



**Job No.:** GSH445**Address:** 699 Tapanui Raes Junction Highway, Kelso, New Zealand**Date:** 04/06/2024**Latitude:** -45.892004**Longitude:** 169.306701**Elevation:** 224 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	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.2 m
Wind Region	NZ2	Terrain Category	2.04	Design Wind Speed	38.1 m/s
Wind Pressure	0.87 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	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 Open

For roof  $C_{p,i} = 0.63$

For roof  $C_{p,e}$  from 0 m To 3.98 m  $C_{p,e} = -0.9$   $p_e = -0.62$  KPa  $p_{net} = -1.10$  KPa

For roof  $C_{p,e}$  from 3.98 m To 7.95 m  $C_{p,e} = -0.5$   $p_e = -0.35$  KPa  $p_{net} = -0.83$  KPa

For wall Windward  $C_{p,i} = 0.63$  side Wall  $C_{p,i} = -0.52$

For wall Windward and Leeward  $C_{p,e}$  from 0 m To 27.60 m  $C_{p,e} = 0.7$   $p_e = 0.55$  KPa  $p_{net} = 1.00$  KPa

For side wall  $C_{p,e}$  from 0 m To 3.98 m  $C_{p,e} =$   $p_e = -0.51$  KPa  $p_{net} = -0.06$  KPa

Maximum Upward pressure used in roof member Design = 1.10 KPa

Maximum Downward pressure used in roof member Design = 0.61 KPa

Maximum Wall pressure used in Design = 1 KPa

Maximum Racking pressure used in Design = 0.94 KPa

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

Purlin Spacing = 900 mm

Purlin Span = 4450 mm

Try Purlin 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 0.79 S1 Downward = 11.27 S1 Upward = 17.62

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

**Capacity Checks**

$M_{1.35D}$	0.75 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	<b>297.33 %</b>
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	2.07 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	<b>143.48 %</b>
$M_{0.9D-W_nUp}$	-1.95 Kn-m	Capacity	-2.93 Kn-m	Passing Percentage	<b>150.26 %</b>
$V_{1.35D}$	0.68 Kn	Capacity	9.65 Kn	Passing Percentage	<b>1419.12 %</b>

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V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	1.86 Kn	Capacity	12.86 Kn	Passing Percentage	<b>691.40 %</b>
V <sub>0.9D-WnUp</sub>	-1.75 Kn	Capacity	-16.08 Kn	Passing Percentage	<b>918.86 %</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 = 11.80 mm                      Limit by Woolcock et al, 1999 Span/240 = 18.33 mm

Deflection under Dead and Service Wind = 15.83 mm                      Limit by Woolcock et al, 1999 Span/100 = 44.00 mm

**Reactions**

Maximum downward = 1.86 kn    Maximum upward = -1.75 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 = 4600 mm                      Internal Rafter Span = 8550 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)

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 = 8.40    S<sub>1</sub> Upward = 8.40

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>	14.19 Kn-m	Capacity	43.44 Kn-m	Passing Percentage	<b>306.13 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	39.09 Kn-m	Capacity	57.92 Kn-m	Passing Percentage	<b>148.17 %</b>
M <sub>0.9D-WnUp</sub>	-36.78 Kn-m	Capacity	-72.42 Kn-m	Passing Percentage	<b>196.90 %</b>
V <sub>1.35D</sub>	6.64 Kn	Capacity	55.22 Kn	Passing Percentage	<b>831.63 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	18.29 Kn	Capacity	73.64 Kn	Passing Percentage	<b>402.62 %</b>
V <sub>0.9D-WnUp</sub>	-17.21 Kn	Capacity	-92.04 Kn	Passing Percentage	<b>534.81 %</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 = 24.07 mm                      Limit by Woolcock et al, 1999 Span/240 = 36.25 mm

Deflection under Dead and Service Wind = 35.88 mm                      Limit by Woolcock et al, 1999 Span/100 = 87.00 mm

**Reactions**

Maximum downward = 18.29 kn    Maximum upward = -17.21 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 = 90 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 > -17.21 Kn

### Rafter Design External

External Rafter Load Width = 2300 mm

External Rafter Span = 8512 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

$M_{1.35D}$	7.03 Kn-m	Capacity	29.91 Kn-m	Passing Percentage	<b>425.46 %</b>
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	19.37 Kn-m	Capacity	39.88 Kn-m	Passing Percentage	<b>205.89 %</b>
$M_{0.9D-W_nUp}$	-18.23 Kn-m	Capacity	-49.85 Kn-m	Passing Percentage	<b>273.45 %</b>
$V_{1.35D}$	3.30 Kn	Capacity	38.66 Kn	Passing Percentage	<b>1171.52 %</b>
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	9.10 Kn	Capacity	51.54 Kn	Passing Percentage	<b>566.37 %</b>
$V_{0.9D-W_nUp}$	-8.57 Kn	Capacity	-64.43 Kn	Passing Percentage	<b>751.81 %</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 = 19.10 mm

