

Job No.: Andrew Griffiths**Address:** 96 Jones Road, Grovetown, Blenheim 7273, New Zealand**Date:** 31/10/2024**Latitude:** -41.495912**Longitude:** 173.992544**Elevation:** 2 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N3	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	7 m
Wind Region	NZ2	Terrain Category	1.0	Design Wind Speed	42.77 m/s
Wind Pressure	1.1 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 5.6 m $C_{p,e} = -0.9$ $p_e = -0.89$ KPa $p_{net} = -0.89$ KPa

For roof $C_{p,e}$ from 5.6 m To 11.2 m $C_{p,e} = -0.5$ $p_e = -0.49$ KPa $p_{net} = -0.49$ 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 $C_{p,e} = 0.7$ $p_e = 0.69$ KPa $p_{net} = 1.02$ KPa

For side wall $C_{p,e}$ from 0 m To 5.6 m $C_{p,e} =$ $p_e = -0.64$ KPa $p_{net} = -0.64$ KPa

Maximum Upward pressure used in roof member Design = 0.89 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 1.02 KPa

Maximum Racking pressure used in Design = 1.18 KPa

Design Summary**Purlin Design**

Purlin Spacing = 900 mm

Purlin Span = 4350 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 = 0.47 S1 Downward = 11.27 S1 Upward = 24.64

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

Capacity Checks

$M_{1.35D}$	0.72 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	309.72 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	1.83 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	162.30 %
$M_{0.9D-W_nUp}$	-1.42 Kn-m	Capacity	-1.76 Kn-m	Passing Percentage	123.94 %
$V_{1.35D}$	0.66 Kn	Capacity	9.65 Kn	Passing Percentage	1462.12 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.43 Kn	Capacity	12.86 Kn	Passing Percentage	899.30 %
V _{0.9D-WnUp}	-1.30 Kn	Capacity	-16.08 Kn	Passing Percentage	1236.92 %

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 = 10.76 mm Limit by Woolcock et al, 1999 Span/240 = 17.92 mm

Deflection under Dead and Service Wind = 12.83 mm Limit by Woolcock et al, 1999 Span/100 = 43.00 mm

Reactions

Maximum downward = 1.43 kn Maximum upward = -1.30 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 = 4500 mm Internal Rafter Span = 9850 mm Try Rafter 2x400x63 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 = 6.26 S₁ Upward = 6.26

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

Capacity Checks

M _{1.35D}	18.42 Kn-m	Capacity	58.42 Kn-m	Passing Percentage	317.16 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	39.84 Kn-m	Capacity	77.88 Kn-m	Passing Percentage	195.48 %
M _{0.9D-WnUp}	-36.29 Kn-m	Capacity	-97.36 Kn-m	Passing Percentage	268.28 %
V _{1.35D}	7.48 Kn	Capacity	81.04 Kn	Passing Percentage	1083.42 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	16.18 Kn	Capacity	108.06 Kn	Passing Percentage	667.86 %
V _{0.9D-WnUp}	-14.74 Kn	Capacity	-135.08 Kn	Passing Percentage	916.42 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 23.78 mm Limit by Woolcock et al, 1999 Span/240 = 41.67 mm

Deflection under Dead and Service Wind = 31.485 mm Limit by Woolcock et al, 1999 Span/100 = 100.00 mm

Reactions

Maximum downward = 16.18 kn Maximum upward = -14.74 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

$K_{11} = 12.6$ fpj = 22.7 Mpa for Rafter with effective thickness = 126 mm

For Parallel to grain loading

$K_{11} = 2.0$ fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 43.67 Kn > -14.74 Kn

Rafter Design External

External Rafter Load Width = 2250 mm

External Rafter Span = 5531 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)

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 = 0.94

K_8 Upward = 0.94 S_1 Downward = 13.93 S_1 Upward = 13.93

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

Capacity Checks

$M_{1.35D}$	2.90 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	162.76 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	6.28 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	100.32 %
$M_{0.9D-W_nUp}$	-5.72 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	137.59 %
$V_{1.35D}$	2.10 Kn	Capacity	14.47 Kn	Passing Percentage	689.05 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.54 Kn	Capacity	19.30 Kn	Passing Percentage	425.11 %
$V_{0.9D-W_nUp}$	-4.14 Kn	Capacity	-24.12 Kn	Passing Percentage	582.61 %

