

Job Number:

**BWhite  
Consulting Ltd**

Issue:

## **PRODUCER STATEMENT-PS1-DESIGN**

ISSUED BY: **BWhite Consulting Ltd (Design Engineer: Bevan White)**

TO BE SUPPLIED TO: **Manawatu District Council** IN RESPECT OF: **Proposed NEW Farm Shed**

AT: **59 Arapata Road, Waituna West 4779, New Zealand**

### **LEGAL DESCRIPTION**

We have been engaged by **Ezequote Pty Ltd** to provide **Specific Structural Engineering Design** services in respect of the requirements of Clause(s) **B1** of the Building Code for part only (as specified in the attachment to this statement), of the proposed building work.

☐ ALL ☒ Part only as specified: Purlins, Rafters, Girts, Poles, Columns, Pole embedment and all connections

The design has been prepared in accordance with compliance documents to NZ Building Code issued by Ministry of Business, Innovation & Employment Clauses **B1/VM1 and B1/VM4**

The proposed building work covered by the producer statement is described on **Ezequote** drawings title **Guadagin** and numbered **A101-A120 Rev-01** dated **16/02/2024** together with the following specification, and other documents set out in the schedule attached to this statement: **Design Featured Report Dated 15/02/2024 and numbered "Second Page"**

**On behalf of BWhite Consulting Ltd, and subject to:**

1. Site verification of the following design assumptions: **an Ultimate foundation bearing pressure of 300 kPa in accordance with NZS3604:2011**
2. **The building has a design life of 50 years and am Importance Level 1**
3. **Unless specifically noted, compliance of the drawings to None-Specific codes such as NZS3604 and NZS4229 have not been checked by this practice**
4. **This Certificate does not cover any other building code clause including weather tightness**
5. **Inspections of the building to be completed by Manawatu District Council. As BWhite Consulting Ltd are not undertaking inspections, we cannot issue a producer Statement-PS4- Construction Review.**
6. **This Producer Statement- Design is valid for a building consent issued within 1 year from the date of issue**
7. All proprietary products meeting their performance specification requirements

**I believe on reasonable grounds** that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the follow level of construction monitoring/observation:

☒ CM1 ☐ CM2 ☐ CM3 ☐ CM4 ☐ CM5 or as per agreement with owner/developer (**stated above**)

**I, Bevan White** am CPEng **108276** I am Member of Engineering New Zealand and hold the following qualification: **BE.Civil**

BWhite Consulting Ltd holds a current policy of Professional Indemnity Insurance no less than \$200,000.

Signed by **Bevan White** on behalf of **BWhite Consulting Ltd** Dated: **15/02/2024**

Email: [bwhitecpeng@gmail.com](mailto:bwhitecpeng@gmail.com) Phone: 0211-979786

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Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of \$200,000.

This form is to accompany Form 2 of the Building (Forms) Regulations 2004 for the application of a Building Consent

**Date:** 15/02/2024

18B Jules Crescent,

Bell Block New Plymouth 4312

New Zealand

File No:

**BWhite  
Consulting Ltd**

**DESIGN FEATURES SUMMARY FOR PROPOSED NEW FARM SHED 59 ARAPATA ROAD, WAITUNA WEST 4779, NEW ZEALAND**

**Site Specific Loads**

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	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & EQ ARI	100 Years	Max Height	4.465 m
Wind Region	NZ2	Terrain Category	2.28	Design Wind Speed	40.37 m/s
Wind Pressure	0.98 KPa	Lee Zone	NO	Ultimate Snow ARI	50 Years

**Timber**

Sawn Timber to be graded to the properties of SG6 and SG8 or better as mentioned on plans, with moisture content of 18% or less for dry and 25% or less for wet.

