

Job No.: Dennis Wilks - 483-211700C **Address:** 38 Castlegrave Drive, Tahawai Katikati, New Zealand **Date:** 29/08/2024
Latitude: -37.526016 **Longitude:** 175.935743 **Elevation:** 60.5 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 & Earthquake ARI	100 Years	Max Height	4.1 m
Wind Region	NZ1	Terrain Category	2.5	Design Wind Speed	46.19 m/s
Wind Pressure	1.28 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	Very 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 Enclosed

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

For roof $C_{p,e}$ from 0 m To 3.75 m $C_{p,e} = -0.9$ $p_e = -1.04$ KPa $p_{net} = -1.04$ KPa

For roof $C_{p,e}$ from 3.75 m To 7.50 m $C_{p,e} = -0.5$ $p_e = -0.58$ KPa $p_{net} = -0.58$ 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 9 m $C_{p,e} = 0.7$ $p_e = 0.81$ KPa $p_{net} = 1.19$ KPa

For side wall $C_{p,e}$ from 0 m To 3.75 m $C_{p,e} =$ $p_e = -0.75$ KPa $p_{net} = -0.75$ KPa

Maximum Upward pressure used in roof member Design = 1.04 KPa

Maximum Downward pressure used in roof member Design = 0.61 KPa

Maximum Wall pressure used in Design = 1.19 KPa

Maximum Racking pressure used in Design = 1.39 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 4050 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)

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

K8 Upward = 0.76 S1 Downward = 12.23 S1 Upward = 18.23

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

Capacity Checks

M _{1.35D}	0.62 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	288.71 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.68 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	141.67 %
M _{0.9D-W_nUp}	-1.5 Kn-m	Capacity	-2.30 Kn-m	Passing Percentage	306.67 %
V _{1.35D}	0.62 Kn	Capacity	8.25 Kn	Passing Percentage	1330.65 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.66 Kn	Capacity	11.00 Kn	Passing Percentage	662.65 %
V _{0.9D-WnUp}	-1.49 Kn	Capacity	-13.75 Kn	Passing Percentage	922.82 %

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 = 10.44 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 14.01 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 1.66 kn Maximum upward = -1.49 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 = 4200 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}	3.35 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	300.90 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	9.04 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	148.67 %
M _{0.9D-WnUp}	-8.10 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	207.41 %
V _{1.35D}	3.08 Kn	Capacity	28.94 Kn	Passing Percentage	939.61 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.31 Kn	Capacity	38.6 Kn	Passing Percentage	464.50 %
V _{0.9D-WnUp}	-7.45 Kn	Capacity	-48.24 Kn	Passing Percentage	647.52 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.985 mm Limit by Woolcock et al, 1999 Span/240 = 18.75 mm

Deflection under Dead and Service Wind = 7.43 mm Limit by Woolcock et al, 1999 Span/100 = 45.00 mm

Reactions

Maximum downward = 8.31 kn Maximum upward = -7.45 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ 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 > -7.45 Kn

Rafter Design External

External Rafter Load Width = 2100 mm

External Rafter Span = 4314 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

$M_{1.35D}$	1.65 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	286.06 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.45 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	141.57 %
$M_{0.9D-W_nUp}$	-3.98 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	197.74 %
$V_{1.35D}$	1.53 Kn	Capacity	14.47 Kn	Passing Percentage	945.75 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	4.12 Kn	Capacity	19.30 Kn	Passing Percentage	468.45 %
$V_{0.9D-W_nUp}$	-3.69 Kn	Capacity	-24.12 Kn	Passing Percentage	653.66 %

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 = 5.54 mm

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

Deflection under Dead and Service Wind = 7.43 mm

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

Reactions

Maximum downward = 4.12 kn Maximum upward = -3.69 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

$K_{11} = 2.0$ $f_{cj} = 36.1$ 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 > -3.69 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.69 Kn

Intermediate Design Front and Back

Intermediate Spacing = 2100 mm

Intermediate Span = 3250 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.98

K_8 Upward = 1.00 S_1 Downward = 12.23 S_1 Upward = 0.73

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

Capacity Checks

$M_{Wind+Snow}$	3.30 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	183.64 %
$V_{0.9D-WnUp}$	4.06 Kn	Capacity	-27.5 Kn	Passing Percentage	677.34 %

Deflections

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

Deflection under Snow and Service Wind = 13.06 mm

Limit by Woolcock et al, 1999 Span/100 = 32.50 mm

Reactions

Maximum = 4.06 kn

Intermediate Design Sides

Intermediate Spacing = 2250 mm

Intermediate Span = 3775 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.98

