

Job Number:

Issue:

**BWhite
Consulting Ltd****PRODUCER STATEMENT-PS1-DESIGN**ISSUED BY: **BWhite Consulting Ltd (Design Engineer: Bevan White)**TO BE SUPPLIED TO: **Timaru District Council** IN RESPECT OF: **Proposed NEW Farm Shed**AT: **2 Southbelt, North Canterbury, 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/VMI and B1/VM4**

The proposed building work covered by the producer statement is described on **Ezequote** drawings title **Advertisement Shed 3** and numbered **A101-A115 Rev-1** dated **19/01/2024** together with the following specification, and other documents set out in the schedule attached to this statement: **Design Featured Report Dated 22/01/2024 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 an 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 Timaru 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: **22/01/2024**

Email: **bwhitecpeng@gmail.com** Phone: **0211-979786**

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: **22/01/2024**

18B Jules Crescent,

Bell Block New Plymouth 4312

New Zealand

File No:

**BWhite
Consulting Ltd****DESIGN FEATURES SUMMARY FOR PROPOSED NEW FARM SHED 2 SOUTHBELT, NORTH CANTERBURY, 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 | N4 | Ground Snow Load | 1.51 KPa | Roof Snow Load | 1.06 KPa |
| Earthquake Zone | 2 | Subsoil Category | D | Exposure Zone | B |
| Importance Level | 1 | Ultimate wind & EQ ARI | 100 Years | Max Height | 4 m |
| Wind Region | NZ2 | Terrain Category | 2.0 | Design Wind Speed | 38.81 m/s |
| Wind Pressure | 0.9 KPa | Lee Zone | NO | Ultimate Snow ARI | 50 Years |

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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.: Advertisement Shed 3

Address: 2 Southbelt, North Canterbury, New Zealand

Date: 22/01/2024

Latitude: -45.4741

Longitude: 168.686335

Elevation: 319 m

General Input

| | | | | | |
|------------------|----------|--------------------------------|-----------|----------------------|-----------|
| Roof Live Load | 0.25 KPa | Roof Dead Load | 0.25 KPa | Roof Live Point Load | 1.1 Kn |
| Snow Zone | N4 | Ground Snow Load | 1.51 KPa | Roof Snow Load | 1.06 KPa |
| Earthquake Zone | 2 | Subsoil Category | D | Exposure Zone | B |
| Importance Level | 1 | Ultimate wind & Earthquake ARI | 100 Years | Max Height | 4 m |
| Wind Region | NZ2 | Terrain Category | 2.0 | Design Wind Speed | 38.81 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 Enclosed

For roof $C_{p,i} = -0.6351$

For roof $C_{p,e}$ from 0 m To 3.50 m $C_{p,e} = -0.9$ $p_e = -0.58$ KPa $p_{net} = -0.92$ KPa

For roof $C_{p,e}$ from 3.50 m To 7.0 m $C_{p,e} = -0.5$ $p_e = -0.32$ KPa $p_{net} = -0.66$ KPa

For wall Windward $C_{p,i} = 0.4844$ side Wall $C_{p,i} = -0.6351$

For wall Windward and Leeward $C_{p,e}$ from 0 m To 13.50 m $C_{p,e} = 0.7$ $p_e = 0.57$ KPa $p_{net} = 1.14$ KPa

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For side wall C_{pe} from 0 m To 3.50 m $C_{pe} = p_e = -0.53 \text{ KPa}$ $p_{net} = 0.04 \text{ KPa}$

Maximum Upward pressure used in roof member Design = 0.92 KPa

Maximum Downward pressure used in roof member Design = 0.73 KPa

Maximum Wall pressure used in Design = 1.14 KPa

Maximum Racking pressure used in Design = 0.98 KPa

Design Summary

Purlin Design

Purlin Spacing = 850 mm

Purlin Span = 4350 mm

Try Purlin 200x50 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 = 0.47 S1 Downward = 11.27 S1 Upward = 24.64

