The Evolution of Roofing Membranes

Summer Camp ‘17

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GAF
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Carl G. Cash Award
So let’s talk about roofing membranes...
The Roofing System...

- System
  - Wind/Fire
  - Traffic
  - Bldg. Use
  - Access
  - Secondary Use
  - Maintenance
Structural Deck…

- Deck
  - Ability to attach
  - Moisture
  - Movement
  - Slope
  - Movement relative to walls
  - Air leakage
Insulation...

- Insulation
  - Number of layers
  - Attachment
  - Compatibility
  - Fastener location
  - Durability to traffic
  - Coverboard or not
  - Joints staggered
Membrane...

- System Type
  - Mechanically attached
  - Hot asphalt
  - Heat welding
  - Fully adhered

- Membrane
  - Number of layers
  - Type

- Vapor Retarder
  - Need
  - Type
  - Attachment
  - Compatibility
Details
Critical to ANY Installation...
Paraprosdokian...

WHERE THERE'S A WILL, I WANT TO BE IN IT

*Paraprosdokians...are figures of speech in which the latter part of a sentence or phrase is surprising or unexpected; frequently humorous.
Evolution…

WHERE DID WE COME FROM?
From Tar Pits to TPO…
Tar pits are composed of heavy oil fractions called gilsonite, which seeped from the Earth as oil. In Hancock Park, crude oil seeps up along the 6th Street Fault from the Salt Lake Oil Field, which underlies much of the Fairfax District north of the park.[3] The oil reaches the surface and forms pools at several locations in the park, becoming asphalt as the lighter fractions of the petroleum biodegrade or evaporate.

This seepage has been happening for tens of thousands of years. From time to time, the asphalt would form a deposit thick enough to trap animals, and the surface would be covered with layers of water, dust, or leaves. Animals would wander in, become trapped, and eventually die. Predators would enter to eat the trapped animals and also become stuck.

Indians would use surface bitumen to waterproof...
From 1896...
Represents over 50 years actual experience…
Everything but the man and the hammer comes in the roll—goes down like a carpet. Any workman can lay

**REX FLINTKOTE ROOFING**

Contains no paper and no tar; will not leak or crack or soften or shrink or stretch; is made of tough, fibre wool-felt, treated by our special process; keeps out the cold in winter, the heat in summer and the wet always. What more could any roof do?

**Write for Free Samples**

which we will gladly send you, and also our valuable free booklet on roofing. "Look for the Boy" on every roll.

**J. A. & W. BIRD & CO.**

33 India St., Boston, Mass.

Agents everywhere
Bitumen…

- Pitch
- Asphalt
  - Type I  Dead Level Applications
  - Type II
  - Type III
  - Type IV  Steep Slope Applications
    2/12+
- Rubberized
Plies…

- Type IV Fiberglass
- Type VI Fiberglass
- Fiberglass Reinforced
- Polyester Reinforced
Surfacing…

- Protection
  - UV Degradation
  - Roof Top Traffic
  - Wind Damage
- Aggregate
- Mineral Surface (Granulated)
- Coating
BUR

BENEFITS

- Multi-ply
- Waterproofing
- Surfacing Options
BUR

**BENEFITS**
- Multi-ply
- Waterproofing
- Surfacing Options

**LIMITATIONS**
- Labor
- Fumes
- Temperature
BUR

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- Multi-ply
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LIMITATIONS
- Labor
- Fumes
- Temperature

MISPERCEPTIONS
- “Old Technology”
- Not Energy Star/Reflective
- No Longer Available
From Tar Pits to TPO…
EPDM…

• Since 1960’s
• Went down quickly-large panels
• Very economical-gravel ballast
• More versatile-building movement
• “Cleaner” than BUR
EPDM

BENEFITS
- Very Stable Membrane
- Large Sheet Size
- Taped Seams Perform Well

LIMITATIONS

MISPERCEPTIONS
EPDM

BENEFITS
- Very Stable Membrane
- Large Sheet Size
- Taped Seams Perform Well

LIMITATIONS
- Low Reflectivity
- Taped/Glued Seam vs. Heat Fused/Welded
- “Single Ply”