K_8 Upward = 1.00 S_1 Downward = 12.23 S_1 Upward = 0.79

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

Capacity Checks

$M_{Wind+Snow}$	2.38 Kn-m	Capacity	6.06 Kn-m	Passing Percentage	254.62 %
$V_{0.9D-WnUp}$	2.53 Kn	Capacity	27.5 Kn	Passing Percentage	1086.96 %

Deflections

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

Deflection under Snow and Service Wind = 25.485 mm

Limit by Woolcock et al, 1999 Span/100 = 37.75 mm

Reactions

Maximum = 2.53 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2100 mm

Try Girt 190x45 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 =0.73 S1 Downward =12.23 S1 Upward =18.68

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

Capacity Checks

$M_{Wind+Snow}$	0.85 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	262.35 %
$V_{0.9D-WnUp}$	1.62 Kn	Capacity	13.75 Kn	Passing Percentage	848.77 %

Deflections

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

Deflection under Snow and Service Wind = 2.27 mm

Limit by Woolcock et al, 1999 Span/100 = 21.00 mm

Sag during installation = 1.46 mm

Reactions

Maximum = 1.62 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2250 mm

Try Girt 190x45 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 =0.70 S1 Downward =12.23 S1 Upward =19.33

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

Capacity Checks

$M_{Wind+Snow}$	0.98 Kn-m	Capacity	2.13 Kn-m	Passing Percentage	217.35 %
$V_{0.9D-WnUp}$	1.74 Kn	Capacity	13.75 Kn	Passing Percentage	790.23 %

Deflections

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

Deflection under Snow and Service Wind = 3.00 mm

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

Sag during installation =1.92 mm

Reactions

Maximum = 1.74 kn

Middle Pole Design

Geometry

200 UNI H5	Dry Use	Height	3800 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	3800 mm c/c		

Loads

Total Area over Pole = 18.9 m²

Dead	4.72 Kn	Live	4.72 Kn
Wind Down	11.53 Kn	Snow	0.00 Kn
Moment wind	12.24 Kn-m		
Phi	0.8	K ₈	0.72
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	325.19 Kn	PhiM _{nx} Wind	15.50 Kn-m	PhiV _{nx} Wind	55.77 Kn
PhiN _{cx} Dead	195.12 Kn	PhiM _{nx} Dead	9.30 Kn-m	PhiV _{nx} Dead	33.46 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.85 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.69 < 1$ OK

Deflection at top under service lateral loads = 38.81 mm < 38.00 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 =	1550 mm	Pile embedment length
f ₁ =	3075 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

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Loads

Moment Wind = 12.24 Kn-m
Shear Wind = 3.98 Kn

Pile Properties

Safety Factory 0.55
Hu = 7.17 Kn Ultimate Lateral Strength of the Pile, Short pile
Mu = 13.15 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.93 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

200 UNI H5	Dry Use	Height	3800 mm
Area	31400 mm ²	As	23550 mm ²
Ix	78500000 mm ⁴	Zx	785000 mm ³
Iy	78500000 mm ⁴	Zy	785000 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 9.45 m²

Dead	2.36 Kn	Live	2.36 Kn
Wind Down	5.76 Kn	Snow	0.00 Kn
Moment Wind	6.12 Kn-m		
Phi	0.8	K8	0.72
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Shaving	Steaming	Normal	Dry Use
fb =	34.325 MPa	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	20.75 MPa	E =	8793 MPa

Capacities

PhiNcx Wind	325.31 Kn	PhiMnx Wind	15.51 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	195.18 Kn	PhiMnx Dead	9.31 Kn-m	PhiVnx Dead	33.46 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.43 < 1 OK

(Mx/PhiMnx)^2+(N/phiNcx) = 0.19 < 1 OK

Deflection at top under service lateral loads = 20.88 mm < 40.90 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3075 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 9.45 m²

Moment Wind =	6.12 Kn-m
Shear Wind =	1.99 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.47 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.07 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.76 < 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 =	1300 mm	Pile embedment length
f1 =	3075 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	6.12 Kn-m
Shear Wind =	1.99 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.47 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.07 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.76 < 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(1550) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1550)

Skin Friction = 19.40 Kn

Weight of Pile + Pile Skin Friction = 23.68 Kn

Uplift on one Pile = 15.40 Kn

Uplift is ok