

**Job No.:** 446-264438

**Address:** 41 Wards Road, Rolleston, New Zealand

**Date:** 24/01/2024

**Latitude:** -43.588986

**Longitude:** 172.367839

**Elevation:** 59.5 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        | B         |
| Importance Level | 1        | Ultimate wind & Earthquake ARI | 100 Years | Max Height           | 3 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 15 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

#### Rafter Design Internal

Internal Rafter Load Width = 5000 mm

Internal Rafter Span = 6850 mm

Try Rafter 2x300x45 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 = 7.61 S1 Upward = 7.61

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

#### Capacity Checks

|   |             |          |             |                    |                 |
|---|-------------|----------|-------------|--------------------|-----------------|
| M <sub>1.35D</sub>  | 9.90 Kn-m   | Capacity | 31.1 Kn-m   | Passing Percentage | <b>314.14 %</b> |
| M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub> | 27.27 Kn-m  | Capacity | 41.48 Kn-m  | Passing Percentage | <b>152.11 %</b> |
| M <sub>0.9D-W<sub>n</sub>Up</sub>   | -14.22 Kn-m | Capacity | -51.84 Kn-m | Passing Percentage | <b>364.56 %</b> |

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|                              |          |          |          |                    |                 |
|------------------------------|----------|----------|----------|--------------------|-----------------|
| V1.35D                       | 5.78 Kn  | Capacity | 46.02 Kn | Passing Percentage | <b>796.19 %</b> |
| V1.2D+1.5L 1.2D+Sn 1.2D+WnDn | 15.93 Kn | Capacity | 61.36 Kn | Passing Percentage | <b>385.19 %</b> |
| V0.9D-WnUp                   | -8.31 Kn | Capacity | -76.7 Kn | Passing Percentage | <b>922.98 %</b> |

## **Deflections**

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 18.945 mm

Limit by Woolcock et al, 1999 Span/240 = 29.17 mm

Deflection under Dead and Service Wind = 24.91 mm

Limit by Woolcock et al, 1999 Span/100 = 70.00 mm

## **Reactions**

Maximum downward =15.93 kn Maximum upward = -8.31 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 > -8.31 Kn

## **Rafter Design External**

External Rafter Load Width = 2500 mm

External Rafter Span = 6826 mm

Try Rafter 300x45 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 =0.88

K8 Upward =0.88 S1 Downward =15.50 S1 Upward =15.50

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

## **Capacity Checks**

|                              |            |          |             |                    |                 |
|------------------------------|------------|----------|-------------|--------------------|-----------------|
| M1.35D                       | 4.91 Kn-m  | Capacity | 13.69 Kn-m  | Passing Percentage | <b>278.82 %</b> |
| M1.2D+1.5L 1.2D+Sn 1.2D+WnDn | 13.54 Kn-m | Capacity | 18.26 Kn-m  | Passing Percentage | <b>134.86 %</b> |
| M0.9D-WnUp                   | -7.06 Kn-m | Capacity | -22.82 Kn-m | Passing Percentage | <b>323.23 %</b> |
| V1.35D                       | 2.88 Kn    | Capacity | 23.01 Kn    | Passing Percentage | <b>798.96 %</b> |
| V1.2D+1.5L 1.2D+Sn 1.2D+WnDn | 7.94 Kn    | Capacity | 30.68 Kn    | Passing Percentage | <b>386.40 %</b> |
| V0.9D-WnUp                   | -4.14 Kn   | Capacity | -38.35 Kn   | Passing Percentage | <b>926.33 %</b> |

**Deflections**

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 21.05 mm

Limit by Woolcock et al, 1999 Span/240 = 29.17 mm

Deflection under Dead and Service Wind = 24.91 mm

Limit by Woolcock et al, 1999 Span/100 = 70.00 mm

**Reactions**

Maximum downward = 7.94 kn Maximum upward = -4.14 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 fpj = 22.7 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

K11 = 2.0 fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$  (Eq 4.12) = -40.07 kn > -4.14 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -4.14 Kn

**Intermediate Design Front and Back**

Intermediate Spacing = 2500 mm

Intermediate Span = 2850 mm

Try Intermediate 2x150x50 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 = 1.00 S1 Downward = 9.63 S1 Upward = 0.54

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

**Capacity Checks**

|                        |           |          |             |                    |                 |
|------------------------|-----------|----------|-------------|--------------------|-----------------|
| M <sub>Wind+Snow</sub> | 2.28 Kn-m | Capacity | 4.2 Kn-m    | Passing Percentage | <b>184.21 %</b> |
| V <sub>0.9D-WnUp</sub> | 3.21 Kn-m | Capacity | -24.12 Kn-m | Passing Percentage | <b>751.40 %</b> |

