

Pole Shed App Ver 01 2022

Job No.: 751 Lower Sefton Road Sefton **Address:** 751 Lower Sefton Road, Sefton, New Zealand **Date:** 14/12/2023
Latitude: -43.263101 **Longitude:** 172.685163 **Elevation:** 4.5 m

General Input

| | | | | | |
|------------------|----------|--------------------------------|-----------|----------------------|-----------|
| Roof Live Load | 0.25 KPa | Roof Dead Load | 0.25 KPa | Roof Live Point Load | 1.1 Kn |
| Snow Zone | N4 | Ground Snow Load | 0.9 KPa | Roof Snow Load | 0.63 KPa |
| Earthquake Zone | 2 | Subsoil Category | D | Exposure Zone | C |
| Importance Level | 1 | Ultimate wind & Earthquake ARI | 100 Years | Max Height | 3.6 m |
| Wind Region | NZ2 | 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 $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 3.30 m $C_{p,e} = -0.9$ $p_e = -0.71$ KPa $p_{net} = -0.71$ KPa

For roof $C_{p,e}$ from 3.30 m To 6.60 m $C_{p,e} = -0.5$ $p_e = -0.39$ KPa $p_{net} = -0.39$ 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 9 m $C_{p,e} = 0.7$ $p_e = 0.55$ KPa $p_{net} = 0.81$ KPa

For side wall $C_{p,e}$ from 0 m To 3.30 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = -0.51$ KPa

Maximum Upward pressure used in roof member Design = 0.71 KPa

Maximum Downward pressure used in roof member Design = 0.42 KPa

Maximum Wall pressure used in Design = 0.81 KPa

Maximum Racking pressure used in Design = 0.94 KPa

Design Summary

Purlin Design

Purlin Spacing = 750 mm Purlin Span = 3850 mm Try Purlin 150x50 SG8 Dry

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Moisture Condition = Dry (Moisture in timber is less than 16% and 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 = 0.68 S1 Downward = 9.63 S1 Upward = 19.79

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

Capacity Checks

| | | | | | |
|---------------------------------------------------------------------------|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 0.47 Kn-m | Capacity | 1.26 Kn-m | Passing Percentage | 268.09 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 1.48 Kn-m | Capacity | 1.68 Kn-m | Passing Percentage | 113.51 % |
| M _{0.9D-W_nUp} | -0.67 Kn-m | Capacity | -1.43 Kn-m | Passing Percentage | 144.44 % |
| V _{1.35D} | 0.49 Kn | Capacity | 7.24 Kn | Passing Percentage | 1477.55 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 1.34 Kn | Capacity | 9.65 Kn | Passing Percentage | 720.15 % |
| V _{0.9D-W_nUp} | -0.70 Kn | Capacity | -12.06 Kn | Passing Percentage | 1722.86 % |

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 = 12.97 mm Limit by Woolcock et al, 1999 Span/240 = 15.83 mm

Deflection under Dead and Service Wind = 15.34 mm Limit by Woolcock et al, 1999 Span/100 = 38.00 mm

Reactions

Maximum downward = 1.34 kn Maximum upward = -0.70 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 = 4000 mm Internal Rafter Span = 4350 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

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| | | | | | |
|------------------------------------------|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 3.19 Kn-m | Capacity | 10.08 Kn-m | Passing Percentage | 315.99 % |
| M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 8.80 Kn-m | Capacity | 13.44 Kn-m | Passing Percentage | 152.73 % |
| M _{0.9D-WnUp} | -4.59 Kn-m | Capacity | -16.8 Kn-m | Passing Percentage | 366.01 % |
| V _{1.35D} | 2.94 Kn | Capacity | 28.94 Kn | Passing Percentage | 984.35 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 8.09 Kn | Capacity | 38.6 Kn | Passing Percentage | 477.13 % |
| V _{0.9D-WnUp} | -4.22 Kn | Capacity | -48.24 Kn | Passing Percentage | 1143.13 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.745 mm Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 6.24 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward = 8.09 kn Maximum upward = -4.22 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 = 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

K₁₁ = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 100 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 = 21.67 Kn > -4.22 Kn

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 4310 mm Try Rafter 300x50 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 =0.94

