

Job No.: Lance Wilkin
Latitude: -40.188806

Address: 220 Spur Road West, Colyton 4775, New Zealand
Longitude: 175.641713

Date: 06/12/2024
Elevation: 120 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	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ2	Terrain Category	2.43	Design Wind Speed	38.74 m/s
Wind Pressure	0.9 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 $C_{p,i} = 0.6579$

For roof $C_{p,e}$ from 0 m To 3.5 m $C_{p,e} = -0.9$ $p_e = -0.58$ KPa $p_{net} = -1.09$ KPa

For roof $C_{p,e}$ from 3.5 m To 7 m $C_{p,e} = -0.5$ $p_e = -0.32$ KPa $p_{net} = -0.83$ KPa

For wall Windward $C_{p,i} = 0.6597$ side Wall $C_{p,i} = -0.5717$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 22.5 m $C_{p,e} = 0.7$ $p_e = 0.55$ KPa $p_{net} = 1.09$ KPa

For side wall $C_{p,e}$ from 0 m To 3.5 m $C_{p,e} =$ $p_e = -0.51$ KPa $p_{net} = 0.03$ KPa

Maximum Upward pressure used in roof member Design = 1.09 KPa

Maximum Downward pressure used in roof member Design = 0.70 KPa

Maximum Wall pressure used in Design = 1.09 KPa

Maximum Racking pressure used in Design = 0.98 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 = 0.80 S1 Downward = 11.27 S1 Upward = 17.42

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 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nDn}$	2.13 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	139.44 %
$M_{0.9D-W_nUp}$	-1.84 Kn-m	Capacity	-2.97 Kn-m	Passing Percentage	79.41 %
$V_{1.35D}$	0.66 Kn	Capacity	9.65 Kn	Passing Percentage	1462.12 %
$V_{1.2D+1.5L 1.2D+S_n 1.2D+W_nDn}$	1.96 Kn	Capacity	12.86 Kn	Passing Percentage	656.12 %
$V_{0.9D-W_nUp}$	-1.69 Kn	Capacity	-16.08 Kn	Passing Percentage	951.48 %

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 = 15.25 mm

Limit by Woolcock et al, 1999 Span/100 = 43.00 mm

Reactions

Second page

Maximum downward = 1.96 kn Maximum upward = -1.69 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 = 4500 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}	3.59 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	280.78 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.64 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	126.32 %
M _{0.9D-WnUp}	-9.21 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	182.41 %
V _{1.35D}	3.30 Kn	Capacity	28.94 Kn	Passing Percentage	876.97 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.79 Kn	Capacity	38.6 Kn	Passing Percentage	394.28 %
V _{0.9D-WnUp}	-8.47 Kn	Capacity	-48.24 Kn	Passing Percentage	569.54 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.34 mm

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

Deflection under Dead and Service Wind = 8.405 mm

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

Reactions

Maximum downward = 9.79 kn Maximum upward = -8.47 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

K₁₁ = 14.9 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 21.67 Kn > -8.47 Kn

Rafter Design External

External Rafter Load Width = 2250 mm

External Rafter Span = 4328 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

Pole Shed App Ver 01 2022

M1.35D	1.78 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	265.17 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	5.27 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	119.54 %
M0.9D-WnUp	-4.56 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	172.59 %
V1.35D	1.64 Kn	Capacity	14.47 Kn	Passing Percentage	882.32 %
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	4.87 Kn	Capacity	19.30 Kn	Passing Percentage	396.30 %
V0.9D-WnUp	-4.21 Kn	Capacity	-24.12 Kn	Passing Percentage	572.92 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 5.93 mm
 Deflection under Dead and Service Wind = 8.40 mm

Limit by Woolcock et al, 1999 Span/240= 18.75 mm
 Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward =4.87 kn Maximum upward = -4.21 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

K11 = 14.9 fpj = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

K11 = 2.0 fcj = 36.1 Mpa for Pole with effective thickness = 100 mm

Eccentric Load check

V = phi x k1 x k4 x k5 x fs x b x ds (Eq 4.12) = -25.20 kn > -4.21 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -4.21 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2250 mm Intermediate Span = 2848 mm Try Intermediate 2x150x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and does not remain in continuous wet condition after installation)

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

K8 Upward =1.00 S1 Downward =9.63 S1 Upward =0.54

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

Capacity Checks

MWind+Snow	2.49 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	168.67 %
V0.9D-WnUp	3.49 Kn	Capacity	-24.12 Kn	Passing Percentage	691.12 %

Deflections

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

Deflection under Snow and Service Wind = 13.84 mm Limit by Woolcock et al, 1999 Span/100 = 28.48 mm

