

Job No.: Shed 2 10 Factory lane Hikurangi **Address:** Shed 2 10 Factory lane Hikurangi **Date:** 8/12/2022
Latitude: -35.693553 **Longitude:** 174.336547 **Elevation:** 25 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	2.35	Design Wind Speed	38.67 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 1.93 m $C_{p,e} = -1.01$ $p_e = -0.82$ KPa $p_{net} = -0.82$ KPa

For roof $C_{p,e}$ from 1.93 m To 3.85 m $C_{p,e} = -0.8433$ $p_e = -0.68$ KPa $p_{net} = -0.68$ 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 20 m $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 0.84$ KPa

For side wall $C_{p,e}$ from 0 m To 3.85 m $C_{p,e} =$ $p_e = -0.52$ KPa $p_{net} = -0.52$ KPa

Maximum Upward pressure used in roof member Design = 0.82 KPa

Maximum Downward pressure used in roof member Design = 0.43 KPa

Maximum Wall pressure used in Design = 0.84 KPa

Maximum Racking pressure used in Design = 0.97 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 3800 mm Try Purlin 200x50 SG8 Dry

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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 = 0.53 S1 Downward = 11.27 S1 Upward = 23.16

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	2.39 Kn-m	Passing Percentage	434.55 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.53 Kn-m	Capacity	3.18 Kn-m	Passing Percentage	207.84 %
M _{0.9D-W_nUp}	-0.97 Kn-m	Capacity	-2.10 Kn-m	Passing Percentage	216.49 %
V _{1.35D}	0.58 Kn	Capacity	9.65 Kn	Passing Percentage	1663.79 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.25 Kn	Capacity	12.86 Kn	Passing Percentage	1028.80 %
V _{0.9D-W_nUp}	-1.02 Kn	Capacity	-16.08 Kn	Passing Percentage	1576.47 %

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 = 5.50 mm Limit by AS1170.0 Table C1 Span/250 = 15.20 mm

Deflection under Dead and Service Wind = 6.55 mm Limit by AS1170.0 Table C1 Span/120 = 31.67 mm

Reactions

Maximum downward = 1.25 kn Maximum upward = -1.02 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 = 5850 mm Try Rafter 2x400x22.5 LVL13

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 = 0.77

K8 Upward = 0.77 S1 Downward = 17.94 S1 Upward = 17.94

Shear Capacity of timber = 5.3 MPa Bending Capacity of timber = 48 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

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M _{1.35D}	5.78 Kn-m	Capacity	23.92 Kn-m	Passing Percentage	413.84 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	12.49 Kn-m	Capacity	31.9 Kn-m	Passing Percentage	255.40 %
M _{0.9D-WnUp}	-10.18 Kn-m	Capacity	-39.88 Kn-m	Passing Percentage	391.75 %
V _{1.35D}	3.95 Kn	Capacity	30.68 Kn	Passing Percentage	776.71 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	8.54 Kn	Capacity	40.9 Kn	Passing Percentage	478.92 %
V _{0.9D-WnUp}	-6.96 Kn	Capacity	-51.14 Kn	Passing Percentage	734.77 %

Deflections

Modulus of Elasticity = 11000 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 6.905 mm Limit by AS1170.0 Table C1 Span/250 = 24.00 mm

Deflection under Dead and Service Wind = 9.14 mm Limit by AS1170.0 Table C1 Span/120 = 50.00 mm

Reactions

Maximum downward = 8.54 kn Maximum upward = -6.96 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 = J2 Joint Group for Pole = J5

Minimum Bolt edge, end and spacing for Load perpendicular to grains = 43.125 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 45 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 = 17.16 Kn > -6.96 Kn

Rafter Design External

External Rafter Load Width = 2000 mm External Rafter Span = 2804 mm Try Rafter 400x22.5 LVL13

