

Pole Shed App Ver 01 2022

Job No.: 460-788428 -
Brad0924

Address: 461 Frontier Road, Waikato 3876, New
Zealand

Date: 17/11/2024

Latitude: -38.010868

Longitude: 175.250039

Elevation: 33 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N1	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	3.6 m
Wind Region	NZ1	Terrain Category	2.27	Design Wind Speed	39.71 m/s
Wind Pressure	0.95 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 $C_{p,i} = 0.63$

For roof $C_{p,e}$ from 0 m To 3.3 m $C_{p,e} = -0.9$ $p_e = -0.71$ KPa $p_{net} = -1.31$ KPa

For roof $C_{p,e}$ from 3.3 m To 6.6 m $C_{p,e} = -0.5$ $p_e = -0.39$ KPa $p_{net} = -0.99$ KPa

For wall Windward $C_{p,i} = 0.63$ side Wall $C_{p,i} = -0.52$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 9 m $C_{p,e} = 0.7$ $p_e = 0.6$ KPa $p_{net} = 1.09$ KPa

For side wall $C_{p,e}$ from 0 m To 3.3 m $C_{p,e} =$ $p_e = -0.55$ KPa $p_{net} = -0.06$ KPa

Maximum Upward pressure used in roof member Design = 1.31 KPa

Maximum Downward pressure used in roof member Design = 0.67 KPa

Maximum Wall pressure used in Design = 1.09 KPa

Maximum Racking pressure used in Design = 1.03 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4050 mm

Try Purlin 200x50 SG8 Dry

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

Second page

Pole Shed App Ver 01 2022

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 = 11.27 S1 Upward = 16.80

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

Capacity Checks

M _{1.35D}	0.62 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	359.68 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.79 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	165.92 %
M _{0.9D-W_nUp}	-2 Kn-m	Capacity	-3.08 Kn-m	Passing Percentage	83.02 %
V _{1.35D}	0.62 Kn	Capacity	9.65 Kn	Passing Percentage	1556.45 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.77 Kn	Capacity	12.86 Kn	Passing Percentage	726.55 %
V _{0.9D-W_nUp}	-1.98 Kn	Capacity	-16.08 Kn	Passing Percentage	812.12 %

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 = 8.06 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 11.22 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 1.77 kn Maximum upward = -1.98 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 = 4200 mm Internal Rafter Span = 4350 mm Try Rafter 2x300x50 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 = 6.81 S1 Upward = 6.81

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

Capacity Checks

M _{1.35D}	3.35 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	300.90 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	9.64 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	139.42 %

Pole Shed App Ver 01 2022

M _{0.9D-WnUp}	-10.78 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	155.84 %
V _{1.35D}	3.08 Kn	Capacity	28.94 Kn	Passing Percentage	939.61 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.86 Kn	Capacity	38.6 Kn	Passing Percentage	435.67 %
V _{0.9D-WnUp}	-9.91 Kn	Capacity	-48.24 Kn	Passing Percentage	486.78 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.985 mm Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 7.705 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward = 8.86 kn Maximum upward = -9.91 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 = 100 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 = 21.67 Kn > -9.91 Kn

Rafter Design External

External Rafter Load Width = 2100 mm External Rafter Span = 4310 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

Pole Shed App Ver 01 2022

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}	1.65 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	286.06 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.73 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	133.19 %
M _{0.9D-W_nUp}	-5.29 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	148.77 %
V _{1.35D}	1.53 Kn	Capacity	14.47 Kn	Passing Percentage	945.75 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.39 Kn	Capacity	19.30 Kn	Passing Percentage	439.64 %
V _{0.9D-W_nUp}	-4.91 Kn	Capacity	-24.12 Kn	Passing Percentage	491.24 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.54 mm Limit by Woolcock et al, 1999 Span/240= 18.75 mm

Deflection under Dead and Service Wind = 7.71 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward =4.39 kn Maximum upward = -4.91 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 x k₁ x k₄ x k₅ x f_s x b x d_s (Eq 4.12) = -25.20 kn > -4.91 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.91 Kn

Intermediate Design Sides

Intermediate Spacing = 2250 mm Intermediate Span = 3300 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 =0.58

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

Capacity Checks

M _{Wind+Snow}	1.67 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	251.50 %
V _{0.9D-WnUp}	2.02 Kn	Capacity	24.12 Kn	Passing Percentage	1194.06 %

Deflections

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

Deflection under Snow and Service Wind = 24.93 mm Limit by Woolcock et al, 1999 Span/100 = 33.00 mm

Reactions

Maximum = 2.02 kn

Girt Design Front and Back

Girt's Spacing = 750 mm Girt's Span = 4200 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}	1.80 Kn-m	Capacity	1.91 Kn-m	Passing Percentage	106.11 %
V _{0.9D-WnUp}	1.72 Kn	Capacity	12.06 Kn	Passing Percentage	701.16 %

