

Pole Shed App Ver 01 2022

Job No.: 168-3022315

Address: 71 OMAHA VALLEY ROAD,
MATAKANA, New Zealand

Date: 19/12/2023

Latitude: -36.317786

Longitude: 174.723958

Elevation: 16 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 | 4.2 m |
| Wind Region | NZ1 | Terrain Category | 2.0 | Design Wind Speed | 38.22 m/s |
| Wind Pressure | 0.88 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 Enclosed

For roof $C_{p,i} = 0.6459$

For roof $C_{p,e}$ from 0 m To 2.0 m $C_{p,e} = -1.033$ $p_e = -0.69$ KPa $p_{net} = -1.21$ KPa

For roof $C_{p,e}$ from 2.0 m To 4.0 m $C_{p,e} = -0.8333$ $p_e = -0.56$ KPa $p_{net} = -1.08$ KPa

For wall Windward $C_{p,i} = 0.6459$ side Wall $C_{p,i} = -0.5495$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 18 m $C_{p,e} = 0.7$ $p_e = 0.55$ KPa $p_{net} = 1.07$ KPa

For side wall $C_{p,e}$ from 0 m To 4.0 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = 0.01$ KPa

Maximum Upward pressure used in roof member Design = 1.21 KPa

Maximum Downward pressure used in roof member Design = 0.68 KPa

Maximum Wall pressure used in Design = 1.07 KPa

Maximum Racking pressure used in Design = 0.94 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 5850 mm

Try Purlin 240x45 LVL13

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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 = 0.24 S1 Downward = 13.82 S1 Upward = 35.08

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

Capacity Checks

| | | | | | |
|---|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 1.3 Kn-m | Capacity | 9.37 Kn-m | Passing Percentage | 720.77 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 3.77 Kn-m | Capacity | 12.49 Kn-m | Passing Percentage | 331.30 % |
| M _{0.9D-W_nUp} | -3.79 Kn-m | Capacity | -3.97 Kn-m | Passing Percentage | 104.75 % |
| V _{1.35D} | 0.89 Kn | Capacity | 18.41 Kn | Passing Percentage | 2068.54 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 2.58 Kn | Capacity | 24.54 Kn | Passing Percentage | 951.16 % |
| V _{0.9D-W_nUp} | -2.59 Kn | Capacity | -30.68 Kn | Passing Percentage | 1184.56 % |

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 = 12.69 mm Limit by Woolcock et al, 1999 Span/240 = 24.17 mm

Deflection under Dead and Service Wind = 17.76 mm Limit by Woolcock et al, 1999 Span/100 = 58.00 mm

Reactions

Maximum downward = 2.58 kn Maximum upward = -2.59 kn

Number of Blocking = 0 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 = 5850 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

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| | | | | | |
|--|-------------|----------|-------------|--------------------|-----------------|
| M _{1.35D} | 8.66 Kn-m | Capacity | 43.44 Kn-m | Passing Percentage | 501.62 % |
| M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 25.15 Kn-m | Capacity | 57.92 Kn-m | Passing Percentage | 230.30 % |
| M _{0.9D-WnUp} | -25.28 Kn-m | Capacity | -72.42 Kn-m | Passing Percentage | 286.47 % |
| V _{1.35D} | 5.92 Kn | Capacity | 55.22 Kn | Passing Percentage | 932.77 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 17.20 Kn | Capacity | 73.64 Kn | Passing Percentage | 428.14 % |
| V _{0.9D-WnUp} | -17.29 Kn | Capacity | -92.04 Kn | Passing Percentage | 532.33 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 7.1 mm Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 11.05 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 17.20 kn Maximum upward = -17.29 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

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 = 43.67 Kn > -17.29 Kn

Rafter Design External

External Rafter Load Width = 3000 mm External Rafter Span = 5813 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)

K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.81

K8 Upward = 0.81 S1 Downward = 17.01 S1 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} | 4.28 Kn-m | Capacity | 17.70 Kn-m | Passing Percentage | 413.55 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 12.42 Kn-m | Capacity | 23.60 Kn-m | Passing Percentage | 190.02 % |
| M _{0.9D-W_nUp} | -12.48 Kn-m | Capacity | -29.50 Kn-m | Passing Percentage | 236.38 % |
| V _{1.35D} | 2.94 Kn | Capacity | 27.61 Kn | Passing Percentage | 939.12 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 8.55 Kn | Capacity | 36.82 Kn | Passing Percentage | 430.64 % |
| V _{0.9D-W_nUp} | -8.59 Kn | Capacity | -46.02 Kn | Passing Percentage | 535.74 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 7.89 mm Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 11.05 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 8.55 kn Maximum upward = -8.59 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

K₁₁ = 12.6 f_{pj} = 22.7 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

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$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -50.09 kn > -8.59 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -8.59 Kn

Girt Design Front and Back

Girt's Spacing = 800 mm

Girt's Span = 6000 mm

Try Girt 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 K4 =1 K5 =1 K8 Downward =0.97

K8 Upward =0.72 S1 Downward =12.68 S1 Upward =18.90

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

Capacity Checks

| | | | | | |
|-----------------|-----------|----------|------------|--------------------|-----------------|
| $M_{Wind+Snow}$ | 3.85 Kn-m | Capacity | 4.22 Kn-m | Passing Percentage | 109.61 % |
| $V_{0.9D-WnUp}$ | 2.57 Kn-m | Capacity | 20.10 Kn-m | Passing Percentage | 782.10 % |

Deflections

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

Deflection under Snow and Service Wind = 33.12 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Sag during installation = 78.58 mm

Reactions

Maximum = 2.57 kn

Girt Design Sides

Girt's Spacing = 800 mm

Girt's Span = 6000 mm

Try Girt 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 K4 =1 K5 =1 K8 Downward =0.97

