Engineering Analysis

TruFlush Backing
Fixed and Two piece backing
Grade 50, ASTM A653, F_Y=50 KSI

Report S5381.01-122-34-R1

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Scope

Architectural Testing, Inc., an Intertek company, was contracted by Stockton Products to perform a cursory engineering analysis using targeted Grade 50, ASTM A653, F_y=50 KSI material. This report will determine spans based on smaller values of the section properties of member and the end shear carried by the fastening. The fastening capacity will vary due to differences of gages used in this analysis. We will assess attachment to gage metals of 16, 18, and 20 Gage for this analysis. Section properties in this evaluation are based on custom sections provided by Stockton. Section properties for the Tru-Backing are determined with *CFS® Design Software – RGS Software.*
The Wind load tables in the report are associated with 16, 18, and 20 gage Tru-backing pieces that are a backing element in CFMF wall are considered non-structural. It is a product used in stiffening a sheathed wall. It is positioned flush against the inside face sheathing on one side of the wall cavity. However positive fastening with screw attachments is ***(3) three #10-16***[1] screws on each side of the TruFlush Backing. Supporting calculations for the connection at studs in on Pages 10-11. In this analysis there will be no consideration of composite action with sheathing.

Revision #1 – 14 gauge for ADA compliant grab bars.[1]

Engineering Analysis - Stockton TruFlush 14Ga TruFlush. Assess the Stockton TruFlush member for the ability to support grab bars. The grab bar bracket will impose a 250 lb concentrated load. This loading is in line with ADA (American Disabilities Act) requirements for Grab bars and their attachment brackets. In this analysis, a 14-gauge (68 mil) (0.0713 in) TruFlush adjustable bracket will be used to determine its ability to support the concentrated loading of grab bar brackets. Intertek is not responsible for the bracket attachment to the Tru-backing or any consideration of composite action with sheathing

Three considerations will be analyzed.

- Moment Capacity of the 14-gage material with a 250 lb concentrated load centered in a 16” span. A 24” maximum stud spacing and conservative center point loading on the TruFlush member
- Stiffness of the TruFlush backing under the imposed concentrated load.
- Fastener Capacity at the various vertical stud gauges, 12, 14, 16, 18, and 20 gauges.

Revision #1 Conclusion:[1,2]

14 gauge (0.0713 in) fixed and adjustable TruFlush backing can span 24” with the stud spacing to support a grab bar bracket at 250 lb. at any location within the bracket span. This analysis qualifies 12” and 16” stud spacing. See Page 11 for analysis

References

Reference standards utilized in this project include:

- 2018 *International Building Code (IBC)*
- 2018 *International Residential Code (IRC)*
- AISI S100-2012 *North American Specification for the Design of Cold Formed Steel Structural s*
- AISI D100-2012 *Cold Formed Steel Design Manual*

1. Revision 1 Updates with ADA compliant loading
2. 14 gage Tru-Backing shape is limited to 250 lb concentrated loading for ADA compliance or other mechanisms not exceeding 250 lb

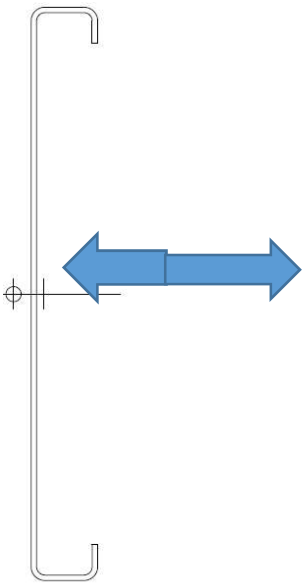
Analyses

The information provided by Stockton Products was used to perform calculations using a fundamental engineering approach in accordance with AISI- S100. Our engineering will determine backing span lengths based on the least conditions of span or connection capacities to the various gages.

Section Properties and Strengths

Section properties related to fixed span neglect the crimp section as these lock into the vertical stud flange of an adjoining stud. Therefore, the flexural section considered will be in the clear span between studs.

