

Job No.: Abbey Tuhakaraina **Address:** 18 Tangitu Rd, Te Puna, New Zealand **Date:** 7/22/2022
483-184143C
Latitude: -37.666648 **Longitude:** 176.076939 **Elevation:** 23.5 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 ARI	100 Years	Max Height	4 m
Wind Region	NZ1	Terrain Category	2.23	Design Wind Speed	41.22 m/s
Wind Pressure	1.02 KPa	Lee Zone	NO	Ultimate ARI	100 Years
Wind Category	High				

Pressure Coefficients and Pressures

Shed Type = Mono Enclosed

For roof $C_{p,i} = -0.3$

For roof $C_{p,e}$ from 0 m To 3.65 m $C_{p,e} = -0.9$ $p_e = -0.83$ KPa $p_{net} = -0.83$ KPa

For roof $C_{p,e}$ from 3.65 m To 7.30 m $C_{p,e} = -0.5$ $p_e = -0.46$ KPa $p_{net} = -0.46$ 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 10 m $C_{p,e} = 0.7$ $p_e = 0.64$ KPa $p_{net} = 0.95$ KPa

For side wall $C_{p,e}$ from 0 m To 3.65 m $C_{p,e} =$ $p_e = -0.6$ KPa $p_{net} = -0.60$ KPa

Maximum Upward pressure used in roof member Design = 0.83 KPa

Maximum Downward pressure used in roof member Design = 0.40 KPa

Maximum Wall pressure used in Design = 0.95 KPa

Maximum Racking pressure used in Design = 1 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 3400 mm Try Purlin 190x45 SG8

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

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K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.98

K8 Upward = 0.50 S1 Downward = 12.23 S1 Upward = 23.77

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

Capacity Checks

M _{1.35D}	0.44 Kn-m	Capacity	1.93 Kn-m	Passing Percentage	438.64 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.33 Kn-m	Capacity	2.57 Kn-m	Passing Percentage	193.23 %
M _{0.9D-W_nUp}	-0.79 Kn-m	Capacity	-1.64 Kn-m	Passing Percentage	207.59 %
V _{1.35D}	0.52 Kn	Capacity	8.25 Kn	Passing Percentage	1586.54 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.07 Kn	Capacity	11.00 Kn	Passing Percentage	1028.04 %
V _{0.9D-W_nUp}	-0.93 Kn	Capacity	-13.75 Kn	Passing Percentage	1478.49 %

Deflections

Modulus of Elasticity = 8000 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 = 4.57 mm Limit by AS1170.0 Table C1 Span/250 = 13.60 mm

Deflection under Dead and Service Wind = 5.33 mm Limit by AS1170.0 Table C1 Span/120 = 28.33 mm

Reactions

Maximum downward = 1.07 kn Maximum upward = -0.93 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 = 5000 mm Try Rafter 2x290x45 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 = 7.47 S1 Upward = 7.47

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

Capacity Checks

M _{1.35D}	3.80 Kn-m	Capacity	9.52 Kn-m	Passing Percentage	250.53 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	7.88 Kn-m	Capacity	12.7 Kn-m	Passing Percentage	161.17 %

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M _{0.9D-WnUp}	-6.81 Kn-m	Capacity	-15.86 Kn-m	Passing Percentage	232.89 %
V _{1.35D}	3.04 Kn	Capacity	25.18 Kn	Passing Percentage	828.29 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	6.30 Kn	Capacity	33.58 Kn	Passing Percentage	533.02 %
V _{0.9D-WnUp}	-5.45 Kn	Capacity	-41.96 Kn	Passing Percentage	769.91 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 8.01 mm Limit by AS1170.0 Table C1 Span/250 = 20.00 mm

Deflection under Dead and Service Wind = 10.38 mm Limit by AS1170.0 Table C1 Span/120 = 41.67 mm

Reactions

Maximum downward = 6.30 kn Maximum upward = -5.45 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 fpj = 12.9 Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

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

Capacity under short term loads = 19.50 Kn > -5.45 Kn

Rafter Design External

External Rafter Load Width = 1800 mm External Rafter Span = 4812 mm Try Rafter 290x45 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 = 0.89

