

Job No.: Josh Curtis
Latitude: -40.055656

Address: 37 London Street, Kimbolton, New Zealand
Longitude: 175.769564

Date: 04/04/2024
Elevation: 446.5 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N1	Ground Snow Load	0.47 KPa	Roof Snow Load	0.33 KPa
Earthquake Zone	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.6 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	44.88 m/s
Wind Pressure	1.21 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Very 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 $C_{p,i} = 0.7$

For roof $C_{p,e}$ from 0 m To 1.65 m $C_{p,e} = -0.94$ $p_e = -0.69$ KPa $p_{net} = -1.31$ KPa

For roof $C_{p,e}$ from 1.65 m To 3.30 m $C_{p,e} = -0.88$ $p_e = -0.64$ KPa $p_{net} = -1.26$ KPa

For wall Windward $C_{p,i} = 0.7$ side Wall $C_{p,i} = -0.65$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 6 m $C_{p,e} = 0.7$ $p_e = 0.76$ KPa $p_{net} = 1.42$ KPa

For side wall $C_{p,e}$ from 0 m To 3.30 m $C_{p,e} =$ $p_e = -0.71$ KPa $p_{net} = -0.05$ KPa

Maximum Upward pressure used in roof member Design = 1.31 KPa

Maximum Downward pressure used in roof member Design = 0.83 KPa

Maximum Wall pressure used in Design = 1.42 KPa

Maximum Racking pressure used in Design = 1.3 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 2850 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 = 0.82 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

$M_{1.35D}$	0.31 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	406.45 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nDn}$	1.06 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	158.49 %
$M_{0.9D-W_nUp}$	-0.99 Kn-m	Capacity	-1.71 Kn-m	Passing Percentage	172.73 %
$V_{1.35D}$	0.43 Kn	Capacity	7.24 Kn	Passing Percentage	1683.72 %
$V_{1.2D+1.5L 1.2D+S_n 1.2D+W_nDn}$	1.45 Kn	Capacity	9.65 Kn	Passing Percentage	665.52 %
$V_{0.9D-W_nUp}$	-1.39 Kn	Capacity	-12.06 Kn	Passing Percentage	867.63 %

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 = 4.59 mm

Limit by Woolcock et al, 1999 Span/240 = 11.67 mm

Deflection under Dead and Service Wind = 7.00 mm

Limit by Woolcock et al, 1999 Span/100 = 28.00 mm

Reactions

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Maximum downward = 1.45 kn Maximum upward = -1.39 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 = 3000 mm

Internal Rafter Span = 5850 mm

Try Rafter 2x300x50 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 = 6.81 S1 Upward = 6.81

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

Capacity Checks

M _{1.35D}	4.33 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	232.79 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	14.50 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	92.69 %
M _{0.9D-WnUp}	-13.92 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	120.69 %
V _{1.35D}	2.96 Kn	Capacity	28.94 Kn	Passing Percentage	977.70 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.92 Kn	Capacity	38.6 Kn	Passing Percentage	389.11 %
V _{0.9D-WnUp}	-9.52 Kn	Capacity	-48.24 Kn	Passing Percentage	506.72 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 11.25 mm

Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 19.065 mm

Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 9.92 kn Maximum upward = -9.52 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

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 14.9 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 21.67 Kn > -9.52 Kn

Rafter Design External

External Rafter Load Width = 1500 mm

External Rafter Span = 5830 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)

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

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M1.35D	2.15 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	219.53 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	7.20 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	87.50 %
M0.9D-WnUp	-6.91 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	113.89 %
V1.35D	1.48 Kn	Capacity	14.47 Kn	Passing Percentage	977.70 %
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	4.94 Kn	Capacity	19.30 Kn	Passing Percentage	390.69 %
V0.9D-WnUp	-4.74 Kn	Capacity	-24.12 Kn	Passing Percentage	508.86 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 12.50 mm

Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 19.06 mm

Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

Reactions

Maximum downward = 4.94 kn Maximum upward = -4.74 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) = -25.20 kn > -4.74 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.74 Kn

Intermediate Design Sides

Intermediate Spacing = 3000 mm

Intermediate Span = 3150 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 = 0.67

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

Capacity Checks

MWind+Snow	2.64 Kn-m	Capacity	7.46 Kn-m	Passing Percentage	282.58 %
V0.9D-WnUp	3.35 Kn	Capacity	32.16 Kn	Passing Percentage	960.00 %

