

TO : Metal Forming, Inc.
100 International Drive
Peachtree City, Georgia 30269

Attn.: Mr. Frank Callis

FROM : Thomas M. Shingler, P.E.
Registered Structural Engineer
President
Design Dynamics, Inc.

DATE : December 2, 2005

SUBJECT : Metal Forming, Inc.
1 1/2" SNAP LOCK @ 19 5/8" wide x 0.040" Aluminum
with 18 gauge steel clip
ASTM E-72 Structural Testing
for the determination of.....
* Flexural Moment Capacity
* Flexural Stiffness

Purpose : This series of metal roof panel testing is designed to establish the positive/negative flexural moment capacity, flexural stiffness index (Moment of Inertia) of the Metal Forming, Inc. 1 1/2" SNAP LOCK product @ 19 5/8" wide x 0.040" Aluminum using the industry-accepted ASTM E-72 chamber procedure. This information will be utilized to determine the gravity load and inward (positive) wind pressure response of the roof panel product.

Method : The positive/negative flexural moment capacity and the flexural stiffness index of the panel was determined using a single span (4.50 ft) test panel arrangement. There were three (3) full width test panels with male/female joint starter and terminal edges. The male/female joint starter and terminal edges were utilized to render continuity to the lay-up of the panel assembly and prevent the influence of so-called "edge effects". For the positive flexural moment capacity and positive flexural stiffness index, the panels were installed with the rib configuration in an "up" position. For the negative flexural moment capacity and negative flexural stiffness index, the panels were installed with the rib configuration in a "down" position.

The positive/negative flexural stiffness indices were computed using load vs deflection points at controlled levels of loading.

Set-up : In-plan, the test chamber for the single span flexural moment capacity and flexural stiffness index evaluation was 5'-9" wide x 4'-0" long.

Relative to the positive/negative flexural moment capacity and the positive/negative flexural stiffness index, the ASTM E-72 testing procedure is designed to apply a uniform suction pressure to the roof panel specimen.

For the flexural moment capacity testing.....

A "rib up" orientation forces the top portion of the rib element into compression and the panel broad flat into tension.....emulating single curvature positive bending.

The net result of testing this panel orientation to buckling failure is the establishment of the **positive flexural moment capacity**.

A Factor-of-Safety of 2.00 applied to the positive flexural moment capacity determines the **allowable positive flexural moment** for the panel.

A "rib down" orientation forces the top portion of the rib element into tension and the panel broad flat into compression.....emulating single curvature negative bending.

The net result of testing this panel orientation to buckling failure is the establishment of the **negative flexural moment capacity**.

A Factor-of-Safety of 2.00 applied to the negative flexural moment capacity determines the **allowable negative flexural moment** for the panel.

The positive/negative flexural stiffness indices (positive/negative Moments of Inertia) were determined from single span rib up/rib down load vs. deflection values inserted into the established single span maximum deflection equation and then solving for the applicable (+/-) Moment of Inertia value.

For extreme accuracy, a series of at least ten (10) load vs. deflection increments falling within the elastic range of the profile were incorporated into the test procedure for determining flexural stiffness.

The applicable deflection equation is as follows....

$$\text{deflection} = \frac{22.5 \times w \times L^4}{E \times I}$$

deflection = recorded test deflection
for a corresponding test
pressure value, in.

w = test pressure value, psf

L = test span, ft.

L = 4.50 ft.

I = Moment of Inertia, in⁴

E = Modulus of Elasticity of Aluminum,
#/in²

E = 10.1 x 10⁶ #/in² (aluminum)

Re-arranging terms and solving for the Moment of
Inertia value, the equation becomes.....

$$I = \frac{22.5 \times w \times L^4}{E \times \text{deflection}}$$

Test Results :

Positive Stiffness Index, (+) I Determination.....

Test Pressure, psf	Test No. 1 (+) I	Test No. 2 (+) I	Test No. 3 (+) I	Test-Determined (+) I, in ⁴ (avg)
20.8	0.076	0.072	0.073	0.074

(+) I (average) = 0.074 in⁴

Positive Flexural Moment Capacity :

The applicable flexural moment equation is as follows.....

$$M \text{ (ultimate)} = 1.50 \times w \text{ (ultimate)} \times L^2$$

$$M \text{ (allowable)} = \frac{M \text{ (ultimate)}}{F.S. = 2.00}$$

Test No.	w (ultimate), #/ft ²	M (ultimate), in-#	M (allowable), in-#
1	42.64	1295	648
2	42.64	1295	648
3	42.12	1279	640

$$(+)\ M \text{ (allowable, average)} = 645 \text{ in-#}$$

Determine the (+) Section Modulus for the profile based on an allowable flexural stress level Fb of 10,000 #/in².....

$$(+)\ S = \frac{(+)\ M \text{ (allow)}}{F_b} = \frac{645 \text{ in-#}}{10,000 \text{ \#/in}^2} = 0.064 \text{ in}^3$$

$$(+)\ S = 0.064 \text{ in}^3$$

Negative Stiffness Index, (-) I Determination.....