TFBF: TruFlush Backing – Fixed- 16 Gage



Load Diagram

Section Inputs

Material: A653 SS Grade 50/1
No cold work of forming strength increase.
Apply inelastic reserve strength increase.

Modulus of Elasticity, E	29500 ksi
Yield Strength, Fy	50 ksi
Tensile Strength, Fu	65 ksi
Torsion Constant Override, J	0 in⁴
Warping Constant Override, Cw	0 in⁶

Stiffened Channel, Thickness 0.0566 in (16 Gage)
Placement of Part from Origin:

X to center of gravity	0 in
Y to center of gravity	0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.3750	270.000	0.084900	None	0.000	0.0000	0.1875
2	0.6875	180.000	0.084900	Single	0.000	0.0000	0.3438
3	6.0000	90.000	0.084900	Cee	0.000	0.0000	3.0000
4	0.6875	0.000	0.084900	Single	0.000	0.0000	0.3438
5	0.3750	-90.000	0.084900	None	0.000	0.0000	0.1875

Direct Strength Parameters
Prequalified Section: No

Compression:	Pcrl/Py = 0.23708	Pcrd/Py =	0.23295
Positive Mx:	Mcrl/My = 1.47638	Mcrd/My =	1.33405
Negative Mx:	Mcrl/My = 1.47638	Mcrd/My =	1.33405
Positive My:	Mcrl/My = 15.93924	Mcrd/My =	8.33106
Negative My:	Mcrl/My = 1.44450	Mcrd/My =	1000.00000
Shear:	Vcr/Vy(y)= 0.00000	Vcr/Vy(x)=	0.00000

Fully Braced Strength - AISI S100-16/S1-18, US, ASD

Material Type: A653 SS Grade 50/1, Fy=50 ksi

Axial		Positive Bending		Positive Bending	
Pao	5.613 k	Maxo	14.703 k-in	Mayo	1.079 k-in
Ae	0.22451 in²	Ixe	1.7644 in⁴	Iye	0.0185 in⁴
Ta	13.056 k	Sxe(t)	0.58812 in³	Sye(l)	0.14377 in³
		Sxe(b)	0.58812 in³	Sye(r)	0.03314 in³
Shear					
Vay	2.822 k	Negative Bending		Negative Bending	
Vax	0.859 k	Maxo	14.703 k-in	Mayo	0.793 k-in
		Ixe	1.7644 in⁴	Iye	0.0177 in⁴
Torsion		Sxe(t)	0.58812 in³	Sye(l)	0.13761 in³
Ba	2.646 k-in²	Sxe(b)	0.58812 in³	Sye(r)	0.03172 in³

Section Properties and Strengths(cont'd)

Section properties related to fixed span neglect the crimp section as these lock into the vertical stud flange of an adjoining stud. Therefore, the flexural section considered will be in the clear span between studs.

TFBF: TruFlush Backing – Fixed- 20 Gage

Section Inputs

```
Material: A653 SS Grade 50/1
No cold work of forming strength increase.
No inelastic reserve strength increase.
Modulus of Elasticity, E          29500 ksi
Yield Strength, Fy                   50 ksi
Tensile Strength, Fu                 65 ksi
Torsion Constant Override, J          0 in⁴
Warping Constant Override, Cw         0 in⁶

Stiffened Channel, Thickness 0.0346 in (20 Gage)
Placement of Part from Origin:
X to center of gravity           0 in
Y to center of gravity           0 in
Outside dimensions, Open shape
        Length      Angle     Radius  Web      k    Hole Size   Distance
          (in)      (deg)       (in)          Coef.       (in)       (in)
  1     0.3750    270.000   0.076400 None    0.000     0.0000     0.1875
  2     0.6875    180.000   0.076400 Single  0.000     0.0000     0.3438
  3     6.0000     90.000   0.076400 Cee     0.000     0.0000     3.0000
  4     0.6875      0.000   0.076400 Single  0.000     0.0000     0.3438
  5     0.3750    -90.000   0.076400 None    0.000     0.0000     0.1875

Direct Strength Parameters
  Prequalified Section: No
  Compression: Pcrl/Py =  0.10518  Pcrd/Py =1000.00000
  Positive Mx: Mcrl/My =  0.61430  Mcrd/My =  0.65278
  Negative Mx: Mcrl/My =  0.61430  Mcrd/My =  0.65278
  Positive My: Mcrl/My =  5.57375  Mcrd/My =  4.39286
  Negative My: Mcrl/My =  0.56236  Mcrd/My =1000.00000
  Shear:      Vcr/Vy(y)=  0.00000 Vcr/Vy(x)=  0.00000
```

