

Pole Shed App Ver 01 2022

Job No.: Lisa Welch and Daniel Mouatt
Address: Lot 10 DP 535188 Te Kapua Rise,
Puketapu, New Zealand

Date: 17/04/2025

Latitude: -39.483081

Longitude: 176.817103

Elevation: 29.5 m

General Input

| | | | | | |
|------------------|----------|--------------------------------|-----------|----------------------|-----------|
| Roof Live Load | 0.25 KPa | Roof Dead Load | 0.25 KPa | Roof Live Point Load | 1.1 Kn |
| Snow Zone | N1 | Ground Snow Load | 0 KPa | Roof Snow Load | 0 KPa |
| Earthquake Zone | 3 | Subsoil Category | D | Exposure Zone | C |
| Importance Level | 1 | Ultimate wind & Earthquake ARI | 100 Years | Max Height | 5.67 m |
| Wind Region | NZ2 | Terrain Category | 1.78 | Design Wind Speed | 37.68 m/s |
| Wind Pressure | 0.85 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 $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 2.68 m $C_{p,e} = -1.035$ $p_e = -0.77$ KPa $p_{net} = -0.77$ KPa

For roof $C_{p,e}$ from 2.68 m To 5.35 m $C_{p,e} = -0.8325$ $p_e = -0.62$ KPa $p_{net} = -0.62$ KPa

For wall Windward $C_{p,i} = -0.3$ side Wall $C_{p,i} = -0.3$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 12 m $C_{p,e} = 0.7$ $p_e = 0.53$ KPa $p_{net} = 0.78$ KPa

For side wall $C_{p,e}$ from 0 m To 5.35 m $C_{p,e} =$ $p_e = -0.49$ KPa $p_{net} = -0.49$ KPa

Maximum Upward pressure used in roof member Design = 0.77 KPa

Maximum Downward pressure used in roof member Design = 0.33 KPa

Maximum Wall pressure used in Design = 0.78 KPa

Maximum Racking pressure used in Design = 0.89 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 6040 mm

Try Purlin 240x45 LVL13

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 = 0.94

K8 Upward = 0.45 S1 Downward = 13.82 S1 Upward = 25.21

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

Capacity Checks

| | | | | | |
|---|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 1.39 Kn-m | Capacity | 9.37 Kn-m | Passing Percentage | 674.10 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 3.72 Kn-m | Capacity | 12.49 Kn-m | Passing Percentage | 335.75 % |
| M _{0.9D-W_nUp} | -2.24 Kn-m | Capacity | -7.53 Kn-m | Passing Percentage | 336.16 % |
| V _{1.35D} | 0.92 Kn | Capacity | 18.41 Kn | Passing Percentage | 2001.09 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 1.83 Kn | Capacity | 24.54 Kn | Passing Percentage | 1340.98 % |
| V _{0.9D-W_nUp} | -1.48 Kn | Capacity | -30.68 Kn | Passing Percentage | 2072.97 % |

Deflections

Modulus of Elasticity = 12100 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 = 19.88 mm Limit by Woolcock et al, 1999 Span/240 = 24.96 mm

Deflection under Dead and Service Wind = 15.99 mm Limit by Woolcock et al, 1999 Span/100 = 59.90 mm

Reactions

Maximum downward = 1.83 kn Maximum upward = -1.48 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 = 6190 mm Internal Rafter Span = 8050 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

| | | | | | |
|---|------------|----------|------------|--------------------|-----------------|
| M _{1.35D} | 16.92 Kn-m | Capacity | 43.44 Kn-m | Passing Percentage | 256.74 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 33.85 Kn-m | Capacity | 57.92 Kn-m | Passing Percentage | 171.11 % |

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| | | | | | |
|--|-------------|----------|-------------|--------------------|-----------------|
| M _{0.9D-WnUp} | -27.33 Kn-m | Capacity | -72.42 Kn-m | Passing Percentage | 264.98 % |
| V _{1.35D} | 8.41 Kn | Capacity | 55.22 Kn | Passing Percentage | 656.60 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 16.82 Kn | Capacity | 73.64 Kn | Passing Percentage | 437.81 % |
| V _{0.9D-WnUp} | -13.58 Kn | Capacity | -92.04 Kn | Passing Percentage | 677.76 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 25.56 mm Limit by Woolcock et al, 1999 Span/240 = 34.17 mm

Deflection under Dead and Service Wind = 31.48 mm Limit by Woolcock et al, 1999 Span/100 = 82.00 mm

Reactions

Maximum downward = 16.82 kn Maximum upward = -13.58 kn

Rafter to Pole Connection check

Bolt Size = M16 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

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 76.25 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 = 68.64 Kn > -13.58 Kn

Intermediate Design Front and Back

Intermediate Spacing = 3095 mm Intermediate Span = 4803 mm Try Intermediate 2x240x45 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 = 0.94

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K8 Upward =1.00 S1 Downward =13.82 S1 Upward =1.01

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|-----------------|
| M _{Wind+Snow} | 6.96 Kn-m | Capacity | 9.68 Kn-m | Passing Percentage | 139.08 % |
| V _{0.9D-WnUp} | 5.80 Kn | Capacity | -34.74 Kn | Passing Percentage | 598.97 % |

Deflections

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

Deflection under Snow and Service Wind = 29.87 mm Limit by Woolcock et al, 1999 Span/100 = 48.03 mm