The following standards have been used in the design of this structure

- NZS 3603:1993 Timber Structures Standard
- NZS 3604:2011 Timber Framed Buildings. Standards New Zealand, 2011
- NZS 3404:1997 Steel Structures
- AS/NZS 1170 2003 Structural Design Actions
- AS/NZS 1170.2 2021 Structural Design Actions- Wind Action
- Branz. "Engineering Basis of NZS 3604". April 2013

Yours Faithfully

**BWhite CONSULTING LTD**

**Bevan White**

Director | BE Civil . CMengNZ CPEng

Email: bwhitecpeng@gmail.com Contact: 0211 979 786

**Job No.:** Guadagin**Address:** 59 Arapata Road, Waituna West 4779, New Zealand**Date:** 15/02/2024**Latitude:** -40.060608**Longitude:** 175.59898**Elevation:** 254.5 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	3	Subsoil Category	D	Exposure Zone	B
Importance Level	1	Ultimate wind & Earthquake ARI	100 Years	Max Height	4.465 m
Wind Region	NZ2	Terrain Category	2.28	Design Wind Speed	40.37 m/s
Wind Pressure	0.98 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 Enclosed

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

For roof  $C_{p,e}$  from 0 m To 2.65 m  $C_{p,e} = -0.924$   $p_e = -0.81$  KPa  $p_{net} = -0.81$  KPa

For roof  $C_{p,e}$  from 2.65 m To 5.30 m  $C_{p,e} = -0.888$   $p_e = -0.78$  KPa  $p_{net} = -0.78$  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 10 m  $C_{p,e} = 0.7$   $p_e = 0.62$  KPa  $p_{net} = 0.91$  KPa

For side wall  $C_{p,e}$  from 0 m To 5.30 m  $C_{p,e} =$   $p_e = -0.57$  KPa  $p_{net} = -0.57$  KPa

Maximum Upward pressure used in roof member Design = 0.81 KPa

Maximum Downward pressure used in roof member Design = 0.25 KPa

Maximum Wall pressure used in Design = 0.91 KPa

Maximum Racking pressure used in Design = 1.02 KPa

**Design Summary****Purlin Design**

Purlin Spacing = 900 mm

Purlin Span = 3183 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 = 0.77 S1 Downward = 9.63 S1 Upward = 17.97

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

**Capacity Checks**

M <sub>1.35D</sub>	0.38 Kn-m	Capacity	1.26 Kn-m	Passing Percentage	<b>331.58 %</b>
M <sub>1.2D+1.5L 1.2D+S<sub>n</sub> 1.2D+W<sub>n</sub>D<sub>n</sub></sub>	1.22 Kn-m	Capacity	1.68 Kn-m	Passing Percentage	<b>137.70 %</b>
M <sub>0.9D-W<sub>n</sub>Up</sub>	-0.67 Kn-m	Capacity	-1.62 Kn-m	Passing Percentage	<b>241.79 %</b>

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V <sub>1.35D</sub>	0.48 Kn	Capacity	7.24 Kn	Passing Percentage	<b>1508.33 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	0.97 Kn	Capacity	9.65 Kn	Passing Percentage	<b>994.85 %</b>
V <sub>0.9D-WnUp</sub>	-0.84 Kn	Capacity	-12.06 Kn	Passing Percentage	<b>1435.71 %</b>

**Deflections**

Modulus of Elasticity = 6700 MPa NZS3603 Amt 4, Table 2.3 considering at least 4 members acting together

k<sub>2</sub> for Long Term Loads = 2

Deflection under Dead and Live Load = 7.19 mm	Limit by Woolcock et al, 1999 Span/240 = 13.05 mm
Deflection under Dead and Service Wind = 7.49 mm	Limit by Woolcock et al, 1999 Span/100 = 31.33 mm

**Reactions**

Maximum downward = 0.97 kn Maximum upward = -0.84 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 = 3333 mm Internal Rafter Span = 5850 mm Try Rafter 2x300x50 SG8 Dry

Moisture Condition = Dry (Moisture in timber is less than 16% and timber does not remain in continuous wet condition after installation)

K<sub>1</sub> Short term = 1 K<sub>1</sub> Medium term = 0.8 K<sub>1</sub> Long term = 0.6 K<sub>4</sub> = 1 K<sub>5</sub> = 1 K<sub>8</sub> Downward = 1.00