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

Capacity Checks

| | | | | | |
|--|-----------|----------|------------|--------------------|------------------|
| $M_{1.35D}$ | 0.68 Kn-m | Capacity | 2.23 Kn-m | Passing Percentage | 327.94 % |
| $M_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$ | 2.73 Kn-m | Capacity | 2.97 Kn-m | Passing Percentage | 108.79 % |
| $M_{0.9D-W_nUp}$ | -1.4 Kn-m | Capacity | -1.76 Kn-m | Passing Percentage | 270.77 % |
| $V_{1.35D}$ | 0.62 Kn | Capacity | 9.65 Kn | Passing Percentage | 1556.45 % |
| $V_{1.2D+1.5L \ 1.2D+S_n \ 1.2D+W_nD_n}$ | 2.51 Kn | Capacity | 12.86 Kn | Passing Percentage | 512.35 % |
| $V_{0.9D-W_nUp}$ | -1.28 Kn | Capacity | -16.08 Kn | Passing Percentage | 1256.25 % |

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 = 10.17 mm

Limit by Woolcock et al, 1999 Span/240 = 17.92 mm

Deflection under Dead and Service Wind = 14.66 mm

Limit by Woolcock et al, 1999 Span/100 = 43.00 mm

Reactions

Maximum downward = 2.51 kn Maximum upward = -1.28 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 = 4500 mm

Internal Rafter Span = 3850 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)

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 = 6.81 S1 Upward = 6.81

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

Capacity Checks

| | | | | | |
|---|------------|----------|------------|--------------------|-----------------|
| M _{1.35D} | 2.81 Kn-m | Capacity | 10.08 Kn-m | Passing Percentage | 358.72 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 11.34 Kn-m | Capacity | 13.44 Kn-m | Passing Percentage | 118.52 % |
| M _{0.9D-W_nUp} | -5.79 Kn-m | Capacity | -16.8 Kn-m | Passing Percentage | 290.16 % |
| V _{1.35D} | 2.92 Kn | Capacity | 28.94 Kn | Passing Percentage | 991.10 % |
| V _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 11.78 Kn | Capacity | 38.6 Kn | Passing Percentage | 327.67 % |
| V _{0.9D-W_nUp} | -6.02 Kn | Capacity | -48.24 Kn | Passing Percentage | 801.33 % |

Deflections

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

k₂ for Long Term Loads = 2

| | |
|--|---|
| Deflection under Dead and Live Load = 3.335 mm | Limit by Woolcock et al, 1999 Span/240 = 16.67 mm |
| Deflection under Dead and Service Wind = 5.34 mm | Limit by Woolcock et al, 1999 Span/100 = 40.00 mm |

Reactions

Maximum downward = 11.78 kn Maximum upward = -6.02 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

K₁₁ = 14.9 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 100 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 36.1 Mpa for Pole with effective thickness = 100 mm

Capacity under short term loads = 21.67 Kn > -6.02 Kn

Rafter Design External

External Rafter Load Width = 2250 mm External Rafter Span = 3831 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)

K₁ Short term = 1 K₁ Medium term = 0.8 K₁ Long term = 0.6 K₄ = 1 K₅ = 1 K₈ Downward = 0.94

K₈ Upward = 0.94 S₁ Downward = 13.93 S₁ 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} | 1.39 Kn-m | Capacity | 4.72 Kn-m | Passing Percentage | 339.57 % |
| M _{1.2D+1.5L 1.2D+S_n 1.2D+W_nD_n} | 5.61 Kn-m | Capacity | 6.30 Kn-m | Passing Percentage | 112.30 % |

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| | | | | | |
|--|------------|----------|------------|--------------------|-----------------|
| M _{0.9D-WnUp} | -2.87 Kn-m | Capacity | -7.87 Kn-m | Passing Percentage | 274.22 % |
| V _{1.35D} | 1.45 Kn | Capacity | 14.47 Kn | Passing Percentage | 997.93 % |
| V _{1.2D+1.5L 1.2D+Sn 1.2D+WnDn} | 5.86 Kn | Capacity | 19.30 Kn | Passing Percentage | 329.35 % |
| V _{0.9D-WnUp} | -3.00 Kn | Capacity | -24.12 Kn | Passing Percentage | 804.00 % |

