# STRUCTURAL CALCULATIONS
# MICROPILE 5
# 2835 NW CORNELL RD.

## PORTLAND, OREGON 97210
## (NORTHWEST SOIL STABILIZATION)

STRUCTURAL
REGISTERED PROFESSIONAL ENGINEER
51411PE
OREGON
SEPT. 22, 1998
TIMOTHY T. TERICH
EXPIRES: 6-30-12

MAY 30, 2012
JOB NUMBER: 12-T110

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DOCUMENT SERVICES

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FROELICH
ENGINEERS INC

* * * LIMITATIONS * * *
ENGINEER WAS RETAINED IN A LIMITED CAPACITY FOR THIS PROJECT. DESIGN IS BASED UPON INFORMATION PROVIDED BY THE CLIENT, WHO IS SOLELY RESPONSIBLE FOR ACCURACY OF SAME. NO RESPONSIBILITY AND / OR LIABILITY IS ASSUMED BY, OR IS TO BE ASSIGNED TO THE ENGINEER FOR ITEMS BEYOND THAT SHOWN ON THESE SHEETS.

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# Scope of Work

**Client:** Northwest Soil Stabilization
**Project:** 2835 NW Cornell Rd. MicroPiles
**Project Number:** 12-T110
**Date:** May 2012
**By:** CAN

## Scope of Work:

Froelich Consulting Engineers, Inc. (FCE) has provided micropile design of the project per the 2009 International Building Code (IBC) and 2010 Oregon Structural Specialty Code (OSSC).

Froelich Consulting Engineers, Inc. has provided details only to the areas pertaining to our design. Froelich Consulting Engineers, Inc. did not design or review the details for the entire project.

## Project Description:

Design-Build Micropile design for new residential structure. Micropile capacities will be verified by testing.

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CLIENT: NWSS
PROJECT: 2835 NW Cornell
NUMBER: 12-TT10
DATE: 2012-05-29
BY: CAN



