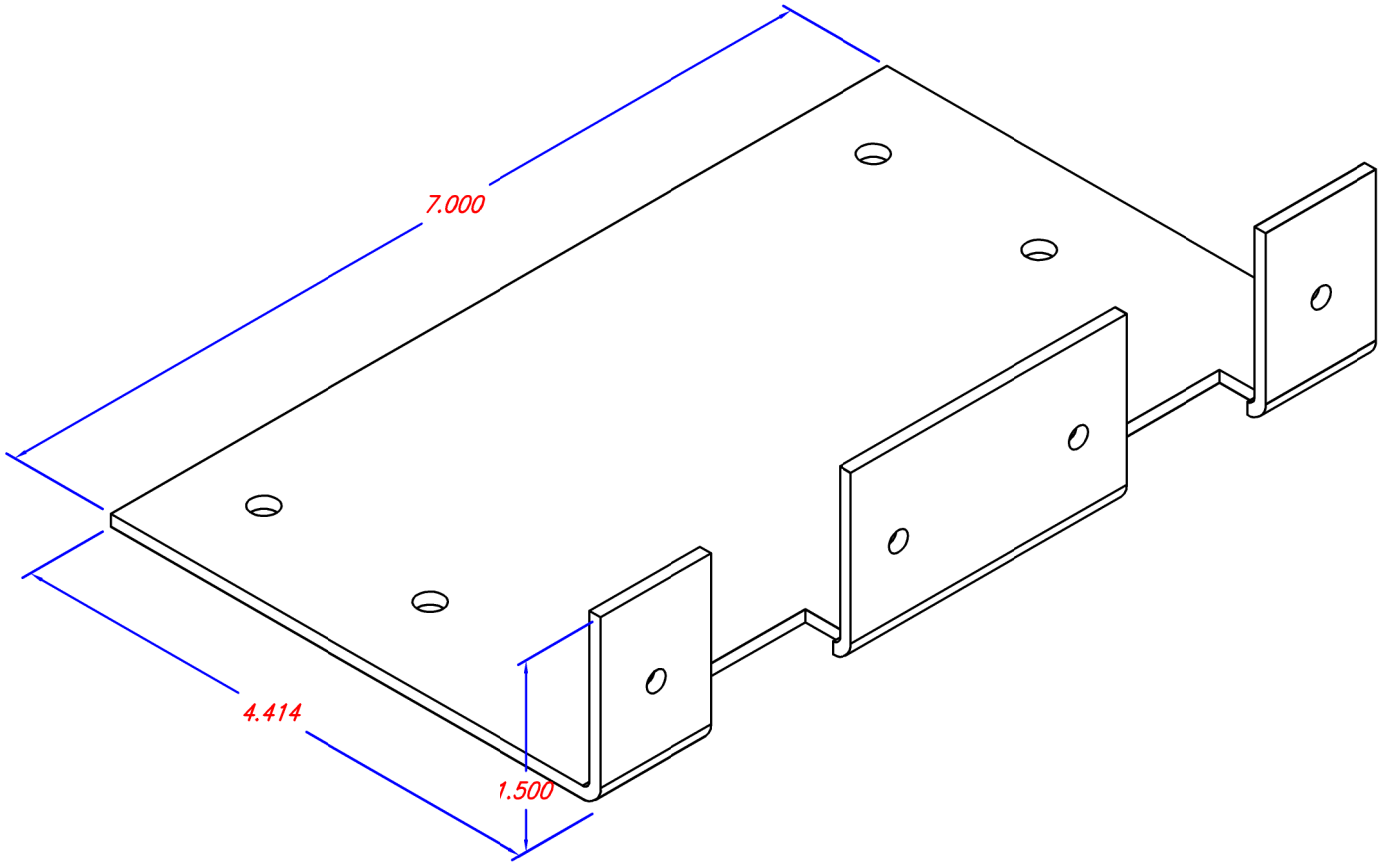



Confidential: Piazza PCCF-97

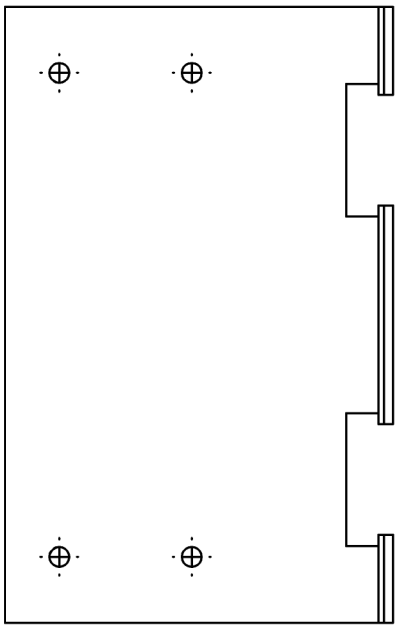
| | | |
|---|---|---|
| piazza STONEWORKS | DRAWING NUMBER: PCCF-97<br>DRAWN: cbs CHECKED: mjh<br>SHEET: DATE: 2/14/2020 | REVISION |
| TITLE: PIAZZA PRODUCT DETAIL<br>CUSTOMER: PIAZZA STONEWORKS | PROJECT: PIAZZA WEBSITE<br>SHEET TITLE: PIAZZA PCCF-97 | |

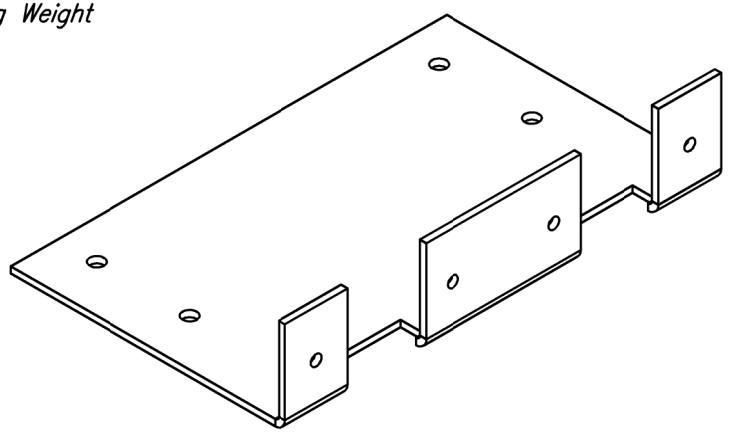
*Confidential: Piazza PCCF-97*

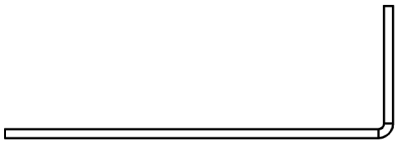
*97mil Min Thickness*

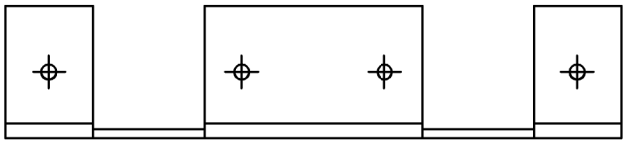
*50ksi Min Yield Strength*

*G90 Min Coating Weight*









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| DRAWING NUMBER | REVISION |
|---|---|
| PCCF-97 | |
| DRAWN: cbs / CHECKED: mjh | |
| SHEET / DATE: 2/14/2020 | |

