

Pole Shed App Ver 01 2022

Job No.: Julian & Jochen Merz, No2 Pole Building

Address: 793 Waikakaho Rd, Rarangi, New Zealand

Date: 29/10/2024

Latitude: -41.400747

Longitude: 173.846709

Elevation: 75.5 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	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	2.6 m
Wind Region	NZ2	Terrain Category	3.0	Design Wind Speed	39.66 m/s
Wind Pressure	0.94 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 Open

For roof $C_{p,i} = 0.6932$

For roof $C_{p,e}$ from 0 m To 1.25 m $C_{p,e} = -0.9762$ $p_e = -0.47$ KPa $p_{net} = -0.88$ KPa

For roof $C_{p,e}$ from 1.25 m To 2.50 m $C_{p,e} = -0.8619$ $p_e = -0.42$ KPa $p_{net} = -0.83$ KPa

For wall Windward $C_{p,i} = 0.6932$ side Wall $C_{p,i} = -0.6374$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 4.2 m $C_{p,e} = 0.7$ $p_e = 0.59$ KPa $p_{net} = 1.10$ KPa

For side wall $C_{p,e}$ from 0 m To 2.5 m $C_{p,e} =$ $p_e = -0.55$ KPa $p_{net} = -0.04$ KPa

Maximum Upward pressure used in roof member Design = 0.88 KPa

Maximum Downward pressure used in roof member Design = 0.63 KPa

Maximum Wall pressure used in Design = 1.10 KPa

Maximum Racking pressure used in Design = 1.01 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 2850 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 = 0.82 S1 Downward = 9.63 S1 Upward = 16.99

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

Capacity Checks

M _{1.35D}	0.31 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	406.45 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.06 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	158.49 %
M _{0.9D-W_nUp}	-0.6 Kn-m	Capacity	-1.71 Kn-m	Passing Percentage	247.83 %

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V _{1.35D}	0.43 Kn	Capacity	7.24 Kn	Passing Percentage	1683.72 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.19 Kn	Capacity	9.65 Kn	Passing Percentage	810.92 %
V _{0.9D-WnUp}	-0.84 Kn	Capacity	-12.06 Kn	Passing Percentage	1435.71 %

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 = 4.59 mm	Limit by Woolcock et al, 1999 Span/240 = 11.67 mm
Deflection under Dead and Service Wind = 6.23 mm	Limit by Woolcock et al, 1999 Span/100 = 28.00 mm

Reactions

Maximum downward = 1.19 kn Maximum upward = -0.84 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 = 3000 mm Internal Rafter Span = 4050 mm Try Rafter 2x250x50 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 = 6.13 S₁ Upward = 6.13

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

Capacity Checks

M _{1.35D}	2.08 Kn-m	Capacity	7 Kn-m	Passing Percentage	336.54 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	5.72 Kn-m	Capacity	9.34 Kn-m	Passing Percentage	163.29 %
M _{0.9D-WnUp}	-4.03 Kn-m	Capacity	-11.66 Kn-m	Passing Percentage	289.33 %
V _{1.35D}	2.05 Kn	Capacity	24.12 Kn	Passing Percentage	1176.59 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	5.65 Kn	Capacity	32.16 Kn	Passing Percentage	569.20 %
V _{0.9D-WnUp}	-3.98 Kn	Capacity	-40.2 Kn	Passing Percentage	1010.05 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.67 mm	Limit by Woolcock et al, 1999 Span/240 = 17.50 mm
Deflection under Dead and Service Wind = 7.045 mm	Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Reactions

Maximum downward = 5.65 kn Maximum upward = -3.98 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

$K_{11} = 2.0$ $f_{cj} = 36.1$ Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 21.67 Kn > -3.98 Kn

Rafter Design External

External Rafter Load Width = 1500 mm

External Rafter Span = 4005 mm

Try Rafter 250x50 SG8 Dry

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

K_1 Short term = 1 K_1 Medium term = 0.8 K_1 Long term = 0.6 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.97

K_8 Upward = 0.97 S_1 Downward = 12.68 S_1 Upward = 12.68

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

Capacity Checks

$M_{1.35D}$	1.02 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	333.33 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	2.80 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	161.79 %
$M_{0.9D-W_nUp}$	-1.97 Kn-m	Capacity	-5.67 Kn-m	Passing Percentage	287.82 %
$V_{1.35D}$	1.01 Kn	Capacity	12.06 Kn	Passing Percentage	1194.06 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	2.79 Kn	Capacity	16.08 Kn	Passing Percentage	576.34 %
$V_{0.9D-W_nUp}$	-1.97 Kn	Capacity	-20.10 Kn	Passing Percentage	1020.30 %

Deflections

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

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 5.19 mm

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

Deflection under Dead and Service Wind = 7.04 mm

Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Reactions

Maximum downward = 2.79 kn Maximum upward = -1.97 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

