

Pole Shed App Ver 01 2022

Job No.: 210 Waitekauri Road **Address:** 210 Waitekauri Road, Waihi, New Zealand **Date:** 04/12/2024
Waihi

Latitude: -37.397444 **Longitude:** 175.783616 **Elevation:** 87.5 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	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ1	Terrain Category	2.54	Design Wind Speed	38.75 m/s
Wind Pressure	0.9 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 1.85 m $C_{p,e} = -0.9625$ $p_e = -0.78$ KPa $p_{net} = -0.78$ KPa

For roof $C_{p,e}$ from 1.85 m To 3.70 m $C_{p,e} = -0.8688$ $p_e = -0.70$ KPa $p_{net} = -0.70$ 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 6.40 m $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 0.84$ KPa

For side wall $C_{p,e}$ from 0 m To 3.70 m $C_{p,e} =$ $p_e = -0.53$ KPa $p_{net} = -0.53$ KPa

Maximum Upward pressure used in roof member Design = 0.78 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 0.84 KPa

Maximum Racking pressure used in Design = 0.98 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4050 mm

Try Purlin 190x45 SG8

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

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K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.98

K8 Upward = 0.43 S1 Downward = 12.23 S1 Upward = 25.78

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	1.79 Kn-m	Passing Percentage	288.71 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.67 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	142.51 %
M _{0.9D-WnUp}	-1.02 Kn-m	Capacity	-1.32 Kn-m	Passing Percentage	129.41 %
V _{1.35D}	0.62 Kn	Capacity	8.25 Kn	Passing Percentage	1330.65 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.33 Kn	Capacity	11.00 Kn	Passing Percentage	827.07 %
V _{0.9D-WnUp}	-1.01 Kn	Capacity	-13.75 Kn	Passing Percentage	1361.39 %

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 = 10.44 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 12.45 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 1.33 kn Maximum upward = -1.01 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 = 4200 mm Internal Rafter Span = 6250 mm Try Rafter 2x240x63 LVL13

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 = 4.59 S1 Upward = 4.59

Shear Capacity of timber = 5.3 MPa Bending Capacity of timber = 48 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	6.92 Kn-m	Capacity	27.86 Kn-m	Passing Percentage	402.60 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	14.97 Kn-m	Capacity	37.16 Kn-m	Passing Percentage	248.23 %

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M _{0.9D-WnUp}	-11.38 Kn-m	Capacity	-46.44 Kn-m	Passing Percentage	408.08 %
V _{1.35D}	4.43 Kn	Capacity	51.54 Kn	Passing Percentage	1163.43 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.58 Kn	Capacity	68.72 Kn	Passing Percentage	717.33 %
V _{0.9D-WnUp}	-7.28 Kn	Capacity	-85.9 Kn	Passing Percentage	1179.95 %

Deflections

Modulus of Elasticity = 11000 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 15.515 mm Limit by Woolcock et al, 1999 Span/240 = 26.67 mm

Deflection under Dead and Service Wind = 20.545 mm Limit by Woolcock et al, 1999 Span/100 = 64.00 mm

Reactions

Maximum downward = 9.58 kn Maximum upward = -7.28 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

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 126 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 = 29.11 Kn > -7.28 Kn

Rafter Design External

External Rafter Load Width = 2100 mm External Rafter Span = 3014 mm Try Rafter 190x45 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 K₁ Medium term = 0.8 K₁ Long term = 0.6 K₄ = 1 K₅ = 1 K₈ Downward = 0.98

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K8 Upward =0.98 S1 Downward =12.23 S1 Upward =12.23

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

Capacity Checks

M _{1.35D}	0.80 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	223.75 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.74 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	136.78 %
M _{0.9D-W_nUp}	-1.32 Kn-m	Capacity	-2.98 Kn-m	Passing Percentage	225.76 %
V _{1.35D}	1.07 Kn	Capacity	8.25 Kn	Passing Percentage	771.03 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.31 Kn	Capacity	11.00 Kn	Passing Percentage	476.19 %
V _{0.9D-W_nUp}	-1.76 Kn	Capacity	-13.75 Kn	Passing Percentage	781.25 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 6.19 mm Limit by Woolcock et al, 1999 Span/240= 13.33 mm

Deflection under Dead and Service Wind = 7.38 mm Limit by Woolcock et al, 1999 Span/100 = 32.00 mm

Reactions

Maximum downward =2.31 kn Maximum upward = -1.76 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 x k₁ x k₄ x k₅ x f_s x b x d_s (Eq 4.12) = -12.28 kn > -1.76 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -1.76 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2100 mm Intermediate Span = 3850 mm Try Intermediate 2x140x45 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 =1.00 S1 Downward =10.36 S1 Upward =0.68

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

Capacity Checks

M _{Wind+Snow}	3.27 Kn-m	Capacity	3.3 Kn-m	Passing Percentage	100.92 %
V _{0.9D-WnUp}	3.40 Kn	Capacity	-20.26 Kn	Passing Percentage	595.88 %