## MP Design

32K MP +6K = 38K
45K MP +6K = 51K

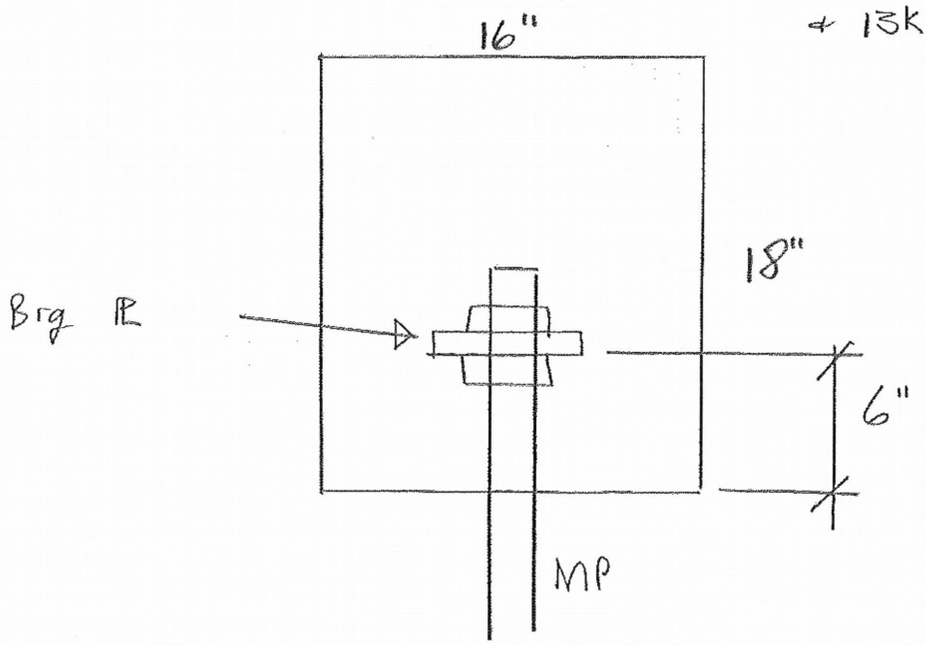
add downdrag force = 250 psf on casing

Casing = $\pi d = \pi(4.5'') = 14.14$ in = 1.18 ft  4" std pipe

downdrag = (250 psf)(1.18')(20') = 5.9K

## Grade Beam

Conn must develope
50K ↓
+ 13K ↑



FROELICH ENGINEERS

**Client:** NWSoil
**Project:** 2835 NW Cornell
**Proj. #:** 12-T110
**Date:** 5/27/2012
**By:** CAN

Drop Down Selection
Automatically Filled

# 32k Micropile Design

Per 2010 Oregon Structural Specialty Code (OSSC)
and Federal Highway Administration Micropile Design and Construction (FHWA-NHI-05-039)

| | |
|---|---|
| **Geotechnical Factor of Safety =** | **2** |
| **Design Compression Load (kips) =** | **38** |
| **Design Tension Load (kips) =** | **25** |

## Givens:

**Bar Properties**

| | | | | |
|---|---|---|---|---|
| Bar = | 32 mm HB | | HB = Hollow Bar by Williams® Form Engineering Corp. | |
| $d_{bar}$ = | 1.250 | in. | Otherwise, solid rebar. | |
| $d_{bi}$ = | 0.787 | in. | Inner Diameter of Hollow Bar (if applicable) | |
| $f_{ybar}$ = | 85 | ksi | ASTM A519 Cont. Threaded Rod | |
| $A_{bar}$ = | 0.56 | $in.^2$ | Net Area of Bar through Threads | |
| **Casing Properties** | | | | |
| Casing | Pipe 4 Std. | | | |
| $OD_{casing}$ = | 4.50 | in. | Outer Diameter of Casing | |
| $ID_{casing}$ = | 4.03 | in. | Inner Diameter of Casing | |
| $t_{casing}$ = | 0.221 | in. | Wall Thickness of Casing | |
| $A_{casing}$ = | 2.970 | $in.^2$ | Area of Casing Steel | |
| $t_{sacrificial}$= | 0.000 | in. | Sacrificial Wall Thickness of Casing | |
| $OD_{casing}$ = | 4.500 | in. | Modified for sacrificial steel on outside of casing. | |
| $t_{casing}$ = | 0.221 | in. | Modified for sacrificial steel on outside of casing. | |
| $A_{casing}$ = | 2.951 | $in.^2$ | Modified for sacrificial steel on outside of casing. | |
| $f_{ycasing}$ = | 35 | ksi | ASTM A53 Grade B Structural Pipe | |
| $L_{casing}$ = | 20 | ft | Length of Casing (below bottom of Pile Cap) | |
| **Grout Properties** | | | | |
| $f'_{c\text{-}grout}$ = | 4 | ksi | Compressive Strength of Grout | |
| **Drill Hole Properties** | | | | |
| $d_{drill\text{-}ca}$ = | 5.0 | in. | Diameter of Drill Hole in the Cased Portion | |
| $d_{drill}$ = | 5.0 | in. | Diameter of Drill Hole in the Uncased Portion | |
| **Geotechnical Properties** | | | $\alpha_{bond}$ | Ultimate grout to ground bond strength* |
| **Zone** | $\alpha_{bond}$ | **Top Elev.** | **Bot Elev.** | |
| | **(psf)** | **(ft)** | **(ft)** | **Description** |
| 1 | 0 | 0 | -20 | Un-bonded zone at casing |
| 2 | 2880 | -20 | -40 | Dense Gravel or Rock |
| 3 | | | | |
| 4 | | | | |
| | | | Per Geotechnical Investigation by: | |
| | | | Foster Gambee Geotechnical, PC | |
| | | | Report Number: 1027 | |
| | | | Dated: May 25, 2012 | |

## Allowable Micropile Load - Cased Length

$A_{grout}$ = 11.53 in.$^2$ Area of Grout = $\pi ID_{casing}^2/4 - \pi d_{bar}^2/4$

