



**Job No.:** Kj2449**Address:** 821 Oxford Road, Fernside, New Zealand**Date:** 25/07/2024**Latitude:** -43.314423**Longitude:** 172.478061**Elevation:** 76 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	0.9 KPa	Roof Snow Load	0.63 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	5.33 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	38.23 m/s
Wind Pressure	0.88 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  $C_{p,i} = 0.63$

For roof  $C_{p,e}$  from 0 m To 5.02 m  $C_{p,e} = -0.9$   $p_e = -0.54$  KPa  $p_{net} = -0.99$  KPa

For roof  $C_{p,e}$  from 5.02 m To 10.03 m  $C_{p,e} = -0.5$   $p_e = -0.30$  KPa  $p_{net} = -0.75$  KPa

For wall Windward  $C_{p,i} = 0.63$  side Wall  $C_{p,i} = -0.52$

For wall Windward and Leeward  $C_{p,e}$  from 0 m To 24 m  $C_{p,e} = 0.7$   $p_e = 0.55$  KPa  $p_{net} = 1.04$  KPa

For side wall  $C_{p,e}$  from 0 m To 5.02 m  $C_{p,e} =$   $p_e = -0.51$  KPa  $p_{net} = -0.02$  KPa

Maximum Upward pressure used in roof member Design = 0.99 KPa

Maximum Downward pressure used in roof member Design = 0.65 KPa

Maximum Wall pressure used in Design = 1.04 KPa

Maximum Racking pressure used in Design = 0.94 KPa

**Design Summary****Purlin Design**

Purlin Spacing = 850 mm

Purlin Span = 5850 mm

Try Purlin 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 = 0.54 S1 Downward = 12.68 S1 Upward = 22.76

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

**Capacity Checks**

M <sub>1.35D</sub>	1.23 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	276.42 %
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>nDn</sub></sub>	3.45 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	131.30 %
M <sub>0.9D-W<sub>nUp</sub></sub>	-2.78 Kn-m	Capacity	-3.16 Kn-m	Passing Percentage	464.71 %
V <sub>1.35D</sub>	0.84 Kn	Capacity	12.06 Kn	Passing Percentage	1435.71 %

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V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	2.36 Kn	Capacity	16.08 Kn	Passing Percentage	<b>681.36 %</b>
V <sub>0.9D-WnUp</sub>	-1.90 Kn	Capacity	-20.10 Kn	Passing Percentage	<b>1057.89 %</b>

**Deflections**

Modulus of Elasticity = 6700 MPa NZS3603 Amt 4, Table 2.3 considering at least 4 members acting together

k<sub>2</sub> for Long Term Loads = 2

Deflection under Dead and Live Load = 17.23 mm Limit by Woolcock et al, 1999 Span/240 = 24.17 mm

Deflection under Dead and Service Wind = 23.69 mm Limit by Woolcock et al, 1999 Span/100 = 58.00 mm

**Reactions**

Maximum downward = 2.36 kn Maximum upward = -1.90 kn

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

**Rafter Design External**

External Rafter Load Width = 3000 mm External Rafter Span = 3806 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<sub>1</sub> Short term = 1 K<sub>1</sub> Medium term = 0.8 K<sub>1</sub> Long term = 0.6 K<sub>4</sub> = 1 K<sub>5</sub> = 1 K<sub>8</sub> Downward = 0.94

K<sub>8</sub> Upward = 0.94 S<sub>1</sub> Downward = 13.93 S<sub>1</sub> Upward = 13.93

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

**Capacity Checks**

M <sub>1.35D</sub>	1.83 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>257.92 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	5.16 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>122.09 %</b>
M <sub>0.9D-WnUp</sub>	-4.16 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>189.18 %</b>
V <sub>1.35D</sub>	1.93 Kn	Capacity	14.47 Kn	Passing Percentage	<b>749.74 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	5.42 Kn	Capacity	19.30 Kn	Passing Percentage	<b>356.09 %</b>
V <sub>0.9D-WnUp</sub>	-4.37 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>551.95 %</b>

