

Job No.: Scott Wilks

Address: 38 Castlegrace Drive, Tahawai, New Zealand

Date: 8/25/2022

Latitude: -37.523376

Longitude: 175.934705

Elevation: 52 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N0	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	1	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ1	Terrain Category	2.23	Design Wind Speed	42.48 m/s
Wind Pressure	1.08 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	High				

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 $C_{p,i} = -0.6$

For roof $C_{p,e}$ from 0 m To 3.60 m $C_{p,e} = -0.9$ $p_e = -0.766$ KPa $p_{net} = -1.43$ KPa

For roof $C_{p,e}$ from 3.60 m To 7.20 m $C_{p,e} = -0.5$ $p_e = -0.42$ KPa $p_{net} = -1.09$ KPa

For wall Windward $C_{p,i} = 0.66$ side Wall $C_{p,i} = -0.57$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 14.40 m $C_{p,e} = 0.7$ $p_e = 0.66$ KPa $p_{net} = 1.31$ KPa

For side wall $C_{p,e}$ from 0 m To 3.60 m $C_{p,e} =$ $p_e = -0.61$ KPa $p_{net} = 0.46$ KPa

Maximum Upward pressure used in roof member Design = 1.43 KPa

Maximum Downward pressure used in roof member Design = 0.74 KPa

Maximum Wall pressure used in Design = 1.31 KPa

Maximum Racking pressure used in Design = 1.17 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3400 mm

Try Purlin 240x45 SG8 Wet

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Moisture Condition = Wet (Moisture in timber is less than 25%)

K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.95

K8 Upward = 0.43 S1 Downward = 13.82 S1 Upward = 26.86

Shear Capacity of timber = 3 MPa Bending Capacity of timber = 11.7 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	0.44 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	540.91 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.35 Kn-m	Capacity	3.17 Kn-m	Passing Percentage	234.81 %
M _{0.9D-W_nUp}	-1.57 Kn-m	Capacity	-1.82 Kn-m	Passing Percentage	115.92 %
V _{1.35D}	0.52 Kn	Capacity	10.42 Kn	Passing Percentage	2003.85 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.59 Kn	Capacity	13.89 Kn	Passing Percentage	873.58 %
V _{0.9D-W_nUp}	-1.84 Kn	Capacity	-17.37 Kn	Passing Percentage	944.02 %

Deflections

Modulus of Elasticity = 6500 MPa NZS3603 Amt 4, Table 2.3 considering at least 4 members acting together

k₂ for Long Term Loads = 3

Deflection under Dead and Live Load = 3.95 mm Limit by AS1170.0 Table C1 Span/250 = 13.60 mm

Deflection under Dead and Service Wind = 5.21 mm Limit by AS1170.0 Table C1 Span/120 = 28.33 mm

Reactions

Maximum downward = 1.59 kn Maximum upward = -1.84 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 = 3600 mm Internal Rafter Span = 4350 mm Try Rafter 2x290x45 SG8 Wet

Moisture Condition = Wet (Moisture in timber is less than 25%)

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 = 7.47 S1 Upward = 7.47

Shear Capacity of timber = 3 MPa Bending Capacity of timber = 11.7 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	2.87 Kn-m	Capacity	7.96 Kn-m	Passing Percentage	277.35 %
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M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.86 Kn-m	Capacity	10.6 Kn-m	Passing Percentage	119.64 %
M _{0.9D-WnUp}	-10.26 Kn-m	Capacity	-13.26 Kn-m	Passing Percentage	129.24 %
V _{1.35D}	2.64 Kn	Capacity	25.18 Kn	Passing Percentage	953.79 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.14 Kn	Capacity	33.58 Kn	Passing Percentage	412.53 %
V _{0.9D-WnUp}	-9.44 Kn	Capacity	-41.96 Kn	Passing Percentage	444.49 %

Deflections

Modulus of Elasticity = 4400 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 3

Deflection under Dead and Live Load = 9.435 mm Limit by AS1170.0 Table C1 Span/250 = 18.00 mm

Deflection under Dead and Service Wind = 13.375 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Reactions

Maximum downward = 8.14 kn Maximum upward = -9.44 kn

Rafter to Pole Connection check

Bolt Size = M16 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 = 76.25 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 14.9 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 90 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 = 18.20 Kn > -9.44 Kn

Rafter Design External

External Rafter Load Width = 1800 mm External Rafter Span = 4318 mm Try Rafter 290x45 SG8 Wet

Moisture Condition = Wet (Moisture in timber is less than 25%)

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K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.90

K8 Upward = 0.90 S1 Downward = 15.23 S1 Upward = 15.23

Shear Capacity of timber = 3 MPa Bending Capacity of timber = 11.7 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	1.42 Kn-m	Capacity	3.22 Kn-m	Passing Percentage	226.76 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.36 Kn-m	Capacity	4.29 Kn-m	Passing Percentage	98.39 %
M _{0.9D-W_nUp}	-5.06 Kn-m	Capacity	-5.36 Kn-m	Passing Percentage	105.93 %
V _{1.35D}	1.31 Kn	Capacity	12.59 Kn	Passing Percentage	961.07 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.04 Kn	Capacity	16.79 Kn	Passing Percentage	415.59 %
V _{0.9D-W_nUp}	-4.68 Kn	Capacity	-20.98 Kn	Passing Percentage	448.29 %

