



Pole Shed App Ver 01 2022

**Job No.:** James Berryman - 1

**Address:** 54E Murphy Road, Awakeri, Whakatane, New Zealand

**Date:** 22/05/2024

**Latitude:** -38.003658

**Longitude:** 176.898422

**Elevation:** 72.5 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	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.7 m
Wind Region	NZ2	Terrain Category	2.07	Design Wind Speed	49.25 m/s
Wind Pressure	1.46 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Very 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  $C_{p,i} = -0.3$

For roof  $C_{p,e}$  from 0 m To 4.18 m  $C_{p,e} = -0.9$   $p_e = -1.18$  KPa  $p_{net} = -1.18$  KPa

For roof  $C_{p,e}$  from 4.18 m To 8.35 m  $C_{p,e} = -0.5$   $p_e = -0.65$  KPa  $p_{net} = -0.65$  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 1 m To 8.2 m  $C_{p,e} = 0.7$   $p_e = 0.92$  KPa  $p_{net} = 1.36$  KPa

For side wall  $C_{p,e}$  from 0 m To 4.18 m  $C_{p,e} =$   $p_e = -0.85$  KPa  $p_{net} = -0.85$  KPa

Maximum Upward pressure used in roof member Design = 1.18 KPa

Maximum Downward pressure used in roof member Design = 0.7 KPa

Maximum Wall pressure used in Design = 1.36 KPa

Maximum Racking pressure used in Design = 1.31 KPa

**Design Summary**

**Rafter Design Internal**

Internal Rafter Load Width = 4000 mm

Internal Rafter Span = 8050 mm

Try Rafter 2x360x45 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 = 8.40 S1 Upward = 8.40

Shear Capacity of timber = 5.3 MPa Bending Capacity of timber = 48 MPa NZS3603 Amt 4, table 2.3

**Capacity Checks**

M <sub>1.35D</sub>	10.94 Kn-m	Capacity	43.44 Kn-m	Passing Percentage	397.07 %
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>nDn</sub></sub>	32.40 Kn-m	Capacity	57.92 Kn-m	Passing Percentage	178.77 %
M <sub>0.9D-W<sub>nUp</sub></sub>	-30.94 Kn-m	Capacity	-72.42 Kn-m	Passing Percentage	234.07 %
V <sub>1.35D</sub>	5.43 Kn	Capacity	55.22 Kn	Passing Percentage	1016.94 %

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V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	16.10 Kn	Capacity	73.64 Kn	Passing Percentage	457.39 %
V <sub>0.9D-W<sub>n</sub>Up</sub>	-15.38 Kn	Capacity	-92.04 Kn	Passing Percentage	598.44 %

**Deflections**

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

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

Deflection under Dead and Live Load = 16.52 mm                      Limit by Woolcock et al, 1999 Span/240 = 34.17 mm

Deflection under Dead and Service Wind = 26 mm                      Limit by Woolcock et al, 1999 Span/100 = 82.00 mm

**Reactions**

Maximum downward = 16.10 kn    Maximum upward = -15.38 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<sub>11</sub> = 12.6 f<sub>pj</sub> = 22.7 Mpa for Rafter with effective thickness = 90 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

Capacity under short term loads = 43.67 Kn > -15.38 Kn

**Rafter Design External**

External Rafter Load Width = 2000 mm                      External Rafter Span = 8216 mm                      Try Rafter 360x45 LVL13

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 = 0.81

K<sub>8</sub> Upward = 0.81    S<sub>1</sub> Downward = 17.01    S<sub>1</sub> Upward = 17.01

Shear Capacity of timber = 5.3 MPa    Bending Capacity of timber = 48 MPa NZS3603 Amt 4, table 2.3

**Capacity Checks**

M <sub>1.35D</sub>	5.70 Kn-m	Capacity	17.70 Kn-m	Passing Percentage	310.53 %
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	16.88 Kn-m	Capacity	23.60 Kn-m	Passing Percentage	139.81 %
M <sub>0.9D-W<sub>n</sub>Up</sub>	-16.12 Kn-m	Capacity	-29.50 Kn-m	Passing Percentage	183.00 %
V <sub>1.35D</sub>	2.77 Kn	Capacity	27.61 Kn	Passing Percentage	996.75 %
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	8.22 Kn	Capacity	36.82 Kn	Passing Percentage	447.93 %
V <sub>0.9D-W<sub>n</sub>Up</sub>	-7.85 Kn	Capacity	-46.02 Kn	Passing Percentage	586.24 %

### Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 18.35 mm

Limit by Woolcock et al, 1999 Span/240 = 34.17 mm

Deflection under Dead and Service Wind = 26.00 mm

Limit by Woolcock et al, 1999 Span/100 = 82.00 mm

### Reactions

Maximum downward = 8.22 kn Maximum upward = -7.85 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

Factor of Safety = 0.7

For Perpendicular to grain loading

K11 = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

K11 = 2.0 fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

V = phi x k1 x k4 x k5 x fs x b x ds ..... (Eq 4.12) = -50.09 kn > -7.85 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -7.85 Kn

### Girt Design Front and Back

Girt's Spacing = 700 mm

Girt's Span = 4000 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>	1.90 Kn-m	Capacity	1.94 Kn-m	Passing Percentage	102.11 %
V <sub>0.9D-WnUp</sub>	1.90 Kn	Capacity	12.06 Kn	Passing Percentage	634.74 %

### Deflections

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

Deflection under Snow and Service Wind = 33.68 mm

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

Sag during installation = 15.52 mm

### Reactions

Maximum = 1.90 kn

### Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 4100 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 =0.64    S1 Downward =9.63    S1 Upward =20.56

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>	3.72 Kn-m	Capacity	1.35 Kn-m	Passing Percentage	<b>36.29 %</b>
V <sub>0.9D-WnUp</sub>	3.62 Kn	Capacity	12.06 Kn	Passing Percentage	<b>333.15 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 69.04 mm

Limit by Woolcock et al. 1999 Span/100 = 41.00 mm

Sag during installation =17.13 mm

### Reactions

Maximum = 3.62 kn

### Middle Pole Design

#### Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	35448 mm <sup>2</sup>	As	26585.7421875 mm <sup>2</sup>
I <sub>x</sub>	100042702 mm <sup>4</sup>	Z <sub>x</sub>	941578 mm <sup>3</sup>
I <sub>y</sub>	100042702 mm <sup>4</sup>	Z <sub>y</sub>	941578 mm <sup>3</sup>
Lateral Restraint	3700 mm c/c		

### Loads

Total Area over Pole = 16.4 m<sup>2</sup>

Dead	4.10 Kn	Live	4.10 Kn
Wind Down	11.48 Kn	Snow	0.00 Kn
Moment wind	13.42 Kn-m		
Phi	0.8	K8	0.80
K1 snow	0.8	K1 Dead	0.6
K1 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

PhiNcx Wind	406.33 Kn	PhiMnx Wind	21.77 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	243.80 Kn	PhiMnx Dead	13.06 Kn-m	PhiVnx Dead	37.77 Kn

#### Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.66 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.43 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 27.87 \text{ mm} < 37.00 \text{ mm}$$

### 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>
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 =	2775 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	13.42 Kn-m
Shear Wind =	4.83 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	8.34 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	14.01 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

$$\text{Applied Forces/Capacities} = 0.96 < 1 \text{ OK}$$

### End Pole Design

#### Geometry For End Bay Pole

#### Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3340 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 = 16.4 m2

Dead	4.10 Kn	Live	4.10 Kn
Wind Down	11.48 Kn	Snow	0.00 Kn
Moment Wind	6.71 Kn-m		
Phi	0.8	K8	0.78
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	308.87 Kn	PhiMnx Wind	14.60 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	185.32 Kn	PhiMnx Dead	8.76 Kn-m	PhiVnx Dead	29.41 Kn

**Checks**

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.52 < 1$  OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.27 < 1$  OK

Deflection at top under service lateral loads = 22.93 mm < 36.91 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	2775 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

**Loads**

Total Area over Pole = 16.4 m2

Moment Wind =	6.71 Kn-m
Shear Wind =	2.42 Kn

**Pile Properties**

Safety Factory	0.55	
Hu =	4.80 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.89 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.85 < 1 OK

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

**Assumed Soil Properties**

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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 =	2775 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

**Loads**

Moment Wind =	6.71 Kn-m
Shear Wind =	2.42 Kn

**Pile Properties**

Safety Factory	0.55	
Hu =	4.80 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.89 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.85 < 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(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 = 15.66 Kn

Uplift is ok