

Pole Shed App Ver 01 2022

Job No.: S & K Bennett

Address: 45 Charnley Way, Taupo, New Zealand

Date: 14/06/2024

Latitude: -38.6621

Longitude: 175.978186

Elevation: 493.5 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 | 4.1 m |
| Wind Region | NZ2 | Terrain Category | 2.12 | Design Wind Speed | 38.89 m/s |
| Wind Pressure | 0.91 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 Pressures

Shed Type = Mono Open

For roof $C_{p,i} = 0.6643$

For roof $C_{p,e}$ from 0 m To 3.85 m $C_{p,e} = -0.9$ $p_e = -0.74$ KPa $p_{net} = -1.39$ KPa

For roof $C_{p,e}$ from 3.85 m To 7.70 m $C_{p,e} = -0.5$ $p_e = -0.41$ KPa $p_{net} = -1.06$ KPa

For wall Windward $C_{p,i} = 0.6643$ side Wall $C_{p,i} = -0.5836$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 8 m $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 1.14$ KPa

For side wall $C_{p,e}$ from 0 m To 3.85 m $C_{p,e} =$ $p_e = -0.41$ KPa $p_{net} = 0.16$ KPa

Maximum Upward pressure used in roof member Design = 1.39 KPa

Maximum Downward pressure used in roof member Design = 0.65 KPa

Maximum Wall pressure used in Design = 1.14 KPa

Maximum Racking pressure used in Design = 0.98 KPa

Design Summary

Purlin Design

Purlin Spacing = 600 mm

Purlin Span = 5850 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 = 0.54 S1 Downward = 12.68 S1 Upward = 22.76

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

Capacity Checks

| | | | | | |
|--|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 0.87 Kn-m | Capacity | 3.40 Kn-m | Passing Percentage | 390.80 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}} | 2.44 Kn-m | Capacity | 4.53 Kn-m | Passing Percentage | 185.66 % |
| M _{0.9D-W_{nUp}} | -2.99 Kn-m | Capacity | -3.16 Kn-m | Passing Percentage | 105.69 % |
| V _{1.35D} | 0.59 Kn | Capacity | 12.06 Kn | Passing Percentage | 2044.07 % |

Pole Shed App Ver 01 2022

| | | | | | |
|--|----------|----------|-----------|--------------------|-----------------|
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 1.67 Kn | Capacity | 16.08 Kn | Passing Percentage | 962.87 % |
| V _{0.9D-WnUp} | -2.04 Kn | Capacity | -20.10 Kn | Passing Percentage | 985.29 % |

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 = 12.16 mm Limit by Woolcock et al, 1999 Span/240 = 24.17 mm

Deflection under Dead and Service Wind = 16.72 mm Limit by Woolcock et al, 1999 Span/100 = 58.00 mm

Reactions

Maximum downward = 1.67 kn Maximum upward = -2.04 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 = 3850 mm Try Rafter 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 K₁ Medium term = 0.8 K₁ Long term = 0.6 K₄ = 1 K₅ = 1 K₈ Downward = 1.00

K₈ Upward = 1.00 S₁ Downward = 6.81 S₁ Upward = 6.81

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

Capacity Checks

| | | | | | |
|--|-------------|----------|------------|--------------------|-----------------|
| M _{1.35D} | 3.75 Kn-m | Capacity | 10.08 Kn-m | Passing Percentage | 268.80 % |
| M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 10.56 Kn-m | Capacity | 13.44 Kn-m | Passing Percentage | 127.27 % |
| M _{0.9D-WnUp} | -12.95 Kn-m | Capacity | -16.8 Kn-m | Passing Percentage | 129.73 % |
| V _{1.35D} | 3.90 Kn | Capacity | 28.94 Kn | Passing Percentage | 742.05 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 10.97 Kn | Capacity | 38.6 Kn | Passing Percentage | 351.87 % |
| V _{0.9D-WnUp} | -13.46 Kn | Capacity | -48.24 Kn | Passing Percentage | 358.40 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.445 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 6.79 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 10.97 kn Maximum upward = -13.46 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 = 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

$K_{11} = 2.0$ $f_{cj} = 36.1$ Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 32.51 Kn > -13.46 Kn

Rafter Design External

External Rafter Load Width = 3000 mm

External Rafter Span = 3808 mm

Try Rafter 360x45 LVL13

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

K_1 Short term = 1 K_1 Medium term = 0.8 K_1 Long term = 0.6 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.81

