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The Subcommittee on Evaluation has reviewed the data submitted for compliance with the Standard Building Code® and the Florida Building Code-Building and submits to the Building Official or other authority having jurisdiction the following report. The Subcommittee on Evaluation, ICC-ES and its staff are not responsible for any errors or omissions to any documents, calculations, drawings, specifications, tests or summaries prepared and submitted by the design professional or preparer of record that are listed in the Substantiating Data Section of this report. Portions of this report were previously included in SBCCI Evaluation Report #9225, and PST & ESI Evaluation Reports #9377, #9577, #9577A, and #9577B.

REPORT NO.: 2309

EXPIRES: See the current EVALUATION REPORT INDEX

CATEGORY: FLOOR, WALL AND ROOF SYSTEMS

SUBMITTED BY:

SIPLAST/ICOPAL
1000 EAST ROCHELLE BOULEVARD
IRVING, TEXAS 75062-3940

1. PRODUCT TRADE NAME

- 1.1 Zonolite® Roof Insulation System
1.2 Insulcel® Roof Insulation System
1.3 Zonocel® Roof Insulation System
1.4 Type 38-NVST™ Roof Insulation System

2. SCOPE OF EVALUATION

- 2.1 1, 1½, or 2 hour fire resistive roof assembly
2.2 Wind uplift resistant roof assembly.

3. USES

Used as: (1) a 1, 1½, or 2 hour fire resistive construction assembly when placed over a high strength, galvanized steel substrate or a poured-in-place/precast structural concrete substrate; and (2) a wind uplift resistant assembly.

4. DESCRIPTION

4.1 General

Zonolite® Roof Insulation, Insulcel® Roof Insulation, Zonocel® Roof Insulation, and Type 38-NVST™ Roof Insulation are composite systems that combine the properties of either

lightweight Zonolite®, Zonocel®, Type 38-NVST™, or Insulcel® Concrete and the Insulperm® expanded polystyrene foam plastic board. Installed in stair-step configuration, Insulperm® provides the base for sloping the roof insulation system for positive water removal through total, positive slope-to-drain.

The Insulcel®, Zonocel®, Type 38-NVST™, or Zonolite® Concrete perform three functions in the roof insulation system. It:

- 1. bonds the Insulperm® Insulating Board to the structural substrate by flowing around and through the Insulperm®.
2. encapsulates and protects the Insulperm® polystyrene, shielding it against interior and exterior fires and from damage due to foot traffic and other building trades.
3. forms a smooth top surface which will allow nailed attachment of roofing systems.

4.2 Zonolite® Insulating Concrete

Zonolite® Concrete is a mixture of Portland Cement, water, and Zonolite® Vermiculite Concrete Aggregate. The insulating concrete is job site mixed with sufficient water to provide the proper wet density. This mixture shall obtain a minimum oven dry density of 22 pcf (352 kg/m³) and a minimum compressive strength of 125 psi (862 kPa) when tested in accordance with ASTM C 495. The insulating concrete may be mixed 1:6 (by volume, Portland Cement to Vermiculite) for a wet density of 44 to 60 pcf (705 to 961 kg/m³) or 1:4 (by volume, Portland Cement to Vermiculite) for a wet density of 53 to 63 pcf (849 to 1009 kg/m³).

4.3 Type 38-NVST™ Insulating Concrete

NVS Concrete is a mixture of Portland Cement, water, and NVS Aggregate. The concrete (1:3.5 by volume, Portland Cement to Vermiculite) is jobsite mixed with sufficient water to provide a wet density of 60 to 68 pcf (961 to 1089 kg/m³). A minimum compressive strength of 300 psi (2069 kPa) shall be obtained when tested in accordance with ASTM C 495.

4.4 Insulcel® Insulating Concrete

Insulcel® Concrete is a mixture of Portland Cement, water, and pre-generated foam produced from Insulcel® Liquid Concentrate. This mixture is typically placed with a cast density of 38 to 48 pcf (609 to 769 kg/m³) and shall obtain a dry density range of 30 to 36 pcf (481 to 577 kg/m³) and minimum compressive strength of 200 psi (1379 kPa) when tested in accordance with ASTM C 495.

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4.5 Zonocel® Insulating Concrete

Zonocel concrete is a mixture of Portland Cement, Zonolite Vermiculite Concrete Aggregate, and pre-generated foam produced from Insulcel Liquid Concentrate. The concrete is job-site mixed, consisting (two four cubic foot bags of aggregate per yard of concrete) of 1:0.9 ratio of portland cement to Vermiculite and sufficient pregenerated Insulcel foam to create a cast density of 43 to 53 pcf (689 to 849 kg/m³). The mixture shall generate a minimum dry density of 30 pcf (481 kg/m³) and minimum compressive strength of 200 psi (1379 kPa) when tested in accordance with ASTM C 495.

4.6 INSULPERM® Insulation Board

INSULPERM® Insulation Board is a premium grade polystyrene manufactured by Siplast/Icopal and supplied in 2 ft x 4 ft (610 x 1219 mm) boards in thicknesses from 1 to 8 inches (25 to 203 mm) as required. The board has a density of 0.6 to 1.2 pcf (10 to 19 kg/m³). Each board contains a nominal 3% open area consisting of 30 slots [nominal 2¼ inches x ⅛ inch (57 x 3 mm)] and 30 holes (nominal 1 inch (25 mm) diameter) or a combination of 14 holes (nominal 1½ inch (38 mm) diameter) and 4 holes (nominal 1¼ inch (32 mm) diameter) or 10 combination holes (nominal 1⅞ inch (48 mm) diameter) and slot [nominal ⅜ x 5⅞ inch (5 x 149 mm)] openings.

INSULPERM® insulation manufactured by Siplast/Icopal, when tested to a maximum thickness of 4 inches (102 mm) and in accordance with ASTM E 84, has a flamespread rating of 75 or less and a smoke developed rating of 450 or less.

