

Job No.: 2208053 .M

Address: 87 Douglas Road, Motueka, New Zealand

Date: 9/8/2022

Latitude: -41.108524

Longitude: 172.969847

Elevation: 14 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N3	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	100 Years	Max Height	3.8 m
Wind Region	NZ2	Terrain Category	2.09	Design Wind Speed	37.95 m/s
Wind Pressure	0.86 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 3.40 m $C_{p,e} = -0.9$ $p_e = -0.7$ KPa $p_{net} = -0.7$ KPa

For roof $C_{p,e}$ from 3.40 m To 6.80 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 10 m $C_{p,e} = 0.7$ $p_e = 0.54$ KPa $p_{net} = 0.8$ KPa

For side wall $C_{p,e}$ from 0 m To 3.40 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = -0.51$ KPa

Maximum Upward pressure used in roof member Design = 0.70 KPa

Maximum Downward pressure used in roof member Design = 0.34 KPa

Maximum Wall pressure used in Design = 0.8 KPa

Maximum Racking pressure used in Design = 0.91 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}	-0.99 Kn-m	Capacity	-1.88 Kn-m	Passing Percentage	189.90 %
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}	1.31 Kn	Capacity	12.86 Kn	Passing Percentage	981.68 %
V _{0.9D-W_nUp}	-0.92 Kn	Capacity	-16.08 Kn	Passing Percentage	1747.83 %

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 = 10.07 mm Limit by AS1170.0 Table C1 Span/120 = 35.83 mm

Reactions

Maximum downward = 1.31 kn Maximum upward = -0.92 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 = 9850 mm Try Rafter 2x360x63 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 = 5.90 S1 Upward = 5.90

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}	18.42 Kn-m	Capacity	70.4 Kn-m	Passing Percentage	382.19 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	36.84 Kn-m	Capacity	93.86 Kn-m	Passing Percentage	254.78 %
M _{0.9D-WnUp}	-25.92 Kn-m	Capacity	-117.34 Kn-m	Passing Percentage	452.70 %
V _{1.35D}	7.48 Kn	Capacity	77.32 Kn	Passing Percentage	1033.69 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	14.96 Kn	Capacity	103.08 Kn	Passing Percentage	689.04 %
V _{0.9D-WnUp}	-10.53 Kn	Capacity	-128.86 Kn	Passing Percentage	1223.74 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 29.36 mm Limit by AS1170.0 Table C1 Span/250 = 40.00 mm

Deflection under Dead and Service Wind = 36.425 mm Limit by AS1170.0 Table C1 Span/120 = 83.33 mm

Reactions

Maximum downward = 14.96 kn Maximum upward = -10.53 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 = 126 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 > -10.53 Kn

Rafter Design External

External Rafter Load Width = 2250 mm External Rafter Span = 4816 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}	2.20 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	214.55 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.40 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	143.18 %
M _{0.9D-W_nUp}	-3.10 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	253.87 %
V _{1.35D}	1.83 Kn	Capacity	14.47 Kn	Passing Percentage	790.71 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.66 Kn	Capacity	19.30 Kn	Passing Percentage	527.32 %
V _{0.9D-W_nUp}	-2.57 Kn	Capacity	-24.12 Kn	Passing Percentage	938.52 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 9.04 mm Limit by AS1170.0 Table C1 Span/250 = 20.00 mm

Deflection under Dead and Service Wind = 10.10 mm Limit by AS1170.0 Table C1 Span/120 = 41.67 mm

Reactions

Maximum downward = 3.66 kn Maximum upward = -2.57 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 > -2.57 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.57 Kn

Intermediate Design Sides

Intermediate Spacing = 2500 mm Intermediate Span = 3450 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 = 0.60

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

Capacity Checks

M _{Wind+Snow}	1.49 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	316.78 %
V _{0.9D-WnUp}	1.72 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	1402.33 %

Deflections

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

Deflection under Snow and Service Wind = 24.285 mm Limit by AS1170.0 Table C1 Span/120 = 28.75 mm

Reactions

Maximum = 1.72 kn

Girt Design Front and Back

Girt's Spacing = 1300 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}	1.32 Kn-m	Capacity	1.41 Kn-m	Passing Percentage	106.82 %
V _{0.9D-WnUp}	1.17 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	1030.77 %

Deflections

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

Deflection under Snow and Service Wind = 24.68 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Sag during installation = 20.82 mm

Reactions

Maximum = 1.17 kn

Middle Pole Design

Geometry

175 SED H5)	Dry Use	Height	3100 mm
Area	24041 mm ²	As	18030.46875 mm ²
Ix	46015259 mm ⁴	Zx	525889 mm ³
Iy	46015259 mm ⁴	Zy	525889 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 22.5 m²

Dead	5.63 Kn	Live	5.63 Kn
Wind	7.65 Kn	Snow	0.00 Kn
Moment wind	Kn-m		
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1 wind	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	346.19 Kn	PhiMnx Wind	15.27 Kn-m	PhiVnx Wind	42.70 Kn
PhiNcx Dead	207.71 Kn	PhiMnx Dead	9.16 Kn-m	PhiVnx Dead	25.62 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.78 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.58 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 42.97 \text{ mm} < 41.33 \text{ mm}$$

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 = 1500 mm Pile embedment length
f1 = 2850 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 11.06 Kn-m
Shear Wind = 3.88 Kn

Pile Properties

Safety Factory 0.55
Hu = 6.91 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 11.80 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.94 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter
L = 1300 mm Pile embedment length
f1 = 2850 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 = 5.625 m²

Moment Wind = 3.69 Kn-m

Shear Wind = 1.29 Kn

Pile Properties

Safety Factory 0.55

$H_u = 4.72 \text{ Kn}$ Ultimate Lateral Strength of the Pile, Short pile

$M_u = 7.94 \text{ Kn-m}$ Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.46 < 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

$f_1 = 2850 \text{ mm}$ Distance at which the shear force is applied

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

Loads

Moment Wind = 3.69 Kn-m

Shear Wind = 1.29 Kn

Pile Properties

Safety Factory 0.55

$H_u = 4.72 \text{ Kn}$ Ultimate Lateral Strength of the Pile, Short pile

$M_u = 7.94 \text{ Kn-m}$ Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.46 < 1$ 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 (1500) x K_s (1.5) x $\tan(30)$ x π x Dia of Pile (0.6) x Height of Pile (1500)

Skin Friction = 18.17 Kn

Weight of Pile + Pile Skin Friction = 22.82 Kn

Uplift on one Pile = 10.69 Kn

Uplift is ok