



**Job No.:** Justin Mills - 1**Address:** 2 Robinson Street, Cambridge 3434, New Zealand**Date:** 08/11/2024**Latitude:** -37.884276**Longitude:** 175.476739**Elevation:** 70.5 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        | B         |
| Importance Level | 1        | Ultimate wind & Earthquake ARI | 100 Years | Max Height           | 3.5 m     |
| Wind Region      | NZ1      | Terrain Category               | 3.0       | Design Wind Speed    | 40.08 m/s |
| Wind Pressure    | 0.96 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 = Gable Enclosed

For roof  $C_{p,i} = -0.3$

For roof  $C_{p,e}$  from 0 m To 4.38 m  $C_{p,e} = -0.9$   $p_e = -0.78$  KPa  $p_{net} = -0.78$  KPa

For roof  $C_{p,e}$  from 4.38 m To 8.75 m  $C_{p,e} = -0.5$   $p_e = -0.43$  KPa  $p_{net} = -0.43$  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 11 m  $C_{p,e} = 0.7$   $p_e = 0.61$  KPa  $p_{net} = 0.90$  KPa

For side wall  $C_{p,e}$  from 0 m To 4.38 m  $C_{p,e} =$   $p_e = -0.56$  KPa  $p_{net} = -0.56$  KPa

Maximum Upward pressure used in roof member Design = 0.78 KPa

Maximum Downward pressure used in roof member Design = 0.38 KPa

Maximum Wall pressure used in Design = 0.78 KPa

Maximum Racking pressure used in Design = 1.04 KPa

**Design Summary****Girt Design Front and Back**

Girt's Spacing = 1300 mm

Girt's Span = 2750 mm

Try Girt 140x45 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 = 1.00

K8 Upward = 0.76 S1 Downward = 10.36 S1 Upward = 18.11

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

**Capacity Checks**

|                 |           |          |           |                    |          |
|-----------------|-----------|----------|-----------|--------------------|----------|
| $M_{Wind+Snow}$ | 0.96 Kn-m | Capacity | 1.26 Kn-m | Passing Percentage | 131.25 % |
| $V_{0.9D-WnUp}$ | 1.39 Kn   | Capacity | 10.13 Kn  | Passing Percentage | 728.78 % |

**Deflections**

### Pole Shed App Ver 01 2022

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

Deflection under Snow and Service Wind = 10.95 mm

Limit by Woolcock et al, 1999 Span/100 = 27.50 mm

Sag during installation = 4.28 mm

#### Reactions

Maximum = 1.39 kn

#### Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2100 mm

Try Girt 140x45 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 =1.00

K8 Upward =0.87    S1 Downward =10.36    S1 Upward =15.83

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

#### Capacity Checks

|                 |           |          |           |                    |                 |
|-----------------|-----------|----------|-----------|--------------------|-----------------|
| $M_{Wind+Snow}$ | 0.56 Kn-m | Capacity | 1.43 Kn-m | Passing Percentage | <b>255.36 %</b> |
| $V_{0.9D-WnUp}$ | 1.06 Kn   | Capacity | 10.13 Kn  | Passing Percentage | <b>955.66 %</b> |

#### Deflections

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

Deflection under Snow and Service Wind = 3.73 mm

Limit by Woolcock et al. 1999 Span/100 = 21.00 mm

Sag during installation =1.46 mm

#### Reactions

Maximum = 1.06 kn

#### Middle Pole Design

##### Geometry

|  |                           |                |                               |
|--|---------------------------|----------------|-------------------------------|
| 200 SED H5 (Minimum 225 dia. at Floor Level) | Dry Use                   | Height         | 3260 mm                       |
| Area   | 35448 mm <sup>2</sup>     | As             | 26585.7421875 mm <sup>2</sup> |
| I <sub>x</sub>                               | 100042702 mm <sup>4</sup> | Z <sub>x</sub> | 941578 mm <sup>3</sup>        |
| I <sub>y</sub>                               | 100042702 mm <sup>4</sup> | Z <sub>y</sub> | 941578 mm <sup>3</sup>        |
| Lateral Restraint                            | 3400 mm c/c               |                |                               |

