

The Role of the Roof in Resilient Building Design



S009 April 4 + 5, 2017



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S009 April 4 + 5, 2017



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Brief Course Description

- Recent powerful climate storms have the government discussing the need for resilient buildings: buildings that can withstand the storms, provide life safety and be repairable. Challenging building owners require sustainable, energy efficient and resilient buildings. The roofing system is often the first line of defense in catastrophic natural disasters. The roof, if designed properly, can mitigate the impacts of these emergencies and allow a building to withstand and recover from the disruption.
- Resilience is increasingly being viewed as an important performance objective for construction. Interest in resiliency is high and is being actively discussed at all levels of the building industry: Governmental, Codes and Standards, and Trade Organizations. Without building codes or standards to guide designers in their efforts to ensure that new and existing buildings are resilient, what are the best practices that can be employed in both new construction and retrofit/re-roof projects?



Learning Objectives

Upon completion of this presentation, participants will:

- Be able to define resiliency and differentiate it from other building attributes
- Know what various organizations are discussing about resiliency
- Know the material attributes that contribute to a resilient roof
- Know the various design details that make a roof more resilient



Agenda

- What is resiliency?
- Why do we need resilient building design?
- Who is talking about resilience?
- What are these organizations saying?
- The role of the roof in resilient building design
- Attributes of a resilient roof
- EPDM: The Resilient Roof
- Prototype Assemblies
- Case Study



What is Resiliency?

Sustainability + Durability + Energy Efficiency

What is resiliency?

- Durability > Sustainability > Resiliency
- Adapt > Withstand > Recover



What is resiliency?

- Responsive and Active
- Beyond Durability
- Focus on Extreme Events and Outcomes

Source: Dr. Jim Hoff, More Than Just a Single-Ply



What is resiliency?

“Resilience is the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance. It is the capacity to bounce back after a disturbance or interruption. From Katrina to Sandy, California drought to Mississippi flooding, resilience is both response and action.”

- *Source: Resilient Design Institute*



Need for resilient building design

Need for resilient building design

- Climate extremes
- Weather issues
- Physical terrorism (even wildlife!)
- Greater long-term benefits
- High performance building owners
- Unique considerations for medical and educational facilities



Need for resilient building design



Need for resilient building design



Need for resilient building design



Need for resilient building design



Contributors to resilience conversation

Contributors to resilience conversation

- U.S. Government Agencies
 - DHS
 - NIBS
 - National Academy of Science
 - NOAA
 - White House Conference
- Canadian Government
- Non-Governmental Organizations
 - ICC
 - USGBC
 - Resilience Building Coalition
- Trade Associations
 - BOMA
 - AIA



Contributors to resilience conversation

7th International Conference on Building Resilience Using scientific knowledge to inform policy and practice in disaster risk reduction

27-29 November 2017, Swissotel Le Concorde, Bangkok, Thailand
www.buildresilience.org/2017



Content of resilience conversations

Content of resilience conversations

- Commonalities among definitions
- Position statements and policies
- Industries represented



Content of resilience conversations



Content of resilience conversations



- ‘The term "resilience" refers to the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies. Whether it is resilience towards acts of terrorism, cyber attacks, pandemics, and catastrophic natural disasters, our national preparedness is the shared responsibility of all levels of government, the private and nonprofit sectors, and individual citizens.’



Content of resilience conversations



“ . . . commits to creating webinars focused on existing buildings and code adoption to provide guidance and best practices on how to increase resiliency of buildings.”



Content of resilience conversations



“ . . . announces that it will co-lead an effort to organize an inclusive, nationwide coalition to create and develop the country’s first Whole-Community metric for resilience..”



Content of resilience conversations



“. . . commits to actively engaging through its partnership in Resilient Communities for America and additional efforts to promote resilient building codes in communities across the country....”



Content of resilience conversations



THE AMERICAN
INSTITUTE
OF ARCHITECTS



National Institute of
BUILDING SCIENCES



Content of resilience conversations

PREPARING TO THRIVE: THE BUILDING INDUSTRY STATEMENT ON RESILIENCE

▪
*Helping communities construct
a more certain future.*



Content of resilience conversations

The Resilience Building Coalition

- Developing and advocating for codes and policies that advance resilience;
- Developing “whole-systems resilient design” approaches for the built environment; and
- Providing guidance, beyond the baseline life-safety codes, that recognizes the importance of fortifying property for individual and community resilience.