Test Pressure, psf	Test No. 1 (-) I	Test No. 2 (-) I	Test No. 3 (-) I	Test-Determined (-) I, in ⁴ (avg)
20.8	0.034	0.033	0.032	0.033

$$(-) I (\text{average}) = 0.033 \text{ in}^4$$

Negative Flexural Moment Capacity :

Test No.	w (ultimate), #/ft ²	M (ultimate), in-#	M (allowable), in-#
1	41.60	1264	632
2	41.60	1264	632
3	41.08	1248	624

$$(-) M (\text{allowable, average}) = 629 \text{ in-#}$$

Determine the (-) Section Modulus for the profile based on an allowable flexural stress level of 10,000 #/in².....

$$(-) S = \frac{(-) M (\text{allow})}{F_b} = \frac{629 \text{ in-#}}{10,000 \text{ \#/in}^2} = 0.062 \text{ in}^3$$

$$(-) S = 0.062 \text{ in}^3$$

State **Effective** Section Properties per ft of width of Profile
profile : 1 1/2" Snap Lock @ 19 5/8" wide x 0.040" aluminum

$$(+)\ I\ (\text{eff}) = [0.71 \times 0.074] + [0.29 \times 0.033] = 0.062\ \text{in}^4$$

$$(+)\ S\ (\text{eff}) = \frac{645\ \text{in}\cdot\#}{10,000\ \#/\text{in}^2} = 0.064\ \text{in}^3$$

$$(-)\ I\ (\text{eff}) = [0.71 \times 0.033] + [0.29 \times 0.074] = 0.044\ \text{in}^4$$

$$(-)\ S\ (\text{eff}) = \frac{629\ \text{in}\cdot\#}{10,000\ \#/\text{in}^2} = 0.062\ \text{in}^3$$

Note : Use (+) I '(eff) for deflection considerations when the panel is experiencing downward (positive) loading normal to the plane of the roof.

Use (-) I (eff) for deflection considerations when the panel is experiencing upward (negative) loading normal to the plane of the roof.

***** END OF REPORT *****

Load/Span Chart for 1 1/2" SNAP LOCK @ 17 5/8" wide x 0.032"
Aluminum based on downward (positive) wind pressure and three
(3) or more equal spans (clip spacing) :

Span, ft.	(-) w (allowable), psf
2.00	(+) 129.17 psf
2.25	(+) 102.06 psf
2.50	(+) 82.67 psf
2.75	(+) 68.32 psf
3.00	(+) 57.41 psf
3.25	(+) 48.92 psf
3.50	(+) 42.18 psf
3.75	(+) 36.74 psf
4.00	(+) 32.29 psf

DESIGN INPUT DATA FOR 1 1/2" SNAP LOCK @ 19 5/8 x .040

*ALUMINUM
INWARD PRESSURE*

PRODUCT PROPERTIES :

E = 10100. KSI

I = .0620 IN⁴/FT

S = .0620 IN³/FT

DESIGN PARAMETERS :

DEFLECTION = L/ 180.

ALLOW. BENDING STRESS (PSI)

= 10000.0

ALLOW. REACTION NOT CONSIDERED

LOAD-SPAN TABLE FOR 1 1/2" SNAP LOCK @ 19 5/8 x .040 *ALUM*

DEFLECTION = L/ 180.

Inward Pressure

SPAN (FT)	TWO EQUAL SPAN			THREE EQUAL SPAN		
	W(PSF)	RE	RI	W(PSF)	RE	RI
2.00	103.33	77.5	258.3	129.17	103.3	284.2
2.25	81.65	68.9	229.6	102.06	91.9	252.6
2.50	66.13	62.0	206.7	82.67	82.7	227.3
2.75	54.66	56.4	187.9	68.32	75.2	206.7
3.00	45.93	51.7	172.2	57.41	68.9	189.4
3.25	39.13	47.7	159.0	48.92	63.6	174.9
3.50	33.74	44.3	147.6	42.18	59.0	162.4
3.75	29.39	41.3	137.8	36.74	55.1	151.6
4.00	25.83	38.8	129.2	32.29	51.7	142.1
4.25	22.88	36.5	121.6	28.60	48.6	133.7
4.50	20.41	34.4	114.8	25.51	45.9	126.3
4.75	18.32	32.6	108.8	22.90	43.5	119.6
5.00	16.53	31.0	103.3	20.67	41.3	113.7

W = ALLOWABLE UNIFORM LOAD

RE = END SUPPORT REACTION AT ALLOW. LOAD (#/FT)

