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

Laboratory Report 02764.09.05

Wind Uplift Resistance
of
Polyfoam TITE-SET® Insulation Adhesive
Over Concrete & LWIC Roof Decks
in accordance with
TAS 114, Appendix D
(FM 4470)

Prepared for:
Polyfoam Products, Inc.
10798 NW 53rd Street
Sunrise, FL 33351

Date of Issuance:
September 9, 2005

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Client Information: Polyfoam Products, Inc.
10798 NW 53rd Street
Sunrise, FL 33351
c/o: Bob Ferrante

Client Reference: Uplift Testing, TITESET over LWIC decks & with Tapered Insulation

ERD Reference: Projects #02764.05LAB and #02766.05LAB

Samples: TITESET® Roofing Adhesive is a two component polyurethane adhesive, used to secure insulation to a substrate or additional layers of insulation.

Sample Delivery:

- The named client shipped samples of TITESET to ERD Lab.
- Celcore, Inc. shipped pre-cast slabs of Celcore LWIC to ERD Lab.
- Elastizell Corporation of American and Cellular Concrete, LLC. shipped Elastizell and Mearlcrete foaming-agent to ERD Lab.
- ERD procured cement from local distribution.
- ERD procured insulations from the respective manufacturers.

Test Date(s): July 6, 7 and 26, 2005

M-D Notification: Notification number not provided in a timely fashion. Contact ERD for Miami-Dade Notification Number.

ERD Technicians: Charles Phillips, Nelson Morez

Properties: Simulated Wind Uplift Resistance

Standards: FM Standard 4470, *Class 1 Roof Covers,* © FM Global, 1986 (1992)

TAS 114-95, Appendix D – *Test Procedure for Simulated Uplift Pressure Resistance of Adhered Roof System Assemblies*, © 1995, Miami-Dade BCCO.

1. Simulated Wind Uplift Resistance – 2 x 2 ft

1.1 Specimen Preparation:

1.1.1 Three specimens measuring 2 x 2 ft were constructed for each of the following sample descriptions. Each specimen is built atop a structural concrete deck and allowed to cure. The simulated wind uplift pressure tests utilize a 0.75 in thick piece of plywood adhered to the top of the specimen as a load transfer device to which a 2 ft (0.6 m) long by 2 ft (0.6 m) wide steel plate is mechanically attached. A load cell is connected to the steel plate and the test frame. A hydraulic pump is used to incur pressure at pre-established standard rates to the load cell and test panel.

1.1.2 Celcore LWIC specimens were supplied as pre-cast, 200 psi, 2-inch thick slabs, which ERD bonded to the concrete substrate in hot asphalt. Elastizell and Mearlcrete specimens were cast on-site by ERD personnel using foaming agent supplied by the respective manufacturer. Testing was conducted 28-days after LWIC specimens were cast.

1.1.3 ERD selected the critical (worst-case) insulation material based on data contained in ERD Report No. 02762.03.05 dated March 30, 2005.

Table 1A: Summary of 2 x 2 ft Specimen Construction

Sample ID	Deck	Lightweight Concrete	Insulation	Roof Cover
1.	Structural Concrete Min. 2500 psi	Min. 200 psi Celcore LWIC	1.5" thick Hunter H-Shield, adhered in 3" – 3.5" wide ribbons of TITE-SET® spaced 12" o.c.	None
2.	Structural Concrete Min. 2500 psi	Min. 200 psi Elastizell LWIC	1.5" thick Hunter H-Shield, adhered in 3" – 3.5" wide ribbons of TITE-SET® spaced 12" o.c.	None
3.	Structural Concrete Min. 2500 psi	Min. 200 psi Mearlcrete LWIC	1.5" thick Hunter H-Shield, adhered in 3" – 3.5" wide ribbons of TITE-SET® spaced 12" o.c.	None
4.	Structural Concrete Min. 2500 psi	None	Base layer of 1.5" thick Hunter H-Shield followed by Tapered H-Shield; both adhered in 3" – 3.5" wide ribbons of TITE-SET® spaced 12" o.c.	None

1.2 Procedure:

1.2.1 A net pressure of 30 psf (1.4 kPa) is applied to the test sample and maintained for 1 minute. The pressure is increased to 45 psf (2.2 kPa), then to 60 psf (2.9 kPa) and held for 1 min. after each increment. The pressure is increased in increments of 15 psf (0.7 kPa) every min. until failure occurs.