MISPERCEPTIONS
**EPDM**

**BENEFITS**
- Very Stable Membrane
- Large Sheet Size
- Taped Seams Perform Well

**LIMITATIONS**
- Low Reflectivity
- Taped/Glued Seam vs. Heat Fused/Welded
- “Single Ply”

**MISPERCEPTIONS**
- Most Are Ballasted
- Black ≠ Energy Efficient
- Not Puncture Resistant
Flexible membranes
Easy walls
Huge sheets
From Tar Pits to TPO…
PVC…

- Introduced in early 1970’s
- Heat welded seams
- Highly reflective - white
- Very chemical resistant
- High fire resistance
PVC

BENEFITS
- Reflective
- Heat Welded Seams
- Chemical Resistance

LIMITATIONS

MISPERCEPTIONS
PVC

**BENEFITS**
- Reflective
- Heat Welded Seams
- Chemical Resistance

**LIMITATIONS**
- “Red Listed” by some
- High Temperature
- Single Ply

**MISPERCEPTIONS**
PVC

**Benefits**
- Reflective
- Heat Welded Seams
- Chemical Resistance

**Limitations**
- “Red Listed” by some
- High Temperature
- Single Ply

**Misperceptions**
- Shatters
- Shrinkage
- Impact Resistance
Paraprosdokian…

**If I agreed with you, we'd both be wrong.**
From Tar Pits to TPO…

- BUR
- EPDM
- PVC
- Modified Bitumen
Polymer Modified Bitumen…
APP...

- Atactic Polypropylene
- Developed in Italy, introduced to US in late 70’s
- Excellent inherent flexibility and stability
- Heat (Torch) Applied
SBS...

- Styrene Butadiene Styrene
- Developed in Northern Europe
- Excellent flexibility and elongation characteristics
- Hot Applied
- Cold Applied
- Torch Applied
- Self Adhered Applied
Mod Bit

BENEFITS
- Multi-ply
- High Abuse/Puncture
- Easy Repair/Maintenance

LIMITATIONS

MISPERCEPTIONS
Mod Bit

**BENEFITS**
- Multi-ply
- High Abuse/Puncture
- Easy Repair/Maintenance

**LIMITATIONS**
- Labor
- Open Flames (APP)
- Cost

**MISPERCEPTIONS**
Mod Bit

**BENEFITS**
- Multi-ply
- High Abuse/Puncture
- Easy Repair/Maintenance

**LIMITATIONS**
- Labor
- Open Flames (APP)
- Cost

**MISPERCEPTIONS**
- “Old Technology”
- Not Energy Star/Reflective
- Durability in High UV
Technology + Asphalt
Ability to mix with BUR
BUR + cold adhesive
Strain Energy
From Tar Pits to TPO...
TPO...

- Introduced in late 1980’s
- Heat welded seams
- Highly reflective - white
- Cost effective
- High UV/heat formulations
TPO

BENEFITS
- Reflective
- Heat Welded Seams
- Cost

LIMITATIONS

MISPERCEPTIONS
TPO

**BENEFITS**
- Reflective
- Heat Welded Seams
- Cost

**LIMITATIONS**
- Chemicals
- Weather - Adhered
- Single Ply

**MISPERCEPTIONS**
TPO

BENEFITS
- Reflective
- Heat Welded Seams
- Cost

LIMITATIONS
- Chemicals
- Weather - Adhered
- Single Ply

MISPERCEPTIONS
- Length on Market
- Performance
- Impact Resistance
• High UV/Heat Resistant Formulations
• Cost Effective Alternative to PVC
From Tar Pits to TPO…
Ads Evolved Too...

And ... circa 2013...“As Seen on TV”!
Paraprosdokian...

To steal ideas from one person is plagiarism. To steal from many is research.
Installation Evolution...