K_8 Upward = 0.81 S_1 Downward = 17.01 S_1 Upward = 17.01

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

Capacity Checks

| | | | | | |
|--|------------|----------|-------------|--------------------|------------------|
| $M_{1.35D}$ | 1.84 Kn-m | Capacity | 17.70 Kn-m | Passing Percentage | 961.96 % |
| $M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$ | 5.17 Kn-m | Capacity | 23.60 Kn-m | Passing Percentage | 456.48 % |
| $M_{0.9D-W_nUp}$ | -6.34 Kn-m | Capacity | -29.50 Kn-m | Passing Percentage | 465.30 % |
| $V_{1.35D}$ | 1.93 Kn | Capacity | 27.61 Kn | Passing Percentage | 1430.57 % |
| $V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$ | 5.43 Kn | Capacity | 36.82 Kn | Passing Percentage | 678.08 % |
| $V_{0.9D-W_nUp}$ | -6.65 Kn | Capacity | -46.02 Kn | Passing Percentage | 692.03 % |

Deflections

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

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 1.56 mm

Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 2.14 mm

Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 5.43 kn Maximum upward = -6.65 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

Factor of Safety = 0.7

For Perpendicular to grain loading

$K_{11} = 12.6$ $f_{pj} = 22.7$ Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

$K_{11} = 2.0$ $f_{c,j} = 36.1$ MPa for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi_i \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -50.09 kN > -6.65 kN

Single Shear Capacity under short term loads = -14.56 kN > -6.65 kN

Intermediate Design Front and Back

Intermediate Spacing = 3000 mm

Intermediate Span = 3950 mm

Try Intermediate 2x200x50 SG8 Dry

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

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 1.00 S_1 Downward = 11.27 S_1 Upward = 0.75

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

Capacity Checks

| | | | | | |
|-----------------|-----------|----------|-----------|--------------------|-----------------|
| $M_{Wind+Snow}$ | 6.67 kN-m | Capacity | 7.46 kN-m | Passing Percentage | 111.84 % |
| $V_{0.9D-WnUp}$ | 6.75 kN | Capacity | -32.16 kN | Passing Percentage | 476.44 % |

Deflections

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

Deflection under Snow and Service Wind = 30.115 mm

Limit by Woolcock et al, 1999 Span/100 = 39.50 mm

Reactions

Maximum = 6.75 kN

Girt Design Front and Back

Girt's Spacing = 1300 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.64 S_1 Downward = 11.27 S_1 Upward = 20.58

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

Capacity Checks

| | | | | | |
|-----------------|-----------|----------|-----------|--------------------|-----------------|
| $M_{Wind+Snow}$ | 1.67 kN-m | Capacity | 2.40 kN-m | Passing Percentage | 143.71 % |
| $V_{0.9D-WnUp}$ | 2.22 kN | Capacity | 16.08 kN | Passing Percentage | 724.32 % |

Deflections

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

Deflection under Snow and Service Wind = 7.00 mm

Limit by Woolcock et al, 1999 Span/100 = 30.00 mm

Sag during installation = 4.91 mm

Reactions

Maximum = 2.22 kn

Girt Design Sides

Girt's Spacing = 800 mm

Girt's Span = 4000 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 =0.50 S1 Downward =11.27 S1 Upward =23.76

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|-----------------|
| M _{Wind+Snow} | 1.82 Kn-m | Capacity | 1.87 Kn-m | Passing Percentage | 102.75 % |
| V _{0.9D-WnUp} | 1.82 Kn | Capacity | 16.08 Kn | Passing Percentage | 883.52 % |

Deflections

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

Deflection under Snow and Service Wind = 13.61 mm

Limit by Woolcock et al. 1999 Span/100 = 40.00 mm

Sag during installation =15.52 mm

Reactions

Maximum = 1.82 kn

Middle Pole Design

Geometry

| | | | |
|--|---------------------------|----------------|-------------------------------|
| 200 SED H5 (Minimum 225 dia. at Floor Level) | Dry Use | Height | 3800 mm |
| Area | 35448 mm ² | As | 26585.7421875 mm ² |
| I _x | 100042702 mm ⁴ | Z _x | 941578 mm ³ |
| I _y | 100042702 mm ⁴ | Z _x | 941578 mm ³ |
| Lateral Restraint | 1300 mm c/c | | |