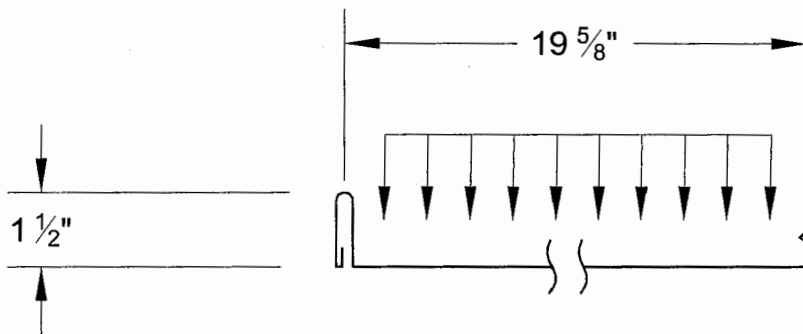
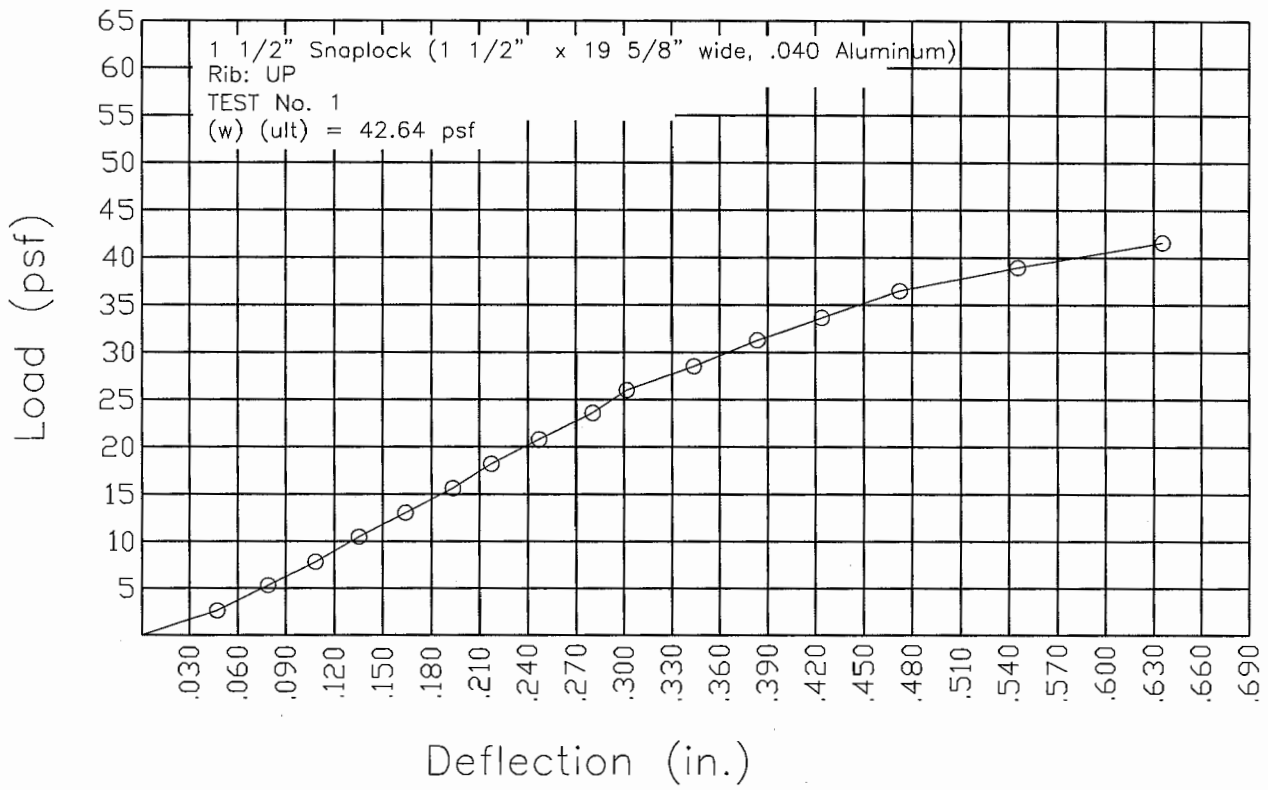
RI = INTERMEDIATE SUPPORT REACTION AT ALLOW. LOAD (#/FT)

ASTM E-72 TESTING
SNAP LOCK 1 1/2" X 19 5/8"
.040 ALUMINUM

TEST #1 - POSITIVE BENDING MOMENT

Pressure in. H2O	Pressure psf	Deflection in.
0.500	2.600	0.047
1.000	5.200	0.079
1.500	7.800	0.109
2.000	10.400	0.136
2.500	13.000	0.163
3.000	15.600	0.193
3.500	18.200	0.217
4.000	20.800	0.247
4.500	23.400	0.280
5.000	26.000	0.309
5.500	28.600	0.343
6.000	31.200	0.383
6.500	33.800	0.423
7.000	36.400	0.472
7.500	39.000	0.546
8.000	41.600	0.636