**Deflections**

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

k<sub>2</sub> for Long Term Loads = 2

Deflection under Dead and Live Load = 4.94 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 6.79 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

**Reactions**

Maximum downward = 5.42 kn Maximum upward = -4.37 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

$K_{11} = 14.9 \text{ f} \cdot \text{p} \cdot \text{j} = 12.9 \text{ Mpa}$  for Rafter with effective thickness = 50 mm

For Parallel to grain loading

$K_{11} = 2.0 \text{ f} \cdot \text{c} \cdot \text{j} = 36.1 \text{ Mpa}$  for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots (\text{Eq 4.12}) = -25.20 \text{ kn} > -4.37 \text{ Kn}$

Single Shear Capacity under short term loads = -10.84 Kn > -4.37 Kn

### **Girt Design Front and Back**

Girt's Spacing = 800 mm

Girt's Span = 6000 mm

Try Girt 250x50 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 = 0.97

$K_8$  Upward = 0.72     $S_1$  Downward = 12.68     $S_1$  Upward = 18.90

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

### **Capacity Checks**

$M_{\text{Wind+Snow}}$	3.74 Kn-m	Capacity	4.22 Kn-m	Passing Percentage	<b>112.83 %</b>
$V_{0.9D-WnUp}$	2.50 Kn	Capacity	20.10 Kn	Passing Percentage	<b>804.00 %</b>

### **Deflections**

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

Deflection under Snow and Service Wind = 51.69 mm

Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Sag during installation = 78.58 mm

### **Reactions**

Maximum = 2.50 kn

### **Girt Design Sides**

Girt's Spacing = 1100 mm

Girt's Span = 4000 mm

Try Girt 250x50 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 = 0.97

$K_8$  Upward = 0.41     $S_1$  Downward = 12.68     $S_1$  Upward = 26.73

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

### **Capacity Checks**

$M_{\text{Wind+Snow}}$	2.29 Kn-m	Capacity	2.37 Kn-m	Passing Percentage	<b>103.49 %</b>
$V_{0.9D-WnUp}$	2.29 Kn	Capacity	20.10 Kn	Passing Percentage	<b>877.73 %</b>

**Deflections**

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

Deflection under Snow and Service Wind = 14.04 mm

Limit by Woolcock et al. 1999 Span/100 = 40.00 mm

Sag during installation = 15.52 mm

**Reactions**

Maximum = 2.29 kn

**Middle Pole Design**

**Geometry**

275 SED H5 (Minimum 300 dia. at Floor Level)	Dry Use	Height	4715 mm
Area	64885 mm <sup>2</sup>	As	48663.8671875 mm <sup>2</sup>
I <sub>x</sub>	335197731 mm <sup>4</sup>	Z <sub>x</sub>	2331810 mm <sup>3</sup>
I <sub>y</sub>	335197731 mm <sup>4</sup>	Z <sub>y</sub>	2331810 mm <sup>3</sup>
Lateral Restraint	1300 mm c/c		

**Loads**

Total Area over Pole = 36 m<sup>2</sup>

Dead	9.00 Kn	Live	9.00 Kn
Wind Down	23.40 Kn	Snow	22.68 Kn
Moment wind	29.97 Kn-m	Moment snow	7.18 Kn-m
Phi	0.8	K <sub>8</sub>	1.00
K <sub>1</sub> snow	0.8	K <sub>1</sub> Dead	0.6
K <sub>1</sub> wind	1		

**Material**

Peeling	Steaming	Normal	Dry Use
f <sub>b</sub> =	36.3 MPa	f <sub>s</sub> =	2.96 MPa
f <sub>c</sub> =	18 MPa	f <sub>p</sub> =	7.2 MPa
f <sub>t</sub> =	22 MPa	E =	9257 MPa

