<u>Pole Shed App Ver 01 2022</u>

Job No.: Steve Broadbent **Address:** 196 Trig Road, Whitford, New Zealand **Date:** 13/04/2024

Latitude: -36.949815 **Longitude:** 174.985436 **Elevation:** 77.5 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	3.3 m
Wind Region	NZ1	Terrain Category	2.5	Design Wind Speed	45.33 m/s
Wind Pressure	1.23 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Very High	Earthquake ARI	100		

Note: Wind lateral loads are governing over Earthquake loads, So only wind loads are considered in calculations

Pressure Coefficients and Pressues

Shed Type = Gable Enclosed

For roof Cp,i = -0.3

For roof CP,e from 0 m To 3.30 m Cpe = -0.9 pe = -1.0 KPa pnet = -1.0 KPa

For roof CP,e from 3.30 m To 6.60 m Cpe = -0.5 pe = -0.55 KPa pnet = -0.55 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 7 m Cpe = 0.7 pe = 0.78 KPa pnet = 1.15 KPa

For side wall CP,e from 0 m To 3.30 m Cpe = pe = -0.72 KPa pnet = -0.72 KPa

Maximum Upward pressure used in roof member Design = 1.0 KPa

Maximum Downward pressure used in roof member Design = 0.59 KPa

Maximum Wall pressure used in Design = 1.15 KPa

Maximum Racking pressure used in Design = 1.13 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 4850 mm Try Purlin 240x45 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 =0.94

K8 Upward =0.55 S1 Downward =13.82 S1 Upward =22.57

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

Capacity Checks

$M_{1.35D}$	0.89 Kn-m	Capacity	2.73 Kn-m	Passing Percentage	**306.74 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	2.36 Kn-m	Capacity	3.64 Kn-m	Passing Percentage	**154.24 %**
$M_{0.9D-WnUp}$	-2.05 Kn-m	Capacity	-2.66 Kn-m	Passing Percentage	**136.41 %**
$V_{1.35D}$	0.74 Kn	Capacity	10.42 Kn	Passing Percentage	**1408.11 %**

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$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.94 Kn	Capacity	13.89 Kn	Passing Percentage	**715.98 %**
$V_{0.9D-WnUp}$	-1.69 Kn	Capacity	-17.37 Kn	Passing Percentage	**1027.81 %**

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 = 10.75 mm	Limit by Woolcock et al, 1999 Span/240 = 20.00 mm
Deflection under Dead and Service Wind = 14.24 mm	Limit by Woolcock et al, 1999 Span/100 = 48.00 mm

Reactions

Maximum downward =1.94 kn   Maximum upward = -1.69 kn

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

Rafter Design Internal

Internal Rafter Load Width = 5000 mm   Internal Rafter Span = 6850 mm   Try Rafter 2x360x45 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 =1.00

K8 Upward =1.00   S1 Downward =8.40   S1 Upward =8.40

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

Capacity Checks

$M_{1.35D}$	9.90 Kn-m	Capacity	34.4 Kn-m	Passing Percentage	**347.47 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	26.10 Kn-m	Capacity	45.86 Kn-m	Passing Percentage	**175.71 %**
$M_{0.9D-WnUp}$	-22.73 Kn-m	Capacity	-57.32 Kn-m	Passing Percentage	**252.18 %**
$V_{1.35D}$	5.78 Kn	Capacity	52.1 Kn	Passing Percentage	**901.38 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	15.24 Kn	Capacity	69.46 Kn	Passing Percentage	**455.77 %**
$V_{0.9D-WnUp}$	-13.27 Kn	Capacity	-86.84 Kn	Passing Percentage	**654.41 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 12.185 mm	Limit by Woolcock et al, 1999 Span/240 = 29.17 mm
Deflection under Dead and Service Wind = 17.935 mm	Limit by Woolcock et al, 1999 Span/100 = 70.00 mm

Reactions

Maximum downward =15.24 kn   Maximum upward = -13.27 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts = 3

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 = 90 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 = 43.67 Kn > -13.27 Kn

Rafter Design External

External Rafter Load Width = 2500 mm External Rafter Span = 7080 mm Try Rafter 360x45 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 =0.81

K8 Upward =0.81 S1 Downward =17.01 S1 Upward =17.01

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

Capacity Checks

$M_{1.35D}$	5.29 Kn-m	Capacity	14.01 Kn-m	Passing Percentage	**264.84 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	13.94 Kn-m	Capacity	18.68 Kn-m	Passing Percentage	**134.00 %**
$M_{0.9D-WnUp}$	-12.14 Kn-m	Capacity	-23.35 Kn-m	Passing Percentage	**192.34 %**
$V_{1.35D}$	2.99 Kn	Capacity	26.05 Kn	Passing Percentage	**871.24 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	7.88 Kn	Capacity	34.73 Kn	Passing Percentage	**440.74 %**
$V_{0.9D-WnUp}$	-6.86 Kn	Capacity	-43.42 Kn	Passing Percentage	**632.94 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 13.54 mm Limit by Woolcock et al, 1999 Span/240= 29.17 mm
Deflection under Dead and Service Wind = 17.94 mm Limit by Woolcock et al, 1999 Span/100 = 70.00 mm

