

Job No.: Kevin Andreassend, 2 bay
Enclosed Gable

Address: 7 Sarich Road, Te Kopuru 0391, New Zealand

Date: 30/05/2024

Latitude: -36.135455

Longitude: 173.975064

Elevation: 51 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N0	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.35 m
Wind Region	NZ1	Terrain Category	2.08	Design Wind Speed	40.61 m/s
Wind Pressure	0.99 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 = Gable Enclosed

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

For roof $C_{p,e}$ from 0 m To 3.65 m $C_{p,e} = -0.9$ $p_e = -0.78$ KPa $p_{net} = -0.78$ KPa

For roof $C_{p,e}$ from 3.65 m To 7.3 m $C_{p,e} = -0.5$ $p_e = -0.43$ KPa $p_{net} = -0.43$ 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 10 m $C_{p,e} = 0.7$ $p_e = 0.61$ KPa $p_{net} = 0.9$ KPa

For side wall $C_{p,e}$ from 0 m To 3.65 m $C_{p,e} =$ $p_e = -0.56$ KPa $p_{net} = -0.56$ KPa

Maximum Upward pressure used in roof member Design = 0.78 KPa

Maximum Downward pressure used in roof member Design = 0.46 KPa

Maximum Wall pressure used in Design = 0.90 KPa

Maximum Racking pressure used in Design = 1.04 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 5650 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 = 0.24 S1 Downward = 13.93 S1 Upward = 34.75

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

Capacity Checks

M _{1.35D}	1.21 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	390.08 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.73 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	230.77 %
M _{0.9D-W_nUp}	-1.99 Kn-m	Capacity	-2.05 Kn-m	Passing Percentage	103.02 %

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V _{1.35D}	0.86 Kn	Capacity	14.47 Kn	Passing Percentage	1682.56 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.93 Kn	Capacity	19.30 Kn	Passing Percentage	1000.00 %
V _{0.9D-WnUp}	-1.41 Kn	Capacity	-24.12 Kn	Passing Percentage	1710.64 %

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 = 9.17 mm	Limit by Woolcock et al, 1999 Span/240 = 23.33 mm
Deflection under Dead and Service Wind = 11.16 mm	Limit by Woolcock et al, 1999 Span/100 = 56.00 mm

Reactions

Maximum downward = 1.93 kn Maximum upward = -1.41 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 = 5800 mm Internal Rafter Span = 9850 mm Try Rafter 2x450x45 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 = 9.45 S₁ Upward = 9.45

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

Capacity Checks

M _{1.35D}	23.74 Kn-m	Capacity	65.4 Kn-m	Passing Percentage	275.48 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	53.46 Kn-m	Capacity	87.2 Kn-m	Passing Percentage	163.11 %
M _{0.9D-WnUp}	-39.04 Kn-m	Capacity	-109 Kn-m	Passing Percentage	279.20 %
V _{1.35D}	9.64 Kn	Capacity	69.04 Kn	Passing Percentage	716.18 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	21.71 Kn	Capacity	92.04 Kn	Passing Percentage	423.95 %
V _{0.9D-WnUp}	-15.85 Kn	Capacity	-115.06 Kn	Passing Percentage	725.93 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 27.125 mm	Limit by Woolcock et al, 1999 Span/240 = 41.67 mm
Deflection under Dead and Service Wind = 36.665 mm	Limit by Woolcock et al, 1999 Span/100 = 100.00 mm

Reactions

Maximum downward = 21.71 kn Maximum upward = -15.85 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

$K_{11} = 12.6 \text{ f}_{pj} = 22.7 \text{ Mpa}$ for Rafter with effective thickness = 90 mm

For Parallel to grain loading

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

Capacity under short term loads = 43.67 Kn > -15.85 Kn

Rafter Design External

External Rafter Load Width = 2900 mm

External Rafter Span = 9872 mm

Try Rafter 450x45 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 = 0.72

K_8 Upward = 0.72 S_1 Downward = 19.04 S_1 Upward = 19.04

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

Capacity Checks

$M_{1.35D}$	11.92 Kn-m	Capacity	23.45 Kn-m	Passing Percentage	196.73 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	26.85 Kn-m	Capacity	31.26 Kn-m	Passing Percentage	116.42 %
$M_{0.9D-W_nUp}$	-19.61 Kn-m	Capacity	-39.08 Kn-m	Passing Percentage	199.29 %
$V_{1.35D}$	4.83 Kn	Capacity	34.52 Kn	Passing Percentage	714.70 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	10.88 Kn	Capacity	46.02 Kn	Passing Percentage	422.98 %
$V_{0.9D-W_nUp}$	-7.94 Kn	Capacity	-57.53 Kn	Passing Percentage	724.56 %

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 = 30.14 mm

Limit by Woolcock et al, 1999 Span/240 = 41.67 mm

Deflection under Dead and Service Wind = 36.67 mm

Limit by Woolcock et al, 1999 Span/100 = 100.00 mm

Reactions

Maximum downward = 10.88 kn Maximum upward = -7.94 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

