



**Job No.:** EHB 248**Address:** 94 Brookdale Road, Kaka Point 9271, New Zealand**Date:** 09/07/2024**Latitude:** -46.373161**Longitude:** 169.765452**Elevation:** 35 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	1	Subsoil Category	D	Exposure Zone	C
Importance Level	2	Ultimate wind & Earthquake ARI	500 Years	Max Height	3.47 m
Wind Region	NZ2	Terrain Category	2.32	Design Wind Speed	45.28 m/s
Wind Pressure	1.23 KPa	Lee Zone	NO	Ultimate Snow ARI	150 Years
Wind Category	Very High	Earthquake ARI	500		

Note: Wind lateral loads are governing over Earthquake loads, So only wind loads are considered in calculations

**Pressure Coefficients and Pressures**

Shed Type = Gable Open

For roof  $C_{p,i} = 0.5616$

For roof  $C_{p,e}$  from 0 m To 3.47 m  $C_{p,e} = -0.9$   $p_e = -0.74$  KPa  $p_{net} = -1.25$  KPa

For roof  $C_{p,e}$  from 3.47 m To 6.94 m  $C_{p,e} = -0.5$   $p_e = -0.41$  KPa  $p_{net} = -0.92$  KPa

For wall Windward  $C_{p,i} = 0.5616$  side Wall  $C_{p,i} = -0.5771$

For wall Windward and Leeward  $C_{p,e}$  from 0 m To 12 m  $C_{p,e} = 0.7$   $p_e = 0.78$  KPa  $p_{net} = 1.49$  KPa

For side wall  $C_{p,e}$  from 0 m To 3.47 m  $C_{p,e} =$   $p_e = -0.72$  KPa  $p_{net} = -0.01$  KPa

Maximum Upward pressure used in roof member Design = 1.25 KPa

Maximum Downward pressure used in roof member Design = 0.93 KPa

Maximum Wall pressure used in Design = 1.49 KPa

Maximum Racking pressure used in Design = 1.26 KPa

**Design Summary****Purlin Design**

Purlin Spacing = 850 mm

Purlin Span = 5850 mm

Try Purlin 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 = 0.46 S1 Downward = 13.93 S1 Upward = 25.01

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

**Capacity Checks**

$M_{1.35D}$	1.23 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>383.74 %</b>
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	4.47 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>140.94 %</b>
$M_{0.9D-W_nUp}$	-3.73 Kn-m	Capacity	-3.87 Kn-m	Passing Percentage	<b>103.75 %</b>
$V_{1.35D}$	0.84 Kn	Capacity	14.47 Kn	Passing Percentage	<b>1722.62 %</b>

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V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	3.06 Kn	Capacity	19.30 Kn	Passing Percentage	<b>630.72 %</b>
V <sub>0.9D-WnUp</sub>	-2.55 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>945.88 %</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 = 9.97 mm Limit by Woolcock et al, 1999 Span/360 = 16.11 mm

Deflection under Dead and Service Wind = 16.04 mm Limit by Woolcock et al, 1999 Span/250 = 38.67 mm

**Reactions**

Maximum downward = 3.06 kn Maximum upward = -2.55 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 = 6000 mm Internal Rafter Span = 5150 mm Try Rafter 2x360x63 LVL13

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 = 5.90 S<sub>1</sub> Upward = 5.90

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>	6.71 Kn-m	Capacity	60.82 Kn-m	Passing Percentage	<b>906.41 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	24.47 Kn-m	Capacity	81.1 Kn-m	Passing Percentage	<b>331.43 %</b>
M <sub>0.9D-WnUp</sub>	-20.39 Kn-m	Capacity	-101.38 Kn-m	Passing Percentage	<b>497.20 %</b>
V <sub>1.35D</sub>	5.21 Kn	Capacity	77.32 Kn	Passing Percentage	<b>1484.07 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	19.00 Kn	Capacity	103.08 Kn	Passing Percentage	<b>542.53 %</b>
V <sub>0.9D-WnUp</sub>	-15.84 Kn	Capacity	-128.86 Kn	Passing Percentage	<b>813.51 %</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 = 3.09 mm Limit by Woolcock et al, 1999 Span/360 = 14.72 mm

Deflection under Dead and Service Wind = 5.52 mm Limit by Woolcock et al, 1999 Span/250 = 35.33 mm

**Reactions**

Maximum downward = 19.00 kn Maximum upward = -15.84 kn

**Rafter to Pole Connection check**

Bolt Size = M12 Number of Bolts = 3

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

$K_{11} = 12.6 \text{ fpj} = 22.7 \text{ Mpa}$  for Rafter with effective thickness = 126 mm