K8 Upward =0.94 S1 Downward =13.93 S1 Upward =13.93

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

Capacity Checks

| | | | | | |
|---------------------------------------------------------------------------|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 1.57 Kn-m | Capacity | 4.72 Kn-m | Passing Percentage | 300.64 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 4.32 Kn-m | Capacity | 6.30 Kn-m | Passing Percentage | 145.83 % |
| M _{0.9D-W_nUp} | -2.25 Kn-m | Capacity | -7.87 Kn-m | Passing Percentage | 349.78 % |
| V _{1.35D} | 1.45 Kn | Capacity | 14.47 Kn | Passing Percentage | 997.93 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 4.01 Kn | Capacity | 19.30 Kn | Passing Percentage | 481.30 % |
| V _{0.9D-W_nUp} | -2.09 Kn | Capacity | -24.12 Kn | Passing Percentage | 1154.07 % |

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 5.27 mm Limit by Woolcock et al, 1999 Span/240= 18.75 mm

Deflection under Dead and Service Wind = 6.24 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward =4.01 kn Maximum upward = -2.09 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 =J5 Joint Group for Pole = J5

Factor of Safety = 0.7

For Perpendicular to grain loading

K11 = 14.9 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 50 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) = -25.20 kn > -2.09 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.09 Kn

Intermediate Design Sides

Intermediate Spacing = 2250 mm Intermediate Span = 3300 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)

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

K8 Upward = 1.00 S1 Downward = 11.27 S1 Upward = 0.68

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

Capacity Checks

| | | | | | |
|-----------------|-----------|----------|------------|--------------------|------------------|
| $M_{Wind+Snow}$ | 1.38 Kn-m | Capacity | 7.46 Kn-m | Passing Percentage | 540.58 % |
| $V_{0.9D-WnUp}$ | 1.67 Kn-m | Capacity | 32.16 Kn-m | Passing Percentage | 1925.75 % |

Deflections

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

Deflection under Snow and Service Wind = 16.5 mm Limit by Woolcock et al, 1999 Span/100 = 33.00 mm

Reactions

Maximum = 1.67 kn

Girt Design Front and Back

Girt's Spacing = 800 mm Girt's Span = 4000 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 = 0.65 S1 Downward = 9.63 S1 Upward = 20.31

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

Capacity Checks

| | | | | | |
|-----------------|-----------|----------|-----------|--------------------|-----------------|
| $M_{Wind+Snow}$ | 1.30 Kn-m | Capacity | 1.38 Kn-m | Passing Percentage | 106.15 % |
|-----------------|-----------|----------|-----------|--------------------|-----------------|

| | | | | | |
|------------------------|-----------|----------|------------|--------------------|-----------------|
| V _{0.9D-WnUp} | 1.30 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | 927.69 % |
|------------------------|-----------|----------|------------|--------------------|-----------------|

Deflections

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

Deflection under Snow and Service Wind = 40.76 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm
Sag during installation = 15.52 mm

Reactions

Maximum = 1.30 kn

Girt Design Sides

Girt's Spacing = 1200 mm Girt's Span = 2250 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 = 0.89 S1 Downward = 9.63 S1 Upward = 15.23

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|------------|--------------------|------------------|
| M _{Wind+Snow} | 0.62 Kn-m | Capacity | 1.87 Kn-m | Passing Percentage | 301.61 % |
| V _{0.9D-WnUp} | 1.09 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | 1106.42 % |

Deflections

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

Deflection under Snow and Service Wind = 6.12 mm Limit by Woolcock et al. 1999 Span/100 = 22.50 mm
Sag during installation = 1.55 mm

Reactions

Maximum = 1.09 kn

Middle Pole Design

Geometry

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| | | | |
|----------------------------------------------|--------------------------|--------|-------------------------------|
| 150 SED H5 (Minimum 175 dia. at Floor Level) | Dry Use | Height | 3300 mm |
| Area | 20729 mm ² | As | 15546.6796875 mm ² |
| Ix | 34210793 mm ⁴ | Zx | 421056 mm ³ |
| Iy | 34210793 mm ⁴ | Zy | 421056 mm ³ |
| Lateral Restraint | 3400 mm c/c | | |

