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

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**Job No.:** Nick White | **Address:** 25 Rossiters Road, Loburn 7472, New Zealand | **Date:** 09/12/2024

**Latitude:** -43.27728 | **Longitude:** 172.567465 | **Elevation:** 50 m

## General Input

| | | | | | |
|---|---|---|---|---|---|
| Roof Live Load | 0.25 KPa | Roof Dead Load | 0.25 KPa | Roof Live Point Load | 1.1 Kn |
| Snow Zone | N4 | Ground Snow Load | 0.9 KPa | Roof Snow Load | 0.63 KPa |
| Earthquake Zone | 2 | Subsoil Category | D | Exposure Zone | B |
| Importance Level | 1 | Ultimate wind & Earthquake ARI | 100 Years | Max Height | 7.2 m |
| Wind Region | NZ2 | Terrain Category | 2.71 | Design Wind Speed | 36.19 m/s |
| Wind Pressure | 0.79 KPa | Lee Zone | NO | Ultimate Snow ARI | 50 Years |
| Wind Category | Medium | 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 Enclosed

For roof Cp,i = -0.3

For roof CP,e from 0 m To 6.6 m Cpe = -0.9 pe = -0.64 KPa pnet = -0.64 KPa

For roof CP,e from 6.6 m To 13.2 m Cpe = -0.5 pe = -0.35 KPa pnet = -0.35 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 18 m Cpe = 0.7 pe = 0.50 KPa pnet = 0.74 KPa

For side wall CP,e from 0 m To 6.6 m Cpe = pe = -0.46 KPa pnet = -0.46 KPa

Maximum Upward pressure used in roof member Design = 0.64 KPa

Maximum Downward pressure used in roof member Design = 0.37 KPa

Maximum Wall pressure used in Design = 0.74 KPa

Maximum Racking pressure used in Design = 0.85 KPa

## Design Summary

## Purlin Design

Purlin Spacing = 900 mm | Purlin Span = 4850 mm | Try Purlin 200x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and timber does not remain in continuous wet condition after installation)

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K1 Short term = 1  K1 Medium term = 0.8  K1 Long term = 0.6  K4 =1  K5 =1  K8 Downward =1.00

K8 Upward =0.75  S1 Downward =11.27  S1 Upward =18.41

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 | 2.23 Kn-m | Passing Percentage | **250.56 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 2.46 Kn-m | Capacity | 2.97 Kn-m | Passing Percentage | **120.73 %** |
| $M_{0.9D-WnUp}$ | -1.1 Kn-m | Capacity | -2.79 Kn-m | Passing Percentage | **253.64 %** |
| $V_{1.35D}$ | 0.74 Kn | Capacity | 9.65 Kn | Passing Percentage | **1304.05 %** |
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 2.03 Kn | Capacity | 12.86 Kn | Passing Percentage | **633.50 %** |
| $V_{0.9D-WnUp}$ | -0.91 Kn | Capacity | -16.08 Kn | Passing Percentage | **1767.03 %** |

**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 = 16.71 mm | Limit by Woolcock et al, 1999 Span/240 = 20.00 mm |
| Deflection under Dead and Service Wind = 19.08 mm | Limit by Woolcock et al, 1999 Span/100 = 48.00 mm |

**Reactions**

Maximum downward =2.03 kn  Maximum upward = -0.91 kn

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

## Rafter Design External

External Rafter Load Width = 2500 mm  External Rafter Span = 5806 mm  Try Rafter 300x50 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 =0.94

