

**Job No.:** The Wright Build

**Address:** River Terrace, Cromwell, New Zealand

**Date:** 8/30/2022

**Latitude:** -45.056186

**Longitude:** 169.162575

**Elevation:** 226.5 m

### General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N5	Ground Snow Load	0.9 KPa	Roof Snow Load	0.63 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.2 m
Wind Region	NZ2	Terrain Category	2.35	Design Wind Speed	37.04 m/s
Wind Pressure	0.82 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	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 3.60 m  $C_{p,e} = -0.9$   $p_e = -0.67$  KPa  $p_{net} = -0.67$  KPa

For roof  $C_{p,e}$  from 3.60 m To 7.20 m  $C_{p,e} = -0.5$   $p_e = -0.37$  KPa  $p_{net} = -0.37$  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  $C_{p,e} = 0.7$   $p_e = 0.52$  KPa  $p_{net} = 0.77$  KPa

For side wall  $C_{p,e}$  from 0 m To 3.60 m  $C_{p,e} =$   $p_e = -0.48$  KPa  $p_{net} = -0.48$  KPa

Maximum Upward pressure used in roof member Design = 0.67 KPa

Maximum Downward pressure used in roof member Design = 0.40 KPa

Maximum Wall pressure used in Design = 0.77 KPa

Maximum Racking pressure used in Design = 0.9 KPa

### Design Summary

#### Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4800 mm

Try Purlin 250x50 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 = 0.97

K8 Upward = 0.34    S1 Downward = 12.68    S1 Upward = 29.28

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>	0.87 Kn-m	Capacity	3.51 Kn-m	Passing Percentage	<b>403.45 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	2.41 Kn-m	Capacity	4.67 Kn-m	Passing Percentage	<b>193.78 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-1.15 Kn-m	Capacity	-2.04 Kn-m	Passing Percentage	<b>177.39 %</b>
V <sub>1.35D</sub>	0.73 Kn	Capacity	12.06 Kn	Passing Percentage	<b>1652.05 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	2.01 Kn	Capacity	16.08 Kn	Passing Percentage	<b>800.00 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-0.96 Kn	Capacity	-20.10 Kn	Passing Percentage	<b>2093.75 %</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 = 7.17 mm    Limit by AS1170.0 Table C1 Span/250 = 19.20 mm

Deflection under Dead and Service Wind = 8.36 mm    Limit by AS1170.0 Table C1 Span/120 = 40.00 mm

#### Reactions

Maximum downward = 2.01 kn    Maximum upward = -0.96 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 = 5000 mm    Internal Rafter Span = 8850 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

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M <sub>1.35D</sub>	16.52 Kn-m	Capacity	50.28 Kn-m	Passing Percentage	<b>304.36 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	45.52 Kn-m	Capacity	67.04 Kn-m	Passing Percentage	<b>147.28 %</b>
M <sub>0.9D-WnUp</sub>	-21.78 Kn-m	Capacity	-83.82 Kn-m	Passing Percentage	<b>384.85 %</b>
V <sub>1.35D</sub>	7.47 Kn	Capacity	55.22 Kn	Passing Percentage	<b>739.22 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	20.58 Kn	Capacity	73.64 Kn	Passing Percentage	<b>357.82 %</b>
V <sub>0.9D-WnUp</sub>	-9.85 Kn	Capacity	-92.04 Kn	Passing Percentage	<b>934.42 %</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 = 29.965 mm      Limit by AS1170.0 Table C1 Span/250 = 36.00 mm

Deflection under Dead and Service Wind = 38.84 mm      Limit by AS1170.0 Table C1 Span/120 = 75.00 mm

**Reactions**

Maximum downward = 20.58 kn    Maximum upward = -9.85 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 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 = 29.11 Kn > -9.85 Kn

**Rafter Design External**

External Rafter Load Width = 2500 mm      External Rafter Span = 4304 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)

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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>	1.95 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>242.05 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	5.38 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>117.10 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-2.58 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>305.04 %</b>
V <sub>1.35D</sub>	1.82 Kn	Capacity	14.47 Kn	Passing Percentage	<b>795.05 %</b>
V <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	5.00 Kn	Capacity	19.30 Kn	Passing Percentage	<b>386.00 %</b>
V <sub>0.9D-W<sub>n</sub>Up</sub>	-2.39 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>1009.21 %</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 = 6.59 mm      Limit by AS1170.0 Table C1 Span/250 = 18.00 mm

Deflection under Dead and Service Wind = 7.69 mm      Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

**Reactions**

Maximum downward = 5.00 kn    Maximum upward = -2.39 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 =  $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$  ..... (Eq 4.12) = -25.20 kn > -2.39 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.39 Kn