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 =0.23

K8 Upward =0.23 S1 Downward =35.97 S1 Upward =35.97

Shear Capacity of timber =5.3 MPa Bending Capacity of timber =48 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	0.66 Kn-m	Capacity	3.01 Kn-m	Passing Percentage	456.06 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	1.43 Kn-m	Capacity	4.01 Kn-m	Passing Percentage	280.42 %
M _{0.9D-W_{nUp}}	-1.17 Kn-m	Capacity	-5.01 Kn-m	Passing Percentage	428.21 %
V _{1.35D}	0.95 Kn	Capacity	15.34 Kn	Passing Percentage	1614.74 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	2.05 Kn	Capacity	20.45 Kn	Passing Percentage	997.56 %
V _{0.9D-W_{nUp}}	-1.67 Kn	Capacity	-25.57 Kn	Passing Percentage	1531.14 %

Deflections

Modulus of Elasticity = 11000 MPa NZS3603 Amt 4, Table 2.3

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 0.48 mm Limit by AS1170.0 Table C1 Span/250 = 12.00 mm

Deflection under Dead and Service Wind = 0.57 mm Limit by AS1170.0 Table C1 Span/120 = 25.00 mm

Reactions

Maximum downward =2.05 kn Maximum upward = -1.67 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 =J2 Joint Group for Pole = J5

Factor of Safety = 0.7

For Perpendicular to grain loading

K11 = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 22.5 mm

For Parallel to grain loading

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

Eccentric Load check

$V = \phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s \dots\dots\dots$ (Eq 4.12) = -28.38 kn > -1.67 Kn

Single Shear Capacity under short term loads = -8.58 Kn > -1.67 Kn

Girt Design Front and Back

Girt's Spacing = 1300 mm Girt's Span = 4000 mm Try Intermediate 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 =0.65 S1 Downward =9.63 S1 Upward =20.31

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

Capacity Checks

$M_{Wind+Snow}$	1.09 Kn-m	Capacity	1.54 Kn-m	Passing Percentage	141.28 %
$V_{0.9D-WnUp}$	1.09 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	1106.42 %

Deflections

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

Deflection under Snow and Service Wind = 16.18 mm Limit by AS1170.0 Table C1 Span/120 = 33.33 mm

Sag during installation = 13.00 mm

Reactions

Maximum = 1.09 kn

Girt Design Sides

Girt's Spacing = 900 mm Girt's Span = 3000 mm Try Intermediate 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 =0.79 S1 Downward =9.63 S1 Upward =17.59

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 _{Wind+Snow}	0.43 Kn-m	Capacity	1.86 Kn-m	Passing Percentage	432.56 %
V _{0.9D-WnUp}	0.57 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	2115.79 %

Deflections

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

Deflection under Snow and Service Wind = 3.54 mm Limit by AS1170.0 Table C1 Span/120 = 25.00 mm
Sag during installation = 4.11 mm

Reactions

Maximum = 0.57 kn

Middle Pole Design

Geometry

175 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	39741 mm ²	As	29805.46875 mm ²
I _x	125741821 mm ⁴	Z _x	1117705 mm ³
I _y	125741821 mm ⁴	Z _y	1117705 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 12 m²

Dead	3.00 Kn	Live	3.00 Kn
Wind	5.16 Kn	Snow	0.00 Kn
Moment wind	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

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PhiNcx Wind	572.26 Kn	PhiMnx Wind	32.46 Kn-m	PhiVnx Wind	70.58 Kn
PhiNcx Dead	343.36 Kn	PhiMnx Dead	19.47 Kn-m	PhiVnx Dead	42.35 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.38 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.15 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 20.74 \text{ mm} < 49.33 \text{ mm}$$

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

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 =	600 mm	Pile Diameter
L =	1500 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 =	11.61 Kn-m
Shear Wind =	3.87 Kn

Pile Properties

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

Checks

$$\text{Applied Forces/Capacities} = 0.97 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

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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 = 3 m²

Moment Wind = 3.87 Kn-m
Shear Wind = 1.29 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 = 0.48 < 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 = 3000 mm Distance at which the shear force is applied
f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 3.87 Kn-m
Shear Wind = 1.29 Kn

Pile Properties

Safety Factor 0.55

$H_u = 4.55 \text{ Kn}$ Ultimate Lateral Strength of the Pile, Short pile

$M_u = 8.02 \text{ Kn-m}$ Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = $0.48 < 1$ 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) x Density of Soil(18) x Height of Pile(1500) x K_s (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 = 21.83 Kn

Uplift on one Pile = 7.14 Kn

Uplift is ok