Deflections

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

Deflection under Snow and Service Wind = 45.41 mm Limit by Woolcock et al, 1999 Span/100 = 38.50 mm

Reactions

Maximum = 3.40 kn

Intermediate Design Sides

Intermediate Spacing = 1600 mm Intermediate Span = 3700 mm Try Intermediate 2x190x45 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 =0.98

K8 Upward =1.00 S1 Downward =12.23 S1 Upward =0.78

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

Capacity Checks

M _{Wind+Snow}	1.15 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	526.96 %
V _{0.9D-WnUp}	1.24 Kn	Capacity	27.5 Kn	Passing Percentage	2217.74 %

Deflections

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

Deflection under Snow and Service Wind = 11.805 mm Limit by Woolcock et al, 1999 Span/100 = 37.00 mm

Reactions

Maximum = 1.24 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2100 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 = 0.87 S1 Downward = 10.36 S1 Upward = 15.83

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

Capacity Checks

M _{Wind+Snow}	0.60 Kn-m	Capacity	1.43 Kn-m	Passing Percentage	238.33 %
V _{0.9D-WnUp}	1.15 Kn	Capacity	10.13 Kn	Passing Percentage	880.87 %

Deflections

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

Deflection under Snow and Service Wind = 4.01 mm Limit by Woolcock et al, 1999 Span/100 = 21.00 mm

Sag during installation = 1.46 mm

Reactions

Maximum = 1.15 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 1600 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 = 0.94 S1 Downward = 10.36 S1 Upward = 13.82

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

Capacity Checks

$M_{Wind+Snow}$	0.35 Kn-m	Capacity	1.55 Kn-m	Passing Percentage	442.86 %
$V_{0.9D-WnUp}$	0.87 Kn	Capacity	10.13 Kn	Passing Percentage	1164.37 %

Deflections

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

Deflection under Snow and Service Wind = 1.35 mm Limit by Woolcock et al. 1999 Span/100 = 16.00 mm
Sag during installation = 0.49 mm

Reactions

Maximum = 0.87 kn

Middle Pole Design

Geometry

225 UNI H5	Dry Use	Height	3700 mm
Area	39741 mm ²	As	29805.46875 mm ²
Ix	125741821 mm ⁴	Zx	1117705 mm ³
Iy	125741821 mm ⁴	Zy	1117705 mm ³
Lateral Restraint	3700 mm c/c		

Loads

Total Area over Pole = 13.44 m²

Dead	3.36 Kn	Live	3.36 Kn
Wind Down	5.78 Kn	Snow	0.00 Kn
Moment wind	12.32 Kn-m		
Phi	0.8	K8	0.84
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Shaving	Steaming	Normal	Dry Use
$f_b =$	34.325 MPa	$f_s =$	2.96 MPa
$f_c =$	18 MPa	$f_p =$	7.2 MPa

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ft = 20.75 MPa

E = 8793 MPa

Capacities

PhiNcx Wind	480.87 Kn	PhiMnx Wind	25.79 Kn-m	PhiVnx Wind	70.58 Kn
PhiNcx Dead	288.52 Kn	PhiMnx Dead	15.47 Kn-m	PhiVnx Dead	42.35 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.50 < 1$ OK

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

Deflection at top under service lateral loads = 23.17 mm < 37.00 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 =	1600 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 =	12.32 Kn-m
Shear Wind =	4.11 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.93 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	14.27 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.86 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

200 UNI H5	Dry Use	Height	3800 mm
Area	31400 mm ²	As	23550 mm ²
Ix	78500000 mm ⁴	Zx	785000 mm ³
Iy	78500000 mm ⁴	Zx	785000 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 6.72 m²

Dead	1.68 Kn	Live	1.68 Kn
Wind Down	2.89 Kn	Snow	0.00 Kn
Moment Wind	4.11 Kn-m		
Phi	0.8	K8	0.72
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Shaving	Steaming	Normal	Dry Use
fb =	34.325 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	20.75 MPa	E =	8793 MPa

Capacities

PhiNcx Wind	325.30 Kn	PhiMnx Wind	15.51 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	195.18 Kn	PhiMnx Dead	9.31 Kn-m	PhiVnx Dead	33.46 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.28 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.09 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 13.34 \text{ mm} < 39.90 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length

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f1 = 3000 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Total Area over Pole = 6.72 m²

Moment Wind = 4.11 Kn-m
Shear Wind = 1.37 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 = 0.51 < 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 = 4.11 Kn-m
Shear Wind = 1.37 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 = 0.51 < 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(1600) x Ks(1.5) x $0.5 \times \tan(30)$ x Pi x Dia of Pile(0.6) x Height of Pile(1600)

Skin Friction = 20.68 Kn

Weight of Pile + Pile Skin Friction = 24.58 Kn

Uplift on one Pile = 7.46 Kn

Uplift is ok