K8 Upward =0.72 S1 Downward =12.68 S1 Upward =18.90

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

Capacity Checks

Pole Shed App Ver 01 2022

| | | | | | |
|------------------------|-----------|----------|------------|--------------------|-----------------|
| M _{Wind+Snow} | 3.85 Kn-m | Capacity | 4.22 Kn-m | Passing Percentage | 109.61 % |
| V _{0.9D-WnUp} | 2.57 Kn-m | Capacity | 20.10 Kn-m | Passing Percentage | 782.10 % |

Deflections

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

Deflection under Snow and Service Wind = 33.12 mm Limit by Woolcock et al. 1999 Span/100 = 60.00 mm
Sag during installation = 78.58 mm

Reactions

Maximum = 2.57 kn

Middle Pole Design

Geometry

| | | | |
|-------------------|---------------------------|----------------|-----------------------------|
| 225 UNI H5 | Dry Use | Height | 3900 mm |
| Area | 39741 mm ² | As | 29805.46875 mm ² |
| I _x | 125741821 mm ⁴ | Z _x | 1117705 mm ³ |
| I _y | 125741821 mm ⁴ | Z _y | 1117705 mm ³ |
| Lateral Restraint | 1300 mm c/c | | |

Loads

Total Area over Pole = 18 m²

| | | | |
|---------------------|------------|---------------------|---------|
| Dead | 4.50 Kn | Live | 4.50 Kn |
| Wind Down | 12.24 Kn | Snow | 0.00 Kn |
| Moment wind | 18.61 Kn-m | | |
| Phi | 0.8 | K ₈ | 1.00 |
| K ₁ snow | 0.8 | K ₁ Dead | 0.6 |
| K ₁ wind | 1 | | |

Material

| | | | |
|------------------|------------|------------------|----------|
| Shaving | Steaming | Normal | Dry Use |
| f _b = | 34.325 MPa | f _s = | 2.96 MPa |
| f _c = | 18 MPa | f _p = | 7.2 MPa |
| f _t = | 20.75 MPa | E = | 8793 MPa |

Capacities

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| | | | | | |
|-------------|-----------|-------------|------------|-------------|----------|
| PhiNcx Wind | 572.26 Kn | PhiMnx Wind | 30.69 Kn-m | PhiVnx Wind | 70.58 Kn |
| PhiNcx Dead | 343.36 Kn | PhiMnx Dead | 18.42 Kn-m | PhiVnx Dead | 42.35 Kn |

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.64 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.40 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 38.73 \text{ mm} < 39.00 \text{ mm}$$

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 |
| K ₀ = | $(1 - \sin(30)) / (1 + \sin(30))$ | | | | |
| K _p = | $(1 + \sin(30)) / (1 - \sin(30))$ | | | | |

Geometry For Middle Bay Pole

| | | |
|------------------|---------|--|
| D _s = | 0.6 mm | Pile Diameter |
| L = | 1700 mm | Pile embedment length |
| f ₁ = | 3150 mm | Distance at which the shear force is applied |
| f ₂ = | 0 mm | Distance of top soil at rest pressure |

Loads

| | |
|---------------|------------|
| Moment Wind = | 18.61 Kn-m |
| Shear Wind = | 5.91 Kn |

Pile Properties

| | | |
|------------------|------------|---|
| Safety Factory | 0.55 | |
| H _u = | 9.03 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| M _u = | 17.07 Kn-m | Ultimate Moment Capacity of Pile |

Checks

$$\text{Applied Forces/Capacities} = 1.09 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

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Geometry

| | | | |
|-------------------|---------------------------|--------|-----------------------------|
| 225 UNI H5 | Dry Use | Height | 3840 mm |
| Area | 39741 mm ² | As | 29805.46875 mm ² |
| Ix | 125741821 mm ⁴ | Zx | 1117705 mm ³ |
| Iy | 125741821 mm ⁴ | Zy | 1117705 mm ³ |
| Lateral Restraint | mm c/c | | |

Loads

Total Area over Pole = 18 m²

| | | | |
|-------------|-----------|---------|---------|
| Dead | 4.50 Kn | Live | 4.50 Kn |
| Wind Down | 12.24 Kn | Snow | 0.00 Kn |
| Moment Wind | 9.30 Kn-m | | |
| Phi | 0.8 | K8 | 0.81 |
| K1 snow | 0.8 | K1 Dead | 0.6 |
| K1 wind | 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 | 464.88 Kn | PhiMnx Wind | 24.93 Kn-m | PhiVnx Wind | 70.58 Kn |
| PhiNcx Dead | 278.93 Kn | PhiMnx Dead | 14.96 Kn-m | PhiVnx Dead | 42.35 Kn |

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.42 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.18 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 20.80 mm < 41.90 mm

| | | |
|------|---------|--|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1700 mm | Pile embedment length |
| f1 = | 3150 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

Total Area over Pole = 18 m²

Moment Wind = 9.30 Kn-m

Shear Wind = 2.95 Kn

Pile Properties

Safety Factory 0.55

Hu = 9.03 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 17.07 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.55 < 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 = 1700 mm Pile embedment length

f1 = 3150 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 9.30 Kn-m

Shear Wind = 2.95 Kn

Pile Properties

Safety Factory 0.55

Hu = 9.03 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 17.07 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.55 < 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(1700) x Ks(1.5) x $0.5 \times \tan(30) \times \pi \times \text{Dia of Pile}(0.6) \times \text{Height of Pile}(1700)$

Skin Friction = 23.34 Kn

Weight of Pile + Pile Skin Friction = 27.49 Kn

Uplift on one Pile = 17.73 Kn

Uplift is ok