TITLE
PIAZZA PRODUCT DETAIL

CUSTOMER
PIAZZA STONEWORKS

PROJECT
PIAZZA PART w/ ISO
NO DIMS

SHEET TITLE
PIAZZA PCCF-97



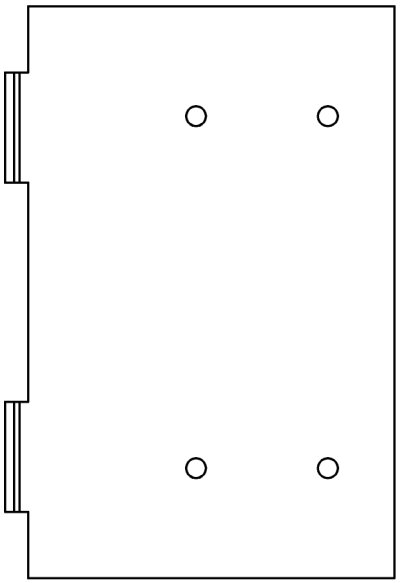
PIAZZA TRACK AND PIAZZA CLIPS
ARE MANUFACTURED
EXCLUSIVELY BY
THE STEEL NETWORK, Inc. (TSN).
US Patent #7,503,150
*www.steelnetwork.com*

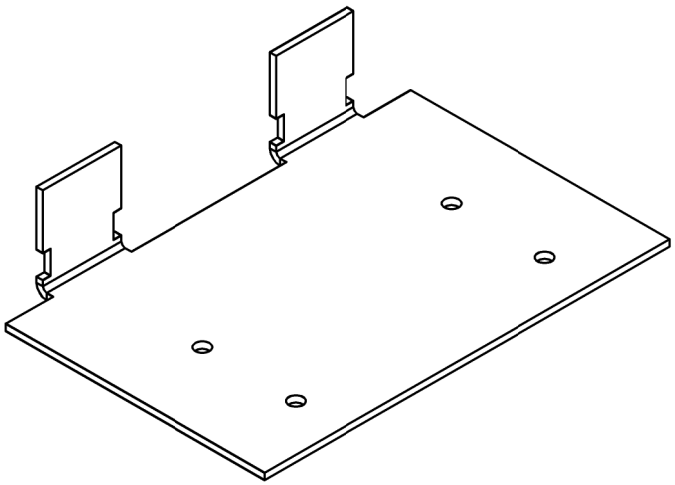
*Confidential: Piazza PCCM-97*

*97mil Min Thickness*

*50ksi Min Yield Strength*

*G90 Min Coating Weight*





piazza STONEWORKS™

| DRAWING NUMBER | REVISION |
|---|---|
| PCCM-97 | |
| DRAWN: cbs / CHECKED: mjh | |
| SHEET / DATE: 2/14/2020 | |

TITLE
PIAZZA PRODUCT DETAIL

CUSTOMER
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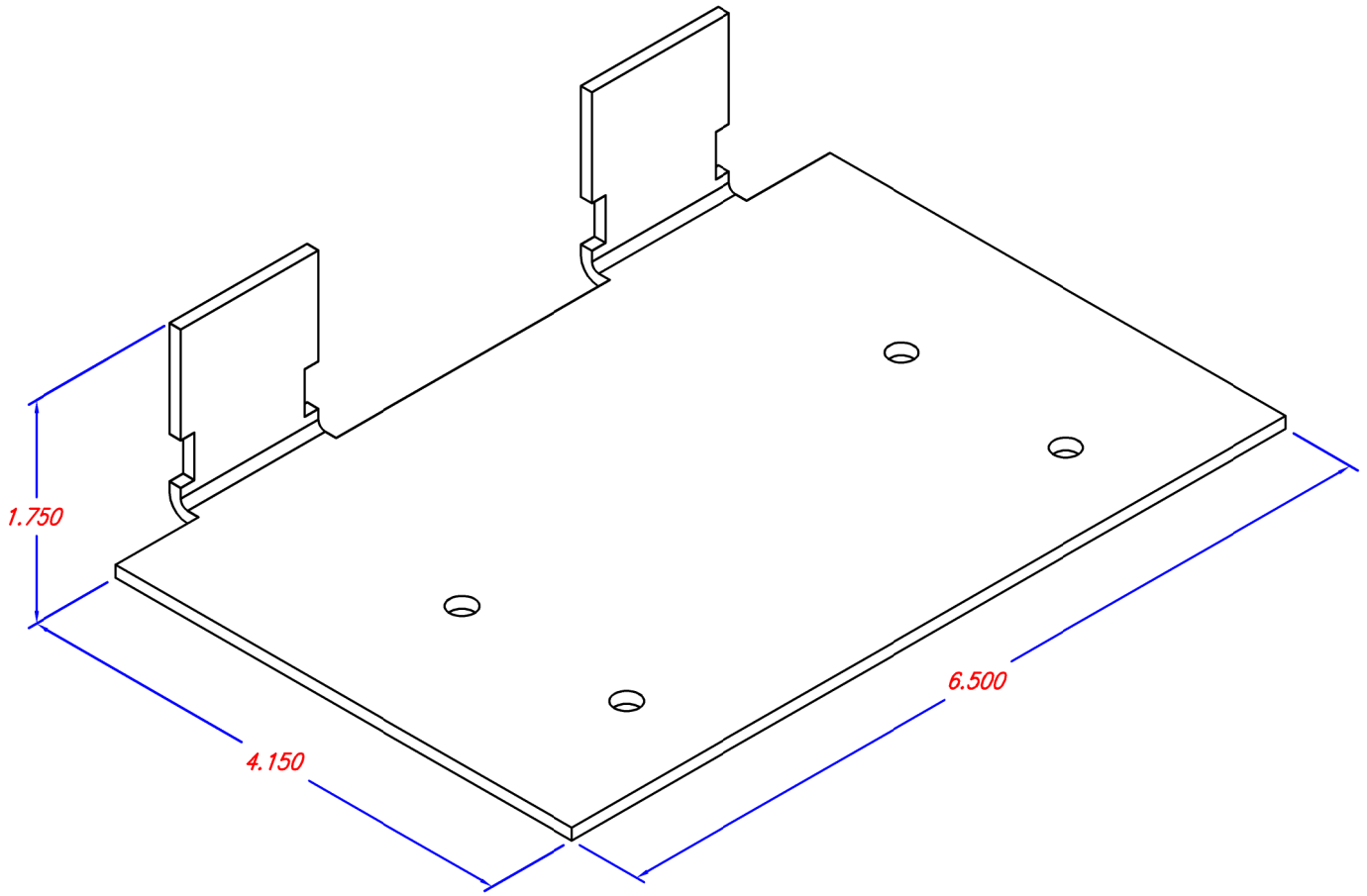


*Confidential: Piazza PCCM-97*

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|---|---|---|
| piazza STONEWORKS | DRAWING NUMBER: PCCM-97<br>DRAWN: cbs<br>CHECKED: mjh<br>SHEET:<br>DATE: 2/14/2020 | REVISION<br>△<br>△<br>△<br>△<br>△ |
| TITLE: PIAZZA PRODUCT DETAIL<br>CUSTOMER: PIAZZA STONEWORKS | PROJECT: PIAZZA WEBSITE<br>SHEET TITLE: PIAZZA PCCM-97 | |



PIAZZA TRACK AND PIAZZA CLIPS ARE MANUFACTURED EXCLUSIVELY BY THE STEEL NETWORK, Inc. (TSN). US Patent #7,503,150 *www.steelnetwork.com*

# Structural Test Report

Piazza PCCF-97 and PCCM-97

F3 (Gravity)

12/31/2020

**Written by:** Sean Doty

**Reviewed by:** Matt Harford, Director of Engineering and Quality

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**www.steelnetwork.com**

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## BACKGROUND

The PiazzaStone track and clip system is designed for lightweight stone attachment to structures. Various combinations of PiazzaStone clips can be used on their own or in conjunction with a track in accordance with design requirements.

