

Job No.: 230211**Address:** 32 Kahu Lane, Springvale, New Zealand**Date:** 3/15/2023**Latitude:** -45.182188**Longitude:** 169.452559**Elevation:** 219.5 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	KPa	Roof Live Point Load	Kn
Snow Zone	N5	Ground Snow Load	0.9 KPa	Roof Snow Load	0.63 KPa
Earthquake Zone	2	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.2 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	38.53 m/s
Wind Pressure	0.89 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years
Wind Category	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 3.90 m $C_{p,e} = -0.9$ $p_e = -0.72$ KPa $p_{net} = -0.72$ KPa

For roof $C_{p,e}$ from 3.90 m To 7.80 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 $p_{net} = 0.56$ KPa

For side wall $C_{p,e}$ from 0 m To 3.90 m $C_{p,e} =$ $p_e = -0.52$ KPa $p_{net} = -0.52$ KPa

Maximum Upward pressure used in roof member Design = 0.72 KPa

Maximum Downward pressure used in roof member Design = 0.43 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 = 4650 mm

Try Purlin 250x50 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 = 0.97

K8 Upward = 0.35 S1 Downward = 12.68 S1 Upward = 28.66

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

Capacity Checks

$M_{1.35D}$	0.82 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	414.63 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	2.26 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	200.44 %
$M_{0.9D-W_nUp}$	-1.2 Kn-m	Capacity	-2.07 Kn-m	Passing Percentage	191.67 %
$V_{1.35D}$	0.71 Kn	Capacity	12.06 Kn	Passing Percentage	1698.59 %

Pole Shed App Ver 01 2022

V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.95 Kn	Capacity	16.08 Kn	Passing Percentage	824.62 %
V _{0.9D-WnUp}	-1.04 Kn	Capacity	-20.10 Kn	Passing Percentage	1932.69 %

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 = 7.22 mm Limit by Woolcock et al, 1999 Span/ = 18.40 mm

Deflection under Dead and Service Wind = 8.60 mm Limit by Woolcock et al, 1999 Span/ = 30.67 mm

Reactions

Maximum downward = 1.95 kn Maximum upward = -1.04 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 = 4800 mm Internal Rafter Span = 11850 mm Try Rafter 2x400x90 LVL11

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 = 4.25 S₁ Upward = 4.25

Shear Capacity of timber = 5 MPa Bending Capacity of timber = 38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

M _{1.35D}	28.44 Kn-m	Capacity	83.44 Kn-m	Passing Percentage	293.39 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	78.36 Kn-m	Capacity	111.26 Kn-m	Passing Percentage	141.99 %
M _{0.9D-WnUp}	-41.71 Kn-m	Capacity	-139.08 Kn-m	Passing Percentage	333.45 %
V _{1.35D}	9.60 Kn	Capacity	115.78 Kn	Passing Percentage	1206.04 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	26.45 Kn	Capacity	154.36 Kn	Passing Percentage	583.59 %
V _{0.9D-WnUp}	-14.08 Kn	Capacity	-192.96 Kn	Passing Percentage	1370.45 %

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 36.82 mm Limit by Woolcock et al, 1999 Span/ = 48.00 mm

Deflection under Dead and Service Wind = 48.75 mm Limit by Woolcock et al, 1999 Span/ = 80.00 mm

Reactions

Maximum downward = 26.45 kn Maximum upward = -14.08 kn

Rafter to Pole Connection check

Bolt Size = M16 Number of Bolts = 3

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 = 80 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

$K_{11} = 12.6 \text{ fpj} = 22.7 \text{ Mpa}$ for Rafter with effective thickness = 180 mm

For Parallel to grain loading

$K_{11} = 2.0 \text{ fcj} = 36.1 \text{ Mpa}$ for Pole with effective thickness = 100 mm