4.7 Base Ply Fasteners

Fasteners for use with minimum 2 inch (51 mm) roofing base of Zonolite, Insulcel, or Zonocel concrete:

4.7.1 Siplast/Icopal:

Zono-tite Fastener - galvanized steel with black coating on cap only. 1.75 inch (44 mm) long rectangular shank, 1.2 inch (30 mm) rectangular head and 2.7 inch (69 mm) diameter AZ55 Galvalume disc assembled to the fastener.

4.7.2 E.S. Products:

1. F.M. - 60 baseply fastener - galvanized steel with black urethane coating on cap only. 1.7 inch (43 mm) long diverging leg anchor, 1.2 inch (30 mm) diameter cap.
2. F.M. - 30 disc - Galvanized steel with black urethane coating both sides or Galvalume AZ-55 - 2.7 inch (69 mm) diameter, 0.013 inch (0.3 mm) thick.
3. F.M. - 90 assembled baseply fastener - FM - 60 base ply fastener with FM-30 disc attached.

4.7.3 Olympic Manufacturing Group:

1. C-R Base Felt Fastener - steel, CR-10 or Answer Coating (black). 1¾ inch (44 mm) long rectangular shank, 1 x 1⅞ inch (25 x 29 mm) rectangular head.
2. C-R Base Sheet Disc. - steel, AZ-55 Galvalume, 2¾ inch (70 mm) diameter x 0.035 inch (0.9 mm).

Fasteners for use with minimum 1 inch (25 mm) thick 38-NVS concrete:

4.7.4 Siplast/Icopal:

NVS Fastener - galvanized steel with black coating on cap only. 1.2 inch (30 mm) long rectangular shank, 1.2 inch (30 mm) rectangular head, and 2.7 inch (69 mm) diameter AZ55 Galvalume disc assembled to the fastener.

4.7.5 E.S. Products:

1. FM - 45 base ply fastener - galvanized steel with black urethane coating on cap only. 1 inch (25 mm) long diverging leg anchor, 1.2 inch (30 mm) diameter cap.
2. FM 30 disc - Galvanized steel with black urethane coating both sides or Galvalume AZ-55 - 2.7 inch (69 mm) diameter, 0.013 inch (0.3 mm) thick.

4.7.6 Olympic Manufacturing Group:

1. C-R Base Felt Fastener - Steel, CR-10 1.2 inch (30 mm) long rectangular shank, 1 x 1⅞ inch (25 x 29 mm) rectangular head.
2. C-R Base Sheet Disc. - steel, AZ-55 Galvalume, 2¾ inch (70 mm) diameter x 0.035 inch (0.9 mm).

5. INSTALLATION

5.1 General

The Zonolite®, Type 38-NVS™, Zonocel®, and Insulcel® Roof Insulation Systems shall be installed by Siplast/Icopal approved applicators who are properly trained and equipped to perform this type of installation.

The manufacturer's published installation instructions shall be strictly adhered to and a copy of these instructions shall be available on the jobsite at all times during installation. If there are any conflicts, installation instructions contained within this report will govern.

The deck is covered with a Zonolite®, Type 38-NVS™, Zonocel, or Insulcel® concrete slurry leveled to a ⅛ inch (3 mm) minimum thickness. ZONOLITE® INSULPERM® board (1 to 4 inch (25 to 102 mm) thickness unless otherwise specified in this report) is placed within 30 minutes into wet slurry with end joints staggered and all joints butted snugly. A 2 inch (51 mm) minimum thickness of Zonolite®, Zonocel®, or Insulcel® Concrete, or a 1 inch (25 mm) minimum thickness of Type 38-NVS™ Concrete is then immediately placed and screeded to a level even surface to receive the roof covering.

5.2 Wind Uplift Assemblies

Roofing Systems can be classified when installed in new construction as follows:

5.2.1 UL Wind Uplift - Class 90 Wind Resistance

(UL Construction No. 110)

(45 PSF (2.2 kPa) Maximum Allowable Wind Uplift)

1. Steel Supports - Minimum Type 10H2 open web steel joists or other structural supports acceptable to authorities having jurisdiction.

Spaced 48 in. (1219 mm) o.c. when used with No. 28 MSG steel deck.

Spaced 72 in. (1829 mm) o.c. when used with No. 26 MSG steel deck.

Supports to be laterally braced as required.

