

Job No.: 5115024031 - 2**Address:** Ashburton, Ashburton, New Zealand**Date:** 23/07/2024**Latitude:** -43.758203**Longitude:** 171.636339**Elevation:** 200.5 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N4	Ground Snow Load	1.08 KPa	Roof Snow Load	0.67 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.5 m
Wind Region	NZ2	Terrain Category	1.55	Design Wind Speed	42.17 m/s
Wind Pressure	1.07 KPa	Lee Zone	YES	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 = Gable Enclosed

For roof $C_{p,i} = 0.6815$

For roof $C_{p,e}$ from 0 m To 3.50 m $C_{p,e} = -0.64$ $p_e = -0.61$ KPa $p_{net} = -1.40$ KPa

For roof $C_{p,e}$ from 3.50 m To 7 m $C_{p,e} = -0.52$ $p_e = -0.50$ KPa $p_{net} = -1.29$ KPa

For wall Windward $C_{p,i} = 0.6815$ side Wall $C_{p,i} = -0.32$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 43.20 m $C_{p,e} = 0.7$ $p_e = 0.67$ KPa $p_{net} = 0.89$ KPa

For side wall $C_{p,e}$ from 0 m To 3.50 m $C_{p,e} =$ $p_e = -0.62$ KPa $p_{net} = -0.40$ KPa

Maximum Upward pressure used in roof member Design = 1.40 KPa

Maximum Downward pressure used in roof member Design = 0.41 KPa

Maximum Wall pressure used in Design = 0.89 KPa

Maximum Racking pressure used in Design = 0.98 KPa

Design Summary**Purlin Design**

Purlin Spacing = 750 mm

Purlin Span = 4050 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 = 0.50 S1 Downward = 11.27 S1 Upward = 23.76

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

Capacity Checks

M _{1.35D}	0.52 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	428.85 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.58 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	187.97 %
M _{0.9D-W_nUp}	-1.81 Kn-m	Capacity	-1.87 Kn-m	Passing Percentage	103.31 %
V _{1.35D}	0.51 Kn	Capacity	9.65 Kn	Passing Percentage	1892.16 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.47 Kn	Capacity	12.86 Kn	Passing Percentage	874.83 %
V _{0.9D-WnUp}	-1.78 Kn	Capacity	-16.08 Kn	Passing Percentage	903.37 %

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 = 6.72 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 7.89 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 1.47 kn Maximum upward = -1.78 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 = 4200 mm Internal Rafter Span = 6850 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

M _{1.35D}	8.31 Kn-m	Capacity	31.1 Kn-m	Passing Percentage	374.25 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	23.90 Kn-m	Capacity	41.48 Kn-m	Passing Percentage	173.56 %
M _{0.9D-WnUp}	-28.95 Kn-m	Capacity	-51.84 Kn-m	Passing Percentage	179.07 %
V _{1.35D}	4.85 Kn	Capacity	46.02 Kn	Passing Percentage	948.87 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	13.95 Kn	Capacity	61.36 Kn	Passing Percentage	439.86 %
V _{0.9D-WnUp}	-16.90 Kn	Capacity	-76.7 Kn	Passing Percentage	453.85 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 15.915 mm Limit by Woolcock et al, 1999 Span/240 = 29.17 mm

Deflection under Dead and Service Wind = 20.78 mm Limit by Woolcock et al, 1999 Span/100 = 70.00 mm

Reactions

Maximum downward = 13.95 kn Maximum upward = -16.90 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

$K_{11} = 12.6$ $f_{pj} = 22.7$ 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 = 43.67 Kn > -16.90 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2100 mm

Intermediate Span = 2346 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)

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

K_8 Upward = 1.00 S_1 Downward = 9.63 S_1 Upward = 0.49

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

Capacity Checks

$M_{Wind+Snow}$	1.56 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	269.23 %
$V_{0.9D-WnUp}$	2.66 Kn	Capacity	-24.12 Kn	Passing Percentage	906.77 %

