Job No.:Bradley Law-ShedAddress:84 Ward Road, Hamurana, Rotorua, New ZealandDate:13/04/2024Latitude:-38.029294Longitude:176.242263Elevation:318.5 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	2	Subsoil Category	D	Exposure Zone	В
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	3.4 m
Wind Region	NZ2	Terrain Category	2.68	Design Wind Speed	44.31 m/s
Wind Pressure	1.18 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 Pressues

Shed Type = Mono Open

For roof Cp, i = 0.6649

For roof CP,e from 0 m To 3.20 m Cpe = -0.9 pe = -0.67 KPa pnet = -1.26 KPa

For roof CP,e from 3.20 m To 6.40 m Cpe = -0.5 pe = -0.37 KPa pnet = -0.96 KPa

For wall Windward Cp, i = 0.6649 side Wall Cp, i = -0.5849

For wall Windward and Leeward $\,$ CP,e $\,$ from 0 m $\,$ To 9 m $\,$ Cpe = 0.7 $\,$ pe = 0.74 KPa $\,$ pnet = 1.49 KPa

For side wall CP,e from 0 m To 3.20 m Cpe = pe = -0.69 KPa pnet = 0.06 KPa

Maximum Upward pressure used in roof member Design = 1.26 KPa

Maximum Downward pressure used in roof member Design = 0.86 KPa

Maximum Wall pressure used in Design = 1.49 KPa

Maximum Racking pressure used in Design = 1.27 KPa

Design Summary

Purlin Design

Purlin Spacing = 900 mm Purlin Span = 2850 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 =0.98 S1 Downward =9.63 S1 Upward =12.01

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

Capacity Checks

M1.35D	0.31 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	406.45 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	1.06 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	158.49 %
$M_{0.9D\text{-W}nUp}$	-0.95 Kn-m	Capacity	-2.07 Kn-m	Passing Percentage	217.89 %
V _{1.35D}	0.43 Kn	Capacity	7.24 Kn	Passing Percentage	1683.72 %

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$V_{1.2D+1.5L\ 1.2D+Sn\ 1.2D+WnDn}$	1.49 Kn	Capacity	9.65 Kn	Passing Percentage	647.65 %
V _{0.9D-WnUp}	-1.33 Kn	Capacity	-12.06 Kn	Passing Percentage	906.77 %

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 = 4.59 mm

Limit by Woolcock et al, 1999 Span/240 = 11.67 mm

Deflection under Dead and Service Wind = 7.11 mm

Limit by Woolcock et al, 1999 Span/100 = 28.00 mm

Reactions

Maximum downward = 1.49 kn Maximum upward = -1.33 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 = 3000 mm Internal Rafter Span = 3350 mm Try Rafter 2x200x50 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 = 5.33 S1 Upward = 5.33

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

Capacity Checks

M1.35D	1.42 Kn-m	Capacity	4.48 Kn-m	Passing Percentage	315.49 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	4.88 Kn-m	Capacity	5.98 Kn-m	Passing Percentage	122.54 %
$M_{0.9D\text{-W}nUp}$	-4.36 Kn-m	Capacity	-7.46 Kn-m	Passing Percentage	171.10 %
V _{1.35D}	1.70 Kn	Capacity	19.3 Kn	Passing Percentage	1135.29 %
V1.2D+1.5L 1.2D+Sn 1.2D+WnDn	5.83 Kn	Capacity	25.72 Kn	Passing Percentage	441.17 %
V0.9D-WnUp	-5.20 Kn	Capacity	-32.16 Kn	Passing Percentage	618.46 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 4.395 mm

Limit by Woolcock et al, 1999 Span/240 = 14.58 mm

Deflection under Dead and Service Wind = 7.57 mm

Limit by Woolcock et al, 1999 Span/100 = 35.00 mm

Reactions

Maximum downward = 5.83 kn Maximum upward = -5.20 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

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 = 100 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 = 21.67 Kn > -5.20 Kn

Rafter Design External

External Rafter Load Width = 1500 mm

External Rafter Span = 3306 mm

Try Rafter 200x50 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 =11.27 S1 Upward =11.27

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

Capacity Checks

M1.35D	0.69 Kn-m	Capacity	2.23 Kn-m	Passing Percentage	323.19 %
M1.2D+1.5L 1.2D+Sn 1.2D+WnDn	2.38 Kn-m	Capacity	2.97 Kn-m	Passing Percentage	124.79 %
$M_{0.9D\text{-W}nUp}$	-2.12 Kn-m	Capacity	-3.72 Kn-m	Passing Percentage	175.47 %
V _{1.35D}	0.84 Kn	Capacity	9.65 Kn	Passing Percentage	1148.81 %
V _{1.2D+1.5L} 1.2D+Sn 1.2D+WnDn	2.88 Kn	Capacity	12.86 Kn	Passing Percentage	446.53 %
V _{0.9D-WnUp}	-2.57 Kn	Capacity	-16.08 Kn	Passing Percentage	625.68 %

Deflections

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

k2 for Long Term Loads = 2

Deflection under Dead and Live Load = 4.88 mm
Deflection under Dead and Service Wind = 7.57 mm

Limit by Woolcock et al, 1999 Span/240= 14.58 mm Limit by Woolcock et al, 1999 Span/100 = 35.00 mm

Reactions

Maximum downward = 2.88 kn Maximum upward = -2.57 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 fpj = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