$K_{11} = 12.6 \text{ f}_{pj} = 22.7 \text{ Mpa}$ for Rafter with effective thickness = 45 mm

For Parallel to grain loading

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

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -65.11 kn > -7.94 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -7.94 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2900 mm

Intermediate Span = 2599 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)

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

K_8 Upward = 1.00 S_1 Downward = 11.27 S_1 Upward = 0.61

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

Capacity Checks

$M_{\text{Wind+Snow}}$	2.20 Kn-m	Capacity	7.46 Kn-m	Passing Percentage	339.09 %
$V_{0.9D-WnUp}$	3.39 Kn	Capacity	-32.16 Kn	Passing Percentage	948.67 %

Deflections

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

Deflection under Snow and Service Wind = 4.31 mm

Limit by Woolcock et al, 1999 Span/100 = 25.99 mm

Reactions

Maximum = 3.39 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2900 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 = 0.66 S_1 Downward = 11.27 S_1 Upward = 20.23

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

Capacity Checks

$M_{\text{Wind+Snow}}$	1.23 Kn-m	Capacity	2.46 Kn-m	Passing Percentage	200.00 %
$V_{0.9D-WnUp}$	1.70 Kn	Capacity	16.08 Kn	Passing Percentage	945.88 %

Deflections

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

Deflection under Snow and Service Wind = 4.82 mm

Limit by Woolcock et al, 1999 Span/100 = 29.00 mm

Sag during installation = 4.29 mm

Reactions

Maximum = 1.70 kn

Girt Design Sides

Girt's Spacing = 0 mm

Girt's Span = 5000 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)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =0.41 S1 Downward =11.27 S1 Upward =26.57

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

Capacity Checks

M _{Wind+Snow}	0.00 Kn-m	Capacity	1.53 Kn-m	Passing Percentage	Infinity %
V _{0.9D-WnUp}	0.00 Kn	Capacity	16.08 Kn	Passing Percentage	Infinity %

Deflections

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

Deflection under Snow and Service Wind = 0.00 mm

Limit by Woolcock et al. 1999 Span/100 = 50.00 mm

Sag during installation =37.90 mm

Reactions

Maximum = 0.00 kn

Middle Pole Design

Geometry

225 SED H5 (Minimum 250 dia. at Floor Level)	Dry Use	Height	2900 mm
Area	44279 mm ²	As	33209.1796875 mm ²
I _x	156100441 mm ⁴	Z _x	1314530 mm ³
I _y	156100441 mm ⁴	Z _y	1314530 mm ³
Lateral Restraint	3400 mm c/c		

Loads

Total Area over Pole = 29 m²

Dead	7.25 Kn	Live	7.25 Kn
Wind Down	13.34 Kn	Snow	0.00 Kn
Moment wind	12.66 Kn-m		
Phi	0.8	K8	0.92
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

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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

PhiNcx Wind	589.62 Kn	PhiMnx Wind	35.30 Kn-m	PhiVnx Wind	78.64 Kn
PhiNcx Dead	353.77 Kn	PhiMnx Dead	21.18 Kn-m	PhiVnx Dead	47.18 Kn

Checks

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

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

Deflection at top under service lateral loads = 11.96 mm < 29.00 mm

Drained Lateral Strength of Middle 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 Middle Bay Pole

$D_s =$	0.6 mm	Pile Diameter
$L =$	1600 mm	Pile embedment length
$f_1 =$	2513 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	12.66 Kn-m
Shear Wind =	5.04 Kn

Pile Properties

Safety Factory	0.55	
$H_u =$	8.87 Kn	Ultimate Lateral Strength of the Pile, Short pile
$M_u =$	13.66 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.93 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	2900 mm
Area	35448 mm ²	A_s	26585.7421875 mm ²

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Ix	100042702 mm ⁴	Zx	941578 mm ³
Iy	100042702 mm ⁴	Zy	941578 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 29 m²

Dead	7.25 Kn	Live	7.25 Kn
Wind Down	13.34 Kn	Snow	0.00 Kn
Moment Wind	6.33 Kn-m		
Phi	0.8	K8	0.95
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 _{cx} Wind	483.02 Kn	PhiM _{nx} Wind	25.87 Kn-m	PhiV _{nx} Wind	62.96 Kn
PhiN _{cx} Dead	289.81 Kn	PhiM _{nx} Dead	15.52 Kn-m	PhiV _{nx} Dead	37.77 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.30 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.12 < 1$ OK

Deflection at top under service lateral loads = 10.75 mm < 33.42 mm

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	2513 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 = 29 m²

Moment Wind =	6.33 Kn-m
Shear Wind =	2.52 Kn

Pile Properties

Safety Factory	0.55	
H _u =	5.13 Kn	Ultimate Lateral Strength of the Pile, Short pile
M _u =	7.71 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.82 < 1$ 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
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 =	2513 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	6.33 Kn-m
Shear Wind =	2.52 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.13 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	7.71 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.82 < 1$ 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 (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 = 24.34 Kn

Uplift on one Pile = 16.10 Kn

Uplift is ok