2. Steel Deck - Minimum No. 28 or 26 MSG gauge coated steel. Deck vented with venting slots covering 1.5% of total deck area. Either gauge to be welded to supports using acceptable weld washers located in every other valley.
3. Zonolite® Insulating Concrete (1:6 and 1:4 design) - poured in place and mixed at a rate of 6 cubic feet (c.f.) (0.2 m³) of aggregate to 1 c.f. (0.03 m³) of cement (1:6) or 4 cubic feet (0.1 m³) of aggregate to 1 c.f. (0.03 m³) of cement (1:4) with approximately 25 gallons (95 ℓ) of water and air entraining agent. When using foamed plastic insulation, a 1/8 in. (3 mm) thick slurry, as measured over the top of the steel deck crests is to be placed beneath the foamed plastic insulation. A minimum 2 in. (51 mm) thickness of Zonolite® Insulating Concrete is to be placed over the insulation before the slurry dries. When foam plastic insulation is not used, a minimum 2 in. (51 mm) thick concrete deck (as measured over the metal deck crests) is to be poured directly over the steel deck.
4. Insulcel® Insulating Concrete - Poured in place and mixed to achieve a cast density of 38 to 48 pcf (609 to 769 kg/m³), a minimum dry density of 30 to 36 pcf (481 to 577 kg/m³) and a minimum compressive strength of 200 psi (1379 kPa) when tested in accordance with ASTM C 495. When using foam plastic insulation, a 1/8 inch (3 mm) thick slurry, as measured over the top of the steel deck crests is to be placed beneath the foamed plastic insulation. A minimum 2 inch (51 mm) thickness of Insulcel® Insulating Concrete shall be placed over the insulation before the slurry dries. When foam insulation is not used, a minimum 2 inch (51 mm) thick concrete deck (as measured over the metal deck crests) is to be poured directly over the steel deck.
5. Zonocel® Concrete - Poured in place and mixed to achieve a cast density of 43-48 pcf (689 to 769 kg/m³), a minimum dry density of 30 pcf (481 kg/m³) and a minimum compressive strength of 200 psi (1379 kPa) when tested in accordance with ASTM C 495. When using foam plastic insulation, a 1/8 inch (3 mm) thick slurry, as measured over the top of the steel deck crests is to be placed beneath the foamed plastic insulation. A minimum 2 inch (51 mm) thickness of Zonocel® concrete shall be placed over the insulation before the slurry dries. When foam plastic insulation is not used, a minimum 2 inch (51 mm) thick concrete deck (as measured over the metal deck crests) is to be poured directly over the steel deck.
6. Insulperm® Insulation Board (Optional) - Sandwiched between the Zonolite®, Zonocel®, or Insulcel® concrete slurry and the Zonolite®, Zonocel®, or Insulcel® concrete deck. Maximum thickness to be 4 inches (102 mm).
7. Roof Fasteners - Used to attach base sheet to the Zonolite®, Zonocel®, or Insulcel® Concrete, as described in the following Item 8.
8. Built-Up-Roof - Built from materials bearing the Underwriters Laboratories Inc. Classification marking. Four ply hot mopped Built-up roof construction consisting of Type 30, 43 lb. (20 kg), base sheet overlapped 4 inches (102 mm) and 3 plies of Type 15 perforated felt.

The base sheet shall be nailed to the concrete using Base Ply Fasteners and discs in rows spaced 16 in. (406

mm) o.c. across the width of the sheet. Rows located in the side lap and center of sheet. The fasteners to be spaced 7½ in. (191 mm) o.c. in a staggered pattern along the length of the felt.

Note: Care is to be taken to assure that the Built-up Roof is applied only when the Zonolite®, Zonocel®, or Insulcel® concrete will bear roof construction traffic without damage (approximately 5 days).

The 3 plies are to be adhered using a minimum of 25 lbs per 100 sq. ft. (1.2 kg/m²) of hot mopping asphalt per ply for a total of 75 lb per 100 sq.ft. (3.7 kg/m²) minimum. The asphalt may be either dead level or steep grade.

5.2.2 Factory Mutual, Class I-60 Wind Resistant

(30 PSF (1.4 kPa) Maximum Allowable Wind Uplift)

Consolidated Systems, Inc. minimum 22 gauge, 1.5 inch (38 mm) deep Type B-Vented galvanized steel form deck conforming to ASTM A 653 Grade 40 deck is secured to structural steel joists spaced 6 feet (1.8 m) o.c. with 3/8 inch (10 mm) diameter weld washers at each bottom rib [6 inches (152 mm) o.c.]. Dens Deck, 5/8 inch (16 mm) thick, is mechanically fastened with Siplast Parafast XHD and Siplast Parafast Metal Plates or Tru-Fast HD fasteners and Tru-Fast MP-3 plates applied at 1 per 1.6 ft² (0.5 m²). Two plies of Approved Type IV glass felt 18 inches (457 mm) o.c. coverage are fully adhered with hot asphalt. A 1/8 inch (3 mm) to 1/4 inch (6 mm) slurry coat of NVS Concrete, minimum wet cast density of 75 pcf (1202 kg/m³) is placed over the glass felts immediately followed by a minimum 1 inch (25 mm) thick Insulperm Insulation. The following day a minimum of 1 inch (25 mm) thick top coat of NVS Concrete with a wet density of 60 pcf (961 kg/m³) is applied over the Insulperm insulation. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck with Simplex Base-Lok Fasteners spaced 12 inches (305 mm) o.c. in the 3 inch (76 mm) wide base sheet laps and 12 inches (305 mm) o.c. in three equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate.

5.2.3 Factory Mutual, Class I-75 Wind Resistant

(38 PSF (1.8 kPa) Maximum Allowable Wind Uplift)

Assembly No. 1

Consolidated Systems, Inc. minimum 22 gauge, 1.5 inch (38 mm) deep Type B-Vented galvanized steel form deck conforming to ASTM A 653 Grade 40 deck is secured to structural steel joists spaced 6 feet (1.8 m) o.c. with 3/8 inch (10 mm) diameter weld washers at each bottom rib [6 inches (152 mm) o.c.]. Lightweight Insulating Concrete is placed on the deck filling the corrugations plus minimum 1/8 inch (3 mm) thick above the top flange immediately followed by 1 inch (25 mm) thick Insulperm insulation. The following day, minimum 2 inch (51 mm) thick Insulcel Lightweight Insulating Concrete is placed. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck by driving Zono-tite or Simplex Base-Lok fasteners. The fasteners are spaced 14 inches (355 mm) o.c. through the 3 inch (76 mm) wide base sheet laps and 14 inches (355 mm) o.c. in two equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt or hot torch adhered (hot torch not allowed when using

Base-Lok Fasteners) as appropriate followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate.

Assembly No. 2

Insulcel Lightweight Insulating Concrete is placed over the structural concrete deck or properly prepared existing built up roof over structural concrete to a minimum $\frac{1}{8}$ inch (3 mm) thickness. It is immediately followed by 1 inch (25 mm) thick Insulperm insulation. The following day, minimum 2 inch (51 mm) thick Insulcel Lightweight Insulating Concrete is placed. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck by driving Zono-tite or Simplex Base-Lok fasteners. The fasteners are spaced 14 inches (355 mm) o.c. through the 3 inch (76 mm) wide base sheet laps and 14 inches (355 mm) o.c. in two equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt or hot torch adhered (hot torch not allowed when using Base-Lok Fastener) as appropriate followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate. When applying to an existing roof system, maximum allowable wind loads shall not exceed the allowable wind load capacity of the existing roof system.