PiazzaStone has requested The Steel Network, the exclusive manufacturer of its clips, to test a new clip that is to be used specifically for the attachment of round lightweight stone pieces to a structural column. This is a system of two clips which fit together without fasteners. The PCCF-97 is attached to the structural column and to one-half of the round lightweight stone. The PCCM-97 is attached to the other half of the round lightweight stone and lifted into place and the PCCM-97 is inserted into the notched section of the PCCF-97 to provide a sufficiently strong gravity connection.

## PURPOSE OF CURRENT TESTS

The present tests were conducted to evaluate the strength in the gravity direction of:

- The PCCF-97 and PCCM-97 clips when used together in the final condition
- The PCCM-97 clip used on its own to evaluate its strength independent of the PCCF-97

This test was required to determine the appropriate connection ASD value in the various conditions present during the installation and end state of these clips.

The strength of the PCCF-97 on its own can be conservatively assumed to be the same as that of the PCCM-97, for the reasons presented in the *Summary of Results* section.

## EQUIPMENT

The following equipment was used:

1. Test setups illustrated by Figure 1, Figure 2, Figure 3, and Figure 4
2. A hydraulic cylinder capable of applying excess of 50 kips of linear load
3. A load cell capable of measuring load at 0.5s increments
4. Linear potentiometers capable of measuring up to 1.5” of linear deflection
5. Angle, plate, and block fixtures to locate the test specimens
6. Socket-head cap screws to secure the test samples to the stationary block and pillow block, respectively
7. A National Instruments program to record incoming data from the strain gauge and potentiometers in a CSV file with a time stamp and date stamp
8. A Microsoft Excel worksheet developed to calculate clip ASD and LRFD design loads in accordance with AISI S100-16, Chapter K
9. A Microsoft Excel worksheet developed to calculate connection design loads based on screw orientation

## PROCEDURE

The PCCF-97 was mounted to a stationary fixture using ¼-20 SCHCs. On the first test, the PCCF-97 was not attached to the plate (see Figure 2). This allowed the load to transfer entirely into the PCCM-97 before transferring into the PCCF-97 through the notches close to the heel of the clip. On the second test, the PCCF-97 was attached to the plate using ¼-20 SCHCs (see Figure 3).

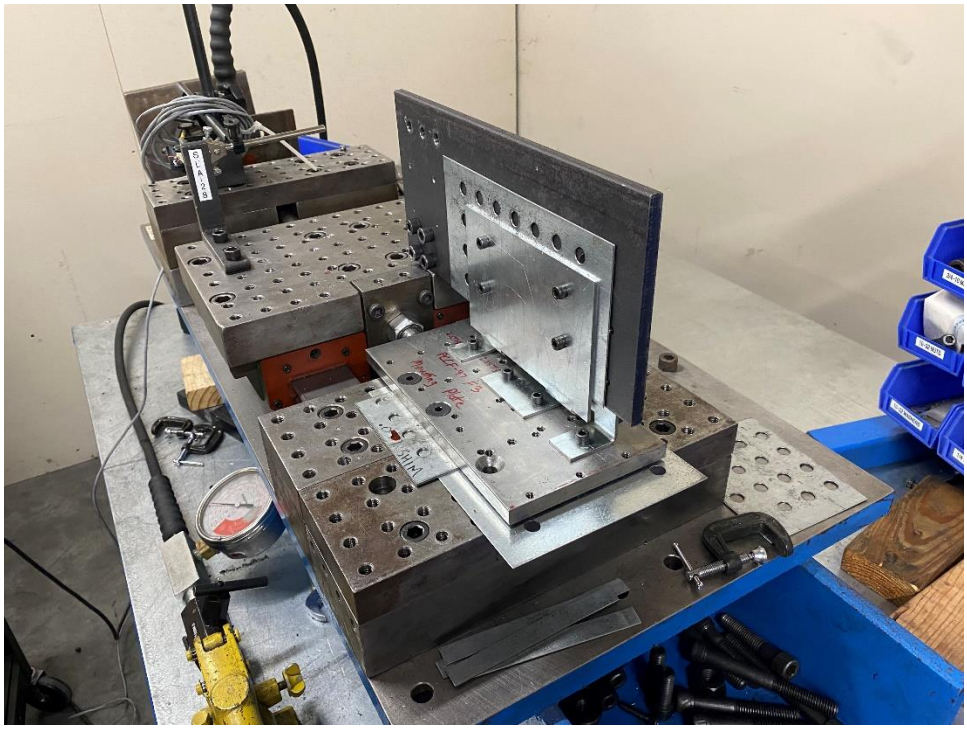


*Figure 1: Test Setup*

In both tests, the PCCM-97 was inserted into the notch on the PCCF-97 and completely attached to the plate passing between the two clips.

The plate passing between the two clips was connected on its other end to a block which was bolted down into the pillow block, through which the load was applied. It should be noted that in actuality the load would be applied on the outside of each clip, but such a test is impractical given the space constraints of the assembly.

The interface between the notches on the PCCF-97 and the PCCM-97 was tested in the worst-case orientation to provide sufficiently conservative results for all possible conditions when the notches are employed properly.

*Figure 2: PCCF-97 Not Mounted to Plate*

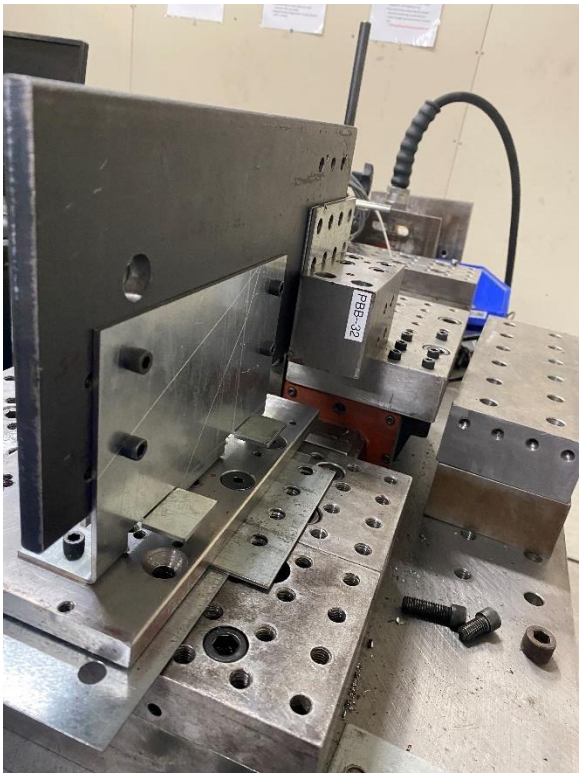


*Figure 3: PCCF-97 Mounted to Plate*

The 1.5” linear potentiometer was placed on pillow block to measure the deflection of the clips.