K<sub>8</sub> Upward = 1.00 S<sub>1</sub> Downward = 6.81 S<sub>1</sub> Upward = 6.81

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

**Capacity Checks**

M <sub>1.35D</sub>	4.81 Kn-m	Capacity	10.08 Kn-m	Passing Percentage	<b>209.56 %</b>
M <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	9.62 Kn-m	Capacity	13.44 Kn-m	Passing Percentage	<b>139.71 %</b>
M <sub>0.9D-WnUp</sub>	-8.34 Kn-m	Capacity	-16.8 Kn-m	Passing Percentage	<b>201.44 %</b>
V <sub>1.35D</sub>	3.29 Kn	Capacity	28.94 Kn	Passing Percentage	<b>879.64 %</b>
V <sub>1.2D+1.5L 1.2D+Sn 1.2D+WnDn</sub>	6.58 Kn	Capacity	38.6 Kn	Passing Percentage	<b>586.63 %</b>
V <sub>0.9D-WnUp</sub>	-5.70 Kn	Capacity	-48.24 Kn	Passing Percentage	<b>846.32 %</b>

**Deflections**

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

k<sub>2</sub> for Long Term Loads = 2

Deflection under Dead and Live Load = 12.5 mm	Limit by Woolcock et al, 1999 Span/240 = 25.00 mm
Deflection under Dead and Service Wind = 14.465 mm	Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

**Reactions**

Maximum downward = 6.58 kn Maximum upward = -5.70 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

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

Capacity under short term loads = 21.67 Kn > -5.70 Kn

### **Rafter Design External**

External Rafter Load Width = 1666.5 mm

External Rafter Span = 6728 mm

Try Rafter 300x50 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 = 0.94

$K_8$  Upward = 0.94     $S_1$  Downward = 13.93     $S_1$  Upward = 13.93

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

### **Capacity Checks**

$M_{1.35D}$	3.18 Kn-m	Capacity	4.72 Kn-m	Passing Percentage	<b>148.43 %</b>
$M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	6.36 Kn-m	Capacity	6.30 Kn-m	Passing Percentage	<b>99.06 %</b>
$M_{0.9D-W_nUp}$	-5.52 Kn-m	Capacity	-7.87 Kn-m	Passing Percentage	<b>142.57 %</b>
$V_{1.35D}$	1.89 Kn	Capacity	14.47 Kn	Passing Percentage	<b>765.61 %</b>
$V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$	3.78 Kn	Capacity	19.30 Kn	Passing Percentage	<b>510.58 %</b>
$V_{0.9D-W_nUp}$	-3.28 Kn	Capacity	-24.12 Kn	Passing Percentage	<b>735.37 %</b>

### **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 = 13.89 mm

Limit by Woolcock et al, 1999 Span/240 = 25.00 mm

Deflection under Dead and Service Wind = 14.47 mm

Limit by Woolcock et al, 1999 Span/100 = 60.00 mm

### **Reactions**

Maximum downward = 3.78 kn    Maximum upward = -3.28 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

$K_{11} = 14.9 \text{ fpj} = 12.9 \text{ Mpa}$  for Rafter with effective thickness = 50 mm

For Parallel to grain loading

$K_{11} = 2.0 \text{ fcj} = 36.1 \text{ Mpa}$  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) = -25.20 kn > -3.28 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.28 Kn

### Intermediate Design Sides

Intermediate Spacing = 3000 mm

Intermediate Span = 2583 mm

Try Intermediate 2x150x50 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 = 1.00     $S_1$  Downward = 9.63     $S_1$  Upward = 0.52

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

### Capacity Checks

$M_{\text{Wind+Snow}}$	1.14 Kn-m	Capacity	4.2 Kn-m	Passing Percentage	<b>368.42 %</b>
$V_{0.9D-WnUp}$	1.76 Kn-m	Capacity	24.12 Kn-m	Passing Percentage	<b>1370.45 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 10.42 mm