5.2.4 Factory Mutual, Class I-90 Wind Resistant (45 PSF (2.2 kPa) Maximum Allowable Wind Uplift)

Assembly No. 1

1. Steel Deck Assemblies

The wind uplift resistant assembly consists of slotted galvanized steel center deck, minimum 26 gauge, or galvanized $1\frac{1}{2}$ inch (38 mm) deep wide rib steel deck, minimum 22 MSG. The corrugated steel forming is welded to the supporting members with a plug weld through the welding washer hole every other corrugation for Class I-60 or every corrugation for Class I-90. Sheets are to overlap a minimum of 2 inches (51 mm) on ends. Deck is covered with a Zonolite®, Zonocel®, or Insulcel® Concrete Slurry leveled to a $\frac{1}{8}$ inch (3 mm) minimum thickness over the flutes. Insulperm® Board (1 to 12 inch (25 to 305 mm) thickness) is placed within 30 minutes into the wet slurry with end joints staggered and all joints butted snugly. Either a 2 inch (51 mm) minimum thickness of Zonolite® (1:6 mix), Zonocel®, Insulcel® Concrete, or a $1\frac{1}{4}$ inch (32 mm) minimum thickness of Zonolite® Concrete (1:4 mix) is then immediately placed and screeded to a smooth even surface to receive the BUR roofing membrane.

2. Structural Concrete Substrates

The wind uplift resistant assembly consists of poured-in-place or precast single or double tees of normal or lightweight concrete (minimum of 2500 psi (17.2 MPa) compressive strength and 2 inch (51 mm) thickness) or an existing asphaltic roof membrane over one of these structural concrete substrates covered with Type 38-NVS™, or Insulcel® Concrete slurry leveled to a $\frac{1}{8}$ inch (3 mm) minimum thickness. Zonolite® Insulperm® board (1 to 12 inch (25 to 305 mm) thickness) is placed within 30 minutes into the wet slurry with end joints staggered and all joints butted snugly. A minimum 1 inch thickness of Type 38-NVS™ Concrete or 2 inch (51 mm) thickness

of Insulcel® Concrete is then immediately placed and screeded to a smooth even surface to receive the BUR roofing membrane.

3. Deck Covering

Within 48 to 72 hours after placement of the concrete the steel or concrete roof deck should be covered as follows:

A Siplast Parabase or Parabase Plus; Johns Manville Ventsulation, Dynabase, or GlasBase; GAF Stratavent or GAFGLAS #75; Celotex Vaporbar base sheet is fastened to the concrete with Siplast Zono-tite, ES90 or Olympic CR1.7 (with disc) (Zonolite, Zonocel or Insulcel) or Siplast NVS, ES75 or Olympic CR1.2 (with disc) (38-NVS) base ply fasteners spaced 7.5 inches (191 mm) on center in the base sheet overlap and 2 rows 10 inches (254 mm) on center in the field of the sheet.

A Siplast two ply modified bitumen roof cover is adhered to the base sheet with hot asphalt, PA-311 adhesive, or by torch.

Alternatively, an approved three ply modified bitumen, organic or glass felt roof cover is attached to the base sheet with hot asphalt.

Assembly No. 2

Consolidated Systems, Inc. minimum 22 gauge, 1.5 inch (38 mm) deep Type B-Vented galvanized steel form deck conforming to ASTM A 653 Grade 40 deck is secured to structural steel joists spaced **6** feet (1.8 m) o.c. with $\frac{3}{8}$ inch (10 mm) diameter weld washers at each bottom rib [6 inches (152 mm) o.c.]. Lightweight Insulating Concrete is placed on the deck filling the corrugations plus minimum $\frac{1}{8}$ inch (3 mm) thick above the top flange immediately followed by 1 inch (25 mm) thick Insulperm insulation. The following day, minimum 2 inch (51 mm) thick Insulcel Lightweight Insulating Concrete is placed. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck by driving Simplex Base-Lok fasteners into the deck with an electric screw gun. The fasteners are spaced 10 inches (254 mm) o.c. through the 3 inch (76 mm) wide base sheet laps and 10 inches (254 mm) o.c. in two equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate.

Assembly No. 3

Insulcel Lightweight Insulating Concrete is placed over the structural concrete deck or properly prepared existing built up roof over structural concrete to a minimum $\frac{1}{8}$ inch (3 mm) thickness. It is immediately followed by 1 inch (25 mm) thick Insulperm insulation. The following day, minimum 2 inch (51 mm) thick Insulcel Lightweight Insulating Concrete is placed. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck by driving Simplex Base-Lok fasteners. The fasteners are spaced 10 inches (254 mm) o.c. through the 3 inch (76 mm) wide base sheet laps and 10 inches (254 mm) o.c. in two equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate. When applying to an existing roof system,

maximum allowable wind loads shall not exceed the allowable wind load capacity of the existing roof system.

Assembly No. 4

Consolidated Systems, Inc. minimum 22 gauge, 1.5 inch (38 mm) deep Type B-Vented galvanized steel form deck conforming to ASTM A 653 Grade 40 deck is secured to structural steel joists spaced 6 feet (1.8 m) o.c. with $\frac{3}{8}$ inch (10 mm) diameter weld washers at each bottom rib [6 inches (152 mm) o.c.]. Dens Deck, $\frac{5}{8}$ inch (16 mm) thick, is mechanically fastened with Siplast Parafast XHD and Siplast Parafast Metal Plates or Tru-Fast HD fasteners and Tru-Fast MP-3 plates applied at 1 per 1.6 ft² (0.5 m²). Two plies of Approved Type IV glass felt 18 inches (457 mm) o.c. coverage are fully adhered with hot asphalt. A $\frac{1}{8}$ inch (3 mm) to $\frac{1}{4}$ inch (6 mm) slurry coat of NVS Concrete, minimum wet cast density of 75 pcf (1202 kg/m³) is placed over the glass felts immediately followed by a minimum 1 inch (25 mm) thick Insulperm insulation. The following day a minimum of 1 inch (25 mm) thick top coat of NVS Concrete with a wet density of 60 pcf (961 kg/m³) is applied over the Insulperm insulation. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck with Simplex Base-Lok Fasteners spaced 10 inches (254 mm) o.c. in the 3 inch (76 mm) wide base sheet laps and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate.