Load was applied until failure. After the completion of the test, the data was analyzed in accordance with AISI S100-16, Section K.

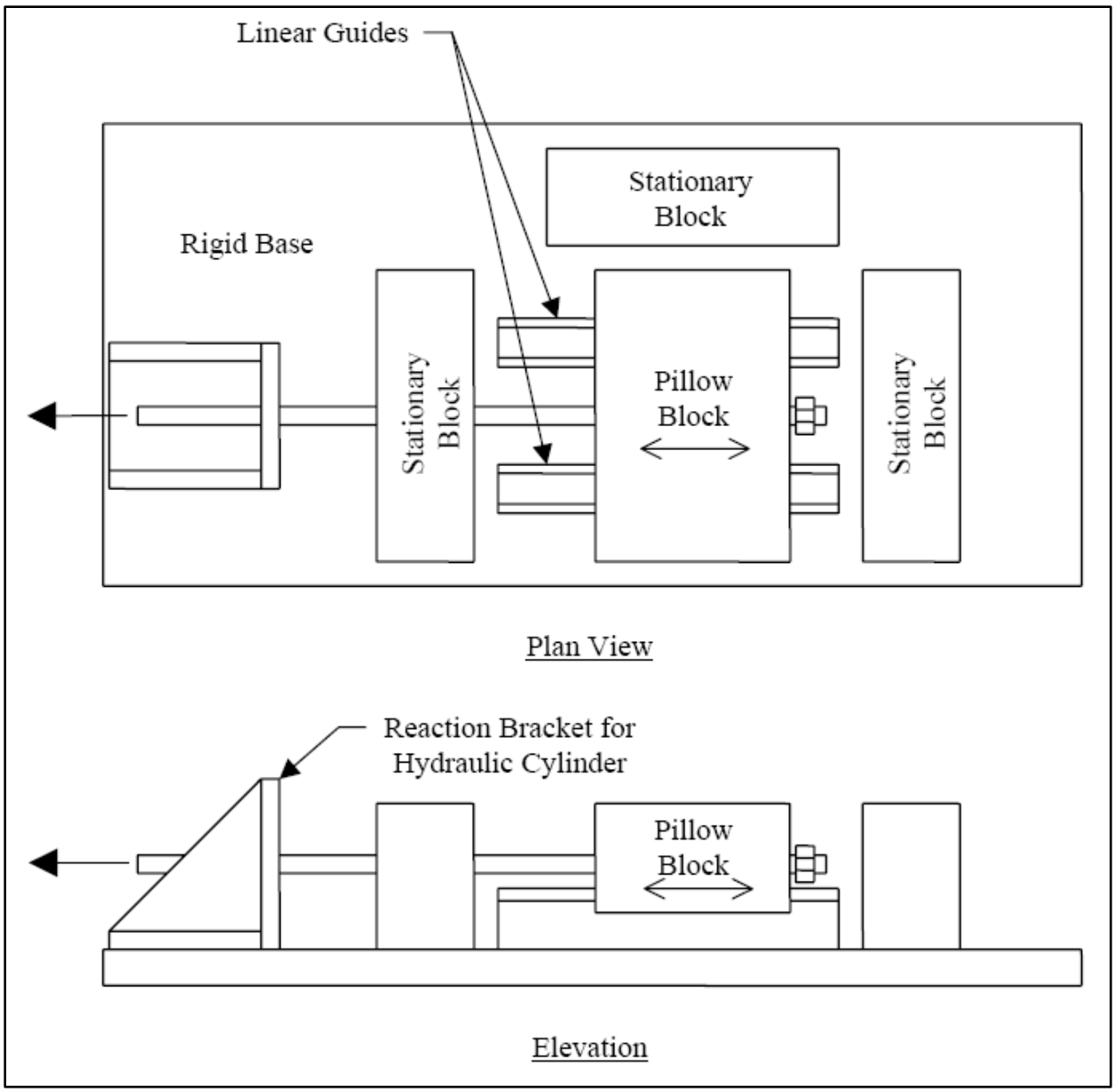



*Figure 4: Test Apparatus Diagram*

## TEST MATRIX

| Product | F1 | F2 | F3 | M1 |
|---|---|---|---|---|
| PCCM-97 | | | x | |
| PCCM-97 and PCCF-97 Combined | | | x | |

## RESULTS

### Test 1

| Design Information (lbs) | |
|---|---|
| ASD | 584 |
| ω | 3.50 |
| LRFD | 934 |
| ϕ | 0.457 |
| Nominal | 1038 |
| Ultimate | 2044 |

### Test 2

| Design Information (lbs) | |
|---|---|
| ASD | 1519 |
| ω | 3.50 |
| LRFD | 2431 |
| ϕ | 0.457 |
| Nominal | 2701 |
| Ultimate | 5319 |

## OBSERVATIONS

### Test 1

All three tests were extremely consistent. As the hydraulic cylinder was pumped the load increased at a very slow rate until approximately 1/16" deflection. This is probably best explained by settling in the interface between the two clips, as there is no fastener connecting them.

After 1/16" deflection, the load rapidly rose in a logarithmic curve shape. After approximately 2100 lbs the load began decreasing due to yielding in the PCCM-97 clip. Prior testing indicated that this was in fact the true maximum.

### Test 2

As the hydraulic cylinder was pumped the load increased steadily in an approximately linear manner. After approximately 5.5kips the load seemed to be approaching a maximum when the third screw

attaching the heel of the PCCF-97 to the mounting plate sheared, ending the test. This failure mode was present in all three tests.

The differences in the tested stiffnesses of the PCCM-97 and PCCF-97 assembly (this can be seen in the chart as the shifting left and right of the various test samples) are probably best explained as the minor tolerances which can results in a bit of variation in the actual distance between the notches on the two clips.

## SUMMARY OF RESULTS

The only condition not explicitly demonstrated by the tests contained in this report is that of the PCCF-97 on its own before the PCCM-97 has been inserted into the notches. This condition can be conservatively assumed to have the same ASD value as that of the PCCM-97 for the following reasons:

- The eccentricity of the load is within 1/8" between the two clips
- The heel of the PCCF-97 is more securely attached
- The screw group on the PCCF-97 is more conservative
- The more than 2x ultimate values on the combined test seem to indicate that the PCCF-97 is taking more than half of the load

For the clips irrespective of screw patterns, the following ASD values are therefore recommended:

- PCCM-97 F3 ASD = **584 lbs**
- PCCF-97 F3 = **584 lbs**
- PCCF-97 and PCCM-97 Combined = **1519 lbs**

Based on the geometry of each clip, the following screw group factors are recommended to be used in the analysis of the screwed connection to the lightweight stone:

- PCCM-97 SGF = **2.05**
- PCCF-97 SGF = **2.44**

## ATTACHMENTS

The attachments which follow contain detailed test information from each structural test mentioned in this report. In addition, there are drawings attached which demonstrate the actual clips tested. There is also a screw group calculation appended for each clip.