Content of resilience conversations

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The National Academies of
SCIENCES • ENGINEERING • MEDICINE

RESILIENT AMERICA
OFFICE OF SPECIAL PROJECTS
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Roundtable member, Mr. Roy Wright, the Federal Emergency Management Agency's Deputy Associate Administrator for Insurance and Mitigation, was invited to guest lecture at the University of Pennsylvania's Wharton Business School about challenges in reforming the National Flood Insurance Program.

NEWS
Watch the videos of the live webcast of the State of Resilience event

NEWS
Roundtable member, Dr. Lucy Jones, featured in U.S. media outlets for her long career at t ...

NEWS
Roundtable member, Mr. Roy Wright, guest lectured at the Wharton Business school about the National ...

NEWS
Roundtable member, Linda Langston, takes on a new position at NACo

[More...](#)

ResilientAmerica

The ResilientAmerica Roundtable and its programs aim to help communities and the nation build resilience to extreme events, save lives, and reduce the physical and economic costs of disasters.



BUILDING A MORE Resilient America

Every year, disasters kill hundreds of Americans and displace thousands more. And the financial costs of disasters are staggering.

Our Current Path:

Responding to disasters after they occur takes a devastating human and financial toll.

Federal disaster declarations each year:



The Path of Resilience:

Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. Building resilience starts before disaster strikes.



What Does a Resilient Community Look Like? A RESILIENT COMMUNITY...

- Engages governments, nonprofit and faith-based organizations, businesses, and citizens to identify and manage risks together
- Communicates risks clearly
- Measures resilience and tracks progress
- Exchanges lessons learned with other communities

<http://resilientamerica.nas.edu>





Content of resilience conversations

US Climate Resistance Toolkit case study (published by NOAA) on the retrofitting of Miami Children's Hospital:

“The hospital is now wrapped in a hurricane resistant shell—the retrofit strengthened the building by encapsulating the three-story structure in pre-molded panels of glass fiber-reinforced concrete. This panel system, anchored into the building's existing support structure, forms a protective cocoon around the hospital. Along with impact-resistant windows and a *strengthened roof*, the panel system is designed to withstand winds of up to 200 miles per hour.”



The Building Industry Is Working to Reduce Long-term Costs and Limit Disruptions of Extreme Events

 JULY 27, 2016 BY [JARED O. BLUM](#)  [LEAVE A COMMENT](#)

“Resilience is the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from deliberate attacks, accidents, or naturally occurring threats or incidents.” — White House Presidential Policy Directive on Critical Infrastructure Security and Resilience

In August 2005, Hurricane Katrina made landfall in the Gulf Coast as a category 3 storm. Insured losses topped \$41 billion, the costliest U.S. catastrophe in the history of the industry. Studies following the storm indicated that lax enforcement of building codes had significantly increased the number and severity of claims and structural losses. Researchers at Louisiana State University, Baton Rouge, found that if stronger building codes had been in place, wind damages from Hurricane Katrina would have been reduced by a staggering 80 percent. With one storm, resiliency went from a post-event adjective to a global movement calling for better preparation,



The Role of the R00F in Resiliency

The Role of the Roof in Resiliency

- Resist, Maintain, Produce
- Respond to catastrophic events: 1st line of defense
- Protection from the elements
- As a platform