5.2.5 Factory Mutual, Class I-120 Wind Resistant (60 PSF (2.9 kPa) Maximum Allowable Wind Uplift)

Assembly No. 1

The Type 38-NVS system is installed as above over structural concrete or an existing asphaltic roof cover over structural concrete and should be covered as follows:

A Siplast Parabase or Parabase Plus; Johns Manville Ventsulation, Dynabase, or GlasBase; GAF Stratavent or GAFGLAS #75; Celotex Vaporbar base sheet is fastened to the concrete with Siplast NVS, ES75 or Olympic CR1.2 (with disc) base ply fasteners spaced 7.5 inches (191 mm) on center in the base sheet overlap and 2 rows 10 inches (254 mm) on center in the field on the sheet.

An approved three ply modified bitumen, organic or glass felt roof cover is attached to the base sheet with hot asphalt.

Assembly No. 2

Consolidated Systems, Inc. minimum 22 ga., 1.5 inch (38 mm) deep, Type B-Vented galvanized steel conforming to ASTM A 653 Grade D form deck secured to structural steel joists spaced 6 feet (1829 mm) o.c. with $\frac{3}{8}$ inch (10 mm) diameter weld washers spaced 6 inches (152 mm) o.c. at each bottom rib or Wheeling Corrugating Company's minimum 24 ga. Tensilvent 125 deck is secured to structural steel joists space 6 feet (1829 mm) o.c. with $\frac{3}{8}$ inch (10 mm) diameter weld washers spaced $3\frac{3}{4}$ inches (95 mm) o.c. at each bottom rib. A slurry coat of Zonolite Insulating Concrete (1:4 mix) with a minimum wet cast density of 61 lb/ft³ (977 kg/m³) is placed on the deck filling the corrugations plus a minimum of $\frac{1}{8}$ inch (3 mm) thickness above the top flange. A minimum of 1 inch thick Insulperm insulation is immediately placed on the Zonolite Insulating Concrete. The following day, a minimum thickness of 2 inches (51 mm) of Zonotite Insulating

Concrete (1:4 mix) with a minimum wet cast density of 61 lb/ft³ (977 kg/m³) is placed on the Insulperm insulation. Three days after the top coat is placed, Parabase base sheet is mechanically fastened to the deck with Zonotite fasteners spaced 7 inches (178 mm) o.c. in the 3 inch (76 mm) wide base sheet lap and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Fastener heads are primed with PA-1125 Primer and then any Paradiene 20 series base membrane is fully adhered with hot asphalt followed by any Paradiene 30 TG series roof cover hot torch adhered.

5.2.6 Factory Mutual, Class I-135 Wind Resistant (68 PSF (3.2 kPa) Maximum Allowable Wind Uplift)

Wheeling Corrugating Company's minimum 24 ga. Tensilvent 125 deck is secured to structural steel joists space 6 feet (1.8 m) o.c. with $\frac{3}{8}$ inch (10 mm) diameter weld washers spaced $3\frac{3}{4}$ inches o.c. at each bottom rib. A slurry coat of Insulcel Lightweight Insulation Concrete with a minimum wet cast density of 44 lb/ft³ (705 kg/m³) is placed on the deck filling the corrugations plus a minimum of $\frac{1}{8}$ inch (3 mm) thickness above the top flange. A minimum of 1 inch (25 mm) thick Insulperm insulation is immediately placed on the Insulcel Lightweight Insulation Concrete. The following day, a minimum thickness of 2 inches (51 mm) of Insulcel Lightweight Insulation Concrete with a minimum wet cast density of 44 lb/ft³ (705 kg/m³) or a minimum thickness of 2 inches (51 mm) of Zonotite Insulating Concrete (1:4 mix) with a minimum wet cast density of 61 lb/ft³ (977 kg/m³) is placed on the Insulperm insulation. Three days after the top coat is placed, Parabase base sheet is mechanically fastened to the deck with Zonotite fasteners spaced 7 inches (178 mm) o.c. in the 3 inch (76 mm) wide base sheet lap and 10 inches o.c. in three equally spaced rows in the field of the sheet. Fastener heads are primed with PA-1125 Primer and then any Paradiene 20 series base membrane is fully adhered with hot asphalt followed by any Paradiene 30 TG series roof cover hot torch adhered.

5.2.7 Factory Mutual, Class I-150 Wind Resistant (75 PSF (3.6 kPa) Maximum Allowable Wind Uplift)

Assembly No. 1

NVS Concrete is placed over structural concrete deck to a minimum thickness of $\frac{1}{8}$ inch (3 mm). A minimum of 1 inch (25 mm) thick Insulperm-1 insulation is immediately placed over the NVS concrete. A minimum of 1 inch (25 mm) thickness of NVS concrete is immediately placed over the insulation. Three (3) days after the top coat is placed, Parabase base sheet is mechanically fastened to the deck with NVS Base Sheet Fasteners with Discs space 7 inches (178 mm) o.c. in the 3 inch (76 mm) wide base sheet lap and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Fastener heads primed with PA-1125 Primer and then any Paradiene 20 series base membrane fully adhered with hot asphalt followed by any Paradiene 30 TG series roof cover hot torch adhered.

