

Job No.: 511-5024293**Address:** 371 Racecourse Rd, Ashburton, New Zealand**Date:** 15/07/2024**Latitude:** -43.866872**Longitude:** 171.737283**Elevation:** 116.5 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N4	Ground Snow Load	0.9 KPa	Roof Snow Load	0.63 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.9 m
Wind Region	NZ2	Terrain Category	2.02	Design Wind Speed	38.15 m/s
Wind Pressure	0.87 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 = Gable Enclosed

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

For roof $C_{p,e}$ from 0 m To 4.9 m $C_{p,e} = -0.9$ $p_e = -0.68$ KPa $p_{net} = -0.68$ KPa

For roof $C_{p,e}$ from 4.90 m To 9.80 m $C_{p,e} = -0.5$ $p_e = -0.38$ KPa $p_{net} = -0.38$ 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 18 m $C_{p,e} = 0.7$ $p_e = 0.55$ KPa $p_{net} = 0.81$ KPa

For side wall $C_{p,e}$ from 0 m To 4.90 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = -0.51$ KPa

Maximum Upward pressure used in roof member Design = 0.68 KPa

Maximum Downward pressure used in roof member Design = 0.33 KPa

Maximum Wall pressure used in Design = 0.81 KPa

Maximum Racking pressure used in Design = 0.86 KPa

Design Summary**Purlin Design**

Purlin Spacing = 800 mm

Purlin Span = 3850 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 = 0.68 S1 Downward = 9.63 S1 Upward = 19.79

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

Capacity Checks

M _{1.35D}	0.5 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	252.00 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.5 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	112.00 %
M _{0.9D-W_nUp}	-0.67 Kn-m	Capacity	-1.43 Kn-m	Passing Percentage	162.50 %
V _{1.35D}	0.52 Kn	Capacity	7.24 Kn	Passing Percentage	1392.31 %

Pole Shed App Ver 01 2022

V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.43 Kn	Capacity	9.65 Kn	Passing Percentage	674.83 %
V _{0.9D-WnUp}	-0.70 Kn	Capacity	-12.06 Kn	Passing Percentage	1722.86 %

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 = 13.83 mm Limit by Woolcock et al, 1999 Span/240 = 15.83 mm

Deflection under Dead and Service Wind = 15.33 mm Limit by Woolcock et al, 1999 Span/100 = 38.00 mm

Reactions

Maximum downward = 1.43 kn Maximum upward = -0.70 kn

Number of Blocking = 0 if 0 then no blocking required, if 1 then one midspan blocking required

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 6214 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}	3.26 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	144.79 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.98 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	70.16 %
M _{0.9D-WnUp}	-4.39 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	179.27 %
V _{1.35D}	2.10 Kn	Capacity	14.47 Kn	Passing Percentage	689.05 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	5.78 Kn	Capacity	19.30 Kn	Passing Percentage	333.91 %
V _{0.9D-WnUp}	-2.83 Kn	Capacity	-24.12 Kn	Passing Percentage	852.30 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 16.67 mm Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 18.47 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 5.78 kn Maximum upward = -2.83 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

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

For Parallel to grain loading

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

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots (\text{Eq 4.12}) = -25.20 \text{ kn} > -2.83 \text{ Kn}$

Single Shear Capacity under short term loads = -10.84 Kn > -2.83 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4000 mm

Try Girt 200x50 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 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.50 S_1 Downward = 11.27 S_1 Upward = 23.76

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

Capacity Checks

$M_{\text{Wind+Snow}}$	1.46 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	128.08 %
$V_{0.9D-WnUp}$	1.46 Kn	Capacity	16.08 Kn	Passing Percentage	1101.37 %

Deflections

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

Deflection under Snow and Service Wind = 19.34 mm

Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Sag during installation = 15.52 mm

Reactions

Maximum = 1.46 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 3000 mm

Try Girt 200x50 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 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.64 S_1 Downward = 11.27 S_1 Upward = 20.58

