



**Job No.:** Dennis Wilks - 483-211700C    **Address:** 38 Castlegrave Drive, Tahawai Katikati, New Zealand    **Date:** 29/08/2024  
**Latitude:** -37.526016    **Longitude:** 175.935743    **Elevation:** 60.5 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	1	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.1 m
Wind Region	NZ1	Terrain Category	2.5	Design Wind Speed	46.19 m/s
Wind Pressure	1.28 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 = Mono    Enclosed

For roof  $C_{p,i} = -0.3$

For roof  $C_{p,e}$  from 0 m To 3.75 m  $C_{p,e} = -0.9$   $p_e = -1.04$  KPa  $p_{net} = -1.04$  KPa

For roof  $C_{p,e}$  from 3.75 m To 7.50 m  $C_{p,e} = -0.5$   $p_e = -0.58$  KPa  $p_{net} = -0.58$  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  $C_{p,e} = 0.7$   $p_e = 0.81$  KPa  $p_{net} = 1.19$  KPa

For side wall  $C_{p,e}$  from 0 m To 3.75 m  $C_{p,e} =$   $p_e = -0.75$  KPa  $p_{net} = -0.75$  KPa

Maximum Upward pressure used in roof member Design = 1.04 KPa

Maximum Downward pressure used in roof member Design = 0.61 KPa

Maximum Wall pressure used in Design = 1.19 KPa

Maximum Racking pressure used in Design = 1.39 KPa

### Design Summary

#### Purlin Design

Purlin Spacing = 900 mm    Purlin Span = 4050 mm    Try Purlin 190x45 SG8

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 = 0.98

K8 Upward = 0.76    S1 Downward = 12.23    S1 Upward = 18.23

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>	0.62 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	<b>288.71 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.68 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	<b>141.67 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-1.5 Kn-m	Capacity	-2.30 Kn-m	Passing Percentage	<b>153.33 %</b>
V <sub>1.35D</sub>	0.62 Kn	Capacity	8.25 Kn	Passing Percentage	<b>1330.65 %</b>

Pole Shed App Ver 01 2022

V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	1.66 Kn	Capacity	11.00 Kn	Passing Percentage	<b>662.65 %</b>
V <sub>0.9D-WnUp</sub>	-1.49 Kn	Capacity	-13.75 Kn	Passing Percentage	<b>922.82 %</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 = 10.44 mm                      Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 14.01 mm                      Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

**Reactions**

Maximum downward = 1.66 kn    Maximum upward = -1.49 kn

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

**Rafter Design Internal**

Internal Rafter Load Width = 4200 mm                      Internal Rafter Span = 4350 mm                      Try Rafter 2x290x45 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 = 7.47    S<sub>1</sub> Upward = 7.47

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>	3.35 Kn-m	Capacity	8.48 Kn-m	Passing Percentage	<b>253.13 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	9.04 Kn-m	Capacity	11.3 Kn-m	Passing Percentage	<b>125.00 %</b>
M <sub>0.9D-WnUp</sub>	-8.10 Kn-m	Capacity	-14.12 Kn-m	Passing Percentage	<b>174.32 %</b>
V <sub>1.35D</sub>	3.08 Kn	Capacity	25.18 Kn	Passing Percentage	<b>817.53 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	8.31 Kn	Capacity	33.58 Kn	Passing Percentage	<b>404.09 %</b>
V <sub>0.9D-WnUp</sub>	-7.45 Kn	Capacity	-41.96 Kn	Passing Percentage	<b>563.22 %</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 = 6.13 mm                      Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 9.14 mm                      Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

**Reactions**

Maximum downward = 8.31 kn    Maximum upward = -7.45 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

$K_{11} = 14.9$   $f_{pj} = 12.9$  Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