#### Loads

Total Area over Pole = 16.5 m<sup>2</sup>

|             |            |         |         |
|-------------|------------|---------|---------|
| Dead        | 4.13 Kn    | Live    | 4.13 Kn |
| Wind Down   | 6.27 Kn    | Snow    | 0.00 Kn |
| Moment wind | 13.11 Kn-m |         |         |
| Phi         | 0.8        | K8      | 0.86    |
| K1 snow     | 0.8        | K1 Dead | 0.6     |
| K1 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**

|             |           |             |            |             |          |
|-------------|-----------|-------------|------------|-------------|----------|
| PhiNcx Wind | 438.78 Kn | PhiMnx Wind | 23.50 Kn-m | PhiVnx Wind | 62.96 Kn |
| PhiNcx Dead | 263.27 Kn | PhiMnx Dead | 14.10 Kn-m | PhiVnx Dead | 37.77 Kn |

**Checks**

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.59 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.34 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 22.69 \text{ mm} < 32.60 \text{ mm}$$

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

**Assumed Soil Properties**

|         |                                   |                |        |          |                     |
|---------|-----------------------------------|----------------|--------|----------|---------------------|
| Gamma   | 18 Kn/m <sup>3</sup>              | Friction angle | 30 deg | Cohesion | 0 Kn/m <sup>3</sup> |
| $K_0 =$ | $(1 - \sin(30)) / (1 + \sin(30))$ |                |        |          |                     |
| $K_p =$ | $(1 + \sin(30)) / (1 - \sin(30))$ |                |        |          |                     |

**Geometry For Middle Bay Pole**

|         |         |  |
|---------|---------|--|
| $D_s =$ | 0.6 mm  | Pile Diameter                                |
| $L =$   | 1600 mm | Pile embedment length                        |
| $f_1 =$ | 2625 mm | Distance at which the shear force is applied |
| $f_2 =$ | 0 mm    | Distance of top soil at rest pressure        |

**Loads**

|               |            |
|---------------|------------|
| Moment Wind = | 13.11 Kn-m |
| Shear Wind =  | 4.99 Kn    |

**Pile Properties**

|                |            |   |
|----------------|------------|---|
| Safety Factory | 0.55       |   |
| $H_u =$        | 8.64 Kn    | Ultimate Lateral Strength of the Pile, Short pile |
| $M_u =$        | 13.81 Kn-m | Ultimate Moment Capacity of Pile                  |

**Checks**

$$\text{Applied Forces/Capacities} = 0.95 < 1 \text{ OK}$$

**End Pole Design**

**Geometry For End Bay Pole**

**Geometry**

Pole Shed App Ver 01 2022

|  |                           |                |                               |
|--|---------------------------|----------------|-------------------------------|
| 200 SED H5 (Minimum 225 dia. at Floor Level) | Dry Use                   | Height         | 3350 mm                       |
| Area   | 35448 mm <sup>2</sup>     | As             | 26585.7421875 mm <sup>2</sup> |
| I <sub>x</sub>                               | 100042702 mm <sup>4</sup> | Z <sub>x</sub> | 941578 mm <sup>3</sup>        |
| I <sub>y</sub>                               | 100042702 mm <sup>4</sup> | Z <sub>y</sub> | 941578 mm <sup>3</sup>        |
| Lateral Restraint                            | mm c/c                    |                |                               |

**Loads**

Total Area over Pole = 11.550577528876442 m<sup>2</sup>

|                     |           |                     |         |
|---------------------|-----------|---------------------|---------|
| Dead                | 2.89 Kn   | Live                | 2.89 Kn |
| Wind Down           | 4.39 Kn   | Snow                | 0.00 Kn |
| Moment Wind         | 5.40 Kn-m |                     |         |
| Phi                 | 0.8       | K <sub>8</sub>      | 0.87    |
| K <sub>1</sub> snow | 0.8       | K <sub>1</sub> Dead | 0.6     |
| K <sub>1</sub> wind | 1         |                     |         |