Assembly No. 2

NVS Concrete is placed over structural concrete deck to a minimum thickness of 1 inch (25 mm). Three (3) days after the top coat is placed, Parabase base sheet is mechanically fastened to the deck with NVS Base Sheet Fasteners with Discs space 7 inches (178 mm) o.c. in the 3 inch (76 mm) wide base sheet lap and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Fastener heads primed with PA-1125 Primer and then any Paradiene 20 series base membrane

fully adhered with hot asphalt followed by any Paradiene 30 TG series roof cover hot torch adhered.

Assembly No. 3

Consolidated Systems, Inc. minimum 22 ga., 1.5 inch (38 mm) deep, Type B-Vented galvanized steel conforming to ASTM A 653 Grade D form deck secured to structural steel joists spaced 6 feet (1.8 m) o.c. with 3/8 inch diameter weld washers spaced 6 inches (152 mm) o.c. at each bottom rib. A slurry coat of Insulcel Lightweight Insulation Concrete with a minimum wet cast density of 44 lb/ft³ (705 kg/m³) is placed on the deck filling the corrugations plus a minimum of 1/8 inch (3 mm) thickness above the top flange. A minimum of 1 inch (25 mm) thick Insulperm insulation is immediately placed on the Insulcel Lightweight Insulation Concrete. The following day, a minimum thickness of 2 inches (51 mm) of Insulcel Lightweight Insulation Concrete with a minimum wet cast density of 44 lb/ft³ (705 kg/m³) or a minimum thickness of 2 inches (51 mm) of Zonotite Insulating Concrete (1:4 mix) with a minimum wet cast density of 61 lb/ft³ (977 kg/m³) is placed on the Insulperm insulation. Three days after the top coat is placed, Parabase base sheet is mechanically fastened to the deck with Zonotite fasteners spaced 7 inches (178 mm) o.c. in the 3 inch (76 mm) wide base sheet lap and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Fastener heads are primed with PA-1125 Primer and then any Paradiene 20 series base membrane is fully adhered with hot asphalt followed by any Paradiene 30 TG series roof cover hot torch adhered.

Assembly No. 4

Consolidated Systems, Inc. minimum 22 gauge, 1.5 inch (38 mm) deep Type B-Vented galvanized steel form deck conforming to ASTM A 653 Grade 40 deck is secured to structural steel joists spaced 6 feet (1.8 m) o.c. with 3/8 inch (10 mm) diameter weld washers at each bottom rib [6 inches (152 mm) o.c.]. Lightweight Insulating Concrete is placed on the deck filling the corrugations plus minimum 1/8 inch (3 mm) thick above the top flange immediately followed by 1 inch (25 mm) thick Insulperm insulation. The following day, minimum 2 inch (51 mm) thick Insulcel Lightweight Insulating Concrete is placed. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck by driving Zono-tite fasteners. The fasteners are spaced 7 inches (178 mm) o.c. through the 3 inch (76 mm) wide base sheet laps and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Zono-tite fastener heads are primed with PA-1125 Primer and then Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt or hot torch adhered as appropriate followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate.

Assembly No. 5

Insulcel Lightweight Insulating Concrete is placed over the structural concrete deck or properly prepared existing built up roof over structural concrete to a minimum 1/8 inch (3 mm) thickness. It is immediately followed by 1 inch (25 mm) thick Insulperm insulation. The following day, minimum 2 inch (51 mm) thick Insulcel Lightweight Insulating Concrete is placed. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck by driving Zono-tite fasteners. The fasteners are spaced 7 inches (178 mm) o.c. through the 3 inch (76 mm) wide base sheet laps and 10 inches (254 mm) o.c. in three equally spaced

rows in the field of the sheet. Zono-tite fastener heads are primed with PA-1125 Primer and then Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt or hot torch adhered as appropriate followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate. When applying to an existing roof system, maximum allowable wind loads shall not exceed the allowable wind load capacity of the existing roof system.

Assembly No. 6

Consolidated Systems, Inc. minimum 22 gauge, 1.5 inch (38 mm) deep Type B-Vented galvanized steel form deck conforming to ASTM A 653 Grade 40 deck is secured to structural steel joists spaced 6 feet (1.8 m) o.c. with 3/8 inch (10 mm) diameter weld washers at each bottom rib [6 inches (152 mm) o.c.]. Dens Deck, 5/8 inch (16 mm) thick, is mechanically fastened with Siplast Parafast XHD and Siplast Parafast Metal Plates or Tru-Fast HD fasteners and Tru-Fast MP-3 plates applied at 1 per 1.6 ft² (0.5 m²). Two plies of Approved Type IV glass felt 18 inches (457 mm) o.c. coverage are fully adhered with hot asphalt. A 1/8 inch (3 mm) to 1/4 inch (6 mm) slurry coat of NVS Concrete, minimum wet cast density of 75 pcf (1202 kg/m³) is placed over the glass felts immediately followed by a minimum 1 inch (25 mm) thick Insulperm insulation. The following day a minimum of 1 inch (25 mm) thick top coat of NVS Concrete with a wet density of 60 pcf (961 kg/m³) is applied over the Insulperm insulation. Three days after the top coat is placed, Parabase, Parabase FS, or Parabase Plus base sheet is mechanically fastened to the deck with NVS Fasteners spaced 7 inches (254 mm) o.c. in the 3 inch (76 mm) wide base sheet laps and 10 inches (254 mm) o.c. in three equally spaced rows in the field of the sheet. Paradiene 20 series or Irex series base membrane is fully adhered with hot asphalt or hot torch adhered as appropriate followed by a Paradiene 30 series, Paradiene 40 FR, Veral, or Parafor 50 LT roof cover with hot asphalt or hot torch adhered as appropriate.