Deflections

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

Deflection under Snow and Service Wind = 10.75 mm

Limit by Woolcock et al, 1999 Span/100 = 23.46 mm

Reactions

Maximum = 2.66 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2100 mm

Try Girt 150x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and 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 = 0.91 S_1 Downward = 9.63 S_1 Upward = 14.71

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

Capacity Checks

$M_{Wind+Snow}$	0.64 Kn-m	Capacity	1.91 Kn-m	Passing Percentage	298.44 %
$V_{0.9D-WnUp}$	1.21 Kn	Capacity	12.06 Kn	Passing Percentage	996.69 %

Deflections

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

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Deflection under Snow and Service Wind = 5.45 mm

Limit by Woolcock et al, 1999 Span/100 = 21.00 mm

Sag during installation = 1.18 mm

Reactions

Maximum = 1.21 kn

Girt Design Sides

Girt's Spacing = 1200 mm

Girt's Span = 3500 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 =0.57 S1 Downward =11.27 S1 Upward =22.23

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

Capacity Checks

$M_{Wind+Snow}$	1.64 Kn-m	Capacity	2.11 Kn-m	Passing Percentage	128.66 %
$V_{0.9D-WnUp}$	1.87 Kn	Capacity	16.08 Kn	Passing Percentage	859.89 %

Deflections

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

Deflection under Snow and Service Wind = 16.38 mm

Limit by Woolcock et al. 1999 Span/100 = 35.00 mm

Sag during installation =9.10 mm

Reactions

Maximum = 1.87 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	2700 mm
Area	27598 mm ²	As	20698.2421875 mm ²
I _x	60639381 mm ⁴	Z _x	646820 mm ³
I _y	60639381 mm ⁴	Z _y	646820 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 14.7 m²

Dead	3.67 Kn	Live	3.67 Kn
Wind Down	6.03 Kn	Snow	9.85 Kn
Moment wind	9.43 Kn-m	Moment snow	3.96 Kn-m
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

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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	397.41 Kn	PhiMnx Wind	18.78 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	238.44 Kn	PhiMnx Dead	11.27 Kn-m	PhiVnx Dead	29.41 Kn
PhiNcx Snow	317.93 Kn	PhiMnx Snow	15.03 Kn-m	PhiVnx Snow	39.21 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.55 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.30 < 1$ OK

Deflection at top under service lateral loads = 22.31 mm < 27.00 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
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 =	1600 mm	Pile embedment length
f1 =	2625 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	9.43 Kn-m	Moment Snow =	Kn-m
Shear Wind =	3.59 Kn	Shear Snow =	3.96 Kn

Pile Properties

Safety Factory	0.55	
Hu =	8.64 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	13.81 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.68 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

Dry Use	Height	3350 mm
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150 SED H5 (Minimum 175 dia. at Floor Level)

Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zy	421056 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 7.35 m²

Dead	1.84 Kn	Live	1.84 Kn
Wind Down	3.01 Kn	Snow	4.92 Kn
Moment Wind	3.14 Kn-m	Moment snow	1.32 Kn-m
Phi	0.8	K _s	0.64
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	191.13 Kn	PhiM _{nx} Wind	7.83 Kn-m	PhiV _{nx} Wind	36.81 Kn
PhiN _{cx} Dead	114.68 Kn	PhiM _{nx} Dead	4.70 Kn-m	PhiV _{nx} Dead	22.09 Kn
PhiN _{cx} Snow	152.90 Kn	PhiM _{nx} Snow	6.26 Kn-m	PhiV _{nx} Snow	29.45 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.45 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.21 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 17.04 mm < 34.91 mm

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	2625 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 7.35 m²

Moment Wind =	3.14 Kn-m	Moment Snow =	1.32 Kn-m
Shear Wind =	1.20 Kn	Shear Snow =	1.32 Kn

Pile Properties

Safety Factory	0.55	
H _u =	4.99 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	7.79 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.40 < 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 =	2625 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	3.14 Kn-m	Moment Snow =	1.32 Kn-m
Shear Wind =	1.20 Kn	Shear Snow =	1.32 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.99 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.79 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.40 < 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 = 25.36 Kn

Uplift on one Pile = 17.27 Kn

Uplift is ok