Pole Shed App Ver 01 2022

Job No.:	Apiti Shed	**Address:**	101 Table Flat Rd, Apiti, New Zealand	**Date:**	10/3/2023
Latitude:	-39.948308	**Longitude:**	175.912963	**Elevation:**	558 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N1	Ground Snow Load	1.11 KPa	Roof Snow Load	0.75 KPa
Earthquake Zone	3	Subsoil Category	D	Exposure Zone	B
Importance Level	2	Ultimate wind & Earthquake ARI	500 Years	Max Height	6.2 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	48.36 m/s
Wind Pressure	1.4 KPa	Lee Zone	NO	Ultimate Snow ARI	150 Years
Wind Category	Very High	Earthquake ARI	500		

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 6.20 m Cpe = -0.9 pe = -1.14 KPa pnet = -1.14 KPa

For roof CP,e from 6.20 m To 12.40 m Cpe = -0.5 pe = -0.63 KPa pnet = -0.63 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 28.8 m Cpe = 0.7 pe = 0.88 KPa pnet = 1.30 KPa

For side wall CP,e from 0 m To 6.20 m Cpe = pe = -0.82 KPa pnet = -0.82 KPa

Maximum Upward pressure used in roof member Design = 1.14 KPa

Maximum Downward pressure used in roof member Design = 0.67 KPa

Maximum Wall pressure used in Design = 1.30 KPa

Maximum Racking pressure used in Design = 1.26 KPa

Design Summary

Purlin Design

Purlin Spacing = 800 mm Purlin Span = 4650 mm Try Purlin 250x50 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 =0.97

K8 Upward =0.35   S1 Downward =12.68   S1 Upward =28.66

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

Capacity Checks

$M_{1.35D}$	0.73 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	**465.75 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	2.27 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	**199.56 %**
$M_{0.9D-WnUp}$	-1.98 Kn-m	Capacity	-2.07 Kn-m	Passing Percentage	**92.83 %**
$V_{1.35D}$	0.63 Kn	Capacity	12.06 Kn	Passing Percentage	**1914.29 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.95 Kn	Capacity	16.08 Kn	Passing Percentage	**824.62 %**
$V_{0.9D-WnUp}$	-1.70 Kn	Capacity	-20.10 Kn	Passing Percentage	**1182.35 %**

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 = 6.42 mm   Limit by Woolcock et al, 1999 Span/360 = 12.78 mm
Deflection under Dead and Service Wind = 8.93 mm   Limit by Woolcock et al, 1999 Span/250 = 30.67 mm

Reactions

Maximum downward =1.95 kn   Maximum upward = -1.70 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 = 4800 mm   Internal Rafter Span = 4850 mm   Try Rafter 2x360x45 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 =8.40   S1 Upward =8.40

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

Capacity Checks

Second page

$M_{1.35D}$	4.76 Kn-m	Capacity	43.44 Kn-m	Passing Percentage	**912.61 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	14.82 Kn-m	Capacity	57.92 Kn-m	Passing Percentage	**390.82 %**
$M_{0.9D-WnUp}$	-12.91 Kn-m	Capacity	-72.42 Kn-m	Passing Percentage	**560.96 %**
$V_{1.35D}$	3.93 Kn	Capacity	55.22 Kn	Passing Percentage	**1405.09 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	12.22 Kn	Capacity	73.64 Kn	Passing Percentage	**602.62 %**
$V_{0.9D-WnUp}$	-10.65 Kn	Capacity	-92.04 Kn	Passing Percentage	**864.23 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 2.74 mm Limit by Woolcock et al, 1999 Span/360 = 13.89 mm
Deflection under Dead and Service Wind = 4.235 mm Limit by Woolcock et al, 1999 Span/250 = 33.33 mm

Reactions

Maximum downward =12.22 kn Maximum upward = -10.65 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 = 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 = 29.11 Kn > -10.65 Kn

Rafter Design External

External Rafter Load Width = 2400 mm External Rafter Span = 4912 mm Try Rafter 240x45 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 =0.94

K8 Upward =0.94 S1 Downward =13.82 S1 Upward =13.82

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

Capacity Checks

$M_{1.35D}$	2.44 Kn-m	Capacity	9.37 Kn-m	Passing Percentage	**384.02 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	7.60 Kn-m	Capacity	12.49 Kn-m	Passing Percentage	**164.34 %**
$M_{0.9D\text{-}WnUp}$	-6.62 Kn-m	Capacity	-15.61 Kn-m	Passing Percentage	**235.80 %**
$V_{1.35D}$	1.99 Kn	Capacity	18.41 Kn	Passing Percentage	**925.13 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	6.19 Kn	Capacity	24.54 Kn	Passing Percentage	**396.45 %**
$V_{0.9D\text{-}WnUp}$	-5.39 Kn	Capacity	-30.68 Kn	Passing Percentage	**569.20 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 10.28 mm	Limit by Woolcock et al, 1999 Span/360= 13.89 mm
Deflection under Dead and Service Wind = 14.30 mm	Limit by Woolcock et al, 1999 Span/250 = 33.33 mm

