Exterior Research & Design, L.L.C.
Building Science and Envelope Consultants

Laboratory Report E1060.03.06

Withdrawal and Pull-Through Performance Testing
of
ES Products FM-260 and FM-260V Fasteners
in accordance with
TAS 117(A) and TAS 117(B)

Prepared for:
ES Products, Inc.
280 Franklin Street
Bristol, RI 02809

Date of Issuance:
March 14, 2006

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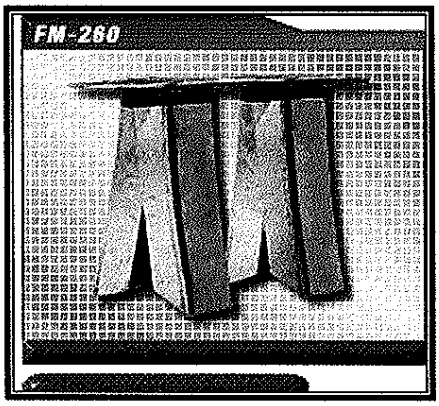
Client: ES Products, Inc.
280 Franklin Street
Bristol, RI 02809
Attention: John Barker

Reference: FM-260 Fastener Testing

ERD Reference: Project #2005.E1060LAB

Samples: ES Product's FM-260 and FM-260V Fasteners are two-legged fasteners used to attach base sheets to lightweight insulating concrete decking. The difference between the FM-260 and FM-260V is the tip configuration whereby the FM-260 has a flat, square tip and the FM-260V has a pointed V-tip.



Sample Delivery: The named client shipped materials to ERD's Laboratory for testing.

Test Date(s): October 2005 – March 2006

Technicians: Charles Phillips, Jonas Hawk, Mike Beelendorf

Standards:

Withdrawal Resistance	TAS 117(A)
Pull-Through Resistance	TAS 117(B)

Standards: TAS 117(A)-95 – *Test Procedure for Withdrawal Resistance Testing of Mechanical Fasteners Used in Roof System Assemblies*, © FBC 2004.
TAS 117(B)-95 – *Test Procedure for Dynamic Pull-Through Performance of Roofing Membranes Over Fastener Heads or Fasteners with Metal Bearing Plates*, © FBC 2004.

Equipment:

Withdrawal Resistance	Satec T-5000
Pull-Through Resistance	Com-Ten

1. Withdrawal Resistance:

1.1 Specimens:

1.1.1 Fourteen specimens were prepared for each of the following substrates for both static and dynamic loading conditions.

- ***Lightweight Insulating Concrete:*** The FM-260 Fastener was installed through a specialized pull strap designed for the fastener, into 200-psi cellular lightweight concrete on day 3 of the lightweight concrete cure.

1.1.2 ERD conducted preliminary static withdrawal tests of the FM-260 and FM-260V parts installed in 3-day cured LWC specimens to determine the critical leg-configuration for the full-series of tests. These tests indicate the FM-260V to have slightly lesser withdrawal performance (80 lbf for the 'V' part vs. 88 lbf for the standard part), and all further withdrawal work was conducted using the FM-260V fastener.

1.2 Procedure:

1.2.1 Static Loading:

1.2.1.1 The test specimen, consisting of the installed fastener and substrate, is secured in the tensile loading device in such a manner that any bending or shear loads are avoided.

1.2.1.2 The tensile loading device is operated at a vertical deflection rate of 2-inches per minute and the peak load at failure is recorded.

1.2.1.3 The withdrawal resistance under static loading is determined in accordance with TAS 117(A), Section 6.5.

1.2.2 Pulsating Loading:

1.2.2.1 The initial pulsating load interval is $1/5^{th}$ of the withdrawal resistance under static load, rounded to the next 10 lbf. Pulsating load interval increments are $1/5^{th}$ of the withdrawal resistance under static load, rounded up to the next 10 lbf.

1.2.2.2 Each pulsating load interval consists of 200 load cycles (loading / unloading). After each interval, the loading device is set to the next loading interval, increasing by the predetermined load interval increment, until failure occurs.

