

**Job No.:** 2207027

**Address:** 72 Matenga Road, Liger Bay, New Zealand **Date:** 7/29/2022

**Latitude:** -40.829193

**Longitude:** 172.90663

**Elevation:** 42.5 m

### General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N2	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind ARI	100 Years	Max Height	3.4 m
Wind Region	NZ2	Terrain Category	2.5	Design Wind Speed	45.19 m/s
Wind Pressure	1.23 KPa	Lee Zone	NO	Ultimate ARI	100 Years
Wind Category	Very High				

### 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 m  $C_{p,e} = -0.9$   $p_e = -1$  KPa  $p_{net} = -1$  KPa

For roof  $C_{p,e}$  from 3 m To 6 m  $C_{p,e} = -0.5$   $p_e = -0.55$  KPa  $p_{net} = -0.55$  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 6.50 m  $C_{p,e} = 0.7$   $p_e = 0.77$  KPa  $p_{net} = 1.14$  KPa

For side wall  $C_{p,e}$  from 0 m To 3 m  $C_{p,e} =$   $p_e = -0.72$  KPa  $p_{net} = -0.72$  KPa

Maximum Upward pressure used in roof member Design = 1 KPa

Maximum Downward pressure used in roof member Design = 0.48 KPa

Maximum Wall pressure used in Design = 1.14 KPa

Maximum Racking pressure used in Design = 1.3 KPa

### Design Summary

#### Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3050 mm

Try Purlin 140x45 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 = 1.00

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

K8 Upward =0.72    S1 Downward =10.36    S1 Upward =19.08

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>	0.35 Kn-m	Capacity	1.12 Kn-m	Passing Percentage	<b>320.00 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.15 Kn-m	Capacity	1.50 Kn-m	Passing Percentage	<b>130.43 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-0.81 Kn-m	Capacity	-1.34 Kn-m	Passing Percentage	<b>165.43 %</b>
V <sub>1.35D</sub>	0.46 Kn	Capacity	6.08 Kn	Passing Percentage	<b>1321.74 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.07 Kn	Capacity	8.10 Kn	Passing Percentage	<b>757.01 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-1.06 Kn	Capacity	-10.13 Kn	Passing Percentage	<b>955.66 %</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 = 7.39 mm      Limit by AS1170.0 Table C1 Span/250 = 12.20 mm

Deflection under Dead and Service Wind = 9.12 mm      Limit by AS1170.0 Table C1 Span/120 = 25.42 mm

**Reactions**

Maximum downward =1.07 kn    Maximum upward = -1.06 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 = 3250 mm      Internal Rafter Span = 6850 mm      Try Rafter 2x300x45 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 =7.61    S1 Upward =7.61

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>	6.43 Kn-m	Capacity	34.92 Kn-m	Passing Percentage	<b>543.08 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	14.87 Kn-m	Capacity	46.56 Kn-m	Passing Percentage	<b>313.11 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-14.77 Kn-m	Capacity	-58.2 Kn-m	Passing Percentage	<b>394.04 %</b>

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

V <sub>1.35D</sub>	3.76 Kn	Capacity	46.02 Kn	Passing Percentage	<b>1223.94 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	8.68 Kn	Capacity	61.36 Kn	Passing Percentage	<b>706.91 %</b>
V <sub>0.9D-WnUp</sub>	-8.63 Kn	Capacity	-76.7 Kn	Passing Percentage	<b>888.76 %</b>

**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 = 12.315 mm      Limit by AS1170.0 Table C1 Span/250 = 28.00 mm

Deflection under Dead and Service Wind = 16.875 mm      Limit by AS1170.0 Table C1 Span/120 = 58.33 mm

**Reactions**

Maximum downward = 8.68 kn    Maximum upward = -8.63 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<sub>11</sub> = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 90 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 = 29.11 Kn > -8.63 Kn

**Rafter Design External**

External Rafter Load Width = 1625 mm      External Rafter Span = 3323 mm      Try Rafter 240x45 SG8 Wet

Moisture Condition = Wet (Moisture in timber is less than 25%)

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 = 0.95

K<sub>8</sub> Upward = 0.95    S<sub>1</sub> Downward = 13.82    S<sub>1</sub> Upward = 13.82

Shear Capacity of timber = 3 MPa    Bending Capacity of timber = 11.7 MPa NZS3603 Amt 4, table 2.3

### Capacity Checks

M <sub>1.35D</sub>	0.76 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	<b>313.16 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	1.75 Kn-m	Capacity	3.17 Kn-m	Passing Percentage	<b>181.14 %</b>
M <sub>0.9D-WnUp</sub>	-1.74 Kn-m	Capacity	-3.97 Kn-m	Passing Percentage	<b>228.16 %</b>
V <sub>1.35D</sub>	0.91 Kn	Capacity	10.42 Kn	Passing Percentage	<b>1145.05 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	2.11 Kn	Capacity	13.89 Kn	Passing Percentage	<b>658.29 %</b>
V <sub>0.9D-WnUp</sub>	-2.09 Kn	Capacity	-17.37 Kn	Passing Percentage	<b>831.10 %</b>

### Deflections

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

k<sub>2</sub> for Long Term Loads = 3

Deflection under Dead and Live Load = 5.92 mm      Limit by AS1170.0 Table C1 Span/250 = 14.00 mm