## Piazza PCCM-97 F3

| Test # | Load @ 1/8 in | Max Load Unscaled |
|---|---|---|
| 1 | 1243 | 2113 |
| 2 | 1259 | 2046 |
| 3 | 1262 | 2091 |

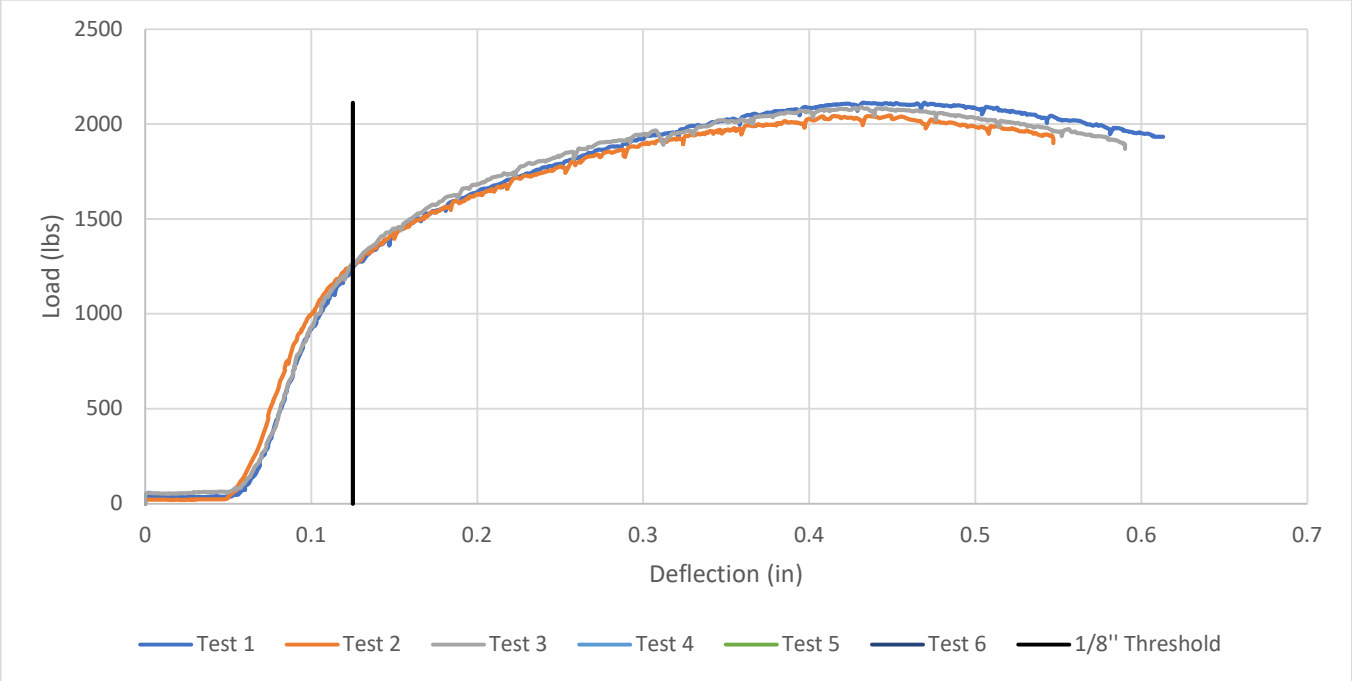
| | |
|---|---|
| Test ID | PCCM-97-1-F3 |
| Date | 12/30/2020 |
| Standard | AISI S100-16, Chapter K |
| Avg Max Load Unscaled | 2083 |
| Strength Scale Factor | 0.981 |
| Thickness Scale Factor | 1 |
| Avg Scaled Max Load/F.S. | 584 |
| Avg Load @ 1/8 in | 1255 |

| Design Information (lbs) | |
|---|---|
| ASD | 584 |
| ω | 3.50 |
| LRFD | 934 |
| ϕ | 0.457 |
| Nominal | 1038 |
| Ultimate | 2044 |

| | |
|---|---|
| Sensors Calibrated? | Yes |
| AISI Test Type | Screw Connections |
| Failure Mode | Clip Yielding |

**Test Results**

As the hydraulic cylinder was pumped the load increased at a very slow rate until approximately 1/16" deflection. This is probably best explained by settling in the interface between the two clips, as there is no fastener connecting them. After 1/16" deflection, the load rapidly rose in a curve shape. After approximately 2200 lbs the load began decreasing due to yielding in the PCCM-97 clip. Prior testing indicated that this was in fact the true maximum.

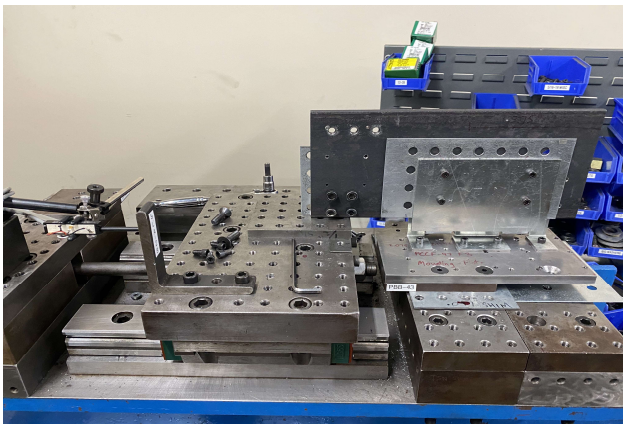


## Test Sample Information

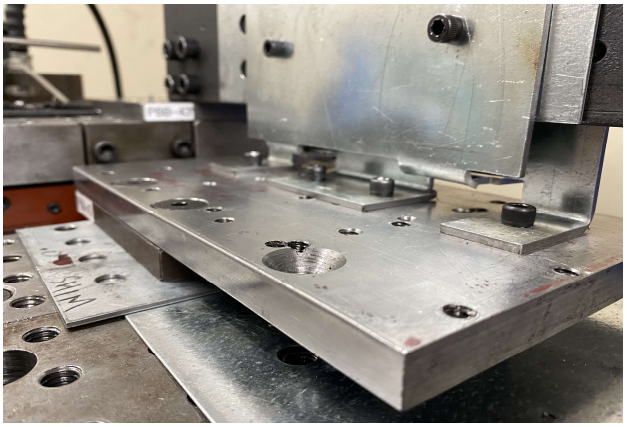
| Specified Clip Material Properties | |
|---|---|
| Steel Grade | ASTM A1003 ST50H |
| Coating | ASTM A653 G90 |
| Specified Yield Strength (ksi) | 50 |
| Specified Tensile Strength (ksi) | 65 |
| Specified Design Thickness (in) | 0.1017 |

| ASTM A370 Tested Material Properties | |
|---|---|
| Material Property Source | ASTM A370 Test by Steel Mill |
| Actual Yield Strength | 50.96 |
| Actual Tensile Strength | 70.18 |
| Elongation | 34 |
| Material Test Vendor | N/A |
| Material Test Number | N/A |

| Measured Thicknesses | |
|---|---|
| Sample | Actual Thickness |
| Test 1 | 0.10305 |
| Test 2 | 0.10215 |
| Test 3 | 0.10305 |



