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

Job No.: Andrew Merts		**Address:** 219 Caroline Drive, Taupo, New Zealand		**Date:** 03/09/2024	
Latitude: -38.728188		**Longitude:** 176.141675		**Elevation:** 538.5 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	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ2	Terrain Category	2.46	Design Wind Speed	41.58 m/s
Wind Pressure	1.04 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 Pressues

Shed Type = Mono   Open

For roof Cp,i = 0.6509

For roof   CP,e   from 0 m   To 1.90 m   Cpe = -0.9677   pe = -0.69 KPa   pnet = -1.25 KPa

For roof   CP,e   from 1.90 m   To 3.80 m   Cpe = -0.8662   pe = -0.62 KPa   pnet = -1.18 KPa

For wall Windward Cp,i = 0.6509   side Wall Cp,i = -0.5587

For wall Windward and Leeward   CP,e   from 0 m   To 16 m   Cpe = 0.7   pe = 0.65 KPa   pnet = 1.28 KPa

For side wall   CP,e   from 0 m   To 3.80 m   Cpe =   pe = -0.61 KPa   pnet = 0.02 KPa

Maximum Upward pressure used in roof member Design = 1.25 KPa

Maximum Downward pressure used in roof member Design = 0.82 KPa

Maximum Wall pressure used in Design = 1.28 KPa

Maximum Racking pressure used in Design = 1.12 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm   Purlin Span = 3850 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)

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

K8 Upward =0.78   S1 Downward =12.23   S1 Upward =17.77

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

Capacity Checks

$M_{1.35D}$	0.56 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	**319.64 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.87 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	**127.27 %**
$M_{0.9D-WnUp}$	-1.71 Kn-m	Capacity	-2.36 Kn-m	Passing Percentage	**265.17 %**
$V_{1.35D}$	0.58 Kn	Capacity	8.25 Kn	Passing Percentage	**1422.41 %**

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$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.94 Kn	Capacity	11.00 Kn	Passing Percentage	**567.01 %**
$V_{0.9D\text{-}WnUp}$	-1.78 Kn	Capacity	-13.75 Kn	Passing Percentage	**772.47 %**

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 = 8.51 mm	Limit by Woolcock et al, 1999 Span/240 = 15.83 mm
Deflection under Dead and Service Wind = 12.90 mm	Limit by Woolcock et al, 1999 Span/100 = 38.00 mm

Reactions

Maximum downward =1.94 kn   Maximum upward = -1.78 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 = 4000 mm   Internal Rafter Span = 3100 mm   Try Rafter 2x240x45 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 =1.00

K8 Upward =1.00   S1 Downward =6.71   S1 Upward =6.71

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

Capacity Checks

$M_{1.35D}$	1.62 Kn-m	Capacity	5.8 Kn-m	Passing Percentage	**358.02 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	5.38 Kn-m	Capacity	7.74 Kn-m	Passing Percentage	**143.87 %**
$M_{0.9D\text{-}WnUp}$	-4.93 Kn-m	Capacity	-9.68 Kn-m	Passing Percentage	**196.35 %**
$V_{1.35D}$	2.09 Kn	Capacity	20.84 Kn	Passing Percentage	**997.13 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	6.94 Kn	Capacity	27.78 Kn	Passing Percentage	**400.29 %**
$V_{0.9D\text{-}WnUp}$	-6.36 Kn	Capacity	-34.74 Kn	Passing Percentage	**546.23 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 2.8 mm	Limit by Woolcock et al, 1999 Span/240 = 13.54 mm
Deflection under Dead and Service Wind = 4.72 mm	Limit by Woolcock et al, 1999 Span/100 = 32.50 mm

Reactions

Maximum downward =6.94 kn   Maximum upward = -6.36 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 = 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 = 19.50 Kn > -6.36 Kn

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 3056 mm Try Rafter 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 =0.94 S1 Downward =13.82 S1 Upward =13.82

