

Pole Shed App Ver 01 2022

Job No.: Marsh - 203 Waingaro **Address:** 203 Waingaro Road, Ngaruawahia, New Zealand **Date:** 10/11/2023
Latitude: -37.676894 **Longitude:** 175.136782 **Elevation:** 18.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N0	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ1	Terrain Category	2.34	Design Wind Speed	40.14 m/s
Wind Pressure	0.97 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	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 3.60 m $C_{p,e} = -0.9$ $p_e = -0.78$ KPa $p_{net} = -0.78$ KPa

For roof $C_{p,e}$ from 3.60 m To 7.20 m $C_{p,e} = -0.5$ $p_e = -0.44$ KPa $p_{net} = -0.44$ 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 14.40 m $C_{p,e} = 0.7$ $p_e = 0.61$ KPa $p_{net} = 0.90$ KPa

For side wall $C_{p,e}$ from 0 m To 3.60 m $C_{p,e} =$ $p_e = -0.57$ KPa $p_{net} = -0.57$ KPa

Maximum Upward pressure used in roof member Design = 0.78 KPa

Maximum Downward pressure used in roof member Design = 0.46 KPa

Maximum Wall pressure used in Design = 0.90 KPa

Maximum Racking pressure used in Design = 1.05 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 4650 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 = 0.44 S1 Downward = 11.27 S1 Upward = 25.48

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

Capacity Checks

M _{1.35D}	0.82 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	271.95 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.01 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	147.76 %
M _{0.9D-W_nUp}	-1.35 Kn-m	Capacity	-1.66 Kn-m	Passing Percentage	122.96 %
V _{1.35D}	0.71 Kn	Capacity	9.65 Kn	Passing Percentage	1359.15 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.59 Kn	Capacity	12.86 Kn	Passing Percentage	808.81 %
V _{0.9D-W_nUp}	-1.16 Kn	Capacity	-16.08 Kn	Passing Percentage	1386.21 %

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 = 14.10 mm Limit by Woolcock et al, 1999 Span/240 = 19.17 mm

Deflection under Dead and Service Wind = 17.15 mm Limit by Woolcock et al, 1999 Span/100 = 46.00 mm

Reactions

Maximum downward = 1.59 kn Maximum upward = -1.16 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 = 4800 mm Internal Rafter Span = 11850 mm Try Rafter 2x450x63 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 = 6.68 S1 Upward = 6.68

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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M1.35D	28.44 Kn-m	Capacity	91.56 Kn-m	Passing Percentage	321.94 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	64.03 Kn-m	Capacity	122.08 Kn-m	Passing Percentage	190.66 %
M0.9D-WnUp	-46.76 Kn-m	Capacity	-152.6 Kn-m	Passing Percentage	326.35 %
V1.35D	9.60 Kn	Capacity	96.64 Kn	Passing Percentage	1006.67 %
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	21.61 Kn	Capacity	128.86 Kn	Passing Percentage	596.30 %
V0.9D-WnUp	-15.78 Kn	Capacity	-161.08 Kn	Passing Percentage	1020.79 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 33.245 mm Limit by Woolcock et al, 1999 Span/240 = 50.00 mm

Deflection under Dead and Service Wind = 44.945 mm Limit by Woolcock et al, 1999 Span/100 = 120.00 mm

Reactions

Maximum downward = 21.61 kn Maximum upward = -15.78 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 fpj = 22.7 Mpa for Rafter with effective thickness = 126 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 = 43.67 Kn > -15.78 Kn

Rafter Design External

External Rafter Load Width = 2400 mm External Rafter Span = 5813 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}	3.42 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	138.01 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	7.70 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	81.82 %
M _{0.9D-W_nUp}	-5.63 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	139.79 %
V _{1.35D}	2.35 Kn	Capacity	14.47 Kn	Passing Percentage	615.74 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	5.30 Kn	Capacity	19.30 Kn	Passing Percentage	364.15 %
V _{0.9D-W_nUp}	-3.87 Kn	Capacity	-24.12 Kn	Passing Percentage	623.26 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 20.00 mm Limit by Woolcock et al, 1999 Span/240= 25.00 mm

Deflection under Dead and Service Wind = 24.33 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward =5.30 kn Maximum upward = -3.87 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 > -3.87 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.87 Kn

Intermediate Design Sides

Intermediate Spacing = 3000 mm Intermediate Span = 3650 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 =0.61

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

Capacity Checks

$M_{Wind+Snow}$	2.25 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	186.67 %
$V_{0.9D-WnUp}$	2.46 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	980.49 %

Deflections

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

Deflection under Snow and Service Wind = 41.07 mm Limit by Woolcock et al, 1999 Span/100 = 36.50 mm

Reactions

Maximum = 2.46 kn

Girt Design Front and Back

Girt's Spacing = 700 mm Girt's Span = 4800 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 =0.87 S1 Downward =9.63 S1 Upward =15.73

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

Capacity Checks

$M_{Wind+Snow}$	1.81 Kn-m	Capacity	1.83 Kn-m	Passing Percentage	101.10 %
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V _{0.9D-WnUp}	1.51 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	798.68 %
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Deflections

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

Deflection under Snow and Service Wind = 46.22 mm Limit by Woolcock et al, 1999 Span/100 = 48.00 mm
Sag during installation = 32.19 mm

Reactions

Maximum = 1.51 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}	0.91 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	181.32 %
V _{0.9D-WnUp}	1.22 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	988.52 %

Deflections

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

Deflection under Snow and Service Wind = 9.07 mm Limit by Woolcock et al. 1999 Span/100 = 30.00 mm
Sag during installation = 4.91 mm

Reactions

Maximum = 1.22 kn

Middle Pole Design

Geometry

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200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3640 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	3400 mm c/c		

Loads

Total Area over Pole = 28.8 m²

Dead	7.20 Kn	Live	7.20 Kn
Wind Down	13.25 Kn	Snow	0.00 Kn
Moment wind	15.08 Kn-m		
Phi	0.8	K8	0.86
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	438.78 Kn	PhiMnx Wind	23.50 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	263.27 Kn	PhiMnx Dead	14.10 Kn-m	PhiVnx Dead	37.77 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.70 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.47 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 33.32 \text{ mm} < 36.40 \text{ mm}$$

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 =	1650 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	15.08 Kn-m
Shear Wind =	5.03 Kn

Pile Properties

Safety Factory	0.55	
Hu =	8.61 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	15.54 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.97 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3700 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	mm c/c		

Loads

Total Area over Pole = 14.4 m²

Dead	3.60 Kn	Live	3.60 Kn
Wind Down	6.62 Kn	Snow	0.00 Kn
Moment Wind	5.03 Kn-m		
Phi	0.8	K8	0.68

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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	271.57 Kn	PhiMnx Wind	12.84 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	162.94 Kn	PhiMnx Dead	7.70 Kn-m	PhiVnx Dead	29.41 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.44 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.20 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 20.08 \text{ mm} < 39.90 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

$$\text{Total Area over Pole} = 14.4 \text{ m}^2$$

Moment Wind =	5.03 Kn-m
Shear Wind =	1.68 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.55 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.02 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.63 < 1 \text{ OK}$$

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 = 3000 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 5.03 Kn-m
Shear Wind = 1.68 Kn

Pile Properties

Safety Factory 0.55
Hu = 4.55 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 8.02 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.63 < 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(1650) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1650)

Skin Friction = 21.99 Kn

Weight of Pile + Pile Skin Friction = 26.27 Kn

Uplift on one Pile = 15.98 Kn

Uplift is ok