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

Job No.:	Joyce Shed	**Address:**	276A Cape Hill Rd,Pukekohe,New Zealand	**Date:**	04/06/2024
Latitude:	-37.174073	**Longitude:**	174.910227	**Elevation:**	78.5 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	3.35 m
Wind Region	NZ1	Terrain Category	1.96	Design Wind Speed	44.61 m/s
Wind Pressure	1.19 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 3.35 m Cpe = -0.9 pe = -0.97 KPa pnet = -0.97 KPa

For roof CP,e from 3.35 m To 6.70 m Cpe = -0.5 pe = -0.54 KPa pnet = -0.54 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 9 m Cpe = 0.7 pe = 0.75 KPa pnet = 1.11 KPa

For side wall CP,e from 0 m To 3.35 m Cpe = pe = -0.70 KPa pnet = -0.70 KPa

Maximum Upward pressure used in roof member Design = 0.97 KPa

Maximum Downward pressure used in roof member Design = 0.57 KPa

Maximum Wall pressure used in Design = 1.11 KPa

Maximum Racking pressure used in Design = 1.29 KPa

Design Summary

Rafter Design Internal

Internal Rafter Load Width = 5000 mm Internal Rafter Span = 8850 mm Try Rafter 2x400x45 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 =8.88 S1 Upward =8.88

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

Capacity Checks

$M_{1.35D}$	16.52 Kn-m	Capacity	52.7 Kn-m	Passing Percentage	**319.01 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	42.59 Kn-m	Capacity	70.26 Kn-m	Passing Percentage	**164.97 %**
$M_{0.9D-WnUp}$	-36.47 Kn-m	Capacity	-87.84 Kn-m	Passing Percentage	**240.86 %**
$V_{1.35D}$	7.47 Kn	Capacity	61.36 Kn	Passing Percentage	**821.42 %**

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$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	19.25 Kn	Capacity	81.82 Kn	Passing Percentage	**425.04 %**
$V_{0.9D-WnUp}$	-16.48 Kn	Capacity	-102.26 Kn	Passing Percentage	**620.51 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 21.845 mm	Limit by Woolcock et al, 1999 Span/240 = 37.50 mm
Deflection under Dead and Service Wind = 31.755 mm	Limit by Woolcock et al, 1999 Span/100 = 90.00 mm

Reactions

Maximum downward =19.25 kn Maximum upward = -16.48 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts = 4

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 = 58.22 Kn > -16.48 Kn

Rafter Design External

External Rafter Load Width = 2500 mm	External Rafter Span = 8908 mm	Try Rafter 400x45 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 =0.77

K8 Upward =0.77   S1 Downward =17.94   S1 Upward =17.94

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

Capacity Checks

$M_{1.35D}$	8.37 Kn-m	Capacity	20.31 Kn-m	Passing Percentage	**242.65 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	21.57 Kn-m	Capacity	27.08 Kn-m	Passing Percentage	**125.54 %**
$M_{0.9D-WnUp}$	-18.47 Kn-m	Capacity	-33.85 Kn-m	Passing Percentage	**183.27 %**
$V_{1.35D}$	3.76 Kn	Capacity	30.68 Kn	Passing Percentage	**815.96 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	9.69 Kn	Capacity	40.91 Kn	Passing Percentage	**422.19 %**
$V_{0.9D-WnUp}$	-8.30 Kn	Capacity	-51.13 Kn	Passing Percentage	**616.02 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 24.27 mm	Limit by Woolcock et al, 1999 Span/240= 37.50 mm
Deflection under Dead and Service Wind = 31.75 mm	Limit by Woolcock et al, 1999 Span/100 = 90.00 mm

Reactions

Maximum downward =9.69 kn   Maximum upward = -8.30 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

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) = -56.76 kn > -8.30 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -8.30 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2500 mm	Intermediate Span = 2499 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 =0.55

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

Capacity Checks

$M_{Wind+Snow}$	2.17 Kn-m	Capacity	3.3 Kn-m	Passing Percentage	**152.07 %**
$V_{0.9D-WnUp}$	3.47 Kn	Capacity	-20.26 Kn	Passing Percentage	**583.86 %**

Deflections

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

Deflection under Snow and Service Wind = 12.685 mm	Limit byWoolcock et al, 1999 Span/100 = 24.99 mm