**Pre Test**



**Mid Test**

**Post Test**

## Piazza PCC-97 Combined F3

| Test # | Load @ 1/8 in | Max Load Unscaled |
|---|---|---|
| 1 | 4149 | 5515 |
| 2 | 2463 | 5510 |
| 3 | 3148 | 5240 |

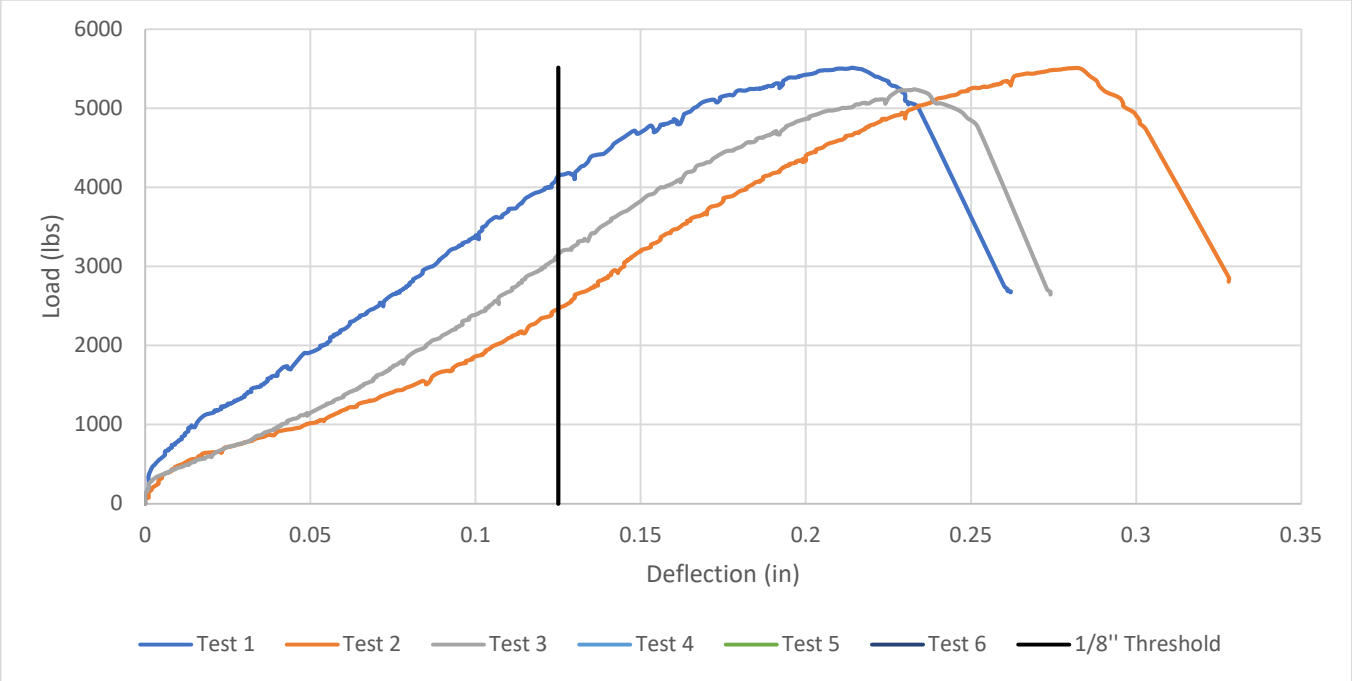
| | |
|---|---|
| Test ID | PCC-97-1-F3 |
| Date | 12/30/2020 |
| Standard | AISI S100-16, Chapter K |
| Avg Max Load Unscaled | 5422 |
| Strength Scale Factor | 0.981 |
| Thickness Scale Factor | 1 |
| Avg Scaled Max Load/F.S. | 1519 |
| Avg Load @ 1/8 in | 3253 |

| Design Information (lbs) | |
|---|---|
| ASD | 1519 |
| ω | 3.50 |
| LRFD | 2431 |
| ϕ | 0.457 |
| Nominal | 2701 |
| Ultimate | 5319 |

| | |
|---|---|
| Sensors Calibrated? | Yes |
| AISI Test Type | Screw Connections |
| Failure Mode | Screw shearing |

**Test Results**

As the hydraulic cylinder was pumped the load increased steadily in an approximately linear manner. After approximately 5.5kips the load seemed to be approaching a maximum when the third screw attaching the heel of the PCCF-97 to the mounting plate sheared, ending the test.

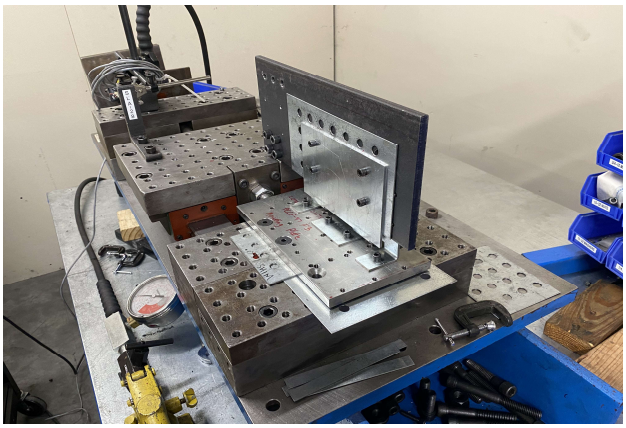


## Test Sample Information

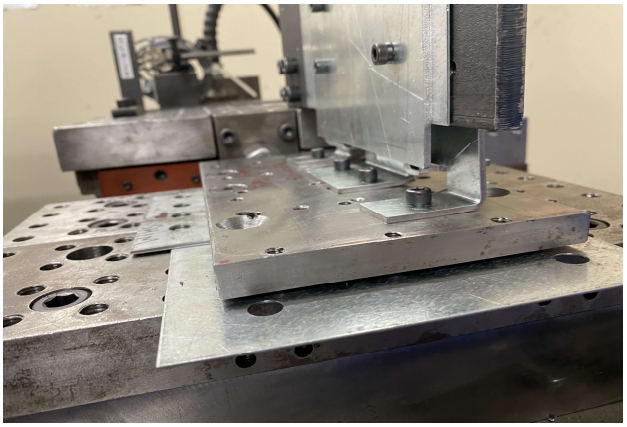
| Specified Clip Material Properties | |
|---|---|
| Steel Grade | ASTM A1003 ST50H |
| Coating | ASTM A653 G90 |
| Specified Yield Strength (ksi) | 50 |
| Specified Tensile Strength (ksi) | 65 |
| Specified Design Thickness (in) | 0.1017 |

| ASTM A370 Tested Material Properties | |
|---|---|
| Material Property Source | ASTM A370 Test by Steel Mill |
| Actual Yield Strength | 50.96 |
| Actual Tensile Strength | 70.18 |
| Elongation | 34 |
| Material Test Vendor | N/A |
| Material Test Number | N/A |