For compression, limit fy-bar and fy-casing to 87 ksi (based on limitation of grout failure at a strain of 0.003)

| | FHWA | | | OSSC | | |
|---|---|---|---|---|---|---|
| $P_{c\text{-allow}}$ = | **89.21** | **kips** | FHWA Eq 5-1 | **73.22** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{c\text{-allow}}$ = | $0.4f'_c x A_{grout} + 0.47(f_{ybar} x A_{bar} + f_{ycas} x A_{casing})$ | | | $0.33xf'_c x A_{grout} + 0.4f_{ybar} x A_{bar} + 0.4fy_{casing} A_{casing}$ | | |
| | | | | 0.4*fy-bar is limited to 30 ksi | | |
| | | | | 0.4*fy-casing is limited to 32 ksi | | |
| | | | | Capacity limited by OSSC 1810.3.10.3 | | |
| $P_{t\text{-allow}}$ = | **82.81** | **kips** | FHWA Eq 5-2 | **90.34** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{t\text{-allow}}$ = | $0.55(f_{ybar} x A_{bar} + f_{ycasing} x A_{casing})$ | | | $0.6(f_{ybar} x A_{bar} + f_{ycasing} x A_{casing})$ | | |

## Allowable Micropile Load - Uncased Length

$A_{grout}$ = 18.41 in.$^2$ Area of Grout = $\pi d_{drill}^2/4 - \pi d_{bar}^2/4$

For compression, limit fy-bar to 87 ksi (based on limitation of grout failure at a strain of 0.003)

| | FHWA | | | OSSC | | |
|---|---|---|---|---|---|---|
| $P_{c\text{-allow}}$ = | **51.66** | **kips** | FHWA Eq 5-7 | **38.77** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{c\text{-allow}}$ = | $0.4f'_c x A_{grout} + 0.47 f_{ybar} x A_{bar}$ | | | $0.3xf'_c x A_{grout} + 0.4f_{ybar} x A_{bar}$ | | |
| | | | | 0.4*fy-bar is limited 30 ksi | | |
| | | | | Capacity limited by OSSC 1810.3.10.3 | | |
| $P_{t\text{-allow}}$ = | **25.99** | **kips** | FHWA Eq 5-8 | **28.36** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{t\text{-allow}}$ = | $0.55 f_{ybar} x A_{bar}$ | | | $0.6 f_{ybar} x A_{bar}$ | | |

## Allowable Micropile Load - Geotechnical Bond Capacity

| Zone | $\alpha_{bond}$ (psf) | Top Elev. (ft) | Bot Elev. (ft) | $L_b$ (ft) | $P_{G\text{-allow}}$ (kips) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | -20 | 20 | 0.00 |
| 2 | 2880 | -20 | -40 | 20 | 37.70 |
| 3 | 0 | 0 | 0 | 0 | 0.00 |
| 4 | 0 | 0 | 0 | 0 | 0.00 |
| | | | | | **37.70** **kips** |

$P_{G\text{-allow}} = \alpha_{bond} x \pi x d_{drill} x L_b/FS$

## Allowable Micropile Load - Summary

| | Design Load (kips) | Allowable Capacities (kips) FHWA | OSSC | Soil Bond |
|---|---|---|---|---|
| Compression Load = | 38 | 52 | 39 | 38 |
| Tension Load = | 25 | 26 | 28 | 38 |

FROELICH ENGINEERS

**Client:** NWSoil
**Project:** 2835 NW Cornell
**Proj. #:** 12-T110
**Date:** 5/27/2012
**By:** CAN

Drop Down Selection
Automatically Filled

# 45k Micropile Design

Per 2010 Oregon Structural Specialty Code (OSSC)
and Federal Highway Administration Micropile Design and Construction (FHWA-NHI-05-039)

| | |
|---|---|
| **Geotechnical Factor of Safety =** | **2** |
| **Design Compression Load (kips) =** | **51** |
| **Design Tension Load (kips) =** | **32** |

