

Pole Shed App Ver 01 2022

Job No.: Sheryl & Barry
Thorne - 1

Address: 133 Apotu Rd, Kauri, New Zealand

Date: 10/11/2023

Latitude: -35.640736

Longitude: 174.283816

Elevation: 163 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	500 Years	Max Height	5.3 m
Wind Region	NZ1	Terrain Category	2.53	Design Wind Speed	42.84 m/s
Wind Pressure	1.1 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 = Gable Enclosed

For roof $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 5.59 m $C_{p,e} = -0.9$ $p_e = -0.82$ KPa $p_{net} = -0.82$ KPa

For roof $C_{p,e}$ from 5.59 m To 11.18 m $C_{p,e} = -0.5$ $p_e = -0.46$ KPa $p_{net} = -0.46$ 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 $C_{p,e} = 0.7$ $p_e = 0.69$ KPa $p_{net} = 1.02$ KPa

For side wall $C_{p,e}$ from 0 m To 5.59 m $C_{p,e} =$ $p_e = -0.64$ KPa $p_{net} = -0.64$ KPa

Maximum Upward pressure used in roof member Design = 0.82 KPa

Maximum Downward pressure used in roof member Design = 0.40 KPa

Maximum Wall pressure used in Design = 1.02 KPa

Maximum Racking pressure used in Design = 1.21 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4950 mm

Try Purlin 250x50 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 = 0.97

K8 Upward = 0.33 S1 Downward = 12.68 S1 Upward = 29.58

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

Capacity Checks

M _{1.35D}	0.93 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	365.59 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.19 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	206.85 %
M _{0.9D-W_nUp}	-1.64 Kn-m	Capacity	-1.94 Kn-m	Passing Percentage	118.29 %
V _{1.35D}	0.75 Kn	Capacity	12.06 Kn	Passing Percentage	1608.00 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.56 Kn	Capacity	16.08 Kn	Passing Percentage	1030.77 %
V _{0.9D-W_nUp}	-1.33 Kn	Capacity	-20.10 Kn	Passing Percentage	1511.28 %

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 = 9.29 mm Limit by Woolcock et al, 1999 Span/360 = 13.61 mm

Deflection under Dead and Service Wind = 10.84 mm Limit by Woolcock et al, 1999 Span/250 = 32.67 mm

Reactions

Maximum downward = 1.56 kn Maximum upward = -1.33 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 = 5100 mm Internal Rafter Span = 4550 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

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M _{1.35D}	4.45 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	226.52 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.24 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	145.45 %
M _{0.9D-WnUp}	-7.85 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	214.01 %
V _{1.35D}	3.92 Kn	Capacity	28.94 Kn	Passing Percentage	738.27 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.12 Kn	Capacity	38.6 Kn	Passing Percentage	475.37 %
V _{0.9D-WnUp}	-6.90 Kn	Capacity	-48.24 Kn	Passing Percentage	699.13 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 7.2 mm Limit by Woolcock et al, 1999 Span/360 = 13.06 mm

Deflection under Dead and Service Wind = 9.335 mm Limit by Woolcock et al, 1999 Span/250 = 31.33 mm

Reactions

Maximum downward = 8.12 kn Maximum upward = -6.90 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 > -6.90 Kn

Rafter Design External

External Rafter Load Width = 2550 mm External Rafter Span = 9777 mm Try Rafter 400x63 LVL11

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 =0.97 S1 Downward =12.78 S1 Upward =12.78

Shear Capacity of timber =5 MPa Bending Capacity of timber =38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	10.28 Kn-m	Capacity	28.31 Kn-m	Passing Percentage	275.39 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	21.33 Kn-m	Capacity	37.75 Kn-m	Passing Percentage	176.98 %
M _{0.9D-W_nUp}	-18.13 Kn-m	Capacity	-47.19 Kn-m	Passing Percentage	260.29 %
V _{1.35D}	4.21 Kn	Capacity	40.52 Kn	Passing Percentage	962.47 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	8.73 Kn	Capacity	54.03 Kn	Passing Percentage	618.90 %
V _{0.9D-W_nUp}	-7.42 Kn	Capacity	-67.54 Kn	Passing Percentage	910.24 %

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 23.38 mm Limit by Woolcock et al, 1999 Span/360= 26.11 mm

Deflection under Dead and Service Wind = 27.28 mm Limit by Woolcock et al, 1999 Span/250 = 62.67 mm

Reactions

Maximum downward =8.73 kn Maximum upward = -7.42 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 =J2 Joint Group for Pole = J5

Factor of Safety = 0.7

For Perpendicular to grain loading

K11 = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 63 mm

For Parallel to grain loading

K11 = 2.0 fcj = 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) = -74.97 kn > -7.42 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -7.42 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 2550 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 =0.61 S1 Downward =12.68 S1 Upward =21.34