(w) (ult) = 8.2 in. H2O

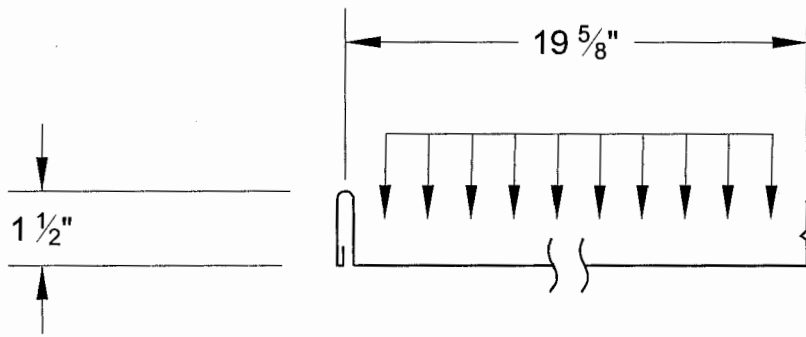
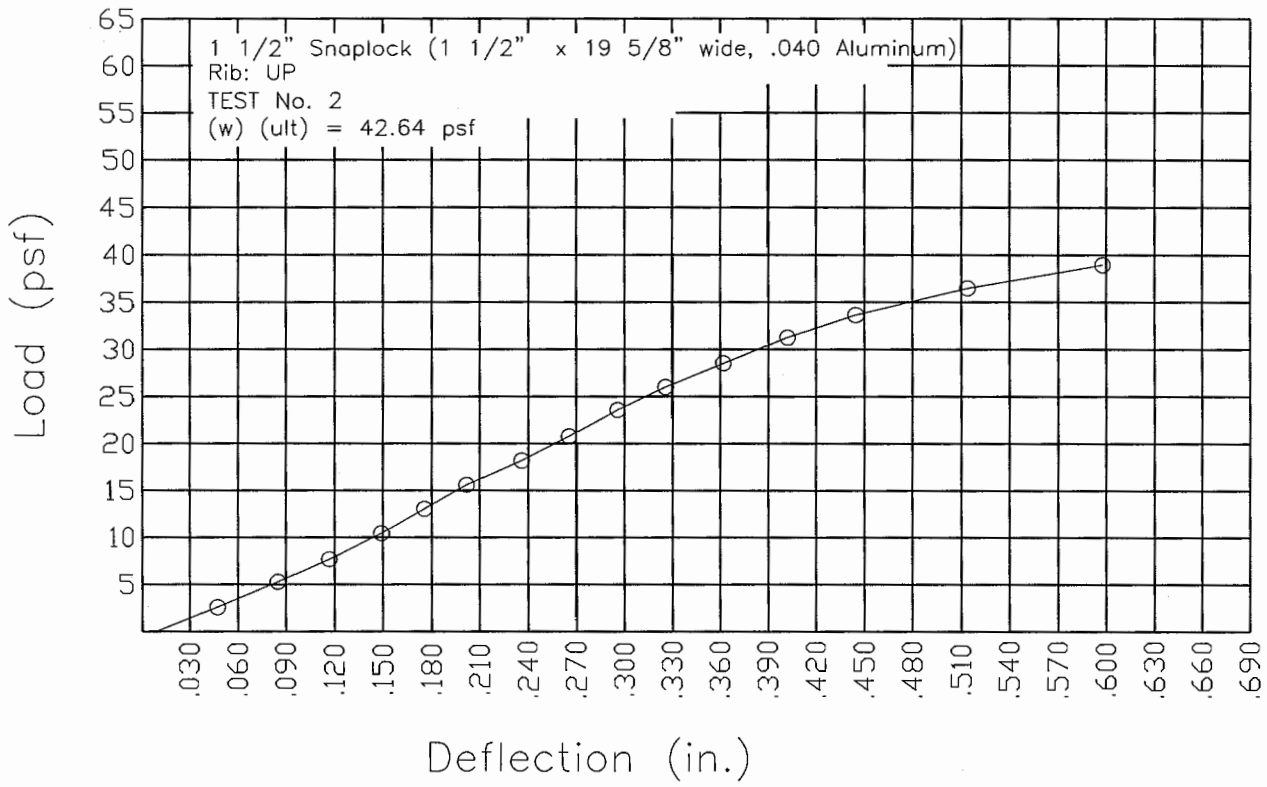


ASTM E-72 TESTING
SNAP LOCK 1 1/2" X 19 5/8"
.040 ALUMINUM

TEST #2 - POSITIVE BENDING MOMENT

Pressure in. H2O	Pressure psf	Deflection in.
0.500	2.600	0.047
1.000	5.200	0.085
1.500	7.800	0.117
2.000	10.400	0.149
2.500	13.000	0.175
3.000	15.600	0.205
3.500	18.200	0.235
4.000	20.800	0.265
4.500	23.400	0.295
5.000	26.000	0.326
5.500	28.600	0.361
6.000	31.200	0.402
6.500	33.800	0.445
7.000	36.400	0.512
7.500	39.000	0.590

