

Job No.: Michael MacKinnon **Address:** 106 Golf Road, Taumarunui, New Zealand **Date:** 8/9/2022
Latitude: -38.871003 **Longitude:** 175.254993 **Elevation:** 188 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	4 m
Wind Region	NZ2	Terrain Category	2.66	Design Wind Speed	38.74 m/s
Wind Pressure	0.9 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 3.75 m $C_{p,e} = -0.9$ $p_e = -0.73$ KPa $p_{net} = -0.73$ KPa

For roof $C_{p,e}$ from 3.75 m To 7.50 m $C_{p,e} = -0.50$ $p_e = -0.41$ KPa $p_{net} = -0.41$ 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 $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 0.84$ KPa

For side wall $C_{p,e}$ from 0 m To 3.75 m $C_{p,e} =$ $p_e = -0.53$ KPa $p_{net} = -0.53$ KPa

Maximum Upward pressure used in roof member Design = 0.73 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 0.84 KPa

Maximum Racking pressure used in Design = 0.92 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 4300 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 = 0.47 S1 Downward = 11.27 S1 Upward = 24.64

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

Capacity Checks

M _{1.35D}	0.7 Kn-m	Capacity	2.39 Kn-m	Passing Percentage	341.43 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.81 Kn-m	Capacity	3.18 Kn-m	Passing Percentage	175.69 %
M _{0.9D-W_nUp}	-1.05 Kn-m	Capacity	-1.88 Kn-m	Passing Percentage	179.05 %
V _{1.35D}	0.65 Kn	Capacity	9.65 Kn	Passing Percentage	1484.62 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.41 Kn	Capacity	12.86 Kn	Passing Percentage	912.06 %
V _{0.9D-W_nUp}	-0.98 Kn	Capacity	-16.08 Kn	Passing Percentage	1640.82 %

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 = 9.01 mm Limit by AS1170.0 Table C1 Span/250 = 17.20 mm

Deflection under Dead and Service Wind = 10.74 mm Limit by AS1170.0 Table C1 Span/120 = 35.83 mm

Reactions

Maximum downward = 1.41 kn Maximum upward = -0.98 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 = 4500 mm Internal Rafter Span = 11850 mm Try Rafter 2x450x45 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 = 9.45 S1 Upward = 9.45

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}	26.66 Kn-m	Capacity	78.58 Kn-m	Passing Percentage	294.75 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	57.66 Kn-m	Capacity	104.76 Kn-m	Passing Percentage	181.69 %
M _{0.9D-WnUp}	-39.89 Kn-m	Capacity	-130.96 Kn-m	Passing Percentage	328.30 %
V _{1.35D}	9.00 Kn	Capacity	69.04 Kn	Passing Percentage	767.11 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	19.46 Kn	Capacity	92.04 Kn	Passing Percentage	472.97 %
V _{0.9D-WnUp}	-13.46 Kn	Capacity	-115.06 Kn	Passing Percentage	854.83 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 43.635 mm Limit by AS1170.0 Table C1 Span/250 = 48.00 mm

Deflection under Dead and Service Wind = 57.78 mm Limit by AS1170.0 Table C1 Span/120 = 100.00 mm

Reactions

Maximum downward = 19.46 kn Maximum upward = -13.46 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 > -13.46 Kn

Rafter Design External

External Rafter Load Width = 2250 mm External Rafter Span = 11810 mm Try Rafter 450x45 LVL13

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 = 0.72

K8 Upward = 0.72 S1 Downward = 19.04 S1 Upward = 19.04

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

Capacity Checks

M _{1.35D}	13.24 Kn-m	Capacity	23.45 Kn-m	Passing Percentage	177.11 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	28.64 Kn-m	Capacity	31.26 Kn-m	Passing Percentage	109.15 %
M _{0.9D-W_nUp}	-19.81 Kn-m	Capacity	-39.08 Kn-m	Passing Percentage	197.27 %
V _{1.35D}	4.48 Kn	Capacity	34.52 Kn	Passing Percentage	770.54 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	9.70 Kn	Capacity	46.02 Kn	Passing Percentage	474.43 %
V _{0.9D-W_nUp}	-6.71 Kn	Capacity	-57.53 Kn	Passing Percentage	857.38 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 48.48 mm Limit by AS1170.0 Table C1 Span/250 = 48.00 mm

