Job No.: Alister Baxter   **Address:** 495 Waterholes Road, Rolleston, New Zealand   **Date:** 8/24/2022

Latitude: -43.595137   **Longitude:** 172.449093   **Elevation:** 35.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N4	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	3.8 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	38.22 m/s
Wind Pressure	0.88 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 Pressues

Shed Type = Mono   Enclosed

For roof $C_{p,i}$ = -0.3

For roof $C_{P,e}$ from 0 m To 3.40 m C_{pe} = -0.9   pe = -0.71 KPa   pnet = -0.71 KPa

For roof $C_{P,e}$ from 3.40 m To 6.80 m C_{pe} = -0.5   pe = -0.39 KPa   pnet = -0.39 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 21 m C_{pe} = 0.7   pe = 0.55 KPa   pnet = 0.81 KPa

For side wall $C_{P,e}$ from 0 m To 3.40 m C_{pe} =   pe = -0.51 KPa   pnet = -0.51 KPa

Maximum Upward pressure used in roof member Design = 0.71 KPa

Maximum Downward pressure used in roof member Design = 0.42 KPa

Maximum Wall pressure used in Design = 0.81 KPa

Maximum Racking pressure used in Design = 0.94 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm	Purlin Span = 4000 mm	Try Purlin 200x50 SG8 Dry

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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 =0.50   S1 Downward =11.27   S1 Upward =23.76

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

Capacity Checks

$M_{1.35D}$	0.61 Kn-m	Capacity	2.39 Kn-m	Passing Percentage	**391.80 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.67 Kn-m	Capacity	3.18 Kn-m	Passing Percentage	**190.42 %**
$M_{0.9D-WnUp}$	-0.87 Kn-m	Capacity	-2.01 Kn-m	Passing Percentage	**231.03 %**
$V_{1.35D}$	0.61 Kn	Capacity	9.65 Kn	Passing Percentage	**1581.97 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.67 Kn	Capacity	12.86 Kn	Passing Percentage	**770.06 %**
$V_{0.9D-WnUp}$	-0.87 Kn	Capacity	-16.08 Kn	Passing Percentage	**1848.28 %**

Deflections

Modulus of Elasticity = 8000 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 = 6.75 mm   Limit by AS1170.0 Table C1 Span/250 = 16.00 mm
Deflection under Dead and Service Wind = 7.99 mm   Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

Reactions

Maximum downward =1.67 kn   Maximum upward = -0.87 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 = 4200 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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$M_{1.35D}$	13.88 Kn-m	Capacity	50.28 Kn-m	Passing Percentage	**362.25 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	38.24 Kn-m	Capacity	67.04 Kn-m	Passing Percentage	**175.31 %**
$M_{0.9D-WnUp}$	-19.94 Kn-m	Capacity	-83.82 Kn-m	Passing Percentage	**420.36 %**
$V_{1.35D}$	6.27 Kn	Capacity	55.22 Kn	Passing Percentage	**880.70 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	17.28 Kn	Capacity	73.64 Kn	Passing Percentage	**426.16 %**
$V_{0.9D-WnUp}$	-9.01 Kn	Capacity	-92.04 Kn	Passing Percentage	**1021.53 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 25.17 mm   Limit by AS1170.0 Table C1 Span/250 = 36.00 mm

Deflection under Dead and Service Wind = 33.09 mm   Limit by AS1170.0 Table C1 Span/120 = 75.00 mm

Reactions

Maximum downward =17.28 kn   Maximum upward = -9.01 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

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 = 43.67 Kn > -9.01 Kn

Rafter Design External

External Rafter Load Width = 2100 mm   External Rafter Span = 8835 mm   Try Rafter 360x45 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 =0.81

K8 Upward =0.81   S1 Downward =17.01   S1 Upward =17.01

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

Capacity Checks

$M_{1.35D}$	6.92 Kn-m	Capacity	17.70 Kn-m	Passing Percentage	**255.78 %**
$M_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	19.06 Kn-m	Capacity	23.60 Kn-m	Passing Percentage	**123.82 %**
$M_{0.9D-WnUp}$	-9.94 Kn-m	Capacity	-29.50 Kn-m	Passing Percentage	**296.78 %**
$V_{1.35D}$	3.13 Kn	Capacity	27.61 Kn	Passing Percentage	**882.11 %**
$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	8.63 Kn	Capacity	36.82 Kn	Passing Percentage	**426.65 %**
$V_{0.9D-WnUp}$	-4.50 Kn	Capacity	-46.02 Kn	Passing Percentage	**1022.67 %**