Deflections

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

Deflection under Snow and Service Wind = 20.18 mm

Limit by Woolcock et al, 1999 Span/100 = 31.50 mm

Reactions

Maximum = 3.35 kn

Girt Design Front and Back

Girt's Spacing = 900 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

$M_{Wind+Snow}$	1.44 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	114.58 %
$V_{0.9D-WnUp}$	1.92 Kn	Capacity	12.06 Kn	Passing Percentage	628.13 %

Deflections

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

Deflection under Snow and Service Wind = 17.63 mm

Limit by Woolcock et al, 1999 Span/100 = 30.00 mm

Sag during installation = 4.91 mm

Reactions

Maximum = 1.92 kn

Girt Design Sides

Girt's Spacing = 900 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

$M_{Wind+Snow}$	1.44 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	114.58 %
$V_{0.9D-WnUp}$	1.92 Kn	Capacity	12.06 Kn	Passing Percentage	628.13 %

Deflections

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

Deflection under Snow and Service Wind = 17.63 mm

Limit by Woolcock et al. 1999 Span/100 = 30.00 mm

Sag during installation =4.91 mm

Reactions

Maximum = 1.92 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	27598 mm ²	As	20698.2421875 mm ²
Ix	60639381 mm ⁴	Zx	646820 mm ³
Iy	60639381 mm ⁴	Zy	646820 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 9 m²

Dead	2.25 Kn	Live	2.25 Kn
Wind Down	7.47 Kn	Snow	2.97 Kn

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Moment wind	9.45 Kn-m	Moment snow	1.27 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	397.41 Kn	PhiMnx Wind	18.78 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	238.44 Kn	PhiMnx Dead	11.27 Kn-m	PhiVnx Dead	29.41 Kn
PhiNcx Snow	317.93 Kn	PhiMnx Snow	15.03 Kn-m	PhiVnx Snow	39.21 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.53 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.28 < 1$ OK

Deflection at top under service lateral loads = 28.11 mm < 33.00 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 =	1400 mm	Pile embedment length
f1 =	2700 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	9.45 Kn-m	Moment Snow =	Kn-m
Shear Wind =	3.50 Kn	Shear Snow =	1.27 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.96 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	9.63 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.98 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	20729 mm2	As	15546.6796875 mm2
Ix	34210793 mm4	Zx	421056 mm3
Iy	34210793 mm4	Zy	421056 mm3

Lateral Restraint

mm c/c

Loads

Total Area over Pole = 9 m²

Dead	2.25 Kn	Live	2.25 Kn
Wind Down	7.47 Kn	Snow	2.97 Kn
Moment Wind	4.73 Kn-m	Moment snow	0.63 Kn-m
Phi	0.8	K8	0.66
K1 snow	0.8	K1 Dead	0.6
K1 wind	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

PhiN _c Wind	195.59 Kn	PhiM _n Wind	8.01 Kn-m	PhiV _n Wind	36.81 Kn
PhiN _c Dead	117.35 Kn	PhiM _n Dead	4.81 Kn-m	PhiV _n Dead	22.09 Kn
PhiN _c Snow	156.47 Kn	PhiM _n Snow	6.41 Kn-m	PhiV _n Snow	29.45 Kn

Checks

$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.65 < 1$ OK

$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.41 < 1$ OK

Deflection at top under service lateral loads = 27.11 mm < 35.91 mm

D _s =	0.6 mm	Pile Diameter
L =	1400 mm	Pile embedment length
f ₁ =	2700 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 = 9 m²

Moment Wind =	4.73 Kn-m	Moment Snow =	0.63 Kn-m
Shear Wind =	1.75 Kn	Shear Snow =	0.63 Kn

Pile Properties

Safety Factory	0.55	
H _u =	5.96 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	9.63 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.49 < 1 OK

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

Assumed Soil Properties

Gamma	18 Kn/m ³	Friction angle	30 deg	Cohesion	0 Kn/m ³
K ₀ =	$(1 - \sin(30)) / (1 + \sin(30))$				
K _p =	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For End Bay Pole

D _s =	0.6 mm	Pile Diameter
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L =	1400 mm	Pile embedment length
f1 =	2700 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	4.73 Kn-m	Moment Snow =	0.63 Kn-m
Shear Wind =	1.75 Kn	Shear Snow =	0.63 Kn

Pile Properties

Safety Factor	0.55	
Hu =	5.96 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	9.63 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.49 < 1$ 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 = Safety factor (0.55) x Density of Soil(18) x Height of Pile(1400) x Ks(1.5) x 0.5 x tan(30) x π x Dia of Pile(0.6) x Height of Pile(1400)

Skin Friction = 15.83 Kn

Weight of Pile + Pile Skin Friction = 19.92 Kn

Uplift on one Pile = 9.77 Kn

Uplift is ok