

**Job No.:** Advertisement Shed 3

**Address:** 2 Southbelt, North Canterbury, New Zealand

**Date:** 22/01/2024

**Latitude:** -45.4741

**Longitude:** 168.686335

**Elevation:** 319 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	1.51 KPa	Roof Snow Load	1.06 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	38.81 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  $C_{p,i} = -0.6351$

For roof  $C_{p,e}$  from 0 m To 3.50 m  $C_{p,e} = -0.9$   $p_e = -0.58$  KPa  $p_{net} = -0.92$  KPa

For roof  $C_{p,e}$  from 3.50 m To 7.0 m  $C_{p,e} = -0.5$   $p_e = -0.32$  KPa  $p_{net} = -0.66$  KPa

For wall Windward  $C_{p,i} = 0.4844$  side Wall  $C_{p,i} = -0.6351$

For wall Windward and Leeward  $C_{p,e}$  from 0 m To 13.50 m  $C_{p,e} = 0.7$   $p_e = 0.57$  KPa  $p_{net} = 1.14$  KPa

For side wall  $C_{p,e}$  from 0 m To 3.50 m  $C_{p,e} =$   $p_e = -0.53$  KPa  $p_{net} = 0.04$  KPa

Maximum Upward pressure used in roof member Design = 0.92 KPa

Maximum Downward pressure used in roof member Design = 0.73 KPa

Maximum Wall pressure used in Design = 1.14 KPa

Maximum Racking pressure used in Design = 0.98 KPa

### Design Summary

#### Purlin Design

Purlin Spacing = 850 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 <sub>1.35D</sub>	0.68 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	<b>327.94 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	2.73 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	<b>108.79 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-1.4 Kn-m	Capacity	-1.76 Kn-m	Passing Percentage	<b>125.71 %</b>

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V <sub>1.35D</sub>	0.62 Kn	Capacity	9.65 Kn	Passing Percentage	<b>1556.45 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	2.51 Kn	Capacity	12.86 Kn	Passing Percentage	<b>512.35 %</b>
V <sub>0.9D-WnUp</sub>	-1.28 Kn	Capacity	-16.08 Kn	Passing Percentage	<b>1256.25 %</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 = 10.17 mm

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

Deflection under Dead and Service Wind = 14.66 mm

Limit by Woolcock et al, 1999 Span/100 = 43.00 mm

**Reactions**

Maximum downward = 2.51 kn Maximum upward = -1.28 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 = 3850 mm

Try Rafter 2x300x50 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 = 1.00

K<sub>8</sub> Upward = 1.00 S<sub>1</sub> Downward = 6.81 S<sub>1</sub> Upward = 6.81

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>	2.81 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	<b>358.72 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	11.34 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	<b>118.52 %</b>
M <sub>0.9D-WnUp</sub>	-5.79 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	<b>290.16 %</b>
V <sub>1.35D</sub>	2.92 Kn	Capacity	28.94 Kn	Passing Percentage	<b>991.10 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	11.78 Kn	Capacity	38.6 Kn	Passing Percentage	<b>327.67 %</b>
V <sub>0.9D-WnUp</sub>	-6.02 Kn	Capacity	-48.24 Kn	Passing Percentage	<b>801.33 %</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 = 3.335 mm

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

Deflection under Dead and Service Wind = 5.34 mm

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

**Reactions**

Maximum downward = 11.78 kn Maximum upward = -6.02 kn

**Rafter to Pole Connection check**

Bolt Size = M12 Number of Bolts = 2

Calculations as per NZS 3603:1993 Amend 2005 clause 4.4

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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 = 100 mm

For Parallel to grain loading

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

Capacity under short term loads = 21.67 Kn > -6.02 Kn

### **Rafter Design External**

External Rafter Load Width = 2250 mm

External Rafter Span = 3831 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**

$M_{1.35D}$	1.39 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>339.57 %</b>
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	5.61 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>112.30 %</b>
$M_{0.9D-W_nUp}$	-2.87 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>274.22 %</b>
$V_{1.35D}$	1.45 Kn	Capacity	14.47 Kn	Passing Percentage	<b>997.93 %</b>
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	5.86 Kn	Capacity	19.30 Kn	Passing Percentage	<b>329.35 %</b>
$V_{0.9D-W_nUp}$	-3.00 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>804.00 %</b>

### **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 = 3.70 mm

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

Deflection under Dead and Service Wind = 5.34 mm

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

### **Reactions**

Maximum downward = 5.86 kn    Maximum upward = -3.00 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

$K_{11} = 14.9 \text{ f}_{pj} = 12.9 \text{ Mpa}$  for Rafter with effective thickness = 50 mm

For Parallel to grain loading

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

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$  (Eq 4.12) = -25.20 kn > -3.00 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.00 Kn

### Intermediate Design Sides

Intermediate Spacing = 2000 mm

Intermediate Span = 3599 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 = 0.71

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

### Capacity Checks

$M_{\text{Wind+Snow}}$	2.44 Kn-m	Capacity	7.46 Kn-m	Passing Percentage	<b>305.74 %</b>
$V_{0.9D-WnUp}$	2.72 Kn-m	Capacity	32.16 Kn-m	Passing Percentage	<b>1182.35 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 32.165 mm