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Single Ply Membranes...
Not As Simple As a Few Years Ago…

2000

Ballasted
Fully Adhered
Mechanically Attached

Today

Mechanically Attached
Fully Adhered*
Ballasted
RhinoBond Attachment
Self Adhered
Mechanically Attached

Ballasted

Fully Adhered
- Solvent Based
- Low VOC
- Water Based
- Low Rise Foam
- 2 Part

RhinoBond® System

Self-Adhered

Installation Methods
Mechanically Attached

• Cost effective
• Most common installation method
• No sprayers or additional capital investment
• No odors
• Up to 50% faster installation than fully adhered smooth membranes
• Membrane carries wind load
• Wide application temperature
Mechanically Attached Limitations/Considerations

- Deck type/holding power
- Insulation thickness
- Tapered insulation difficulty*
- Impact resistance
- Need for an air barrier
- Moisture
- Roof as a platform

* Note: tapered with any mechanical attachment increases difficulty
Ballasted

- Low labor cost
- No sprayers or additional capital investment
- No odors
- Ballast provides wind resistance
- Minimal fastening required
- Ideal for very wide sheets
- High impact resistance
Ballasted
Limitations/Considerations

- Deck type – capacity for load
- Availability of quality ballast
- Leak detection
- Wind resistance – code restrictions
- Roof as a platform
Fully Adhered – Bonding Adhesive

- No sprayers or additional capital investment
- Excellent wind uplift performance
- Familiarity with workers
- Solvent, low VOC, and water based adhesives
- Uniform, smooth appearance
- Ability to “bury” fasteners
Fully Adhered – Bonding Adhesive

Limitations/Considerations

- VOC content of adhesive
- Weather limitations for both application AND storage
- Open time – largest installation time
- Material costs
- Wet decks and adhesives don’t play well
Fully Adhered – Fleece-Back Laid in Wet

- Fast installation time – low labor cost
- Excellent wind uplift performance
- Low odor/VOC compliant
- No open cure times
- Uniform, smooth appearance
- Ability to “bury” fasteners
- Excellent impact resistance
Fully Adhered – Fleece-Back Laid in Wet
Limitations/Considerations

- Material costs
- Wet decks and adhesives don’t play well
- Substrates
- Cure times
Fully Adhered – Low Rise Foam & 2 Part Adhesives

- Fast installation time – low labor cost
- Excellent wind uplift performance
- Low odor
- VOC compliant
- Uniform, smooth appearance
- Ability to “bury” fasteners
- Excellent impact resistance
Fully Adhered – Low Rise Foam & 2 Part Adhesives
Limitations/Considerations

- Depending on adhesive, equipment cost can be high
- Material costs
- Wet decks and adhesives don’t play well
- Substrates
Rhinobond® System

- Moderate material cost
- No open cure times
- No need for half sheets at perimeter and corners
- Less flutter than MA systems
- Less fatigue on fasteners
- Wide application temperature
Rhinobond® System
Limitations/Considerations

• Equipment cost (however, can increase speed with second machine)
• Deck type/holding power
• Tapered insulation difficulty
• Impact resistance
• Need for an air barrier?
• Moisture
• Roof as a platform
Self-Adhered

- No sprayers or additional capital investment
- Excellent wind uplift performance
- No odors/no adhesives
- No open cure times
- Ability to “bury” fasteners
Self-Adhered Limitations/Considerations

- Material cost
- Single layer of insulation
- Self-adhered lap vs. heat welded lap
- Aesthetics
Paraprosdokian...

I'M SUPPOSED TO RESPECT MY ELDERS, BUT ITS GETTING HARDER AND HARDER FOR ME TO FIND ONE NOW.
Market Evolution...

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Technology Transition
Technology Transition…
digging a little deeper
The Roof Retrofit Multiplier Effect:

New Roofing

3 Billion Sq. Ft.

Re-Roofing / Retrofit

1 Billion Sq. Ft.

North American Low-Slope Roofing Market
(Billions of Square Feet, 2006)

Each year, 3 billion square feet of commercial roof retrofits are installed in North America, exceeding new commercial roof installations by 3 to 1!