1.2.2.3 The withdrawal resistance under pulsating load is determined in accordance with TAS 117(B), Section 6.5.

1.3 Results:

Table 1B: Test Results, Lightweight Concrete Compressive Strength

Specimen	Compressive Strength (psi)
1	221.0
2	203.0
3	198.0
4	182.0
Average:	**201.0**
Standard Deviation:	16.1

Table 1B: Test Results, Static Withdrawal, FM-260V in 200 psi Cellular LWC		
Specimen	Peak Load (lbf)	
	Day-3	Day-28
1	79.6	152.2
2	81.2	201.0
3	107.2	195.4
4	69.5	112.3
5	82.4	72.4 - low
6	95.4	205.9
7	60.1	133.2
8	93.4	136.7
9	85.4	209.9 - high
10	141.2 - high	171.2
11	122.3	154.0
12	97.4	160.3
13	39.5 - low	189.7
14	81.1	156.6
Average:	**87.9**	**164.0**
Standard Deviation:	16.6	29.4
Coefficient of Variation:	19%	18%
2 to 1 margin:	44.0	82.0

Note: Cells highlighted yellow indicate 'high' and 'low' values omitted from statistical analysis.

Table 1C: Test Results, Cyclic Withdrawal, FM-260V in 200 psi Cellular LWC		
Specimen	Cyclic Performance at Day-28	
	Maximum Load (lbf)	Cycle
1	200	980
2	120	465
3	80	392
4	120	452
5	120	529
6	120	582
7	80	288
8	160	786
9	160	792
10	120	595
11	120	574
12	120	565
13	160	795
14	160	780
Average:	**130**	
Standard Deviation:	25	
Coefficient of Variation:	19%	
2 to 1 margin:	65.0	

Note: Cells highlighted yellow indicate 'high' and 'low' values omitted from statistical analysis.

1.4 Observations:

1.4.1 Withdrawal resistance results are applicable to the FM-260 and FM-260V fasteners.

2. Pull-Through Performance:

2.1 Specimens:

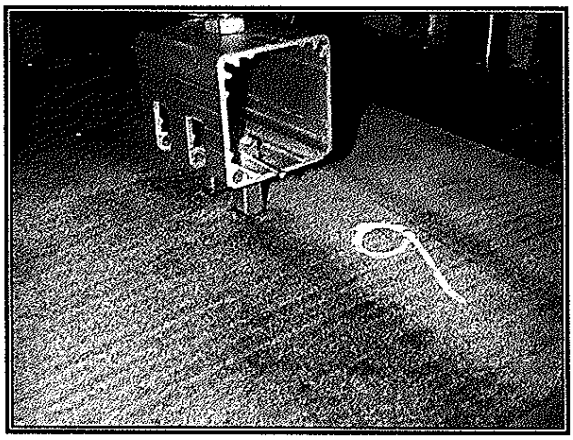
2.1.1 Four specimens of each base sheet were prepared by installing the FM-260 Fastener through the center of an 18" x18" sample. Each base sheet was covered with the minimum roof cover applicable for use with the base sheet material.

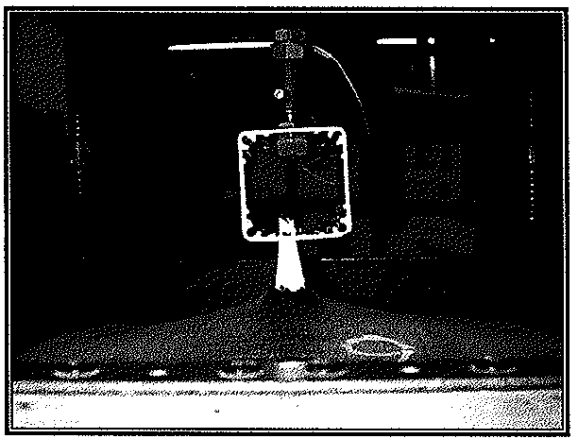
2.2 Procedure:

2.2.1 The test specimen, consisting of the membrane sample and fastener assembly sample mounted in the appropriate holding device, is mounted in the tensile loading device such that any bending or shear loads are avoided.

2.2.2 The tensile loading device is operated at a vertical deflection rate of 2-inches per minute and the peak load at failure is recorded.

2.2.3 The pull-through performance value is determined in accordance with TAS 117(B), Section 6.5.





Photos 1 and 2: Overview of Base Sheet Pull-Through Testing

2.3 Results:

Table 2: Test Results, Base Sheet Pull-Through Resistance

Specimen Description			Test Number				Avg	Std. Dev.	C of V
Mfgr	Base	Cap	1	2	3	4			
Black Warrior	Modified Arrowbase	Asphalt-applied	182.5	165.0	189.2	192.4	**182.3**	12.2	7%
CertainTeed	Flexiglas FR Base	Asphalt-applied	247.3	264.1	240.0	221.3	**243.2**	17.7	7%
	PolySMS Base	Asphalt-applied	179.6	203.3	218.7	192.6	**198.6**	16.6	8%
	UltraPoly SMS Base	Asphalt-applied	227.3	213.7	255.3	233.8	**232.5**	17.3	7%