**Deflections**

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

Deflection under Snow and Service Wind = 24.18 mm

Limit by Woolcock et al, 1999 Span/100 = 28.50 mm

**Reactions**

Maximum = 3.21 kn

### Intermediate Design Sides

Intermediate Spacing = 3500 mm

Intermediate Span = 2550 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 =0.60

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

### Capacity Checks

|                 |           |          |            |                    |                  |
|-----------------|-----------|----------|------------|--------------------|------------------|
| $M_{Wind+Snow}$ | 1.28 Kn-m | Capacity | 7.46 Kn-m  | Passing Percentage | <b>582.81 %</b>  |
| $V_{0.9D-WnUp}$ | 2.01 Kn-m | Capacity | 32.16 Kn-m | Passing Percentage | <b>1600.00 %</b> |

### Deflections

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

Deflection under Snow and Service Wind = 9.15 mm

Limit by Woolcock et al, 1999 Span/100 = 25.50 mm

### Reactions

Maximum = 2.01 kn

### Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 2500 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 =0.86    S1 Downward =9.63    S1 Upward =16.05

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

### Capacity Checks

|                 |           |          |            |                    |                  |
|-----------------|-----------|----------|------------|--------------------|------------------|
| $M_{Wind+Snow}$ | 0.57 Kn-m | Capacity | 1.80 Kn-m  | Passing Percentage | <b>315.79 %</b>  |
| $V_{0.9D-WnUp}$ | 0.91 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | <b>1325.27 %</b> |

### Deflections

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

Deflection under Snow and Service Wind = 7.00 mm

Limit by Woolcock et al, 1999 Span/100 = 25.00 mm

Sag during installation = 2.37 mm

### Reactions

Maximum = 0.91 kn

### Girt Design Sides

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Girt's Spacing = 900 mm

Girt's Span = 3500 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 =0.72    S1 Downward =9.63    S1 Upward =19.00

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

**Capacity Checks**

|                        |           |          |            |                    |                 |
|------------------------|-----------|----------|------------|--------------------|-----------------|
| M <sub>Wind+Snow</sub> | 1.12 Kn-m | Capacity | 1.51 Kn-m  | Passing Percentage | <b>134.82 %</b> |
| V <sub>0.9D-WnUp</sub> | 1.28 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | <b>942.19 %</b> |

**Deflections**

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

Deflection under Snow and Service Wind = 26.88 mm

Limit by Woolcock et al. 1999 Span/100 = 35.00 mm

Sag during installation =9.10 mm

**Reactions**

Maximum = 1.28 kn

**Middle Pole Design**

**Geometry**

|  |                           |                |                               |
|--|---------------------------|----------------|-------------------------------|
| 200 SED H5 (Minimum 225 dia. at Floor Level) | Dry Use                   | Height         | 3300 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                            | 3401 mm c/c               |                |                               |

**Loads**

Total Area over Pole = 17.5 m<sup>2</sup>

|             |           |             |           |
|-------------|-----------|-------------|-----------|
| Dead        | 4.38 Kn   | Live        | 4.38 Kn   |
| Wind Down   | 7.35 Kn   | Snow        | 11.03 Kn  |
| Moment wind | 7.91 Kn-m | Moment snow | 3.37 Kn-m |
| Phi         | 0.8       | K8          | 0.86      |
| K1 snow     | 0.8       | K1 Dead     | 0.6       |
| K1wind      | 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**

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|             |           |             |            |             |          |
|-------------|-----------|-------------|------------|-------------|----------|
| PhiNcx Wind | 438.68 Kn | PhiMnx Wind | 23.50 Kn-m | PhiVnx Wind | 62.96 Kn |
| PhiNcx Dead | 263.21 Kn | PhiMnx Dead | 14.10 Kn-m | PhiVnx Dead | 37.77 Kn |
| PhiNcx Snow | 350.94 Kn | PhiMnx Snow | 18.80 Kn-m | PhiVnx Snow | 50.36 Kn |

**Checks**

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.39 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.16 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 11.88 \text{ mm} < 33.00 \text{ mm}$$

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

**Assumed Soil Properties**

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

**Geometry For Middle Bay Pole**

|                  |         |  |
|------------------|---------|--|
| D <sub>s</sub> = | 0.6 mm  | Pile Diameter                                |
| L =              | 1500 mm | Pile embedment length                        |
| f <sub>1</sub> = | 2250 mm | Distance at which the shear force is applied |
| f <sub>2</sub> = | 0 mm    | Distance of top soil at rest pressure        |

