

Pole Shed App Ver 01 2022

**Job No.:** 2309029      **Address:** 103 Neudorf Road, Upper Moutere, New Zealand      **Date:** 11/22/2023  
**Latitude:** -41.248247      **Longitude:** 172.995411      **Elevation:** 64 m

**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N3	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.8 m
Wind Region	NZ2	Terrain Category	2.24	Design Wind Speed	41.24 m/s
Wind Pressure	1.02 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 4.45 m  $C_{p,e} = -0.9$   $p_e = -0.83$  KPa  $p_{net} = -0.83$  KPa

For roof  $C_{p,e}$  from 4.45 m To 8.90 m  $C_{p,e} = -0.5$   $p_e = -0.46$  KPa  $p_{net} = -0.46$  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 10.0 m  $C_{p,e} = 0.7$   $p_e = 0.64$  KPa  $p_{net} = 0.95$  KPa

For side wall  $C_{p,e}$  from 0 m To 4.45 m  $C_{p,e} =$   $p_e = -0.60$  KPa  $p_{net} = -0.60$  KPa

Maximum Upward pressure used in roof member Design = 0.83 KPa

Maximum Downward pressure used in roof member Design = 0.46 KPa

Maximum Wall pressure used in Design = 0.95 KPa

Maximum Racking pressure used in Design = 1.1 KPa

**Design Summary**

**Purlin Design**

Purlin Spacing = 900 mm      Purlin Span = 4650 mm      Try Purlin 200x50 SG8 Dry

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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 = 0.44    S1 Downward = 11.27    S1 Upward = 25.48

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>	0.82 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	<b>271.95 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	2.01 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	<b>147.76 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-1.47 Kn-m	Capacity	-1.66 Kn-m	Passing Percentage	<b>112.93 %</b>
V <sub>1.35D</sub>	0.71 Kn	Capacity	9.65 Kn	Passing Percentage	<b>1359.15 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.59 Kn	Capacity	12.86 Kn	Passing Percentage	<b>808.81 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-1.27 Kn	Capacity	-16.08 Kn	Passing Percentage	<b>1266.14 %</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 = 14.10 mm    Limit by Woolcock et al, 1999 Span/240 = 19.17 mm

Deflection under Dead and Service Wind = 17.15 mm    Limit by Woolcock et al, 1999 Span/100 = 46.00 mm

#### **Reactions**

Maximum downward = 1.59 kn    Maximum upward = -1.27 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 = 4800 mm    Internal Rafter Span = 4850 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)

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 = 6.81    S1 Upward = 6.81

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

#### **Capacity Checks**

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M <sub>1.35D</sub>	4.76 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	<b>211.76 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	10.73 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	<b>125.26 %</b>
M <sub>0.9D-WnUp</sub>	-8.54 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	<b>196.72 %</b>
V <sub>1.35D</sub>	3.93 Kn	Capacity	28.94 Kn	Passing Percentage	<b>736.39 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	8.85 Kn	Capacity	38.6 Kn	Passing Percentage	<b>436.16 %</b>
V <sub>0.9D-WnUp</sub>	-7.04 Kn	Capacity	-48.24 Kn	Passing Percentage	<b>685.23 %</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 = 8.68 mm      Limit by Woolcock et al, 1999 Span/240 = 20.83 mm

Deflection under Dead and Service Wind = 11.735 mm      Limit by Woolcock et al, 1999 Span/100 = 50.00 mm

**Reactions**

Maximum downward = 8.85 kn    Maximum upward = -7.04 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<sub>11</sub> = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

K<sub>11</sub> = 2.0 fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 21.67 Kn > -7.04 Kn

**Rafter Design External**

External Rafter Load Width = 2400 mm      External Rafter Span = 4812 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)

K1 Short term = 1    K1 Medium term = 0.8    K1 Long term = 0.6    K4 = 1    K5 = 1    K8 Downward = 0.94

K8 Upward = 0.94    S1 Downward = 13.93    S1 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>	2.34 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>201.71 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	5.28 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>119.32 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-4.20 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>187.38 %</b>
V <sub>1.35D</sub>	1.95 Kn	Capacity	14.47 Kn	Passing Percentage	<b>742.05 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	4.39 Kn	Capacity	19.30 Kn	Passing Percentage	<b>439.64 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-3.49 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>691.12 %</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 = 9.65 mm    Limit by Woolcock et al, 1999 Span/240 = 20.83 mm

Deflection under Dead and Service Wind = 11.73 mm    Limit by Woolcock et al, 1999 Span/100 = 50.00 mm

#### Reactions

Maximum downward = 4.39 kn    Maximum upward = -3.49 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<sub>11</sub> = 14.9 f<sub>pj</sub> = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

K<sub>11</sub> = 2.0 f<sub>cj</sub> = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

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$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$  (Eq 4.12) = -25.20 kn > -3.49 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.49 Kn

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

Girt's Spacing = 900 mm

Girt's Span = 4800 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 =0.75    S1 Downward =11.27    S1 Upward =18.41

