

Job No.: Trevor Hutchinson**Address:** 466 State Highway 5, Wairakei, New Zealand**Date:** 27/09/2024**Latitude:** -38.597317**Longitude:** 176.131842**Elevation:** 445.5 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	4.5 m
Wind Region	NZ2	Terrain Category	2.3	Design Wind Speed	38.79 m/s
Wind Pressure	0.9 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 4.2 m $C_{p,e} = -0.9$ $p_e = -0.73$ KPa $p_{net} = -0.73$ KPa

For roof $C_{p,e}$ from 4.2 m To 8.4 m $C_{p,e} = -0.5$ $p_e = -0.41$ 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 11 m $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 0.57$ KPa

For side wall $C_{p,e}$ from 0 m To 4.2 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 = 0.35 KPa

Maximum Wall pressure used in Design = 0.84 KPa

Maximum Racking pressure used in Design = 0.94 KPa

Design Summary**Purlin Design**

Purlin Spacing = 900 mm

Purlin Span = 5350 mm

Try Purlin 240x45 SG8

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 = 0.94

K8 Upward = 0.50 S1 Downward = 13.82 S1 Upward = 23.71

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

Capacity Checks

$M_{1.35D}$	1.09 Kn-m	Capacity	2.73 Kn-m	Passing Percentage	250.46 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	2.44 Kn-m	Capacity	3.64 Kn-m	Passing Percentage	149.18 %
$M_{0.9D-W_nUp}$	-1.63 Kn-m	Capacity	-2.44 Kn-m	Passing Percentage	Infinity %
$V_{1.35D}$	0.81 Kn	Capacity	10.42 Kn	Passing Percentage	1286.42 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.63 Kn	Capacity	13.89 Kn	Passing Percentage	852.15 %
V _{0.9D-WnUp}	-1.22 Kn	Capacity	-17.37 Kn	Passing Percentage	1423.77 %

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 = 15.97 mm Limit by Woolcock et al, 1999 Span/240 = 22.08 mm

Deflection under Dead and Service Wind = 17.97 mm Limit by Woolcock et al, 1999 Span/100 = 53.00 mm

Reactions

Maximum downward = 1.63 kn Maximum upward = -1.22 kn

Number of Blocking = 1 if 0 then no blocking required, if 1 then one midspan blocking required

Rafter Design Internal

Internal Rafter Load Width = 5500 mm Internal Rafter Span = 4850 mm Try Rafter 2x290x45 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 = 1.00 S₁ Downward = 7.47 S₁ Upward = 7.47

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

Capacity Checks

M _{1.35D}	5.46 Kn-m	Capacity	8.48 Kn-m	Passing Percentage	155.31 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.92 Kn-m	Capacity	11.3 Kn-m	Passing Percentage	103.48 %
M _{0.9D-WnUp}	-8.17 Kn-m	Capacity	-14.12 Kn-m	Passing Percentage	172.83 %
V _{1.35D}	4.50 Kn	Capacity	25.18 Kn	Passing Percentage	559.56 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.00 Kn	Capacity	33.58 Kn	Passing Percentage	373.11 %
V _{0.9D-WnUp}	-6.74 Kn	Capacity	-41.96 Kn	Passing Percentage	622.55 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 12.235 mm Limit by Woolcock et al, 1999 Span/240 = 20.83 mm

Deflection under Dead and Service Wind = 15.295 mm Limit by Woolcock et al, 1999 Span/100 = 50.00 mm

Reactions

Maximum downward = 9.00 kn Maximum upward = -6.74 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

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

Factor of Safety = 0.7

For Perpendicular to grain loading

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

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

Capacity under short term loads = 19.50 Kn > -6.74 Kn

Rafter Design External

External Rafter Load Width = 2750 mm

External Rafter Span = 4809 mm

Try Rafter 290x45 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 = 0.89

K_8 Upward = 0.89 S_1 Downward = 15.23 S_1 Upward = 15.23

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

Capacity Checks

$M_{1.35D}$	2.68 Kn-m	Capacity	3.78 Kn-m	Passing Percentage	141.04 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	5.37 Kn-m	Capacity	5.04 Kn-m	Passing Percentage	93.85 %
$M_{0.9D-W_nUp}$	-4.01 Kn-m	Capacity	-6.29 Kn-m	Passing Percentage	156.86 %
$V_{1.35D}$	2.23 Kn	Capacity	12.59 Kn	Passing Percentage	564.57 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.46 Kn	Capacity	16.79 Kn	Passing Percentage	376.46 %
$V_{0.9D-W_nUp}$	-3.34 Kn	Capacity	-20.98 Kn	Passing Percentage	628.14 %

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 = 13.59 mm

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

Deflection under Dead and Service Wind = 15.29 mm

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

Reactions

Maximum downward = 4.46 kn Maximum upward = -3.34 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

$K_{11} = 2.0 f_{cj} = 36.1 \text{ Mpa}$ for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi_i \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots (\text{Eq 4.12}) = -21.73 \text{ kn} > -3.34 \text{ Kn}$

Single Shear Capacity under short term loads = $-9.75 \text{ Kn} > -3.34 \text{ Kn}$