## Givens:

**Bar Properties**

| | | | | |
|---|---|---|---|---|
| Bar = | 38 mm HB | | HB = Hollow Bar by Williams® Form Engineering Corp. | |
| $d_{bar}$ = | 1.500 | in. | Otherwise, solid rebar. | |
| $d_{bi}$ = | 0.830 | in. | Inner Diameter of Hollow Bar (if applicable) | |
| $f_{ybar}$ = | 85 | ksi | ASTM A519 Cont. Threaded Rod | |
| $A_{bar}$ = | 1.07 | $in.^2$ | Net Area of Bar through Threads | |
| **Casing Properties** | | | | |
| Casing | Pipe 4 Std. | | | |
| $OD_{casing}$ = | 4.50 | in. | Outer Diameter of Casing | |
| $ID_{casing}$ = | 4.03 | in. | Inner Diameter of Casing | |
| $t_{casing}$ = | 0.221 | in. | Wall Thickness of Casing | |
| $A_{casing}$ = | 2.970 | $in.^2$ | Area of Casing Steel | |
| $t_{sacrificial}$= | 0.000 | in. | Sacrificial Wall Thickness of Casing | |
| $OD_{casing}$ = | 4.500 | in. | Modified for sacrificial steel on outside of casing. | |
| $t_{casing}$ = | 0.221 | in. | Modified for sacrificial steel on outside of casing. | |
| $A_{casing}$ = | 2.951 | $in.^2$ | Modified for sacrificial steel on outside of casing. | |
| $f_{ycasing}$ = | 35 | ksi | ASTM A53 Grade B Structural Pipe | |
| $L_{casing}$ = | 20 | ft | Length of Casing (below bottom of Pile Cap) | |
| **Grout Properties** | | | | |
| $f'_{c\text{-}grout}$ = | 4 | ksi | Compressive Strength of Grout | |
| **Drill Hole Properties** | | | | |
| $d_{drill\text{-}ca}$ = | 5.0 | in. | Diameter of Drill Hole in the Cased Portion | |
| $d_{drill}$ = | 5.0 | in. | Diameter of Drill Hole in the Uncased Portion | |
| **Geotechnical Properties** | | | $\alpha_{bond}$ | Ultimate grout to ground bond strength* |
| **Zone** | $\alpha_{bond}$ | **Top Elev.** | **Bot Elev.** | |
| | **(psf)** | **(ft)** | **(ft)** | **Description** |
| 1 | 0 | 0 | -20 | Un-bonded zone at casing |
| 2 | 2880 | -20 | -50 | Dense Gravel or Rock |
| 3 | | | | |
| 4 | | | | |
| | | | Per Geotechnical Investigation by: | |
| | | | | Foster Gambee Geotechnical, PC |
| | | | | Report Number: 1027 |
| | | | | Dated: May 25, 2012 |

## Allowable Micropile Load - Cased Length

$A_{grout}$ = 10.99 in.$^2$ Area of Grout = $\pi ID_{casing}^2/4 - \pi d_{bar}^2/4$

For compression, limit fy-bar and fy-casing to 87 ksi (based on limitation of grout failure at a strain of 0.003)

| | FHWA | | | OSSC | | |
|---|---|---|---|---|---|---|
| $P_{c\text{-}allow}$ = | **108.76** | **kips** | FHWA Eq 5-1 | **87.83** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{c\text{-}allow}$ = | $0.4f'_c x A_{grout} + 0.47(f_{ybar} x A_{bar} + f_{ycas} x A_{casing})$ | | | $0.33xf'_c x A_{grout} + 0.4f_{ybar} x A_{bar} + 0.4fy_{casing} A_{casing}$ | | |
| | | | | 0.4*fy-bar is limited to 30 ksi | | |
| | | | | 0.4*fy-casing is limited to 32 ksi | | |
| | | | | Capacity limited by OSSC 1810.3.10.3 | | |
| $P_{t\text{-}allow}$ = | **106.70** | **kips** | FHWA Eq 5-2 | **116.40** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{t\text{-}allow}$ = | $0.55(f_{ybar} x A_{bar} + f_{ycasing} x A_{casing})$ | | | $0.6(f_{ybar} x A_{bar} + f_{ycasing} x A_{casing})$ | | |