Deflections

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

k₂ for Long Term Loads = 2

Deflection under Dead and Live Load = 3.70 mm

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

Deflection under Dead and Service Wind = 5.34 mm

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

Reactions

Maximum downward = 5.86 kn Maximum upward = -3.00 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 f_{pj} = 12.9 Mpa for Rafter with effective thickness = 50 mm

For Parallel to grain loading

K₁₁ = 2.0 f_{cj} = 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) = -25.20 kn > -3.00 Kn

Single Shear Capacity under short term loads = -10.84 Kn > -3.00 Kn

Intermediate Design Sides

Intermediate Spacing = 2000 mm

Intermediate Span = 3599 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)

K₁ Short term = 1 K₄ = 1 K₅ = 1 K₈ Downward = 1.00

K₈ Upward = 1.00 S₁ Downward = 11.27 S₁ Upward = 0.71

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 | 7.46 Kn-m | Passing Percentage | 305.74 % |
| V _{0.9D-WnUp} | 2.72 Kn-m | Capacity | 32.16 Kn-m | Passing Percentage | 1182.35 % |

Deflections

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

Deflection under Snow and Service Wind = 32.165 mm

Limit by Woolcock et al, 1999 Span/100 = 35.99 mm

Reactions

Maximum = 2.72 kn

Girt Design Front and Back

Girt's Spacing = 1300 mm

Girt's Span = 2250 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 =0.89 S1 Downward =9.63 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 _{Wind+Snow} | 0.94 Kn-m | Capacity | 1.87 Kn-m | Passing Percentage | 198.94 % |
| V _{0.9D-WnUp} | 1.67 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | 722.16 % |

Deflections

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

Deflection under Snow and Service Wind = 10.13 mm

Limit by Woolcock et al, 1999 Span/100 = 22.50 mm

Sag during installation = 1.55 mm

Reactions

Maximum = 1.67 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} | 0.74 Kn-m | Capacity | 1.94 Kn-m | Passing Percentage | 262.16 % |
| V _{0.9D-WnUp} | 1.48 Kn-m | Capacity | 12.06 Kn-m | Passing Percentage | 814.86 % |

Deflections

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

Deflection under Snow and Service Wind = 6.32 mm

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

Sag during installation =0.97 mm

Reactions

Maximum = 1.48 kn

Middle Pole Design

Geometry

| | | | |
|--|--------------------------|--------|-------------------------------|
| 175 SED H5 (Minimum 200 dia. at Floor Level) | Dry Use | Height | 3700 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 | 1300 mm c/c | | |

Loads

Total Area over Pole = 18 m²

| | | | |
|---------------------|-----------|---------------------|-----------|
| Dead | 4.50 Kn | Live | 4.50 Kn |
| Wind Down | 13.14 Kn | Snow | 19.08 Kn |
| Moment wind | 8.80 Kn-m | Moment snow | 4.52 Kn-m |
| Phi | 0.8 | K _s | 1.00 |
| K ₁ snow | 0.8 | K ₁ Dead | 0.6 |
| K ₁ 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

| | | | | | |
|------------------------|-----------|------------------------|------------|------------------------|----------|
| PhiN _c Wind | 397.41 Kn | PhiM _n Wind | 18.78 Kn-m | PhiV _n Wind | 49.01 Kn |
| PhiN _c Dead | 238.44 Kn | PhiM _n Dead | 11.27 Kn-m | PhiV _n Dead | 29.41 Kn |
| PhiN _c Snow | 317.93 Kn | PhiM _n Snow | 15.03 Kn-m | PhiV _n Snow | 39.21 Kn |

Checks

$(M_x/\Phi M_n) + (N/\Phi N_c) = 0.55 < 1$ OK

$(M_x/\Phi M_n)^2 + (N/\Phi N_c) = 0.30 < 1$ OK

Deflection at top under service lateral loads = 32.59 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 ² |
| K ₀ = | $(1 - \sin(30)) / (1 + \sin(30))$ | | | | |
| K _p = | $(1 + \sin(30)) / (1 - \sin(30))$ | | | | |