Intermediate Design Front and Back

Intermediate Spacing = 2750 mm

Intermediate Span = 3749 mm

Try Intermediate 2x190x45 SG8

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 = 0.98

K_8 Upward = 1.00 S_1 Downward = 12.23 S_1 Upward = 0.79

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

Capacity Checks

$M_{\text{Wind+Snow}}$	4.06 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	149.26 %
$V_{0.9D-WnUp}$	4.33 Kn	Capacity	-27.5 Kn	Passing Percentage	635.10 %

Deflections

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

Deflection under Snow and Service Wind = 21.385 mm

Limit by Woolcock et al, 1999 $\text{Span}/100 = 37.49 \text{ mm}$

Reactions

Maximum = 4.33 kn

Intermediate Design Sides

Intermediate Spacing = 2500 mm

Intermediate Span = 4200 mm

Try Intermediate 2x190x45 SG8

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 = 0.98

K_8 Upward = 1.00 S_1 Downward = 12.23 S_1 Upward = 0.84

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

Capacity Checks

$M_{\text{Wind+Snow}}$	2.31 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	262.34 %
$V_{0.9D-WnUp}$	2.20 Kn	Capacity	27.5 Kn	Passing Percentage	1250.00 %

Deflections

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

Deflection under Snow and Service Wind = 30.62 mm

Limit by Woolcock et al, 1999 $\text{Span}/100 = 42.00 \text{ mm}$

Reactions

Maximum = 2.20 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2750 mm

Try Girt 140x45 SG8

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 =0.76 S1 Downward =10.36 S1 Upward =18.11

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

Capacity Checks

$M_{Wind+Snow}$	1.03 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	122.33 %
$V_{0.9D-WnUp}$	1.50 Kn	Capacity	10.13 Kn	Passing Percentage	675.33 %

Deflections

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

Deflection under Snow and Service Wind = 11.80 mm

Limit by Woolcock et al, 1999 Span/100 = 27.50 mm

Sag during installation = 4.28 mm

Reactions

Maximum = 1.50 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2500 mm

Try Girt 140x45 SG8

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 =0.80 S1 Downward =10.36 S1 Upward =17.27

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

Capacity Checks

$M_{Wind+Snow}$	0.85 Kn-m	Capacity	1.32 Kn-m	Passing Percentage	155.29 %
$V_{0.9D-WnUp}$	1.36 Kn	Capacity	10.13 Kn	Passing Percentage	744.85 %

Deflections

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

Deflection under Snow and Service Wind = 8.06 mm

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

Sag during installation =2.92 mm

Reactions

Maximum = 1.36 kn

Middle Pole Design

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	4200 mm
Area	35448 mm ²	As	26585.7421875 mm ²
I _x	100042702 mm ⁴	Z _x	941578 mm ³
I _y	100042702 mm ⁴	Z _y	941578 mm ³
Lateral Restraint	4200 mm c/c		

Loads

Total Area over Pole = 27.5 m²

Dead	6.88 Kn	Live	6.88 Kn
Wind Down	9.63 Kn	Snow	0.00 Kn
Moment wind	13.05 Kn-m		
Phi	0.8	K ₈	0.68
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 _c Wind	347.89 Kn	PhiM _n Wind	18.64 Kn-m	PhiV _n Wind	62.96 Kn
PhiN _c Dead	208.74 Kn	PhiM _n Dead	11.18 Kn-m	PhiV _n Dead	37.77 Kn

Checks

$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.77 < 1$ OK

$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.56 < 1$ OK

Deflection at top under service lateral loads = 37.43 mm < 42.00 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
K ₀ =	$(1 - \sin(30)) / (1 + \sin(30))$				
K _p =	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For Middle Bay Pole

D _s =	0.6 mm	Pile Diameter
L =	1600 mm	Pile embedment length
f ₁ =	3375 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

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Loads

Moment Wind = 13.05 Kn-m
Shear Wind = 3.87 Kn

Pile Properties

Safety Factory 0.55
Hu = 7.34 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 14.67 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.89 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	4300 mm
Area	27598 mm ²	As	20698.2421875 mm ²
Ix	60639381 mm ⁴	Zx	646820 mm ³
Iy	60639381 mm ⁴	Zy	646820 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 13.75 m²

Dead	3.44 Kn	Live	3.44 Kn
Wind Down	4.81 Kn	Snow	0.00 Kn
Moment Wind	6.53 Kn-m		
Phi	0.8	K8	0.54
K1 snow	0.8	K1 Dead	0.6
K1wind	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	212.61 Kn	PhiMnx Wind	10.05 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	127.57 Kn	PhiMnx Dead	6.03 Kn-m	PhiVnx Dead	29.41 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.70 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.48 < 1 OK

Deflection at top under service lateral loads = 33.00 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 = 13.75 m²

Moment Wind =	6.53 Kn-m
Shear Wind =	1.93 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 = 0.79 < 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 =	6.53 Kn-m
Shear Wind =	1.93 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 = 0.79 < 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 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1600)

Skin Friction = 20.68 Kn

Weight of Pile + Pile Skin Friction = 24.83 Kn

Uplift on one Pile = 13.89 Kn

Uplift is ok