## Allowable Micropile Load - Uncased Length

$A_{grout}$ = 17.87 in.$^2$ Area of Grout = $\pi d_{drill}^2/4 - \pi d_{bar}^2/4$

For compression, limit fy-bar to 87 ksi (based on limitation of grout failure at a strain of 0.003)

| | FHWA | | | OSSC | | |
|---|---|---|---|---|---|---|
| $P_{c\text{-}allow}$ = | **71.22** | **kips** | FHWA Eq 5-7 | **53.45** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{c\text{-}allow}$ = | $0.4f'_c x A_{grout} + 0.47f_{ybar} x A_{bar}$ | | | $0.3xf'_c x A_{grout} + 0.4f_{ybar} x A_{bar}$ | | |
| | | | | 0.4*fy-bar is limited 30 ksi | | |
| | | | | Capacity limited by OSSC 1810.3.10.3 | | |
| $P_{t\text{-}allow}$ = | **49.88** | **kips** | FHWA Eq 5-8 | **54.42** | **kips** | OSSC Table 1810.3.2.6 |
| $P_{t\text{-}allow}$ = | $0.55f_{ybar} x A_{bar}$ | | | $0.6f_{ybar} x A_{bar}$ | | |

## Allowable Micropile Load - Geotechnical Bond Capacity

| Zone | $\alpha_{bond}$ (psf) | Top Elev. (ft) | Bot Elev. (ft) | $L_b$ (ft) | $P_{G\text{-}allow}$ (kips) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | -20 | 20 | 0.00 |
| 2 | 2880 | -20 | -50 | 30 | 56.55 |
| 3 | 0 | 0 | 0 | 0 | 0.00 |
| 4 | 0 | 0 | 0 | 0 | 0.00 |
| | | | | | **56.55** **kips** |

$P_{G\text{-}allow} = \alpha_{bond} x \pi x d_{drill} x L_b/FS$

## Allowable Micropile Load - Summary

| | Design Load (kips) | Allowable Capacities (kips) FHWA | OSSC | Soil Bond |
|---|---|---|---|---|
| Compression Load = | 51 | 71 | 53 | 57 |
| Tension Load = | 32 | 50 | 54 | 57 |

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**Client:** NWSoil
**Project:** 2835 NW Cornell
**Proj. #:** 12-T110
**Date:** 5/27/2012
**By:** CAN

# 45k Micropile Bearing Plate Design

Per 2010 Oregon Structural Specialty Code (OSSC), 2009 IBC
ACI 318-08
AISC 360-05
2012 AASHTO LRFD Bridge Design Specifications

## Givens:

| | | |
|---|---|---|
| | **Design Load (kips) =** | **45** |
| AASHTO | **Pu = 1.75*Design Load (kips) =** | **78.75** |
| IBC | **Pu = 1.6*Design Load (kips) =** | **72** |

| **Pile Cap Properties** | | | |
|---|---|---|---|
| X = | 16 | in. | Width of Concrete Support |
| Z = | 16 | in. | Length of Concrete Support |
| d = | 8 | in. | Depth of embed of plate into concrete |
| $f'_c$ = | 3000 | psi | Compressive Strength of Concrete |
| **Bearing Plate Properties** | | | |
| B = | 6.00 | in. | Length of Bearing Plate |
| N = | 6.00 | in. | Width of Bearing Plate |
| t = | 0.750 | in. | Thickness of Bearing Plate |
| $f_y$ = | 36 | ksi | ASTM A36 Steel Plate |
| $d_h$ = | 2 | in. | Diameter of Hole in Bearing Plate for Micropile |

