

Job No.: 432 TUKAIRANGI ROAD**Address:** 432 TUKAIRANGI ROAD, Taupo, New Zealand**Date:** 06/12/2024**Latitude:** -38.654353**Longitude:** 176.018862**Elevation:** 543 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	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.328 m
Wind Region	NZ2	Terrain Category	2.0	Design Wind Speed	48.03 m/s
Wind Pressure	1.38 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 = Gable Enclosed

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

For roof $C_{p,e}$ from 0 m To 4.33 m $C_{p,e} = -0.9$ $p_e = -1.12$ KPa $p_{net} = -1.12$ KPa

For roof $C_{p,e}$ from 4.33 m To 8.66 m $C_{p,e} = -0.5$ $p_e = -0.62$ KPa $p_{net} = -0.62$ 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 8 m $C_{p,e} = 0.7$ $p_e = 0.87$ KPa $p_{net} = 1.29$ KPa

For side wall $C_{p,e}$ from 0 m To 4.33 m $C_{p,e} =$ $p_e = -0.81$ KPa $p_{net} = -0.81$ KPa

Maximum Upward pressure used in roof member Design = 1.12 KPa

Maximum Downward pressure used in roof member Design = 0.67 KPa

Maximum Wall pressure used in Design = 1.29 KPa

Maximum Racking pressure used in Design = 1.37 KPa

Design Summary**Purlin Design**

Purlin Spacing = 900 mm

Purlin Span = 3948 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 = 0.77 S1 Downward = 12.23 S1 Upward = 17.99

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

Capacity Checks

$M_{1.35D}$	0.59 Kn-m	Capacity	1.79 Kn-m	Passing Percentage	303.39 %
$M_{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}$	1.7 Kn-m	Capacity	2.38 Kn-m	Passing Percentage	140.00 %
$M_{0.9D-W_nUp}$	-1.57 Kn-m	Capacity	-2.33 Kn-m	Passing Percentage	148.41 %
$V_{1.35D}$	0.60 Kn	Capacity	8.25 Kn	Passing Percentage	1375.00 %

Pole Shed App Ver 01 2022

V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.72 Kn	Capacity	11.00 Kn	Passing Percentage	639.53 %
V _{0.9D-W_nUp}	-1.59 Kn	Capacity	-13.75 Kn	Passing Percentage	864.78 %

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 = 9.42 mm Limit by Woolcock et al, 1999 Span/240 = 16.24 mm

Deflection under Dead and Service Wind = 13.11 mm Limit by Woolcock et al, 1999 Span/100 = 38.98 mm

Reactions

Maximum downward = 1.72 kn Maximum upward = -1.59 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 = 4098 mm Internal Rafter Span = 7850 mm Try Rafter 2x300x63 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 = 1.00

K₈ Upward = 1.00 S₁ Downward = 5.30 S₁ Upward = 5.30

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

Capacity Checks

M _{1.35D}	10.65 Kn-m	Capacity	43.54 Kn-m	Passing Percentage	408.83 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	30.62 Kn-m	Capacity	58.06 Kn-m	Passing Percentage	189.61 %
M _{0.9D-W_nUp}	-28.25 Kn-m	Capacity	-72.58 Kn-m	Passing Percentage	256.92 %
V _{1.35D}	5.43 Kn	Capacity	64.42 Kn	Passing Percentage	1186.37 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	15.60 Kn	Capacity	85.9 Kn	Passing Percentage	550.64 %
V _{0.9D-W_nUp}	-14.40 Kn	Capacity	-107.38 Kn	Passing Percentage	745.69 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 18.925 mm Limit by Woolcock et al, 1999 Span/240 = 33.33 mm

Deflection under Dead and Service Wind = 29.26 mm Limit by Woolcock et al, 1999 Span/100 = 80.00 mm

Reactions

Maximum downward = 15.60 kn Maximum upward = -14.40 kn

Rafter to Pole Connection check

Bolt Size = M12 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 = 60 mm

Factor of Safety = 0.7

For Perpendicular to grain loading

K11 = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 126 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 = 43.67 Kn > -14.40 Kn

