

Job No.: Whites Road

Address: 195 Whites Road, Ohoka, New Zealand

Date: 8/5/2022

Latitude: -43.380819

Longitude: 172.56213

Elevation: 24 m

General Input

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N3	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	C
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.9 m
Wind Region	NZ2	Terrain Category	1.88	Design Wind Speed	38.66 m/s
Wind Pressure	0.9 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 Enclosed

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

For roof $C_{p,e}$ from 0 m To 4.25 m $C_{p,e} = -0.9$ $p_e = -0.73$ KPa $p_{net} = -0.73$ KPa

For roof $C_{p,e}$ from 4.25 m To 8.50 m $C_{p,e} = -0.5$ $p_e = -0.40$ KPa $p_{net} = -0.40$ 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 12 m $C_{p,e} = 0.7$ $p_e = 0.56$ KPa $p_{net} = 0.83$ KPa

For side wall $C_{p,e}$ from 0 m To 4.25 m $C_{p,e} =$ $p_e = -0.52$ KPa $p_{net} = -0.52$ KPa

Maximum Upward pressure used in roof member Design = 0.73 KPa

Maximum Downward pressure used in roof member Design = 0.35 KPa

Maximum Wall pressure used in Design = 0.83 KPa

Maximum Racking pressure used in Design = 0.96 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm

Purlin Span = 3800 mm

Try Purlin 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 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 1.00

K8 Upward = 0.68 S1 Downward = 9.63 S1 Upward = 19.79

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

Capacity Checks

M _{1.35D}	0.55 Kn-m	Capacity	1.41 Kn-m	Passing Percentage	256.36 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.53 Kn-m	Capacity	1.89 Kn-m	Passing Percentage	123.53 %
M _{0.9D-W_nUp}	-0.82 Kn-m	Capacity	-1.60 Kn-m	Passing Percentage	195.12 %
V _{1.35D}	0.58 Kn	Capacity	7.24 Kn	Passing Percentage	1248.28 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.15 Kn	Capacity	9.65 Kn	Passing Percentage	839.13 %
V _{0.9D-W_nUp}	-0.86 Kn	Capacity	-12.06 Kn	Passing Percentage	1402.33 %

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 = 13.03 mm Limit by AS1170.0 Table C1 Span/250 = 15.20 mm

Deflection under Dead and Service Wind = 14.66 mm Limit by AS1170.0 Table C1 Span/120 = 31.67 mm

Reactions

Maximum downward = 1.15 kn Maximum upward = -0.86 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 = 4000 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

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M _{1.35D}	3.19 Kn-m	Capacity	11.32 Kn-m	Passing Percentage	354.86 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	6.39 Kn-m	Capacity	15.08 Kn-m	Passing Percentage	235.99 %
M _{0.9D-WnUp}	-4.78 Kn-m	Capacity	-18.86 Kn-m	Passing Percentage	394.56 %
V _{1.35D}	2.94 Kn	Capacity	28.94 Kn	Passing Percentage	984.35 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	5.87 Kn	Capacity	38.6 Kn	Passing Percentage	657.58 %
V _{0.9D-WnUp}	-4.39 Kn	Capacity	-48.24 Kn	Passing Percentage	1098.86 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.745 mm Limit by AS1170.0 Table C1 Span/250 = 18.00 mm

Deflection under Dead and Service Wind = 5.935 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Reactions

Maximum downward = 5.87 kn Maximum upward = -4.39 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 > -4.39 Kn

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 4347 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)

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K1 Short term = 1 K1 Medium term = 0.8 K1 Long term = 0.6 K4 = 1 K5 = 1 K8 Downward = 0.94

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}	1.59 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	296.86 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	3.19 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	197.49 %
M _{0.9D-W_nUp}	-2.39 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	329.29 %
V _{1.35D}	1.47 Kn	Capacity	14.47 Kn	Passing Percentage	984.35 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	2.93 Kn	Capacity	19.30 Kn	Passing Percentage	658.70 %
V _{0.9D-W_nUp}	-2.20 Kn	Capacity	-24.12 Kn	Passing Percentage	1096.36 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 5.27 mm Limit by AS1170.0 Table C1 Span/250 = 18.00 mm

Deflection under Dead and Service Wind = 5.93 mm Limit by AS1170.0 Table C1 Span/120 = 37.50 mm

Reactions

Maximum downward = 2.93 kn Maximum upward = -2.20 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 = 50 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) = -25.20 kn > -2.20 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -2.20 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2000 mm Intermediate Span = 4750 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 = 0.70

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

Capacity Checks

M _{Wind+Snow}	4.68 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	100.85 %
V _{0.9D-WnUp}	3.94 Kn-m	Capacity	-24.12 Kn-m	Passing Percentage	612.18 %

Deflections

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

Deflection under Snow and Service Wind = 72.45 mm Limit by AS1170.0 Table C1 Span/120 = 39.58 mm

Reactions

Maximum = 3.94 kn

Intermediate Design Sides

Intermediate Spacing = 2250 mm Intermediate Span = 4425 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 = 0.68

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

Capacity Checks

M _{Wind+Snow}	2.29 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	206.11 %
V _{0.9D-WnUp}	2.07 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	1165.22 %

Deflections

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

Deflection under Snow and Service Wind = 61.385 mm Limit by AS1170.0 Table C1 Span/120 = 36.87 mm

Reactions

Maximum = 2.07 kn

Middle Pole Design

Geometry

150 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3950 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	3950 mm c/c		

Loads

Total Area over Pole = 18 m²

Dead	4.50 Kn	Live	4.50 Kn
Wind	6.30 Kn	Snow	0.00 Kn
Moment wind	Kn-m		
Phi	0.8	K ₈	0.68
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 _{cx} Wind	308.50 Kn	PhiM _{nx} Wind	15.55 Kn-m	PhiV _{nx} Wind	55.77 Kn
PhiN _{cx} Dead	185.10 Kn	PhiM _{nx} Dead	9.33 Kn-m	PhiV _{nx} Dead	33.46 Kn

Checks

$$(M_x/\phi M_{nx}) + (N/\phi N_{cx}) = 0.79 < 1 \text{ OK}$$

$$(M_x/\phi M_{nx})^2 + (N/\phi N_{cx}) = 0.60 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 43.02 \text{ mm} < 52.67 \text{ mm}$$

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 = 1500 mm Pile embedment length
f1 = 3675 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 11.50 Kn-m
Shear Wind = 3.13 Kn

Pile Properties

Safety Factory 0.55
Hu = 5.81 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 12.49 Kn-m Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.92 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter
L = 1300 mm Pile embedment length
f1 = 3675 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 = 5.75 Kn-m

Shear Wind = 1.56 Kn

Pile Properties

Safety Factory 0.55

Hu = 3.93 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.37 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.69 < 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

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

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

Geometry For End Bay Pole

Ds = 600 mm Pile Diameter

L = 1300 mm Pile embedment length

f1 = 3675 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 5.75 Kn-m

Shear Wind = 1.56 Kn

Pile Properties

Safety Factory 0.55

Hu = 3.93 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.37 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.69 < 1$ 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(1500) \times K_s (1.5) \times $\tan(30)$ \times $\pi \times$ Dia of Pile(0.6) \times Height of Pile(1500)

Skin Friction = 18.17 Kn

Weight of Pile + Pile Skin Friction = 22.31 Kn

Uplift on one Pile = 9.09 Kn

Uplift is ok