Fully Braced Strength - AISI S100-16/S1-18, US, ASD

```
Material Type: A653 SS Grade 50/1, Fy=50 ksi
Axial                   Positive Bending          Positive Bending
Pao       2.5823 k      Maxo      6.9666 k-in     Mayo      0.5614 k-in
Ae       0.10329 in²    Ixe      0.83599 in⁴      Iye      0.01264 in⁴
Ta        8.1069 k      Sxc(t)   0.27866 in³      Syc(1)   0.10130 in³
                        Sxe(b)   0.27866 in³      Sye(r)   0.02246 in³
Shear
Vay       0.6379 k      Negative Bending          Negative Bending
Vax       0.6040 k      Maxo      6.9666 k-in     Mayo      0.3928 k-in
                        Ixe      0.83599 in⁴      Iye      0.00884 in⁴
Torsion                 Sxe(t)   0.27866 in³      Sye(1)   0.07088 in³
Ba        1.7625 k-in²  Sxe(b)   0.27866 in³      Sye(r)   0.01571 in³
```

Section Properties and Strengths (cont'd)

Section properties related to 2-, and 3-piece segments that create an adjustable span length. We will neglect the crimp section as the end segment as it locks into the flange of an adjoining stud. Therefore, the reduced section of the slip mechanism will be used. A 1-1/2" minimum lap length is required for development length for bending at maximum stretch.

TFBF: TruFlush Backing – 2 Piece, 3 Piece- 16 Gage.

Section Inputs

```
Material: A653 SS Grade 50/1
No cold work of forming strength increase.
Apply inelastic reserve strength increase.
Modulus of Elasticity, E           29500 ksi
Yield Strength, Fy                    50 ksi
Tensile Strength, Fu                  65 ksi
Torsion Constant Override, J           0 in⁴
Warping Constant Override, Cw          0 in⁶

Stiffened Channel, Thickness 0.0566 in (16 Gage)
Placement of Part from Origin:
X to center of gravity           0 in
Y to center of gravity           0 in
Outside dimensions, Open shape
        Length      Angle     Radius  Web      k    Hole Size   Distance
          (in)      (deg)       (in)         Coef.       (in)       (in)
  1     0.3750    270.000   0.084900 None    0.000     0.0000     0.1875
  2     0.5625    180.000   0.084900 Single  0.000     0.0000     0.2813
  3     6.0000     90.000   0.084900 Cee     0.000     0.0000     3.0000
  4     0.5625      0.000   0.084900 Single  0.000     0.0000     0.2813
  5     0.3750    -90.000   0.084900 None    0.000     0.0000     0.1875

Direct Strength Parameters
  Prequalified Section: No
  Compression: Pcrl/Py =  0.22071  Pcrd/Py =  0.21526
  Positive Mx: Mcrl/My =  1.49172  Mcrd/My =  1.23069
  Negative Mx: Mcrl/My =  1.49172  Mcrd/My =  1.23069
  Positive My: Mcrl/My = 16.88732  Mcrd/My = 10.32236
  Negative My: Mcrl/My =  1.47493  Mcrd/My =1000.00000
  Shear:      Vcr/Vy(y)=  0.00000 Vcr/Vy(x)=  0.00000
```