Source: Dr. Jim Hoff, More Than Just a Single-Ply



Attributes of a Resilient Roof

Attributes of a Resilient Roof

- Durable Components
- Robust Design
- Resist, Maintain, Produce



EPDM: The Resilient Roof

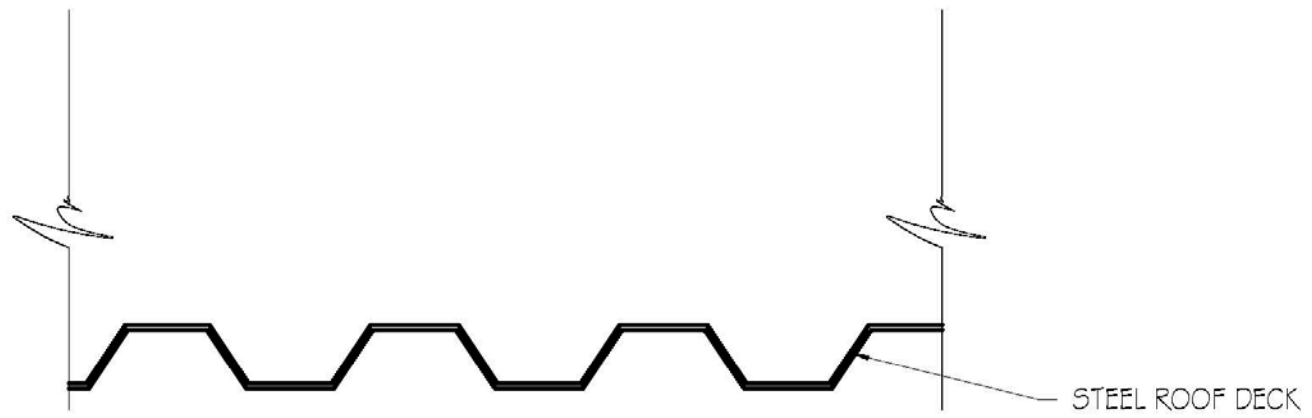
EPDM: The Resilient Roof

- Thermoset Material
- Resistant to UV exposure
- Versatile
- Durable
- Long-Lasting
- Repairable in a crisis