Rafter Design External

External Rafter Load Width = 2049 mm

External Rafter Span = 4057 mm

Try Rafter 290x45 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 =0.89

K8 Upward =0.89 S1 Downward =15.23 S1 Upward =15.23

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

Capacity Checks

M _{1.35D}	1.42 Kn-m	Capacity	3.78 Kn-m	Passing Percentage	266.20 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.09 Kn-m	Capacity	5.04 Kn-m	Passing Percentage	123.23 %
M _{0.9D-W_nUp}	-3.77 Kn-m	Capacity	-6.29 Kn-m	Passing Percentage	166.84 %
V _{1.35D}	1.40 Kn	Capacity	12.59 Kn	Passing Percentage	899.29 %
V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	4.03 Kn	Capacity	16.79 Kn	Passing Percentage	416.63 %
V _{0.9D-W_nUp}	-3.72 Kn	Capacity	-20.98 Kn	Passing Percentage	563.98 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.15 mm

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

Deflection under Dead and Service Wind = 5.77 mm

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

Reactions

Maximum downward =4.03 kn Maximum upward = -3.72 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 = 45 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) = -21.73 kn > -3.72 Kn

Single Shear Capacity under short term loads = -9.75 Kn > -3.72 Kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 4098 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)

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

K_8 Upward = 0.90 S_1 Downward = 12.23 S_1 Upward = 15.06

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

Capacity Checks

$M_{Wind+Snow}$	2.44 Kn-m	Capacity	2.72 Kn-m	Passing Percentage	111.48 %
$V_{0.9D-WnUp}$	2.38 Kn	Capacity	13.75 Kn	Passing Percentage	577.73 %

Deflections

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

Deflection under Snow and Service Wind = 24.74 mm

Limit by Woolcock et al, 1999 Span/100 = 40.98 mm

Sag during installation = 21.11 mm

Reactions

Maximum = 2.38 kn

Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 4000 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)

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

K_8 Upward = 0.90 S_1 Downward = 12.23 S_1 Upward = 14.88

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

Capacity Checks

$M_{Wind+Snow}$	2.32 Kn-m	Capacity	2.74 Kn-m	Passing Percentage	118.10 %
$V_{0.9D-WnUp}$	2.32 Kn	Capacity	13.75 Kn	Passing Percentage	592.67 %

Deflections

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

Deflection under Snow and Service Wind = 22.46 mm

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

Sag during installation = 19.16 mm

Reactions

Maximum = 2.32 kn

End Pole Design

Geometry For End Bay Pole

Geometry

200 UNI H5	Dry Use	Height	4128 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 = 8.196 m²

Dead	2.05 Kn	Live	2.05 Kn
Wind Down	5.49 Kn	Snow	0.00 Kn
Moment Wind	6.56 Kn-m		
Phi	0.8	K8	0.64
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	288.98 Kn	PhiMnx Wind	13.78 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	173.39 Kn	PhiMnx Dead	8.27 Kn-m	PhiVnx Dead	33.46 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.51 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.26 < 1$ OK

Deflection at top under service lateral loads = 24.94 mm < 43.17 mm

Ds =	0.6 mm	Pile Diameter
L =	1300 mm	Pile embedment length
f1 =	3246 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 8.196 m²

Moment Wind = 6.56 Kn-m

Shear Wind = 2.02 Kn

Pile Properties

Safety Factor 0.55

Hu = 4.31 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.16 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.80 < 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 = $(1 - \sin(30)) / (1 + \sin(30))$

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 = 3246 mm Distance at which the shear force is applied

f2 = 0 mm Distance of top soil at rest pressure

Loads

Moment Wind = 6.56 Kn-m

Shear Wind = 2.02 Kn

Pile Properties

Safety Factor 0.55

Hu = 4.31 Kn Ultimate Lateral Strength of the Pile, Short pile

Mu = 8.16 Kn-m Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.80 < 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(1300) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of

Pile(0.6) x Height of Pile(1300)

Skin Friction = 13.65 Kn

Weight of Pile + Pile Skin Friction = 16.44 Kn

Uplift on one Pile = 14.67 Kn

Uplift is ok