

Pole Shed App Ver 01 2022

Job No.: 166 Millar - 1

Address: 166 Millar Way, Mahurangi East, New Zealand

Date: 18/12/2024

Latitude: -36.464636

Longitude: 174.746802

Elevation: 37.5 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 | D |
| Importance Level | 1 | Ultimate wind & Earthquake ARI | 100 Years | Max Height | 6 m |
| Wind Region | NZ1 | Terrain Category | 1.04 | Design Wind Speed | 55.21 m/s |
| Wind Pressure | 1.83 KPa | Lee Zone | NO | Ultimate Snow ARI | 50 Years |
| Wind Category | extra 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 $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 6.0 m $C_{p,e} = -1.1472$ $p_e = -1.89$ KPa $p_{net} = -1.89$ KPa

For roof $C_{p,e}$ from m To m $C_{p,e} =$ $p_e =$ KPa $p_{net} =$ 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 00 m To 6 m $C_{p,e} = 0.7$ $p_e = 1.15$ KPa $p_{net} = 1.70$ KPa

For side wall $C_{p,e}$ from 0 m To 5.40 m $C_{p,e} =$ $p_e = -1.07$ KPa $p_{net} = -1.07$ KPa

Maximum Upward pressure used in roof member Design = 1.89 KPa

Maximum Downward pressure used in roof member Design = 0.30 KPa

Maximum Wall pressure used in Design = 1.70 KPa

Maximum Racking pressure used in Design = 1.64 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3450 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 = 0.88 S1 Downward = 11.27 S1 Upward = 15.49

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

Capacity Checks

| | | | | | |
|--|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 0.45 Kn-m | Capacity | 2.23 Kn-m | Passing Percentage | 495.56 % |
| M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 1.35 Kn-m | Capacity | 2.97 Kn-m | Passing Percentage | 220.00 % |
| M _{0.9D-WnUp} | -2.23 Kn-m | Capacity | -3.29 Kn-m | Passing Percentage | 147.53 % |
| V _{1.35D} | 0.52 Kn | Capacity | 9.65 Kn | Passing Percentage | 1855.77 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 1.05 Kn | Capacity | 12.86 Kn | Passing Percentage | 1224.76 % |
| V _{0.9D-WnUp} | -2.58 Kn | Capacity | -16.08 Kn | Passing Percentage | 623.26 % |

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 = 4.21 mm Limit by Woolcock et al, 1999 Span/240 = 14.17 mm

Deflection under Dead and Service Wind = 4.56 mm Limit by Woolcock et al, 1999 Span/100 = 34.00 mm

Reactions

Maximum downward = 1.05 kn Maximum upward = -2.58 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 = 3600 mm Internal Rafter Span = 5850 mm Try Rafter 2x240x45 LVL11

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 = 6.71 S1 Upward = 6.71

Shear Capacity of timber = 5 MPa Bending Capacity of timber = 38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

| | | | | | |
|--|------------|----------|------------|--------------------|-----------------|
| M _{1.35D} | 5.20 Kn-m | Capacity | 15.76 Kn-m | Passing Percentage | 303.08 % |
| M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 10.40 Kn-m | Capacity | 21.02 Kn-m | Passing Percentage | 202.12 % |

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| | | | | | |
|--|-------------|----------|-------------|--------------------|-----------------|
| M _{0.9D-WnUp} | -25.64 Kn-m | Capacity | -26.26 Kn-m | Passing Percentage | 102.42 % |
| V _{1.35D} | 3.55 Kn | Capacity | 34.74 Kn | Passing Percentage | 978.59 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 7.11 Kn | Capacity | 46.32 Kn | Passing Percentage | 651.48 % |
| V _{0.9D-WnUp} | -17.53 Kn | Capacity | -57.88 Kn | Passing Percentage | 330.18 % |

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 15.98 mm Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 19.235 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 7.11 kn Maximum upward = -17.53 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

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 = 29.11 Kn > -17.53 Kn

Rafter Design External

External Rafter Load Width = 1800 mm External Rafter Span = 5973 mm Try Rafter 240x45 LVL11

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

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K8 Upward =0.94 S1 Downward =13.82 S1 Upward =13.82

Shear Capacity of timber =5 MPa Bending Capacity of timber =38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

| | | | | | |
|---|-------------|----------|-------------|--------------------|-----------------|
| M _{1.35D} | 2.71 Kn-m | Capacity | 7.41 Kn-m | Passing Percentage | 273.43 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 5.42 Kn-m | Capacity | 9.89 Kn-m | Passing Percentage | 182.47 % |
| M _{0.9D-W_nUp} | -13.37 Kn-m | Capacity | -12.36 Kn-m | Passing Percentage | 92.45 % |
| V _{1.35D} | 1.81 Kn | Capacity | 17.37 Kn | Passing Percentage | 959.67 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 3.63 Kn | Capacity | 23.16 Kn | Passing Percentage | 638.02 % |
| V _{0.9D-W_nUp} | -8.95 Kn | Capacity | -28.94 Kn | Passing Percentage | 323.35 % |