Capacity under short term loads = 77.63 Kn > -14.08 Kn

Rafter Design External

External Rafter Load Width = 2400 mm

External Rafter Span = 11815 mm

Try Rafter 400x90 LVL11

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 = 1.00

K_8 Upward = 1.00 S_1 Downward = 8.88 S_1 Upward = 8.88

Shear Capacity of timber = 5 MPa Bending Capacity of timber = 38 MPa NZS3603 Amt 4, table 2.3

Capacity Checks

$M_{1.35D}$	14.13 Kn-m	Capacity	41.72 Kn-m	Passing Percentage	295.26 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	38.95 Kn-m	Capacity	55.63 Kn-m	Passing Percentage	142.82 %
$M_{0.9D-W_nUp}$	-20.73 Kn-m	Capacity	-69.54 Kn-m	Passing Percentage	335.46 %
$V_{1.35D}$	4.79 Kn	Capacity	57.89 Kn	Passing Percentage	1208.56 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	13.19 Kn	Capacity	77.18 Kn	Passing Percentage	585.14 %
$V_{0.9D-W_nUp}$	-7.02 Kn	Capacity	-96.48 Kn	Passing Percentage	1374.36 %

Deflections

Modulus of Elasticity = 9900 MPa NZS3603 Amt 4, Table 2.3

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 40.91 mm

Limit by Woolcock et al, 1999 Span/= 48.00 mm

Deflection under Dead and Service Wind = 48.75 mm

Limit by Woolcock et al, 1999 Span/= 80.00 mm

Reactions

Maximum downward = 13.19 kn Maximum upward = -7.02 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

$K_{11} = 12.6 \text{ fpj} = 22.7 \text{ Mpa}$ for Rafter with effective thickness = 90 mm

For Parallel to grain loading

$K_{11} = 2.0$ $f_{c,j} = 36.1$ 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) = -107.10 kn > -7.02 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -7.02 Kn

Intermediate Design Sides

Intermediate Spacing = 6000 mm

Intermediate Span = 3749 mm

Try Intermediate 2x250x50 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 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.97

K_8 Upward = 1.00 S_1 Downward = 12.68 S_1 Upward = 0.82

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

Capacity Checks

$M_{Wind+Snow}$	4.74 Kn-m	Capacity	11.66 Kn-m	Passing Percentage	245.99 %
$V_{0.9D-WnUp}$	5.06 Kn	Capacity	40.2 Kn	Passing Percentage	794.47 %

Deflections

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

Deflection under Snow and Service Wind = 37.98 mm

Limit by Woolcock et al, 1999 Span/ = 24.99 mm

Reactions

Maximum = 5.06 kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4800 mm

Try Girt 200x50 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 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.75 S_1 Downward = 11.27 S_1 Upward = 18.41

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

Capacity Checks

$M_{Wind+Snow}$	2.15 Kn-m	Capacity	2.79 Kn-m	Passing Percentage	129.77 %
$V_{0.9D-WnUp}$	1.79 Kn	Capacity	16.08 Kn	Passing Percentage	898.32 %

Deflections

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

Deflection under Snow and Service Wind = 40.67 mm

Limit by Woolcock et al, 1999 Span/ = 32.00 mm

Sag during installation = 32.19 mm

Reactions

Maximum = 1.79 kn

Girt Design Sides

Girt's Spacing = 600 mm

Girt's Span = 6000 mm

Try Girt 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 K4 =1 K5 =1 K8 Downward =1.00

K8 Upward =0.64 S1 Downward =11.27 S1 Upward =20.58

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

Capacity Checks

M _{Wind+Snow}	2.24 Kn-m	Capacity	2.40 Kn-m	Passing Percentage	107.14 %
V _{0.9D-WnUp}	1.49 Kn	Capacity	16.08 Kn	Passing Percentage	1079.19 %