**Capacities**

PhiN <sub>c</sub> Wind	934.35 Kn	PhiM <sub>n</sub> Wind	67.72 Kn-m	PhiV <sub>n</sub> Wind	115.24 Kn
PhiN <sub>c</sub> Dead	560.61 Kn	PhiM <sub>n</sub> Dead	40.63 Kn-m	PhiV <sub>n</sub> Dead	69.14 Kn
PhiN <sub>c</sub> Snow	747.48 Kn	PhiM <sub>n</sub> Snow	54.17 Kn-m	PhiV <sub>n</sub> Snow	92.19 Kn

**Checks**

$$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.49 < 1 \text{ OK}$$

$$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.25 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 34.10 mm < 47.15 mm

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

**Assumed Soil Properties**

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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 Middle Bay Pole**

Ds =	0.6 mm	Pile Diameter
L =	2100 mm	Pile embedment length
f1 =	3998 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

**Loads**

Moment Wind =	29.97 Kn-m	Moment Snow =	Kn-m
Shear Wind =	7.50 Kn	Shear Snow =	7.18 Kn

**Pile Properties**

Safety Factory	0.55	
Hu =	13.53 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	32.38 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.93 < 1 OK

**End Pole Design**

**Geometry For End Bay Pole**

**Geometry**

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	5030 mm
Area	35448 mm2	As	26585.7421875 mm2
Ix	100042702 mm4	Zx	941578 mm3
Iy	100042702 mm4	Zx	941578 mm3
Lateral Restraint	mm c/c		

**Loads**

Total Area over Pole = 12 m2

Dead	3.00 Kn	Live	3.00 Kn
Wind Down	7.80 Kn	Snow	7.56 Kn
Moment Wind	7.49 Kn-m	Moment snow	1.79 Kn-m
Phi	0.8	K8	0.51
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

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$f_t =$  22 MPa  $E =$  9257 MPa

**Capacities**

PhiNcx Wind	258.11 Kn	PhiMnx Wind	13.83 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	154.87 Kn	PhiMnx Dead	8.30 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	206.49 Kn	PhiMnx Snow	11.06 Kn-m	PhiVnx Snow	50.36 Kn

**Checks**

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.60 < 1$  OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.35 < 1$  OK

Deflection at top under service lateral loads = 32.21 mm < 53.17 mm

$D_s =$	0.6 mm	Pile Diameter
$L =$	1400 mm	Pile embedment length
$f_1 =$	3998 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 = 12 m<sup>2</sup>

Moment Wind =	7.49 Kn-m	Moment Snow =	1.79 Kn-m
Shear Wind =	1.87 Kn	Shear Snow =	1.79 Kn

**Pile Properties**

Safety Factor	0.55	
$H_u =$	4.53 Kn	Ultimate Lateral Strength of the Pile, Short pile
$M_u =$	10.47 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.72 < 1 OK

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

**Assumed Soil Properties**

Gamma	18 Kn/m <sup>3</sup>	Friction angle	30 deg	Cohesion	0 Kn/m <sup>3</sup>
$K_0 =$	$(1 - \sin(30)) / (1 + \sin(30))$				
$K_p =$	$(1 + \sin(30)) / (1 - \sin(30))$				

**Geometry For End Bay Pole**

$D_s =$	0.6 mm	Pile Diameter
$L =$	1400 mm	Pile embedment length
$f_1 =$	3998 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

**Loads**

Moment Wind =	7.49 Kn-m	Moment Snow =	1.79 Kn-m
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Shear Wind = 1.87 Kn      Shear Snow = 1.79 Kn

**Pile Properties**

Safety Factory      0.55  
Hu = 4.53 Kn      Ultimate Lateral Strength of the Pile, Short pile  
Mu = 10.47 Kn-m      Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.72 < 1 OK

**Uplift Check**

Density of Concrete = 24 Kn/m<sup>3</sup>

Density of Timber Pole = 5 Kn/m<sup>3</sup>

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(2100) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(2100)

Skin Friction = 35.62 Kn

Weight of Pile + Pile Skin Friction = 39.29 Kn

Uplift on one Pile = 27.54 Kn

Uplift is ok