Fully Braced Strength - AISI S100-16/S1-18, US, ASD

```
Material Type: A653 SS Grade 50/1, Fy=50 ksi
Axial                   Positive Bending          Positive Bending
Pao       5.291 k       Maxo      13.744 k-in     Mayo       0.805 k-in
Ae      0.21165 in²     Ixe       1.6493 in⁴      Iye       0.0112 in⁴
Ta       12.632 k       Sxe(t)   0.54976 in³      Sye(1)   0.10856 in³
                        Sxe(b)   0.54976 in³      Sye(r)   0.02436 in³
Shear
Vay       2.822 k       Negative Bending          Negative Bending
Vax       0.593 k       Maxo      13.744 k-in     Mayo       0.587 k-in
                        Ixe       1.6493 in⁴      Iye       0.0108 in⁴
Torsion                 Sxe(t)   0.54976 in³      Sye(1)   0.10459 in³
Ba       2.0015 k-in²   Sxe(b)   0.54976 in³      Sye(r)   0.02347 in³
```

Section Properties and Strengths (cont'd)

TFBF: TruFlush Backing – 2 Piece, 3 Piece- 20 Gage.

Section Inputs

```
Material: A653 SS Grade 50/1
No cold work of forming strength increase.
No inelastic reserve strength increase.
Modulus of Elasticity, E          29500 ksi
Yield Strength, Fy                   50 ksi
Tensile Strength, Fu                 65 ksi
Torsion Constant Override, J          0 in⁴
Warping Constant Override, Cw         0 in⁶

Stiffened Channel, Thickness 0.0346 in (20 Gage)
Placement of Part from Origin:
X to center of gravity           0 in
Y to center of gravity           0 in
Outside dimensions, Open shape
        Length      Angle     Radius  Web      k    Hole Size   Distance
          (in)      (deg)       (in)          Coef.       (in)       (in)
  1     0.3750    270.000   0.076400 None    0.000     0.0000     0.1875
  2     0.5625    180.000   0.076400 Single  0.000     0.0000     0.2813
  3     6.0000     90.000   0.076400 Cee     0.000     0.0000     3.0000
  4     0.5625      0.000   0.076400 Single  0.000     0.0000     0.2813
  5     0.3750    -90.000   0.076400 None    0.000     0.0000     0.1875

Direct Strength Parameters
  Prequalified Section: No
  Compression: Pcrl/Py =  0.09562  Pcrd/Py =1000.00000
  Positive Mx: Mcrl/My =  0.59165  Mcrd/My =  0.58552
  Negative Mx: Mcrl/My =  0.59165  Mcrd/My =  0.58552
  Positive My: Mcrl/My =  5.88753  Mcrd/My =  5.38026
  Negative My: Mcrl/My =  0.58651  Mcrd/My =1000.00000
  Shear:      Vcr/Vy(y)=  0.00000 Vcr/Vy(x)=  0.00000
```

Fully Braced Strength - AISI S100-16/S1-18, US, ASD

```
Material Type: A653 SS Grade 50/1, Fy=50 ksi
Axial                   Positive Bending          Positive Bending
Pao      3.1702 k       Maxo      8.6173 k-in     Mayo      0.5019 k-in
Ae      0.11413 in²     Ixe      0.95798 in⁴      Iye      0.00778 in⁴
Ta       7.8479 k       Sxe(t)   0.28782 in³      Sye(l)   0.07914 in³
                        Sxe(b)   0.35858 in³      Sye(r)   0.01676 in³
Shear
Vay      0.6379 k       Negative Bending          Negative Bending
Vax      0.4418 k       Maxo      8.6173 k-in     Mayo      0.4788 k-in
                        Ixe      0.95798 in⁴      Iye      0.00636 in⁴
Torsion                 Sxe(t)   0.35858 in³      Sye(l)   0.03868 in³
Ba        1.351 k-in²   Sxe(b)   0.28782 in³      Sye(r)   0.01599 in³
```

Analyses (Revision 1)

The information provided by Stockton Products was used to perform calculations using a fundamental engineering approach in accordance with AISI- S100. Our engineering will determine backing span lengths based on the least conditions of span or connection capacities to the various gages.

Section Properties and Strengths

Section properties related to 2-, and 3-piece segments that create an adjustable span length out to 24". We will neglect the crimp section as the end segment as it locks into the flange of an adjoining stud. Therefore, the reduced section of the slip mechanism will be used. A 1-1/2" minimum lap length is required for development length for bending at maximum stretch.