Deflection under Dead and Service Wind = 6.89 mm      Limit by AS1170.0 Table C1 Span/120 = 29.17 mm

### Reactions

Maximum downward = 2.11 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<sub>11</sub> = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

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

Eccentric Load check

V =  $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$  ..... (Eq 4.12) = -17.01 kn > -2.09 Kn

Single Shear Capacity under short term loads = -6.83 Kn > -2.09 Kn

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

Girt's Spacing = 1300 mm

Girt's Span = 3250 mm

Try Intermediate 140x45 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 =1.00

K8 Upward =0.69    S1 Downward =10.36    S1 Upward =19.69

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>	0.98 Kn-m	Capacity	1.28 Kn-m	Passing Percentage	<b>130.61 %</b>
V <sub>0.9D-WnUp</sub>	1.20 Kn-m	Capacity	10.13 Kn-m	Passing Percentage	<b>844.17 %</b>

#### **Deflections**

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

Deflection under Snow and Service Wind = 13.08 mm    Limit by AS1170.0 Table C1 Span/120 = 27.08 mm

Sag during installation = 6.99 mm

#### **Reactions**

Maximum = 1.20 kn

### **Girt Design Sides**

Girt's Spacing = 1300 mm

Girt's Span = 3500 mm

Try Intermediate 140x45 SG6

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 =0.65    S1 Downward =10.36    S1 Upward =20.44

Shear Capacity of timber =3 MPa    Bending Capacity of timber =10 MPa NZS3603 Amt 4, table 2.3

#### **Capacity Checks**

M <sub>Wind+Snow</sub>	1.13 Kn-m	Capacity	0.87 Kn-m	Passing Percentage	<b>76.99 %</b>
V <sub>0.9D-WnUp</sub>	1.30 Kn-m	Capacity	10.13 Kn-m	Passing Percentage	<b>779.23 %</b>

## Deflections

Modulus of Elasticity = 6000 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 23.45 mm      Limit by AS1170.0 Table C1 Span/120 = 29.17 mm

Sag during installation = 12.54 mm

## Reactions

Maximum = 1.30 kn

## Middle Pole Design

### Geometry

150 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3100 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	1300 mm c/c		

### Loads

Total Area over Pole = 11.375 m<sup>2</sup>

Dead	2.84 Kn	Live	2.84 Kn
Wind	5.46 Kn	Snow	0.00 Kn
Moment wind	Kn-m		
Phi	0.8	K <sub>8</sub>	1.00
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

PhiN <sub>cx</sub> Wind	452.16 Kn	PhiM <sub>nx</sub> Wind	22.80 Kn-m	PhiV <sub>nx</sub> Wind	55.77 Kn
PhiN <sub>cx</sub> Dead	271.30 Kn	PhiM <sub>nx</sub> Dead	13.68 Kn-m	PhiV <sub>nx</sub> Dead	33.46 Kn

**Checks**

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

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.19 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 18.62 \text{ mm} < 41.33 \text{ mm}$$

**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 = 1400 mm Pile embedment length  
f1 = 2550 mm Distance at which the shear force is applied  
f2 = 0 mm Distance of top soil at rest pressure

**Loads**

Moment Wind = 9.13 Kn-m  
Shear Wind = 3.58 Kn

**Pile Properties**

Safety Factory 0.55  
Hu = 6.19 Kn Ultimate Lateral Strength of the Pile, Short pile  
Mu = 9.49 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**

Ds = 600 mm Pile Diameter  
L = 1300 mm Pile embedment length  
f1 = 2550 mm Distance at which the shear force is applied

$f_2 = 0 \text{ mm}$  Distance of top soil at rest pressure

#### Loads

Total Area over Pole = 2.84375 m<sup>2</sup>

Moment Wind = 3.04 Kn-m

Shear Wind = 1.19 Kn

#### Pile Properties

Safety Factory 0.55

$H_u = 5.08 \text{ Kn}$  Ultimate Lateral Strength of the Pile, Short pile

$M_u = 7.74 \text{ Kn-m}$  Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities = 0.39 < 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

$D_s = 600 \text{ mm}$  Pile Diameter

$L = 1300 \text{ mm}$  Pile embedment length

$f_1 = 2550 \text{ mm}$  Distance at which the shear force is applied

$f_2 = 0 \text{ mm}$  Distance of top soil at rest pressure

#### Loads

Moment Wind = 3.04 Kn-m

Shear Wind = 1.19 Kn

#### Pile Properties

Safety Factory 0.55

$H_u = 5.08 \text{ Kn}$  Ultimate Lateral Strength of the Pile, Short pile

$M_u = 7.74 \text{ Kn-m}$  Ultimate Moment Capacity of Pile



**Checks**

Applied Forces/Capacities =  $0.39 < 1$  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(1400) x  $K_s(1.5)$  x  $\tan(30)$  x  $\pi$  x Dia of Pile(0.6) x Height of Pile(1400)

Skin Friction =  $15.83 \text{ Kn}$

Weight of Pile + Pile Skin Friction =  $19.69 \text{ Kn}$

Uplift on one Pile =  $8.82 \text{ Kn}$

Uplift is ok