Loads

Total Area over Pole = 18 m²

| | | | |
|-------------|-----------|-------------|-----------|
| Dead | 4.50 Kn | Live | 4.50 Kn |
| Wind Down | 7.56 Kn | Snow | 11.34 Kn |
| Moment wind | 6.08 Kn-m | Moment snow | 2.15 Kn-m |
| Phi | 0.8 | K8 | 0.63 |
| 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 | 186.64 Kn | PhiMnx Wind | 7.65 Kn-m | PhiVnx Wind | 36.81 Kn |
| PhiNcx Dead | 111.98 Kn | PhiMnx Dead | 4.59 Kn-m | PhiVnx Dead | 22.09 Kn |
| PhiNcx Snow | 149.31 Kn | PhiMnx Snow | 6.12 Kn-m | PhiVnx Snow | 29.45 Kn |

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.92 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.76 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 32.03 \text{ mm} < 33.00 \text{ mm}$$

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 |
|-------|----------------------|----------------|--------|----------|---------------------|

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

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

Geometry For Middle Bay Pole

| | | |
|------|---------|----------------------------------------------|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1300 mm | Pile embedment length |
| f1 = | 2700 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

| | | | |
|---------------|-----------|---------------|---------|
| Moment Wind = | 6.08 Kn-m | Moment Snow = | Kn-m |
| Shear Wind = | 2.25 Kn | Shear Snow = | 2.15 Kn |

Pile Properties

| | | |
|----------------|-----------|---------------------------------------------------|
| Safety Factory | 0.55 | |
| Hu = | 4.89 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 7.84 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.78 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

| | | | |
|----------------------------------------------|--------------------------|--------|-------------------------------|
| 150 SED H5 (Minimum 175 dia. at Floor Level) | Dry Use | Height | 3300 mm |
| Area | 20729 mm ² | As | 15546.6796875 mm ² |
| Ix | 34210793 mm ⁴ | Zx | 421056 mm ³ |
| Iy | 34210793 mm ⁴ | Zy | 421056 mm ³ |
| Lateral Restraint | mm c/c | | |

Loads

Total Area over Pole = 9 m²

| | | | |
|-------------|-----------|-------------|-----------|
| Dead | 2.25 Kn | Live | 2.25 Kn |
| Wind Down | 3.78 Kn | Snow | 5.67 Kn |
| Moment Wind | 3.04 Kn-m | Moment snow | 1.08 Kn-m |

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| | | | |
|---------|-----|---------|------|
| Phi | 0.8 | K8 | 0.66 |
| 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 | 195.59 Kn | PhiMnx Wind | 8.01 Kn-m | PhiVnx Wind | 36.81 Kn |
| PhiNcx Dead | 117.35 Kn | PhiMnx Dead | 4.81 Kn-m | PhiVnx Dead | 22.09 Kn |
| PhiNcx Snow | 156.47 Kn | PhiMnx Snow | 6.41 Kn-m | PhiVnx Snow | 29.45 Kn |

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.44 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.20 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 17.42 \text{ mm} < 35.91 \text{ mm}$$

| | | |
|------|---------|----------------------------------------------|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1300 mm | Pile embedment length |
| f1 = | 2700 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

$$\text{Total Area over Pole} = 9 \text{ m}^2$$

| | | | |
|---------------|-----------|---------------|-----------|
| Moment Wind = | 3.04 Kn-m | Moment Snow = | 1.08 Kn-m |
| Shear Wind = | 1.13 Kn | Shear Snow = | 1.08 Kn |

Pile Properties

| | | |
|----------------|-----------|---------------------------------------------------|
| Safety Factory | 0.55 | |
| Hu = | 4.89 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 7.84 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.39 < 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 = $(1 - \sin(30)) / (1 + \sin(30))$
K_p = $(1 + \sin(30)) / (1 - \sin(30))$

Geometry For End Bay Pole

D_s = 0.6 mm Pile Diameter
L = 1300 mm Pile embedment length
f₁ = 2700 mm Distance at which the shear force is applied
f₂ = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 3.04 Kn-m Moment Snow = 1.08 Kn-m
Shear Wind = 1.13 Kn Shear Snow = 1.08 Kn

Pile Properties

Safety Factory 0.55
H_u = 4.89 Kn Ultimate Lateral Strength of the Pile, Short pile
M_u = 7.84 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.39 < 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

K_s (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(1300) x K_s(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.91 Kn

Uplift on one Pile = 8.73 Kn

Uplift is ok