K8 Upward =0.89 S1 Downward =15.23 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 _{1.35D}	1.76 Kn-m	Capacity	3.80 Kn-m	Passing Percentage	215.91 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.65 Kn-m	Capacity	5.06 Kn-m	Passing Percentage	138.63 %
M _{0.9D-W_nUp}	-3.15 Kn-m	Capacity	-6.33 Kn-m	Passing Percentage	200.95 %
V _{1.35D}	1.46 Kn	Capacity	12.59 Kn	Passing Percentage	862.33 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.03 Kn	Capacity	16.79 Kn	Passing Percentage	554.13 %
V _{0.9D-W_nUp}	-2.62 Kn	Capacity	-20.98 Kn	Passing Percentage	800.76 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 8.90 mm Limit by AS1170.0 Table C1 Span/250 = 20.00 mm

Deflection under Dead and Service Wind = 10.38 mm Limit by AS1170.0 Table C1 Span/120 = 41.67 mm

Reactions

Maximum downward =3.03 kn Maximum upward = -2.62 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 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 x k₁ x k₄ x k₅ x f_s x b x d_s (Eq 4.12) = -21.73 kn > -2.62 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -2.62 Kn

Intermediate Design Sides

Intermediate Spacing = 2500 mm Intermediate Span = 3675 mm Try Intermediate 2x140x45 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 = 1.00

K8 Upward = 1.00 S1 Downward = 10.36 S1 Upward = 0.66

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

Capacity Checks

M _{Wind+Snow}	2.00 Kn-m	Capacity	3.74 Kn-m	Passing Percentage	187.00 %
V _{0.9D-WnUp}	2.18 Kn-m	Capacity	20.26 Kn-m	Passing Percentage	929.36 %

Deflections

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

Deflection under Snow and Service Wind = 50.74 mm Limit by AS1170.0 Table C1 Span/120 = 30.62 mm

Reactions

Maximum = 2.18 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 3600 mm Try Intermediate 140x45 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 = 1.00

K8 Upward = 0.63 S1 Downward = 10.36 S1 Upward = 20.73

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

Capacity Checks

M _{Wind+Snow}	1.00 Kn-m	Capacity	1.19 Kn-m	Passing Percentage	119.00 %
V _{0.9D-WnUp}	1.11 Kn-m	Capacity	10.13 Kn-m	Passing Percentage	912.61 %

Deflections

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Modulus of Elasticity = 8000 MPa NZS3603 Amt 4, Table 2.3

Deflection under Snow and Service Wind = 16.41 mm Limit by AS1170.0 Table C1 Span/120 = 30.00 mm

Sag during installation = 10.53 mm

Reactions

Maximum = 1.11 kn

Middle Pole Design

Geometry

175 UNI H5	Dry Use	Height	3350 mm
Area	24041 mm ²	As	18030.46875 mm ²
I _x	46015259 mm ⁴	Z _x	525889 mm ³
I _y	46015259 mm ⁴	Z _y	525889 mm ³
Lateral Restraint	3350 mm c/c		

Loads

Total Area over Pole = 18 m²

Dead	4.50 Kn	Live	4.50 Kn
Wind	7.20 Kn	Snow	0.00 Kn
Moment wind	Kn-m		
Phi	0.8	K ₈	0.71
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	246.54 Kn	PhiM _{nx} Wind	10.28 Kn-m	PhiV _{nx} Wind	42.70 Kn
PhiN _{cx} Dead	147.93 Kn	PhiM _{nx} Dead	6.17 Kn-m	PhiV _{nx} Dead	25.62 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.76 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.55 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 33.42 \text{ mm} < 44.67 \text{ mm}$$

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 = 1300 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 = 7.18 Kn-m
Shear Wind = 2.39 Kn

Pile Properties

Safety Factory 0.55
Hu = 4.55 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 8.02 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.89 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter
L = 1300 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 = 4.5 m²

Moment Wind = 3.59 Kn-m

Shear Wind = 1.20 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.55 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.02 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

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 = 1300 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 = 3.59 Kn-m

Shear Wind = 1.20 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.55 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.02 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.45 < 1$ OK

Uplift Check

Density of Concrete = 24 Kn/m^3

Density of Timber Pole = 5 Kn/m^3

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

K_s (Lateral Earth Pressure Coefficient) for cast into place concrete piles = 1.5

Formula to calculate Skin Friction = Safety factor (0.55) \times Density of Soil(18) \times Height of Pile(1300) \times K_s (1.5) \times $\tan(30)$ \times $\pi \times$ Dia of Pile(0.6) \times Height of Pile(1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 17.68 Kn

Uplift on one Pile = 10.89 Kn

Uplift is ok