Limit by Woolcock et al, 1999 Span/100 = 35.99 mm

### Reactions

Maximum = 2.72 kn

### Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2250 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 = 0.89     $S_1$  Downward = 9.63     $S_1$  Upward = 15.23

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

### Capacity Checks

$M_{\text{Wind+Snow}}$	0.94 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	<b>198.94 %</b>
$V_{0.9D-WnUp}$	1.67 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	<b>722.16 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 10.13 mm

Limit by Woolcock et al, 1999 Span/100 = 22.50 mm

Sag during installation = 1.55 mm

#### Reactions

Maximum = 1.67 kn

#### Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2000 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)

K1 Short term = 1    K4 =1    K5 =1    K8 Downward =1.00

K8 Upward =0.92    S1 Downward =9.63    S1 Upward =14.36

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

#### Capacity Checks

M <sub>Wind+Snow</sub>	0.74 Kn-m	Capacity	1.94 Kn-m	Passing Percentage	<b>262.16 %</b>
V <sub>0.9D-WnUp</sub>	1.48 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	<b>814.86 %</b>

#### Deflections

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

Deflection under Snow and Service Wind = 6.32 mm

Limit by Woolcock et al. 1999 Span/100 = 20.00 mm

Sag during installation =0.97 mm

#### Reactions

Maximum = 1.48 kn

#### Middle Pole Design

##### Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	27598 mm <sup>2</sup>	As	20698.2421875 mm <sup>2</sup>
I <sub>x</sub>	60639381 mm <sup>4</sup>	Z <sub>x</sub>	646820 mm <sup>3</sup>
I <sub>y</sub>	60639381 mm <sup>4</sup>	Z <sub>y</sub>	646820 mm <sup>3</sup>
Lateral Restraint	1300 mm c/c		

#### Loads

Total Area over Pole = 18 m<sup>2</sup>

Dead	4.50 Kn	Live	4.50 Kn
Wind Down	13.14 Kn	Snow	19.08 Kn
Moment wind	8.80 Kn-m	Moment snow	4.52 Kn-m
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1wind	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 = 32.59 mm < 37.00 mm

### **Drained Lateral Strength of Middle 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>
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 =	1350 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	8.80 Kn-m	Moment Snow =	Kn-m
Shear Wind =	2.93 Kn	Shear Snow =	4.52 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	5.04 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.91 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities = 0.99 < 1 OK

### **End Pole Design**

#### Geometry For End Bay Pole

#### Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3700 mm
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Area	20729 mm <sup>2</sup>	As	15546.6796875 mm <sup>2</sup>
Ix	34210793 mm <sup>4</sup>	Zx	421056 mm <sup>3</sup>
Iy	34210793 mm <sup>4</sup>	Zy	421056 mm <sup>3</sup>
Lateral Restraint	mm c/c		

**Loads**

Total Area over Pole = 9 m<sup>2</sup>

Dead	2.25 Kn	Live	2.25 Kn
Wind Down	6.57 Kn	Snow	9.54 Kn
Moment Wind	4.40 Kn-m	Moment snow	2.26 Kn-m
Phi	0.8	K <sub>s</sub>	0.54
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	161.75 Kn	PhiM <sub>n</sub> Wind	6.63 Kn-m	PhiV <sub>n</sub> Wind	36.81 Kn
PhiN <sub>c</sub> Dead	97.05 Kn	PhiM <sub>n</sub> Dead	3.98 Kn-m	PhiV <sub>n</sub> Dead	22.09 Kn
PhiN <sub>c</sub> Snow	129.40 Kn	PhiM <sub>n</sub> Snow	5.30 Kn-m	PhiV <sub>n</sub> Snow	29.45 Kn

**Checks**

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

$$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.54 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 31.15 mm < 39.90 mm

D <sub>s</sub> =	0.6 mm	Pile Diameter
L =	1350 mm	Pile embedment length
f <sub>1</sub> =	3000 mm	Distance at which the shear force is applied
f <sub>2</sub> =	0 mm	Distance of top soil at rest pressure

**Loads**

Total Area over Pole = 9 m<sup>2</sup>

Moment Wind =	4.40 Kn-m	Moment Snow =	2.26 Kn-m
Shear Wind =	1.47 Kn	Shear Snow =	2.26 Kn

**Pile Properties**

Safety Factory	0.55	
H <sub>u</sub> =	5.04 Kn	Ultimate Lateral Strength of the Pile, Short pile
M <sub>u</sub> =	8.91 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities =  $0.49 < 1$  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>
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 =	1350 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	4.40 Kn-m	Moment Snow =	2.26 Kn-m
Shear Wind =	1.47 Kn	Shear Snow =	2.26 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	5.04 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.91 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities =  $0.49 < 1$  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(1350) x Ks(1.5) x  $0.5 \times \tan(30)$  x  $\pi$  x Dia of Pile(0.6) x Height of Pile(1350)

Skin Friction = 14.72 Kn

Weight of Pile + Pile Skin Friction = 18.67 Kn

Uplift on one Pile = 12.51 Kn

Uplift is ok