Limit by Woolcock et al, 1999 Span/240 = 36.25 mm

Deflection under Dead and Service Wind = 25.63 mm

Limit by Woolcock et al, 1999 Span/100 = 87.00 mm

### Reactions

Maximum downward = 9.10 kn    Maximum upward = -8.57 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 > -8.57 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -8.57 Kn

### Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4600 mm

Try Girt 200x50 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 = 1.00

$K_8$  Upward = 0.77     $S_1$  Downward = 11.27     $S_1$  Upward = 18.02

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	2.86 Kn-m	Passing Percentage	<b>120.17 %</b>
$V_{0.9D-WnUp}$	2.07 Kn	Capacity	16.08 Kn	Passing Percentage	<b>776.81 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 38.30 mm

Limit by Woolcock et al, 1999 Span/100 = 46.00 mm

Sag during installation = 27.15 mm

### Reactions

Maximum = 2.07 kn

### Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 4350 mm

Try Girt 200x50 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 = 1.00

$K_8$  Upward = 0.79     $S_1$  Downward = 11.27     $S_1$  Upward = 17.52

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

### Capacity Checks

$M_{Wind+Snow}$	2.13 Kn-m	Capacity	2.95 Kn-m	Passing Percentage	<b>138.50 %</b>
$V_{0.9D-WnUp}$	1.96 Kn	Capacity	16.08 Kn	Passing Percentage	<b>820.41 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 30.62 mm

Limit by Woolcock et al. 1999 Span/100 = 43.50 mm

Sag during installation = 21.71 mm

#### Reactions

Maximum = 1.96 kn

#### Middle Pole Design

##### Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3840 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 = 20.01 m<sup>2</sup>

Dead	5.00 Kn	Live	5.00 Kn
Wind Down	12.21 Kn	Snow	12.61 Kn
Moment wind	14.27 Kn-m	Moment snow	4.34 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

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.57 < 1$  OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.32 < 1$  OK

Deflection at top under service lateral loads = 34.91 mm < 38.40 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 =	$(1 + \sin(30)) / (1 - \sin(30))$				

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**Geometry For Middle Bay Pole**

Ds =	0.6 mm	Pile Diameter
L =	1600 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 =	14.27 Kn-m	Moment Snow =	Kn-m
Shear Wind =	4.53 Kn	Shear Snow =	4.34 Kn

**Pile Properties**

Safety Factory	0.55	
Hu =	7.68 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	14.44 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities = 0.99 < 1 OK

**End Pole Design**

**Geometry For End Bay Pole**

**Geometry**

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3840 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>	Zy	941578 mm <sup>3</sup>
Lateral Restraint	mm c/c		

**Loads**

Total Area over Pole = 20.01 m<sup>2</sup>

Dead	5.00 Kn	Live	5.00 Kn
Wind Down	12.21 Kn	Snow	12.61 Kn
Moment Wind	7.13 Kn-m	Moment snow	2.17 Kn-m
Phi	0.8	K8	0.76
K1 snow	0.8	K1 Dead	0.6
K1wind	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	390.41 Kn	PhiMnx Wind	20.91 Kn-m	PhiVnx Wind	62.96 Kn
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PhiNcx Dead	234.24 Kn	PhiMnx Dead	12.55 Kn-m	PhiVnx Dead	37.77 Kn
PhiNcx Snow	312.32 Kn	PhiMnx Snow	16.73 Kn-m	PhiVnx Snow	50.36 Kn

**Checks**

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.41 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.18 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 19.04 \text{ mm} < 41.90 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1300 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**

$$\text{Total Area over Pole} = 20.01 \text{ m}^2$$

Moment Wind =	7.13 Kn-m	Moment Snow =	2.17 Kn-m
Shear Wind =	2.26 Kn	Shear Snow =	2.17 Kn

**Pile Properties**

Safety Factory	0.55	
Hu =	4.40 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.11 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

$$\text{Applied Forces/Capacities} = 0.88 < 1 \text{ OK}$$

**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 =	3150 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

**Loads**

Moment Wind =	7.13 Kn-m	Moment Snow =	2.17 Kn-m
Shear Wind =	2.26 Kn	Shear Snow =	2.17 Kn

**Pile Properties**

Safety Factory	0.55
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Hu =	4.40 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.11 Kn-m	Ultimate Moment Capacity of Pile

#### Checks

Applied Forces/Capacities =  $0.88 < 1$  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(1600) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1600)

Skin Friction = 20.68 Kn

Weight of Pile + Pile Skin Friction = 24.83 Kn

Uplift on one Pile = 17.51 Kn

Uplift is ok