

Pole Shed App Ver 01 2022

Job No.: Steve Payne

Address: 621 Knight Rd, Ruatangata West, New Zealand

Date: 26/02/2024

Latitude: -35.694973

Longitude: 174.149056

Elevation: 83.5 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	2.65	Design Wind Speed	37.21 m/s
Wind Pressure	0.83 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 3.76 m $C_{p,e} = -0.9$ $p_e = -0.67$ KPa $p_{net} = -0.67$ KPa

For roof $C_{p,e}$ from 3.76 m To 7.53 m $C_{p,e} = -0.5$ $p_e = -0.37$ KPa $p_{net} = -0.37$ 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 $C_{p,e} = 0.7$ $p_e = 0.52$ KPa $p_{net} = 0.77$ KPa

For side wall $C_{p,e}$ from 0 m To 3.76 m $C_{p,e} =$ $p_e = -0.49$ KPa $p_{net} = -0.49$ KPa

Maximum Upward pressure used in roof member Design = 0.67 KPa

Maximum Downward pressure used in roof member Design = 0.37 KPa

Maximum Wall pressure used in Design = 0.77 KPa

Maximum Racking pressure used in Design = 0.89 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4250 mm

Try Purlin 190x45 SG8

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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 = 0.98

K8 Upward = 0.41 S1 Downward = 12.23 S1 Upward = 26.42

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

Capacity Checks

M _{1.35D}	0.69 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	259.42 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.78 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	133.71 %
M _{0.9D-W_nUp}	-0.9 Kn-m	Capacity	-1.26 Kn-m	Passing Percentage	140.00 %
V _{1.35D}	0.65 Kn	Capacity	8.25 Kn	Passing Percentage	1269.23 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.29 Kn	Capacity	11.00 Kn	Passing Percentage	852.71 %
V _{0.9D-W_nUp}	-0.85 Kn	Capacity	-13.75 Kn	Passing Percentage	1617.65 %

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 = 12.70 mm Limit by Woolcock et al, 1999 Span/240 = 17.50 mm

Deflection under Dead and Service Wind = 14.49 mm Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Reactions

Maximum downward = 1.29 kn Maximum upward = -0.85 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 = 4400 mm Internal Rafter Span = 4350 mm Try Rafter 2x290x45 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 = 7.47 S1 Upward = 7.47

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

Capacity Checks

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M1.35D	3.51 Kn-m	Capacity	8.48 Kn-m	Passing Percentage	241.60 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	7.02 Kn-m	Capacity	11.3 Kn-m	Passing Percentage	160.97 %
M0.9D-WnUp	-4.63 Kn-m	Capacity	-14.12 Kn-m	Passing Percentage	304.97 %
V1.35D	3.23 Kn	Capacity	25.18 Kn	Passing Percentage	779.57 %
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	6.46 Kn	Capacity	33.58 Kn	Passing Percentage	519.81 %
V0.9D-WnUp	-4.26 Kn	Capacity	-41.96 Kn	Passing Percentage	984.98 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 6.42 mm Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 8.145 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward = 6.46 kn Maximum upward = -4.26 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 > -4.26 Kn

Rafter Design External

External Rafter Load Width = 2200 mm External Rafter Span = 4310 mm Try Rafter 290x45 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 = 0.89

K8 Upward = 0.89 S1 Downward = 15.23 S1 Upward = 15.23

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

Capacity Checks

M _{1.35D}	1.72 Kn-m	Capacity	3.78 Kn-m	Passing Percentage	219.77 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.45 Kn-m	Capacity	5.04 Kn-m	Passing Percentage	146.09 %
M _{0.9D-W_nUp}	-2.27 Kn-m	Capacity	-6.29 Kn-m	Passing Percentage	277.09 %
V _{1.35D}	1.60 Kn	Capacity	12.59 Kn	Passing Percentage	786.88 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.20 Kn	Capacity	16.79 Kn	Passing Percentage	524.69 %
V _{0.9D-W_nUp}	-2.11 Kn	Capacity	-20.98 Kn	Passing Percentage	994.31 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 7.14 mm Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 8.15 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward = 3.20 kn Maximum upward = -2.11 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

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -21.73 kn > -2.11 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -2.11 Kn

Girt Design Front and Back

Girt's Spacing = 700 mm

Girt's Span = 4400 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 =0.85 S1 Downward =10.36 S1 Upward =16.20

