| | | | | | |
|---|---|---|---|---|---|
| **Job No.:** | Michael Noble | **Address:** | 1066 Ohakura Road, Atiamuri,New Zealand | **Date:** | 25/07/2024 |
| **Latitude:** | -38.398485 | **Longitude:** | 176.080686 | **Elevation:** | 315.5 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 | 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 | 41.06 m/s |
| Wind Pressure | 1.01 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 Pressues**

Shed Type = Mono Open

For roof Cp,i = 0.6731

For roof CP,e from 0 m To 2.85 m Cpe = -0.9 pe = -0.58 KPa pnet = -1.10 KPa

For roof CP,e from 2.85 m To 5.70 m Cpe = -0.5 pe = -0.32 KPa pnet = -0.84 KPa

For wall Windward Cp,i = 0.6731 side Wall Cp,i = -0.6001

For wall Windward and Leeward CP,e from 0 m To 8 m Cpe = 0.7 pe = 0.64 KPa pnet = 1.19 KPa

For side wall CP,e from 0 m To 2.85 m Cpe = pe = -0.59 KPa pnet = -0.04 KPa

Maximum Upward pressure used in roof member Design = 1.10 KPa

Maximum Downward pressure used in roof member Design = 0.73 KPa

Maximum Wall pressure used in Design = 1.19 KPa

Maximum Racking pressure used in Design = 1.1 KPa

**Design Summary**

**Purlin Design**

Purlin Spacing = 800 mm Purlin Span = 3850 mm Try Purlin 190x45 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 =1 K5 =1 K8 Downward =0.98

K8 Upward =0.46 S1 Downward =12.23 S1 Upward =25.13

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

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 0.5 Kn-m | Capacity | 1.79 Kn-m | Passing Percentage | **358.00 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 1.53 Kn-m | Capacity | 2.38 Kn-m | Passing Percentage | **155.56 %** |
| $M_{0.9D-WnUp}$ | -1.3 Kn-m | Capacity | -1.39 Kn-m | Passing Percentage | **60.70 %** |
| $V_{1.35D}$ | 0.52 Kn | Capacity | 8.25 Kn | Passing Percentage | **1586.54 %** |

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| | | | | | |
|---|---|---|---|---|---|
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 1.59 Kn | Capacity | 11.00 Kn | Passing Percentage | **691.82 %** |
| $V_{0.9D-WnUp}$ | -1.35 Kn | Capacity | -13.75 Kn | Passing Percentage | **1018.52 %** |

**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 = 7.56 mm — Limit by Woolcock et al, 1999 Span/240 = 15.83 mm

Deflection under Dead and Service Wind = 10.90 mm — Limit by Woolcock et al, 1999 Span/100 = 38.00 mm

**Reactions**

Maximum downward =1.59 kn  Maximum upward = -1.35 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 = 3850 mm  Try Rafter 2x240x45 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  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 =3 MPa  Bending Capacity of timber =14 MPa NZS3603 Amt 4, table 2.3

**Capacity Checks**

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 2.50 Kn-m | Capacity | 5.8 Kn-m | Passing Percentage | **232.00 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 7.63 Kn-m | Capacity | 7.74 Kn-m | Passing Percentage | **101.44 %** |
| $M_{0.9D-WnUp}$ | -6.48 Kn-m | Capacity | -9.68 Kn-m | Passing Percentage | **149.38 %** |
| $V_{1.35D}$ | 2.60 Kn | Capacity | 20.84 Kn | Passing Percentage | **801.54 %** |
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 7.93 Kn | Capacity | 27.78 Kn | Passing Percentage | **350.32 %** |
| $V_{0.9D-WnUp}$ | -6.74 Kn | Capacity | -34.74 Kn | Passing Percentage | **515.43 %** |

**Deflections**

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 6.43 mm — Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 10.3 mm — Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

**Reactions**

Maximum downward =7.93 kn  Maximum upward = -6.74 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 = 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 = 19.50 Kn > -6.74 Kn

## Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 3803 mm Try Rafter 240x45 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 =1 K5 =1 K8 Downward =0.94

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

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

#### Capacity Checks

| | | | | | |
|---|---|---|---|---|---|
| $M_{1.35D}$ | 1.22 Kn-m | Capacity | 2.73 Kn-m | Passing Percentage | **223.77 %** |
| $M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 3.72 Kn-m | Capacity | 3.64 Kn-m | Passing Percentage | **97.85 %** |
| $M_{0.9D-WnUp}$ | -3.16 Kn-m | Capacity | -4.55 Kn-m | Passing Percentage | **143.99 %** |
| $V_{1.35D}$ | 1.28 Kn | Capacity | 10.42 Kn | Passing Percentage | **814.06 %** |
| $V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$ | 3.92 Kn | Capacity | 13.89 Kn | Passing Percentage | **354.34 %** |
| $V_{0.9D-WnUp}$ | -3.33 Kn | Capacity | -17.37 Kn | Passing Percentage | **521.62 %** |

#### Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 7.14 mm Limit by Woolcock et al, 1999 Span/240= 16.67 mm
Deflection under Dead and Service Wind = 10.30 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