Data Source & Graphic by TEGNOS Research, Inc. (2006)
REGARDLESS OF MEMBRANE, Still Need Good Bones!!!
Don’t Forget the “20 Questions!”

- Identify the poison pills
- Rule out what won’t work
- Drill down to better options

*These questions should identify*

**WHAT won’t work,**

**WHAT will work,**

*and WHAT are the best options for the specific property… and WHY,* based on the needs of the building owner
PART IV: Theory Is Nice…But Let’s Look at Reality
Real World…

**Specifics…**
- New Construction
- Concrete Deck
- Iso Insulation

**What Comes to Mind**
- What is concrete poured over?
- Concrete = Adhered
- Is the deck flat?
- What kind of “concrete”? Why?
• Probably Not
  Cost to fasten into concrete
  Time
  Tapered Insulation?
  Vapor Retarder -

• Perhaps
  Access
  Owner Preference
  Wind Limitations
  Availability of Ballast

• Better/Best
  Attachment Ease
  Wind Uplift
  Vapor Retarder +
  Think Water
Real World…

**Specifics**
- Tear Off to Existing Lightweight Concrete Poured over Tectum
- 1/4” – 1/2” Cracks

**What Comes to Mind**
- Deck movement
- Fastening to What?
- Cracks telegraphing
- Is the Lightweight wet?

Why?
• Probably Not

What fastener are you going to use?
Can you engage the tectum deck?

• Better/Best

Weight Concerns(ballast)
Traditional adhesive to what?

To a MA base sheet
Separates the new roof from a problem substrate
Provided venting
Real World

- Existing Standing Seam Metal Deck
- Want to Add Insulation

What Comes to Mind
- Attachment to what?
- Wind Performance
- Fire Performance
- This is NOT a traditional 22 gauge metal deck
Highlights… Retrofit Over Metal

- Retrofit – means existing metal building may well have been built with earlier/different strength limits
- Deflection limits for total load of L/60, whereas for membrane roofing “deck deflection should be no more than L/240 (4 times less deflection allowed)
Highlights… Retrofit Over Metal

- Retrofit – means existing metal building may well have been built with earlier/different strength limits
- Deflection limits for total load of L/60, whereas for membrane roofing “deck deflection should be no more than L/240 (4 times less deflection allowed)
- Most existing wind uplift ratings based on 22 gauge or thicker metal deck with 33 or 80 ksi yield strength
- FM 1-31 on Panel Roof Systems may be a good source of recommendations
(Probably) Not

Weight - ballasted
Deflection for fully adhered

Perhaps

Into secondary support structure
Only with structural evaluation

Better

Only into secondary support structure
Only with structural evaluation
Real World...

- Metal Deck
- NE Coastal
- Replace due to Blow Off
- 85’ Building Height

What Comes to Mind
- Wind performance
- Parapet walls?
- Type of steel deck?
- Exposure – C or D?
(Probably) **Not**

It’s all about wind performance…

Check out FM Data Sheets…don’t think you can get there!

**Best Solution**

Well attached insulation + fully adhered membrane
Real World

- Steel Mill
- Needs to be Title 24 Compliant
- Metal deck

What Comes to Mind
- What’s ending up on the roof?
- Temperature from operations (at penetrations, at deck)
- Rooftop traffic

Why?
Critical…

- Color of roof membrane in situ (like after it’s been there for 6 months)
- Roof top temperature
- Temperatures at exhausts and things you have to flash
Probably Not

Need high reflective membrane (vs. ballast)

Heat transfer via fasteners to membrane

Best Solution

Bury insulation fasteners to stop heat

Use high temperature membrane

Implement routine roof cleaning

Insulate penetrations from flashings
Real World…

**Specifics**
- Roof as a Platform
- Solar

**What Comes to Mind**
- Type of solar system
- Roof area to be covered?
- Age of existing roof?
- Ability to perform maintenance?
- Impact resistance?

*Why?*
Paraprosdokian...

**YOU DO NOT NEED A PARACHUTE TO SKYDIVE. YOU ONLY NEED A PARACHUTE TO SKYDIVE TWICE.**
THANK YOU!

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