Reactions

Maximum downward =7.88 kn Maximum upward = -6.86 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 = 45 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) = -47.25 kn > -6.86 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -6.86 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2500 mm   Intermediate Span = 2150 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 =0.51

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

Capacity Checks

$M_{Wind+Snow}$	1.66 Kn-m	Capacity	3.3 Kn-m	Passing Percentage	**198.80 %**
$V_{0.9D-WnUp}$	3.09 Kn	Capacity	-20.26 Kn	Passing Percentage	**655.66 %**

Deflections

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

Deflection under Snow and Service Wind = 7.195 mm   Limit byWoolcock et al, 1999 Span/100 = 21.50 mm

Reactions

Maximum = 3.09 kn

Intermediate Design Sides

Intermediate Spacing = 3500 mm   Intermediate Span = 3150 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 =0.72

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

Capacity Checks

$M_{Wind+Snow}$	2.50 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	**242.40 %**
$V_{0.9D-WnUp}$	3.17 Kn	Capacity	27.5 Kn	Passing Percentage	**867.51 %**

Deflections

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

Deflection under Snow and Service Wind = 18.575 mm   Limit by Woolcock et al, 1999 Span/100 = 31.50 mm

Reactions

Maximum = 3.17 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 2500 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 =0.80 S1 Downward =10.36 S1 Upward =17.27

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

Capacity Checks

$M_{Wind+Snow}$	1.17 Kn-m	Capacity	1.32 Kn-m	Passing Percentage	**112.82 %**
$V_{0.9D-WnUp}$	1.87 Kn	Capacity	10.13 Kn	Passing Percentage	**541.71 %**

Deflections

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

Deflection under Snow and Service Wind = 11.03 mm Limit by Woolcock et al, 1999 Span/100 = 25.00 mm
Sag during installation = 2.92 mm

Reactions

Maximum = 1.87 kn

Girt Design Sides

Girt's Spacing = 800 mm Girt's Span = 3500 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 =0.92 S1 Downward =10.36 S1 Upward =14.45

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

Capacity Checks

$M_{Wind+Snow}$	1.41 Kn-m	Capacity	1.51 Kn-m	Passing Percentage	**107.09 %**
$V_{0.9D-WnUp}$	1.61 Kn	Capacity	10.13 Kn	Passing Percentage	**629.19 %**

Deflections

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

Deflection under Snow and Service Wind = 26.07 mm Limit by Woolcock et al. 1999 Span/100 = 35.00 mm
Sag during installation =11.23 mm

Reactions

Maximum = 1.61 kn

Middle Pole Design

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3440 mm
Area	35448 mm2	As	26585.7421875 mm2
Ix	100042702 mm4	Zx	941578 mm3
Iy	100042702 mm4	Zx	941578 mm3
Lateral Restraint	3440 mm c/c		

Loads

Total Area over Pole = 17.5 m2

Dead	4.38 Kn	Live	4.38 Kn
Wind Down	10.32 Kn	Snow	0.00 Kn
Moment wind	11.51 Kn-m		
Phi	0.8	K8	0.85
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	434.65 Kn	PhiMnx Wind	23.28 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	260.79 Kn	PhiMnx Dead	13.97 Kn-m	PhiVnx Dead	37.77 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.54 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.29 < 1 OK

Deflection at top under service lateral loads = 19.82 mm < 34.40 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 =	1550 mm	Pile embedment length
f1 =	2475 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	11.51 Kn-m
Shear Wind =	4.65 Kn

Pile Properties

Safety Factory	0.55	
Hu =	8.24 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	12.47 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.92 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3100 mm
Area	35448 mm2	As	26585.7421875 mm2
Ix	100042702 mm4	Zx	941578 mm3
Iy	100042702 mm4	Zx	941578 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 17.5 m2

Dead	4.38 Kn	Live	4.38 Kn
Wind Down	10.32 Kn	Snow	0.00 Kn
Moment Wind	5.75 Kn-m		
Phi	0.8	K8	0.92
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	467.23 Kn	PhiMnx Wind	25.03 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	280.34 Kn	PhiMnx Dead	15.02 Kn-m	PhiVnx Dead	37.77 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.27 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.09 < 1 OK

Deflection at top under service lateral loads = 9.48 mm < 32.92 mm

Ds =	0.6 mm	Pile Diameter
L =	1550 mm	Pile embedment length
f1 =	2475 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 17.5 m2

Moment Wind =	5.75 Kn-m
Shear Wind =	2.32 Kn

Pile Properties

Safety Factory	0.55	
Hu =	8.24 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	12.47 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/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 =	1550 mm	Pile embedment length
f1 =	2475 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	5.75 Kn-m
Shear Wind =	2.32 Kn

Pile Properties

Safety Factory	0.55	
Hu =	8.24 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	12.47 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 = Safecty factor (0.55) x Density of Soil(18) x Height of Pile(1550) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1550)

Skin Friction = 19.40 Kn

Weight of Pile + Pile Skin Friction = 23.43 Kn

Uplift on one Pile = 13.56 Kn

Uplift is ok