Reactions

Maximum = 3.47 kn

Intermediate Design Sides

Intermediate Spacing = 4500 mm Intermediate Span = 3200 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 =0.73

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

Capacity Checks

$M_{Wind+Snow}$	3.20 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	**189.38 %**
$V_{0.9D-WnUp}$	4.00 Kn	Capacity	27.5 Kn	Passing Percentage	**687.50 %**

Deflections

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

Deflection under Snow and Service Wind = 24.55 mm Limit by Woolcock et al, 1999 Span/100 = 32.00 mm

Reactions

Maximum = 4.00 kn

Girt Design Front and Back

Girt's Spacing = 900 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

$M_{Wind+Snow}$	0.78 Kn-m	Capacity	1.32 Kn-m	Passing Percentage	**169.23 %**
$V_{0.9D-WnUp}$	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 = 7.37 mm Limit by Woolcock et al, 1999 Span/100 = 25.00 mm
Sag during installation = 2.92 mm

Reactions

Maximum = 1.25 kn

Girt Design Sides

Girt's Spacing = 600 mm   Girt's Span = 4500 mm   Try Girt 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   K4 =1   K5 =1   K8 Downward =0.98

K8 Upward =0.70   S1 Downward =12.23   S1 Upward =19.33

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

Capacity Checks

$M_{Wind+Snow}$	1.69 Kn-m	Capacity	2.13 Kn-m	Passing Percentage	**126.04 %**
$V_{0.9D-WnUp}$	1.50 Kn	Capacity	13.75 Kn	Passing Percentage	**916.67 %**

Deflections

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

Deflection under Snow and Service Wind = 20.63 mm   Limit by Woolcock et al. 1999 Span/100 = 45.00 mm

Sag during installation =30.70 mm

Reactions

Maximum = 1.50 kn

Middle Pole Design

Geometry

225 UNI H5	Dry Use	Height	3340 mm
Area	39741 mm2	As	29805.46875 mm2
Ix	125741821 mm4	Zx	1117705 mm3
Iy	125741821 mm4	Zx	1117705 mm3
Lateral Restraint	3400 mm c/c		

Loads

Total Area over Pole = 22.5 m2

Dead	5.63 Kn	Live	5.63 Kn
Wind Down	12.82 Kn	Snow	0.00 Kn
Moment wind	13.54 Kn-m		
Phi	0.8	K8	0.90
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	512.60 Kn	PhiMnx Wind	27.49 Kn-m	PhiVnx Wind	70.58 Kn
PhiNcx Dead	307.56 Kn	PhiMnx Dead	16.50 Kn-m	PhiVnx Dead	42.35 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 = 19.25 mm < 33.40 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 =	1750 mm	Pile embedment length
f1 =	2513 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	13.54 Kn-m
Shear Wind =	5.39 Kn

Pile Properties

Safety Factory	0.55	
Hu =	11.20 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	17.46 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.78 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

200 UNI H5	Dry Use	Height	2950 mm
Area	31400 mm2	As	23550 mm2
Ix	78500000 mm4	Zx	785000 mm3
Iy	78500000 mm4	Zx	785000 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 22.5 m2

Dead	5.63 Kn	Live	5.63 Kn
Wind Down	12.82 Kn	Snow	0.00 Kn
Moment Wind	6.77 Kn-m		
Phi	0.8	K8	0.91
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	411.23 Kn	PhiMnx Wind	19.61 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	246.74 Kn	PhiMnx Dead	11.76 Kn-m	PhiVnx Dead	33.46 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.40 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.18 < 1 OK

Deflection at top under service lateral loads = 15.43 mm < 33.42 mm

Ds =	0.6 mm	Pile Diameter
L =	1500 mm	Pile embedment length
f1 =	2513 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 22.5 m2

Moment Wind =	6.77 Kn-m
Shear Wind =	2.69 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.49 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	11.44 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.59 < 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 =	1500 mm	Pile embedment length
f1 =	2513 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	6.77 Kn-m
Shear Wind =	2.69 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.49 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	11.44 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.59 < 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(1750) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1750)

Skin Friction = 24.73 Kn

Weight of Pile + Pile Skin Friction = 29.01 Kn

Uplift on one Pile = 16.76 Kn

Uplift is ok