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

Capacity Checks

$M_{Wind+Snow}$	0.75 Kn-m	Capacity	3.53 Kn-m	Passing Percentage	470.67 %
$V_{0.9D-WnUp}$	1.17 Kn-m	Capacity	20.10 Kn-m	Passing Percentage	1717.95 %

Deflections

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

Deflection under Snow and Service Wind = 1.16 mm Limit by Woolcock et al, 1999 Span/250 = 10.20 mm

Sag during installation = 2.56 mm

Reactions

Maximum = 1.17 kn

Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 4700 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 =0.65 S1 Downward =12.68 S1 Upward =20.48

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}	2.53 Kn-m	Capacity	3.77 Kn-m	Passing Percentage	149.01 %
V _{0.9D-WnUp}	2.16 Kn-m	Capacity	20.10 Kn-m	Passing Percentage	930.56 %

Deflections

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

Deflection under Snow and Service Wind = 13.37 mm Limit by Woolcock et al. 1999 Span/100 = 18.80 mm
Sag during installation = 29.59 mm

Reactions

Maximum = 2.16 kn

Middle Pole Design

Geometry

225 SED H5 HIGH DENSITY (Minimum 250 dia. at Floor Level) Dry Use		Height 5000 mm	
Area	44279 mm ²	As	33209.1796875 mm ²
I _x	156100441 mm ⁴	Z _x	1314530 mm ³
I _y	156100441 mm ⁴	Z _y	1314530 mm ³
Lateral Restraint	5000 mm c/c		

Loads

Total Area over Pole = 23.97 m²

Dead	5.99 Kn	Live	5.99 Kn
Wind Down	9.59 Kn	Snow	0.00 Kn
Moment wind	21.61 Kn-m		
Phi	0.8	K ₈	0.62
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

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PhiNcx Wind	616.79 Kn	PhiMnx Wind	32.37 Kn-m	PhiVnx Wind	75.45 Kn
PhiNcx Dead	370.07 Kn	PhiMnx Dead	19.42 Kn-m	PhiVnx Dead	45.27 Kn

Checks

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

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.48 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 40.05 \text{ mm} < 33.33 \text{ mm}$$

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 =	1800 mm	Pile embedment length
f ₁ =	3975 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	21.61 Kn-m
Shear Wind =	5.44 Kn

Pile Properties

Safety Factory	0.55	
H _u =	9.00 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	21.10 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 1.02 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Pole Shed App Ver 01 2022

Geometry

225 SED H5 HIGH DENSITY (Minimum 250 dia. at Floor Level) Dry Use		Height 5100 mm	
Area	44279 mm ²	As	33209.1796875 mm ²
Ix	156100441 mm ⁴	Zx	1314530 mm ³
Iy	156100441 mm ⁴	Zy	1314530 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 23.97 m²

Dead	5.99 Kn	Live	5.99 Kn
Wind Down	9.59 Kn	Snow	0.00 Kn
Moment Wind	16.21 Kn-m		
Phi	0.8	K8	0.60
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Peeling	Steaming	Normal	Dry Use
fb =	49.725 MPa	fs =	2.84 MPa
fc =	28.125 MPa	fp =	8.66 MPa
ft =	29.64 MPa	E =	12874 MPa

Capacities

PhiNcx Wind	597.32 Kn	PhiMnx Wind	31.35 Kn-m	PhiVnx Wind	75.45 Kn
PhiNcx Dead	358.39 Kn	PhiMnx Dead	18.81 Kn-m	PhiVnx Dead	45.27 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.55 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.30 < 1$ OK

Deflection at top under service lateral loads = 31.76 mm < 35.24 mm

Ds =	0.6 mm	Pile Diameter
L =	1800 mm	Pile embedment length
f1 =	3975 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 23.97 m²

Moment Wind = 16.21 Kn-m

Shear Wind = 4.08 Kn

Pile Properties

Safety Factory 0.55

Hu = 9.00 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 21.10 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.77 < 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 = 1800 mm Pile embedment length

f1 = 3975 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 16.21 Kn-m

Shear Wind = 4.08 Kn

Pile Properties

Safety Factory 0.55

Hu = 9.00 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 21.10 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.77 < 1$ OK

Uplift Check

Density of Concrete = 24 Kn/m^3

Density of Timber Pole = 5 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 (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(1800) x K_s (1.5) x $0.5 \times \tan(30) \times \pi \times \text{Dia of Pile}(0.6) \times \text{Height of Pile}(1800)$

Skin Friction = 26.17 Kn

Weight of Pile + Pile Skin Friction = 30.29 Kn

Uplift on one Pile = 14.26 Kn

Uplift is ok