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

Capacity Checks

$M_{\text{Wind+Snow}}$	1.18 Kn-m	Capacity	2.40 Kn-m	Passing Percentage	203.39 %
$V_{0.9D-WnUp}$	1.58 Kn	Capacity	16.08 Kn	Passing Percentage	1017.72 %

Deflections

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

Deflection under Snow and Service Wind = 8.84 mm

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

Sag during installation = 4.91 mm

Reactions

Maximum = 1.58 kn

Middle Pole Design

Geometry

300 SED H5 (Minimum 325 dia. at Floor Level)	Dry Use	Height	4050 mm
Area	76660 mm ²	As	57495.1171875 mm ²
I _x	467896461 mm ⁴	Z _x	2994537 mm ³
I _y	467896461 mm ⁴	Z _y	2994537 mm ³
Lateral Restraint	4050 mm c/c		

Loads

Total Area over Pole = 36 m²

Dead	9.00 Kn	Live	9.00 Kn
Wind Down	11.88 Kn	Snow	22.68 Kn
Moment wind	15.45 Kn-m	Moment snow	4.40 Kn-m
Phi	0.8	K ₈	0.97
K ₁ snow	0.8	K ₁ Dead	0.6
K ₁ 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 _c Wind	1065.27 Kn	PhiM _n Wind	83.92 Kn-m	PhiV _n Wind	136.15 Kn
PhiN _c Dead	639.16 Kn	PhiM _n Dead	50.35 Kn-m	PhiV _n Dead	81.69 Kn
PhiN _c Snow	852.22 Kn	PhiM _n Snow	67.13 Kn-m	PhiV _n Snow	108.92 Kn

Checks

$$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.23 < 1 \text{ OK}$$

$$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.08 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 9.94 mm < 40.50 mm

Drained Lateral Strength of Middle pile in cohesionless soils Free Head short pile

Assumed Soil Properties

Pole Shed App Ver 01 2022

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
L =	1650 mm	Pile embedment length
f1 =	3675 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	15.45 Kn-m	Moment Snow =	Kn-m
Shear Wind =	4.20 Kn	Shear Snow =	4.40 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.52 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	16.28 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.95 < 1$ OK

End Pole Design

Geometry For End Bay Pole

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	4600 mm
Area	35448 mm ²	As	26585.7421875 mm ²
Ix	100042702 mm ⁴	Zx	941578 mm ³
Iy	100042702 mm ⁴	Zy	941578 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 12 m²

Dead	3.00 Kn	Live	3.00 Kn
Wind Down	3.96 Kn	Snow	7.56 Kn
Moment Wind	3.86 Kn-m	Moment snow	1.10 Kn-m
Phi	0.8	K8	0.59
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

Peeling	Steaming	Normal	Dry Use
fb =	36.3 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa

Pole Shed App Ver 01 2022

ft = 22 MPa E = 9257 MPa

Capacities

PhiNcx Wind	301.95 Kn	PhiMnx Wind	16.17 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	181.17 Kn	PhiMnx Dead	9.70 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	241.56 Kn	PhiMnx Snow	12.94 Kn-m	PhiVnx Snow	50.36 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.29 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.11 < 1$ OK

Deflection at top under service lateral loads = 14.03 mm < 48.88 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3675 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 12 m²

Moment Wind =	3.86 Kn-m	Moment Snow =	1.10 Kn-m
Shear Wind =	1.05 Kn	Shear Snow =	1.10 Kn

Pile Properties

Safety Factor	0.55	
Hu =	3.93 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.37 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.46 < 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
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 =	3675 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	3.86 Kn-m	Moment Snow =	1.10 Kn-m
---------------	-----------	---------------	-----------

Shear Wind = 1.05 Kn Shear Snow = 1.10 Kn

Pile Properties

Safety Factory 0.55
Hu = 3.93 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 8.37 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.46 < 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 = 24.48 Kn

Uplift on one Pile = 16.38 Kn

Uplift is ok