

Pole Shed App Ver 01 2022

Job No.: Whitehall Fruitpackers Pole Shed **Address:** 714 Maungatautari Road,, Maungatautari, New Zealand **Date:** 23/08/2024
Latitude: -37.940972 **Longitude:** 175.546278 **Elevation:** 81.5 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	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4 m
Wind Region	NZ1	Terrain Category	2.56	Design Wind Speed	42.68 m/s
Wind Pressure	1.09 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 3.70 m $C_{p,e} = -0.9$ $p_e = -0.89$ KPa $p_{net} = -1.11$ KPa

For roof $C_{p,e}$ from 3.70 m To 7.40 m $C_{p,e} = -0.5$ $p_e = -0.49$ KPa $p_{net} = -0.71$ 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 24 m $C_{p,e} = 0.7$ $p_e = 0.69$ KPa $p_{net} = 1.02$ KPa

For side wall $C_{p,e}$ from 0 m To 3.70 m $C_{p,e} =$ $p_e = -0.64$ KPa $p_{net} = -0.64$ KPa

Maximum Upward pressure used in roof member Design = 1.11 KPa

Maximum Downward pressure used in roof member Design = 0.53 KPa

Maximum Wall pressure used in Design = 1.02 KPa

Maximum Racking pressure used in Design = 1.18 KPa

Design Summary

Purlin Design

Purlin Spacing = 850 mm Purlin Span = 3279 mm Try Purlin 140x45 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 =1.00

K8 Upward =0.69 S1 Downward =10.36 S1 Upward =19.63

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

Capacity Checks

M _{1.35D}	0.39 Kn-m	Capacity	0.99 Kn-m	Passing Percentage	253.85 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	1.24 Kn-m	Capacity	1.32 Kn-m	Passing Percentage	106.45 %
M _{0.9D-W_{nUp}}	-1.01 Kn-m	Capacity	-1.13 Kn-m	Passing Percentage	121.51 %

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V _{1.35D}	0.47 Kn	Capacity	6.08 Kn	Passing Percentage	1293.62 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.16 Kn	Capacity	8.10 Kn	Passing Percentage	698.28 %
V _{0.9D-WnUp}	-1.23 Kn	Capacity	-10.13 Kn	Passing Percentage	823.58 %

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 = 10.47 mm	Limit by Woolcock et al, 1999 Span/240 = 13.45 mm
Deflection under Dead and Service Wind = 13.35 mm	Limit by Woolcock et al, 1999 Span/100 = 32.29 mm

Reactions

Maximum downward = 1.16 kn Maximum upward = -1.23 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 = 3429 mm Internal Rafter Span = 7350 mm Try Rafter 2x300x45 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 = 7.61 S₁ Upward = 7.61

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

Capacity Checks

M _{1.35D}	7.81 Kn-m	Capacity	24.62 Kn-m	Passing Percentage	315.24 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	19.22 Kn-m	Capacity	32.84 Kn-m	Passing Percentage	170.86 %
M _{0.9D-WnUp}	-20.49 Kn-m	Capacity	-41.04 Kn-m	Passing Percentage	200.29 %
V _{1.35D}	4.25 Kn	Capacity	43.42 Kn	Passing Percentage	1021.65 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	10.46 Kn	Capacity	57.88 Kn	Passing Percentage	553.35 %
V _{0.9D-WnUp}	-11.15 Kn	Capacity	-72.36 Kn	Passing Percentage	648.97 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 19.025 mm	Limit by Woolcock et al, 1999 Span/240 = 31.25 mm
Deflection under Dead and Service Wind = 26.955 mm	Limit by Woolcock et al, 1999 Span/100 = 75.00 mm

Reactions

Maximum downward = 10.46 kn Maximum upward = -11.15 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 = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

$K_{11} = 12.6$ $f_{pj} = 22.7$ Mpa for Rafter with effective thickness = 90 mm

For Parallel to grain loading

$K_{11} = 2.0$ $f_{cj} = 36.1$ Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 29.11 Kn > -11.15 Kn

Rafter Design External

External Rafter Load Width = 1714.5 mm

External Rafter Span = 7323 mm

Try Rafter 300x45 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 = 0.88

K_8 Upward = 0.88 S_1 Downward = 15.50 S_1 Upward = 15.50

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

Capacity Checks

$M_{1.35D}$	3.88 Kn-m	Capacity	10.84 Kn-m	Passing Percentage	279.38 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	9.54 Kn-m	Capacity	14.45 Kn-m	Passing Percentage	151.47 %
$M_{0.9D-W_nUp}$	-10.17 Kn-m	Capacity	-18.07 Kn-m	Passing Percentage	177.68 %
$V_{1.35D}$	2.12 Kn	Capacity	21.71 Kn	Passing Percentage	1024.06 %
$V_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	5.21 Kn	Capacity	28.94 Kn	Passing Percentage	555.47 %
$V_{0.9D-W_nUp}$	-5.56 Kn	Capacity	-36.18 Kn	Passing Percentage	650.72 %