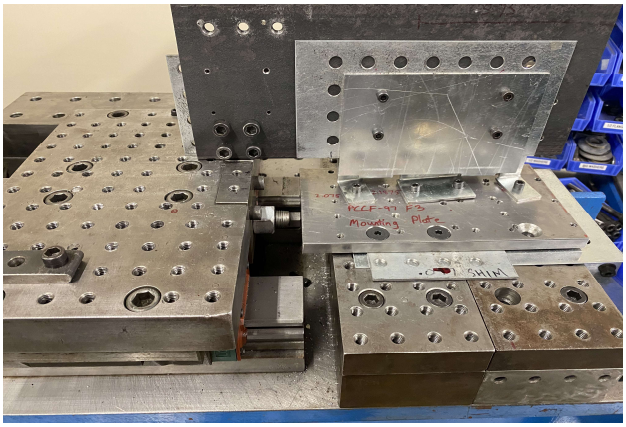
| Measured Thicknesses | |
|---|---|
| Sample | Actual Thickness |
| Test 1 | 0.1038 |
| Test 2 | 0.1041 |
| Test 3 | 0.10315 |



**Pre Test**

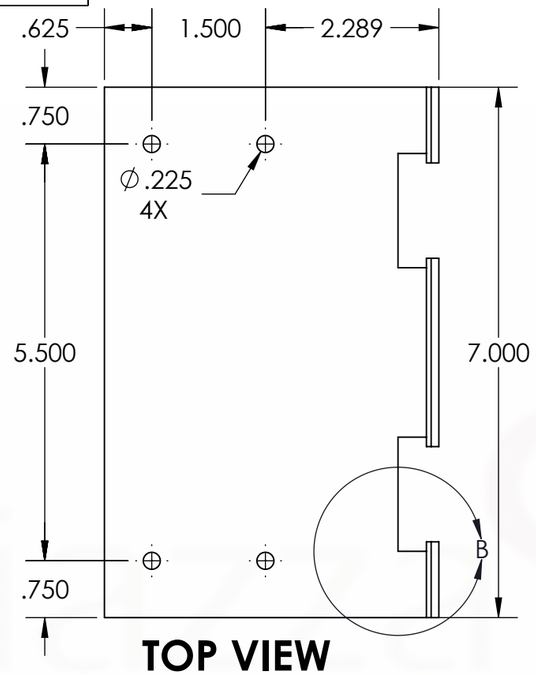


**Mid Test**

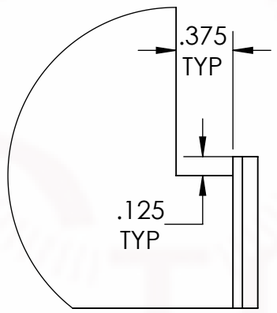


**Post Test**

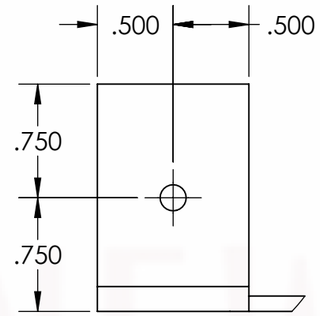
| Material Gauge | Bend Allowance |
|---|---|
| 12ga/97mil | 0.18 |



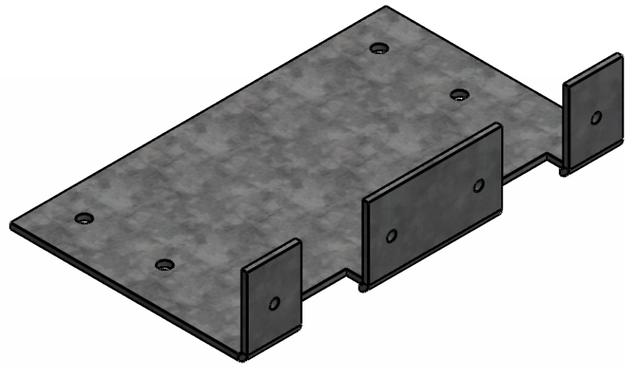

## TOP VIEW
SCALE: 1" = 1" 1:2



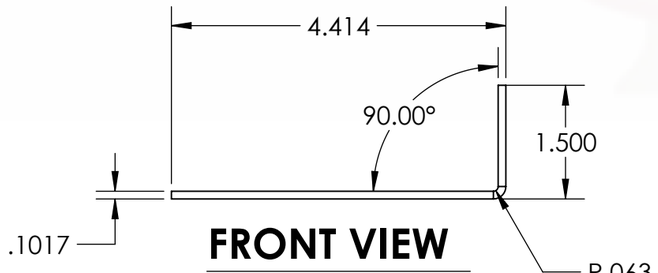

DETAIL B



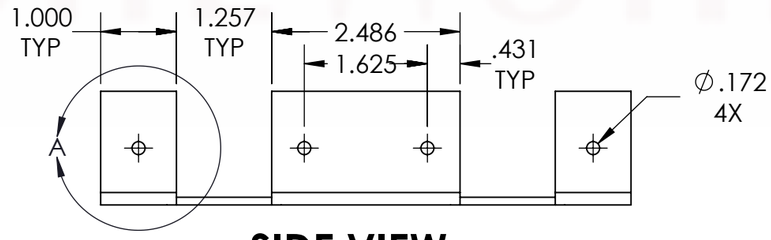

DETAIL A
SCALE 1 : 1



## ISOMETRIC VIEW
SCALE: 1/2" = 1" 1:2




## FRONT VIEW
SCALE: 1" = 1" 1:2




## SIDE VIEW
SCALE: 1" = 1" 1:2

piazza STONEWORKS

The Steel Network

PART NAME: PCCF-97

| DRAWN BY | APPROVED BY | DRAWING VERSION |
|---|---|---|
| BRS | MJH | Production |
| DATE | DATE | VIEW SCALE |
| 12/29/2020 | 12/29/2020 | 1:2 |

REVISION MAP

| REV. | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| 01 | Initial release | 12/29/2020 | mharford |

**MATERIAL SPECIFICATION**

ASTM A1003 ST50H
50ksi Min Yield Strength
60ksi Min Tensile Strength
0.0966 Min Base Metal Thickness
0.0981 Min CoatedThickness
G90 Min Coating or Approved Equivalent

**TOLERANCE**

1.00" and Under: ±0.031"
1.00"-2.00": ±0.047"
Over 2.00": ±0.062"
Holes and Slots: ±0.005"
Angles: ±1.5°
Inside Radius = 1.5(Thickness)

**COPYRIGHT NOTICE**



**HARDCOPY LOCATIONS**

Production File

# SCREW GROUP FACTOR CALCULATOR

| | | |
|---|---|---|
| Product | Piazza PCCF-97 | |
| # of Screws in Group | 4 | |
| Vertical Load | 1000 | lbs |
| Eccentricity | 3.039 | in. |
| % of bending moment to group | 100 | |
| Resulting Torsional M | 3039 | in-lb |
| | | |
| **Screw Group Data & Results** | | |

