

Job No.: Ben Abplanalp
Latitude: -35.604506

Address: 118 Jordan Valley Road, Hikurangi, New Zealand
Longitude: 174.272371

Date: 27/09/2024
Elevation: 121 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	100 Years	Max Height	4.5 m
Wind Region	NZ1	Terrain Category	1.73	Design Wind Speed	42.23 m/s
Wind Pressure	1.07 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 Pressures

Shed Type = Mono Enclosed

For roof $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 5 m $C_{p,e} = -0.9$ $p_e = -0.87$ KPa $p_{net} = -0.87$ KPa

For roof $C_{p,e}$ from 5 m To 10 m $C_{p,e} = -0.5$ $p_e = -0.48$ KPa $p_{net} = -0.48$ 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 13.5 m $C_{p,e} = 0.7$ $p_e = 0.67$ KPa $p_{net} = 0.99$ KPa

For side wall $C_{p,e}$ from 0 m To 5 m $C_{p,e} =$ $p_e = -0.63$ KPa $p_{net} = -0.63$ KPa

Maximum Upward pressure used in roof member Design = 0.87 KPa

Maximum Downward pressure used in roof member Design = 0.42 KPa

Maximum Wall pressure used in Design = 0.99 KPa

Maximum Racking pressure used in Design = 0.96 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4350 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

$M_{1.35D}$	0.72 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	309.72 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	1.83 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	162.30 %
$M_{0.9D-W_nUp}$	-1.37 Kn-m	Capacity	-1.76 Kn-m	Passing Percentage	128.47 %
$V_{1.35D}$	0.66 Kn	Capacity	9.65 Kn	Passing Percentage	1462.12 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.41 Kn	Capacity	12.86 Kn	Passing Percentage	912.06 %
V _{0.9D-WnUp}	-1.26 Kn	Capacity	-16.08 Kn	Passing Percentage	1276.19 %

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 = 10.76 mm Limit by Woolcock et al, 1999 Span/240 = 17.92 mm

Deflection under Dead and Service Wind = 12.74 mm Limit by Woolcock et al, 1999 Span/100 = 43.00 mm

Reactions

Maximum downward = 1.41 kn Maximum upward = -1.26 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

M _{1.35D}	18.42 Kn-m	Capacity	60.82 Kn-m	Passing Percentage	330.18 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	39.29 Kn-m	Capacity	81.1 Kn-m	Passing Percentage	206.41 %
M _{0.9D-WnUp}	-35.20 Kn-m	Capacity	-101.38 Kn-m	Passing Percentage	288.01 %
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}	15.96 Kn	Capacity	103.08 Kn	Passing Percentage	645.86 %
V _{0.9D-WnUp}	-14.29 Kn	Capacity	-128.86 Kn	Passing Percentage	901.75 %

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 Woolcock et al, 1999 Span/240 = 41.67 mm

Deflection under Dead and Service Wind = 38.6 mm Limit by Woolcock et al, 1999 Span/100 = 100.00 mm

Reactions

Maximum downward = 15.96 kn Maximum upward = -14.29 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

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

$K_{11} = 12.6$ fpj = 22.7 Mpa for Rafter with effective thickness = 126 mm

For Parallel to grain loading

$K_{11} = 2.0$ fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 43.67 Kn > -14.29 Kn

Rafter Design External

External Rafter Load Width = 2250 mm

External Rafter Span = 4899 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)

K_1 Short term = 1 K_1 Medium term = 0.8 K_1 Long term = 0.6 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.94

K_8 Upward = 0.94 S_1 Downward = 13.93 S_1 Upward = 13.93

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

Capacity Checks

$M_{1.35D}$	2.28 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	207.02 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.86 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	129.63 %
$M_{0.9D-W_nUp}$	-4.35 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	180.92 %
$V_{1.35D}$	1.86 Kn	Capacity	14.47 Kn	Passing Percentage	777.96 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	3.97 Kn	Capacity	19.30 Kn	Passing Percentage	486.15 %
$V_{0.9D-W_nUp}$	-3.55 Kn	Capacity	-24.12 Kn	Passing Percentage	679.44 %

Deflections

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

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 9.04 mm

Limit by Woolcock et al, 1999 Span/240 = 20.83 mm

Deflection under Dead and Service Wind = 10.70 mm

Limit by Woolcock et al, 1999 Span/100 = 50.00 mm

Reactions

Maximum downward = 3.97 kn Maximum upward = -3.55 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

$K_{11} = 14.9$ fpj = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

$K_{11} = 2.0$ $f_{c,j} = 36.1$ MPa for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi_i \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -25.20 kn > -3.55 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.55 Kn

Intermediate Design Sides

Intermediate Spacing = 2500 mm Intermediate Span = 3850 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 1.00 S_1 Downward = 11.27 S_1 Upward = 0.74

