

Job No.: 224 2898465**Address:****Date:** 13/04/2024**Latitude:** -43.382189**Longitude:** 172.381231**Elevation:** 112 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N4	Ground Snow Load	0.9 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	3.8 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	39.38 m/s
Wind Pressure	0.93 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 $C_{p,i} = 0.6423$

For roof $C_{p,e}$ from 0 m To 3.50 m $C_{p,e} = -0.9$ $p_e = 0.63$ KPa $p_{net} = -1.17$ KPa

For roof $C_{p,e}$ from 3.50 m To 7 m $C_{p,e} = -0.5$ $p_e = -0.35$ KPa $p_{net} = -0.89$ KPa

For wall Windward $C_{p,i} = 0.6423$ side Wall $C_{p,i} = -0.5428$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 24 m $C_{p,e} = 0.7$ $p_e = 0.59$ KPa $p_{net} = 1.14$ KPa

For side wall $C_{p,e}$ from 0 m To 3.5 m $C_{p,e} =$ $p_e = -0.54$ KPa $p_{net} = 0.01$ KPa

Maximum Upward pressure used in roof member Design = 1.17 KPa

Maximum Downward pressure used in roof member Design = 0.72 KPa

Maximum Wall pressure used in Design = 1.14 KPa

Maximum Racking pressure used in Design = 1.01 KPa

Design Summary**Purlin Design**

Purlin Spacing = 800 mm

Purlin Span = 4650 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 = 0.77 S1 Downward = 11.27 S1 Upward = 18.02

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

Capacity Checks

$M_{1.35D}$	0.73 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	305.48 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	2.21 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	134.39 %
$M_{0.9D-W_nUp}$	-2.04 Kn-m	Capacity	-2.86 Kn-m	Passing Percentage	140.20 %
$V_{1.35D}$	0.63 Kn	Capacity	9.65 Kn	Passing Percentage	1531.75 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.90 Kn	Capacity	12.86 Kn	Passing Percentage	676.84 %
V _{0.9D-WnUp}	-1.76 Kn	Capacity	-16.08 Kn	Passing Percentage	913.64 %

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 = 12.53 mm Limit by Woolcock et al, 1999 Span/240 = 19.17 mm

Deflection under Dead and Service Wind = 17.96 mm Limit by Woolcock et al, 1999 Span/100 = 46.00 mm

Reactions

Maximum downward = 1.90 kn Maximum upward = -1.76 kn

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

Rafter Design Internal

Internal Rafter Load Width = 4800 mm Internal Rafter Span = 4350 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}	3.83 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	263.19 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	11.58 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	116.06 %
M _{0.9D-WnUp}	-10.73 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	156.57 %
V _{1.35D}	3.52 Kn	Capacity	28.94 Kn	Passing Percentage	822.16 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.65 Kn	Capacity	38.6 Kn	Passing Percentage	362.44 %
V _{0.9D-WnUp}	-9.87 Kn	Capacity	-48.24 Kn	Passing Percentage	488.75 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.695 mm Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 9.07 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward = 10.65 kn Maximum upward = -9.87 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

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

Capacity under short term loads = 21.67 Kn > -9.87 Kn

Rafter Design External

External Rafter Load Width = 2400 mm

External Rafter Span = 4310 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

$M_{1.35D}$	1.88 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	251.06 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	5.68 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	110.92 %
$M_{0.9D-W_nUp}$	-5.27 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	149.34 %
$V_{1.35D}$	1.75 Kn	Capacity	14.47 Kn	Passing Percentage	826.86 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	5.28 Kn	Capacity	19.30 Kn	Passing Percentage	365.53 %
$V_{0.9D-W_nUp}$	-4.89 Kn	Capacity	-24.12 Kn	Passing Percentage	493.25 %

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 = 6.33 mm

Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 9.07 mm

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

Reactions

Maximum downward = 5.28 kn Maximum upward = -4.89 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ 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 > -4.89 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.89 Kn

Girt Design Front and Back

Girt's Spacing = 800 mm

Girt's Span = 4800 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 = 0.90 S_1 Downward = 11.27 S_1 Upward = 15.03

