

Job No.: Glenbrook Vintage Railway**Address:** 201 Pukeoware Rd, Waiuku, New Zealand**Date:** 31/10/2024**Latitude:** -37.230813**Longitude:** 174.753685**Elevation:** 29 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	4.3 m
Wind Region	NZ1	Terrain Category	2.38	Design Wind Speed	38.68 m/s
Wind Pressure	0.9 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 Open

For roof $C_{p,i} = 0.6579$

For roof $C_{p,e}$ from 0 m To 2.03 m $C_{p,e} = -0.905$ $p_e = -0.66$ KPa $p_{net} = -1.24$ KPa

For roof $C_{p,e}$ from 2.03 m To 4.05 m $C_{p,e} = -0.8975$ $p_e = -0.66$ KPa $p_{net} = -1.24$ KPa

For wall Windward $C_{p,i} = 0.6579$ side Wall $C_{p,i} = -0.5719$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 11.19 m $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 1.13$ KPa

For side wall $C_{p,e}$ from 0 m To 4.05 m $C_{p,e} =$ $p_e = -0.52$ KPa $p_{net} = 0.04$ KPa

Maximum Upward pressure used in roof member Design = 1.24 KPa

Maximum Downward pressure used in roof member Design = 0.64 KPa

Maximum Wall pressure used in Design = 1.13 KPa

Maximum Racking pressure used in Design = 0.97 KPa

Design Summary**Purlin Design**

Purlin Spacing = 800 mm

Purlin Span = 3580 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 = 0.72 S1 Downward = 9.63 S1 Upward = 19.08

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

Capacity Checks

M _{1.35D}	0.43 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	293.02 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n}	1.37 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	122.63 %
M _{0.9D-W_nUp}	-1.3 Kn-m	Capacity	-1.50 Kn-m	Passing Percentage	115.38 %
V _{1.35D}	0.48 Kn	Capacity	7.24 Kn	Passing Percentage	1508.33 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	1.35 Kn	Capacity	9.65 Kn	Passing Percentage	714.81 %
V _{0.9D-WnUp}	-1.45 Kn	Capacity	-12.06 Kn	Passing Percentage	831.72 %

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 = 10.30 mm Limit by Woolcock et al, 1999 Span/240 = 14.71 mm

Deflection under Dead and Service Wind = 14.08 mm Limit by Woolcock et al, 1999 Span/100 = 35.30 mm

Reactions

Maximum downward = 1.35 kn Maximum upward = -1.45 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 = 3730 mm Internal Rafter Span = 3850 mm Try Rafter 2x250x50 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 = 6.13 S₁ Upward = 6.13

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

Capacity Checks

M _{1.35D}	2.33 Kn-m	Capacity	7 Kn-m	Passing Percentage	300.43 %
M _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	6.50 Kn-m	Capacity	9.34 Kn-m	Passing Percentage	143.69 %
M _{0.9D-WnUp}	-7.01 Kn-m	Capacity	-11.66 Kn-m	Passing Percentage	166.33 %
V _{1.35D}	2.42 Kn	Capacity	24.12 Kn	Passing Percentage	996.69 %
V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	6.75 Kn	Capacity	32.16 Kn	Passing Percentage	476.44 %
V _{0.9D-WnUp}	-7.29 Kn	Capacity	-40.2 Kn	Passing Percentage	551.44 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 4.775 mm Limit by Woolcock et al, 1999 Span/240 = 16.67 mm

Deflection under Dead and Service Wind = 7.25 mm Limit by Woolcock et al, 1999 Span/100 = 40.00 mm

Reactions

Maximum downward = 6.75 kn Maximum upward = -7.29 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

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

Capacity under short term loads = 21.67 Kn > -7.29 Kn

Rafter Design External

External Rafter Load Width = 1865 mm

External Rafter Span = 3808 mm

Try Rafter 250x50 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_1 Medium term = 0.8 K_1 Long term = 0.6 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 0.97

K_8 Upward = 0.97 S_1 Downward = 12.68 S_1 Upward = 12.68

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

Capacity Checks

$M_{1.35D}$	1.14 Kn-m	Capacity	3.40 Kn-m	Passing Percentage	298.25 %
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	3.18 Kn-m	Capacity	4.53 Kn-m	Passing Percentage	142.45 %
$M_{0.9D-W_nUp}$	-3.43 Kn-m	Capacity	-5.67 Kn-m	Passing Percentage	165.31 %
$V_{1.35D}$	1.20 Kn	Capacity	12.06 Kn	Passing Percentage	1005.00 %
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	3.34 Kn	Capacity	16.08 Kn	Passing Percentage	481.44 %
$V_{0.9D-W_nUp}$	-3.60 Kn	Capacity	-20.10 Kn	Passing Percentage	558.33 %

Deflections

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

k_2 for Long Term Loads = 2

Deflection under Dead and Live Load = 5.30 mm

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

Deflection under Dead and Service Wind = 7.25 mm

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

Reactions

Maximum downward = 3.34 kn Maximum upward = -3.60 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