(w) (ult) = 8.20 in. H2O

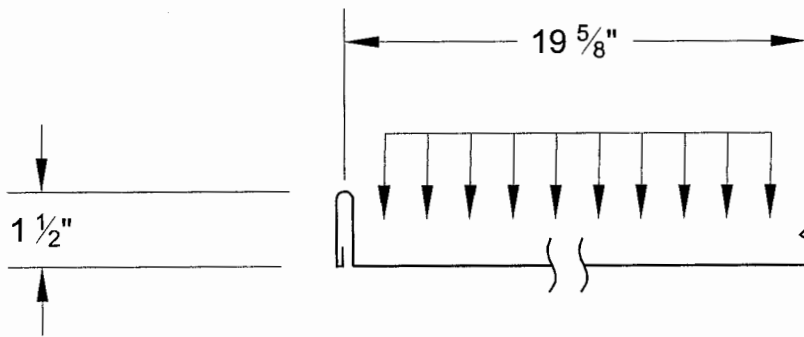
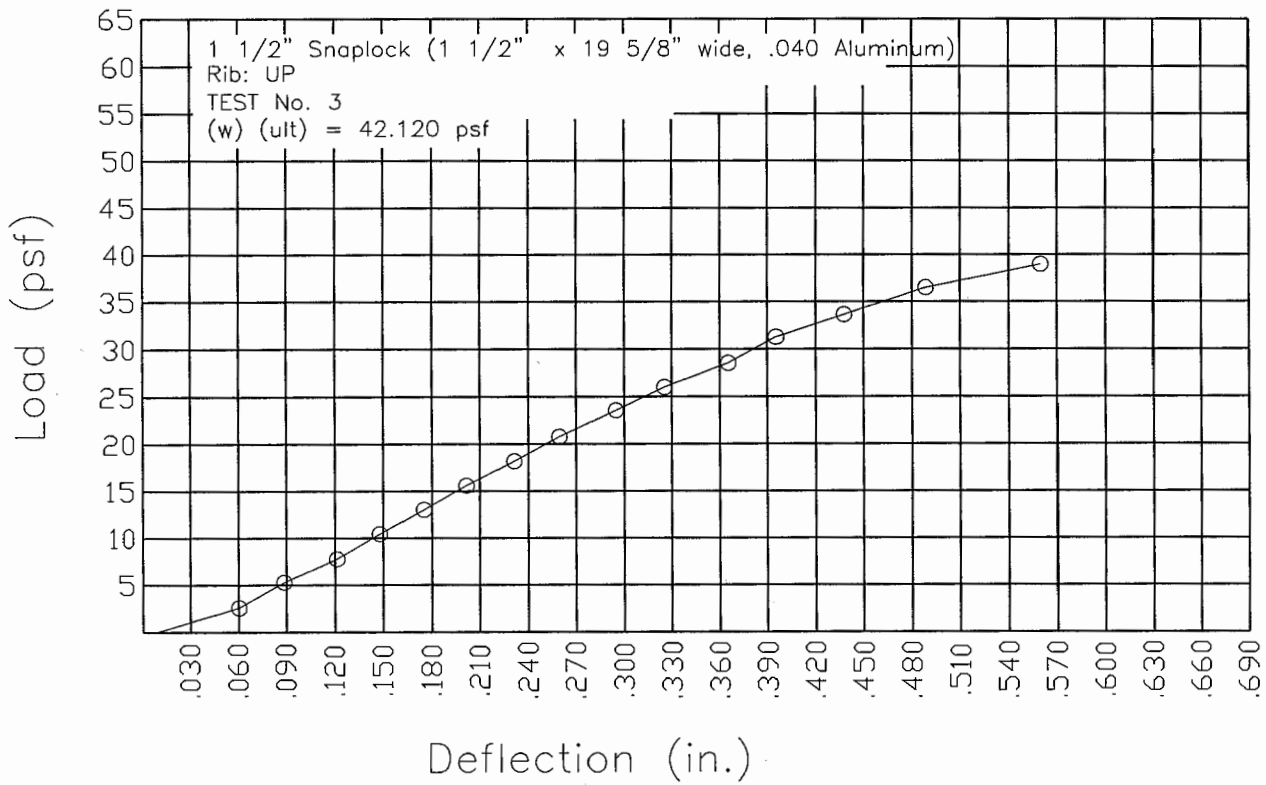


ASTM E-72 TESTING
SNAP LOCK 1 1/2" X 19 5/8"
.040 ALUMINUM

TEST #3 - POSITIVE BENDING MOMENT

Pressure in. H2O	Pressure psf	Deflection in.
0.500	2.600	0.060
1.000	5.200	0.089
1.500	7.800	0.121
2.000	10.400	0.148
2.500	13.000	0.175
3.000	15.600	0.202
3.500	18.200	0.231
4.000	20.800	0.259
4.500	23.400	0.294
5.000	26.000	0.325
5.500	28.600	0.365
6.000	31.200	0.395
6.500	33.800	0.438
7.000	36.400	0.489
7.500	39.000	0.560

(w) (ult) = 8.10 in. H2O

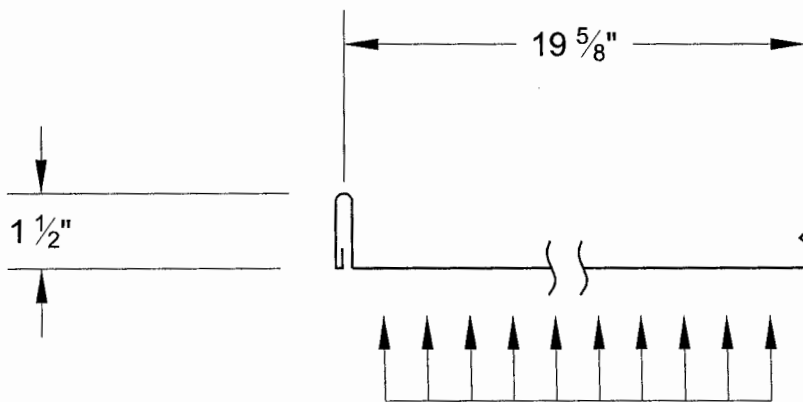
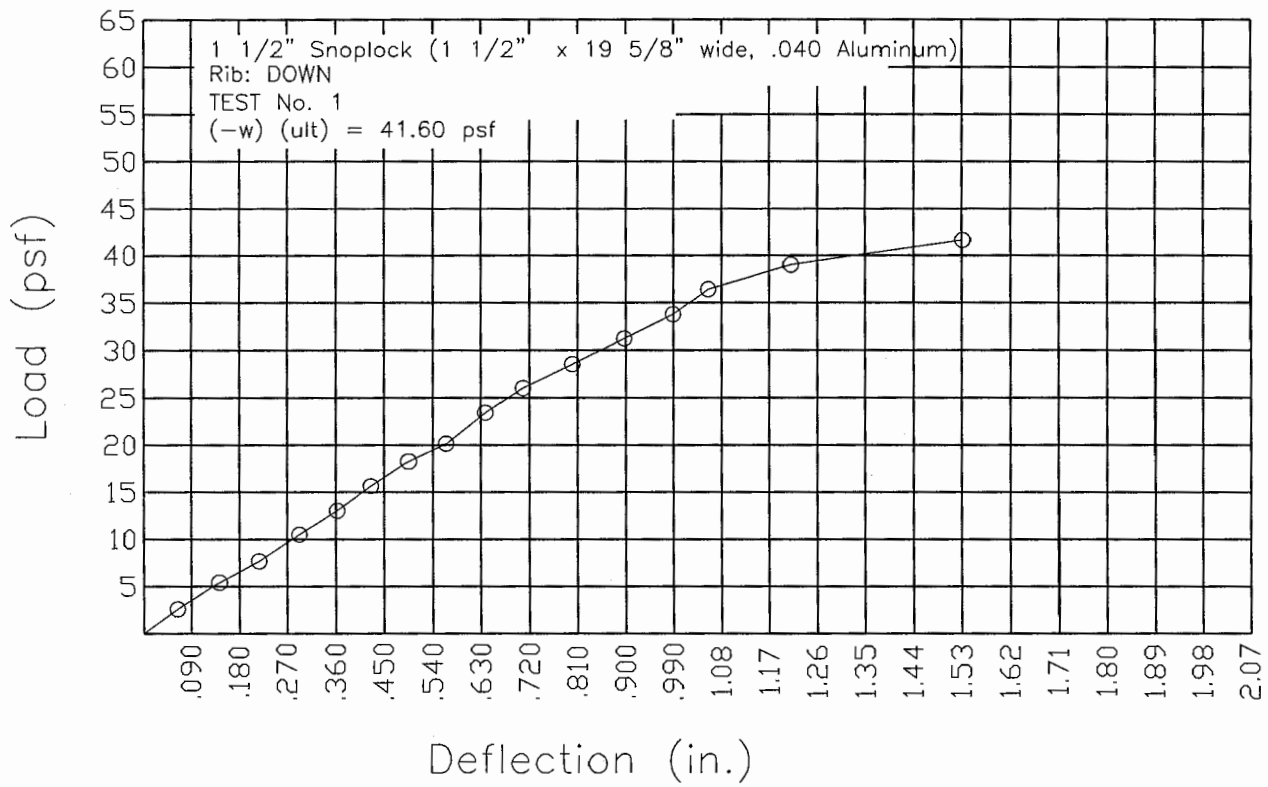