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

Capacity under short term loads = 19.50 Kn > -7.45 Kn

### Rafter Design External

External Rafter Load Width = 2100 mm

External Rafter Span = 4314 mm

Try Rafter 290x45 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 = 0.89

$K_8$  Upward = 0.89     $S_1$  Downward = 15.23     $S_1$  Upward = 15.23

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

### Capacity Checks

$M_{1.35D}$	1.65 Kn-m	Capacity	3.78 Kn-m	Passing Percentage	<b>229.09 %</b>
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.45 Kn-m	Capacity	5.04 Kn-m	Passing Percentage	<b>113.26 %</b>
$M_{0.9D-W_nUp}$	-3.98 Kn-m	Capacity	-6.29 Kn-m	Passing Percentage	<b>158.04 %</b>
$V_{1.35D}$	1.53 Kn	Capacity	12.59 Kn	Passing Percentage	<b>822.88 %</b>
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.12 Kn	Capacity	16.79 Kn	Passing Percentage	<b>407.52 %</b>
$V_{0.9D-W_nUp}$	-3.69 Kn	Capacity	-20.98 Kn	Passing Percentage	<b>568.56 %</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 = 6.81 mm

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

Deflection under Dead and Service Wind = 9.14 mm

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

### Reactions

Maximum downward = 4.12 kn    Maximum upward = -3.69 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

$K_{11} = 14.9$   $f_{pj} = 12.9$  Mpa for Rafter with effective thickness = 45 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

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$  (Eq 4.12) = -21.73 kn > -3.69 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -3.69 Kn

### Intermediate Design Front and Back

Intermediate Spacing = 2100 mm

Intermediate Span = 3250 mm

Try Intermediate 2x190x45 SG8

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 = 0.98

$K_8$  Upward = 1.00     $S_1$  Downward = 12.23     $S_1$  Upward = 0.73

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

### Capacity Checks

$M_{Wind+Snow}$	3.30 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	<b>183.64 %</b>
$V_{0.9D-WnUp}$	4.06 Kn	Capacity	-27.5 Kn	Passing Percentage	<b>677.34 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 13.06 mm

Limit by Woolcock et al, 1999 Span/100 = 32.50 mm

### Reactions

Maximum = 4.06 kn

### Intermediate Design Sides

Intermediate Spacing = 2250 mm

Intermediate Span = 3775 mm

Try Intermediate 2x190x45 SG8

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 = 0.98

$K_8$  Upward = 1.00     $S_1$  Downward = 12.23     $S_1$  Upward = 0.79

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

### Capacity Checks

$M_{Wind+Snow}$	2.38 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	<b>254.62 %</b>
$V_{0.9D-WnUp}$	2.53 Kn	Capacity	27.5 Kn	Passing Percentage	<b>1086.96 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 25.485 mm

Limit by Woolcock et al, 1999 Span/100 = 37.75 mm

**Reactions**

Maximum = 2.53 kn

**Girt Design Front and Back**

Girt's Spacing = 1300 mm

Girt's Span = 2100 mm

Try Girt 190x45 SG8

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 =0.98

K8 Upward =0.73    S1 Downward =12.23    S1 Upward =18.68

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

**Capacity Checks**

$M_{Wind+Snow}$	0.85 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	<b>262.35 %</b>
$V_{0.9D-WnUp}$	1.62 Kn	Capacity	13.75 Kn	Passing Percentage	<b>848.77 %</b>

**Deflections**

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

Deflection under Snow and Service Wind = 2.27 mm

Limit by Woolcock et al, 1999 Span/100 = 21.00 mm

Sag during installation = 1.46 mm

**Reactions**

Maximum = 1.62 kn

**Girt Design Sides**

Girt's Spacing = 1300 mm

Girt's Span = 2250 mm

Try Girt 190x45 SG8

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 =0.98

K8 Upward =0.70    S1 Downward =12.23    S1 Upward =19.33

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

**Capacity Checks**

$M_{Wind+Snow}$	0.98 Kn-m	Capacity	2.13 Kn-m	Passing Percentage	<b>217.35 %</b>
$V_{0.9D-WnUp}$	1.74 Kn	Capacity	13.75 Kn	Passing Percentage	<b>790.23 %</b>