For Parallel to grain loading

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

Capacity under short term loads = 43.67 Kn > -15.84 Kn

### **Rafter Design External**

External Rafter Load Width = 3000 mm

External Rafter Span = 5137 mm

Try Rafter 360x63 LVL13

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 = 0.98

$K_8$  Upward = 0.98     $S_1$  Downward = 12.10     $S_1$  Upward = 12.10

Shear Capacity of timber = 5.3 MPa    Bending Capacity of timber = 48 MPa NZS3603 Amt 4, table 2.3

### **Capacity Checks**

$M_{1.35D}$	3.34 Kn-m	Capacity	29.91 Kn-m	Passing Percentage	<b>895.51 %</b>
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	12.17 Kn-m	Capacity	39.88 Kn-m	Passing Percentage	<b>327.69 %</b>
$M_{0.9D-W_nUp}$	-10.14 Kn-m	Capacity	-49.85 Kn-m	Passing Percentage	<b>491.62 %</b>
$V_{1.35D}$	2.60 Kn	Capacity	38.66 Kn	Passing Percentage	<b>1486.92 %</b>
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	9.48 Kn	Capacity	51.54 Kn	Passing Percentage	<b>543.67 %</b>
$V_{0.9D-W_nUp}$	-7.90 Kn	Capacity	-64.43 Kn	Passing Percentage	<b>815.57 %</b>

### **Deflections**

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

$k_2$  for Long Term Loads = 2

Deflection under Dead and Live Load = 3.43 mm

Limit by Woolcock et al, 1999 Span/360 = 14.72 mm

Deflection under Dead and Service Wind = 5.52 mm

Limit by Woolcock et al, 1999 Span/250 = 35.33 mm

### **Reactions**

Maximum downward = 9.48 kn    Maximum upward = -7.90 kn

### **Rafter to Pole Connection check**

Bolt Size = M12 Number of Bolts = 3

Calculations as per NZS 3603:1993 Amend 2005 clause 4.4

Joint Group for Rafters = J2 Joint Group for Pole = J5

Factor of Safety = 0.7

For Perpendicular to grain loading

$K_{11} = 12.6 \text{ fpj} = 22.7 \text{ Mpa}$  for Rafter with effective thickness = 63 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) = -70.12 kn > -7.90 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -7.90 Kn

### Intermediate Design Front and Back

Intermediate Spacing = 3000 mm                      Intermediate Span = 2379 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)

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

$K_8$  Upward = 1.00     $S_1$  Downward = 9.63     $S_1$  Upward = 0.50

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

#### Capacity Checks

$M_{Wind+Snow}$	3.16 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	<b>132.91 %</b>
$V_{0.9D-WnUp}$	5.32 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>453.38 %</b>

#### Deflections

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

Deflection under Snow and Service Wind = 19.69 mm                      Limit by Woolcock et al, 1999 Span/250 = 9.52 mm

#### Reactions

Maximum = 5.32 kn

### Intermediate Design Sides

Intermediate Spacing = 2650 mm                      Intermediate Span = 3085 mm                      Try Intermediate 2x250x50 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 = 0.97

$K_8$  Upward = 1.00     $S_1$  Downward = 12.68     $S_1$  Upward = 0.74

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

#### Capacity Checks

$M_{Wind+Snow}$	2.35 Kn-m	Capacity	11.66 Kn-m	Passing Percentage	<b>496.17 %</b>
$V_{0.9D-WnUp}$	3.05 Kn	Capacity	40.2 Kn	Passing Percentage	<b>1318.03 %</b>

#### Deflections

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

Deflection under Snow and Service Wind = 10.62 mm                      Limit by Woolcock et al, 1999 Span/250 = 12.34 mm

#### Reactions

Maximum = 3.05 kn

#### Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 3000 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 =0.79    S1 Downward =9.63    S1 Upward =17.59

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

#### Capacity Checks

$M_{Wind+Snow}$	2.18 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	<b>75.69 %</b>
$V_{0.9D-WnUp}$	2.91 Kn	Capacity	12.06 Kn	Passing Percentage	<b>414.43 %</b>

#### Deflections

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

Deflection under Snow and Service Wind = 30.85 mm

Limit by Woolcock et al, 1999 Span/250 = 12.00 mm

Sag during installation = 4.91 mm

#### Reactions

Maximum = 2.91 kn

#### Girt Design Sides

Girt's Spacing = 600 mm

Girt's Span = 2650 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 =1.00    S1 Downward =9.63    S1 Upward =9.54

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

#### Capacity Checks

$M_{Wind+Snow}$	0.78 Kn-m	Capacity	2.10 Kn-m	Passing Percentage	<b>269.23 %</b>
$V_{0.9D-WnUp}$	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 = 8.67 mm