Reactions

Maximum downward =6.19 kn Maximum upward = -5.39 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) = -30.05 kn > -5.39 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -5.39 Kn

Girt Design Front and Back

Girt's Spacing = 600 mm   Girt's Span = 4800 mm   Try Girt 250x50 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 K4 =1 K5 =1 K8 Downward =0.97

K8 Upward =0.64 S1 Downward =12.68 S1 Upward =20.70

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

Capacity Checks

$M_{Wind+Snow}$	2.25 Kn-m	Capacity	3.71 Kn-m	Passing Percentage	**164.89 %**
$V_{0.9D-WnUp}$	1.87 Kn-m	Capacity	20.10 Kn-m	Passing Percentage	**1074.87 %**

Deflections

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

Deflection under Snow and Service Wind = 19.49 mm Limit by Woolcock et al, 1999 Span/250 = 19.20 mm
Sag during installation = 32.19 mm

Reactions

Maximum = 1.87 kn

Girt Design Sides

Girt's Spacing = 600 mm   Girt's Span = 5000 mm   Try Girt 250x50 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 K4 =1 K5 =1 K8 Downward =0.97

K8 Upward =0.62 S1 Downward =12.68 S1 Upward =21.13

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

Capacity Checks

$M_{Wind+Snow}$	2.44 Kn-m	Capacity	3.59 Kn-m	Passing Percentage	**147.13 %**

$V_{0.9D\text{-}WnUp}$	1.95 Kn-m	Capacity	20.10 Kn-m	Passing Percentage	**1030.77 %**

Deflections

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

Deflection under Snow and Service Wind = 22.95 mm   Limit by Woolcock et al. 1999 Span/100 = 20.00 mm
Sag during installation =37.90 mm

Reactions

Maximum = 1.95 kn

Middle Pole Design

Geometry

350 SED H5 (Minimum 375 dia. at Floor Level)	Dry Use	Height	5900 mm
Area	103154 mm2	As	77365.4296875 mm2
Ix	847191750 mm4	Zx	4674161 mm3
Iy	847191750 mm4	Zx	4674161 mm3
Lateral Restraint	5900 mm c/c		

Loads

Total Area over Pole = 24 m2

Dead	6.00 Kn	Live	6.00 Kn
Wind Down	16.08 Kn	Snow	18.00 Kn
Moment wind	21.74 Kn-m	Moment snow	4.12 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	1259.19 Kn	PhiMnx Wind	115.06 Kn-m	PhiVnx Wind	183.20 Kn

PhiNcx Dead	755.51 Kn	PhiMnx Dead	69.04 Kn-m	PhiVnx Dead	109.92 Kn
PhiNcx Snow	1007.35 Kn	PhiMnx Snow	92.05 Kn-m	PhiVnx Snow	146.56 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.22 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.06 < 1 OK

Deflection at top under service lateral loads = 14.25 mm < 39.33 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 =	1900 mm	Pile embedment length
f1 =	4650 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	21.74 Kn-m	Moment Snow =	Kn-m
Shear Wind =	4.68 Kn	Shear Snow =	4.12 Kn

Pile Properties

Safety Factory	0.55	
Hu =	9.33 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	25.37 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.86 < 1 OK

End Pole Design

Geometry For End Bay Pole

Pole Shed App Ver 01 2022

Geometry

300 SED H5 (Minimum 325 dia. at Floor Level)	Dry Use	Height	5960 mm
Area	76660 mm2	As	57495.1171875 mm2
Ix	467896461 mm4	Zx	2994537 mm3
Iy	467896461 mm4	Zx	2994537 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 12 m2

Dead	3.00 Kn	Live	3.00 Kn
Wind Down	8.04 Kn	Snow	9.00 Kn
Moment Wind	10.87 Kn-m	Moment snow	2.06 Kn-m
Phi	0.8	K8	0.72
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	790.29 Kn	PhiMnx Wind	62.26 Kn-m	PhiVnx Wind	136.15 Kn
PhiNcx Dead	474.17 Kn	PhiMnx Dead	37.35 Kn-m	PhiVnx Dead	81.69 Kn
PhiNcx Snow	632.23 Kn	PhiMnx Snow	49.80 Kn-m	PhiVnx Snow	108.92 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.20 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.05 < 1 OK

Deflection at top under service lateral loads = 13.52 mm < 41.23 mm

Ds =	0.6 mm	Pile Diameter
L =	1450 mm	Pile embedment length
f1 =	4650 mm	Distance at which the shear force is applied

f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 12 m2

Moment Wind =	10.87 Kn-m	Moment Snow =	2.06 Kn-m
Shear Wind =	2.34 Kn	Shear Snow =	2.06 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.45 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	11.89 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.91 < 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 =	1450 mm	Pile embedment length
f1 =	4650 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	10.87 Kn-m	Moment Snow =	2.06 Kn-m
Shear Wind =	2.34 Kn	Shear Snow =	2.06 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.45 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	11.89 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.91 < 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(1900) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1900)

Skin Friction = 29.16 Kn

Weight of Pile + Pile Skin Friction = 31.25 Kn

Uplift on one Pile = 21.96 Kn

Uplift is ok