

Pole Shed App Ver 01 2022

Job No.: 111223 **Address:** 242 Waihue Road, Dargaville, New Zealand **Date:** 14/12/2023
Latitude: -35.927292 **Longitude:** 173.852913 **Elevation:** 52 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	1	Subsoil Category	D	Exposure Zone	C
Importance Level	2	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.1 m
Wind Region	NZ1	Terrain Category	2.39	Design Wind Speed	42.39 m/s
Wind Pressure	1.08 KPa	Lee Zone	NO	Ultimate Snow ARI	150 Years
Wind Category	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 3.45 m $C_{p,e} = -0.9$ $p_e = -0.86$ KPa $p_{net} = -0.86$ KPa

For roof $C_{p,e}$ from 3.45 m To 6.90 m $C_{p,e} = -0.5$ $p_e = -0.48$ KPa $p_{net} = -0.48$ 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 9 m $C_{p,e} = 0.7$ $p_e = 0.68$ KPa $p_{net} = 1$ KPa

For side wall $C_{p,e}$ from 0 m To 3.45 m $C_{p,e} =$ $p_e = -0.63$ KPa $p_{net} = -0.63$ KPa

Maximum Upward pressure used in roof member Design = 0.87 KPa

Maximum Downward pressure used in roof member Design = 0.51 KPa

Maximum Wall pressure used in Design = 0.68 KPa

Maximum Racking pressure used in Design = 1.17 KPa

Design Summary

Purlin Design

Purlin Spacing = 800 mm Purlin Span = 5850 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 = 0.54 S1 Downward = 12.68 S1 Upward = 22.76

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

Capacity Checks

M _{1.35D}	1.16 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	293.10 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.77 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	163.54 %
M _{0.9D-W_nUp}	-2.21 Kn-m	Capacity	-3.16 Kn-m	Passing Percentage	142.99 %
V _{1.35D}	0.79 Kn	Capacity	12.06 Kn	Passing Percentage	1526.58 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.90 Kn	Capacity	16.08 Kn	Passing Percentage	846.32 %
V _{0.9D-W_nUp}	-1.51 Kn	Capacity	-20.10 Kn	Passing Percentage	1331.13 %

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 = 16.21 mm Limit by Woolcock et al, 1999 Span/360 = 16.11 mm

Deflection under Dead and Service Wind = 20.40 mm Limit by Woolcock et al, 1999 Span/250 = 38.67 mm

Reactions

Maximum downward = 1.90 kn Maximum upward = -1.51 kn

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

Rafter Design Internal

Internal Rafter Load Width = 6000 mm Internal Rafter Span = 8850 mm Try Rafter 2x360x45 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 = 1.00

K8 Upward = 1.00 S1 Downward = 8.40 S1 Upward = 8.40

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

Capacity Checks

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M _{1.35D}	19.83 Kn-m	Capacity	43.44 Kn-m	Passing Percentage	219.06 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	47.58 Kn-m	Capacity	57.92 Kn-m	Passing Percentage	121.73 %
M _{0.9D-WnUp}	-37.89 Kn-m	Capacity	-72.42 Kn-m	Passing Percentage	191.13 %
V _{1.35D}	8.96 Kn	Capacity	55.22 Kn	Passing Percentage	616.29 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	21.51 Kn	Capacity	73.64 Kn	Passing Percentage	342.35 %
V _{0.9D-WnUp}	-17.12 Kn	Capacity	-92.04 Kn	Passing Percentage	537.62 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 35.955 mm Limit by Woolcock et al, 1999 Span/360 = 25.00 mm

Deflection under Dead and Service Wind = 50.27 mm Limit by Woolcock et al, 1999 Span/250 = 60.00 mm

Reactions

Maximum downward = 21.51 kn Maximum upward = -17.12 kn

Rafter to Pole Connection check

Bolt Size = M12 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

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 12.6 f_{pj} = 22.7 Mpa for Rafter with effective thickness = 90 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 = 43.67 Kn > -17.12 Kn

Rafter Design External

External Rafter Load Width = 3000 mm External Rafter Span = 4344 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)

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K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.94