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

Capacity Checks

$M_{Wind+Snow}$	1.30 Kn-m	Capacity	1.40 Kn-m	Passing Percentage	107.69 %
$V_{0.9D-WnUp}$	1.19 Kn-m	Capacity	10.13 Kn-m	Passing Percentage	851.26 %

Deflections

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

Deflection under Snow and Service Wind = 38.15 mm Limit by Woolcock et al, 1999 Span/100 = 44.00 mm

Sag during installation = 28.06 mm

Reactions

Maximum = 1.19 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2250 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 =0.84 S1 Downward =10.36 S1 Upward =16.38

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 _{Wind+Snow}	0.63 Kn-m	Capacity	1.39 Kn-m	Passing Percentage	220.63 %
V _{0.9D-WnUp}	1.13 Kn-m	Capacity	10.13 Kn-m	Passing Percentage	896.46 %

Deflections

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

Deflection under Snow and Service Wind = 4.85 mm Limit by Woolcock et al. 1999 Span/100 = 22.50 mm
Sag during installation = 1.92 mm

Reactions

Maximum = 1.13 kn

Middle Pole Design

Geometry

150 SED H5 HIGH DENSITY (Minimum 175 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	20729 mm ²	As	15546.6796875 mm ²
I _x	34210793 mm ⁴	Z _x	421056 mm ³
I _y	34210793 mm ⁴	Z _y	421056 mm ³
Lateral Restraint	3700 mm c/c		

Loads

Total Area over Pole = 19.8 m²

Dead	4.95 Kn	Live	4.95 Kn
Wind Down	7.33 Kn	Snow	0.00 Kn
Moment wind	7.81 Kn-m		
Phi	0.8	K8	0.54
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Peeling	Steaming	Normal	Dry Use
f _b =	49.725 MPa	f _s =	2.84 MPa
f _c =	28.125 MPa	f _p =	8.66 MPa
f _t =	29.64 MPa	E =	12874 MPa

Capacities

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PhiNcx Wind	252.61 Kn	PhiMnx Wind	9.07 Kn-m	PhiVnx Wind	35.32 Kn
PhiNcx Dead	151.57 Kn	PhiMnx Dead	5.44 Kn-m	PhiVnx Dead	21.19 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.93 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.81 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 36.89 \text{ mm} < 37.00 \text{ mm}$$

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
K ₀ =	$(1 - \sin(30)) / (1 + \sin(30))$				
K _p =	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For Middle Bay Pole

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	3000 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	7.81 Kn-m
Shear Wind =	2.60 Kn

Pile Properties

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

Checks

$$\text{Applied Forces/Capacities} = 0.97 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

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Geometry

150 SED H5 HIGH DENSITY (Minimum 175 dia. at Floor Level)	Dry Use	Height 3800 mm
Area	20729 mm ²	As 15546.6796875 mm ²
I _x	34210793 mm ⁴	Z _x 421056 mm ³
I _y	34210793 mm ⁴	Z _y 421056 mm ³
Lateral Restraint	mm c/c	

Loads

Total Area over Pole = 9.9 m²

Dead	2.48 Kn	Live	2.48 Kn
Wind Down	3.66 Kn	Snow	0.00 Kn
Moment Wind	3.91 Kn-m		
Phi	0.8	K ₈	0.52
K ₁ snow	0.8	K ₁ Dead	0.6
K ₁ wind	1		

Material

Peeling	Steaming	Normal	Dry Use
f _b =	49.725 MPa	f _s =	2.84 MPa
f _c =	28.125 MPa	f _p =	8.66 MPa
f _t =	29.64 MPa	E =	12874 MPa

Capacities

PhiN _{cx} Wind	241.00 Kn	PhiM _{nx} Wind	8.66 Kn-m	PhiV _{nx} Wind	35.32 Kn
PhiN _{cx} Dead	144.60 Kn	PhiM _{nx} Dead	5.19 Kn-m	PhiV _{nx} Dead	21.19 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.49 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.24 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 19.89 \text{ mm} < 39.90 \text{ mm}$$

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	3000 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 9.9 m²

Moment Wind = 3.91 Kn-m

Shear Wind = 1.30 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 = 0.49 < 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 = 3000 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 3.91 Kn-m

Shear Wind = 1.30 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 = 0.49 < 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(1300) x Ks(1.5) x $0.5 \times \tan(30) \times \pi \times \text{Dia of Pile}(0.6) \times \text{Height of Pile}(1300)$

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.91 Kn

Uplift on one Pile = 8.81 Kn

Uplift is ok