**Material**

|                  |          |                  |          |
|------------------|----------|------------------|----------|
| Peeling          | Steaming | Normal           | Dry Use  |
| f <sub>b</sub> = | 36.3 MPa | f <sub>s</sub> = | 2.96 MPa |
| f <sub>c</sub> = | 18 MPa   | f <sub>p</sub> = | 7.2 MPa  |
| f <sub>t</sub> = | 22 MPa   | E =              | 9257 MPa |

**Capacities**

|                         |           |                         |            |                         |          |
|-------------------------|-----------|-------------------------|------------|-------------------------|----------|
| PhiN <sub>cx</sub> Wind | 443.93 Kn | PhiM <sub>nx</sub> Wind | 23.78 Kn-m | PhiV <sub>nx</sub> Wind | 62.96 Kn |
| PhiN <sub>cx</sub> Dead | 266.36 Kn | PhiM <sub>nx</sub> Dead | 14.27 Kn-m | PhiV <sub>nx</sub> Dead | 37.77 Kn |

**Checks**

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.25 < 1$  OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.07 < 1$  OK

Deflection at top under service lateral loads = 10.00 mm < 34.91 mm

|                  |         |  |
|------------------|---------|--|
| D <sub>s</sub> = | 0.6 mm  | Pile Diameter                                |
| L =              | 1300 mm | Pile embedment length                        |
| f <sub>1</sub> = | 2625 mm | Distance at which the shear force is applied |
| f <sub>2</sub> = | 0 mm    | Distance of top soil at rest pressure        |

**Loads**

Total Area over Pole = 11.550577528876442 m<sup>2</sup>

|               |           |
|---------------|-----------|
| Moment Wind = | 5.40 Kn-m |
| Shear Wind =  | 2.06 Kn   |

**Pile Properties**

|                  |           |   |
|------------------|-----------|---|
| Safety Factory   | 0.55      |   |
| H <sub>u</sub> = | 4.99 Kn   | Ultimate Lateral Strength of the Pile, Short pile |
| M <sub>u</sub> = | 7.79 Kn-m | Ultimate Moment Capacity of Pile                  |

#### Checks

Applied Forces/Capacities =  $0.69 < 1$  OK

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

#### Assumed Soil Properties

|       |                                   |                |        |          |                     |
|-------|-----------------------------------|----------------|--------|----------|---------------------|
| Gamma | 18 Kn/m <sup>3</sup>              | Friction angle | 30 deg | Cohesion | 0 Kn/m <sup>3</sup> |
| 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 =  | 1300 mm | Pile embedment length                        |
| f1 = | 2625 mm | Distance at which the shear force is applied |
| f2 = | 0 mm    | Distance of top soil at rest pressure        |

#### Loads

|               |           |
|---------------|-----------|
| Moment Wind = | 5.40 Kn-m |
| Shear Wind =  | 2.06 Kn   |

#### Pile Properties

|                |           |   |
|----------------|-----------|---|
| Safety Factory | 0.55      |   |
| Hu =           | 4.99 Kn   | Ultimate Lateral Strength of the Pile, Short pile |
| Mu =           | 7.79 Kn-m | Ultimate Moment Capacity of Pile                  |

#### Checks

Applied Forces/Capacities =  $0.69 < 1$  OK

### Uplift Check

Density of Concrete = 24 Kn/m<sup>3</sup>

Density of Timber Pole = 5 Kn/m<sup>3</sup>

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(1600) x Ks(1.5) x  $0.5 \times \tan(30)$  x Pi x Dia of Pile(0.6) x Height of Pile(1600)

Skin Friction = 20.68 Kn

Weight of Pile + Pile Skin Friction = 24.83 Kn

Uplift on one Pile = 9.16 Kn

Uplift is ok