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

### **Capacity Checks**

$M_{Wind+Snow}$	2.46 Kn-m	Capacity	2.79 Kn-m	Passing Percentage	<b>113.41 %</b>
$V_{0.9D-WnUp}$	2.05 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	<b>784.39 %</b>

### **Deflections**

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

Deflection under Snow and Service Wind = 26.46 mm    Limit by Woolcock et al, 1999 Span/100 = 48.00 mm

Sag during installation = 32.19 mm

### **Reactions**

Maximum = 2.05 kn

### **Girt Design Sides**

Girt's Spacing = 900 mm

Girt's Span = 5000 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**

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M <sub>Wind+Snow</sub>	2.67 Kn-m	Capacity	2.72 Kn-m	Passing Percentage	<b>101.87 %</b>
V <sub>0.9D-WnUp</sub>	2.14 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	<b>751.40 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 31.16 mm    Limit by Woolcock et al. 1999 Span/100 = 50.00 mm  
Sag during installation = 37.90 mm

### Reactions

Maximum = 2.14 kn

### Middle Pole Design

#### Geometry

225 SED H5 (Minimum 250 dia. at Floor Level)	Dry Use	Height	4500 mm
Area	44279 mm <sup>2</sup>	As	33209.1796875 mm <sup>2</sup>
I <sub>x</sub>	156100441 mm <sup>4</sup>	Z <sub>x</sub>	1314530 mm <sup>3</sup>
I <sub>y</sub>	156100441 mm <sup>4</sup>	Z <sub>y</sub>	1314530 mm <sup>3</sup>
Lateral Restraint	3400 mm c/c		

#### Loads

Total Area over Pole = 24 m<sup>2</sup>

Dead	6.00 Kn	Live	6.00 Kn
Wind Down	11.04 Kn	Snow	0.00 Kn
Moment wind	15.17 Kn-m		
Phi	0.8	K <sub>8</sub>	0.92
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

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PhiNcx Wind	589.62 Kn	PhiMnx Wind	35.30 Kn-m	PhiVnx Wind	78.64 Kn
PhiNcx Dead	353.77 Kn	PhiMnx Dead	21.18 Kn-m	PhiVnx Dead	47.18 Kn

**Checks**

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.47 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.22 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 31.86 \text{ mm} < 45.00 \text{ mm}$$

**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>

$$K_0 = (1 - \sin(30)) / (1 + \sin(30))$$

$$K_p = (1 + \sin(30)) / (1 - \sin(30))$$

**Geometry For Middle Bay Pole**

Ds = 0.6 mm Pile Diameter  
L = 1650 mm Pile embedment length  
f1 = 3600 mm Distance at which the shear force is applied  
f2 = 0 mm Distance of top soil at rest pressure

**Loads**

Moment Wind = 15.17 Kn-m  
Shear Wind = 4.21 Kn

**Pile Properties**

Safety Factory 0.55  
Hu = 7.62 Kn Ultimate Lateral Strength of the Pile, Short pile  
Mu = 16.21 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**

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### Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	4500 mm
Area	27598 mm <sup>2</sup>	As	20698.2421875 mm <sup>2</sup>
Ix	60639381 mm <sup>4</sup>	Zx	646820 mm <sup>3</sup>
Iy	60639381 mm <sup>4</sup>	Zy	646820 mm <sup>3</sup>
Lateral Restraint	mm c/c		

### Loads

Total Area over Pole = 12 m<sup>2</sup>

Dead	3.00 Kn	Live	3.00 Kn
Wind Down	5.52 Kn	Snow	0.00 Kn
Moment Wind	7.58 Kn-m		
Phi	0.8	K8	0.49
K1 snow	0.8	K1 Dead	0.6
K1 wind	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	196.09 Kn	PhiMnx Wind	9.27 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	117.66 Kn	PhiMnx Dead	5.56 Kn-m	PhiVnx Dead	29.41 Kn

### Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.88 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.73 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 43.63 \text{ mm} < 47.88 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3600 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure



**Loads**

Total Area over Pole = 12 m<sup>2</sup>

Moment Wind = 7.58 Kn-m

Shear Wind = 2.11 Kn

**Pile Properties**

Safety Factory 0.55

Hu = 3.99 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.33 Kn-m Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.91 < 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 = 1300 mm Pile embedment length

f1 = 3600 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

**Loads**

Moment Wind = 7.58 Kn-m

Shear Wind = 2.11 Kn

**Pile Properties**

Safety Factory 0.55

Hu = 3.99 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.33 Kn-m Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities =  $0.91 < 1$  OK

## **Uplift Check**

Density of Concrete =  $24 \text{ Kn/m}^3$

Density of Timber Pole =  $5 \text{ Kn/m}^3$

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

$K_s$  (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(1650) x  $K_s$ (1.5) x  $0.5 \times \tan(30) \times \pi \times \text{Dia of Pile}(0.6) \times \text{Height of Pile}(1650)$

Skin Friction =  $21.99 \text{ Kn}$

Weight of Pile + Pile Skin Friction =  $25.77 \text{ Kn}$

Uplift on one Pile =  $14.52 \text{ Kn}$

Uplift is ok