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

Eccentric Load check

 $V = phi \times k1 \times k4 \times k5 \times fs \times b \times ds \dots (Eq 4.12) = -14.70 \text{ kn} > -2.57 \text{ Kn}$

Single Shear Capacity under short term loads = -10.84 Kn > -2.57 Kn

Girt Design Front and Back

Girt's Spacing = 850 mm Girt's Span = 3000 mm Try Girt 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

 Mwind+Snow
 1.42 Kn-m
 Capacity
 1.65 Kn-m
 Passing Percentage
 116.20 %

 V0.9D-WnUp
 1.90 Kn
 Capacity
 12.06 Kn
 Passing Percentage
 634.74 %

Deflections

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

Deflection under Snow and Service Wind = 14.18 mm Limit by Woolcock et al, 1999 Span/100 = 30.00 mm

Sag during installation = 4.91 mm

Reactions

Maximum = 1.90 kn

Girt Design Sides

Girt's Spacing = 850 mm Girt's Span = 3500 mm Try Girt 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 = 0.95 S1 Downward = 9.63 S1 Upward = 13.43

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

Capacity Checks

Mwind+Snow 1.94 Kn-m Capacity 2.00 Kn-m Passing Percentage 103.09 % V_{0.9D-WnUp} 2.22 Kn Capacity 12.06 Kn Passing Percentage 543.24 %

Deflections

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

Deflection under Snow and Service Wind = 26.27 mm Limit by Woolcock et al. 1999 Span/100 = 35.00 mm

Sag during installation =9.10 mm

Reactions

Maximum = 2.22 kn

Middle Pole Design

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3200 mm
Area	20729 mm2	As	15546.6796875 mm2
Ix	34210793 mm4	Zx	421056 mm3
Iy	34210793 mm4	Zx	421056 mm3
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 10.5 m^2

Dead	2.63 Kn	Live	2.63 Kn
Wind Down	9.03 Kn	Snow	0.00 Kn
Moment wind	5.49 Kn-m		
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

Peeling	Steaming	Normal	Dry Use
fb =	36.3 MPa	$f_S =$	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	22 MPa	E =	9257 MPa

Capacities

PhiNcx Wind	298.50 Kn	PhiMnx Wind	12.23 Kn-m	PhiVnx Wind	36.81 Kn
PhiNcx Dead	179.10 Kn	PhiMnx Dead	7.34 Kn-m	PhiVnx Dead	22.09 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.50 < 1 OK

 $(Mx/PhiMnx)^2+(N/phiNcx) = 0.25 < 1 OK$

Deflection at top under service lateral loads = $26.51 \text{ mm} \le 32.00 \text{ mm}$

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

Assumed 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 Middle Bay Pole

Ds = 0.6 mm Pile Diameter

L= 1200 mm Pile embedment length

f1 = 2550 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 5.49 Kn-m Shear Wind = 2.15 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.11 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 6.20 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.89 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

150 SED H5 (Minimum 175 dia. at Floor Level)	Dry Use	Height	3200 mm
Area	20729 mm2	As	15546.6796875 mm2
Ix	34210793 mm4	Zx	421056 mm3
Iy	34210793 mm4	Zx	421056 mm3
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 5.25 m^2

Dead	1.31 Kn	Live	1.31 Kn
Wind Down	4.51 Kn	Snow	0.00 Kn
Moment Wind	2.75 Kn-m		
Phi	0.8	K8	0.69
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

Peeling	Steaming	Normal	Dry Use
fb =	36.3 MPa	$f_S =$	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	22 MPa	E =	9257 MPa

Capacities

PhiNcx Wind 204.58 Kn PhiMnx Wind 8.38 Kn-m PhiVnx Wind 36.81 Kn

PhiNcx Dead 122.75 Kn PhiMnx Dead 5.03 Kn-m PhiVnx Dead 22.09 Kn

Checks

(Mx/PhiMnx)+(N/phiNcx) = 0.36 < 1 OK

 $(Mx/PhiMnx)^2 + (N/phiNcx) = 0.14 < 1 \text{ OK}$

Deflection at top under service lateral loads = 14.05 mm < 33.91 mm

Ds = 0.6 mm Pile Diameter

L= 1200 mm Pile embedment length

f1 = 2550 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Total Area over Pole = 5.25 m^2

Moment Wind = 2.75 Kn-m Shear Wind = 1.08 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.11 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 6.20 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.44 < 1 OK

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

Assumed Soil Properties

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

 $K0 = \frac{(1-\sin(30)) / (1+\sin(30))}{Kp} = \frac{(1+\sin(30)) / (1-\sin(30))}{(1-\sin(30))}$

Geometry For End Bay Pole

Ds = 0.6 mm Pile Diameter

L= 1200 mm Pile embedment length

f1 = 2550 mm Distance at which the shear force is applied f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 2.75 Kn-m Shear Wind = 1.08 Kn

Pile Properties

Safety Factory 0.55

Hu = 4.11 Kn Ultimate Lateral Strength of the Pile, Short pile

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Mu = 6.20 Kn-m

Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.44 < 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 = Safecty factor (0.55) x Density of Soil(18) x Height of Pile(1200) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1200)

Skin Friction = 11.63 Kn

Weight of Pile + Pile Skin Friction = 15.56 Kn

Uplift on one Pile = 10.87 Kn

Uplift is ok