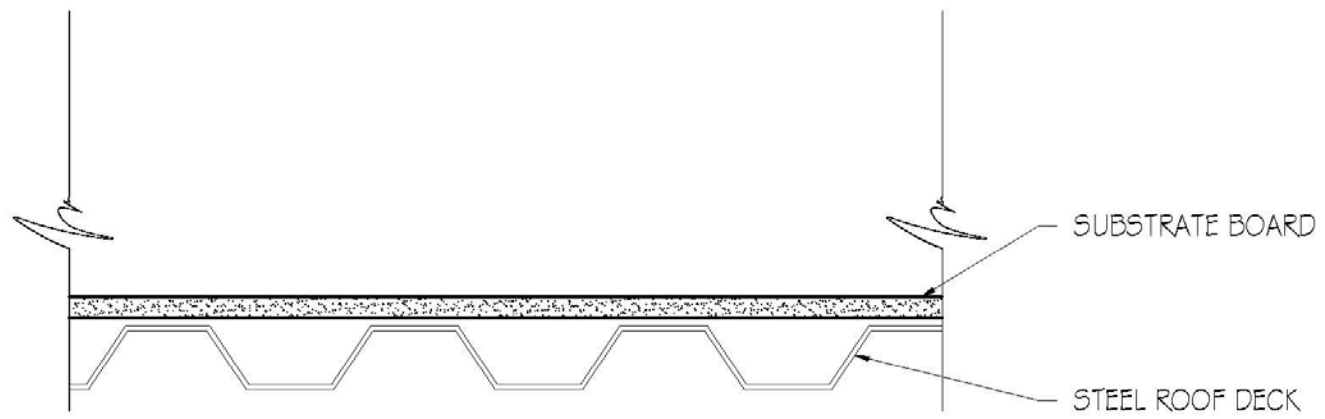


Prototype Assemblies

Resilient Roof System Assemble Components

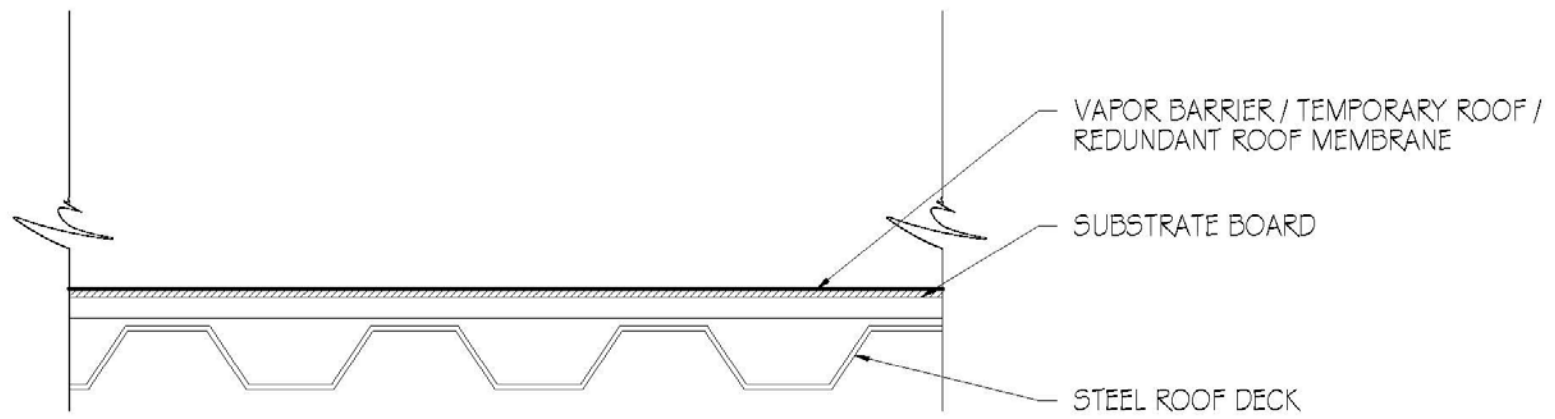


① ROOF SYSTEM INSTALLATION - STEP 1 - STEEL ROOF DECK



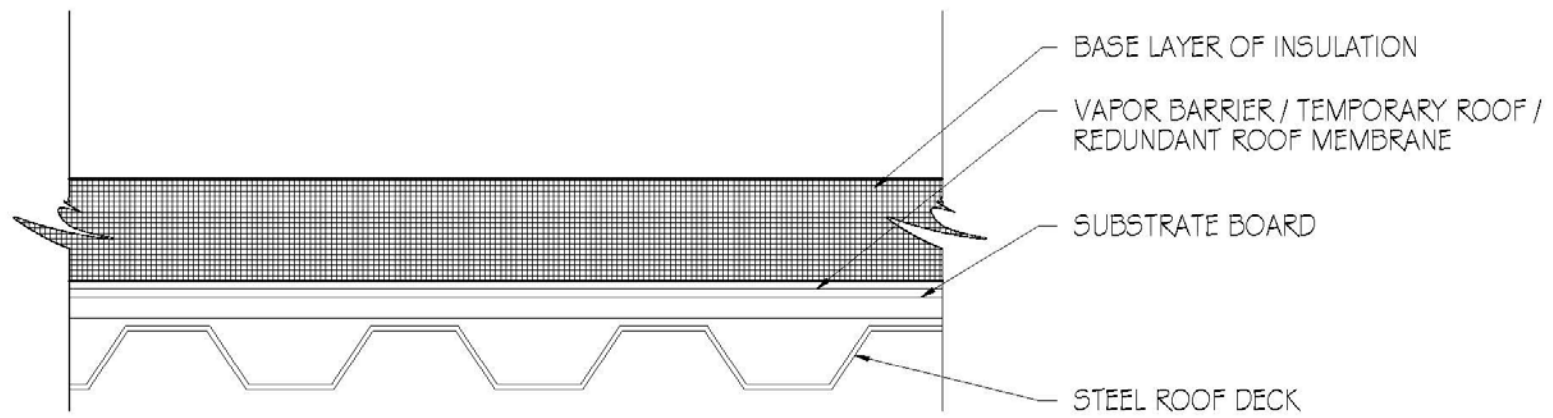
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ROOF SYSTEM INSTALLATION - STEP 2 - SUBSTRATE BOARD



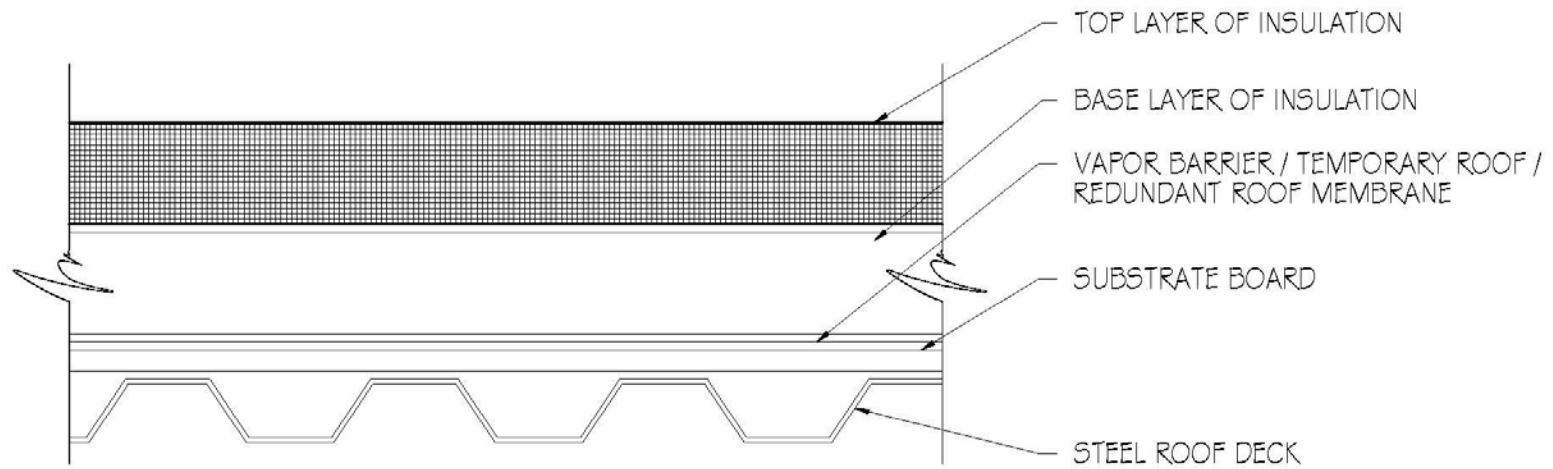
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ROOF SYSTEM INSTALLATION - STEP 3 - REDUNDANT ROOF MEMBRANE



