

Pole Shed App Ver 01 2022

Job No.: 2304005 - 1

Address: 224 Pomona Road, Ruby Bay, New Zealand **Date:** 11/30/2023

Latitude: -41.231767

Longitude: 173.069714

Elevation: 72.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N3	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	C
Importance Level	2	Ultimate wind & Earthquake ARI	500 Years	Max Height	4.2 m
Wind Region	NZ2	Terrain Category	2.5	Design Wind Speed	45.92 m/s
Wind Pressure	1.27 KPa	Lee Zone	NO	Ultimate Snow ARI	150 Years
Wind Category	Very 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 Enclosed

For roof $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 1.95 m $C_{p,e} = -0.9457$ $p_e = -0.96$ KPa $p_{net} = -0.96$ KPa

For roof $C_{p,e}$ from 1.95 m To 3.90 m $C_{p,e} = -0.8771$ $p_e = -0.89$ KPa $p_{net} = -0.89$ 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 14.4 m $C_{p,e} = 0.7$ $p_e = 0.71$ KPa $p_{net} = 1.05$ KPa

For side wall $C_{p,e}$ from 0 m To 3.90 m $C_{p,e} =$ $p_e = -0.66$ KPa $p_{net} = -0.66$ KPa

Maximum Upward pressure used in roof member Design = 0.96 KPa

Maximum Downward pressure used in roof member Design = 0.54 KPa

Maximum Wall pressure used in Design = 1.05 KPa

Maximum Racking pressure used in Design = 1.22 KPa

Design Summary

Purlin Design

Purlin Spacing = 650 mm

Purlin Span = 3450 mm

Try Purlin 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 0.73 S1 Downward = 9.63 S1 Upward = 18.72

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

Capacity Checks

M _{1.35D}	0.33 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	381.82 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.24 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	135.48 %
M _{0.9D-W_nUp}	-0.71 Kn-m	Capacity	-1.54 Kn-m	Passing Percentage	216.90 %
V _{1.35D}	0.38 Kn	Capacity	7.24 Kn	Passing Percentage	1905.26 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	0.94 Kn	Capacity	9.65 Kn	Passing Percentage	1026.60 %
V _{0.9D-W_nUp}	-0.82 Kn	Capacity	-12.06 Kn	Passing Percentage	1470.73 %

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 = 7.20 mm Limit by Woolcock et al, 1999 Span/360 = 9.44 mm

Deflection under Dead and Service Wind = 9.24 mm Limit by Woolcock et al, 1999 Span/250 = 22.67 mm

Reactions

Maximum downward = 0.94 kn Maximum upward = -0.82 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 = 3350 mm Try Rafter 2x200x50 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 = 5.33 S1 Upward = 5.33

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}	1.70 Kn-m	Capacity	4.48 Kn-m	Passing Percentage	263.53 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	4.24 Kn-m	Capacity	5.98 Kn-m	Passing Percentage	141.04 %
M _{0.9D-WnUp}	-3.71 Kn-m	Capacity	-7.46 Kn-m	Passing Percentage	201.08 %
V _{1.35D}	2.04 Kn	Capacity	19.3 Kn	Passing Percentage	946.08 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	5.07 Kn	Capacity	25.72 Kn	Passing Percentage	507.30 %
V _{0.9D-WnUp}	-4.43 Kn	Capacity	-32.16 Kn	Passing Percentage	725.96 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.275 mm Limit by Woolcock et al, 1999 Span/360 = 9.72 mm

Deflection under Dead and Service Wind = 7.525 mm Limit by Woolcock et al, 1999 Span/250 = 23.33 mm

Reactions

Maximum downward = 5.07 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

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 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

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

Capacity under short term loads = 21.67 Kn > -4.43 Kn

Rafter Design External

External Rafter Load Width = 1800 mm External Rafter Span = 3313 mm Try Rafter 200x50 SG8 Dry