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Geometry For Middle Bay Pole

| | | |
|------|---------|--|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1350 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 = | 8.80 Kn-m | Moment Snow = | Kn-m |
| Shear Wind = | 2.93 Kn | Shear Snow = | 4.52 Kn |

Pile Properties

| | | |
|----------------|-----------|---|
| Safety Factory | 0.55 | |
| Hu = | 5.04 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 8.91 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = 0.99 < 1 OK

End Pole Design

Geometry For End Bay Pole

Geometry

| | | | |
|--|--------------------------|--------|-------------------------------|
| 150 SED H5 (Minimum 175 dia. at Floor Level) | Dry Use | Height | 3700 mm |
| Area | 20729 mm ² | As | 15546.6796875 mm ² |
| Ix | 34210793 mm ⁴ | Zx | 421056 mm ³ |
| Iy | 34210793 mm ⁴ | Zx | 421056 mm ³ |
| Lateral Restraint | mm c/c | | |

Loads

Total Area over Pole = 9 m²

| | | | |
|-------------|-----------|-------------|-----------|
| Dead | 2.25 Kn | Live | 2.25 Kn |
| Wind Down | 6.57 Kn | Snow | 9.54 Kn |
| Moment Wind | 4.40 Kn-m | Moment snow | 2.26 Kn-m |
| Phi | 0.8 | K8 | 0.54 |
| 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 | 161.75 Kn | PhiMnx Wind | 6.63 Kn-m | PhiVnx Wind | 36.81 Kn |
|-------------|-----------|-------------|-----------|-------------|----------|

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| | | | | | |
|-------------|-----------|-------------|-----------|-------------|----------|
| PhiNcx Dead | 97.05 Kn | PhiMnx Dead | 3.98 Kn-m | PhiVnx Dead | 22.09 Kn |
| PhiNcx Snow | 129.40 Kn | PhiMnx Snow | 5.30 Kn-m | PhiVnx Snow | 29.45 Kn |

Checks

$$(M_x/\Phi M_{nx}) + (N/\Phi N_{cx}) = 0.77 < 1 \text{ OK}$$

$$(M_x/\Phi M_{nx})^2 + (N/\Phi N_{cx}) = 0.54 < 1 \text{ OK}$$

$$\text{Deflection at top under service lateral loads} = 31.15 \text{ mm} < 39.90 \text{ mm}$$

| | | |
|------|---------|--|
| Ds = | 0.6 mm | Pile Diameter |
| L = | 1350 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

$$\text{Total Area over Pole} = 9 \text{ m}^2$$

| | | | |
|---------------|-----------|---------------|-----------|
| Moment Wind = | 4.40 Kn-m | Moment Snow = | 2.26 Kn-m |
| Shear Wind = | 1.47 Kn | Shear Snow = | 2.26 Kn |

Pile Properties

| | | |
|----------------|-----------|---|
| Safety Factory | 0.55 | |
| Hu = | 5.04 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 8.91 Kn-m | Ultimate Moment Capacity of Pile |

Checks

$$\text{Applied Forces/Capacities} = 0.49 < 1 \text{ OK}$$

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 |
| 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 = | 1350 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 = | 4.40 Kn-m | Moment Snow = | 2.26 Kn-m |
| Shear Wind = | 1.47 Kn | Shear Snow = | 2.26 Kn |

Pile Properties

| | |
|----------------|------|
| Safety Factory | 0.55 |
|----------------|------|

| | | |
|------|-----------|---|
| Hu = | 5.04 Kn | Ultimate Lateral Strength of the Pile, Short pile |
| Mu = | 8.91 Kn-m | Ultimate Moment Capacity of Pile |

Checks

Applied Forces/Capacities = $0.49 < 1$ 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(1350) x Ks(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 = 12.51 Kn

Uplift is ok