

**Job No.:** 219 Norwegian Road **Address:** 219 Norwegian Road, Cambridge, New Zealand **Date:** 9/6/2022  
**Latitude:** -37.965841 **Longitude:** 175.484608 **Elevation:** 120 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	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ1	Terrain Category	2.0	Design Wind Speed	45.53 m/s
Wind Pressure	1.24 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Very High				

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 3.70 m  $C_{p,e} = -0.9$   $p_e = -1.01$  KPa  $p_{net} = -1.01$  KPa

For roof  $C_{p,e}$  from 3.70 m To 7.40 m  $C_{p,e} = -0.5$   $p_e = -0.56$  KPa  $p_{net} = -0.56$  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 8 m  $C_{p,e} = 0.7$   $p_e = 0.78$  KPa  $p_{net} = 1.15$  KPa

For side wall  $C_{p,e}$  from 0 m To 3.70 m  $C_{p,e} =$   $p_e = -0.73$  KPa  $p_{net} = -0.73$  KPa

Maximum Upward pressure used in roof member Design = 1.01 KPa

Maximum Downward pressure used in roof member Design = 0.59 KPa

Maximum Wall pressure used in Design = 1.15 KPa

Maximum Racking pressure used in Design = 1.34 KPa

### Design Summary

#### Purlin Design

Purlin Spacing = 900 mm      Purlin Span = 3800 mm      Try Purlin 200x50 SG8 Dry

### Pole Shed App Ver 01 2022 by RnH Consulting Engineers

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 <sub>1.35D</sub>	0.55 Kn-m	Capacity	2.39 Kn-m	Passing Percentage	<b>434.55 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.53 Kn-m	Capacity	3.18 Kn-m	Passing Percentage	<b>207.84 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-1.28 Kn-m	Capacity	-2.10 Kn-m	Passing Percentage	<b>164.06 %</b>
V <sub>1.35D</sub>	0.58 Kn	Capacity	9.65 Kn	Passing Percentage	<b>1663.79 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.52 Kn	Capacity	12.86 Kn	Passing Percentage	<b>846.05 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-1.34 Kn	Capacity	-16.08 Kn	Passing Percentage	<b>1200.00 %</b>

#### **Deflections**

Modulus of Elasticity = 8000 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 = 5.50 mm    Limit by AS1170.0 Table C1 Span/250 = 15.20 mm

Deflection under Dead and Service Wind = 7.28 mm    Limit by AS1170.0 Table C1 Span/120 = 31.67 mm

#### **Reactions**

Maximum downward = 1.52 kn    Maximum upward = -1.34 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 = 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)

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**

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

M1.35D	2.50 Kn-m	Capacity	11.32 Kn-m	Passing Percentage	<b>452.80 %</b>
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	6.60 Kn-m	Capacity	15.08 Kn-m	Passing Percentage	<b>228.48 %</b>
M0.9D-WnUp	-5.82 Kn-m	Capacity	-18.86 Kn-m	Passing Percentage	<b>324.05 %</b>
V1.35D	2.60 Kn	Capacity	28.94 Kn	Passing Percentage	<b>1113.08 %</b>
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	6.85 Kn	Capacity	38.6 Kn	Passing Percentage	<b>563.50 %</b>
V0.9D-WnUp	-6.04 Kn	Capacity	-48.24 Kn	Passing Percentage	<b>798.68 %</b>

**Deflections**

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 2.965 mm      Limit by AS1170.0 Table C1 Span/250 = 16.00 mm

Deflection under Dead and Service Wind = 4.36 mm      Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

**Reactions**

Maximum downward = 6.85 kn    Maximum upward = -6.04 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

K11 = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

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

Capacity under short term loads = 21.67 Kn > -6.04 Kn

**Rafter Design External**

External Rafter Load Width = 2000 mm      External Rafter Span = 3811 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>	1.23 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>383.74 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	3.23 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>195.05 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-2.85 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>276.14 %</b>
V <sub>1.35D</sub>	1.29 Kn	Capacity	14.47 Kn	Passing Percentage	<b>1121.71 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	3.39 Kn	Capacity	19.30 Kn	Passing Percentage	<b>569.32 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-2.99 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>806.69 %</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 = 3.29 mm    Limit by AS1170.0 Table C1 Span/250 = 16.00 mm