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 17.76 mm Limit by Woolcock et al, 1999 Span/240= 25.00 mm

Deflection under Dead and Service Wind = 19.24 mm Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward =3.63 kn Maximum upward = -8.95 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

V = phi x k₁ x k₄ x k₅ x f_s x b x d_s (Eq 4.12) = -28.35 kn > -8.95 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -8.95 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 3600 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 =0.86 S1 Downward =11.27 S1 Upward =15.94

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|-----------------|
| M _{Wind+Snow} | 2.48 Kn-m | Capacity | 3.22 Kn-m | Passing Percentage | 129.84 % |
| V _{0.9D-WnUp} | 2.75 Kn | Capacity | 16.08 Kn | Passing Percentage | 584.73 % |

Deflections

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

Deflection under Snow and Service Wind = 14.98 mm Limit by Woolcock et al, 1999 Span/100 = 36.00 mm

Sag during installation = 10.18 mm

Reactions

Maximum = 2.75 kn

Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 3000 mm

Try Girt 150x50 SG8 Dry

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

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =0.98 S1 Downward =9.63 S1 Upward =12.44

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|-----------------|
| M _{Wind+Snow} | 1.72 Kn-m | Capacity | 2.05 Kn-m | Passing Percentage | 119.19 % |
| V _{0.9D-WnUp} | 2.29 Kn | Capacity | 12.06 Kn | Passing Percentage | 526.64 % |

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Deflections

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

Deflection under Snow and Service Wind = 17.13 mm Limit by Woolcock et al. 1999 Span/100 = 30.00 mm

Sag during installation = 4.91 mm

Reactions

Maximum = 2.29 kn

Middle Pole Design

Geometry

| | | | |
|--|---------------------------|----------------|-------------------------------|
| 300 SED H5 (Minimum 325 dia. at Floor Level) | Dry Use | Height | 5700 mm |
| Area | 76660 mm ² | As | 57495.1171875 mm ² |
| I _x | 467896461 mm ⁴ | Z _x | 2994537 mm ³ |
| I _y | 467896461 mm ⁴ | Z _y | 2994537 mm ³ |
| Lateral Restraint | 5700 mm c/c | | |

Loads

Total Area over Pole = 10.8 m²

| | | | |
|---------------------|------------|---------------------|---------|
| Dead | 2.70 Kn | Live | 2.70 Kn |
| Wind Down | 3.24 Kn | Snow | 0.00 Kn |
| Moment wind | 39.75 Kn-m | | |
| Phi | 0.8 | K ₈ | 0.76 |
| K ₁ snow | 0.8 | K ₁ Dead | 0.6 |
| K ₁ wind | 1 | | |

Material

| | | | |
|------------------|----------|------------------|----------|
| Peeling | Steaming | Normal | Dry Use |
| f _b = | 36.3 MPa | f _s = | 2.96 MPa |
| f _c = | 18 MPa | f _p = | 7.2 MPa |
| f _t = | 22 MPa | E = | 9257 MPa |

Capacities

| | | | | | |
|-------------------------|-----------|-------------------------|------------|-------------------------|-----------|
| PhiN _{cx} Wind | 834.98 Kn | PhiM _{nx} Wind | 65.78 Kn-m | PhiV _{nx} Wind | 136.15 Kn |
| PhiN _{cx} Dead | 500.99 Kn | PhiM _{nx} Dead | 39.47 Kn-m | PhiV _{nx} Dead | 81.69 Kn |

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_c) = 0.61 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_c) = 0.38 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 44.10 \text{ mm} < 57.00 \text{ mm}$$

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

$$K_0 = (1 - \sin(30)) / (1 + \sin(30))$$

$$K_p = (1 + \sin(30)) / (1 - \sin(30))$$

Geometry For Middle Bay Pole

Ds = 0.6 mm Pile Diameter
L = 2300 mm Pile embedment length
f1 = 4500 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 39.75 Kn-m
Shear Wind = 8.83 Kn

Pile Properties

Safety Factory 0.55
Hu = 15.94 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 42.82 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.93 < 1 \text{ OK}$$

Uplift Check

$$\text{Density of Concrete} = 24 \text{ Kn/m}^3$$

$$\text{Density of Timber Pole} = 5 \text{ Kn/m}^3$$

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

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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(2300) x Ks(1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(2300)

Skin Friction = 42.72 Kn

Weight of Pile + Pile Skin Friction = 46.20 Kn

Uplift on one Pile = 17.98 Kn

Uplift is ok