Reactions

Maximum = 3.49 kn

Intermediate Design Sides

Intermediate Spacing = 2250 mm

Intermediate Span = 3600 mm

Try Intermediate 2x150x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and does not remain in continuous wet condition after installation)

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

K8 Upward =1.00 S1 Downward =9.63 S1 Upward =0.61

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

Capacity Checks

$M_{Wind+Snow}$	1.99 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	211.06 %
$V_{0.9D-WnUp}$	2.21 Kn	Capacity	24.12 Kn	Passing Percentage	1091.40 %

Deflections

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

Deflection under Snow and Service Wind = 35.3 mm

Limit by Woolcock et al, 1999 Span/100 = 36.00 mm

Reactions

Maximum = 2.21 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2250 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)

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

K8 Upward =0.89 S1 Downward =9.63 S1 Upward =15.23

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

Capacity Checks

$M_{Wind+Snow}$	0.90 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	207.78 %
$V_{0.9D-WnUp}$	1.59 Kn	Capacity	12.06 Kn	Passing Percentage	758.49 %

Deflections

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

Deflection under Snow and Service Wind = 5.02 mm

Limit by Woolcock et al, 1999 Span/100 = 22.50 mm

Sag during installation = 1.55 mm

Reactions

Maximum = 1.59 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2250 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)

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

K8 Upward =0.89 S1 Downward =9.63 S1 Upward =15.23

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

Capacity Checks

$M_{Wind+Snow}$	0.90 Kn-m	Capacity	1.87 Kn-m	Passing Percentage	207.78 %
$V_{0.9D-WnUp}$	1.59 Kn	Capacity	12.06 Kn	Passing Percentage	758.49 %

Deflections

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

Deflection under Snow and Service Wind = 5.02 mm

Limit by Woolcock et al. 1999 Span/100 = 22.50 mm

Sag during installation = 1.55 mm

Reactions

Maximum = 1.59 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	9375 mm ²	As	7031.25 mm ²
I _x	27465820 mm ⁴	Z _x	292969 mm ³
I _y	27465820 mm ⁴	Z _y	292969 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 20.25 m²

Dead	5.06 Kn	Live	5.06 Kn
Wind Down	14.18 Kn	Snow	0.00 Kn
Moment wind	8.80 Kn-m		
Phi	0.8	K ₈	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	135.00 Kn	PhiM _n Wind	8.51 Kn-m	PhiV _n Wind	16.65 Kn
PhiN _c Dead	81.00 Kn	PhiM _n Dead	5.10 Kn-m	PhiV _n Dead	9.99 Kn

Checks

$(M_x / \Phi M_n) + (N / \Phi N_c) = 1.21 < 1$ OK

$(M_x / \Phi M_n)^2 + (N / \Phi N_c) = 1.25 < 1$ OK

Deflection at top under service lateral loads = 71.96 mm < 37.00 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 =	1400 mm	Pile embedment length
f ₁ =	3000 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind = 8.80 Kn-m
Shear Wind = 2.93 Kn

Pile Properties

Safety Factory 0.55
Hu = 5.56 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 9.86 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.89 < 1$ OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	8125 mm ²	As	6093.75 mm ²
Ix	17879232 mm ⁴	Zx	220052 mm ³
Iy	17879232 mm ⁴	Zy	220052 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 10.125 m²

Dead	2.53 Kn	Live	2.53 Kn
Wind Down	7.09 Kn	Snow	0.00 Kn
Moment Wind	4.40 Kn-m		
Phi	0.8	K8	0.54
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	63.40 Kn	PhiMnx Wind	3.46 Kn-m	PhiVnx Wind	14.43 Kn
PhiNcx Dead	38.04 Kn	PhiMnx Dead	2.08 Kn-m	PhiVnx Dead	8.66 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 1.46 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 1.81 < 1$ OK

Deflection at top under service lateral loads = 59.60 mm < 39.90 mm

Ds =	0.6 mm	Pile Diameter
L =	1400 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 = 10.125 m²

Moment Wind = 4.40 Kn-m
Shear Wind = 1.47 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.56 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	9.86 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.45 < 1$ 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 =	1400 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 =	4.40 Kn-m
Shear Wind =	1.47 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.56 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	9.86 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.45 < 1$ 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(1400) x Ks(1.5) x $0.5 \times \tan(30)$ x Pi x Dia of Pile(0.6) x Height of Pile(1400)

Skin Friction = 15.83 Kn

Weight of Pile + Pile Skin Friction = 19.92 Kn

Uplift on one Pile = 17.52 Kn

Uplift is ok