

Job No.: Bryan Eagles**Address:** 621 Kelvin Grove Road, Kelvin Grove, New Zealand**Date:** 29/07/2024**Latitude:** -40.308269**Longitude:** 175.676912**Elevation:** 90 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 KPa	Roof Snow Load	0 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 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	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 4.50 m $C_{p,e} = -0.9$ $p_e = -0.71$ KPa $p_{net} = -0.71$ KPa

For roof $C_{p,e}$ from 4.50 m To 9.0 m $C_{p,e} = -0.5$ $p_e = -0.39$ KPa $p_{net} = -0.39$ 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 16.80 m $C_{p,e} = 0.7$ $p_e = 0.55$ KPa $p_{net} = 0.81$ KPa

For side wall $C_{p,e}$ from 0 m To 4.50 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = -0.51$ 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 = 0.79 KPa

Design Summary**Purlin Design**

Purlin Spacing = 900 mm

Purlin Span = 4050 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 = 0.50 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

$M_{1.35D}$	0.62 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	359.68 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	1.67 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	177.84 %
$M_{0.9D-W_nUp}$	-0.89 Kn-m	Capacity	-1.87 Kn-m	Passing Percentage	233.75 %
$V_{1.35D}$	0.62 Kn	Capacity	9.65 Kn	Passing Percentage	1556.45 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.31 Kn	Capacity	12.86 Kn	Passing Percentage	981.68 %
V _{0.9D-WnUp}	-0.88 Kn	Capacity	-16.08 Kn	Passing Percentage	1827.27 %

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 = 8.06 mm	Limit by Woolcock et al, 1999 Span/240 = 16.67 mm
Deflection under Dead and Service Wind = 9.54 mm	Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 1.31 kn Maximum upward = -0.88 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 = 9850 mm Try Rafter 2x360x63 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 = 5.90 S₁ Upward = 5.90

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

Capacity Checks

M _{1.35D}	17.19 Kn-m	Capacity	48.16 Kn-m	Passing Percentage	280.16 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	36.67 Kn-m	Capacity	64.2 Kn-m	Passing Percentage	175.07 %
M _{0.9D-WnUp}	-24.70 Kn-m	Capacity	-80.26 Kn-m	Passing Percentage	324.94 %
V _{1.35D}	6.98 Kn	Capacity	72.94 Kn	Passing Percentage	1044.99 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	14.89 Kn	Capacity	97.26 Kn	Passing Percentage	653.19 %
V _{0.9D-WnUp}	-10.03 Kn	Capacity	-121.56 Kn	Passing Percentage	1211.96 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 30.445 mm	Limit by Woolcock et al, 1999 Span/240 = 41.67 mm
Deflection under Dead and Service Wind = 40.03 mm	Limit by Woolcock et al, 1999 Span/100 = 100.00 mm

Reactions

Maximum downward = 14.89 kn Maximum upward = -10.03 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

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

For Parallel to grain loading

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

Capacity under short term loads = 29.11 Kn > -10.03 Kn

Rafter Design External

External Rafter Load Width = 2100 mm

External Rafter Span = 9998 mm

Try Rafter 360x63 LVL11

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 = 0.98

K_8 Upward = 0.98 S_1 Downward = 12.10 S_1 Upward = 12.10

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

Capacity Checks

$M_{1.35D}$	8.86 Kn-m	Capacity	23.68 Kn-m	Passing Percentage	267.27 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	18.89 Kn-m	Capacity	31.57 Kn-m	Passing Percentage	167.13 %
$M_{0.9D-W_nUp}$	-12.73 Kn-m	Capacity	-39.46 Kn-m	Passing Percentage	309.98 %
$V_{1.35D}$	3.54 Kn	Capacity	36.47 Kn	Passing Percentage	1030.23 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	7.56 Kn	Capacity	48.63 Kn	Passing Percentage	643.25 %
$V_{0.9D-W_nUp}$	-5.09 Kn	Capacity	-60.78 Kn	Passing Percentage	1194.11 %

Deflections

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

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 33.83 mm

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

Deflection under Dead and Service Wind = 40.03 mm

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

Reactions

Maximum downward = 7.56 kn Maximum upward = -5.09 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