1.3 Results: Tables 1B through 1E, below, provides a summary of 2 x 2 ft test results.

Table 1B: Test Results, Sample ID 1 Concrete / Celcore LWIC / Hunter H-Shield in TITE-SET®				
Specimen ID	**Failing Pressure (psf)**	**Failure Time (sec)**	**Mode of Failure**	**Passing Pressure (psf)**
1-A	450	0	Delamination of facer from polyisocyanurate foam core	435
1-B	525	0		510
1-C	405	0	Adhesive failure of load transfer device to specimen	390
			Avg.:	**445**
			Std. Dev.:	61
			Coefficient of Variation:	14%

Table 1C: Test Results, Sample ID 2 Concrete / Elastizell LWIC / Hunter H-Shield in TITE-SET®				
Specimen ID	**Failing Pressure (psf)**	**Failure Time (sec)**	**Mode of Failure**	**Passing Pressure (psf)**
2-A	375	0	Delamination of fiberglass facer to Polyisocyanurate foam core	360
2-B	434	50		420
2-C	315	40		300
			Avg.:	**360**
			Std. Dev.:	60
			Coefficient of Variation:	17%

Table 1D: Test Results, Sample ID 3 Concrete / Mearlcrete LWIC / Hunter H-Shield in TITE-SET®				
Specimen ID	**Failing Pressure (psf)**	**Failure Time (sec)**	**Mode of Failure**	**Passing Pressure (psf)**
3-A	540	0	Adhesive failure of load transfer device to specimen	525
3-B	465	0	Delamination of facer from polyisocyanurate foam core	450
3-C	480	55		465
			Avg.:	**480**
			Std. Dev.:	40
			Coefficient of Variation:	8%

Table 1E: Test Results, Sample ID 4 Concrete / H-Shield in TITE-SET® / Tapered H-Shield in TITE-SET®				
Specimen ID	**Failing Pressure (psf)**	**Failure Time (sec)**	**Mode of Failure**	**Passing Pressure (psf)**
1-A	285	0	Cohesive failure of TITE-SET® between polyisocyanurate layers.	270
1-B	225	0		210
1-C	240	20		225
			Avg.:	**235**
			Std. Dev.:	31
			Coefficient of Variation:	13

Photo 1

Photo 2

Photo 1: Failure Mode, Insulation Facer Delamination (Typical of Samples 1 through 3)

Photo 2: Failure Mode, Cohesive of Adhesive (Typical of Sample 4)

1.4 Observations: Review of this data indicates the following.

1.4.1 By selecting the critical (worst-case) insulation from previous testing, other insulation products are also applicable to the maximum design pressures resulting from this program. Appendix 1 provides a summary of applicable insulation assemblies and associated maximum design pressures.

1.4.2 By utilizing pre-cast Celcore specimens set in hot asphalt over concrete deck, the maximum design pressure of the assembly is limited to the lesser of that resulting from the testing herein compared to data held by Celcore, Inc. for their LWIC cast over concrete deck. The current Celcore Miami-Dade NOA 03-0923.03 (exp. 10/19/08) lists a maximum design pressure of -262.05 psf for this application. Therefore, the data resulting from this program (-222.5 psf) governs. Appendix 1 provides a summary of applicable insulation assemblies and associated maximum design pressures.

Conclusions:

ERD has tested the specimen outlined in Table 1A for wind uplift resistance in accordance with FM Standard 4470, Appendix D and TAS 114, Appendix D. Test results are as outlined in Tables 1B through 1E. Appendix 1 provides a summary of applicable insulation assemblies and associated maximum design pressures.

Laboratory Compliance Statement:

The TAS 114(D) testing reported herein has been performed in full accordance with the requirements of the Florida Building Code, with no deviations.

Please contact our offices with any questions.

Sincerely,
EXTERIOR RESEARCH & DESIGN, LLC.

Charles Phillips
Laboratory Systems Manager

Robert Nieminen, P.E.
Florida Reg. No. 59166
Laboratory Technical Manager

The following comments apply to the assemblies outlined in the following tables:

1. The roof cover shall be any having documented wind uplift performance over the subject insulation or coverboard material. The overall uplift rating of the combined assembly shall be the lesser of the two ratings.
2. For applications over LWC, the overall uplift rating of the combined assembly shall be the lesser of the rating below compared with that for the roof cover over the specific type of insulation or coverboard and that of the LWC roof deck to its structural deck substrate.
3. TITESET® Roofing Adhesive shall be applied in 3 to 3½ inch wide continuous ribbons spaced maximum 12-inch o.c.
4. "EPS" refers to one or more layers of ASTM C578 expanded or extruded polystyrene having the minimum specified density.
5. The vapor barrier / temporary roof systems referenced are as follows:
    - Hot-Applied: Primed concrete followed by optional hot asphalt applied base and/or ply sheets approved for use with roof cover followed by asphalt applied CertainTeed Flintlastic GMS, Firestone SBS Cap, GAF Ruberoid 30, Johns Manville DynaGlas, Soprema Elastophene GR or Sopralene 180 or 250 GR or Siplast Paradiene 30.
    - Torch-Applied: Primed concrete followed by optional torch-applied base membrane approved for use with roof cover followed by CertainTeed Flintlastic GTA or GTS, Firestone APP 180 FR Cap, GAF Ruberoid Torch GR, Johns Manville APPeX 4.5M, Soprema Elastophene Flam GR or Sopralene Flam 180 or 250 GR or Siplast Paradiene 30 TG.
    - Self-Adhering: Primed concrete followed by optional self-adhered base membrane approved for use with roof cover followed by CertainTeed Flintlastic SA Cap, GAF Liberty Cap, Johns Manville DynaGrip Cap or *JM*CleanBond Cap, Polyglass Elastoflex SA VG or Soprema Colphene FR GR or Colphene HR FR GR.
    - Cold-Applied: Primed concrete followed by optional cold-applied base and/or ply sheet approved for use with the roof cover followed by CertainTeed Flintlastic GMS in FlintBond Adhesive, GAF Ruberoid 30 in Matrix 102 Adhesive, Johns Manville DynaGlas in MBR Adhesive, Polyglass Elastoflex VG in 1000 MB SBS Adhesive, Soprema Elastophene GR or Sopralene 180 or 250 GR in FM Adhesive or FM Adhesive (VOC) or Siplast Paradiene 30 in PA-311 Adhesive.