#### Reactions

Maximum downward =3.92 kn Maximum upward = -3.33 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 fpj = 12.9 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 x k1 x k4 x k5 x fs x b x ds ........... (Eq 4.12) = -17.01 kn > -3.33 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -3.33 Kn

## Girt Design Front and Back

Girt's Spacing = 600 mm Girt's Span = 4000 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 =0.88 S1 Downward =10.36 S1 Upward =15.45

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

#### Capacity Checks

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 1.43 Kn-m | Capacity | 1.45 Kn-m | Passing Percentage | **101.40 %** |
| $V_{0.9D-WnUp}$ | 1.43 Kn | Capacity | 10.13 Kn | Passing Percentage | **708.39 %** |

#### Deflections

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

Deflection under Snow and Service Wind = 34.52 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm
Sag during installation = 19.16 mm

#### Reactions

Maximum = 1.43 kn

## Girt Design Sides

Girt's Spacing = 600 mm Girt's Span = 4000 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 =0.88 S1 Downward =10.36 S1 Upward =15.45

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

#### Capacity Checks

| | | | | | |
|---|---|---|---|---|---|
| $M_{Wind+Snow}$ | 1.43 Kn-m | Capacity | 1.45 Kn-m | Passing Percentage | **101.40 %** |
| $V_{0.9D-WnUp}$ | 1.43 Kn | Capacity | 10.13 Kn | Passing Percentage | **708.39 %** |

#### Deflections

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

Deflection under Snow and Service Wind = 34.52 mm Limit by Woolcock et al. 1999 Span/100 = 40.00 mm

Sag during installation =19.16 mm

#### Reactions

Maximum = 1.43 kn

### Middle Pole Design

#### Geometry

| | | | |
|---|---|---|---|
| 150 UNI H5 | Dry Use | Height | 2760 mm |
| Area | 17663 mm2 | As | 13246.875 mm2 |
| Ix | 24837891 mm4 | Zx | 331172 mm3 |
| Iy | 24837891 mm4 | Zx | 331172 mm3 |
| Lateral Restraint | 1300 mm c/c | | |

#### Loads

Total Area over Pole = 16 m2

| | | | |
|---|---|---|---|
| Dead | 4.00 Kn | Live | 4.00 Kn |
| Wind Down | 11.68 Kn | Snow | 0.00 Kn |
| Moment wind | 4.94 Kn-m | | |
| Phi | 0.8 | K8 | 1.00 |
| K1 snow | 0.8 | K1 Dead | 0.6 |
| K1wind | 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 | 254.34 Kn | PhiMnx Wind | 9.09 Kn-m | PhiVnx Wind | 31.37 Kn |
| PhiNcx Dead | 152.60 Kn | PhiMnx Dead | 5.46 Kn-m | PhiVnx Dead | 18.82 Kn |

#### Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.62 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.37 < 1 OK

Deflection at top under service lateral loads = 26.30 mm < 27.60 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 |
| K0 = | (1-sin(30)) / (1+sin(30)) | | | | |
| Kp = | (1+sin(30)) / (1-sin(30)) | | | | |

#### Geometry For Middle Bay Pole

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

| | |
|---|---|
| Moment Wind = | 4.94 Kn-m |
| Shear Wind = | 2.19 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 = 0.66 < 1 OK

### End Pole Design

#### Geometry For End Bay Pole

#### Geometry

| | | | |
|---|---|---|---|
| 150 UNI H5 | Dry Use | Height | 2800 mm |
| Area | 17663 mm2 | As | 13246.875 mm2 |
| Ix | 24837891 mm4 | Zx | 331172 mm3 |
| Iy | 24837891 mm4 | Zx | 331172 mm3 |
| Lateral Restraint | mm c/c | | |

#### Loads

Total Area over Pole = 8 m2

| | | | |
|---|---|---|---|
| Dead | 2.00 Kn | Live | 2.00 Kn |
| Wind Down | 5.84 Kn | Snow | 0.00 Kn |
| Moment Wind | 2.47 Kn-m | | |
| Phi | 0.8 | K8 | 0.74 |
| K1 snow | 0.8 | K1 Dead | 0.6 |
| K1wind | 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 | 187.15 Kn | PhiMnx Wind | 6.69 Kn-m | PhiVnx Wind | 31.37 Kn |

| | | | | | |
|---|---|---|---|---|---|
| PhiNcx Dead | 112.29 Kn | PhiMnx Dead | 4.01 Kn-m | PhiVnx Dead | 18.82 Kn |

**Checks**

(Mx/PhiMnx)+(N/phiNcx) = 0.42 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.19 < 1 OK

Deflection at top under service lateral loads = 14.26 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 = 8 m2

| | |
|---|---|
| Moment Wind = | 2.47 Kn-m |
| Shear Wind = | 1.10 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 = 0.33 < 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 = | 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**

| | |
|---|---|
| Moment Wind = | 2.47 Kn-m |
| Shear Wind = | 1.10 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 = 0.33 < 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 = Safecty factor (0.55) x Density of Soil(18) x Height of Pile(1300) x Ks(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 = 18.15 Kn

Uplift on one Pile = 14.00 Kn

Uplift is ok