$K_{11} = 12.6 \text{ fpj} = 22.7 \text{ Mpa}$ for Rafter with effective thickness = 63 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

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -66.15 kn > -5.09 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -5.09 Kn

Girt Design Front and Back

Girt's Spacing = 700 mm

Girt's Span = 4200 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)

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

K_8 Upward = 0.63 S_1 Downward = 9.63 S_1 Upward = 20.81

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

Capacity Checks

$M_{Wind+Snow}$	1.25 Kn-m	Capacity	1.32 Kn-m	Passing Percentage	105.60 %
$V_{0.9D-WnUp}$	1.19 Kn	Capacity	12.06 Kn	Passing Percentage	1013.45 %

Deflections

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

Deflection under Snow and Service Wind = 24.38 mm

Limit by Woolcock et al, 1999 Span/100 = 42.00 mm

Sag during installation = 18.87 mm

Reactions

Maximum = 1.19 kn

Girt Design Sides

Girt's Spacing = 700 mm

Girt's Span = 5000 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)

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

K_8 Upward = 0.54 S_1 Downward = 9.63 S_1 Upward = 22.70

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

Capacity Checks

$M_{Wind+Snow}$	1.77 Kn-m	Capacity	1.14 Kn-m	Passing Percentage	64.41 %
$V_{0.9D-WnUp}$	1.42 Kn	Capacity	12.06 Kn	Passing Percentage	849.30 %

Deflections

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

Deflection under Snow and Service Wind = 48.97 mm

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

Sag during installation = 37.90 mm

Reactions

Maximum = 1.42 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3640 mm
Area	27598 mm ²	As	20698.2421875 mm ²
Ix	60639381 mm ⁴	Zx	646820 mm ³
Iy	60639381 mm ⁴	Zx	646820 mm ³
Lateral Restraint	3640 mm c/c		

Loads

Total Area over Pole = 21 m²

Dead	5.25 Kn	Live	5.25 Kn
Wind Down	8.82 Kn	Snow	0.00 Kn
Moment wind	9.93 Kn-m		
Phi	0.8	K8	0.70
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	277.72 Kn	PhiMnx Wind	13.13 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	166.63 Kn	PhiMnx Dead	7.88 Kn-m	PhiVnx Dead	29.41 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.83 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.64 < 1$ OK

Deflection at top under service lateral loads = 36.19 mm < 36.40 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
K0 =	$(1 - \sin(30)) / (1 + \sin(30))$				
Kp =	$(1 + \sin(30)) / (1 - \sin(30))$				

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Geometry For Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1450 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	9.93 Kn-m
Shear Wind =	3.31 Kn

Pile Properties

Safety Factory	0.55	
Hu =	6.10 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	10.87 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.91 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3800 mm
Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zy	421056 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 21 m²

Dead	5.25 Kn	Live	5.25 Kn
Wind Down	8.82 Kn	Snow	0.00 Kn
Moment Wind	4.96 Kn-m		
Phi	0.8	K8	0.52
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	154.24 Kn	PhiMnx Wind	6.32 Kn-m	PhiVnx Wind	36.81 Kn
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PhiNcx Dead	92.55 Kn	PhiMnx Dead	3.79 Kn-m	PhiVnx Dead	22.09 Kn
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Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.91 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.74 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 35.15 mm < 39.90 mm

Ds =	0.6 mm	Pile Diameter
L =	1450 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 21 m²

Moment Wind =	4.96 Kn-m
Shear Wind =	1.65 Kn

Pile Properties

Safety Factory	0.55	
Hu =	6.10 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	10.87 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.46 < 1 \text{ OK}$$

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 =	1450 mm	Pile embedment length
f1 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	4.96 Kn-m
Shear Wind =	1.65 Kn

Pile Properties

Safety Factory	0.55	
Hu =	6.10 Kn	Ultimate Lateral Strength of the Pile, Short pile

Mu = 10.87 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.46 < 1$ 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 (1450) x Ks (1.5) x $0.5 \times \tan(30)$ x π x Dia of Pile (0.6) x Height of Pile (1450)

Skin Friction = 16.98 Kn

Weight of Pile + Pile Skin Friction = 21.22 Kn

Uplift on one Pile = 10.19 Kn

Uplift is ok