5.3 Fire Rated Assemblies

The Zonolite® Roof Insulation System, Type 38-NVS™ Roof Insulation System, Zonocel® Roof Insulation System, and the Insulcel® Roof Insulation System have been tested in fire resistant assemblies in accordance with ASTM E 119 (UL 263). These assemblies can be classified as either 1, 1½, or 2 hour Fire Resistive Assemblies when constructed as listed in the Underwriters Laboratories Inc. Fire Resistance Directory. Underwriters Laboratories Inc. assemblies include Design Nos.:

D916, P214, P215, P216, P231, P241, P246, P251, P261, P405, P406, P407, P410, P509, P511, P513, P708, P810, P812, P902, P903, P905, P907, P908, P910, P913, P916, P919, P920, P921, P922, P923

6. SUBSTANTIATING DATA

- 6.1 Manufacturer's descriptive literature.
- 6.2 Report on Wind-Uplift Resistance Tests of roof assembly containing the Zonolite® Roof Insulation System in accordance with UL 580; prepared by Underwriters Laboratories Inc.; File R7045-4,-5; Projects 76NK8567 and 78NK10223; signed by R.M. Berhinig; issued November 6, 1978, and revised March 17, 1980.
- 6.3 Report on Fire Test of Foamed Plastic Insulation Board and Vermiculite Concrete Roof Ceiling Assembly with Bar Joist Supports protected by Cementitious Mixture in accordance with Test Standard UL 263 (ASTM E 119); prepared by Underwriters Laboratories Inc.; File R4339-

- 66; Project 79NK355; signed by R.M. Berhinig, K.W. Howell, and G.T. Castino; Issued April 22, 1980, and revised September 5, 1980.
- 6.4 Report on Small-Scale Fire Tests to determine if the density of Insulperm® Foam Plastic Insulation can be reduced to 0.6 pcf for Fire Resistance Classifications; in accordance with UL 263 (ASTM E 119); prepared by Underwriters Laboratories, Inc.; File No. R6298, Project No. 81NK26660; signed by R.M. Berhinig and Thomas Plens; dated June 1, 1982.
- 6.5 Letter from S.W. Mansour and B. Swytnyk; Underwriters Laboratories Inc.; Subject: Classification of Cellular Concrete (Insulcel), dated June 11, 1987.
- 6.6 Letter Report on Small Scale Fire Tests of Cellular Concrete Roof topping mixture assemblies in accordance with modified UL 2613 (ASTM E 119); prepared by Underwriters Laboratories Inc., Project No. 87NK18243, File No. R12565; signed by S.W. Mansour and James J. Urban; dated November 20, 1987.
- 6.7 Letter from Underwriters Laboratories Inc. on Results of Engineering Project Opened to Determine If Cellular Concrete Made With A Roof Topping Ingredient Identified As "Insulcel" or "Insulcel PB" Can Be Used In Roof Deck Construction No. 110; signed by Greg Rezek and Kenneth Rhodes; dated October 10, 1990.
- 6.8 1991 UL Fire Resistance Directory, Designs No. D916 and P261.
- 6.9 Test report on Fire Resistance of Hybrid Insulating Concrete in accordance with ANSI/UL 263 (ASTM E 119), prepared by Underwriters Laboratories Inc., R12565, 91NK4689, dated October 23, 1991, signed by Joseph A. Treadway and Nestor G. Sanchez.
- 6.10 Letter on Compressive Strength Requirement for the Hybrid Insulating Concrete, prepared by Underwriters Laboratories Inc., R12565, 91NK28643, dated December 19, 1991, signed by Joseph A. Treadway and Nestor G. Snachez.
- 6.11 Letter on Investigation to Include "Insulcel-PB/Vermiculite" as Part of Construction No. 110, prepared by Underwriters Laboratories Inc., R12565, 92NK11732, dated June 8, 1992, signed by Oz Polis and James Hatcher.
- 6.12 Report on Calorimeter Tests and Simulated Wind Uplift Tests on Zonolite® Roof Insulation System in accordance with FM Standard 4450; prepared by Factory Mutual Research Corporation; FM Report No. 24667 (4454); signed by P.A. Goldberg and W.F. Shield; dated April 1, 1975.
- 6.13 Report on Susceptibility to heat damage tests on Zonolite® Roof Insulation System in accordance with FM Standard 4450; prepared by Factory Mutual Research Corporation; FM Report No. 0C3A8.AM (4454); signed by G.A. Smith and B.J. Callahan; dated August 14, 1978.
- 6.14 Report of Tensile Pull Out Tests and compliance with I-60 wind uplift requirements for Type 38-NVS™ Roof Insulation System in accordance with FM Standard 4454; prepared by Factory Mutual Research; FM Report No. J.I. 0F2A9.AM; by L.N. D'Angelo and B.J. Callahan; dated October 22, 1980.
- 6.15 Letter from F.A. Smith, Jr.; Senior Engineer, Factory Mutual Research, dated May 27, 1982, Subject: approved density range (0.6 - 1.5 pcf) for Insulperm® Insulation.
- 6.16 Report on Siplast Paradiene 20/30 Elastomer Bitumen 2-Ply Roof Cover For Use Over Parabase Base Sheet On Zonolite® Lightweight Concrete Roof Decks; prepared by Factory Mutual Research; FM Report No. 0K8A1.AM; signed by E.R. Dunn and B.J. Callahan; dated January 18, 1985.
- 6.17 Report on Tensile Pull-Out Tests using a 1:4 mixture of Zonolite® Roof Insulation System; prepared by Factory Mutual Research Corporation; FM Report No. 1K7A0.AM (4454); signed by G.A. Smith and B.J. Callahan; dated January 23, 1986.
- 6.18 Report on Tensile Pull Out Tests and Simulated Wind Uplift Tests on Insulcel® Roof Insulation System in accordance with FM Standard 4450/4454; prepared by Factory Mutual Research; FM Report No. J.I. 0P8A4.AM; signed by P.E. Huber and B.J. Callahan; dated December 31, 1987.
- 6.19 Test report on Allied Signal Coal Tar Pitch BUR Assembly for Use Over Zonolite or Insulcel Lightweight Concrete Roof Deck in accordance with FM 4454/4470, prepared by Factory Mutual Research, Report No. J.I. 1R6A0.AM, dated May 15, 1990, signed by John P. Cauley and G. A. Smith.
- 6.20 Test report on Hybrid Insulcel-Vermiculite Lightweight Insulating Concrete in accordance with FM 4454; prepared by Factory Mutual Research; Report No. J.I. 0V0A4.AM, dated August 9, 1991, signed by John P. Cauley and G.A. Smith.
- 6.21 Test report of four inch polystyrene beadboard in accordance with ASTM E 84-80; prepared by Southwest Research Institute; Project No. 01-6762-388; signed by Carl A. Hafer, P.E.; dated September 9, 1982.
- 6.22 Test report on Insulcel Lightweight Insulating Concrete Over Structural Concrete in accordance with FM 4454, prepared by Factory Mutual Research Corp., OB9A4.AM, dated May 29, 1997, signed by D.K. Tanaka and L.N. D'Angelo.
- 6.23 Test report on NVS Lightweight Concrete Over Structural Concrete in accordance with FM 4454, prepared by Factory Mutual Research Corp., J.I. 3Z3A7.AM, dated April 12, 1996, signed by D.K. Tanaka and G. A. Smith.
- 6.24 Test report on Zonocel Lightweight Insulating Concrete Over Steel Form Deck in accordance with FM 4454, prepared by Factory Mutual Research, J.I. 2Y1A1.AM, dated April 15, 1996, signed by D.K. Tanaka and L.N. D'Angelo.
- 6.25 Test report on Zonocel Lightweight Insulating Concrete Over Structural Concrete in accordance with FM 4454, prepared by Factory Mutual Research, J.I. 328A6.AM, dated July 23, 1996, signed by D.K. Tanaka and L.N. D'Angelo.
- 6.26 Test report on Siplast Lightweight Insulating Concrete Roof Decks in accordance with FM4454, prepared by Factory Mutual Research, 3005387, dated April 26, 2000, signed by D.K. Tanaka and P.J. Smith.
- 6.27 Test report on Siplast Modified Bitumen Roof Covers in Lightweight Insulation Concrete and Structural Concrete Roof Constructions in accordance with FM 4470, prepared by Factory Mutual Research, Project ID. 3008210, dated April 10, 2001, signed by S.R. Clark and P.J. Smith P.E.
- 6.28 Test report on Siplast Modified Bitumen Roof Covers in Lightweight Insulation Concrete and Structural Concrete Roof Constructions in accordance with FM 4470, prepared by Factory Mutual Research, Project ID. 3011768, dated February 14, 2002, signed by S.R. Clark and J.P. Cauley.

