

Job No.: The Muscat Falls Trust **Address:** 45 Ben Morven Road, Blenheim, Fairhall, New Zealand **Date:** 8/11/2022
Latitude: -41.53481 **Longitude:** 173.907724 **Elevation:** 15 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	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.8 m
Wind Region	NZ2	Terrain Category	2.5	Design Wind Speed	36.54 m/s
Wind Pressure	0.8 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Medium				

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 $C_{p,e} = -0.9$ $p_e = -0.65$ KPa $p_{net} = -0.65$ KPa

For roof $C_{p,e}$ from 3.40 m To 6.80 m $C_{p,e} = -0.5$ $p_e = -0.36$ KPa $p_{net} = -0.36$ 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 10.80 m $C_{p,e} = 0.7$ $p_e = 0.50$ KPa $p_{net} = 0.74$ KPa

For side wall $C_{p,e}$ from 0 m To 3.40 m $C_{p,e} =$ $p_e = -0.47$ KPa $p_{net} = -0.47$ KPa

Maximum Upward pressure used in roof member Design = 0.65 KPa

Maximum Downward pressure used in roof member Design = 0.38 KPa

Maximum Wall pressure used in Design = 0.74 KPa

Maximum Racking pressure used in Design = 0.86 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 3400 mm Try Purlin 150x50 SG8 Dry

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Moisture Condition = Dry (Moisture in timber is less than 16% and 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 = 0.73 S1 Downward = 9.63 S1 Upward = 18.72

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

Capacity Checks

M _{1.35D}	0.44 Kn-m	Capacity	1.41 Kn-m	Passing Percentage	320.45 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.33 Kn-m	Capacity	1.89 Kn-m	Passing Percentage	142.11 %
M _{0.9D-W_nUp}	-0.55 Kn-m	Capacity	-1.73 Kn-m	Passing Percentage	314.55 %
V _{1.35D}	0.52 Kn	Capacity	7.24 Kn	Passing Percentage	1392.31 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.04 Kn	Capacity	9.65 Kn	Passing Percentage	927.88 %
V _{0.9D-W_nUp}	-0.65 Kn	Capacity	-12.06 Kn	Passing Percentage	1855.38 %

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 = 8.35 mm Limit by AS1170.0 Table C1 Span/250 = 13.60 mm

Deflection under Dead and Service Wind = 9.60 mm Limit by AS1170.0 Table C1 Span/120 = 28.33 mm

Reactions

Maximum downward = 1.04 kn Maximum upward = -0.65 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 = 3600 mm Internal Rafter Span = 7850 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

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M1.35D	9.36 Kn-m	Capacity	34.92 Kn-m	Passing Percentage	373.08 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	18.86 Kn-m	Capacity	46.56 Kn-m	Passing Percentage	246.87 %
M0.9D-WnUp	-11.79 Kn-m	Capacity	-58.2 Kn-m	Passing Percentage	493.64 %
V1.35D	4.77 Kn	Capacity	46.02 Kn	Passing Percentage	964.78 %
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	9.61 Kn	Capacity	61.36 Kn	Passing Percentage	638.50 %
V0.9D-WnUp	-6.01 Kn	Capacity	-76.7 Kn	Passing Percentage	1276.21 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 23.275 mm Limit by AS1170.0 Table C1 Span/250 = 32.00 mm

Deflection under Dead and Service Wind = 29.735 mm Limit by AS1170.0 Table C1 Span/120 = 66.67 mm

Reactions

Maximum downward = 9.61 kn Maximum upward = -6.01 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 > -6.01 Kn

Rafter Design External

External Rafter Load Width = 1800 mm External Rafter Span = 3820 mm Try Rafter 250x50 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 =0.97

K8 Upward =0.97 S1 Downward =12.68 S1 Upward =12.68

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

Capacity Checks

M _{1.35D}	1.11 Kn-m	Capacity	3.51 Kn-m	Passing Percentage	316.22 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.23 Kn-m	Capacity	4.67 Kn-m	Passing Percentage	209.42 %
M _{0.9D-W_nUp}	-1.40 Kn-m	Capacity	-5.84 Kn-m	Passing Percentage	417.14 %
V _{1.35D}	1.16 Kn	Capacity	12.06 Kn	Passing Percentage	1039.66 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.34 Kn	Capacity	16.08 Kn	Passing Percentage	687.18 %
V _{0.9D-W_nUp}	-1.46 Kn	Capacity	-20.10 Kn	Passing Percentage	1376.71 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.12 mm Limit by AS1170.0 Table C1 Span/250 = 16.00 mm

Deflection under Dead and Service Wind = 5.89 mm Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

Reactions

Maximum downward =2.34 kn Maximum upward = -1.46 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 =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

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -19.95 kn > -1.46 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -1.46 Kn

Intermediate Design Sides

Intermediate Spacing = 2000 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

$M_{Wind+Snow}$	1.10 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	429.09 %
$V_{0.9D-WnUp}$	1.28 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	1884.38 %

Deflections

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

Deflection under Snow and Service Wind = 17.97 mm Limit by AS1170.0 Table C1 Span/120 = 28.75 mm

Reactions

Maximum = 1.28 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 3600 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 = 0.71 S1 Downward = 9.63 S1 Upward = 19.27

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

Capacity Checks

$M_{Wind+Snow}$	0.78 Kn-m	Capacity	1.66 Kn-m	Passing Percentage	212.82 %
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V _{0.9D-WnUp}	0.87 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	1386.21 %
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Deflections

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

Deflection under Snow and Service Wind = 9.35 mm Limit by AS1170.0 Table C1 Span/120 = 30.00 mm

Sag during installation = 8.53 mm

Reactions

Maximum = 0.87 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3500 mm
Area	39741 mm ²	As	29805.46875 mm ²
I _x	125741821 mm ⁴	Z _x	1117705 mm ³
I _y	125741821 mm ⁴	Z _y	1117705 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 14.4 m²

Dead	3.60 Kn	Live	3.60 Kn
Wind	5.47 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	572.26 Kn	PhiM _{Nx} Wind	32.46 Kn-m	PhiV _{Nx} Wind	70.58 Kn
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PhiNcx Dead 343.36 Kn PhiMnx Dead 19.47 Kn-m PhiVnx Dead 42.35 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.28 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.09 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 13.42 \text{ mm} < 46.67 \text{ mm}$$

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 = 1400 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 = 8.36 Kn-m
Shear Wind = 2.93 Kn

Pile Properties

Safety Factory 0.55
Hu = 5.75 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 9.75 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.86 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter

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L = 1400 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

Total Area over Pole = 3.6 m²

Moment Wind = 2.79 Kn-m
Shear Wind = 0.98 Kn

Pile Properties

Safety Factory 0.55
Hu = 5.75 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 9.75 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.29 < 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
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 = 1400 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 = 2.79 Kn-m
Shear Wind = 0.98 Kn

Pile Properties

Safety Factory 0.55

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Hu = 5.75 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 9.75 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.29 < 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(1400) x Ks(1.5) x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1400)

Skin Friction = 15.83 Kn

Weight of Pile + Pile Skin Friction = 19.25 Kn

Uplift on one Pile = 6.12 Kn

Uplift is ok