**Notes**

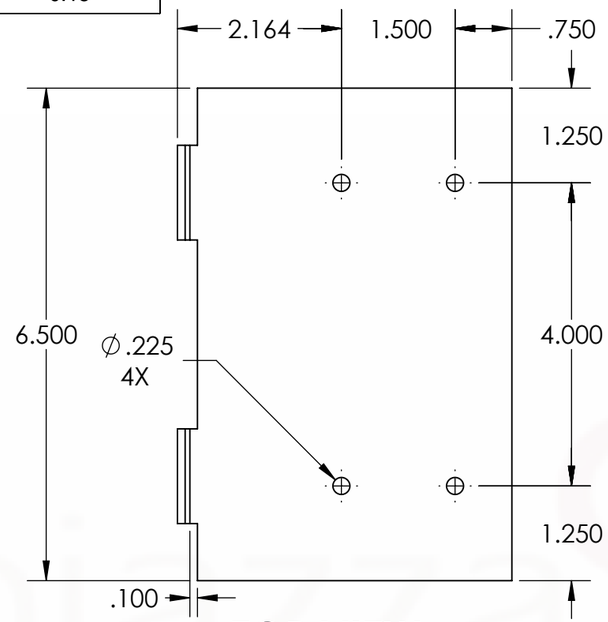
-X is the direction of the Eccentricity measurement

-Y is the direction of the Load

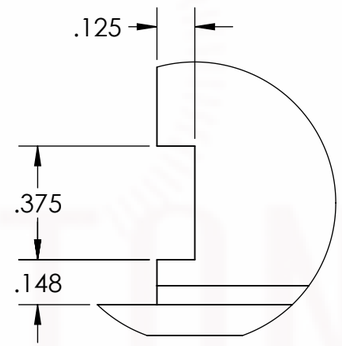
-Resulting Screw Group Factor is in BLUE

| Screw Count | Coord. from C.G. | | | Direct Shear | Torsional Shear | | Total Shear |
|---|---|---|---|---|---|---|---|
| | X | Y | | Y | Y | X | |
| | in. | in. | | lbs | lbs | lbs | lbs |
| 1 | -0.75 | 2.75 | | -250.00 | -70.13 | 257.15 | 410.62 |
| 2 | 0.75 | 2.75 | | -250.00 | 70.13 | 257.15 | 313.81 |
| 3 | -0.75 | -2.75 | | -250.00 | -70.13 | -257.15 | 410.62 |
| 4 | 0.75 | -2.75 | | -250.00 | 70.13 | -257.15 | 313.81 |
| 5 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 6 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 13 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 14 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 15 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 17 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 18 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| Ix, Iy, I total | 2.25 | 30.25 | 32.5 | | | | 410.62 |
| | | | | | Screw Group Factor | | **2.44** |

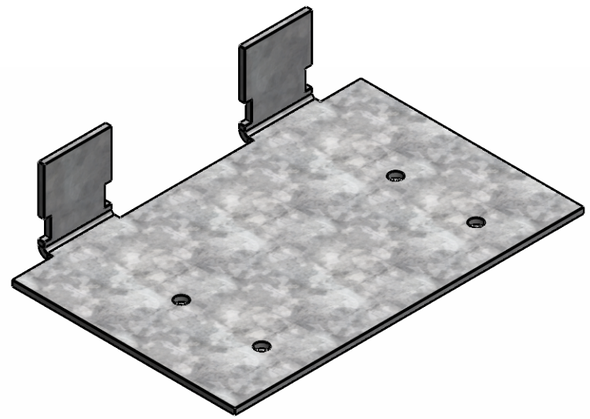
| Material Gauge | Bend Allowance |
|---|---|
| 12ga/97mil | 0.18 |



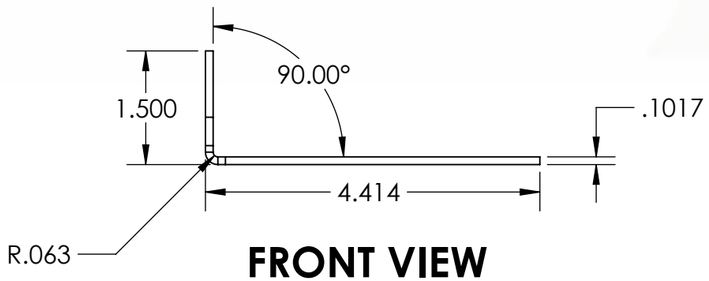

## TOP VIEW
SCALE: 1/2" = 1" 1:2



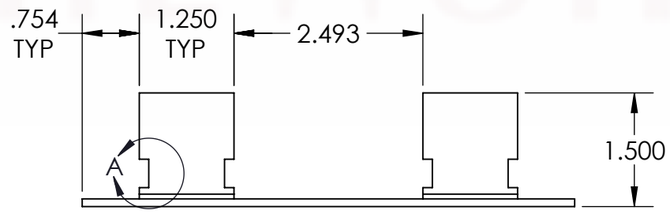

DETAIL A
SCALE 2 : 1



## ISOMETRIC VIEW
SCALE: 1/2" = 1" 1:2




## FRONT VIEW
SCALE: 1" = 1" 1:2




## SIDE VIEW
SCALE: 1/2" = 1" 1:2

piazza STONEWORKS

PART NAME: PCCM-97

| DRAWN BY | APPROVED BY | DRAWING VERSION |
|---|---|---|
| BRS | MJH | Production |
| DATE | DATE | VIEW SCALE |
| 12/29/2020 | 12/29/2020 | 1:2 |

The Steel Network

REVISION MAP

| REV. | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| 01 | Initial release | 12/29/2020 | mharford |

**MATERIAL SPECIFICATION**

ASTM A1003 ST50H

50ksi Min Yield Strength
60ksi Min Tensile Strength
0.0966 Min Base Metal Thickness
0.0981 Min CoatedThickness
G90 Min Coating or Approved Equivalent

**TOLERANCE**

1.00" and Under: ±0.031"
1.00"-2.00": ±0.047"
Over 2.00": ±0.062"
Holes and Slots: ±0.005"
Angles: ±1.5°
Inside Radius = 1.5(Thickness)

**COPYRIGHT NOTICE**



**HARDCOPY LOCATIONS**

Production File

# SCREW GROUP FACTOR CALCULATOR

| | | |
|---|---|---|
| Product | Piazza PCCM-97 | |
| # of Screws in Group | 4 | |
| Vertical Load | 1000 | lbs |
| Eccentricity | 2.914 | in. |
| % of bending moment to group | 100 | |
| Resulting Torsional M | 2914 | in-lb |
| | | |
| **Screw Group Data & Results** | | |

**Notes**

-X is the direction of the Eccentricity measurement

-Y is the direction of the Load

-Resulting Screw Group Factor is in BLUE

| Screw Count | Coord. from C.G. | | | Direct Shear | Torsional Shear | | Total Shear |
|---|---|---|---|---|---|---|---|
| | X | Y | | Y | Y | X | |
| | in. | in. | | lbs | lbs | lbs | lbs |
| 1 | -0.75 | 2 | | -250.00 | -119.75 | 319.34 | 488.57 |
| 2 | 0.75 | 2 | | -250.00 | 119.75 | 319.34 | 344.88 |
| 3 | -0.75 | -2 | | -250.00 | -119.75 | -319.34 | 488.57 |
| 4 | 0.75 | -2 | | -250.00 | 119.75 | -319.34 | 344.88 |
| 5 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 6 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 13 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 14 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 15 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 17 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 18 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | 0 | 0 | | 0.00 | 0.00 | 0.00 | 0.00 |
| Ix, Iy, I total | 2.25 | 16 | 18.25 | | | | 488.57 |
| | | | | | Screw Group Factor | | **2.05** |