Table 2: Test Results, Base Sheet Pull-Through Resistance (continued)									
Specimen Description			Test Number				Avg	Std. Dev.	C of V
Mfgr	Base	Cap	1	2	3	4			
Firestone	APP 160	Heat-welded	220.0	222.0	238.5	237.6	**229.5**	9.9	4%
	SBS Base Sheet	Asphalt-applied	188.5	223.1	167.1	181.2	**190.0**	23.8	13%
	SBS Glass Torch Base	Heat-welded	174.6	204.7	193.0	218.0	**197.6**	18.4	9%
	SBS Poly Torch Base	Heat-welded	333.8	268.3	342.7	340.0	**321.2**	35.5	11%
	SBS PolyBase	Heat-welded	254.1	309.0	299.8	331.2	**298.5**	32.4	11%
	SBS Premium Base	Asphalt-applied	271.0	247.8	211.2	259.7	**247.4**	25.9	10%
	SBS Smooth	Asphalt-applied	258.5	271.5	232.6	245.0	**251.9**	16.8	7%
GAF MC	GAFGLAS #80 Ultima	Heat-welded	195.2	199.7	182.4	200.1	**194.4**	8.3	4%
Garland	Tribase	Heat-welded	176.5	197.2	175.0	189.8	**184.6**	10.7	6%
P.R.S.	Derbibase®	Heat-welded	144.3	154.6	122.3	148.5	**142.4**	14.1	10%
Polyglass	Elastobase V	Heat-welded	130.2	124.7	141.2	157.3	**138.4**	14.4	10%
	Polyprotector™ UDL	Self-adhered	105.6	98.6	109.1	94.2	**101.9**	6.7	7%
Siplast	Irex 30	Heat-welded	150.0	157.7	159.1	154.3	**155.3**	4.1	3%
Soprema	Elastophene 180 Sanded	Asphalt-applied	327.2	347.0	301.3	299.0	**318.6**	22.8	7%
	Soprafix	Self-adhered	182.2	185.8	178.8	200.0	**186.7**	9.3	5%
	Soprabase	Self-adhered	121.5	120.1	125.2	120.5	**121.8**	2.3	2%
Tamko	Versa-Base®	Asphalt-applied	210.2	172.1	209.8	214.1	**201.6**	19.7	10%
Tremco	BURmastic® Composite Ply	Asphalt-applied	161.5	155.0	163.2	151.1	**157.7**	5.6	4%
US Intec	Flex Base 60	Asphalt-applied	195.0	172.6	183.5	192.6	**185.9**	10.2	5%
	Modified Base 190P	Heat-welded	210.2	195.8	208.6	200.8	**203.9**	6.8	3%
US Ply	DuraFlex 30 SBS Base	Asphalt-applied	198.0	179.0	186.5	200.1	**190.9**	9.9	5%
	DuraFlex SBS PolyBase	Heat-welded	235.0	231.5	199.8	220.8	**221.8**	15.8	7%
WP Hickman	Multi-Ply Glass CL	Asphalt-applied	179.5	162.5	201.1	195.7	**184.7**	17.4	9%
	Performance Ply®	Asphalt-applied	278.5	265.5	251.2	263.2	**264.6**	11.2	4%
	Pika Ply HI-TEC 60	Asphalt-applied	335.3	288.7	301.3	283.7	**302.3**	23.2	8%
	Pika Ply HI-TEC 60, Type II	Asphalt-applied	421.0	427.0	432.0	363.0	**410.8**	32.1	8%

2.4 Observations/Comments:

2.4.1 Four specimens, in lieu of 14 specimens, were prepared for each base sheet based on the known consistency of base sheet pull-through performance; running 14 tests of this sort is redundant. The maximum 20% deviation from the mean criteria was maintained.

2.4.2 The head-configurations of the FM-260 and FM-260V fasteners are identical. Results in Table 2 are applicable to either fastener.

3. Conclusions:

3.1 ERD has tested the referenced FM-260 and FM-260V Fastener for withdrawal resistance and pull-through performance in accordance with TAS 117(A) and TAS 117(B), respectively. Test results are as outlined in Tables 1B, 1C and 2 herein.

4. Laboratory Compliance Statement:

4.1 The TAS 117(A) and TAS 117(B) testing outlined herein has been conducted in full compliance with the requirements of the Florida Building Code with no deviations.

Please contact our offices with any questions.

Sincerely,
EXTERIOR RESEARCH & DESIGN, LLC.

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