Pole Shed App Ver 01 2022

| | | | | | |
|---|---|---|---|---|---|
| **Job No.:** | Joyce Shed | **Address:** | 276A Cape Hill Rd,Pukekohe,New Zealand | **Date:** | 17/05/2024 |
| **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**

**Purlin Design**

Purlin Spacing = 700 mm Purlin Span = 5850 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 =0.47 S1 Downward =13.82 S1 Upward =24.81

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

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 1.01 Kn-m | Capacity | 2.73 Kn-m | Passing Percentage | **270.30 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 2.61 Kn-m | Capacity | 3.64 Kn-m | Passing Percentage | **139.46 %** |
| $M_{0.9D-WnUp}$ | -2.23 Kn-m | Capacity | -2.25 Kn-m | Passing Percentage | **277.78 %** |
| $V_{1.35D}$ | 0.69 Kn | Capacity | 10.42 Kn | Passing Percentage | **1510.14 %** |

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| | | | | | |
|---|---|---|---|---|---|
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 1.78 Kn | Capacity | 13.89 Kn | Passing Percentage | **780.34 %** |
| $V_{0.9D\text{-}WnUp}$ | -1.53 Kn | Capacity | -17.37 Kn | Passing Percentage | **1135.29 %** |

**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 = 17.82 mm Limit by Woolcock et al, 1999 Span/240 = 24.17 mm
Deflection under Dead and Service Wind = 23.31 mm Limit by Woolcock et al, 1999 Span/100 = 58.00 mm

**Reactions**

Maximum downward =1.78 kn Maximum upward = -1.53 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 = 6000 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**

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 19.83 Kn-m | Capacity | 52.7 Kn-m | Passing Percentage | **265.76 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 51.11 Kn-m | Capacity | 70.26 Kn-m | Passing Percentage | **137.47 %** |
| $M_{0.9D\text{-}WnUp}$ | -43.76 Kn-m | Capacity | -87.84 Kn-m | Passing Percentage | **200.73 %** |
| $V_{1.35D}$ | 8.96 Kn | Capacity | 61.36 Kn | Passing Percentage | **684.82 %** |
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 23.10 Kn | Capacity | 81.82 Kn | Passing Percentage | **354.20 %** |
| $V_{0.9D\text{-}WnUp}$ | -19.78 Kn | Capacity | -102.26 Kn | Passing Percentage | **516.99 %** |

**Deflections**

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 26.21 mm Limit by Woolcock et al, 1999 Span/240 = 37.50 mm
Deflection under Dead and Service Wind = 38.105 mm Limit by Woolcock et al, 1999 Span/100 = 90.00 mm

**Reactions**

Maximum downward =23.10 kn Maximum upward = -19.78 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 > -19.78 Kn

### Rafter Design External

External Rafter Load Width = 3000 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

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 10.04 Kn-m | Capacity | 20.31 Kn-m | Passing Percentage | **202.29 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 25.89 Kn-m | Capacity | 27.08 Kn-m | Passing Percentage | **104.60 %** |
| $M_{0.9D-WnUp}$ | -22.17 Kn-m | Capacity | -33.85 Kn-m | Passing Percentage | **152.68 %** |
| $V_{1.35D}$ | 4.51 Kn | Capacity | 30.68 Kn | Passing Percentage | **680.27 %** |
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 11.62 Kn | Capacity | 40.91 Kn | Passing Percentage | **352.07 %** |
| $V_{0.9D-WnUp}$ | -9.95 Kn | Capacity | -51.13 Kn | Passing Percentage | **513.87 %** |

#### Deflections

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

k2 for Long Term Loads = 2

| | |
|---|---|
| Deflection under Dead and Live Load = 29.12 mm | Limit by Woolcock et al, 1999 Span/240= 37.50 mm |
| Deflection under Dead and Service Wind = 38.10 mm | Limit by Woolcock et al, 1999 Span/100 = 90.00 mm |

#### Reactions

Maximum downward =11.62 kn Maximum upward = -9.95 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 > -9.95 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -9.95 Kn

**Intermediate Design Front and Back**

Intermediate Spacing = 3000 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**

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 2.60 Kn-m | Capacity | 3.3 Kn-m | Passing Percentage | **126.92 %** |
| $V_{0.9D\text{-}WnUp}$ | 4.16 Kn | Capacity | -20.26 Kn | Passing Percentage | **487.02 %** |

**Deflections**

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

Deflection under Snow and Service Wind = 15.225 mm    Limit byWoolcock et al, 1999 Span/100 = 24.99 mm

**Reactions**

Maximum = 4.16 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 %** |
| $V_{0.9D\text{-}WnUp}$ | 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 = 3000 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 =0.72    S1 Downward =10.36    S1 Upward =18.92

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

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 1.12 Kn-m | Capacity | 1.19 Kn-m | Passing Percentage | **106.25 %** |
| $V_{0.9D-WnUp}$ | 1.50 Kn | Capacity | 10.13 Kn | Passing Percentage | **675.33 %** |

**Deflections**

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

Deflection under Snow and Service Wind = 15.28 mm    Limit by Woolcock et al, 1999 Span/100 = 30.00 mm
Sag during installation = 6.06 mm

**Reactions**

Maximum = 1.50 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 = 27 m2

| | | | |
|---|---|---|---|
| Dead | 6.75 Kn | Live | 6.75 Kn |
| Wind Down | 15.39 Kn | Snow | 0.00 Kn |
| Moment wind | 16.25 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) = 0.65 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.41 < 1 OK

Deflection at top under service lateral loads = 23.10 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 = | 16.25 Kn-m |
| Shear Wind = | 6.47 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 = 0.93 < 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 = 27 m2

| | | | |
|---|---|---|---|
| Dead | 6.75 Kn | Live | 6.75 Kn |
| Wind Down | 15.39 Kn | Snow | 0.00 Kn |
| Moment Wind | 8.12 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) = 0.48 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.24 < 1 OK

Deflection at top under service lateral loads = 18.51 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 = 27 m2

| | |
|---|---|
| Moment Wind = | 8.12 Kn-m |
| Shear Wind = | 3.23 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 = 0.71 < 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 = | 8.12 Kn-m |
| Shear Wind = | 3.23 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 = 0.71 < 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 = 20.11 Kn

Uplift is ok