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

Capacity Checks

$M_{Wind+Snow}$	2.29 Kn-m	Capacity	7.46 Kn-m	Passing Percentage	325.76 %
$V_{0.9D-WnUp}$	2.38 Kn	Capacity	32.16 Kn	Passing Percentage	1351.26 %

Deflections

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

Deflection under Snow and Service Wind = 19.67 mm Limit by Woolcock et al, 1999 Span/100 = 38.50 mm

Reactions

Maximum = 2.38 kn

Girt Design Front and Back

Girt's Spacing = 900 mm Girt's Span = 4500 mm Try Girt 200x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and timber does not remain in continuous wet condition after installation)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.78 S_1 Downward = 11.27 S_1 Upward = 17.82

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

Capacity Checks

$M_{Wind+Snow}$	2.26 Kn-m	Capacity	2.90 Kn-m	Passing Percentage	128.32 %
$V_{0.9D-WnUp}$	2.00 Kn	Capacity	16.08 Kn	Passing Percentage	804.00 %

Deflections

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

Deflection under Snow and Service Wind = 21.30 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Sag during installation = 24.86 mm

Reactions

Maximum = 2.00 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2500 mm

Try Girt 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 =0.73 S1 Downward =11.27 S1 Upward =18.79

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

Capacity Checks

M _{Wind+Snow}	1.01 Kn-m	Capacity	2.72 Kn-m	Passing Percentage	269.31 %
V _{0.9D-WnUp}	1.61 Kn	Capacity	16.08 Kn	Passing Percentage	998.76 %

Deflections

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

Deflection under Snow and Service Wind = 2.93 mm

Limit by Woolcock et al. 1999 Span/100 = 25.00 mm

Sag during installation =2.37 mm

Reactions

Maximum = 1.61 kn

Middle Pole Design

Geometry

225 SED H5 HIGH DENSITY (Minimum 250 dia. at Floor Level)	Dry Use	Height	4140 mm
Area	44279 mm ²	As	33209.1796875 mm ²
I _x	156100441 mm ⁴	Z _x	1314530 mm ³
I _y	156100441 mm ⁴	Z _y	1314530 mm ³
Lateral Restraint	4140 mm c/c		

Loads

Total Area over Pole = 22.5 m²

Dead	5.63 Kn	Live	5.63 Kn
Wind Down	9.45 Kn	Snow	0.00 Kn
Moment wind	16.36 Kn-m		
Phi	0.8	K8	0.80
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Peeling	Steaming	Normal	Dry Use
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fb =	49.725 MPa	fs =	2.84 MPa
fc =	28.125 MPa	fp =	8.66 MPa
ft =	29.64 MPa	E =	12874 MPa

Capacities

PhiNcx Wind	792.14 Kn	PhiMnx Wind	41.58 Kn-m	PhiVnx Wind	75.45 Kn
PhiNcx Dead	475.28 Kn	PhiMnx Dead	24.95 Kn-m	PhiVnx Dead	45.27 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.42 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.18 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 21.31 \text{ mm} < 41.40 \text{ mm}$$

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

Assumed 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 Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1700 mm	Pile embedment length
f1 =	3375 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	16.36 Kn-m
Shear Wind =	4.85 Kn

Pile Properties

Safety Factory	0.55	
Hu =	8.63 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	17.35 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

Geometry

200 SED H5 HIGH DENSITY (Minimum 225 dia. at Floor Level)	Dry Use	Height	4200 mm
Area	35448 mm ²	As	26585.7421875 mm ²

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Ix	100042702 mm ⁴	Zx	941578 mm ³
Iy	100042702 mm ⁴	Zy	941578 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 11.25 m²

Dead	2.81 Kn	Live	2.81 Kn
Wind Down	4.72 Kn	Snow	0.00 Kn
Moment Wind	5.45 Kn-m		
Phi	0.8	K8	0.68
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

Peeling	Steaming	Normal	Dry Use
fb =	49.725 MPa	fs =	2.84 MPa
fc =	28.125 MPa	fp =	8.66 MPa
ft =	29.64 MPa	E =	12874 MPa

Capacities

PhiNcx Wind	543.79 Kn	PhiMnx Wind	25.54 Kn-m	PhiVnx Wind	60.40 Kn
PhiNcx Dead	326.28 Kn	PhiMnx Dead	15.32 Kn-m	PhiVnx Dead	36.24 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.23 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.06 < 1$ OK

Deflection at top under service lateral loads = 12.02 mm < 44.89 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3375 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 11.25 m²

Moment Wind =	5.45 Kn-m
Shear Wind =	1.62 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.19 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.23 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.66 < 1 OK

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

Assumed 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 =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3375 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	5.45 Kn-m
Shear Wind =	1.62 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.19 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.23 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.66 < 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 (1700) x Ks (1.5) x 0.5 x tan(30) x Pi x Dia of Pile (0.6) x Height of Pile (1700)

Skin Friction = 23.34 Kn

Weight of Pile + Pile Skin Friction = 27.24 Kn

Uplift on one Pile = 14.51 Kn

Uplift is ok