

$M_{Wind+Snow}$	2.19 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	191.78 %
$V_{0.9D-WnUp}$	2.79 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	864.52 %

Deflections

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

Deflection under Snow and Service Wind = 29.86 mm Limit by Woolcock et al, 1999 Span/100 = 31.50 mm

Reactions

Maximum = 2.79 kn

Girt Design Front and Back

Girt's Spacing = 900 mm Girt's Span = 3600 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)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =0.95 S1 Downward =9.63 S1 Upward =13.62

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

Capacity Checks

$M_{Wind+Snow}$	1.72 Kn-m	Capacity	1.99 Kn-m	Passing Percentage	115.70 %
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V _{0.9D-WnUp}	1.91 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	631.41 %
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Deflections

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

Deflection under Snow and Service Wind = 24.65 mm Limit by Woolcock et al, 1999 Span/100 = 36.00 mm
Sag during installation = 10.18 mm

Reactions

Maximum = 1.91 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)

K1 Short term = 1 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 0.79 S1 Downward = 9.63 S1 Upward = 17.59

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

Capacity Checks

M _{Wind+Snow}	1.19 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	138.66 %
V _{0.9D-WnUp}	1.59 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	758.49 %

Deflections

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

Deflection under Snow and Service Wind = 11.89 mm Limit by Woolcock et al. 1999 Span/100 = 30.00 mm
Sag during installation = 4.91 mm

Reactions

Maximum = 1.59 kn

Middle Pole Design

Geometry

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175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	27598 mm ²	As	20698.2421875 mm ²
Ix	60639381 mm ⁴	Zx	646820 mm ³
Iy	60639381 mm ⁴	Zy	646820 mm ³
Lateral Restraint	3400 mm c/c		

Loads

Total Area over Pole = 10.8 m²

Dead	2.70 Kn	Live	2.70 Kn
Wind Down	6.59 Kn	Snow	0.00 Kn
Moment wind	11.95 Kn-m		
Phi	0.8	K8	0.76
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	302.65 Kn	PhiMnx Wind	14.30 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	181.59 Kn	PhiMnx Dead	8.58 Kn-m	PhiVnx Dead	29.41 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.88 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.74 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 35.55 \text{ mm} < 33.00 \text{ mm}$$

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
K0 =	$(1 - \sin(30)) / (1 + \sin(30))$				

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$$K_p = (1 + \sin(30)) / (1 - \sin(30))$$

Geometry For Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1550 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 =	11.95 Kn-m
Shear Wind =	4.43 Kn

Pile Properties

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

Checks

Applied Forces/Capacities = 0.94 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zx	421056 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 10.8 m²

Dead	2.70 Kn	Live	2.70 Kn
Wind Down	6.59 Kn	Snow	0.00 Kn
Moment Wind	5.98 Kn-m		
Phi	0.8	K8	0.66

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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	195.59 Kn	PhiMnx Wind	8.01 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	117.35 Kn	PhiMnx Dead	4.81 Kn-m	PhiVnx Dead	22.09 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.81 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.62 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 34.28 \text{ mm} < 35.91 \text{ mm}$$

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

$$\text{Total Area over Pole} = 10.8 \text{ m}^2$$

Moment Wind =	5.98 Kn-m
Shear Wind =	2.21 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

$$\text{Applied Forces/Capacities} = 0.76 < 1 \text{ OK}$$

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

$$K_0 = (1 - \sin(30)) / (1 + \sin(30))$$

$$K_p = (1 + \sin(30)) / (1 - \sin(30))$$

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 = 5.98 Kn-m
Shear Wind = 2.21 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 = 0.76 < 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(1550) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1550)

Skin Friction = 19.40 Kn

Weight of Pile + Pile Skin Friction = 23.94 Kn

Uplift on one Pile = 9.13 Kn

Uplift is ok