Section Inputs

```
Material: A875 SS Grade 50/1
Apply cold work of forming strength increase.
No inelastic reserve strength increase.
Modulus of Elasticity, E          29500 ksi
Yield Strength, Fy                   50 ksi
Tensile Strength, Fu                 65 ksi
Min Elongation in 2 inches           12 %
Torsion Constant Override, J          0 in⁴
Warping Constant Override, Cw         0 in⁶

Stiffened Channel, Thickness 0.0713 in (68 mil)
Placement of Part from Origin:
X to center of gravity             0 in
Y to center of gravity             0 in
Centerline dimensions, Open shape
```

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.4644	270.000	0.10690	None	0.000	0.0000	0.2500
2	0.9287	180.000	0.10690	Single	0.000	0.0000	0.4644
3	5.9287	90.000	0.10690	Cee	0.000	0.0000	2.9644
4	0.9287	0.000	0.10690	Single	0.000	0.0000	0.4644
5	0.4644	-90.000	0.10690	None	0.000	0.0000	0.2144

Fully Braced Strength - AISI S100-16/S1-18, US, ASD

```
Material Type: A875 SS Grade 50/1, Fy=50 ksi
Axial                    Positive Bending          Positive Bending
Pao        11283 lb      Maxo      27.332 k-in     Mayo       3.073 k-in
Ae       0.40618 in²     Ixe       2.7406 in⁴      Iye       0.0657 in⁴
Ta         19052 lb      Sxe(t)   0.91289 in³      Sye(l)   0.29107 in³
                         Sxe(b)   0.91418 in³      Sye(r)   0.08494 in³
Shear
Vay         5352 lb      Negative Bending          Negative Bending
Vax         1721 lb      Maxo      27.332 k-in     Mayo       2.513 k-in
                         Ixe       2.7406 in⁴      Iye       0.0630 in⁴
Torsion                  Sxe(t)   0.91418 in³      Sye(l)   0.25197 in³
Ba        6335.7 lb-in²  Sxe(b)   0.91289 in³      Sye(r)   0.08394 in³
```

Conclusions- Wind Load

The allowable span lengths for the nonstructural steel stud assemblies are based on the limiting span calculated wall at flexural strength, and end reaction strength. Results are summarized in Tables 1 through 4. DP represents wind load pressure in PSF. Sample calculations is presented on page 10.

Table1: TRU-Backing 16 Gage Fixed Allowable spans

	Span lengths (in) based on Strength			
DP (psf)	Vertical Spacing of TruFlush Backing			
	16	24	32	48
5	106.9	87.3	75.6	61.7
10	75.6	61.7	53.4	43.6
15	61.7	50.4	43.6	35.6
30	43.6	35.6	30.8	25.2
40	37.8	30.8	26.7	21.8
50	33.8	27.6	23.9	19.5
60	30.8	25.2	21.8	17.8

Table2: TRU-Backing 20 Gage Fixed Allowable spans

	Span lengths (in) based on Strength			
DP (psf)	Vertical Spacing of TruFlush Backing			
	16	24	32	48
5	75.2	61.4	53.2	43.4
10	53.2	43.4	37.6	30.7
15	43.4	35.5	30.7	25.1
30	30.7	25.1	21.7	17.7
40	26.6	21.7	18.8	15.4
50	23.8	19.4	16.8	13.7
60	21.7	17.7	15.4	12.5

Conclusions – Wind Load (cont'd)

Table3: TRU-Backing 16 Gage 2- and 3-Piece Panel Configuration - Allowable spans

	Span lengths (in) based on Strength			
DP (psf)	Vertical Spacing of TruFlush Backing			
	16	24	32	48
5	91.9	75.1	65.0	53.1
10	65.0	53.1	46.0	37.5
15	53.1	43.3	37.5	30.6
30	37.5	30.6	26.5	21.7
40	32.5	26.5	23.0	18.8
50	29.1	23.7	20.6	16.8
60	26.5	21.7	18.8	15.3