### Intermediate Design Front and Back

Intermediate Spacing = 2500 mm      Intermediate Span = 4050 mm      Try Intermediate 2x150x50 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 = 1.00      S1 Downward = 9.63      S1 Upward = 0.65

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>	4.61 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>102.39 %</b>
V <sub>0.9D-WnUp</sub>	4.56 Kn-m	Capacity	-24.12 Kn-m	Passing Percentage	<b>528.95 %</b>

#### Deflections

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

Deflection under Snow and Service Wind = 96.3 mm      Limit by AS1170.0 Table C1 Span/120 = 33.75 mm

#### Reactions

Maximum = 4.56 kn

### Intermediate Design Sides

Intermediate Spacing = 2250 mm      Intermediate Span = 3950 mm      Try Intermediate 2x150x50 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 = 1.00      S1 Downward = 9.63      S1 Upward = 0.64

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>	1.97 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>239.59 %</b>
V <sub>0.9D-WnUp</sub>	2.00 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	<b>1206.00 %</b>

## Deflections

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

Deflection under Snow and Service Wind = 78.405 mm      Limit by AS1170.0 Table C1 Span/120 = 32.91 mm

## Reactions

Maximum = 2.00 kn

## Middle Pole Design

### Geometry

150 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3300 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	3300 mm c/c		

### Loads

Total Area over Pole = 22.5 m<sup>2</sup>

Dead	5.63 Kn	Live	5.63 Kn
Wind	9.00 Kn	Snow	14.18 Kn
Moment wind	Kn-m	Moment snow	4.71 Kn-m
Phi	0.8	K <sub>8</sub>	0.84
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	378.83 Kn	PhiM <sub>Nx</sub> Wind	19.10 Kn-m	PhiV <sub>Nx</sub> Wind	55.77 Kn
PhiN <sub>Cx</sub> Dead	227.30 Kn	PhiM <sub>Nx</sub> Dead	11.46 Kn-m	PhiV <sub>Nx</sub> Dead	33.46 Kn
PhiN <sub>Cx</sub> Snow	303.06 Kn	PhiM <sub>Nx</sub> Snow	15.28 Kn-m	PhiV <sub>Nx</sub> Snow	44.61 Kn

#### Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.85 < 1 \text{ OK}$$

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

$$\text{Deflection at top under service lateral loads} = 39.79 \text{ mm} < 44.00 \text{ mm}$$

### **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 = 1700 mm Pile embedment length  
f1 = 3150 mm Distance at which the shear force is applied  
f2 = 0 mm Distance of top soil at rest pressure

#### Loads

Moment Wind = 14.85 Kn-m Moment Snow = Kn-m  
Shear Wind = 4.71 Kn Shear Snow = 4.71 Kn

#### Pile Properties

Safety Factory 0.55  
Hu = 9.03 Kn Ultimate Lateral Strength of the Pile, Short pile  
Mu = 17.07 Kn-m Ultimate Moment Capacity of Pile

#### Checks

$$\text{Applied Forces/Capacities} = 0.87 < 1 \text{ OK}$$

### **End Pole Design**

#### Geometry For End Bay Pole

Ds = 600 mm Pile Diameter  
L = 1350 mm Pile embedment length  
f1 = 3150 mm Distance at which the shear force is applied

$f_2 = 0$  mm Distance of top soil at rest pressure

#### Loads

Total Area over Pole = 5.625 m<sup>2</sup>

Moment Wind =	4.95 Kn-m	Moment Snow =	1.57 Kn-m
Shear Wind =	1.57 Kn	Shear Snow =	1.57 Kn

#### Pile Properties

Safety Factory	0.55		
$H_u =$	4.87 Kn	Ultimate Lateral Strength of the Pile, Short pile	
$M_u =$	9.01 Kn-m	Ultimate Moment Capacity of Pile	

#### Checks

Applied Forces/Capacities = 0.55 < 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 mm	Pile Diameter
$L =$	1350 mm	Pile embedment length
$f_1 =$	3150 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	4.95 Kn-m	Moment Snow =	1.57 Kn-m
Shear Wind =	1.57 Kn	Shear Snow =	1.57 Kn

#### Pile Properties

Safety Factory	0.55		
$H_u =$	4.87 Kn	Ultimate Lateral Strength of the Pile, Short pile	
$M_u =$	9.01 Kn-m	Ultimate Moment Capacity of Pile	



**Checks**

Applied Forces/Capacities =  $0.55 < 1$  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 (1700) x  $K_s$  (1.5) x  $\tan(30)$  x  $\pi$  x Dia of Pile (0.6) x Height of Pile (1700)

Skin Friction =  $23.34 \text{ Kn}$

Weight of Pile + Pile Skin Friction =  $28.03 \text{ Kn}$

Uplift on one Pile =  $10.01 \text{ Kn}$

Uplift is ok