Deflections

Pole Shed App Ver 01 2022

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

Deflection under Snow and Service Wind = 35.15 mm Limit by Woolcock et al, 1999 Span/100 = 42.00 mm
Sag during installation = 18.87 mm

Reactions

Maximum = 1.72 kn

Girt Design Sides

Girt's Spacing = 1300 mm Girt's Span = 2250 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 =0.89 S1 Downward =9.63 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 _{Wind+Snow}	0.90 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	207.78 %
V _{0.9D-WnUp}	1.59 Kn	Capacity	12.06 Kn	Passing Percentage	758.49 %

Deflections

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

Deflection under Snow and Service Wind = 5.02 mm Limit by Woolcock et al. 1999 Span/100 = 22.50 mm
Sag during installation =1.55 mm

Reactions

Maximum = 1.59 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	27598 mm ²	As	20698.2421875 mm ²
I _x	60639381 mm ⁴	Z _x	646820 mm ³

Pole Shed App Ver 01 2022

Iy 60639381 mm⁴ Zx 646820 mm³
Lateral Restraint 1300 mm c/c

Loads

Total Area over Pole = 18.9 m²

Dead	4.72 Kn	Live	4.72 Kn
Wind Down	12.66 Kn	Snow	0.00 Kn
Moment wind	6.99 Kn-m		
Phi	0.8	K8	1.00
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	397.41 Kn	PhiMnx Wind	18.78 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	238.44 Kn	PhiMnx Dead	11.27 Kn-m	PhiVnx Dead	29.41 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.43 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.19 < 1$ OK

Deflection at top under service lateral loads = 20.79 mm < 33.00 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
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

Pole Shed App Ver 01 2022

L =	1300 mm	Pile embedment length
f1 =	2700 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	6.99 Kn-m
Shear Wind =	2.59 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.89 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.84 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.89 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zx	421056 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 9.45 m²

Dead	2.36 Kn	Live	2.36 Kn
Wind Down	6.33 Kn	Snow	0.00 Kn
Moment Wind	3.50 Kn-m		
Phi	0.8	K8	0.66
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Pole Shed App Ver 01 2022

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

PhiNcx Wind	195.59 Kn	PhiMnx Wind	8.01 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	117.35 Kn	PhiMnx Dead	4.81 Kn-m	PhiVnx Dead	22.09 Kn

Checks

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

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.25 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 20.05 \text{ mm} < 35.91 \text{ mm}$$

$D_s =$	0.6 mm	Pile Diameter
$L =$	1300 mm	Pile embedment length
$f_1 =$	2700 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

Loads

$$\text{Total Area over Pole} = 9.45 \text{ m}^2$$

Moment Wind =	3.50 Kn-m
Shear Wind =	1.29 Kn

Pile Properties

Safety Factor	0.55	
$H_u =$	4.89 Kn	Ultimate Lateral Strength of the Pile, Short pile
$M_u =$	7.84 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.45 < 1 \text{ OK}$$

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

$$D_s = 0.6 \text{ mm} \quad \text{Pile Diameter}$$

$$L = 1300 \text{ mm} \quad \text{Pile embedment length}$$

$$f_1 = 2700 \text{ mm} \quad \text{Distance at which the shear force is applied}$$

$$f_2 = 0 \text{ mm} \quad \text{Distance of top soil at rest pressure}$$

Loads

$$\text{Moment Wind} = 3.50 \text{ Kn-m}$$

$$\text{Shear Wind} = 1.29 \text{ Kn}$$

Pile Properties

$$\text{Safety Factor} = 0.55$$

$$H_u = 4.89 \text{ Kn} \quad \text{Ultimate Lateral Strength of the Pile, Short pile}$$

$$M_u = 7.84 \text{ Kn-m} \quad \text{Ultimate Moment Capacity of Pile}$$

Checks

$$\text{Applied Forces/Capacities} = 0.45 < 1 \text{ OK}$$

Uplift Check

$$\text{Density of Concrete} = 24 \text{ Kn/m}^3$$

$$\text{Density of Timber Pole} = 5 \text{ Kn/m}^3$$

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

$$K_s \text{ (Lateral Earth Pressure Coefficient) for cast into place concrete piles} = 1.5$$

$$\text{Formula to calculate Skin Friction} = \text{Safety factor (0.55)} \times \text{Density of Soil (18)} \times \text{Height of Pile (1300)} \times K_s (1.5) \times 0.5 \times \tan(30) \times \pi \times \text{Dia of Pile (0.6)} \times \text{Height of Pile (1300)}$$

$$\text{Skin Friction} = 13.65 \text{ Kn}$$

$$\text{Weight of Pile} + \text{Pile Skin Friction} = 17.45 \text{ Kn}$$

$$\text{Uplift on one Pile} = 20.51 \text{ Kn}$$

Uplift is ok