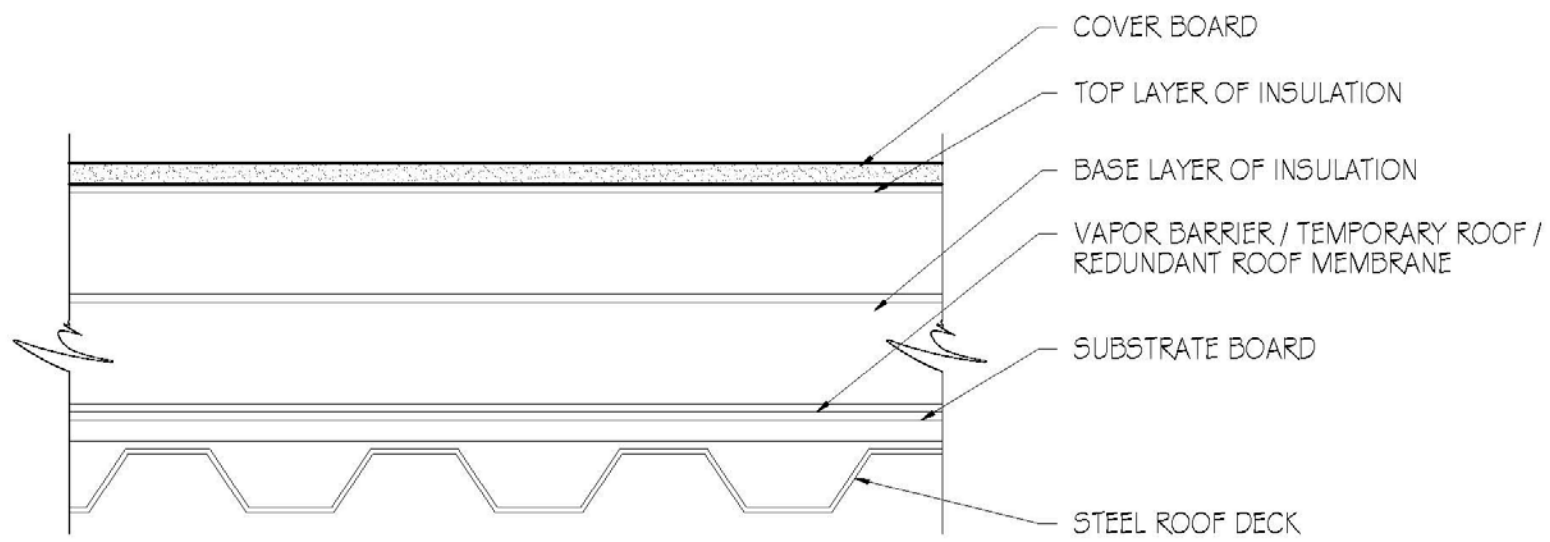
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ROOF SYSTEM INSTALLATION - STEP 4 - BASE LAYER OF INSULATION