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

Capacity Checks

$M_{1.35D}$	0.79 Kn-m	Capacity	2.73 Kn-m	Passing Percentage	**345.57 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	2.61 Kn-m	Capacity	3.64 Kn-m	Passing Percentage	**139.46 %**
$M_{0.9D-WnUp}$	-2.39 Kn-m	Capacity	-4.55 Kn-m	Passing Percentage	**190.38 %**
$V_{1.35D}$	1.03 Kn	Capacity	10.42 Kn	Passing Percentage	**1011.65 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	3.42 Kn	Capacity	13.89 Kn	Passing Percentage	**406.14 %**
$V_{0.9D-WnUp}$	-3.13 Kn	Capacity	-17.37 Kn	Passing Percentage	**554.95 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 3.11 mm Limit by Woolcock et al, 1999 Span/240= 13.54 mm
Deflection under Dead and Service Wind = 4.72 mm Limit by Woolcock et al, 1999 Span/100 = 32.50 mm

Reactions

Maximum downward =3.42 kn Maximum upward = -3.13 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 = 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) = -17.01 kn > -3.13 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -3.13 Kn

Girt Design Front and Back

Girt's Spacing = 600 mm	Girt's Span = 4000 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 =0.97   S1 Downward =10.36   S1 Upward =12.61

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

Capacity Checks

$M_{Wind+Snow}$	1.54 Kn-m	Capacity	1.60 Kn-m	Passing Percentage	**103.90 %**
$V_{0.9D-WnUp}$	1.54 Kn	Capacity	10.13 Kn	Passing Percentage	**657.79 %**

Deflections

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

Deflection under Snow and Service Wind = 37.13 mm   Limit by Woolcock et al, 1999 Span/100 = 40.00 mm
Sag during installation = 19.16 mm

Reactions

Maximum = 1.54 kn

Girt Design Sides

Girt's Spacing = 600 mm	Girt's Span = 3250 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 =0.69   S1 Downward =10.36   S1 Upward =19.69

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

Capacity Checks

$M_{Wind+Snow}$	1.01 Kn-m	Capacity	1.13 Kn-m	Passing Percentage	**111.88 %**
$V_{0.9D-WnUp}$	1.25 Kn	Capacity	10.13 Kn	Passing Percentage	**810.40 %**

Deflections

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

Deflection under Snow and Service Wind = 16.18 mm   Limit by Woolcock et al. 1999 Span/100 = 32.50 mm

Sag during installation =8.35 mm

Reactions

Maximum = 1.25 kn

Middle Pole Design

Geometry

200 UNI H5	Dry Use	Height	3810 mm
Area	31400 mm2	As	23550 mm2
Ix	78500000 mm4	Zx	785000 mm3
Iy	78500000 mm4	Zx	785000 mm3
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 13 m2

Dead	3.25 Kn	Live	3.25 Kn
Wind Down	10.66 Kn	Snow	0.00 Kn
Moment wind	8.94 Kn-m		
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1wind	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	452.16 Kn	PhiMnx Wind	21.56 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	271.30 Kn	PhiMnx Dead	12.93 Kn-m	PhiVnx Dead	33.46 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.45 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.21 < 1 OK

Deflection at top under service lateral loads = 27.73 mm < 38.10 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 =	1400 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 =	8.94 Kn-m
Shear Wind =	2.98 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.56 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	9.86 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.91 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

175 UNI H5	Dry Use	Height	3800 mm
Area	24041 mm2	As	18030.46875 mm2
Ix	46015259 mm4	Zx	525889 mm3
Iy	46015259 mm4	Zx	525889 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 6.5 m2

Dead	1.63 Kn	Live	1.63 Kn
Wind Down	5.33 Kn	Snow	0.00 Kn
Moment Wind	4.47 Kn-m		
Phi	0.8	K8	0.59
K1 snow	0.8	K1 Dead	0.6
K1wind	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	203.71 Kn	PhiMnx Wind	8.50 Kn-m	PhiVnx Wind	42.70 Kn

PhiNcx Dead	122.23 Kn	PhiMnx Dead	5.10 Kn-m	PhiVnx Dead	25.62 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.57 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.32 < 1 OK

Deflection at top under service lateral loads = 24.77 mm < 39.90 mm

Ds =	0.6 mm	Pile Diameter
L =	1400 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

Total Area over Pole = 6.5 m2

Moment Wind =	4.47 Kn-m
Shear Wind =	1.49 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.56 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	9.86 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.45 < 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 =	1400 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 =	4.47 Kn-m
Shear Wind =	1.49 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.56 Kn	Ultimate Lateral Strength of the Pile, Short pile

Mu =	9.86 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.45 < 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(1400) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1400)

Skin Friction = 15.83 Kn

Weight of Pile + Pile Skin Friction = 19.69 Kn

Uplift on one Pile = 13.32 Kn

Uplift is ok