**Deflections**

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

Deflection under Snow and Service Wind = 3.00 mm

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

Sag during installation =1.92 mm

**Reactions**

Maximum = 1.74 kn

## Middle Pole Design

### Geometry

200 UNI H5	Dry Use	Height	3800 mm
Area	31400 mm <sup>2</sup>	As	23550 mm <sup>2</sup>
I <sub>x</sub>	78500000 mm <sup>4</sup>	Z <sub>x</sub>	785000 mm <sup>3</sup>
I <sub>y</sub>	78500000 mm <sup>4</sup>	Z <sub>y</sub>	785000 mm <sup>3</sup>
Lateral Restraint	3800 mm c/c		

### Loads

Total Area over Pole = 18.9 m<sup>2</sup>

Dead	4.72 Kn	Live	4.72 Kn
Wind Down	11.53 Kn	Snow	0.00 Kn
Moment wind	12.24 Kn-m		
Phi	0.8	K <sub>8</sub>	0.72
K <sub>1</sub> snow	0.8	K <sub>1</sub> Dead	0.6
K <sub>1</sub> wind	1		

### Material

Shaving	Steaming	Normal	Dry Use
f <sub>b</sub> =	34.325 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> =	20.75 MPa	E =	8793 MPa

### Capacities

PhiN <sub>c</sub> Wind	325.19 Kn	PhiM <sub>n</sub> Wind	15.50 Kn-m	PhiV <sub>n</sub> Wind	55.77 Kn
PhiN <sub>c</sub> Dead	195.12 Kn	PhiM <sub>n</sub> Dead	9.30 Kn-m	PhiV <sub>n</sub> Dead	33.46 Kn

### Checks

$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.85 < 1$  OK

$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.69 < 1$  OK

Deflection at top under service lateral loads = 38.81 mm < 38.00 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>
K <sub>0</sub> =	$(1 - \sin(30)) / (1 + \sin(30))$				
K <sub>p</sub> =	$(1 + \sin(30)) / (1 - \sin(30))$				

### Geometry For Middle Bay Pole

D <sub>s</sub> =	0.6 mm	Pile Diameter
L =	1550 mm	Pile embedment length
f <sub>1</sub> =	3075 mm	Distance at which the shear force is applied
f <sub>2</sub> =	0 mm	Distance of top soil at rest pressure

Pole Shed App Ver 01 2022

**Loads**

Moment Wind = 12.24 Kn-m  
Shear Wind = 3.98 Kn

**Pile Properties**

Safety Factory 0.55  
Hu = 7.17 Kn Ultimate Lateral Strength of the Pile, Short pile  
Mu = 13.15 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 UNI H5	Dry Use	Height	3900 mm
Area	31400 mm <sup>2</sup>	As	23550 mm <sup>2</sup>
Ix	78500000 mm <sup>4</sup>	Zx	785000 mm <sup>3</sup>
Iy	78500000 mm <sup>4</sup>	Zy	785000 mm <sup>3</sup>
Lateral Restraint	mm c/c		

**Loads**

Total Area over Pole = 9.45 m<sup>2</sup>

Dead	2.36 Kn	Live	2.36 Kn
Wind Down	5.76 Kn	Snow	0.00 Kn
Moment Wind	6.12 Kn-m		
Phi	0.8	K8	0.69
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

**Material**

Shaving	Steaming	Normal	Dry Use
fb =	34.325 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	20.75 MPa	E =	8793 MPa

**Capacities**

PhiNcx Wind	314.17 Kn	PhiMnx Wind	14.98 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	188.50 Kn	PhiMnx Dead	8.99 Kn-m	PhiVnx Dead	33.46 Kn

**Checks**

(Mx/PhiMnx)+(N/phiNcx) = 0.44 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.20 < 1 OK



Deflection at top under service lateral loads = 20.88 mm < 40.90 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3075 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Total Area over Pole = 9.45 m<sup>2</sup>

Moment Wind =	6.12 Kn-m
Shear Wind =	1.99 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	4.47 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.07 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities = 0.76 < 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 =	3075 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	6.12 Kn-m
Shear Wind =	1.99 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	4.47 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.07 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities = 0.76 < 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(1550) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1550)

Skin Friction = 19.40 Kn

Weight of Pile + Pile Skin Friction = 23.68 Kn

Uplift on one Pile = 15.40 Kn

Uplift is ok