Table4: TRU-Backing 20 Gage 2- and 3-Piece Panel Configuration - Allowable spans

	Span lengths (in) based on Strength			
DP (psf)	Vertical Spacing of TruFlush Backing			
	16	24	32	48
5	83.1	67.8	58.7	47.9
10	58.7	47.9	41.5	33.9
15	47.9	39.2	33.9	27.7
30	33.9	27.7	24.0	19.6
40	29.4	24.0	20.8	17.0
50	26.3	21.4	18.6	15.2
60	24.0	19.6	17.0	13.8

Based on the tabular information for both the Fixed and Adjustable Tru Backing the allowable spans as managed in comparison to common stud spacings of 12",16", and 24" can be used with in conjunction with all typical stud gage applications.

Sample Calculations- Wind Load

Effective spans and screw shear related to spacing and Wind loading

$$L = \sqrt{\frac{M\ x\ 8}{DP\ x\ Spacing}}$$

DP = Wind load (PSF)
Spacing (In the vertical direction)
M = Allowable Flexural moment in Tru Backing. (Pages 3 through 6)

$$V_{screws} = \frac{(DP \times spacing) \times L}{2.0}$$

TRU-Backing 16 Gage 2- and 3-Piece Panel Configuration - Allowable spans

24" vertical spacing, 30 PSF design loading

L = (587 lb-in x 8 / (30 PSF / 144) x 24")$^{0.5}$ = 30.6 inches > 24", 16", 12" stud spacing.

V = (5 x 30.6) / 2 = 76 lb – See Next for screw capacity.

End reaction and Fastening

2 or 3 screw patterns at ends of Tru-Backing. #10-16 screws

Common Stud Gages.

20 Gage (0.0346 inches)
18 Gage (0.0451 inches)
16 Gage (0.0566 inches)
14 Gage (0.0713 inches)
12 Gage (0.1017 inches)

AISI D100 2012 Design Guide Table IV-9c

Use 20 Gage to 20 Gage for allowable as it will qualify the typical fastening pattern capacities for other gages, thus

P_{ns} = 530 lb
P_{ns} / Ω =177 lb.

(2) two screws minimum = 353 lb. > 76 lb. As the spacing of studs using this construction is 12", 16", 24 the reactions in the various spans and minimal gages do not control.

ADA Compliant Grab Bar Calculations – Conclusion

14 Gauge backing must be used for Grab bar applications, thus

250 lb Single point load at center of 24" maximum spacing is critical, thus

Check Strength

M-= PL/4 = (250 lb x 24") / 4 = 1,500 lb-in (Critical for weak bending)

M_{ayo} = 2,513 lb-in (Page 7) > 1,500 lb -in.

Check Deflection

PL^3 / 48EI = 250 lb $(24)^3$ / (48) 29,000,000 (0.0630 in^4) = 0.039 in < 1/16"

14 gauge (0.0713 in) fixed and adjustable TruFlush backing will work at 16" maximum stud spacing for the grab bar brackets.

End reaction and Fastening

R = 250 lb at any point of grab bar

2 or 3 screw patterns at ends of Tru-Backing. #10-16 screws

Common Stud Gages.

20 Gage (0.0346 inches)
18 Gage (0.0451 inches)
16 Gage (0.0566 inches)
14 Gage (0.0713 inches)
12 Gage (0.1017 inches)

AISI D100 2012 Design Guide Table IV-9c

Use 20 Gage to 20 Gage for allowable as it will qualify the typical fastening pattern capacities for other gates, thus

P_{ns} = 530 lb
P_{ns} / Ω =177 lb.

Use 3 screws in this application, thus 177 x 3 = 530 lb. >> 250 lb

As the grab is a constant load over the length of the backing the reactions at 20 gage controls qualifying all other vertical stud gauges for attachments. Screw configuration meets and exceeds wind reactions.

Revision Log

Rev. #	Date	Page(s)	Revision(s)
1	04/18/25	12	Add grab bar application
0	04/28/23	10	Original report issue