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 27.97 mm   Limit by AS1170.0 Table C1 Span/250 = 36.00 mm
Deflection under Dead and Service Wind = 33.09 mm   Limit by AS1170.0 Table C1 Span/120 = 75.00 mm

Reactions

Maximum downward =8.63 kn   Maximum upward = -4.50 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

K11 = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

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

Eccentric Load check

$V = phi \times k1 \times k4 \times k5 \times fs \times b \times ds$ .... (Eq 4.12) = -50.09 kn > -4.50 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -4.50 Kn

Intermediate Design Sides

Intermediate Spacing = 4500 mm   Intermediate Span = 3250 mm   Try Intermediate 2x200x50 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   K4 =1   K5 =1   K8 Downward =1.00

K8 Upward =1.00   S1 Downward =11.27   S1 Upward =0.68

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

Capacity Checks

$M_{Wind+Snow}$	2.67 Kn-m	Capacity	7.98 Kn-m	Passing Percentage	**298.88 %**
$V_{0.9D-WnUp}$	3.29 Kn-m	Capacity	32.16 Kn-m	Passing Percentage	**977.51 %**

Deflections

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

Deflection under Snow and Service Wind = 31.05 mm   Limit by AS1170.0 Table C1 Span/120 = 27.08 mm

Reactions

Maximum = 3.29 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm   Girt's Span = 4200 mm   Try Intermediate 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 =0.63   S1 Downward =9.63   S1 Upward =20.81

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

Capacity Checks

$M_{Wind+Snow}$	1.16 Kn-m	Capacity	1.49 Kn-m	Passing Percentage	**128.45 %**

$V_{0.9D\text{-}WnUp}$	1.11 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	**1086.49 %**

Deflections

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

Deflection under Snow and Service Wind = 33.71 mm   Limit by AS1170.0 Table C1 Span/120 = 35.00 mm
Sag during installation = 15.80 mm

Reactions

Maximum = 1.11 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 225 dia. at Floor Level)		Dry Use		Height	3500 mm
Area		39741 mm2	As	29805.46875 mm2	
Ix		125741821 mm4	Zx	1117705 mm3	
Iy		125741821 mm4	Zx	1117705 mm3	
Lateral Restraint		1300 mm c/c			

Loads

Total Area over Pole = 18.9 m2

Dead	4.72 Kn	Live	4.72 Kn
Wind	7.94 Kn	Snow	11.91 Kn
Moment wind	Kn-m	Moment snow	3.58 Kn-m
Phi	0.8	K8	1.00
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	572.26 Kn	PhiMnx Wind	32.46 Kn-m	PhiVnx Wind	70.58 Kn

PhiNcx Dead	343.36 Kn	PhiMnx Dead	19.47 Kn-m	PhiVnx Dead	42.35 Kn
PhiNcx Snow	457.81 Kn	PhiMnx Snow	25.97 Kn-m	PhiVnx Snow	56.46 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.37 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.15 < 1 OK

Deflection at top under service lateral loads = 17.12 mm < 46.67 mm

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

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 =	600 mm	Pile Diameter
L =	1500 mm	Pile embedment length
f1 =	2850 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	10.66 Kn-m	Moment Snow =	Kn-m
Shear Wind =	3.74 Kn	Shear Snow =	3.58 Kn

Pile Properties

Safety Factory	0.55	
Hu =	6.91 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	11.80 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.90 < 1 OK

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm   Pile Diameter

L = 1500 mm   Pile embedment length

f1 = 2850 mm   Distance at which the shear force is applied

f2 = 0 mm   Distance of top soil at rest pressure

Loads

Total Area over Pole = 9.45 m2

Moment Wind =	5.33 Kn-m	Moment Snow =	1.79 Kn-m
Shear Wind =	1.87 Kn	Shear Snow =	1.79 Kn

Pile Properties

Safety Factory	0.55	
Hu =	6.91 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	11.80 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.45 < 1 OK

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

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 = 600 mm   Pile Diameter

L = 1500 mm   Pile embedment length

f1 = 2850 mm   Distance at which the shear force is applied

f2 = 0 mm   Distance of top soil at rest pressure

Loads

Moment Wind =	5.33 Kn-m	Moment Snow =	1.79 Kn-m
Shear Wind =	1.87 Kn	Shear Snow =	1.79 Kn

Pile Properties

Safety Factory   0.55

Hu =   6.91 Kn   Ultimate Lateral Strength of the Pile, Short pile

Mu =   11.80 Kn-m   Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.45 < 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(1500) x Ks(1.5) x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1500)

Skin Friction = 18.17 Kn

Weight of Pile + Pile Skin Friction = 21.83 Kn

Uplift on one Pile = 9.17 Kn

Uplift is ok

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