Deflections

Modulus of Elasticity = 4400 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 3

Deflection under Dead and Live Load = 10.15 mm Limit by AS1170.0 Table C1 Span/250 = 18.00 mm

Deflection under Dead and Service Wind = 13.37 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Reactions

Maximum downward = 4.04 kn Maximum upward = -4.68 kn

Rafter to Pole Connection check

Bolt Size = M16 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 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 45 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 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) = -19.84 kn > -4.68 Kn

Single Shear Capacity under short term loads = -9.10 Kn > -4.68 Kn

Intermediate Design Sides

Intermediate Spacing = 2250 mm Intermediate Span = 3650 mm Try Intermediate 2x190x45 SG8

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 = 0.98

K8 Upward = 1.00 S1 Downward = 12.23 S1 Upward = 0.78

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

Capacity Checks

M _{Wind+Snow}	2.45 Kn-m	Capacity	6.54 Kn-m	Passing Percentage	266.94 %
V _{0.9D-WnUp}	2.69 Kn-m	Capacity	27.5 Kn-m	Passing Percentage	1022.30 %

Deflections

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

Deflection under Snow and Service Wind = 24.52 mm Limit by AS1170.0 Table C1 Span/120 = 30.42 mm

Reactions

Maximum = 2.69 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 3600 mm Try Intermediate 190x45 SG8 Wet

Moisture Condition = Wet (Moisture in timber is less than 25%)

K1 Short term = 1 K4 = 1 K5 = 1 K8 Downward = 0.98

K8 Upward = 0.52 S1 Downward = 12.23 S1 Upward = 24.46

Shear Capacity of timber = 3 MPa Bending Capacity of timber = 11.7 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{Wind+Snow}	1.38 Kn-m	Capacity	1.43 Kn-m	Passing Percentage	103.62 %
V _{0.9D-WnUp}	1.53 Kn-m	Capacity	13.75 Kn-m	Passing Percentage	898.69 %

Deflections

Pole Shed App Ver 01 2022 by RnH Consulting Engineers

Modulus of Elasticity = 6500 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 11.14 mm Limit by AS1170.0 Table C1 Span/120 = 30.00 mm
Sag during installation = 12.96 mm

Reactions

Maximum = 1.53 kn

Middle Pole Design

Geometry

200 UNI H5	Dry Use	Height	3300 mm
Area	31400 mm ²	As	23550 mm ²
I _x	78500000 mm ⁴	Z _x	785000 mm ³
I _y	78500000 mm ⁴	Z _y	785000 mm ³
Lateral Restraint	3300 mm c/c		

Loads

Total Area over Pole = 16.2 m²

Dead	4.05 Kn	Live	4.05 Kn
Wind	11.99 Kn	Snow	0.00 Kn
Moment wind	Kn-m		
Phi	0.8	K ₈	0.84
K ₁ snow	0.8	K ₁ Dead	0.6
K ₁ wind	1		

Material

Shaving	Steaming	Normal	Dry Use
f _b =	34.325 MPa	f _s =	2.96 MPa
f _c =	18 MPa	f _p =	7.2 MPa
f _t =	20.75 MPa	E =	8793 MPa

Capacities

PhiN _{cx} Wind	378.83 Kn	PhiM _{nx} Wind	18.06 Kn-m	PhiV _{nx} Wind	55.77 Kn
PhiN _{cx} Dead	227.30 Kn	PhiM _{nx} Dead	10.84 Kn-m	PhiV _{nx} Dead	33.46 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.52 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.27 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 22.58 \text{ mm} < 44.00 \text{ mm}$$

Drained Lateral Strength of Middle pile in cohesionless soils Free Head short pile

Soil Properties

Gamma 18 Kn/m³ Friction angle 30 deg Cohesion 0 Kn/m³

$$K_0 = (1 - \sin(30)) / (1 + \sin(30))$$

$$K_p = (1 + \sin(30)) / (1 - \sin(30))$$

Geometry For Middle Bay Pole

Ds = 600 mm Pile Diameter
L = 1500 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 = 8.40 Kn-m
Shear Wind = 2.80 Kn

Pile Properties

Safety Factory 0.55
Hu = 6.68 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 11.94 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.70 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter
L = 1500 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 = 4.05 m²

Moment Wind = 4.20 Kn-m

Shear Wind = 1.40 Kn

Pile Properties

Safety Factory 0.55

Hu = 6.68 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 11.94 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.35 < 1 OK

Drained Lateral Strength of End pile in cohesionless soils Free Head short pile

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 = 600 mm Pile Diameter

L = 1500 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 = 4.20 Kn-m

Shear Wind = 1.40 Kn

Pile Properties

Safety Factory 0.55

Hu = 6.68 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 11.94 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.35 < 1$ 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(1500) x Ks(1.5) x $\tan(30)$ x π x Dia of Pile(0.6) x Height of Pile(1500)

Skin Friction = 18.17 Kn

Weight of Pile + Pile Skin Friction = 22.31 Kn

Uplift on one Pile = 19.52 Kn

Uplift is ok