Deflections

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

Deflection under Snow and Service Wind = 66.19 mm

Limit by Woolcock et al. 1999 Span/100 = 40.00 mm

Sag during installation =78.58 mm

Reactions

Maximum = 1.49 kn

Middle Pole Design

Geometry

225 SED H5 (Minimum 250 dia. at Floor Level)	Dry Use	Height	3840 mm
Area	44279 mm ²	As	33209.1796875 mm ²
I _x	156100441 mm ⁴	Z _x	1314530 mm ³
I _y	156100441 mm ⁴	Z _y	1314530 mm ³
Lateral Restraint	3400 mm c/c		

Loads

Total Area over Pole = 28.8 m²

Dead	7.20 Kn	Live	7.20 Kn
Wind Down	12.38 Kn	Snow	18.14 Kn
Moment wind	15.20 Kn-m	Moment snow	4.52 Kn-m
Phi	0.8	K8	0.92
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

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

Capacities

PhiNcx Wind	589.62 Kn	PhiMnx Wind	35.30 Kn-m	PhiVnx Wind	78.64 Kn
PhiNcx Dead	353.77 Kn	PhiMnx Dead	21.18 Kn-m	PhiVnx Dead	47.18 Kn
PhiNcx Snow	471.69 Kn	PhiMnx Snow	28.24 Kn-m	PhiVnx Snow	62.91 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.49 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.25 < 1$ OK

Deflection at top under service lateral loads = 23.84 mm < 51.20 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
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 =	1700 mm	Pile embedment length
f1 =	3150 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	15.20 Kn-m	Moment Snow =	Kn-m
Shear Wind =	4.83 Kn	Shear Snow =	4.52 Kn

Pile Properties

Safety Factory	0.55	
Hu =	9.03 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	17.07 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.89 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

225 SED H5 (Minimum 250 dia. at Floor Level)	Dry Use	Height	4000 mm
Area	44279 mm ²	As	33209.1796875 mm ²

Pole Shed App Ver 01 2022

Ix	156100441 mm ⁴	Zx	1314530 mm ³
Iy	156100441 mm ⁴	Zy	1314530 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 28.8 m²

Dead	7.20 Kn	Live	7.20 Kn
Wind Down	12.38 Kn	Snow	18.14 Kn
Moment Wind	7.60 Kn-m	Moment snow	2.26 Kn-m
Phi	0.8	K _s	0.82
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	524.52 Kn	PhiM _{nx} Wind	31.40 Kn-m	PhiV _{nx} Wind	78.64 Kn
PhiN _{cx} Dead	314.71 Kn	PhiM _{nx} Dead	18.84 Kn-m	PhiV _{nx} Dead	47.18 Kn
PhiN _{cx} Snow	419.62 Kn	PhiM _{nx} Snow	25.12 Kn-m	PhiV _{nx} Snow	62.91 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.31 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.13 < 1$ OK

Deflection at top under service lateral loads = 13.01 mm < 55.86 mm

D _s =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f ₁ =	3150 mm	Distance at which the shear force is applied
f ₂ =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 28.8 m²

Moment Wind =	7.60 Kn-m	Moment Snow =	2.26 Kn-m
Shear Wind =	2.41 Kn	Shear Snow =	2.26 Kn

Pile Properties

Safety Factor	0.55		
H _u =	4.40 Kn	Ultimate Lateral Strength of the Pile, Short pile	
M _u =	8.11 Kn-m	Ultimate Moment Capacity of Pile	

Checks

Applied Forces/Capacities = 0.94 < 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 =	3150 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	7.60 Kn-m	Moment Snow =	2.26 Kn-m
Shear Wind =	2.41 Kn	Shear Snow =	2.26 Kn

Pile Properties

Safety Factory	0.55	
Hu =	4.40 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	8.11 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.94 < 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(1700) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(1700)

Skin Friction = 23.34 Kn

Weight of Pile + Pile Skin Friction = 27.24 Kn

Uplift on one Pile = 14.26 Kn

Uplift is ok