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

Capacity Checks

$M_{Wind+Snow}$	2.63 Kn-m	Capacity	3.36 Kn-m	Passing Percentage	127.76 %
$V_{0.9D-WnUp}$	2.19 Kn	Capacity	16.08 Kn	Passing Percentage	734.25 %

Deflections

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

Deflection under Snow and Service Wind = 43.82 mm

Limit by Woolcock et al, 1999 Span/100 = 48.00 mm

Sag during installation = 32.19 mm

Reactions

Maximum = 2.19 kn

Girt Design Sides

Girt's Spacing = 800 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 = 0.92 S_1 Downward = 11.27 S_1 Upward = 14.55

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

Capacity Checks

$M_{Wind+Snow}$	2.31 Kn-m	Capacity	3.42 Kn-m	Passing Percentage	148.05 %
$V_{0.9D-WnUp}$	2.05 Kn	Capacity	16.08 Kn	Passing Percentage	784.39 %

Deflections

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

Deflection under Snow and Service Wind = 33.85 mm

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

Sag during installation = 24.86 mm

Reactions

Maximum = 2.05 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3500 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 = 21.6 m²

Dead	5.40 Kn	Live	5.40 Kn
Wind Down	15.55 Kn	Snow	13.61 Kn
Moment wind	8.73 Kn-m	Moment snow	2.73 Kn-m
Phi	0.8	K _s	1.00
K ₁ snow	0.8	K ₁ Dead	0.6
K ₁ 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	397.41 Kn	PhiM _n Wind	18.78 Kn-m	PhiV _n Wind	49.01 Kn
PhiN _c Dead	238.44 Kn	PhiM _n Dead	11.27 Kn-m	PhiV _n Dead	29.41 Kn
PhiN _c Snow	317.93 Kn	PhiM _n Snow	15.03 Kn-m	PhiV _n Snow	39.21 Kn

Checks

$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.53 < 1$ OK

$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.29 < 1$ OK

Deflection at top under service lateral loads = 29.06 mm < 35.00 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 ²
K ₀ =	$(1 - \sin(30)) / (1 + \sin(30))$				
K _p =	$(1 + \sin(30)) / (1 - \sin(30))$				

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Geometry For Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1350 mm	Pile embedment length
f1 =	2850 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	8.73 Kn-m	Moment Snow =	Kn-m
Shear Wind =	3.06 Kn	Shear Snow =	2.73 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.22 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.81 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.99 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3500 mm
Area	20729 mm ²	As	15546.6796875 mm ²
Ix	34210793 mm ⁴	Zx	421056 mm ³
Iy	34210793 mm ⁴	Zx	421056 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 10.8 m²

Dead	2.70 Kn	Live	2.70 Kn
Wind Down	7.78 Kn	Snow	6.80 Kn
Moment Wind	4.36 Kn-m	Moment snow	1.36 Kn-m
Phi	0.8	K8	0.60
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	178.07 Kn	PhiMnx Wind	7.29 Kn-m	PhiVnx Wind	36.81 Kn
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PhiNcx Dead	106.84 Kn	PhiMnx Dead	4.38 Kn-m	PhiVnx Dead	22.09 Kn
PhiNcx Snow	142.46 Kn	PhiMnx Snow	5.84 Kn-m	PhiVnx Snow	29.45 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.68 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.44 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 27.89 \text{ mm} < 37.90 \text{ mm}$$

Ds =	0.6 mm	Pile Diameter
L =	1350 mm	Pile embedment length
f1 =	2850 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

$$\text{Total Area over Pole} = 10.8 \text{ m}^2$$

Moment Wind =	4.36 Kn-m	Moment Snow =	1.36 Kn-m
Shear Wind =	1.53 Kn	Shear Snow =	1.36 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.22 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.81 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.50 < 1 \text{ OK}$$

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 =	1350 mm	Pile embedment length
f1 =	2850 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	4.36 Kn-m	Moment Snow =	1.36 Kn-m
Shear Wind =	1.53 Kn	Shear Snow =	1.36 Kn

Pile Properties

Safety Factory	0.55
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Hu =	5.22 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.81 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.50 < 1$ 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(1350) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1350)

Skin Friction = 14.72 Kn

Weight of Pile + Pile Skin Friction = 18.67 Kn

Uplift on one Pile = 20.41 Kn

Uplift is ok