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 = 21.14 mm

Limit by Woolcock et al, 1999 Span/240 = 31.25 mm

Deflection under Dead and Service Wind = 26.95 mm

Limit by Woolcock et al, 1999 Span/100 = 75.00 mm

Reactions

Maximum downward = 5.21 kn Maximum upward = -5.56 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 = 45 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) = -37.80 kn > -5.56 Kn

Single Shear Capacity under short term loads = -14.56 Kn > -5.56 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 3429 mm

Try Girt 140x45 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 =1.00

K8 Upward =0.93 S1 Downward =10.36 S1 Upward =14.30

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

Capacity Checks

$M_{Wind+Snow}$	1.35 Kn-m	Capacity	1.52 Kn-m	Passing Percentage	112.59 %
$V_{0.9D-WnUp}$	1.57 Kn	Capacity	10.13 Kn	Passing Percentage	645.22 %

Deflections

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

Deflection under Snow and Service Wind = 23.97 mm

Limit by Woolcock et al, 1999 Span/100 = 34.29 mm

Sag during installation = 10.35 mm

Reactions

Maximum = 1.57 kn

Girt Design Sides

Girt's Spacing = 0 mm

Girt's Span = 3750 mm

Try Girt SG8 Dry

Moisture Condition = Wet (Moisture in timber is less than 18% and timber does not remain in continuous wet condition after installation)

K1 Short term = 1 K4 =1 K5 =1 K8 Downward =NaN

K8 Upward =NaN S1 Downward =NaN S1 Upward =NaN

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

Capacity Checks

$M_{Wind+Snow}$	0.00 Kn-m	Capacity	NaN Kn-m	Passing Percentage	NaN %
$V_{0.9D-WnUp}$	0.00 Kn	Capacity	0.00 Kn	Passing Percentage	NaN %

Deflections

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

Deflection under Snow and Service Wind = NaN mm

Limit by Woolcock et al. 1999 Span/100 = 37.50 mm

Sag during installation = NaN mm

Reactions

Maximum = 0.00 kn

Middle Pole Design**Geometry**

200 SED H5 (Minimum 225 dia. at Floor Level)	Dry Use	Height	3700 mm
Area	35448 mm ²	As	26585.7421875 mm ²
Ix	100042702 mm ⁴	Zx	941578 mm ³
Iy	100042702 mm ⁴	Zx	941578 mm ³
Lateral Restraint	1300 mm c/c		

LoadsTotal Area over Pole = 12.85875 m²

Dead	3.21 Kn	Live	3.21 Kn
Wind Down	6.82 Kn	Snow	0.00 Kn
Moment wind	12.11 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	fs =	2.96 MPa
fc =	18 MPa	fp =	7.2 MPa
ft =	22 MPa	E =	9257 MPa

Capacities

PhiNcx Wind	510.45 Kn	PhiMnx Wind	27.34 Kn-m	PhiVnx Wind	62.96 Kn
PhiNcx Dead	306.27 Kn	PhiMnx Dead	16.41 Kn-m	PhiVnx Dead	37.77 Kn

Checks $(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.47 < 1$ OK $(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.22 < 1$ OK

Deflection at top under service lateral loads = 27.19 mm < 37.00 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
K0 =	$(1 - \sin(30)) / (1 + \sin(30))$				
Kp =	$(1 + \sin(30)) / (1 - \sin(30))$				

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Geometry For Middle Bay Pole

Ds =	0.6 mm	Pile Diameter
L =	1550 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 =	12.11 Kn-m
Shear Wind =	4.04 Kn

Pile Properties

Safety Factory	0.55	
Hu =	7.29 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	13.07 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.93 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3800 mm
Area	27598 mm ²	As	20698.2421875 mm ²
Ix	60639381 mm ⁴	Zx	646820 mm ³
Iy	60639381 mm ⁴	Zy	646820 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 12.85875 m²

Dead	3.21 Kn	Live	3.21 Kn
Wind Down	6.82 Kn	Snow	0.00 Kn
Moment Wind	6.05 Kn-m		
Phi	0.8	K8	0.66
K1 snow	0.8	K1 Dead	0.6
K1wind	1		

Material

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

Capacities

PhiNcx Wind	261.19 Kn	PhiMnx Wind	12.35 Kn-m	PhiVnx Wind	49.01 Kn
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PhiNcx Dead	156.71 Kn	PhiMnx Dead	7.41 Kn-m	PhiVnx Dead	29.41 Kn
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Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.54 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.29 < 1 \text{ OK}$$

Deflection at top under service lateral loads = 24.19 mm < 39.90 mm

Ds =	0.6 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 = 12.85875 m²

Moment Wind =	6.05 Kn-m
Shear Wind =	2.02 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 = 0.75 < 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 =	3000 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	6.05 Kn-m
Shear Wind =	2.02 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 = $0.75 < 1$ 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 $0.5 \times \tan(30)$ x π x Dia of Pile (0.6) x Height of Pile (1550)

Skin Friction = 19.40 Kn

Weight of Pile + Pile Skin Friction = 23.43 Kn

Uplift on one Pile = 11.38 Kn

Uplift is ok