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 = 1.00

K8 Upward = 1.00 S1 Downward = 11.27 S1 Upward = 11.27

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

Capacity Checks

M _{1.35D}	0.83 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	268.67 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.07 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	143.48 %
M _{0.9D-W_nUp}	-1.82 Kn-m	Capacity	-3.72 Kn-m	Passing Percentage	204.40 %
V _{1.35D}	1.01 Kn	Capacity	9.65 Kn	Passing Percentage	955.45 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.50 Kn	Capacity	12.86 Kn	Passing Percentage	514.40 %
V _{0.9D-W_nUp}	-2.19 Kn	Capacity	-16.08 Kn	Passing Percentage	734.25 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.86 mm Limit by Woolcock et al, 1999 Span/360 = 9.72 mm
Deflection under Dead and Service Wind = 7.52 mm Limit by Woolcock et al, 1999 Span/250 = 23.33 mm

Reactions

Maximum downward = 2.50 kn Maximum upward = -2.19 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

V = $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$ (Eq 4.12) = -14.70 kn > -2.19 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.19 Kn

Girt Design Front and Back

Girt's Spacing = 600 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 =0.71 S1 Downward =9.63 S1 Upward =19.27

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

Capacity Checks

M _{Wind+Snow}	1.02 Kn-m	Capacity	1.48 Kn-m	Passing Percentage	145.10 %
V _{0.9D-WnUp}	1.13 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	1067.26 %

Deflections

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

Deflection under Snow and Service Wind = 14.62 mm Limit by Woolcock et al, 1999 Span/250 = 14.40 mm

Sag during installation = 10.18 mm

Reactions

Maximum = 1.13 kn

Girt Design Sides

Girt's Spacing = 600 mm

Girt's Span = 3500 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 =0.72 S1 Downward =9.63 S1 Upward =19.00

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	1.51 Kn-m	Passing Percentage	157.29 %
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V_{0.9D-WnUp} 1.10 Kn-m Capacity 12.06 Kn-m Passing Percentage **1096.36 %**

Deflections

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

Deflection under Snow and Service Wind = 13.07 mm Limit by Woolcock et al. 1999 Span/100 = 14.00 mm
Sag during installation = 9.10 mm

Reactions

Maximum = 1.10 kn

Middle Pole Design

Geometry

275 SED H5 (Minimum 300 dia. at Floor Level)	Dry Use	Height	3900 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	3900 mm c/c		

Loads

Total Area over Pole = 12.6 m²

Dead	3.15 Kn	Live	3.15 Kn
Wind Down	6.80 Kn	Snow	0.00 Kn
Moment wind	9.66 Kn-m		
Phi	0.8	K ₈	0.95
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 _{cx} Wind	886.30 Kn	PhiM _{nx} Wind	64.23 Kn-m	PhiV _{nx} Wind	115.24 Kn
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PhiNcx Dead 531.78 Kn PhiMnx Dead 38.54 Kn-m PhiVnx Dead 69.14 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.17 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.04 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 7.17 \text{ mm} < 26.00 \text{ mm}$$

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 = 1700 mm Pile embedment length

f1 = 3150 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 9.66 Kn-m

Shear Wind = 3.07 Kn

Pile Properties

Safety Factory 0.55

Hu = 9.03 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 17.07 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.57 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Geometry

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200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	4000 mm
Area	35448 mm ²	As	26585.7421875 mm ²
Ix	100042702 mm ⁴	Zx	941578 mm ³
Iy	100042702 mm ⁴	Zx	941578 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 6.3 m²

Dead	1.57 Kn	Live	1.57 Kn
Wind Down	3.40 Kn	Snow	0.00 Kn
Moment Wind	4.83 Kn-m		
Phi	0.8	K8	0.73
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	371.66 Kn	PhiMnx Wind	19.91 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	223.00 Kn	PhiMnx Dead	11.95 Kn-m	PhiVnx Dead	37.77 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.26 < 1 \text{ OK}$$

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

Deflection at top under service lateral loads = 12.89 mm < 27.93 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3150 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

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Total Area over Pole = 6.3 m²

Moment Wind = 4.83 Kn-m

Shear Wind = 1.53 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.40 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.11 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.60 < 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

fl = 3150 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 4.83 Kn-m

Shear Wind = 1.53 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.40 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.11 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.60 < 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(1700) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1700)

Skin Friction = 23.34 Kn

Weight of Pile + Pile Skin Friction = 26.31 Kn

Uplift on one Pile = 9.26 Kn

Uplift is ok