Pole Shed App Ver 01 2022

Job No.: EHB 80	**Address:** 409 West Plain Road, Invercargill, New Zealand	**Date:** 10/11/2023
Latitude: -46.369645	**Longitude:** 168.300226	**Elevation:** 8 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N5	Ground Snow Load	0.9 KPa	Roof Snow Load	0.63 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3 m
Wind Region	NZ4	Terrain Category	2.0	Design Wind Speed	42.77 m/s
Wind Pressure	1.1 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 Cp,i = -0.3

For roof CP,e from 0 m To 1.38 m Cpe = -1.0238 pe = -1.01 KPa pnet = -1.01 KPa

For roof CP,e from 1.38 m To 2.75 m Cpe = -0.8381 pe = -0.83 KPa pnet = -0.83 KPa

For wall Windward Cp,i = -0.3 side Wall Cp,i = -0.3

For wall Windward and Leeward CP,e from 0 m To 4.20 m Cpe = 0.7 pe = 0.69 KPa pnet = 1.02 KPa

For side wall CP,e from 0 m To 2.75 m Cpe = pe = -0.64 KPa pnet = -0.64 KPa

Maximum Upward pressure used in roof member Design = 1.01 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 1.02 KPa

Maximum Racking pressure used in Design = 0.94 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 3450 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 =0.73   S1 Downward =9.63   S1 Upward =18.72

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

Capacity Checks

$M_{1.35D}$	0.45 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	**280.00 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.35 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	**124.44 %**
$M_{0.9D-WnUp}$	-1.05 Kn-m	Capacity	-1.54 Kn-m	Passing Percentage	**146.67 %**
$V_{1.35D}$	0.52 Kn	Capacity	7.24 Kn	Passing Percentage	**1392.31 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.44 Kn	Capacity	9.65 Kn	Passing Percentage	**670.14 %**
$V_{0.9D-WnUp}$	-1.22 Kn	Capacity	-12.06 Kn	Passing Percentage	**988.52 %**

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 = 9.97 mm	Limit by Woolcock et al, 1999 Span/240 = 14.17 mm
Deflection under Dead and Service Wind = 11.88 mm	Limit by Woolcock et al, 1999 Span/100 = 34.00 mm

Reactions

Maximum downward =1.44 kn   Maximum upward = -1.22 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 = 3600 mm   Internal Rafter Span = 4050 mm   Try Rafter 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   K1 Medium term = 0.8   K1 Long term = 0.6   K4 =1   K5 =1   K8 Downward =1.00

K8 Upward =1.00   S1 Downward =4.28   S1 Upward =4.28

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

Capacity Checks

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$M_{1.35D}$	2.49 Kn-m	Capacity	2.52 Kn-m	Passing Percentage	**101.20 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	6.86 Kn-m	Capacity	3.36 Kn-m	Passing Percentage	**48.98 %**
$M_{0.9D-WnUp}$	-5.79 Kn-m	Capacity	-4.2 Kn-m	Passing Percentage	**72.54 %**
$V_{1.35D}$	2.46 Kn	Capacity	14.48 Kn	Passing Percentage	**588.62 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	6.78 Kn	Capacity	19.3 Kn	Passing Percentage	**284.66 %**
$V_{0.9D-WnUp}$	-5.72 Kn	Capacity	-24.12 Kn	Passing Percentage	**421.68 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 25.93 mm   Limit by Woolcock et al, 1999 Span/240 = 17.50 mm
Deflection under Dead and Service Wind = 34.335 mm   Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Reactions

Maximum downward =6.78 kn   Maximum upward = -5.72 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 > -5.72 Kn

Rafter Design External

External Rafter Load Width = 1800 mm   External Rafter Span = 4031 mm   Try Rafter 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 =1.00 S1 Downward =9.63 S1 Upward =9.63

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

Capacity Checks

$M_{1.35D}$	1.23 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	**102.44 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	3.40 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	**49.41 %**
$M_{0.9D-WnUp}$	-2.87 Kn-m	Capacity	-2.10 Kn-m	Passing Percentage	**73.17 %**
$V_{1.35D}$	1.22 Kn	Capacity	7.24 Kn	Passing Percentage	**593.44 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	3.37 Kn	Capacity	9.65 Kn	Passing Percentage	**286.35 %**
$V_{0.9D-WnUp}$	-2.85 Kn	Capacity	-12.06 Kn	Passing Percentage	**423.16 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 28.81 mm	Limit by Woolcock et al, 1999 Span/240= 17.50 mm
Deflection under Dead and Service Wind = 34.33 mm	Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Reactions

Maximum downward =3.37 kn Maximum upward = -2.85 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 fpj = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