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}	2.39 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	197.49 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	5.73 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	109.95 %
M _{0.9D-W_nUp}	-4.56 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	172.59 %
V _{1.35D}	2.20 Kn	Capacity	14.47 Kn	Passing Percentage	657.73 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	5.28 Kn	Capacity	19.30 Kn	Passing Percentage	365.53 %
V _{0.9D-W_nUp}	-4.20 Kn	Capacity	-24.12 Kn	Passing Percentage	574.29 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 7.91 mm Limit by Woolcock et al, 1999 Span/360 = 12.50 mm
Deflection under Dead and Service Wind = 9.95 mm Limit by Woolcock et al, 1999 Span/250 = 30.00 mm

Reactions

Maximum downward = 5.28 kn Maximum upward = -4.20 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) = -25.20 kn > -4.20 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.20 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 6000 mm

Try Girt 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 K4 =1 K5 =1 K8 Downward =0.97

K8 Upward =0.53 S1 Downward =12.68 S1 Upward =23.15

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

Capacity Checks

M _{Wind+Snow}	2.75 Kn-m	Capacity	3.07 Kn-m	Passing Percentage	111.64 %
V _{0.9D-WnUp}	1.84 Kn-m	Capacity	20.10 Kn-m	Passing Percentage	1092.39 %

Deflections

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

Deflection under Snow and Service Wind = 23.68 mm Limit by Woolcock et al, 1999 Span/250 = 24.00 mm
Sag during installation = 78.58 mm

Reactions

Maximum = 1.84 kn

Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 4500 mm

Try Girt 200x50 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 =1.00

K8 Upward =0.45 S1 Downward =11.27 S1 Upward =25.20

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

Capacity Checks

M _{Wind+Snow}	1.55 Kn-m	Capacity	1.70 Kn-m	Passing Percentage	109.68 %
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V_{0.9D-WnUp} 1.38 Kn-m Capacity 16.08 Kn-m Passing Percentage **1165.22 %**

Deflections

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

Deflection under Snow and Service Wind = 14.63 mm Limit by Woolcock et al. 1999 Span/100 = 18.00 mm
Sag during installation = 24.86 mm

Reactions

Maximum = 1.38 kn

Middle Pole Design

Geometry

250 SED H5 (Minimum 275 dia. at Floor Level)	Dry Use	Height	3450 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	1300 mm c/c		

Loads

Total Area over Pole = 27 m²

Dead	6.75 Kn	Live	6.75 Kn
Wind Down	13.77 Kn	Snow	0.00 Kn
Moment wind	22.07 Kn-m		
Phi	0.8	K ₈	1.00
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	778.92 Kn	PhiM _{Nx} Wind	51.54 Kn-m	PhiV _{Nx} Wind	96.07 Kn
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PhiNcx Dead 467.35 Kn PhiMnx Dead 30.93 Kn-m PhiVnx Dead 57.64 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.46 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.22 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 20.34 mm < 23.00 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 = 1900 mm Pile embedment length
f1 = 3075 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 22.07 Kn-m
Shear Wind = 7.18 Kn

Pile Properties

Safety Factory 0.55
Hu = 12.28 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 23.05 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.96 < 1 \text{ OK}$$

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	3800 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 = 13.5 m²

Dead	3.38 Kn	Live	3.38 Kn
Wind Down	6.88 Kn	Snow	0.00 Kn
Moment Wind	7.36 Kn-m		
Phi	0.8	K8	0.77
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	395.03 Kn	PhiMnx Wind	21.16 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	237.02 Kn	PhiMnx Dead	12.70 Kn-m	PhiVnx Dead	37.77 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.38 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.16 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 18.72 mm < 27.26 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3075 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 = 13.5 m²

Moment Wind = 7.36 Kn-m

Shear Wind = 2.39 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.47 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.07 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.91 < 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 = 3075 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 7.36 Kn-m

Shear Wind = 2.39 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.47 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.07 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.91 < 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(1900) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1900)

Skin Friction = 29.16 Kn

Weight of Pile + Pile Skin Friction = 32.97 Kn

Uplift on one Pile = 17.41 Kn

Uplift is ok