

Job No.: EHB 128

Address: 57 Blackmore Road, Garston, New Zealand

Date: 11/01/2024

Latitude: -45.474083

Longitude: 168.68633

Elevation: 326 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N5	Ground Snow Load	0.95 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	7.9 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	41.27 m/s
Wind Pressure	1.02 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 = Mono Open

For roof $C_{p,i} = 0.6722$

For roof $C_{p,e}$ from 0 m To 15.85 m $C_{p,e} = -0.6948$ $p_e = -0.64$ KPa $p_{net} = -1.39$ KPa

For roof $C_{p,e}$ from m To m $C_{p,e} =$ $p_e =$ KPa $p_{net} =$ KPa

For wall Windward $C_{p,i} = 0.6722$ side Wall $C_{p,i} = -0.5984$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 5 m $C_{p,e} = 0.7$ $p_e = 0.64$ KPa $p_{net} = 1.30$ KPa

For side wall $C_{p,e}$ from 0 m To 5 m $C_{p,e} =$ $p_e = 0.64$ KPa $p_{net} = 1.30$ KPa

Maximum Upward pressure used in roof member Design = 1.39 KPa

Maximum Downward pressure used in roof member Design = 0.39 KPa

Maximum Wall pressure used in Design = 0.3 KPa

Maximum Racking pressure used in Design = 0.92 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 4850 mm

Try Purlin 250x50 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 = 0.97

K8 Upward = 0.64 S1 Downward = 12.68 S1 Upward = 20.70

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

Capacity Checks

$M_{1.35D}$	0.89 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	382.02 %
$M_{1.2D+1.5L\ 1.2D+S_n\ 1.2D+W_nDn}$	2.46 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	184.15 %
$M_{0.9D-W_nUp}$	-3.08 Kn-m	Capacity	-3.71 Kn-m	Passing Percentage	553.73 %

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V _{1.35D}	0.74 Kn	Capacity	12.06 Kn	Passing Percentage	1629.73 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	2.03 Kn	Capacity	16.08 Kn	Passing Percentage	792.12 %
V _{0.9D-WnUp}	-2.54 Kn	Capacity	-20.10 Kn	Passing Percentage	791.34 %

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 = 8.56 mm	Limit by Woolcock et al, 1999 Span/240 = 20.00 mm
Deflection under Dead and Service Wind = 9.91 mm	Limit by Woolcock et al, 1999 Span/100 = 48.00 mm

Reactions

Maximum downward = 2.03 kn Maximum upward = -2.54 kn

Number of Blocking = 1 if 0 then no blocking required, if 1 then one midspan blocking required

Rafter Design External

External Rafter Load Width = 2500 mm External Rafter Span = 5963 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

M _{1.35D}	3.75 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	125.87 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.33 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	60.99 %
M _{0.9D-WnUp}	-12.95 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	60.77 %
V _{1.35D}	2.52 Kn	Capacity	14.47 Kn	Passing Percentage	574.21 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	6.93 Kn	Capacity	19.30 Kn	Passing Percentage	278.50 %
V _{0.9D-WnUp}	-8.68 Kn	Capacity	-24.12 Kn	Passing Percentage	277.88 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 20.59 mm	Limit by Woolcock et al, 1999 Span/240 = 24.93 mm
Deflection under Dead and Service Wind = 23.85 mm	Limit by Woolcock et al, 1999 Span/100 = 59.83 mm

Reactions

Maximum downward = 6.93 kn Maximum upward = -8.68 kn

Rafter to Pole Connection check

Bolt Size = M16 Number of Bolts = 1

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

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

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$ (Eq 4.12) = -23.10 kn > -8.68 Kn

Single Shear Capacity under short term loads = -7.22 Kn > -8.68 Kn

Intermediate Design Sides

Intermediate Spacing = 2991.2911775842485 mm Intermediate Span = 7261 mm Try Intermediate 2x250x50 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 = 0.97

K_8 Upward = 1.00 S_1 Downward = 12.68 S_1 Upward = 1.14

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

Capacity Checks

$M_{Wind+Snow}$	9.36 Kn-m	Capacity	11.66 Kn-m	Passing Percentage	124.57 %
$V_{0.9D-WnUp}$	5.16 Kn-m	Capacity	40.2 Kn-m	Passing Percentage	779.07 %

Deflections

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

Deflection under Snow and Service Wind = 192.495 mm Limit by Woolcock et al, 1999 Span/100 = 72.61 mm

Reactions

Maximum = 5.16 kn

Girt Design Front and Back

Girt's Spacing = 700 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)

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

K_8 Upward = 0.41 S_1 Downward = 11.27 S_1 Upward = 26.57

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

Capacity Checks

$M_{Wind+Snow}$	1.38 Kn-m	Capacity	1.53 Kn-m	Passing Percentage	110.87 %
$V_{0.9D-WnUp}$	1.10 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	1461.82 %

Deflections

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

Deflection under Snow and Service Wind = 23.72 mm

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

Sag during installation = 37.90 mm

Reactions

Maximum = 1.10 kn

Girt Design Sides

Girt's Spacing = 700 mm

Girt's Span = 2991 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 =0.64 S1 Downward =11.27 S1 Upward =20.55

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

Capacity Checks

M _{Wind+Snow}	0.49 Kn-m	Capacity	2.40 Kn-m	Passing Percentage	489.80 %
V _{0.9D-WnUp}	0.66 Kn-m	Capacity	16.08 Kn-m	Passing Percentage	2436.36 %

Deflections

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

Deflection under Snow and Service Wind = 3.04 mm

Limit by Woolcock et al. 1999 Span/100 = 29.91 mm

Sag during installation =4.85 mm

Reactions

Maximum = 0.66 kn

End Pole Design

Geometry For End Bay Pole

Geometry

250 SED H5 (Minimum 275 dia. at Floor Level)	Dry Use	Height	7600 mm
Area	54091 mm ²	As	40568.5546875 mm ²
I _x	232952248 mm ⁴	Z _x	1774874 mm ³
I _y	232952248 mm ⁴	Z _y	1774874 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 14.956455887921242 m²

Dead	3.74 Kn	Live	3.74 Kn
Wind Down	5.83 Kn	Snow	9.42 Kn

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Moment Wind	14.75 Kn-m	Moment snow	2.57 Kn-m
Phi	0.8	K8	0.35
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	270.66 Kn	PhiMnx Wind	17.91 Kn-m	PhiVnx Wind	96.07 Kn
PhiNcx Dead	162.39 Kn	PhiMnx Dead	10.75 Kn-m	PhiVnx Dead	57.64 Kn
PhiNcx Snow	216.52 Kn	PhiMnx Snow	14.33 Kn-m	PhiVnx Snow	76.85 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.89 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.75 < 1$ OK

Deflection at top under service lateral loads = 59.82 mm < 78.80 mm

Ds =	0.6 mm	Pile Diameter
L =	1550 mm	Pile embedment length
f1 =	5925 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 14.956455887921242 m²

Moment Wind =	14.75 Kn-m	Moment Snow =	2.57 Kn-m
Shear Wind =	2.49 Kn	Shear Snow =	2.57 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.44 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	14.96 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.99 < 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 =	1550 mm	Pile embedment length
f1 =	5925 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	14.75 Kn-m	Moment Snow =	2.57 Kn-m
Shear Wind =	2.49 Kn	Shear Snow =	2.57 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.44 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	14.96 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.99 < 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(2701) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(2701)

Skin Friction = 58.92 Kn

Weight of Pile + Pile Skin Friction = 65.11 Kn

Uplift on one Pile = 46.02 Kn

Uplift is ok