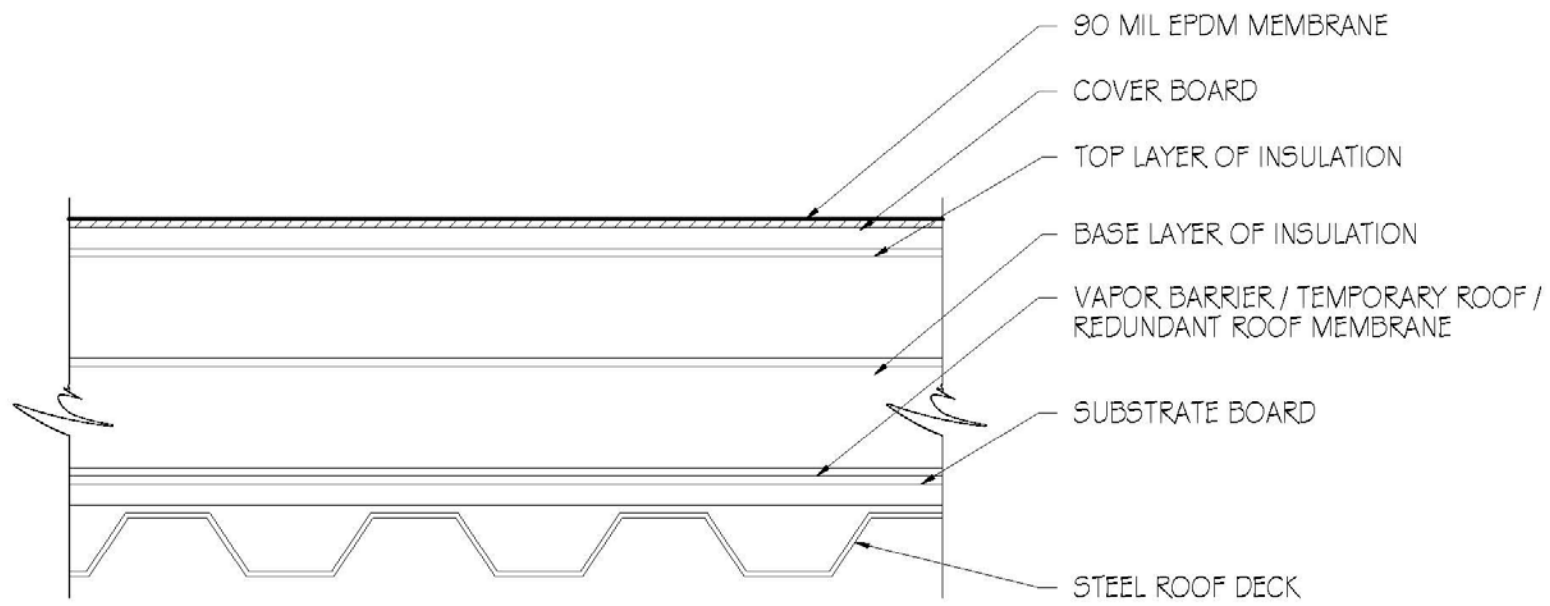


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ROOF SYSTEM INSTALLATION - STEP 5 - TOP LAYER OF INSULATION



6 ROOF SYSTEM INSTALLATION - STEP 6 - COVERBOARD



7

ROOF SYSTEM INSTALLATION - STEP 7 - 90 MIL EPDM MEMBRANE

EPDM: The Resilient Roof

A Case Study in Resiliency

- Roofing Removal and Replacement
- Research, Testing and Office Facility
 - Consider “Critical”



THE PROJECT



THE PROJECT



EPDM: The Resilient Roof

THE PROJECT

- 155,000 SF
- Roofing Removal and Replacement
- Fully Adhered 90 mil EPDM
- Contractor: Olsson Roofing, Aurora, IL
- Centurion, 1000 + Hall of Fame
- Project Manager: Mike Herlihy
- Construction Time: 5 Months
- Construction Cost: \$2,850,000.00



EPDM: The Resilient Roof

THE CLIENT

- Multi Billion Dollar International
- Manufacturing, Laboratories, Test Laboratories, Offices



EPDM: The Resilient Roof

THE CLIENT

- Existing Client
- Poor Roofing History
 - Reroofing handle internally
 - Very low end
- One manufacture
 - Millions of Square Feet
 - Membrane failure one after another



EPDM: The Resilient Roof

THE CLIENT

- Employees needs above all else
 - They're "fical"
- Will not relocate employees
- Noise is always an issue
 - E.g. Noise could disturb multi year testing, thus not allowed
- Vibration:
 - No nailing: Falling contaminates unacceptable
 - Employees always looking to go home



EPDM: The Resilient Roof

CLIENT GOALS

- 30 year plus design and service life
- Long Term Service Life is the Essence of Sustainability
 - Clients now expect it
- Resiliency is the new mandate



EPDM: The Resilient Roof

CLIENT GOALS

- Proven history of membrane performance
- Membrane to be climate appropriate
- Structure to meet current codes



EPDM: The Resilient Roof

PROJECT GOALS

- 30 year warranty
- 30 year service life
- Sustainable and Resilient
- Building had previously experienced wind damage, thus, roof system and especially the roof edge design needs to be well thought.