Reactions

Maximum = 5.80 kn

Girt Design Front and Back

Girt's Spacing = 900 mm Girt's Span = 3095 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 =0.55 S1 Downward =12.23 S1 Upward =22.68

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|------------------|
| M _{Wind+Snow} | 0.84 Kn-m | Capacity | 1.65 Kn-m | Passing Percentage | 196.43 % |
| V _{0.9D-WnUp} | 1.09 Kn | Capacity | 13.75 Kn | Passing Percentage | 1261.47 % |

Deflections

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

Deflection under Snow and Service Wind = 4.87 mm Limit by Woolcock et al, 1999 Span/100 = 30.95 mm
Sag during installation = 6.87 mm

Reactions

Maximum = 1.09 kn

Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 4100 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 = 0.75 S1 Downward = 12.23 S1 Upward = 18.45

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|-----------------|
| M _{Wind+Snow} | 1.48 Kn-m | Capacity | 2.26 Kn-m | Passing Percentage | 152.70 % |
| V _{0.9D-WnUp} | 1.44 Kn | Capacity | 13.75 Kn | Passing Percentage | 954.86 % |

Deflections

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

Deflection under Snow and Service Wind = 14.99 mm Limit by Woolcock et al. 1999 Span/100 = 41.00 mm

Sag during installation = 21.15 mm

Reactions

Maximum = 1.44 kn

Middle Pole Design

Geometry

| | | | |
|--|---------------------------|----------------|-------------------------------|
| 275 SED H5 (Minimum 300 dia. at Floor Level) | Dry Use | Height | 5500 mm |
| Area | 64885 mm ² | As | 48663.8671875 mm ² |
| I _x | 335197731 mm ⁴ | Z _x | 2331810 mm ³ |
| I _y | 335197731 mm ⁴ | Z _y | 2331810 mm ³ |
| Lateral Restraint | 5500 mm c/c | | |

Loads

Total Area over Pole = 25.379 m²

| | | | |
|-------------|------------|------|---------|
| Dead | 6.34 Kn | Live | 6.34 Kn |
| Wind Down | 8.38 Kn | Snow | 0.00 Kn |
| Moment wind | 33.13 Kn-m | | |

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| | | | |
|---------|-----|---------|------|
| Phi | 0.8 | K8 | 0.71 |
| 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 | 665.98 Kn | PhiMnx Wind | 48.27 Kn-m | PhiVnx Wind | 115.24 Kn |
| PhiNcx Dead | 399.59 Kn | PhiMnx Dead | 28.96 Kn-m | PhiVnx Dead | 69.14 Kn |

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.72 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.50 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 46.78 \text{ mm} < 55.00 \text{ mm}$$

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 = | 2200 mm | Pile embedment length |
| f1 = | 4252 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

| | |
|---------------|------------|
| Moment Wind = | 33.13 Kn-m |
| Shear Wind = | 7.79 Kn |

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Pile Properties

| | | |
|----------------|------------|---|
| Safety Factory | 0.55 | |
| Hu = | 14.70 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 37.37 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.89 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

| | | | |
|--|---------------------------|--------|-------------------------------|
| 225 SED H5 (Minimum 250 dia. at Floor Level) | Dry Use | Height | 5470 mm |
| Area | 44279 mm ² | As | 33209.1796875 mm ² |
| Ix | 156100441 mm ⁴ | Zx | 1314530 mm ³ |
| Iy | 156100441 mm ⁴ | Zy | 1314530 mm ³ |
| Lateral Restraint | mm c/c | | |

Loads

Total Area over Pole = 12.6895 m²

| | | | |
|-------------|------------|---------|---------|
| Dead | 3.17 Kn | Live | 3.17 Kn |
| Wind Down | 4.19 Kn | Snow | 0.00 Kn |
| Moment Wind | 11.04 Kn-m | | |
| Phi | 0.8 | K8 | 0.53 |
| 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 | 338.54 Kn | PhiMnx Wind | 20.27 Kn-m | PhiVnx Wind | 78.64 Kn |
| PhiNcx Dead | 203.12 Kn | PhiMnx Dead | 12.16 Kn-m | PhiVnx Dead | 47.18 Kn |

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.58 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.33 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 34.43 \text{ mm} < 56.56 \text{ mm}$$

| | | |
|------|---------|--|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1500 mm | Pile embedment length |
| f1 = | 4252 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

$$\text{Total Area over Pole} = 12.6895 \text{ m}^2$$

| | |
|---------------|------------|
| Moment Wind = | 11.04 Kn-m |
| Shear Wind = | 2.60 Kn |

Pile Properties

| | | |
|----------------|------------|---|
| Safety Factory | 0.55 | |
| Hu = | 5.23 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 12.86 Kn-m | Ultimate Moment Capacity of Pile |

Checks

$$\text{Applied Forces/Capacities} = 0.86 < 1 \text{ OK}$$

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 = | 1500 mm | Pile embedment length |
| f1 = | 4252 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

Moment Wind = 11.04 Kn-m
Shear Wind = 2.60 Kn

Pile Properties

Safety Factory 0.55
Hu = 5.23 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 12.86 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.86 < 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(2200) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(2200)

Skin Friction = 39.09 Kn

Weight of Pile + Pile Skin Friction = 42.94 Kn

Uplift on one Pile = 13.83 Kn

Uplift is ok