7. CODE REFERENCES

Standard Building Code - 1999 Edition

Section 103.7	Alternate Materials and Methods
Chapter 6	Construction Types
Section 701.5	Fire Resistance References
Section 708	Thermal Insulating Materials
Section 1504	Performance Requirements
Section 1509	Roof Insulation
Section 1510	Reroofing
Section 2603	Foam Plastic Insulation

Florida Building Code-Building - 2001 Edition

Section 103.7	Alternate Materials and Methods
Chapter 6	Construction Types
Section 701.5	Fire Resistance References
Section 708	Thermal Insulating Materials
Section 1504.1	Wind Resistance of Roofs
Section 1509	Roof Insulation
Section 1510	Reroofing
Section 2603	Foam Plastic Insulation

8. COMMITTEE FINDINGS

The Subcommittee on Evaluation in review of the data submitted finds that, in their opinion, the Zonolite® Roof Insulation System, Insulcel® Roof Insulation System, Zonocel Roof Insulation System, and Type 38-NVS™ Roof Insulation System as described in this report conform with or are suitable alternates to that specified in the *Standard Building Code* and the Florida Building Code-Building or Supplements thereto.

9. LIMITATIONS

- 9.1 Insulation material shall not be used in fire rated assemblies unless its performance has been established by tests.
- 9.2 Foam plastic insulations used in the roof covering system shall be protected from the interior of the building by a thermal barrier providing a minimum fifteen (15) minute protection or a minimum of 1 inch (25 mm) thickness of masonry or concrete.
- 9.3 Concrete decks shall have a compressive strength of not less than 2500 psi (1.7 MPa).
- 9.4 Class I-60, Class I-75, Class 90/I-90, Class I-120, Class I-135, Class I-150, Class I-180, Class I-225, and Class I-315 Maximum Uplift Pressure Systems shall not be used in areas where the factored wind load pressure exceeds 30, 38, 45, 60, 68, 75, 90, 113, or 158 psf (1.4, 1.8, 2.2, 2.9, 3.6, 4.3, 5.4, or 7.5 kPa) respectively.
- 9.5 The structural roof system shall be certified by a registered engineer or architect as being capable of sustaining the construction, membrane, ballast, and ancillary material loads that will be encountered during and subsequent to membrane application.
- 9.6 The Insulation System shall be designed by a registered engineer or architect when used as a structural roof diaphragm.
- 9.7 Roof covering systems placed on the Siplast roof deck assemblies are outside the scope of this report.

10. IDENTIFICATION

All containers and packaging serving the Zonolite® Roof Insulation System, Insulcel® Roof Insulation System, Zonocel® Insulation System, and Type 38-NVS™ Roof Insulation System that are covered by this report, shall be labeled with the manufacturer's name and/or trademark, the system identification, the appropriate Factory Mutual Approval Mark or UL Classification Mark, the SBCCI Public Safety Testing and Evaluation Services, Inc. initials (SBCCI PST & ESI) or seal, and the number of this report for field identification.

11. PERIOD OF ISSUANCE

SEE THE CURRENT EVALUATION REPORT INDEX FOR STATUS OF THIS LEGACY EVALUATION REPORT.

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