

Pole Shed App Ver 01 2022

Job No.: Fabians Road

Address: 289 Fabians Rd, Greytown, New Zealand

Date: 10/3/2023

Latitude: -41.119218

Longitude: 175.469349

Elevation: 50.5 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	5.213 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	40.71 m/s
Wind Pressure	0.99 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 2.33 m $C_{p,e} = -1.0326$ $p_e = -0.81$ KPa $p_{net} = -0.81$ KPa

For roof $C_{p,e}$ from 2.33 m To 4.66 m $C_{p,e} = -0.8337$ $p_e = -0.66$ KPa $p_{net} = -0.66$ 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 10.50 m $C_{p,e} = 0.7$ $p_e = 0.63$ KPa $p_{net} = 0.93$ KPa

For side wall $C_{p,e}$ from 0 m To 4.66 m $C_{p,e} =$ $p_e = -0.58$ KPa $p_{net} = -0.58$ KPa

Maximum Upward pressure used in roof member Design = 0.81 KPa

Maximum Downward pressure used in roof member Design = 0.18 KPa

Maximum Wall pressure used in Design = 0.93 KPa

Maximum Racking pressure used in Design = 0.99 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3350 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 = 0.75 S1 Downward = 9.63 S1 Upward = 18.44

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

Capacity Checks

M _{1.35D}	0.43 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	293.02 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.3 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	129.23 %
M _{0.9D-W_nUp}	-0.74 Kn-m	Capacity	-1.57 Kn-m	Passing Percentage	212.16 %
V _{1.35D}	0.51 Kn	Capacity	7.24 Kn	Passing Percentage	1419.61 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.40 Kn	Capacity	9.65 Kn	Passing Percentage	689.29 %
V _{0.9D-W_nUp}	-0.88 Kn	Capacity	-12.06 Kn	Passing Percentage	1370.45 %

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 = 8.85 mm Limit by Woolcock et al, 1999 Span/240 = 13.75 mm

Deflection under Dead and Service Wind = 8.70 mm Limit by Woolcock et al, 1999 Span/100 = 33.00 mm

Reactions

Maximum downward = 1.40 kn Maximum upward = -0.88 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 = 3500 mm Internal Rafter Span = 5100 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}	3.84 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	262.50 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.58 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	127.03 %
M _{0.9D-WnUp}	-6.66 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	252.25 %
V _{1.35D}	3.01 Kn	Capacity	28.94 Kn	Passing Percentage	961.46 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.30 Kn	Capacity	38.6 Kn	Passing Percentage	465.06 %
V _{0.9D-WnUp}	-5.22 Kn	Capacity	-48.24 Kn	Passing Percentage	924.14 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 7.695 mm Limit by Woolcock et al, 1999 Span/240 = 21.88 mm

Deflection under Dead and Service Wind = 8.405 mm Limit by Woolcock et al, 1999 Span/100 = 52.50 mm

Reactions

Maximum downward = 8.30 kn Maximum upward = -5.22 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 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 21.67 Kn > -5.22 Kn

Rafter Design External

External Rafter Load Width = 1750 mm External Rafter Span = 5131 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)

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K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.94

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}	1.94 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	243.30 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	5.36 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	117.54 %
M _{0.9D-W_{nUp}}	-3.37 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	233.53 %
V _{1.35D}	1.52 Kn	Capacity	14.47 Kn	Passing Percentage	951.97 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	4.18 Kn	Capacity	19.30 Kn	Passing Percentage	461.72 %
V _{0.9D-W_{nUp}}	-2.63 Kn	Capacity	-24.12 Kn	Passing Percentage	917.11 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 8.55 mm Limit by Woolcock et al, 1999 Span/240 = 21.88 mm

Deflection under Dead and Service Wind = 8.41 mm Limit by Woolcock et al, 1999 Span/100 = 52.50 mm

Reactions

Maximum downward = 4.18 kn Maximum upward = -2.63 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts =

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 = $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$ (Eq 4.12) = -25.20 kn > -2.63 Kn

Single Shear Capacity under short term loads = -0.00 Kn > -2.63 Kn

Girt Design Front and Back

Girt's Spacing = 0 mm

Girt's Span = 1750 mm

Try Girt SG8 Dry

Moisture Condition = Wet (Moisture in timber is less than 18% and timber does not remain in continuous wet condition after installation)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =NaN

K8 Upward =NaN S1 Downward =NaN S1 Upward =NaN

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

Capacity Checks

M _{Wind+Snow}	0.00 Kn-m	Capacity	NaN Kn-m	Passing Percentage	NaN %
V _{0.9D-WnUp}	0.00 Kn-m	Capacity	0.00 Kn-m	Passing Percentage	NaN %