Deflection under Dead and Service Wind = 57.78 mm Limit by AS1170.0 Table C1 Span/120 = 100.00 mm

Reactions

Maximum downward = 9.70 kn Maximum upward = -6.71 kn

Rafter to Pole Connection check

Bolt Size = M12 Number of Bolts = 3

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 f_{pj} = 22.7 Mpa for Rafter with effective thickness = 45 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) = -65.11 kn > -6.71 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -6.71 Kn

Intermediate Design Sides

Intermediate Spacing = 6000 mm Intermediate Span = 3600 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 = 0.71

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

Capacity Checks

M _{Wind+Snow}	4.08 Kn-m	Capacity	7.98 Kn-m	Passing Percentage	195.59 %
V _{0.9D-WnUp}	4.54 Kn-m	Capacity	32.16 Kn-m	Passing Percentage	708.37 %

Deflections

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

Deflection under Snow and Service Wind = 30.605 mm Limit by AS1170.0 Table C1 Span/120 = 30.00 mm

Reactions

Maximum = 4.54 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 4500 mm Try Intermediate 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 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 0.45 S1 Downward = 11.27 S1 Upward = 25.20

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	1.81 Kn-m	Passing Percentage	131.16 %
V _{0.9D-WnUp}	1.23 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	1307.32 %

Deflections

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

Deflection under Snow and Service Wind = 10.93 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Sag during installation = 20.82 mm

Reactions

Maximum = 1.23 kn

Middle Pole Design

Geometry

200 SED H5 (Minimum 250 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	49063 mm ²	As	36796.875 mm ²
I _x	191650391 mm ⁴	Z _x	1533203 mm ³
I _y	191650391 mm ⁴	Z _y	1533203 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 27 m²

Dead	6.75 Kn	Live	6.75 Kn
Wind	11.61 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	706.50 Kn	PhiM _{nx} Wind	44.52 Kn-m	PhiV _{nx} Wind	87.14 Kn
PhiN _{cx} Dead	423.90 Kn	PhiM _{nx} Dead	26.71 Kn-m	PhiV _{nx} Dead	52.28 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.31 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.11 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 14.52 \text{ mm} < 49.33 \text{ mm}$$

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 = 3000 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 12.39 Kn-m
Shear Wind = 4.13 Kn

Pile Properties

Safety Factory 0.55
Hu = 7.93 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 14.27 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.87 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter
L = 1300 mm Pile embedment length
f1 = 3000 mm Distance at which the shear force is applied

$f_2 = 0 \text{ mm}$ Distance of top soil at rest pressure

Loads

Total Area over Pole = 13.5 m²

Moment Wind = 6.19 Kn-m

Shear Wind = 2.06 Kn

Pile Properties

Safety Factory 0.55

$H_u = 4.55 \text{ Kn}$ Ultimate Lateral Strength of the Pile, Short pile

$M_u = 8.02 \text{ Kn-m}$ Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.77 < 1 OK

Drained Lateral Strength of End 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 End Bay Pole

$D_s = 600 \text{ mm}$ Pile Diameter

$L = 1300 \text{ mm}$ Pile embedment length

$f_1 = 3000 \text{ mm}$ Distance at which the shear force is applied

$f_2 = 0 \text{ mm}$ Distance of top soil at rest pressure

Loads

Moment Wind = 6.19 Kn-m

Shear Wind = 2.06 Kn

Pile Properties

Safety Factory 0.55

$H_u = 4.55 \text{ Kn}$ Ultimate Lateral Strength of the Pile, Short pile

$M_u = 8.02 \text{ Kn-m}$ Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.77 < 1$ OK

Uplift Check

Density of Concrete = 24 Kn/m^3

Density of Timber Pole = 5 Kn/m^3

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 (1600) x K_s (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 = 24.11 Kn

Uplift on one Pile = 13.63 Kn

Uplift is ok