$K_{11} = 14.9 \text{ fpj} = 12.9 \text{ Mpa}$ for Rafter with effective thickness = 50 mm

For Parallel to grain loading

$K_{11} = 2.0 \text{ fcj} = 36.1 \text{ Mpa}$ for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi_i \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -19.95 kn > -1.97 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -1.97 Kn

Intermediate Design Sides

Intermediate Spacing = 2100 mm

Intermediate Span = 2350 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 1.00 S_1 Downward = 9.63 S_1 Upward = 0.49

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

Capacity Checks

$M_{\text{Wind+Snow}}$	0.80 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	525.00 %
$V_{0.9D-WnUp}$	1.36 Kn	Capacity	24.12 Kn	Passing Percentage	1773.53 %

Deflections

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

Deflection under Snow and Service Wind = 6.04 mm

Limit by Woolcock et al, 1999 Span/100 = 23.50 mm

Reactions

Maximum = 1.36 kn

Girt Design Front and Back

Girt's Spacing = 1300 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.79 S_1 Downward = 9.63 S_1 Upward = 17.59

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

Capacity Checks

$M_{\text{Wind+Snow}}$	1.61 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	102.48 %
$V_{0.9D-WnUp}$	2.15 Kn	Capacity	12.06 Kn	Passing Percentage	560.93 %

Deflections

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

Deflection under Snow and Service Wind = 16.01 mm

Limit by Woolcock et al, 1999 Span/100 = 30.00 mm

Sag during installation = 4.91 mm

Reactions

Maximum = 2.15 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2100 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 =0.91 S1 Downward =9.63 S1 Upward =14.71

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

Capacity Checks

M _{Wind+Snow}	0.79 Kn-m	Capacity	1.91 Kn-m	Passing Percentage	241.77 %
V _{0.9D-WnUp}	1.50 Kn	Capacity	12.06 Kn	Passing Percentage	804.00 %

Deflections

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

Deflection under Snow and Service Wind = 3.84 mm

Limit by Woolcock et al. 1999 Span/100 = 21.00 mm

Sag during installation =1.18 mm

Reactions

Maximum = 1.50 kn

Middle Pole Design

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	2350 mm
Area	8125 mm ²	As	6093.75 mm ²
I _x	17879232 mm ⁴	Z _x	220052 mm ³
I _y	17879232 mm ⁴	Z _y	220052 mm ³
Lateral Restraint	2350 mm c/c		

Loads

Total Area over Pole = 6.3 m²

Dead	1.57 Kn	Live	1.57 Kn
Wind Down	3.97 Kn	Snow	0.00 Kn
Moment wind	3.83 Kn-m		
Phi	0.8	K8	0.92
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

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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	107.60 Kn	PhiMnx Wind	5.88 Kn-m	PhiVnx Wind	14.43 Kn
PhiNcx Dead	64.56 Kn	PhiMnx Dead	3.53 Kn-m	PhiVnx Dead	8.66 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.72 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.49 < 1$ OK

Deflection at top under service lateral loads = 19.87 mm < 23.50 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 =	$(1 - \sin(30)) / (1 + \sin(30))$				
Kp =	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	1950 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	3.83 Kn-m
Shear Wind =	1.96 Kn

Pile Properties

Safety Factory	0.55	
Hu =	6.02 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.24 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.53 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	2350 mm
Area	8125 mm ²	As	6093.75 mm ²

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Ix	17879232 mm ⁴	Zx	220052 mm ³
Iy	17879232 mm ⁴	Zy	220052 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	3.97 Kn	Snow	0.00 Kn
Moment Wind	1.92 Kn-m		
Phi	0.8	K8	0.92
K1 snow	0.8	K1 Dead	0.6
K1 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	107.62 Kn	PhiM _{nx} Wind	5.88 Kn-m	PhiV _{nx} Wind	14.43 Kn
PhiN _{cx} Dead	64.57 Kn	PhiM _{nx} Dead	3.53 Kn-m	PhiV _{nx} Dead	8.66 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.39 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.17 < 1$ OK

Deflection at top under service lateral loads = 10.97 mm < 25.94 mm

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	1950 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 = 6.3 m²

Moment Wind =	1.92 Kn-m
Shear Wind =	0.98 Kn

Pile Properties

Safety Factory	0.55	
H _u =	6.02 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	7.24 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.26 < 1$ OK

Drained Lateral Strength of End 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 End Bay Pole

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	1950 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	1.92 Kn-m
Shear Wind =	0.98 Kn

Pile Properties

Safety Factory	0.55	
H _u =	6.02 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	7.24 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.26 < 1$ 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

K_s (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 K_s (1.5) x 0.5 x tan(30) x Pi x Dia of Pile (0.6) x Height of Pile (1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.91 Kn

Uplift on one Pile = 4.13 Kn

Uplift is ok