Loads

Total Area over Pole = 24 m²

| | | | |
|-------------|------------|---------|---------|
| Dead | 6.00 Kn | Live | 6.00 Kn |
| Wind Down | 15.60 Kn | Snow | 0.00 Kn |
| Moment wind | 12.32 Kn-m | | |
| Phi | 0.8 | K8 | 1.00 |
| K1 snow | 0.8 | K1 Dead | 0.6 |
| K1 wind | 1 | | |

Material

| | | | |
|---------|----------|--------|---------|
| Peeling | Steaming | Normal | Dry Use |
|---------|----------|--------|---------|

Pole Shed App Ver 01 2022

| | | | |
|------|----------|------|----------|
| fb = | 36.3 MPa | fs = | 2.96 MPa |
| fc = | 18 MPa | fp = | 7.2 MPa |
| ft = | 22 MPa | E = | 9257 MPa |

Capacities

| | | | | | |
|-------------|-----------|-------------|------------|-------------|----------|
| PhiNcx Wind | 510.45 Kn | PhiMnx Wind | 27.34 Kn-m | PhiVnx Wind | 62.96 Kn |
| PhiNcx Dead | 306.27 Kn | PhiMnx Dead | 16.41 Kn-m | PhiVnx Dead | 37.77 Kn |

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.50 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.26 < 1$ OK

Deflection at top under service lateral loads = 29.13 mm < 38.00 mm

Drained Lateral Strength of Middle pile in cohesionless soils Free Head short pile

Assumed Soil Properties

| | | | | | |
|-------|-----------------------------------|----------------|--------|----------|---------------------|
| Gamma | 18 Kn/m ³ | Friction angle | 30 deg | Cohesion | 0 Kn/m ³ |
| 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 = | 3075 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

| | |
|---------------|------------|
| Moment Wind = | 12.32 Kn-m |
| Shear Wind = | 4.01 Kn |

Pile Properties

| | | |
|----------------|------------|---|
| Safety Factory | 0.55 | |
| Hu = | 9.90 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 18.38 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.67 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

| | | | |
|--|--------------------------|--------|-------------------------------|
| 175 SED H5 (Minimum 200 dia. at Floor Level) | Dry Use | Height | 3740 mm |
| Area | 27598 mm ² | As | 20698.2421875 mm ² |
| Ix | 60639381 mm ⁴ | Zx | 646820 mm ³ |

Pole Shed App Ver 01 2022

| | | | |
|-------------------|--------------------------|----|------------------------|
| Iy | 60639381 mm ⁴ | Zx | 646820 mm ³ |
| Lateral Restraint | mm c/c | | |

Loads

Total Area over Pole = 12 m²

| | | | |
|-------------|-----------|---------|---------|
| Dead | 3.00 Kn | Live | 3.00 Kn |
| Wind Down | 7.80 Kn | Snow | 0.00 Kn |
| Moment Wind | 6.16 Kn-m | | |
| Phi | 0.8 | K8 | 0.67 |
| K1 snow | 0.8 | K1 Dead | 0.6 |
| K1 wind | 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 | 267.41 Kn | PhiMnx Wind | 12.64 Kn-m | PhiVnx Wind | 49.01 Kn |
| PhiNcx Dead | 160.44 Kn | PhiMnx Dead | 7.58 Kn-m | PhiVnx Dead | 29.41 Kn |

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.54 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.29 < 1$ OK

Deflection at top under service lateral loads = 25.86 mm < 40.90 mm

| | | |
|------|---------|--|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1400 mm | Pile embedment length |
| f1 = | 3075 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 = | 6.16 Kn-m |
| Shear Wind = | 2.00 Kn |

Pile Properties

| | | |
|---------------|-----------|---|
| Safety Factor | 0.55 | |
| Hu = | 5.46 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 9.92 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.62 < 1 OK

Drained Lateral Strength of End pile in cohesionless soils Free Head short pile

Assumed Soil Properties

| | | | | | |
|-------|-----------------------------------|----------------|--------|----------|---------------------|
| Gamma | 18 Kn/m ³ | Friction angle | 30 deg | Cohesion | 0 Kn/m ³ |
| 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 = | 3075 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

| | |
|---------------|-----------|
| Moment Wind = | 6.16 Kn-m |
| Shear Wind = | 2.00 Kn |

Pile Properties

| | | |
|----------------|-----------|---|
| Safety Factory | 0.55 | |
| Hu = | 5.46 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 9.92 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.62 < 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 = Safety 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 = 29.28 Kn

Uplift on one Pile = 27.96 Kn

Uplift is ok