Limit by Woolcock et al, 1999 Span/100 = 25.83 mm

### Reactions

Maximum = 1.76 kn

### Girt Design Front and Back

Girt's Spacing = 900 mm

Girt's Span = 3333 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 = 0.74     $S_1$  Downward = 9.63     $S_1$  Upward = 18.54

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

### Capacity Checks

$M_{\text{Wind+Snow}}$	1.14 Kn-m	Capacity	1.56 Kn-m	Passing Percentage	<b>136.84 %</b>
$V_{0.9D-WnUp}$	1.36 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	<b>886.76 %</b>

### Deflections

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

Deflection under Snow and Service Wind = 13.97 mm

Limit by Woolcock et al, 1999 Span/100 = 33.33 mm

Sag during installation = 7.48 mm

#### Reactions

Maximum = 1.36 kn

#### Girt Design Sides

Girt's Spacing = 900 mm

Girt's Span = 3000 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 =0.79    S1 Downward =9.63    S1 Upward =17.59

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

#### Capacity Checks

M <sub>Wind+Snow</sub>	0.92 Kn-m	Capacity	1.65 Kn-m	Passing Percentage	<b>179.35 %</b>
V <sub>0.9D-WnUp</sub>	1.23 Kn-m	Capacity	12.06 Kn-m	Passing Percentage	<b>980.49 %</b>

#### Deflections

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

Deflection under Snow and Service Wind = 9.17 mm

Limit by Woolcock et al. 1999 Span/100 = 30.00 mm

Sag during installation =4.91 mm

#### Reactions

Maximum = 1.23 kn

#### Middle Pole Design

##### Geometry

175 SED H5 (Minimum 200 dia. at Floor Level)	Dry Use	Height	3300 mm
Area	27598 mm <sup>2</sup>	As	20698.2421875 mm <sup>2</sup>
I <sub>x</sub>	60639381 mm <sup>4</sup>	Z <sub>x</sub>	646820 mm <sup>3</sup>
I <sub>y</sub>	60639381 mm <sup>4</sup>	Z <sub>y</sub>	646820 mm <sup>3</sup>
Lateral Restraint	3401 mm c/c		

#### Loads

Total Area over Pole = 19.998 m<sup>2</sup>

Dead	5.00 Kn	Live	5.00 Kn
Wind Down	5.00 Kn	Snow	0.00 Kn
Moment wind	8.45 Kn-m		
Phi	0.8	K8	0.76
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

#### Material

### Pole Shed App Ver 01 2022

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	302.55 Kn	PhiMnx Wind	14.30 Kn-m	PhiVnx Wind	49.01 Kn
PhiNcx Dead	181.53 Kn	PhiMnx Dead	8.58 Kn-m	PhiVnx Dead	29.41 Kn

#### Checks

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.64 < 1$  OK

$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.40 < 1$  OK

Deflection at top under service lateral loads = 31.17 mm < 33.00 mm

### **Drained Lateral Strength of Middle pile in cohesionless soils Free Head short pile**

#### Assumed Soil Properties

Gamma	18 Kn/m <sup>3</sup>	Friction angle	30 deg	Cohesion	0 Kn/m <sup>3</sup>
$K_0 =$	$(1 - \sin(30)) / (1 + \sin(30))$				
$K_p =$	$(1 + \sin(30)) / (1 - \sin(30))$				

#### Geometry For Middle Bay Pole

$D_s =$	0.6 mm	Pile Diameter
$L =$	1350 mm	Pile embedment length
$f_1 =$	3349 mm	Distance at which the shear force is applied
$f_2 =$	0 mm	Distance of top soil at rest pressure

#### Loads

Moment Wind =	8.45 Kn-m
Shear Wind =	2.52 Kn

#### Pile Properties

Safety Factory	0.55	
$H_u =$	4.67 Kn	Ultimate Lateral Strength of the Pile, Short pile
$M_u =$	9.13 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	4165 mm
Area	27598 mm <sup>2</sup>	$A_s$	20698.2421875 mm <sup>2</sup>



