

Job No.: Horse Arena**Address:** 131 Sandon Rd, Feilding, New Zealand**Date:** 23/08/2024**Latitude:** -40.218059**Longitude:** 175.542694**Elevation:** 99.5 m**General Input**

Roof Live Load	0.25 KPa	Roof Dead Load	0.25 KPa	Roof Live Point Load	1.1 Kn
Snow Zone	N1	Ground Snow Load	0 KPa	Roof Snow Load	0 KPa
Earthquake Zone	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	5.781 m
Wind Region	NZ2	Terrain Category	2.25	Design Wind Speed	40.72 m/s
Wind Pressure	0.99 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 = Gable Free

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

For roof $C_{p,e}$ from 0 m To 5.78 m $C_{p,e} = -0.9$ $p_e = -0.81$ KPa $p_{net} = -0.81$ KPa

For roof $C_{p,e}$ from 5.78 m To 11.56 m $C_{p,e} = -0.5$ $p_e = -0.45$ KPa $p_{net} = -0.45$ 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 22 m $C_{p,e} = 0.7$ $p_e = 0.63$ KPa $p_{net} = 0.93$ KPa

For side wall $C_{p,e}$ from 0 m To 5.78 m $C_{p,e} =$ $p_e = -0.58$ KPa $p_{net} = -0.58$ KPa

Maximum Upward pressure used in roof member Design = 0.81 KPa

Maximum Downward pressure used in roof member Design = 0.48 KPa

Maximum Wall pressure used in Design = 0.93 KPa

Maximum Racking pressure used in Design = 0.53 KPa

Design Summary**Rafter Design External**

External Rafter Load Width = 2818 mm

External Rafter Span = 10845 mm

Try Rafter 450x63 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 = 0.95

K8 Upward = 0.95 S1 Downward = 13.57 S1 Upward = 13.57

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

Capacity Checks

M _{1.35D}	13.98 Kn-m	Capacity	43.42 Kn-m	Passing Percentage	310.59 %
M _{1.2D+1.5L 1.2D+S_n 1.2D+W_{nDn}}	32.32 Kn-m	Capacity	57.89 Kn-m	Passing Percentage	179.12 %
M _{0.9D-W_{nUp}}	-24.24 Kn-m	Capacity	-72.37 Kn-m	Passing Percentage	298.56 %
V _{1.35D}	5.16 Kn	Capacity	48.32 Kn	Passing Percentage	936.43 %

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V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn}	11.92 Kn	Capacity	64.43 Kn	Passing Percentage	540.52 %
V _{0.9D-WnUp}	-8.94 Kn	Capacity	-80.54 Kn	Passing Percentage	900.89 %

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 30.63 mm

Limit by Woolcock et al, 1999 Span/240 = 45.83 mm

Deflection under Dead and Service Wind = 37.77 mm

Limit by Woolcock et al, 1999 Span/100 = 110.00 mm

Reactions

Maximum downward = 11.92 kn Maximum upward = -8.94 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

Factor of Safety = 0.7

For Perpendicular to grain loading

K₁₁ = 12.6 fpj = 22.7 Mpa for Rafter with effective thickness = 63 mm

For Parallel to grain loading

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

Eccentric Load check

V = $\phi \times k_1 \times k_4 \times k_5 \times f_s \times b \times d_s$ (Eq 4.12) = -91.15 kn > -8.94 Kn

Single Shear Capacity under short term loads = -21.83 Kn > -8.94 Kn

Girt Design Front and Back

Girt's Spacing = 0 mm

Girt's Span = 2818 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

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Deflection under Snow and Service Wind = NaN mm

Limit by Woolcock et al, 1999 Span/100 = 28.18 mm

Sag during installation = NaN mm

Reactions

Maximum = 0.00 kn

Girt Design Sides

Girt's Spacing = 0 mm

Girt's Span = 5500 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 = 55.00 mm

Sag during installation =NaN mm

Reactions

Maximum = 0.00 kn

End Pole Design

Geometry For End Bay Pole

Geometry

250 SED H5 (Minimum 275 dia. at Floor Level)	Dry Use	Height	5581 mm
Area	54091 mm ²	As	40568.5546875 mm ²
I _x	232952248 mm ⁴	Z _x	1774874 mm ³
I _y	232952248 mm ⁴	Z _y	1774874 mm ³
Lateral Restraint	mm c/c		

Loads

Total Area over Pole = 30.998 m²

Dead	7.75 Kn	Live	7.75 Kn
Wind Down	14.88 Kn	Snow	0.00 Kn
Moment Wind	6.22 Kn-m		
Phi	0.8	K8	0.61
K1 snow	0.8	K1 Dead	0.6
K1 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

PhiNcx Wind	474.76 Kn	PhiMnx Wind	31.42 Kn-m	PhiVnx Wind	96.07 Kn
PhiNcx Dead	284.85 Kn	PhiMnx Dead	18.85 Kn-m	PhiVnx Dead	57.64 Kn

Checks

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

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.10 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 13.52 \text{ mm} < 57.67 \text{ mm}$$

$D_s =$	0.6 mm	Pile Diameter
$L =$	1500 mm	Pile embedment length
$f_1 =$	4336 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

Loads

$$\text{Total Area over Pole} = 30.998 \text{ m}^2$$

Moment Wind =	6.22 Kn-m
Shear Wind =	1.44 Kn

Pile Properties

Safety Factory	0.55	
$H_u =$	5.15 Kn	Ultimate Lateral Strength of the Pile, Short pile
$M_u =$	12.91 Kn-m	Ultimate Moment Capacity of Pile

Checks

$$\text{Applied Forces/Capacities} = 0.48 < 1 \text{ OK}$$

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
$K_0 =$	$(1 - \sin(30)) / (1 + \sin(30))$				
$K_p =$	$(1 + \sin(30)) / (1 - \sin(30))$				

Geometry For End Bay Pole

$D_s =$	0.6 mm	Pile Diameter
$L =$	1500 mm	Pile embedment length
$f_1 =$	4336 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

Loads

Moment Wind = 6.22 Kn-m
Shear Wind = 1.44 Kn

Pile Properties

Safety Factor	0.55	
Hu =	5.15 Kn	Ultimate Lateral Strength of the Pile, Short pile
Mu =	12.91 Kn-m	Ultimate Moment Capacity of Pile

Checks

Applied Forces/Capacities = 0.48 < 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(2100) x Ks(1.5) x 0.5 x tan(30) x Pi x Dia of Pile(0.6) x Height of Pile(2100)

Skin Friction = 35.62 Kn

Weight of Pile + Pile Skin Friction = 37.94 Kn

Uplift on one Pile = 36.27 Kn

Uplift is ok