K11 = 2.0 fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

V = phi x k1 x k4 x k5 x fs x b x ds .... (Eq 4.12) = -9.45 kn > -2.85 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.85 Kn

Intermediate Design Sides

Intermediate Spacing = 2100 mm   Intermediate Span = 2596 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 =0.52

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	4.2 Kn-m	Passing Percentage	**466.67 %**
$V_{0.9D-WnUp}$	1.39 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	**1735.25 %**

Deflections

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

Deflection under Snow and Service Wind = 15.695 mm   Limit by Woolcock et al, 1999 Span/100 = 25.96 mm

Reactions

Maximum = 1.39 kn

Girt Design Front and Back

Girt's Spacing = 800 mm   Girt's Span = 3600 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 =0.71   S1 Downward =9.63   S1 Upward =19.27

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

Capacity Checks

$M_{Wind+Snow}$	1.32 Kn-m	Capacity	1.48 Kn-m	Passing Percentage	**112.12 %**

$V_{0.9D\text{-}WnUp}$	1.47 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	**820.41 %**

Deflections

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

Deflection under Snow and Service Wind = 30.64 mm Limit by Woolcock et al, 1999 Span/100 = 36.00 mm
Sag during installation = 10.18 mm

Reactions

Maximum = 1.47 kn

Girt Design Sides

Girt's Spacing = 1300 mm Girt's Span = 2100 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

$M_{Wind+Snow}$	0.73 Kn-m	Capacity	1.91 Kn-m	Passing Percentage	**261.64 %**
$V_{0.9D\text{-}WnUp}$	1.39 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	**867.63 %**

Deflections

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

Deflection under Snow and Service Wind = 5.77 mm Limit by Woolcock et al. 1999 Span/100 = 21.00 mm
Sag during installation =1.18 mm

Reactions

Maximum = 1.39 kn

Middle Pole Design

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	2750 mm
Area	20729 mm2	As	15546.6796875 mm2
Ix	34210793 mm4	Zx	421056 mm3
Iy	34210793 mm4	Zx	421056 mm3
Lateral Restraint	3400 mm c/c		

Loads

Total Area over Pole = 7.56 m2

Dead	1.89 Kn	Live	1.89 Kn
Wind Down	3.25 Kn	Snow	4.76 Kn
Moment wind	5.70 Kn-m	Moment snow	2.42 Kn-m
Phi	0.8	K8	0.63
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
ft =	22 MPa	E =	9257 MPa

Capacities

PhiNcx Wind	186.64 Kn	PhiMnx Wind	7.65 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	111.98 Kn	PhiMnx Dead	4.59 Kn-m	PhiVnx Dead	22.09 Kn
PhiNcx Snow	149.31 Kn	PhiMnx Snow	6.12 Kn-m	PhiVnx Snow	29.45 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.80 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.61 < 1 OK

Deflection at top under service lateral loads = 20.85 mm < 27.50 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
L =	1300 mm	Pile embedment length
f1 =	2250 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	5.70 Kn-m	Moment Snow =	Kn-m
Shear Wind =	2.53 Kn	Shear Snow =	2.42 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.51 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.51 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.76 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	2850 mm
Area	20729 mm2	As	15546.6796875 mm2
Ix	34210793 mm4	Zx	421056 mm3
Iy	34210793 mm4	Zx	421056 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 7.56 m2

Dead	1.89 Kn	Live	1.89 Kn
Wind Down	3.25 Kn	Snow	4.76 Kn
Moment Wind	2.85 Kn-m	Moment snow	1.21 Kn-m

Phi	0.8	K8	0.79
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
ft =	22 MPa	E =	9257 MPa

Capacities

PhiNcx Wind	235.89 Kn	PhiMnx Wind	9.66 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	141.54 Kn	PhiMnx Dead	5.80 Kn-m	PhiVnx Dead	22.09 Kn
PhiNcx Snow	188.72 Kn	PhiMnx Snow	7.73 Kn-m	PhiVnx Snow	29.45 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.34 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.13 < 1 OK

Deflection at top under service lateral loads = 11.34 mm < 29.93 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	2250 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 7.56 m2

Moment Wind =	2.85 Kn-m	Moment Snow =	1.21 Kn-m
Shear Wind =	1.27 Kn	Shear Snow =	1.21 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.51 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.51 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.38 < 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 =	2250 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	2.85 Kn-m	Moment Snow =	1.21 Kn-m
Shear Wind =	1.27 Kn	Shear Snow =	1.21 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.51 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.51 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.38 < 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 = Safecty factor (0.55) x Density of Soil(18) x Height of Pile(1300) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.91 Kn

Uplift on one Pile = 5.93 Kn

Uplift is ok