Deflections

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

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 9.04 mm

Limit by Woolcock et al, 1999 Span/240 = 20.83 mm

Deflection under Dead and Service Wind = 10.78 mm

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

Reactions

Maximum downward = 4.54 kn Maximum upward = -4.14 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

$K_{11} = 14.9$ fpj = 12.9 Mpa for Rafter with effective thickness = 50 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) = -25.20 kn > -4.14 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.14 Kn

Intermediate Design Sides

Intermediate Spacing = 2500 mm

Intermediate Span = 5450 mm

Try Intermediate 2x300x50 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 = 0.94

K_8 Upward = 1.00 S_1 Downward = 13.93 S_1 Upward = 1.08

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

Capacity Checks

$M_{Wind+Snow}$	4.73 Kn-m	Capacity	16.8 Kn-m	Passing Percentage	355.18 %
$V_{0.9D-WnUp}$	3.47 Kn	Capacity	48.24 Kn	Passing Percentage	1390.20 %

Deflections

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

Deflection under Snow and Service Wind = 24.11 mm

Limit by Woolcock et al, 1999 Span/100 = 54.50 mm

Reactions

Maximum = 3.47 kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4500 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 = 0.78 S_1 Downward = 11.27 S_1 Upward = 17.82

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

Capacity Checks

$M_{Wind+Snow}$	2.32 Kn-m	Capacity	2.90 Kn-m	Passing Percentage	125.00 %
$V_{0.9D-WnUp}$	2.07 Kn	Capacity	16.08 Kn	Passing Percentage	776.81 %

Deflections

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

Deflection under Snow and Service Wind = 21.95 mm

Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Sag during installation = 24.86 mm

Reactions

Maximum = 2.07 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2500 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 =0.73 S1 Downward =11.27 S1 Upward =18.79

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

Capacity Checks

M _{Wind+Snow}	1.04 Kn-m	Capacity	2.72 Kn-m	Passing Percentage	261.54 %
V _{0.9D-WnUp}	1.66 Kn	Capacity	16.08 Kn	Passing Percentage	968.67 %

Deflections

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

Deflection under Snow and Service Wind = 3.02 mm

Limit by Woolcock et al. 1999 Span/100 = 25.00 mm

Sag during installation =2.37 mm

Reactions

Maximum = 1.66 kn

End Pole Design

Geometry For End Bay Pole

Geometry

275 SED H5 (Minimum 300 dia. at Floor Level)	Dry Use	Height	6700 mm
Area	64885 mm ²	As	48663.8671875 mm ²
I _x	335197731 mm ⁴	Z _x	2331810 mm ³
I _y	335197731 mm ⁴	Z _y	2331810 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 11.25 m²

Dead	2.81 Kn	Live	2.81 Kn
Wind Down	4.84 Kn	Snow	0.00 Kn
Moment Wind	16.22 Kn-m		
Phi	0.8	K8	0.52
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	485.78 Kn	PhiMnx Wind	35.21 Kn-m	PhiVnx Wind	115.24 Kn
PhiNcx Dead	291.47 Kn	PhiMnx Dead	21.12 Kn-m	PhiVnx Dead	69.14 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.48 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.23 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 35.90 \text{ mm} < 69.83 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1500 mm	Pile embedment length
f1 =	5250 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

$$\text{Total Area over Pole} = 11.25 \text{ m}^2$$

Moment Wind =	16.22 Kn-m
Shear Wind =	3.09 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.46 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	13.36 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 1.21 < 1 \text{ OK}$$

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 =	1500 mm	Pile embedment length
f1 =	5250 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

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Moment Wind = 16.22 Kn-m
Shear Wind = 3.09 Kn

Pile Properties

Safety Factor	0.55	
Hu =	4.46 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	13.36 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 1.21 < 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(1800) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1800)

Skin Friction = 26.17 Kn

Weight of Pile + Pile Skin Friction = 28.89 Kn

Uplift on one Pile = 14.96 Kn

Uplift is ok