

Job No.: Charlotte Pemberton **Address:** 62 Valley View Rd, Otaika, New Zealand **Date:** 8/8/2022
Latitude: -35.784599 **Longitude:** 174.292101 **Elevation:** 20 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 | C |
| Importance Level | 1 | Ultimate wind & Earthquake ARI | 500 Years | Max Height | 3.9 m |
| Wind Region | NZ1 | Terrain Category | 2.23 | Design Wind Speed | 42.72 m/s |
| Wind Pressure | 1.09 KPa | Lee Zone | NO | Ultimate Snow ARI | 50 Years |
| Wind Category | High | | | | |

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 3.90 m $C_{p,e} = -0.9$ $p_e = -0.89$ KPa $p_{net} = -0.89$ KPa

For roof $C_{p,e}$ from 3.90 m To 7.80 m $C_{p,e} = -0.5$ $p_e = -0.49$ KPa $p_{net} = -0.49$ 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 $C_{p,e} = 0.7$ $p_e = 0.69$ KPa $p_{net} = 1.02$ KPa

For side wall $C_{p,e}$ from 0 m To 3.90 m $C_{p,e} =$ $p_e = -0.64$ KPa $p_{net} = -0.64$ KPa

Maximum Upward pressure used in roof member Design = 0.89 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 1.02 KPa

Maximum Racking pressure used in Design = 1.18 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 3800 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)

K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 0.53 S1 Downward = 11.27 S1 Upward = 23.16

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

Capacity Checks

| | | | | | |
|---|------------|----------|------------|--------------------|------------------|
| M _{1.35D} | 0.55 Kn-m | Capacity | 2.39 Kn-m | Passing Percentage | 434.55 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 1.53 Kn-m | Capacity | 3.18 Kn-m | Passing Percentage | 207.84 % |
| M _{0.9D-W_nUp} | -1.08 Kn-m | Capacity | -2.10 Kn-m | Passing Percentage | 194.44 % |
| V _{1.35D} | 0.58 Kn | Capacity | 9.65 Kn | Passing Percentage | 1663.79 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 1.25 Kn | Capacity | 12.86 Kn | Passing Percentage | 1028.80 % |
| V _{0.9D-W_nUp} | -1.14 Kn | Capacity | -16.08 Kn | Passing Percentage | 1410.53 % |

Deflections

Modulus of Elasticity = 8000 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 = 5.50 mm Limit by AS1170.0 Table C1 Span/250 = 15.20 mm

Deflection under Dead and Service Wind = 6.55 mm Limit by AS1170.0 Table C1 Span/120 = 31.67 mm

Reactions

Maximum downward = 1.25 kn Maximum upward = -1.14 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 = 8850 mm Try Rafter 2x360x45 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 = 8.40 S1 Upward = 8.40

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

Capacity Checks

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| | | | | | |
|--|-------------|----------|-------------|--------------------|-----------------|
| M _{1.35D} | 13.22 Kn-m | Capacity | 50.28 Kn-m | Passing Percentage | 380.33 % |
| M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 28.59 Kn-m | Capacity | 67.04 Kn-m | Passing Percentage | 234.49 % |
| M _{0.9D-WnUp} | -26.04 Kn-m | Capacity | -83.82 Kn-m | Passing Percentage | 321.89 % |
| V _{1.35D} | 5.97 Kn | Capacity | 55.22 Kn | Passing Percentage | 924.96 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 12.92 Kn | Capacity | 73.64 Kn | Passing Percentage | 569.97 % |
| V _{0.9D-WnUp} | -11.77 Kn | Capacity | -92.04 Kn | Passing Percentage | 781.99 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 23.97 mm Limit by AS1170.0 Table C1 Span/250 = 36.00 mm

Deflection under Dead and Service Wind = 31.74 mm Limit by AS1170.0 Table C1 Span/120 = 75.00 mm

Reactions

Maximum downward = 12.92 kn Maximum upward = -11.77 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 f_{pj} = 22.7 Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 29.11 Kn > -11.77 Kn

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 4340 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)

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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} | 1.59 Kn-m | Capacity | 4.72 Kn-m | Passing Percentage | 296.86 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 3.44 Kn-m | Capacity | 6.30 Kn-m | Passing Percentage | 183.14 % |
| M _{0.9D-W_nUp} | -3.13 Kn-m | Capacity | -7.87 Kn-m | Passing Percentage | 251.44 % |
| V _{1.35D} | 1.46 Kn | Capacity | 14.47 Kn | Passing Percentage | 991.10 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 3.17 Kn | Capacity | 19.30 Kn | Passing Percentage | 608.83 % |
| V _{0.9D-W_nUp} | -2.89 Kn | Capacity | -24.12 Kn | Passing Percentage | 834.60 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.27 mm Limit by AS1170.0 Table C1 Span/250 = 18.00 mm

Deflection under Dead and Service Wind = 6.28 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Reactions