K8 Upward =0.94  S1 Downward =13.93  S1 Upward =13.93

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

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 3.56 Kn-m | Capacity | 4.72 Kn-m | Passing Percentage | **132.58 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 9.80 Kn-m | Capacity | 6.30 Kn-m | Passing Percentage | **64.29 %** |

| | | | | | |
|---|---|---|---|---|---|
| $M_{0.9D\text{-}WnUp}$ | -4.37 Kn-m | Capacity | -7.87 Kn-m | Passing Percentage | **180.09 %** |
| $V_{1.35D}$ | 2.45 Kn | Capacity | 14.47 Kn | Passing Percentage | **590.61 %** |
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 6.75 Kn | Capacity | 19.30 Kn | Passing Percentage | **285.93 %** |
| $V_{0.9D\text{-}WnUp}$ | -3.01 Kn | Capacity | -24.12 Kn | Passing Percentage | **801.33 %** |

**Deflections**

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 20.83 mm   Limit by Woolcock et al, 1999 Span/240= 25.00 mm
Deflection under Dead and Service Wind = 23.78 mm   Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

**Reactions**

Maximum downward =6.75 kn   Maximum upward = -3.01 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) = -25.20 kn > -3.01 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.01 Kn

**Intermediate Design Sides**

Intermediate Spacing = 3000 mm   Intermediate Span = 6950 mm   Try Intermediate 2x300x50 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 =0.94

K8 Upward =1.00 S1 Downward =13.93 S1 Upward =1.22

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

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 8.15 Kn-m | Capacity | 16.8 Kn-m | Passing Percentage | **206.13 %** |
| $V_{0.9D-WnUp}$ | 4.69 Kn | Capacity | 48.24 Kn | Passing Percentage | **1028.57 %** |

**Deflections**

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

Deflection under Snow and Service Wind = 123.005 mm Limit by Woolcock et al, 1999 Span/100 = 69.50 mm

**Reactions**

Maximum = 4.69 kn

## Girt Design Front and Back

Girt's Spacing = 900 mm Girt's Span = 5000 mm Try Girt 200x50 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 =1.00

K8 Upward =0.73 S1 Downward =11.27 S1 Upward =18.79

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

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 2.08 Kn-m | Capacity | 2.72 Kn-m | Passing Percentage | **130.77 %** |
| $V_{0.9D-WnUp}$ | 1.67 Kn | Capacity | 16.08 Kn | Passing Percentage | **962.87 %** |

**Deflections**

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

Deflection under Snow and Service Wind = 44.93 mm Limit by Woolcock et al, 1999 Span/100 = 50.00 mm
Sag during installation = 37.90 mm

**Reactions**

Maximum = 1.67 kn

## Girt Design Sides

Girt's Spacing = 900 mm Girt's Span = 3000 mm Try Girt 200x50 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 =1.00

K8 Upward =0.64 S1 Downward =11.27 S1 Upward =20.58

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

#### Capacity Checks

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 0.75 Kn-m | Capacity | 2.40 Kn-m | Passing Percentage | **320.00 %** |
| $V_{0.9D-WnUp}$ | 1.00 Kn | Capacity | 16.08 Kn | Passing Percentage | **1608.00 %** |

#### Deflections

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

Deflection under Snow and Service Wind = 5.82 mm Limit by Woolcock et al. 1999 Span/100 = 30.00 mm
Sag during installation =4.91 mm

#### Reactions

Maximum = 1.00 kn

## Middle Pole Design

#### Geometry

| | | | |
|---|---|---|---|
| 350 SED H5 (Minimum 375 dia. at Floor Level) | Dry Use | Height | 6000 mm |
| Area | 103154 mm2 | As | 77365.4296875 mm2 |
| Ix | 847191750 mm4 | Zx | 4674161 mm3 |
| Iy | 847191750 mm4 | Zx | 4674161 mm3 |
| Lateral Restraint | 6000 mm c/c | | |

