



**Job No.:** Towler Shed  
**Latitude:** -40.309034

**Address:** 4/454 Stoney Creek Rd, Manawatu, New Zealand  
**Longitude:** 175.667575

**Date:** 04/06/2024  
**Elevation:** 85 m

### General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N1	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.5 m
Wind Region	NZ2	Terrain Category	2.47	Design Wind Speed	38.29 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  $C_{p,i} = -0.3$

For roof  $C_{p,e}$  from 0 m To 4.20 m  $C_{p,e} = -0.9$   $p_e = -0.71$  KPa  $p_{net} = -0.71$  KPa

For roof  $C_{p,e}$  from 4.2 m To 8.40 m  $C_{p,e} = -0.5$   $p_e = -0.40$  KPa  $p_{net} = -0.40$  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 9 m  $C_{p,e} = 0.7$   $p_e = 0.55$  KPa  $p_{net} = 0.81$  KPa

For side wall  $C_{p,e}$  from 0 m To 4.20 m  $C_{p,e} =$   $p_e = -0.51$  KPa  $p_{net} = -0.51$  KPa

Maximum Upward pressure used in roof member Design = 0.71 KPa

Maximum Downward pressure used in roof member Design = 0.34 KPa

Maximum Wall pressure used in Design = 0.81 KPa

Maximum Racking pressure used in Design = 0.95 KPa

### Design Summary

#### Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3850 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 = 0.53 S1 Downward = 11.27 S1 Upward = 23.16

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

#### Capacity Checks

$M_{1.35D}$	0.56 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	<b>398.21 %</b>
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	1.56 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	<b>190.38 %</b>
$M_{0.9D-W_nUp}$	-0.81 Kn-m	Capacity	-1.96 Kn-m	Passing Percentage	<b>210.75 %</b>
$V_{1.35D}$	0.58 Kn	Capacity	9.65 Kn	Passing Percentage	<b>1663.79 %</b>

Pole Shed App Ver 01 2022

V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	1.17 Kn	Capacity	12.86 Kn	Passing Percentage	<b>1099.15 %</b>
V <sub>0.9D-WnUp</sub>	-0.84 Kn	Capacity	-16.08 Kn	Passing Percentage	<b>1914.29 %</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 = 6.56 mm Limit by Woolcock et al, 1999 Span/240 = 15.83 mm

Deflection under Dead and Service Wind = 7.33 mm Limit by Woolcock et al, 1999 Span/100 = 38.00 mm

**Reactions**

Maximum downward = 1.17 kn Maximum upward = -0.84 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 = 4000 mm Internal Rafter Span = 8850 mm Try Rafter 2x360x45 LVL11

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 = 8.40 S<sub>1</sub> Upward = 8.40

Shear Capacity of timber = 5 MPa Bending Capacity of timber = 38 MPa NZS3603 Amt 4, table 2.3

**Capacity Checks**

M <sub>1.35D</sub>	13.22 Kn-m	Capacity	34.4 Kn-m	Passing Percentage	<b>260.21 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	26.43 Kn-m	Capacity	45.86 Kn-m	Passing Percentage	<b>173.51 %</b>
M <sub>0.9D-WnUp</sub>	-18.99 Kn-m	Capacity	-57.32 Kn-m	Passing Percentage	<b>301.84 %</b>
V <sub>1.35D</sub>	5.97 Kn	Capacity	52.1 Kn	Passing Percentage	<b>872.70 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	11.95 Kn	Capacity	69.46 Kn	Passing Percentage	<b>581.26 %</b>
V <sub>0.9D-WnUp</sub>	-8.58 Kn	Capacity	-86.84 Kn	Passing Percentage	<b>1012.12 %</b>

**Deflections**

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

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

Deflection under Dead and Live Load = 26.635 mm Limit by Woolcock et al, 1999 Span/240 = 37.50 mm

Deflection under Dead and Service Wind = 33.045 mm Limit by Woolcock et al, 1999 Span/100 = 90.00 mm

**Reactions**

Maximum downward = 11.95 kn Maximum upward = -8.58 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 = 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

$K_{11} = 12.6$  fpj = 22.7 Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

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

Capacity under short term loads = 29.11 Kn > -8.58 Kn

### Rafter Design External

External Rafter Load Width = 2000 mm

External Rafter Span = 4307 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

$M_{1.35D}$	1.57 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>300.64 %</b>
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	3.13 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>201.28 %</b>
$M_{0.9D-W_nUp}$	-2.25 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>349.78 %</b>
$V_{1.35D}$	1.45 Kn	Capacity	14.47 Kn	Passing Percentage	<b>997.93 %</b>
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	2.91 Kn	Capacity	19.30 Kn	Passing Percentage	<b>663.23 %</b>
$V_{0.9D-W_nUp}$	-2.09 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>1154.07 %</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 = 5.27 mm

Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 5.89 mm

Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

### Reactions

Maximum downward = 2.91 kn    Maximum upward = -2.09 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

$K_{11} = 14.9$  fpj = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

$K_{11} = 2.0$   $f_{c,j} = 36.1$  MPa for Pole with effective thickness = 100 mm

Eccentric Load check

$V = \phi_i \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$  (Eq 4.12) = -25.20 kn > -2.09 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.09 Kn

### Intermediate Design Sides

Intermediate Spacing = 2250 mm                      Intermediate Span = 4229 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 = 0.77

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

### Capacity Checks

$M_{Wind+Snow}$	2.04 Kn-m	Capacity	7.46 Kn-m	Passing Percentage	<b>365.69 %</b>
$V_{0.9D-WnUp}$	1.93 Kn	Capacity	32.16 Kn	Passing Percentage	<b>1666.32 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 21.085 mm                      Limit by Woolcock et al, 1999 Span/100 = 42.29 mm

### Reactions

Maximum = 1.93 kn

### Girt Design Front and Back

Girt's Spacing = 900 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)

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

$K_8$  Upward = 0.92     $S_1$  Downward = 9.63     $S_1$  Upward = 14.36

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

### Capacity Checks

$M_{Wind+Snow}$	1.46 Kn-m	Capacity	1.94 Kn-m	Passing Percentage	<b>132.88 %</b>
$V_{0.9D-WnUp}$	1.46 Kn	Capacity	12.06 Kn	Passing Percentage	<b>826.03 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 25.79 mm                      Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Sag during installation = 15.52 mm

### Reactions

Maximum = 1.46 kn

### Girt Design Sides

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)

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

K8 Upward =0.89    S1 Downward =9.63    S1 Upward =15.23

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>	0.67 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	<b>279.10 %</b>
V <sub>0.9D-WnUp</sub>	1.18 Kn	Capacity	12.06 Kn	Passing Percentage	<b>1022.03 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 3.73 mm

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

Sag during installation =1.55 mm

### Reactions

Maximum = 1.18 kn

### Middle Pole Design

#### Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	4300 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	4300 mm c/c		

### Loads

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

Dead	4.50 Kn	Live	4.50 Kn
Wind Down	6.12 Kn	Snow	0.00 Kn
Moment wind	14.39 Kn-m		
Phi	0.8	K8	0.66
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

### Material

Peeling	Steaming	Normal	Dry Use
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Pole Shed App Ver 01 2022

fb =	36.3 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	22 MPa	E =	9257 MPa

**Capacities**

PhiNcx Wind	336.13 Kn	PhiMnx Wind	18.01 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	201.68 Kn	PhiMnx Dead	10.80 Kn-m	PhiVnx Dead	37.77 Kn

**Checks**

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.84 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.68 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 42.25 \text{ mm} < 43.00 \text{ mm}$$

**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 =	1650 mm	Pile embedment length
f1 =	3375 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

**Loads**

Moment Wind =	14.39 Kn-m
Shear Wind =	4.26 Kn

**Pile Properties**

Safety Factory	0.55	
Hu =	7.97 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	15.97 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

$$\text{Applied Forces/Capacities} = 0.90 < 1 \text{ OK}$$

**End Pole Design**

**Geometry For End Bay Pole**

**Geometry**

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	4200 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>

Pole Shed App Ver 01 2022

Iy	60639381 mm <sup>4</sup>	Zx	646820 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	3.06 Kn	Snow	0.00 Kn
Moment Wind	4.80 Kn-m		
Phi	0.8	K8	0.56
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	221.65 Kn	PhiMnx Wind	10.48 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	132.99 Kn	PhiMnx Dead	6.29 Kn-m	PhiVnx Dead	29.41 Kn

**Checks**

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.49 < 1$  OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.24 < 1$  OK

Deflection at top under service lateral loads = 24.26 mm < 44.89 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3375 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

**Loads**

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

Moment Wind =	4.80 Kn-m
Shear Wind =	1.42 Kn

**Pile Properties**

Safety Factor	0.55	
Hu =	4.19 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.23 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.58 < 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 =	3375 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

### Loads

Moment Wind =	4.80 Kn-m
Shear Wind =	1.42 Kn

### Pile Properties

Safety Factory	0.55	
Hu =	4.19 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.23 Kn-m	Ultimate Moment Capacity of Pile

### Checks

Applied Forces/Capacities = 0.58 < 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(1650) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1650)

Skin Friction = 21.99 Kn

Weight of Pile + Pile Skin Friction = 26.27 Kn

Uplift on one Pile = 8.73 Kn

Uplift is ok