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Ix	60639381 mm <sup>4</sup>	Zx	646820 mm <sup>3</sup>
Iy	60639381 mm <sup>4</sup>	Zy	646820 mm <sup>3</sup>
Lateral Restraint	mm c/c		

**Loads**

Total Area over Pole = 9.999 m<sup>2</sup>

Dead	2.50 Kn	Live	2.50 Kn
Wind Down	2.50 Kn	Snow	0.00 Kn
Moment Wind	4.23 Kn-m		
Phi	0.8	K8	0.57
K1 snow	0.8	K1 Dead	0.6
K1 wind	1		

**Material**

Peeling	Steaming	Normal	Dry Use
f <sub>b</sub> =	36.3 MPa	f <sub>s</sub> =	2.96 MPa
f <sub>c</sub> =	18 MPa	f <sub>p</sub> =	7.2 MPa
f <sub>t</sub> =	22 MPa	E =	9257 MPa

**Capacities**

PhiN <sub>cx</sub> Wind	224.91 Kn	PhiM <sub>nx</sub> Wind	10.63 Kn-m	PhiV <sub>nx</sub> Wind	49.01 Kn
PhiN <sub>cx</sub> Dead	134.94 Kn	PhiM <sub>nx</sub> Dead	6.38 Kn-m	PhiV <sub>nx</sub> Dead	29.41 Kn

**Checks**

$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.43 < 1$  OK

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

Deflection at top under service lateral loads = 21.03 mm < 44.54 mm

D <sub>s</sub> =	0.6 mm	Pile Diameter
L =	1350 mm	Pile embedment length
f <sub>1</sub> =	3349 mm	Distance at which the shear force is applied
f <sub>2</sub> =	0 mm	Distance of top soil at rest pressure

**Loads**

Total Area over Pole = 9.999 m<sup>2</sup>

Moment Wind =	4.23 Kn-m
Shear Wind =	1.26 Kn

**Pile Properties**

Safety Factory	0.55	
H <sub>u</sub> =	4.67 Kn	Ultimate Lateral Strength of the Pile, Short pile
M <sub>u</sub> =	9.13 Kn-m	Ultimate Moment Capacity of Pile

**Checks**

Applied Forces/Capacities =  $0.46 < 1$  OK

## Drained Lateral Strength of End pile in cohesionless soils Free Head short pile

### Assumed Soil Properties

Gamma	18 Kn/m <sup>3</sup>	Friction angle	30 deg	Cohesion	0 Kn/m <sup>3</sup>
K <sub>0</sub> =	$(1 - \sin(30)) / (1 + \sin(30))$				
K <sub>p</sub> =	$(1 + \sin(30)) / (1 - \sin(30))$				

### Geometry For End Bay Pole

D <sub>s</sub> =	0.6 mm	Pile Diameter
L =	1350 mm	Pile embedment length
f <sub>1</sub> =	3349 mm	Distance at which the shear force is applied
f <sub>2</sub> =	0 mm	Distance of top soil at rest pressure

### Loads

Moment Wind =	4.23 Kn-m
Shear Wind =	1.26 Kn

### Pile Properties

Safety Factory	0.55	
H <sub>u</sub> =	4.67 Kn	Ultimate Lateral Strength of the Pile, Short pile
M <sub>u</sub> =	9.13 Kn-m	Ultimate Moment Capacity of Pile

### Checks

Applied Forces/Capacities =  $0.46 < 1$  OK

## Uplift Check

Density of Concrete = 24 Kn/m<sup>3</sup>

Density of Timber Pole = 5 Kn/m<sup>3</sup>

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

K<sub>s</sub> (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 (1350) x K<sub>s</sub> (1.5) x 0.5 x tan(30) x Pi x Dia of Pile (0.6) x Height of Pile (1350)

Skin Friction = 14.72 Kn

Weight of Pile + Pile Skin Friction = 18.67 Kn

Uplift on one Pile = 11.70 Kn

Uplift is ok