Limit by Woolcock et al. 1999 Span/100 = 10.60 mm

Sag during installation =2.99 mm

#### Reactions

Maximum = 1.18 kn

## Middle Pole Design

### Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3440 mm
Area	35448 mm <sup>2</sup>	As	26585.7421875 mm <sup>2</sup>
Ix	100042702 mm <sup>4</sup>	Zx	941578 mm <sup>3</sup>
Iy	100042702 mm <sup>4</sup>	Zx	941578 mm <sup>3</sup>
Lateral Restraint	1300 mm c/c		

### Loads

Total Area over Pole = 31.8 m<sup>2</sup>

Dead	7.95 Kn	Live	7.95 Kn
Wind Down	29.57 Kn	Snow	20.03 Kn
Moment wind	8.51 Kn-m	Moment snow	2.34 Kn-m
Phi	0.8	K8	1.00
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	510.45 Kn	PhiMnx Wind	27.34 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	306.27 Kn	PhiMnx Dead	16.41 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	408.36 Kn	PhiMnx Snow	21.87 Kn-m	PhiVnx Snow	50.36 Kn

### Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.40 < 1$  OK

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

Deflection at top under service lateral loads = 15.42 mm < 22.93 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 =	2000 mm	Pile embedment length
fl =	2603 mm	Distance at which the shear force is applied

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

**Loads**

Moment Wind =	8.51 Kn-m	Moment Snow =	Kn-m
Shear Wind =	3.27 Kn	Shear Snow =	2.34 Kn

**Pile Properties**

Safety Factory	0.55		
$H_u =$	15.49 Kn	Ultimate Lateral Strength of the Pile, Short pile	
$M_u =$	25.39 Kn-m	Ultimate Moment Capacity of Pile	

**Checks**

Applied Forces/Capacities = 0.34 < 1 OK

**End Pole Design**

**Geometry For End Bay Pole**

**Geometry**

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3110 mm
Area	20729 mm <sup>2</sup>	$A_s$	15546.6796875 mm <sup>2</sup>
$I_x$	34210793 mm <sup>4</sup>	$Z_x$	421056 mm <sup>3</sup>
$I_y$	34210793 mm <sup>4</sup>	$Z_y$	421056 mm <sup>3</sup>
Lateral Restraint	mm c/c		

**Loads**

Total Area over Pole = 15.9 m<sup>2</sup>

Dead	3.98 Kn	Live	3.98 Kn
Wind Down	14.79 Kn	Snow	10.02 Kn
Moment Wind	4.26 Kn-m	Moment snow	1.17 Kn-m
$\Phi$	0.8	K8	0.71
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

**Material**

Peeling	Steaming	Normal	Dry Use
$f_b =$	36.3 MPa	$f_s =$	2.96 MPa
$f_c =$	18 MPa	$f_p =$	7.2 MPa
$f_t =$	22 MPa	E =	9257 MPa

**Capacities**

$\Phi H_{Ncx}$ Wind	212.72 Kn	$\Phi H_{Mnx}$ Wind	8.71 Kn-m	$\Phi V_{Ncx}$ Wind	36.81 Kn
$\Phi H_{Ncx}$ Dead	127.63 Kn	$\Phi H_{Mnx}$ Dead	5.23 Kn-m	$\Phi V_{Ncx}$ Dead	22.09 Kn
$\Phi H_{Ncx}$ Snow	170.18 Kn	$\Phi H_{Mnx}$ Snow	6.97 Kn-m	$\Phi V_{Ncx}$ Snow	29.45 Kn

**Checks**



$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.60 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.35 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 22.68 mm < 23.08 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	2603 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Total Area over Pole = 15.9 m<sup>2</sup>

Moment Wind =	4.26 Kn-m	Moment Snow =	1.17 Kn-m
Shear Wind =	1.64 Kn	Shear Snow =	1.17 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	5.02 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.77 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

#### 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 =	2603 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	4.26 Kn-m	Moment Snow =	1.17 Kn-m
Shear Wind =	1.64 Kn	Shear Snow =	1.17 Kn

#### Pile Properties

Safety Factory	0.55	
Hu =	5.02 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.77 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 (2000) x  $K_s$  (1.5) x  $0.5 \times \tan(30)$  x  $\pi$  x Dia of Pile (0.6) x Height of Pile (2000)

Skin Friction =  $32.31 \text{ Kn}$

Weight of Pile + Pile Skin Friction =  $37.50 \text{ Kn}$

Uplift on one Pile =  $32.59 \text{ Kn}$

Uplift is ok