## Concrete Bearing Strength

| | | | |
|---|---|---|---|
| $A_1$ = | 32.86 | $in.^2$ | Area of Concrete Loaded directly by Bearing Plate (less Micropile Hole). |
| $A_2$ = | 252.86 | $in.^2$ | Area of Supported Concrete Loaded by Bearing Plate (less Micropile Hole). |
| $\sqrt{A_2/A_1}$ = | 2.77 | | |
| $\sqrt{A_2/A_1}$ = | 2.00 | | Use the maximum ratio of 2.0 per ACI 318 10.14.1 |

| | AASHTO | | | IBC | | |
|---|---|---|---|---|---|---|
| m = | 2.00 | | AASHTO Eq. 5.7.5-3 | | | |
| $\phi$ = | 0.70 | | AASHTO 5.5.4.2.1 | 0.65 | | ACI 318 section 9.3.2.4 |
| $\phi P_n$ = | **117** | **kips** | AASHTO Eq. 5.7.5-2 | **109** | **kips** | ACI 318 10.14.1 |
| | | | | **109** | **kips** | AISC eq. J8-2 |

## Concrete Punching Shear

| | | | | | | |
|---|---|---|---|---|---|---|
| $b_o$ = | 56 | in. | Critical Shear Perimeter | | | 4x(B+d) |
| | | | **AASHTO** | | | **IBC** |
| $\phi$ = | 0.90 | | AASHTO 5.5.4.2.1 | 0.75 | | ACI 318 section 9.3.2.3 |
| $\beta_c$ = | 1.00 | | AASHTO 5.13.3.6.3 | | | |
| $\phi V_C$ = | **132** | **kips** | Eq. 5.13.3.6.3-1 | **74** | **kips** | ACI 318 Eq. 11-33 |
| $\phi V_{Cmin}$ = | **88** | **kips** | Eq. 5.13.3.6.3-1 | | | |

## Plate Washer Thickness

| | | | | |
|---|---|---|---|---|
| l = | 2 | in. | cantilever length, less bolt hole | |
| S = | 0.094 | $in^3$ | $bt^2/6$ | per inch of width |
| Z = | 0.141 | $in^3$ | $bt^2/4$ | per inch of width |
| $M_p = F_yZ$ | | per inch of width | | |
| $1.6M_y = 1.6F_yS$ | | per inch of width | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **AASHTO** | | | **IBC** |
| $\phi$ = | 1.00 | | AASHTO 6.5.4.2 | 0.90 | | Per AISC Section F.1 |
| $M_p$ = | 5.1 | kip-in/in | Eq. 6.12.2.2.7-1 | 5.1 | kip-in/in | Per AISC eq. F11-1 |
| $1.6M_y$ = | 5.4 | kip-in/in | | 5.4 | kip-in/in | |
| $\Phi M_n$ = | 5.1 | kip-in/in | | 4.6 | kip-in/in | |
| $\Phi P_n$ = | **83** | **kips** | | **75** | **kips** | $2*\phi Mn/l^2*A_1$ |

## Micropile Bearing Plate - Summary

**Design Load (kips) and Capacities (kips)**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **AASHTO** | | | **IBC** |
| $P_u$ = | **79** | **kips** | Design Load | **72** | **kips** | Design Load |
| $\phi P_n$ = | **117** | **kips** | Capacity | **109** | **kips** | Concrete Bearing |
| $\phi V_C$ = | **88** | **kips** | Capacity | **74** | **kips** | Punching Shear |
| $\phi P_n$ = | **83** | **kips** | Capacity | **75** | **kips** | Plate Washer Steel |

FROELICH ENGINEERS!

**Client:** NWSoil
**Project:** 2835 NW Cornell
**Proj. #:** 12-T110
**Date:** 5/27/2012
**By:** CAN

# Micropile Bearing Plate Design - Tension

Per 2010 Oregon Structural Specialty Code (OSSC), 2009 IBC
ACI 318-08
AISC 360-05
2012 AASHTO LRFD Bridge Design Specifications

## Givens:

| | | |
|---|---|---|
| | **Design Load (kips) =** | **32** |
| AASHTO | **Pu = 1.75*Design Load (kips) =** | **56** |
| IBC | **Pu = 1.6*Design Load (kips) =** | **51.2** |

| **Pile Cap Properties** | | | |
|---|---|---|---|
| X = | 16 | in. | Width of Concrete Support |
| Z = | 16 | in. | Length of Concrete Support |
| d = | 8 | in. | Depth of embed of plate into concrete |
| $f'_c$ = | 3000 | psi | Compressive Strength of Concrete |
| **Bearing Plate Properties** | | | |
| B = | 6.00 | in. | Length of Bearing Plate |
| N = | 6.00 | in. | Width of Bearing Plate |
| t = | 0.750 | in. | Thickness of Bearing Plate |
| $f_y$ = | 36 | ksi | ASTM A36 Steel Plate |
| $d_h$ = | 4.5 | in. | Diameter of Hole in Bearing Plate for Micropile |