Maximum downward = 3.17 kn Maximum upward = -2.89 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

V = $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$ (Eq 4.12) = -25.20 kn > -2.89 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.89 Kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 4000 mm Try Intermediate 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} | 1.33 Kn-m | Capacity | 1.54 Kn-m | Passing Percentage | 115.79 % |
| V _{0.9D-WnUp} | 1.33 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | 906.77 % |

Deflections

Modulus of Elasticity = 8000 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 19.64 mm Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

Sag during installation = 13.00 mm

Reactions

Maximum = 1.33 kn

Girt Design Sides

Girt's Spacing = 1000 mm Girt's Span = 4500 mm Try Intermediate 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 =0.60 S1 Downward =9.63 S1 Upward =21.54

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

Capacity Checks

| | | | | | |
|------------------------|-----------|----------|-----------|--------------------|-----------------|
| M _{Wind+Snow} | 1.29 Kn-m | Capacity | 1.41 Kn-m | Passing Percentage | 109.30 % |
|------------------------|-----------|----------|-----------|--------------------|-----------------|

| | | | | | |
|------------------------|-----------|----------|------------|--------------------|------------------|
| V _{0.9D-WnUp} | 1.15 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | 1048.70 % |
|------------------------|-----------|----------|------------|--------------------|------------------|

Deflections

Modulus of Elasticity = 8000 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 24.21 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Sag during installation = 20.82 mm

Reactions

Maximum = 1.15 kn

Middle Pole Design

Geometry

| | | | |
|--|--------------------------|----------------|------------------------|
| 150 SED H5 (Minimum 200 dia. at Floor Level) | Dry Use | Height | 3300 mm |
| Area | 31400 mm ² | As | 23550 mm ² |
| I _x | 78500000 mm ⁴ | Z _x | 785000 mm ³ |
| I _y | 78500000 mm ⁴ | Z _y | 785000 mm ³ |
| Lateral Restraint | 1000 mm c/c | | |

Loads

Total Area over Pole = 18 m²

| | | | |
|---------------------|---------|---------------------|---------|
| Dead | 4.50 Kn | Live | 4.50 Kn |
| Wind | 7.74 Kn | Snow | 0.00 Kn |
| Moment wind | Kn-m | | |
| Phi | 0.8 | K ₈ | 1.00 |
| 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 | 452.16 Kn | PhiM _{nx} Wind | 22.80 Kn-m | PhiV _{nx} Wind | 55.77 Kn |
|-------------------------|-----------|-------------------------|------------|-------------------------|----------|

PhiNcx Dead 271.30 Kn PhiMnx Dead 13.68 Kn-m PhiVnx Dead 33.46 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.63 < 1 \text{ OK}$$

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

$$\text{Deflection at top under service lateral loads} = 33.41 \text{ mm} < 44.00 \text{ mm}$$

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

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 = 600 mm Pile Diameter
L = 1600 mm Pile embedment length
f1 = 2925 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 13.43 Kn-m
Shear Wind = 4.59 Kn

Pile Properties

Safety Factory 0.55
Hu = 8.07 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 14.19 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

Ds = 600 mm Pile Diameter

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| | | |
|------|---------|--|
| L = | 1300 mm | Pile embedment length |
| f1 = | 2925 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

Total Area over Pole = 4.5 m²

| | |
|---------------|-----------|
| Moment Wind = | 4.48 Kn-m |
| Shear Wind = | 1.53 Kn |

Pile Properties

| | | |
|----------------|-----------|---|
| Safety Factory | 0.55 | |
| Hu = | 4.63 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 7.98 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.56 < 1 OK

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

Soil Properties

| | | | | | |
|-------|-----------------------------------|----------------|--------|----------|---------------------|
| Gamma | 18 Kn/m ³ | Friction angle | 30 deg | Cohesion | 0 Kn/m ³ |
| K0 = | $(1 - \sin(30)) / (1 + \sin(30))$ | | | | |
| Kp = | $(1 + \sin(30)) / (1 - \sin(30))$ | | | | |

Geometry For End Bay Pole

| | | |
|------|---------|--|
| Ds = | 600 mm | Pile Diameter |
| L = | 1300 mm | Pile embedment length |
| f1 = | 2925 mm | Distance at which the shear force is applied |
| f2 = | 0 mm | Distance of top soil at rest pressure |

Loads

| | |
|---------------|-----------|
| Moment Wind = | 4.48 Kn-m |
| Shear Wind = | 1.53 Kn |

Pile Properties

| | |
|----------------|------|
| Safety Factory | 0.55 |
|----------------|------|

Hu = 4.63 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 7.98 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.56 < 1$ 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 = Safety factor (0.55) x Density of Soil(18) x Height of Pile(1600) x Ks(1.5) x $\tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1600)

Skin Friction = 20.68 Kn

Weight of Pile + Pile Skin Friction = 25.09 Kn

Uplift on one Pile = 11.97 Kn

Uplift is ok