ASTM E-72 TESTING
SNAP LOCK 1 1/2" X 19 5/8"
.040 ALUMINUM

TEST #1 - NEGATIVE BENDING MOMENT

Pressure in. H2O	Pressure psf	Deflection in.
0.500	2.600	0.065
1.000	5.200	0.141
1.500	7.800	0.218
2.000	10.400	0.291
2.500	13.000	0.361
3.000	15.600	0.426
3.500	18.200	0.495
4.000	20.800	0.564
4.500	23.400	0.639
5.000	26.000	0.708
5.500	28.600	0.800
6.000	31.200	0.898
6.500	33.800	0.990
7.000	36.400	1.144
7.500	39.000	1.306
8.000	41.600	1.621

(-w) (ult) = 8.00 in. H2O

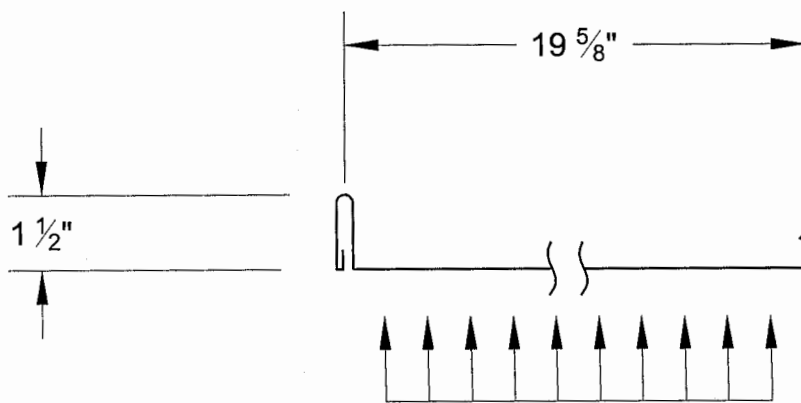
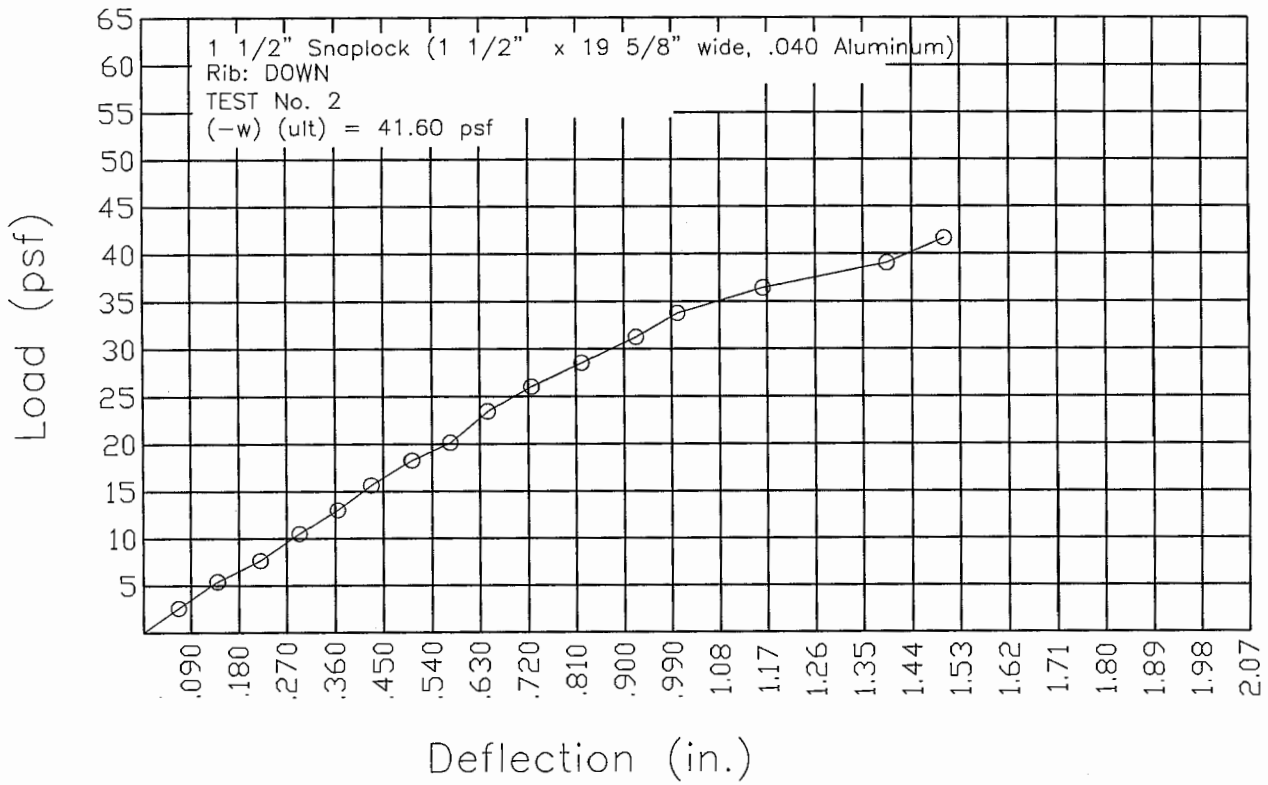