#### Loads

Total Area over Pole = 45 m2

| | | | |
|---|---|---|---|
| Dead | 11.25 Kn | Live | 11.25 Kn |

| | | | |
|---|---|---|---|
| Wind Down | 16.65 Kn | Snow | 28.35 Kn |
| Moment wind | 41.21 Kn-m | Moment snow | 8.08 Kn-m |
| Phi | 0.8 | K8 | 0.84 |
| 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 | 1241.10 Kn | PhiMnx Wind | 113.41 Kn-m | PhiVnx Wind | 183.20 Kn |
| PhiNcx Dead | 744.66 Kn | PhiMnx Dead | 68.05 Kn-m | PhiVnx Dead | 109.92 Kn |
| PhiNcx Snow | 992.88 Kn | PhiMnx Snow | 90.73 Kn-m | PhiVnx Snow | 146.56 Kn |

**Checks**

(Mx/PhiMnx)+(N/phiNcx) = 0.41 < 1 OK

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

Deflection at top under service lateral loads = 31.89 mm < 60.00 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 = | 2300 mm | Pile embedment length |
| f1 = | 5400 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

**Loads**

| | | | |
|---|---|---|---|
| Moment Wind = | 41.21 Kn-m | Moment Snow = | Kn-m |
| Shear Wind = | 7.63 Kn | Shear Snow = | 8.08 Kn |

**Pile Properties**

| | | |
|---|---|---|
| Safety Factory | 0.55 | |
| Hu = | 14.08 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 44.61 Kn-m | Ultimate Moment Capacity of Pile |

**Checks**

Applied Forces/Capacities = 0.92 < 1 OK

## End Pole Design

**Geometry For End Bay Pole**

**Geometry**

| | | | |
|---|---|---|---|
| 275 SED H5 (Minimum 300 dia. at Floor Level) | Dry Use | Height | 6900 mm |
| Area | 64885 mm2 | As | 48663.8671875 mm2 |
| Ix | 335197731 mm4 | Zx | 2331810 mm3 |
| Iy | 335197731 mm4 | Zx | 2331810 mm3 |
| Lateral Restraint | mm c/c | | |

**Loads**

Total Area over Pole = 15 m2

| | | | |
|---|---|---|---|
| Dead | 3.75 Kn | Live | 3.75 Kn |
| Wind Down | 5.55 Kn | Snow | 9.45 Kn |
| Moment Wind | 10.30 Kn-m | Moment snow | 2.02 Kn-m |
| Phi | 0.8 | K8 | 0.49 |
| 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 | 461.03 Kn | PhiMnx Wind | 33.41 Kn-m | PhiVnx Wind | 115.24 Kn |
| PhiNcx Dead | 276.62 Kn | PhiMnx Dead | 20.05 Kn-m | PhiVnx Dead | 69.14 Kn |
| PhiNcx Snow | 368.83 Kn | PhiMnx Snow | 26.73 Kn-m | PhiVnx Snow | 92.19 Kn |

**Checks**

(Mx/PhiMnx)+(N/phiNcx) = 0.35 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.14 < 1 OK

Deflection at top under service lateral loads = 24.12 mm < 71.82 mm

| | | |
|---|---|---|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1800 mm | Pile embedment length |
| f1 = | 5400 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

**Loads**

Total Area over Pole = 15 m2

| | | | |
|---|---|---|---|
| Moment Wind = | 10.30 Kn-m | Moment Snow = | 2.02 Kn-m |
| Shear Wind = | 1.91 Kn | Shear Snow = | 2.02 Kn |

**Pile Properties**

| | | |
|---|---|---|
| Safety Factory | 0.55 | |
| Hu = | 7.22 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 22.46 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 = | 1800 mm | Pile embedment length |
| f1 = | 5400 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

**Loads**

| | | | |
|---|---|---|---|
| Moment Wind = | 10.30 Kn-m | Moment Snow = | 2.02 Kn-m |
| Shear Wind = | 1.91 Kn | Shear Snow = | 2.02 Kn |

**Pile Properties**

| | | |
|---|---|---|
| Safety Factory | 0.55 | |
| Hu = | 7.22 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 22.46 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(2300) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(2300)

Skin Friction = 42.72 Kn

Weight of Pile + Pile Skin Friction = 45.26 Kn

Uplift on one Pile = 18.68 Kn

Uplift is ok