Deflections

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

Deflection under Snow and Service Wind = NaN mm Limit by Woolcock et al, 1999 Span/100 = 17.50 mm
Sag during installation = NaN mm

Reactions

Maximum = 0.00 kn

Girt Design Sides

Girt's Spacing = 0 mm

Girt's Span = 2625 mm

Try Girt SG8 Dry

Moisture Condition = Wet (Moisture in timber is less than 18% and timber does not remain in continuous wet condition after installation)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =NaN

K8 Upward =NaN S1 Downward =NaN S1 Upward =NaN

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

Capacity Checks

M _{Wind+Snow}	0.00 Kn-m	Capacity	NaN Kn-m	Passing Percentage	NaN %
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V_{0.9D-WnUp} 0.00 Kn-m Capacity 0.00 Kn-m Passing Percentage NaN %

Deflections

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

Deflection under Snow and Service Wind = NaN mm Limit by Woolcock et al. 1999 Span/100 = 26.25 mm

Sag during installation = NaN mm

Reactions

Maximum = 0.00 kn

Middle Pole Design

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	4900 mm
Area	35448 mm ²	As	26585.7421875 mm ²
I _x	100042702 mm ⁴	Z _x	941578 mm ³
I _y	100042702 mm ⁴	Z _y	941578 mm ³
Lateral Restraint	4900 mm c/c		

Loads

Total Area over Pole = 18.375 m²

Dead	4.59 Kn	Live	4.59 Kn
Wind Down	3.31 Kn	Snow	11.58 Kn
Moment wind	11.74 Kn-m	Moment snow	2.73 Kn-m
Phi	0.8	K ₈	0.53
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 _{Cx} Wind	270.32 Kn	PhiM _{Nx} Wind	14.48 Kn-m	PhiV _{Nx} Wind	62.96 Kn
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PhiNcx Dead	162.19 Kn	PhiMnx Dead	8.69 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	216.26 Kn	PhiMnx Snow	11.58 Kn-m	PhiVnx Snow	50.36 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.90 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.74 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 45.50 \text{ mm} < 49.00 \text{ mm}$$

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
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 =	1500 mm	Pile embedment length
f1 =	3910 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	11.74 Kn-m	Moment Snow =	Kn-m
Shear Wind =	3.00 Kn	Shear Snow =	2.73 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.56 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	12.65 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.93 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

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Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	4913 mm
Area	35448 mm ²	As	26585.7421875 mm ²
I _x	100042702 mm ⁴	Z _x	941578 mm ³
I _y	100042702 mm ⁴	Z _y	941578 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 9.1875 m²

Dead	2.30 Kn	Live	2.30 Kn
Wind Down	1.65 Kn	Snow	5.79 Kn
Moment Wind	5.87 Kn-m	Moment snow	1.36 Kn-m
Phi	0.8	K ₈	0.53
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 _{cx} Wind	269.18 Kn	PhiM _{nx} Wind	14.42 Kn-m	PhiV _{nx} Wind	62.96 Kn
PhiN _{cx} Dead	161.51 Kn	PhiM _{nx} Dead	8.65 Kn-m	PhiV _{nx} Dead	37.77 Kn
PhiN _{cx} Snow	215.34 Kn	PhiM _{nx} Snow	11.54 Kn-m	PhiV _{nx} Snow	50.36 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.45 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.21 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 24.14 mm < 52.00 mm

D _s =	0.6 mm	Pile Diameter
L =	1400 mm	Pile embedment length
f _l =	3910 mm	Distance at which the shear force is applied

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f2 = 0 mm Distance of top soil at rest pressure

Loads

Total Area over Pole = 9.1875 m²

Moment Wind =	5.87 Kn-m	Moment Snow =	1.36 Kn-m
Shear Wind =	1.50 Kn	Shear Snow =	1.36 Kn

Pile Properties

Safety Factory	0.55		
Hu =	4.60 Kn	Ultimate Lateral Strength of the Pile, Short pile	
Mu =	10.42 Kn-m	Ultimate Moment Capacity of Pile	

Checks

Applied Forces/Capacities = 0.56 < 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 =	1400 mm	Pile embedment length
f1 =	3910 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	5.87 Kn-m	Moment Snow =	1.36 Kn-m
Shear Wind =	1.50 Kn	Shear Snow =	1.36 Kn

Pile Properties

Safety Factory	0.55		
Hu =	4.60 Kn	Ultimate Lateral Strength of the Pile, Short pile	
Mu =	10.42 Kn-m	Ultimate Moment Capacity of Pile	

Checks

Applied Forces/Capacities = $0.56 < 1$ 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(1500) x $K_s(1.5)$ x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1500)

Skin Friction = 18.17 Kn

Weight of Pile + Pile Skin Friction = 22.07 Kn

Uplift on one Pile = 10.75 Kn

Uplift is ok