**Loads**

|               |           |               |         |
|---------------|-----------|---------------|---------|
| Moment Wind = | 7.91 Kn-m | Moment Snow = | Kn-m    |
| Shear Wind =  | 3.52 Kn   | Shear Snow =  | 3.37 Kn |

**Pile Properties**

|                  |            |   |
|------------------|------------|---|
| Safety Factory   | 0.55       |   |
| H <sub>u</sub> = | 8.02 Kn    | Ultimate Lateral Strength of the Pile, Short pile |
| M <sub>u</sub> = | 11.12 Kn-m | Ultimate Moment Capacity of Pile                  |

**Checks**

$$\text{Applied Forces/Capacities} = 0.71 < 1 \text{ OK}$$

**End Pole Design**

**Geometry For End Bay Pole**

**Geometry**

|  |                           |                |                               |
|--|---------------------------|----------------|-------------------------------|
| 200 SED H5 (Minimum 225 dia. at Floor Level) | Dry Use                   | Height         | 2700 mm                       |
| Area   | 35448 mm <sup>2</sup>     | A <sub>s</sub> | 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**

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Total Area over Pole = 17.5 m<sup>2</sup>

|             |           |             |           |
|-------------|-----------|-------------|-----------|
| Dead        | 4.38 Kn   | Live        | 4.38 Kn   |
| Wind Down   | 7.35 Kn   | Snow        | 11.03 Kn  |
| Moment Wind | 3.96 Kn-m | Moment snow | 1.68 Kn-m |
| Phi         | 0.8       | K8          | 0.97      |
| K1 snow     | 0.8       | K1 Dead     | 0.6       |
| K1wind      | 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 | 495.72 Kn | PhiMnx Wind | 26.55 Kn-m | PhiVnx Wind | 62.96 Kn |
| PhiNcx Dead | 297.43 Kn | PhiMnx Dead | 15.93 Kn-m | PhiVnx Dead | 37.77 Kn |
| PhiNcx Snow | 396.58 Kn | PhiMnx Snow | 21.24 Kn-m | PhiVnx Snow | 50.36 Kn |

**Checks**

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.19 < 1$  OK

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

Deflection at top under service lateral loads = 5.39 mm < 29.93 mm

|      |         |  |
|------|---------|--|
| Ds = | 0.6 mm  | Pile Diameter                                |
| L =  | 1300 mm | Pile embedment length                        |
| f1 = | 2250 mm | Distance at which the shear force is applied |
| f2 = | 0 mm    | Distance of top soil at rest pressure        |

**Loads**

Total Area over Pole = 17.5 m<sup>2</sup>

|               |           |               |           |
|---------------|-----------|---------------|-----------|
| Moment Wind = | 3.96 Kn-m | Moment Snow = | 1.68 Kn-m |
| Shear Wind =  | 1.76 Kn   | Shear Snow =  | 1.68 Kn   |

**Pile Properties**

|                |           |   |
|----------------|-----------|---|
| Safety Factory | 0.55      |   |
| Hu =           | 5.51 Kn   | Ultimate Lateral Strength of the Pile, Short pile |
| Mu =           | 7.51 Kn-m | Ultimate Moment Capacity of Pile                  |

**Checks**

Applied Forces/Capacities = 0.53 < 1 OK

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

**Assumed Soil Properties**

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

**Geometry For End Bay Pole**

D<sub>s</sub> =      0.6 mm      Pile Diameter  
L =      1300 mm      Pile embedment length  
f<sub>1</sub> =      2250 mm      Distance at which the shear force is applied  
f<sub>2</sub> =      0 mm      Distance of top soil at rest pressure

**Loads**

Moment Wind =      3.96 Kn-m      Moment Snow =      1.68 Kn-m  
Shear Wind =      1.76 Kn      Shear Snow =      1.68 Kn

**Pile Properties**

Safety Factory      0.55  
H<sub>u</sub> =      5.51 Kn      Ultimate Lateral Strength of the Pile, Short pile  
M<sub>u</sub> =      7.51 Kn-m      Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.53 < 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

K<sub>s</sub> (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 (1500) x K<sub>s</sub> (1.5) x 0.5 x tan(30) x Pi x Dia of Pile (0.6) x Height of Pile (1500)

Skin Friction = 18.17 Kn

Weight of Pile + Pile Skin Friction = 22.07 Kn

Uplift on one Pile = 8.49 Kn

Uplift is ok