ASTM E-72 TESTING
SNAP LOCK 1 1/2" X 19 5/8"
.040 ALUMINUM

TEST #2 - NEGATIVE BENDING MOMENT

Pressure in. H2O	Pressure psf	Deflection in.
0.500	2.600	0.067
1.000	5.200	0.140
1.500	7.800	0.220
2.000	10.400	0.293
2.500	13.000	0.364
3.000	15.600	0.429
3.500	18.200	0.507
4.000	20.800	0.573
4.500	23.400	0.643
5.000	26.000	0.727
5.500	28.600	0.820
6.000	31.200	0.921
6.500	33.800	1.017
7.000	36.400	1.161
7.500	39.000	1.392
8.000	41.600	1.500

(-w) (ult) = 8.00 in. H2O

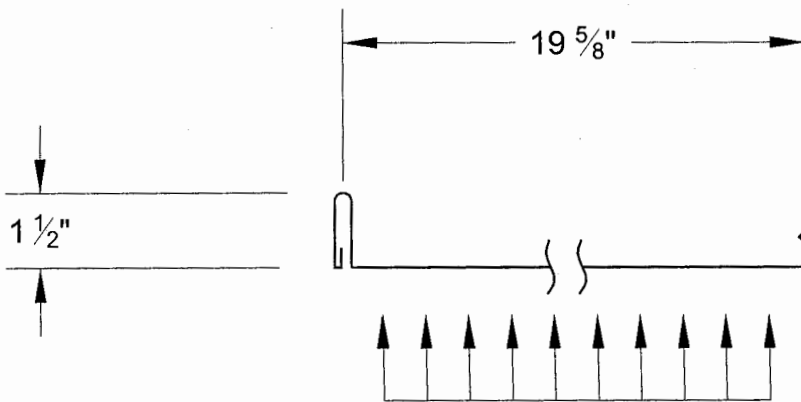
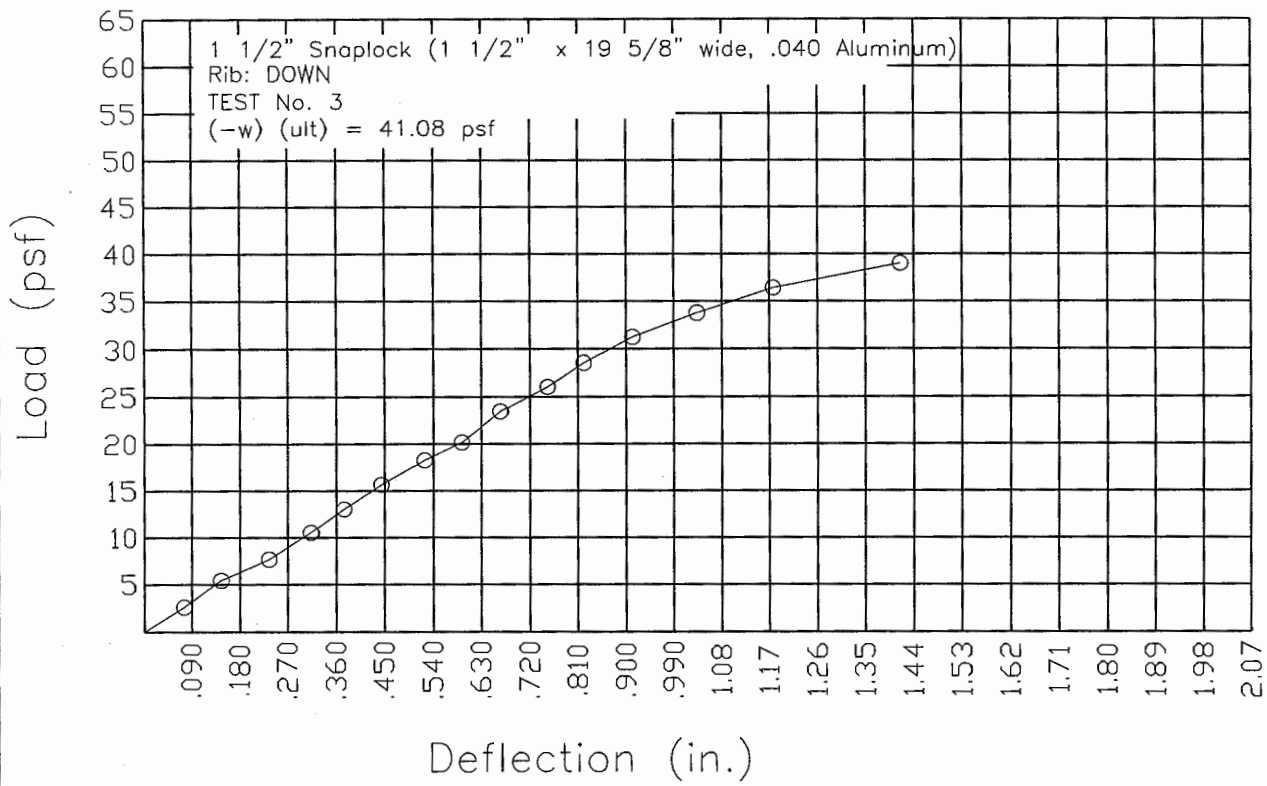


