Job No.:	EHB 211-1	**Address:**	19 Norwood Street, Invercargill,New zealand	**Date:**	22/05/2024
Latitude:	-46.418876	**Longitude:**	168.39318	**Elevation:**	14 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	3.1 m
Wind Region	NZ4	Terrain Category	3.0	Design Wind Speed	38.91 m/s
Wind Pressure	0.91 KPa	Lee Zone	NO	Ultimate Snow ARI	150 Years
Wind Category	High	Earthquake ARI	500		

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

Pressure Coefficients and Pressues

Shed Type = Gable Enclosed

For roof Cp,i = -0.3

For roof CP,e from 0 m To 2.90 m Cpe = -0.9 pe = -0.74 KPa pnet = -0.74 KPa

For roof CP,e from 2.90 m To 5.80 m Cpe = -0.5 pe = -0.41 KPa pnet = -0.41 KPa

For wall Windward Cp,i = -0.3 side Wall Cp,i = -0.3

For wall Windward and Leeward CP,e from 0 m To 6.40 m Cpe = 0.7 pe = 0.57 KPa pnet = 0.84 KPa

For side wall CP,e from 0 m To 2.90 m Cpe = pe = -0.53 KPa pnet = -0.53 KPa

Maximum Upward pressure used in roof member Design = 0.74 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 0.84 KPa

Maximum Racking pressure used in Design = 0.82 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 2650 mm Try Purlin 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =0.84 S1 Downward =9.63 S1 Upward =16.37

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

Capacity Checks

$M_{1.35D}$	0.27 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	**466.67 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	0.97 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	**173.20 %**
$M_{0.9D-WnUp}$	-0.41 Kn-m	Capacity	-1.77 Kn-m	Passing Percentage	**59.20 %**
$V_{1.35D}$	0.40 Kn	Capacity	7.24 Kn	Passing Percentage	**1810.00 %**

Second page

$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.11 Kn	Capacity	9.65 Kn	Passing Percentage	**869.37 %**
$V_{0.9D-WnUp}$	-0.61 Kn	Capacity	-12.06 Kn	Passing Percentage	**1977.05 %**

Deflections

Modulus of Elasticity = 6700 MPa NZS3603 Amt 4, Table 2.3 considering at least 4 members acting together

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 3.41 mm   Limit by Woolcock et al, 1999 Span/360 = 7.22 mm
Deflection under Dead and Service Wind = 4.06 mm   Limit by Woolcock et al, 1999 Span/250 = 17.33 mm

Reactions

Maximum downward =1.11 kn   Maximum upward = -0.61 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 = 2800 mm   Internal Rafter Span = 3050 mm   Try Rafter 2x610x45 LVL11

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 =11.05   S1 Upward =11.05

Shear Capacity of timber =5 MPa   Bending Capacity of timber =38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

$M_{1.35D}$	1.10 Kn-m	Capacity	90.18 Kn-m	Passing Percentage	**8198.18 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	3.03 Kn-m	Capacity	120.24 Kn-m	Passing Percentage	**3968.32 %**
$M_{0.9D-WnUp}$	-1.68 Kn-m	Capacity	-150.28 Kn-m	Passing Percentage	**8945.24 %**
$V_{1.35D}$	1.44 Kn	Capacity	88.28 Kn	Passing Percentage	**6130.56 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	3.97 Kn	Capacity	117.7 Kn	Passing Percentage	**2964.74 %**
$V_{0.9D-WnUp}$	-2.20 Kn	Capacity	-147.14 Kn	Passing Percentage	**6688.18 %**

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 0.06 mm   Limit by Woolcock et al, 1999 Span/360 = 8.89 mm
Deflection under Dead and Service Wind = 0.08 mm   Limit by Woolcock et al, 1999 Span/250 = 21.33 mm

Reactions

Maximum downward =3.97 kn   Maximum upward = -2.20 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

K11 = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 90 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 = 29.11 Kn > -2.20 Kn

Rafter Design External

External Rafter Load Width = 1400 mm External Rafter Span = 3056 mm Try Rafter 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 =1.00 S1 Downward =11.27 S1 Upward =11.27

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

Capacity Checks

$M_{1.35D}$	0.55 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	**405.45 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.52 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	**195.39 %**
$M_{0.9D-WnUp}$	-0.84 Kn-m	Capacity	-3.72 Kn-m	Passing Percentage	**442.86 %**
$V_{1.35D}$	0.72 Kn	Capacity	9.65 Kn	Passing Percentage	**1340.28 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.99 Kn	Capacity	12.86 Kn	Passing Percentage	**646.23 %**
$V_{0.9D-WnUp}$	-1.10 Kn	Capacity	-16.08 Kn	Passing Percentage	**1461.82 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 3.19 mm	Limit by Woolcock et al, 1999 Span/360= 8.89 mm
Deflection under Dead and Service Wind = 3.80 mm	Limit by Woolcock et al, 1999 Span/250 = 21.33 mm

Reactions

Maximum downward =1.99 kn Maximum upward = -1.10 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