## Concrete Bearing Strength

| | | | |
|---|---|---|---|
| $A_1$ = | 20.10 | $in.^2$ | Area of Concrete Loaded directly by Bearing Plate (less Micropile Hole). |
| $A_2$ = | 240.10 | $in.^2$ | Area of Supported Concrete Loaded by Bearing Plate |
| $\sqrt{A_2/A_1}$ = | 3.46 | | |
| $\sqrt{A_2/A_1}$ = | 2.00 | | Use the maximum ratio of 2.0 per ACI 318 10.14.1 |

| | AASHTO | | | IBC | | |
|---|---|---|---|---|---|---|
| m = | 2.00 | | AASHTO Eq. 5.7.5-3 | | | |
| $\phi$ = | 0.70 | | AASHTO 5.5.4.2.1 | 0.65 | | ACI 318 section 9.3.2.4 |
| $\phi P_n$ = | **72** | **kips** | AASHTO Eq. 5.7.5-2 | **67** | **kips** | ACI 318 10.14.1 |
| | | | | **67** | **kips** | AISC eq. J8-2 |

## Concrete Punching Shear

| | | | | | | |
|---|---|---|---|---|---|---|
| $b_o$ = | 56 | in. | Critical Shear Perimeter | | | 4x(B+d) |
| | | | **AASHTO** | | | **IBC** |
| $\phi$ = | 0.90 | | AASHTO 5.5.4.2.1 | 0.75 | | ACI 318 section 9.3.2.3 |
| $\beta_c$ = | 1.00 | | AASHTO 5.13.3.6.3 | | | |
| $\phi V_C$ = | **132** | **kips** | Eq. 5.13.3.6.3-1 | **74** | **kips** | ACI 318 Eq. 11-33 |
| $\phi V_{Cmin}$ = | **88** | **kips** | Eq. 5.13.3.6.3-1 | | | |

## Plate Washer Thickness

| | | | | |
|---|---|---|---|---|
| l = | 0.75 | in. | cantilever length, less bolt hole | |
| S = | 0.094 | $in^3$ | $bt^2/6$ | per inch of width |
| Z = | 0.141 | $in^3$ | $bt^2/4$ | per inch of width |
| $M_p = F_yZ$ | | per inch of width | | |
| $1.6M_y = 1.6F_yS$ | | per inch of width | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **AASHTO** | | | **IBC** |
| $\phi$ = | 1.00 | | AASHTO 6.5.4.2 | 0.90 | | Per AISC Section F.1 |
| $M_p$ = | 5.1 | kip-in/in | Eq. 6.12.2.2.7-1 | 5.1 | kip-in/in | Per AISC eq. F11-1 |
| $1.6M_y$ = | 5.4 | kip-in/in | | 5.4 | kip-in/in | |
| $\Phi M_n$ = | 5.1 | kip-in/in | | 4.6 | kip-in/in | |
| $\Phi P_n$ = | **362** | **kips** | | **326** | **kips** | $2*\phi Mn/l^2*A_1$ |

## Micropile Bearing Plate - Summary

**Design Load (kips) and Capacities (kips)**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **AASHTO** | | | **IBC** |
| $P_u$ = | **56** | **kips** | Design Load | **51** | **kips** | Design Load |
| $\phi P_n$ = | **72** | **kips** | Capacity | **67** | **kips** | Concrete Bearing |
| $\phi V_C$ = | **88** | **kips** | Capacity | **74** | **kips** | Punching Shear |
| $\phi P_n$ = | **362** | **kips** | Capacity | **326** | **kips** | Plate Washer Steel |