TABLE 1: WIND UPLIFT PERFORMANCE – LIGHTWEIGHT CONCRETE DECKS						
System No.	Deck(A)	Insulation		Coverboard		Max. Design Pressure (B)
		Type	Attachment	Type	Attachment	
LWC-1	Min. 200 psi Mearlcrete, Celcore or Elastizell LWC	One or more layers, flat and/or tapered ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK or min. 1/8" Sopraboard or Henry Recover Board	TITESET	-117.5 psf
LWC-2	Min. 200 psi Mearlcrete, Celcore or Elastizell LWC	One or more layers ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. 1/8" Sopraboard or Henry Recover Board	TITESET	-168.5 psf
LWC-3	Min. 200 psi Elastizell LWC	One or more layers ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK	TITESET	-180.0 psf
LWC-4	Min. 200 psi Celcore LWC	One or more layers ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK	TITESET	-222.5 psf
LWC-5	Min. 200 psi Mearlcrete LWC	One or more layers ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK	TITESET	-240.0 psf
LWC-6	Min. 200 psi Mearlcrete, Celcore or Elastizell LWC	One or more layers, min. 1.5" thick, min. 1.25 pcf density ASTM C578 expanded or extruded EPS board	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK or min. 1/8" Sopraboard or Henry Recover Board	TITESET	-87.5
LWC-7	Min. 200 psi Mearlcrete, Celcore or Elastizell LWC	One or more layers, min. 1.5" thick, min. 1.5 pcf density ASTM C578 expanded or extruded EPS board	TITESET	(Optional) Min. 1/8" Sopraboard or Henry Recover Board	TITESET	-168.5
LWC-8	Min. 200 psi Mearlcrete, Celcore or Elastizell LWC	One or more layers, min. 1.5" thick, min. 1.5 pcf density ASTM C578 expanded or extruded EPS board	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK	TITESET	-180.0

TABLE 1 – CONTINUED:

LWC-9	Min. 200 psi Celcore LWC	One or more layers, min. 1.5" thick, min. 2.0 pcf density ASTM C578 expanded or extruded EPS board	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK	TITESET	-222.5 psf
LWC-10	Min. 200 psi Mearlcrete LWC	One or more layers, min. 1.5" thick, min. 2.0 pcf density ASTM C578 expanded or extruded EPS board	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK	TITESET	-240.0 psf

TABLE 2: WIND UPLIFT PERFORMANCE – CONCRETE DECKS

System No.	Roof Deck (A)	Vapor Barrier / Temp Roof	Insulation		Coverboard		Max. Design Pressure (B)
			Type	Attachment	Type	Attachment	
C-1	Structural concrete (primed if using Vapor Barrier/Temp Roof)	(Optional) Cold-applied	One or more layers, flat and/or tapered ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK or min. 1/8" Sopraboard or Henry Recover Board	TITESET	-67.5 psf
C-2	Structural concrete (primed if using Vapor Barrier/Temp Roof)	(Optional) Hot-applied, torch-applied or self-adhered	One or more layers, flat and/or tapered ACFoam II, ACFoam III, ISO 95+GL, H-Shield, H-Shield C, ENRGY 3 or Multi-Max FA	TITESET	(Optional) Min. ½" Temple HD-6 or Knight-Celotex HD Fiberboard or min. ¼" DensDeck, DensDeck Prime or SECUROCK or min. 1/8" Sopraboard or Henry Recover Board	TITESET	-117.5 psf

A. Roof Deck shall be designed and installed to meet the wind load requirements of the applicable building code to the satisfaction of the Authority Having Jurisdiction.

B. Maximum design pressures relate to system performance after a 2 to 1 margin of safety is applied.