EPDM: The Resilient Roof

PROJECT GOALS

- New Roof can not involve nailing or mechanical fastening (cementitious wood fiber)
 - Noise
 - Debris
- Roof deck and structure to be check to current code loading as addition of greater height was added years ago
- System to be 'Resilient'



EPDM: The Resilient Roof

THE EXISTING ROOF SYSTEM

- 2” ISO in bead foam adhesive
 - “mop and flop” applied
 - Foam adhesive beads on top of wood fibers deck
- Roof Edge: Concerns that the roof edge is not attached to a structural element
- Roof Deck: Cementitious Wood Fiber



EPDM: The Resilient Roof

ANALYSIS

- Roof Deck: Structural Analysis
 - Is the Structure able to withstand uplift pressure and snow loads based on current codes?
 - Roof Deck not able to support snow load at addition
 - Roof Deck determined not able to support anticipated point loads; e.g. moving materials across the roof on a balloon wheel cart.
- Roof Edge
 - Floating
 - Exterior masonry not attached to structure



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

- Roof Deck Concerns:

New steel roof deck over the CWF roof deck to support anticipated snow loads



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

ROOF EDGE:

- Verification of existing conditions -- not good
 - No attachment of the masonry or curtain wall to the structure
 - Accident waiting to happen
 - Cavity: Warm air migration to roof possible



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

ROOF EDGE:

- New roof edge design required structural attachment



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

Vapor Retarder on Cementitious Wood Fiber Deck

- Industry standard: Nail Base Sheet
- But...Nailing or mechanical fastening not permitted
- Answer: Fleece Back EPDM in full coverage 'Flexible Fast' spray foam adhesive
- Protection from overspray needs to be considered
- Require additional passes for low spot



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

Insulation

- R 25 Required (now R30)
- Deck is structurally sloped so 2 layers of 2.5"
 - ½" per foot tapered insulation saddles
- Double coated fiber glass faced; 25 psi
- Set in full coverage flexible fast
- Set, place and weight; 10 minutes; 5 -35 pound weights per board
- Spray foam insulated all gaps and voids
- To eliminate cover board, 100 psi composite board used on top layer of insulation



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ROOF SYSTEM DESIGN

Membrane

- Fully adhered 90 mil
- All seams cover stripped
 - Process:
 - Clean
 - Prime
 - Apply splice adhesive
 - Set cover strip



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ROOF SYSTEM DESIGN

Cover Strips

- After placement and rolling of coverstrip
 - Clean
 - Prime
 - Apply splice adhesive
 - Set lap sealant
 - Tool in place



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

Penetrations

- Raise curbs, vent pipes
- Extra base flashing wrap



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

Penetrations

- Raise curbs, vent pipes
- Extra base flashing wrap



EPDM: The Resilient Roof

ROOF SYSTEM DESIGN

Miscellaneous Design Items... Not to be forgotten

- Walk way pavers: 2'-0" x 2'-0" x 2"
- Tie in to existing roofing
- Expansion Joints
 - Envelope
 - Sheet metal cover



EPDM: The Resilient Roof

BIDDING

- High Performing Contractors
- Previous Experience with HDG...Successful
- Experience with Client who has a multitude of construction safety requirements
- Safety classes
- No lifts over buildings with people inside
- Criminal background checks



EPDM: The Resilient Roof

CONSTRUCTION

- Pre-Award Meeting: “Do you have everything?”
- Pre- Construction Meeting
- Schedule
- Submittals: Is what was specified and design being submitted?