Deflection under Dead and Service Wind = 4.36 mm    Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

#### Reactions

Maximum downward =3.39 kn    Maximum upward = -2.99 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

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$  (Eq 4.12) = -25.20 kn > -2.99 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.99 Kn

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

Girt's Spacing = 1300 mm      Girt's Span = 4000 mm      Try Intermediate 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 =0.50    S1 Downward =11.27    S1 Upward =23.76

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

### **Capacity Checks**

$M_{Wind+Snow}$	1.49 Kn-m	Capacity	2.01 Kn-m	Passing Percentage	<b>134.90 %</b>
$V_{0.9D-WnUp}$	1.49 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	<b>1079.19 %</b>

### **Deflections**

Modulus of Elasticity = 8000 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 9.34 mm      Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

Sag during installation = 13.00 mm

### **Reactions**

Maximum = 1.49 kn

### **Girt Design Sides**

Girt's Spacing = 1300 mm      Girt's Span = 4000 mm      Try Intermediate 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 =0.50    S1 Downward =11.27    S1 Upward =23.76

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

### **Capacity Checks**

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

M <sub>Wind+Snow</sub>	1.49 Kn-m	Capacity	2.01 Kn-m	Passing Percentage	<b>134.90 %</b>
V <sub>0.9D-WnUp</sub>	1.49 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	<b>1079.19 %</b>

**Deflections**

Modulus of Elasticity = 8000 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 9.34 mm      Limit by AS1170.0 Table C1 Span/120 = 33.33 mm  
Sag during installation = 13.00 mm

**Reactions**

Maximum = 1.49 kn

**Middle Pole Design**

**Geometry**

150 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3400 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	3400 mm c/c		

**Loads**

Total Area over Pole = 16 m<sup>2</sup>

Dead	4.00 Kn	Live	4.00 Kn
Wind	9.44 Kn	Snow	0.00 Kn
Moment wind	Kn-m		
Phi	0.8	K <sub>8</sub>	0.82
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**

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

PhiNcx Wind	368.60 Kn	PhiMnx Wind	18.58 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	221.16 Kn	PhiMnx Dead	11.15 Kn-m	PhiVnx Dead	33.46 Kn

**Checks**

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.62 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.38 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 28.12 \text{ mm} < 45.33 \text{ mm}$$

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

**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 = 600 mm Pile Diameter  
L = 1450 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 = 10.69 Kn-m  
Shear Wind = 3.56 Kn

**Pile Properties**

Safety Factory 0.55  
Hu = 6.10 Kn Ultimate Lateral Strength of the Pile, Short pile  
Mu = 10.87 Kn-m Ultimate Moment Capacity of Pile

**Checks**

$$\text{Applied Forces/Capacities} = 0.98 < 1 \text{ OK}$$

**End Pole Design**

**Geometry For End Bay Pole**

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

Ds = 600 mm Pile Diameter  
L = 1300 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**

Total Area over Pole = 4 m<sup>2</sup>

Moment Wind = 5.35 Kn-m  
Shear Wind = 1.78 Kn

**Pile Properties**

Safety Factory 0.55  
Hu = 4.55 Kn Ultimate Lateral Strength of the Pile, Short pile  
Mu = 8.02 Kn-m Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.67 < 1 OK

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

**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 End Bay Pole**

Ds = 600 mm Pile Diameter  
L = 1300 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 = 5.35 Kn-m  
Shear Wind = 1.78 Kn

**Pile Properties**



Safety Factor 0.55

$H_u = 4.55 \text{ Kn}$  Ultimate Lateral Strength of the Pile, Short pile

$M_u = 8.02 \text{ Kn-m}$  Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities =  $0.67 < 1$  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(1450) x  $K_s$ (1.5) x  $\tan(30)$  x  $\pi$  x Dia of Pile(0.6) x Height of Pile(1450)

Skin Friction = 16.98 Kn

Weight of Pile + Pile Skin Friction = 20.98 Kn

Uplift on one Pile = 12.56 Kn

Uplift is ok