$K_{11} = 14.9$ $f_{pj} = 12.9$ Mpa for Rafter with effective thickness = 50 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) = -19.95 kn > -3.60 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.60 Kn

Intermediate Design Sides

Intermediate Spacing = 2000 mm

Intermediate Span = 4025 mm

Try Intermediate 2x200x50 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 = 1.00 S_1 Downward = 11.27 S_1 Upward = 0.75

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

Capacity Checks

$M_{Wind+Snow}$	2.29 Kn-m	Capacity	7.46 Kn-m	Passing Percentage	325.76 %
$V_{0.9D-WnUp}$	2.27 Kn	Capacity	32.16 Kn	Passing Percentage	1416.74 %

Deflections

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

Deflection under Snow and Service Wind = 21.45 mm

Limit by Woolcock et al, 1999 Span/100 = 40.25 mm

Reactions

Maximum = 2.27 kn

Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 3730 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)

K_1 Short term = 1 $K_4 = 1$ $K_5 = 1$ K_8 Downward = 1.00

K_8 Upward = 0.94 S_1 Downward = 9.63 S_1 Upward = 13.87

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

Capacity Checks

$M_{Wind+Snow}$	1.77 Kn-m	Capacity	1.97 Kn-m	Passing Percentage	111.30 %
$V_{0.9D-WnUp}$	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 = 27.21 mm

Limit by Woolcock et al, 1999 Span/100 = 37.30 mm

Sag during installation = 11.74 mm

Reactions

Maximum = 1.90 kn

Girt Design Sides

Girt's Spacing = 1300 mm

Girt's Span = 2000 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 =0.92 S1 Downward =9.63 S1 Upward =14.36

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

Capacity Checks

M _{Wind+Snow}	0.73 Kn-m	Capacity	1.94 Kn-m	Passing Percentage	265.75 %
V _{0.9D-WnUp}	1.47 Kn	Capacity	12.06 Kn	Passing Percentage	820.41 %

Deflections

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

Deflection under Snow and Service Wind = 3.25 mm

Limit by Woolcock et al. 1999 Span/100 = 20.00 mm

Sag during installation =0.97 mm

Reactions

Maximum = 1.47 kn

Middle Pole Design

Geometry

200 UNI H5	Dry Use	Height	4050 mm
Area	31400 mm ²	As	23550 mm ²
I _x	78500000 mm ⁴	Z _x	785000 mm ³
I _y	78500000 mm ⁴	Z _y	785000 mm ³
Lateral Restraint	1300 mm c/c		

Loads

Total Area over Pole = 14.92 m²

Dead	3.73 Kn	Live	3.73 Kn
Wind Down	9.55 Kn	Snow	0.00 Kn
Moment wind	8.34 Kn-m		
Phi	0.8	K8	1.00
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

Material

Shaving	Steaming	Normal	Dry Use
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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	452.16 Kn	PhiMnx Wind	21.56 Kn-m	PhiVnx Wind	55.77 Kn
PhiNcx Dead	271.30 Kn	PhiMnx Dead	12.93 Kn-m	PhiVnx Dead	33.46 Kn

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.42 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.19 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 29.57 \text{ mm} < 40.50 \text{ mm}$$

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 =	1400 mm	Pile embedment length
f1 =	3225 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	8.34 Kn-m
Shear Wind =	2.59 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.29 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	10.02 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.83 < 1 \text{ OK}$$

End Pole Design

Geometry For End Bay Pole

Geometry

175 UNI H5	Dry Use	Height	4050 mm
Area	24041 mm ²	As	18030.46875 mm ²
Ix	46015259 mm ⁴	Zx	525889 mm ³

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Iy	46015259 mm ⁴	Zx	525889 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 7.46 m²

Dead	1.86 Kn	Live	1.86 Kn
Wind Down	4.77 Kn	Snow	0.00 Kn
Moment Wind	4.17 Kn-m		
Phi	0.8	K8	0.53
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	182.23 Kn	PhiMnx Wind	7.60 Kn-m	PhiVnx Wind	42.70 Kn
PhiNcx Dead	109.34 Kn	PhiMnx Dead	4.56 Kn-m	PhiVnx Dead	25.62 Kn

Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.60 < 1$ OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.35 < 1$ OK

Deflection at top under service lateral loads = 26.71 mm < 42.89 mm

Ds =	0.6 mm	Pile Diameter
L =	1400 mm	Pile embedment length
f1 =	3225 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Total Area over Pole = 7.46 m²

Moment Wind =	4.17 Kn-m
Shear Wind =	1.29 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.29 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	10.02 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.42 < 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 =	1400 mm	Pile embedment length
f1 =	3225 mm	Distance at which the shear force is applied
f2 =	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind =	4.17 Kn-m
Shear Wind =	1.29 Kn

Pile Properties

Safety Factory	0.55	
Hu =	5.29 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	10.02 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.42 < 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 (1400) x Ks (1.5) x 0.5 x tan(30) x Pi x Dia of Pile (0.6) x Height of Pile (1400)

Skin Friction = 15.83 Kn

Weight of Pile + Pile Skin Friction = 19.69 Kn

Uplift on one Pile = 15.14 Kn

Uplift is ok