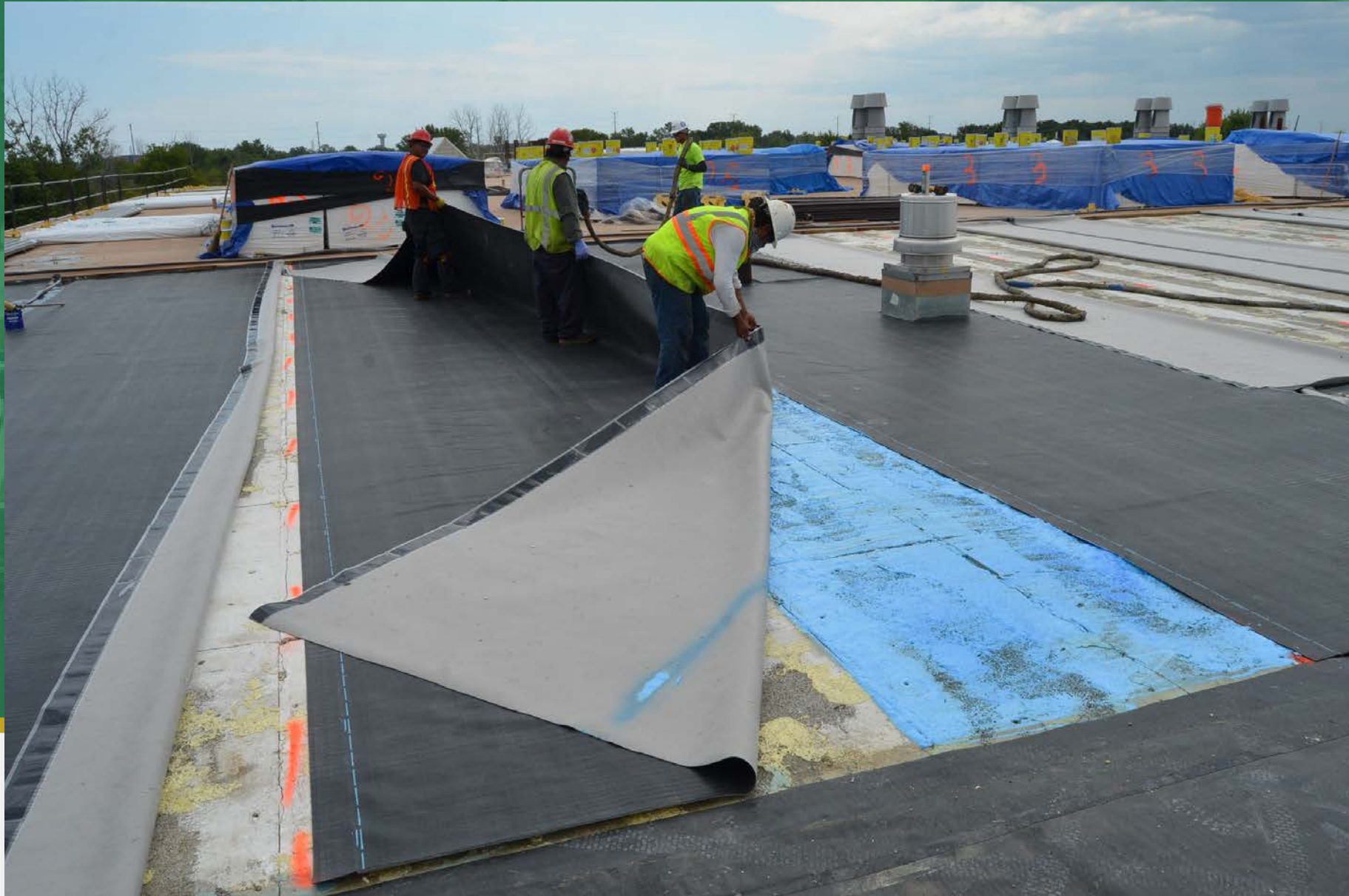
EPDM: The Resilient Roof

CONSTRUCTION

- Work with Technical Rep who was required to be onsite 5 times
- On site field observations – OVARC
- Observe
- Verify
- Anticipate
- Record
- Confirm



CONSTRUCTION



CONSTRUCTION



CONSTRUCTION



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CONSTRUCTION



EPDM: The Resilient Roof

LESSONS LEARNED

1. Listen
2. Listen
3. Listen
4. Understand what is said
5. Confirm understanding
6. Investigate existing conditions
7. Verify through calculations structural elements



EPDM: The Resilient Roof

LESSONS LEARNED

8. Realize and communicate to the client that:
 - Sustainability is all about Long Term Service Life
 - Resiliency takes good design thought with the knowledge that sustainability is all about Long Term Service Life.



EPDM: The Resilient Roof

LESSONS LEARNED

9. Design:

- a. Think holistically
- b. Thick constructability
 - i. If you do not have this skill, get out in the field and observe
- c. Drawings should be:
 - i. Extensive to clearly delineate all requirements
 - ii. Project Specific; not manufacturer details
 - iii. Detail, Detail, Detail
 - a) Leave nothing for the contractor to decide



EPDM: The Resilient Roof

LESSONS LEARNED

10. Construction Verification

- a. Realize unknowns will appear – be flexible
- b. If BAAAD -- Tear it out

11. Remember you are part of a Team



EPDM: The Resilient Roof

LESSONS LEARNED

12. LOVE WHAT YOU DO!!



www.EPDMtheResilientRoof.com

www.epdmroofs.org



Questions?

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