K11 = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

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

Eccentric Load check

V = phi x k1 x k4 x k5 x fs x b x ds .... (Eq 4.12) = -14.70 kn > -1.10 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -1.10 Kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 2800 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 =0.82 S1 Downward =9.63 S1 Upward =16.99

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

Capacity Checks

$M_{Wind+Snow}$	1.07 Kn-m	Capacity	1.71 Kn-m	Passing Percentage	**159.81 %**
$V_{0.9D-WnUp}$	1.53 Kn	Capacity	12.06 Kn	Passing Percentage	**788.24 %**

Deflections

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

Deflection under Snow and Service Wind = 16.23 mm Limit by Woolcock et al, 1999 Span/250 = 11.20 mm
Sag during installation = 3.73 mm

Reactions

Maximum = 1.53 kn

Girt Design Sides

Girt's Spacing = 600 mm Girt's Span = 3200 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 =0.76 S1 Downward =9.63 S1 Upward =18.16

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

Capacity Checks

$M_{Wind+Snow}$	0.65 Kn-m	Capacity	1.60 Kn-m	Passing Percentage	**246.15 %**
$V_{0.9D-WnUp}$	0.81 Kn	Capacity	12.06 Kn	Passing Percentage	**1488.89 %**

Deflections

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

Deflection under Snow and Service Wind = 12.78 mm Limit by Woolcock et al. 1999 Span/100 = 12.80 mm

Sag during installation =6.36 mm

Reactions

Maximum = 0.81 kn

Middle Pole Design

Geometry

175 UNI H5	Dry Use	Height	3050 mm
Area	0 mm2	As	0 mm2
Ix	0 mm4	Zx	0 mm3
Iy	0 mm4	Zx	0 mm3
Lateral Restraint	3400 mm c/c		

Loads

Total Area over Pole = 8.96 m2

Dead	2.24 Kn	Live	2.24 Kn
Wind Down	3.85 Kn	Snow	5.64 Kn
Moment wind	2.75 Kn-m	Moment snow	1.30 Kn-m
Phi	0.8	K8	0.70
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

Shaving	Steaming	Normal	Dry Use
fb =	34.325 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	20.75 MPa	E =	8793 MPa

Capacities

PhiNcx Wind	0.00 Kn	PhiMnx Wind	0.00 Kn-m	PhiVnx Wind	0.00 Kn
PhiNcx Dead	0.00 Kn	PhiMnx Dead	0.00 Kn-m	PhiVnx Dead	0.00 Kn
PhiNcx Snow	0.00 Kn	PhiMnx Snow	0.00 Kn-m	PhiVnx Snow	0.00 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = Infinity < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = Infinity < 1 OK

Deflection at top under service lateral loads = Infinity mm < 20.33 mm

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

Assumed Soil Properties

Gamma	18 Kn/m3	Friction angle	30 deg	Cohesion	0 Kn/m3
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 =	1300 mm	Pile embedment length
f1 =	2325 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	2.75 Kn-m	Moment Snow =	Kn-m
Shear Wind =	1.18 Kn	Shear Snow =	1.30 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.40 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.57 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.36 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 UNI H5	Dry Use	Height	2900 mm
Area	0 mm2	As	0 mm2
Ix	0 mm4	Zx	0 mm3
Iy	0 mm4	Zx	0 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 4.48 m2

Dead	1.12 Kn	Live	1.12 Kn
Wind Down	1.93 Kn	Snow	2.82 Kn
Moment Wind	1.38 Kn-m	Moment snow	0.65 Kn-m
Phi	0.8	K8	0.70
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

Shaving	Steaming	Normal	Dry Use
fb =	34.325 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	20.75 MPa	E =	8793 MPa

Capacities

PhiNcx Wind	0.00 Kn	PhiMnx Wind	0.00 Kn-m	PhiVnx Wind	0.00 Kn

PhiNcx Dead	0.00 Kn	PhiMnx Dead	0.00 Kn-m	PhiVnx Dead	0.00 Kn
PhiNcx Snow	0.00 Kn	PhiMnx Snow	0.00 Kn-m	PhiVnx Snow	0.00 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = Infinity < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = Infinity < 1 OK

Deflection at top under service lateral loads = Infinity mm < 20.61 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	2325 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 4.48 m2

Moment Wind =	1.38 Kn-m	Moment Snow =	0.65 Kn-m
Shear Wind =	0.59 Kn	Shear Snow =	0.65 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.40 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.57 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.18 < 1 OK

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

Assumed Soil Properties

Gamma	18 Kn/m3	Friction angle	30 deg	Cohesion	0 Kn/m3
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 =	2325 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	1.38 Kn-m	Moment Snow =	0.65 Kn-m
Shear Wind =	0.59 Kn	Shear Snow =	0.65 Kn

Pile Properties

Safety Factory	0.55

Hu =	5.40 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.57 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.18 < 1 OK

Uplift Check

Density of Concrete = 24 Kn/m3

Density of Timber Pole = 5 Kn/m3

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 = Safecty factor (0.55) x Density of Soil(18) x Height of Pile(1300) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.68 Kn

Uplift on one Pile = 4.61 Kn

Uplift is ok