ASTM E-72 TESTING
SNAP LOCK 1 1/2" X 19 5/8"
.040 ALUMINUM

TEST #3 - NEGATIVE BENDING MOMENT

Pressure in. H2O	Pressure psf	Deflection in.
0.500	2.600	0.076
1.000	5.200	0.146
1.500	7.800	0.234
2.000	10.400	0.314
2.500	13.000	0.373
3.000	15.600	0.444
3.500	18.200	0.522
4.000	20.800	0.592
4.500	23.400	0.665
5.000	26.000	0.751
5.500	28.600	0.820
6.000	31.200	0.912
6.500	33.800	1.034
7.000	36.400	1.178
7.500	39.000	1.415

(-w) (ult) = 7.90 in. H2O



TO : Metal Forming, Inc.
100 International Drive
Peachtree City, Georgia 30269

Attn.: Mr. Frank Callis

FROM : Thomas M. Shingler, P.E.
Registered Structural Engineer
President
Design Dynamics, Inc.

DATE : December 8, 2005

SUBJECT : Metal Forming, Inc.
1 1/2" SNAP LOCK @ 19 5/8" wide x 0.040" Aluminum
with 18 gauge steel clip
ASTM E-72 Structural Testing
for the determination of.....
* Clip/Sidejoint Interactive Capacity

Purpose : This series of metal roof panel testing
is designed to establish the clip/sidejoint
interactive capacity of the Metal Forming, Inc.
1 1/2" SNAP LOCK product using the industry-
accepted ASTM E-72 chamber procedure.

Method : The clip/sidejoint interactive capacity was
determined using a series of two (2) ASTM E-72
chamber tests.
The two (2) tests had panel clip fastening spaced
at 2.0 ft. o/c with male/female joint starter and
terminal edges.
The male/female joint starter and terminal edges
consisted of full-width panels utilized to render
continuity to the lay-up of the panel assembly and
negate the influence of so-called "edge effects".
For the clip/sidejoint interactive capacity
test, the panels were installed with the rib
configuration in a "down" position.

Set-up : The test assembly consisted of a three (3) panel
array with four (4) equal 2 ft. spans.
(see enclosed Sketch)
The clip/sidejoint interactive capacity testing
involved the development of a high intensity clip
reaction forces thru the application of ever-
increasing "ramped-up" test pressures.
The test pressure was applied to the panel assembly
in a "ribs down" orientation to simulate the effects
of wind induced "lift".
The test pressures were gradually applied until
clip/sidejoint failure occurred, with the point
of failure being defined as the clip/sidejoint
interactive strength.

Set-up : (continued)

A Factor-of-Safety of 1.875 applied to the test-determined clip/sidejoint interactive strength capacity value determines the allowable clip/sidejoint reaction.

Clip/Sidejoint Interactive Strength Capacity : 18 ga. clip

The applicable clip/sidejoint reaction equation is as follows..... $R = w \times L$

where R = clip reaction, #/ft of panel width
 w = test pressure value, psf
 L = test span, ft.
 L = 2.0 ft. (4 equal spans)

Test Results : 1 1/2" SNAP LOCK @ 19 5/8" wide x .040" Alum.

Test No.	Span ft.	w (ultimate) #/ft ²	R (ultimate) #/ft	R (allowable) #/ft
1	2.00	80.08	160.16	85.42
2	2.00	81.12	162.24	86.52

R (allow, avg) = 85.97 #/ft

Note : Use R (allowable) value for the consideration of clip/sidejoint interactive capacity when the panel system experiences upward (negative) loading normal to the plane of the roof.

***** END OF REPORT *****

CLIP INTER-ACTION TEST
RUN 11-23-05 FOR
METALFORMING INC.

