



# RETROFIT ROOF SYSTEMS, 1 LU/HSW HOUR

Prepared and presented by MBCI



## BEST PRACTICE SLIDE

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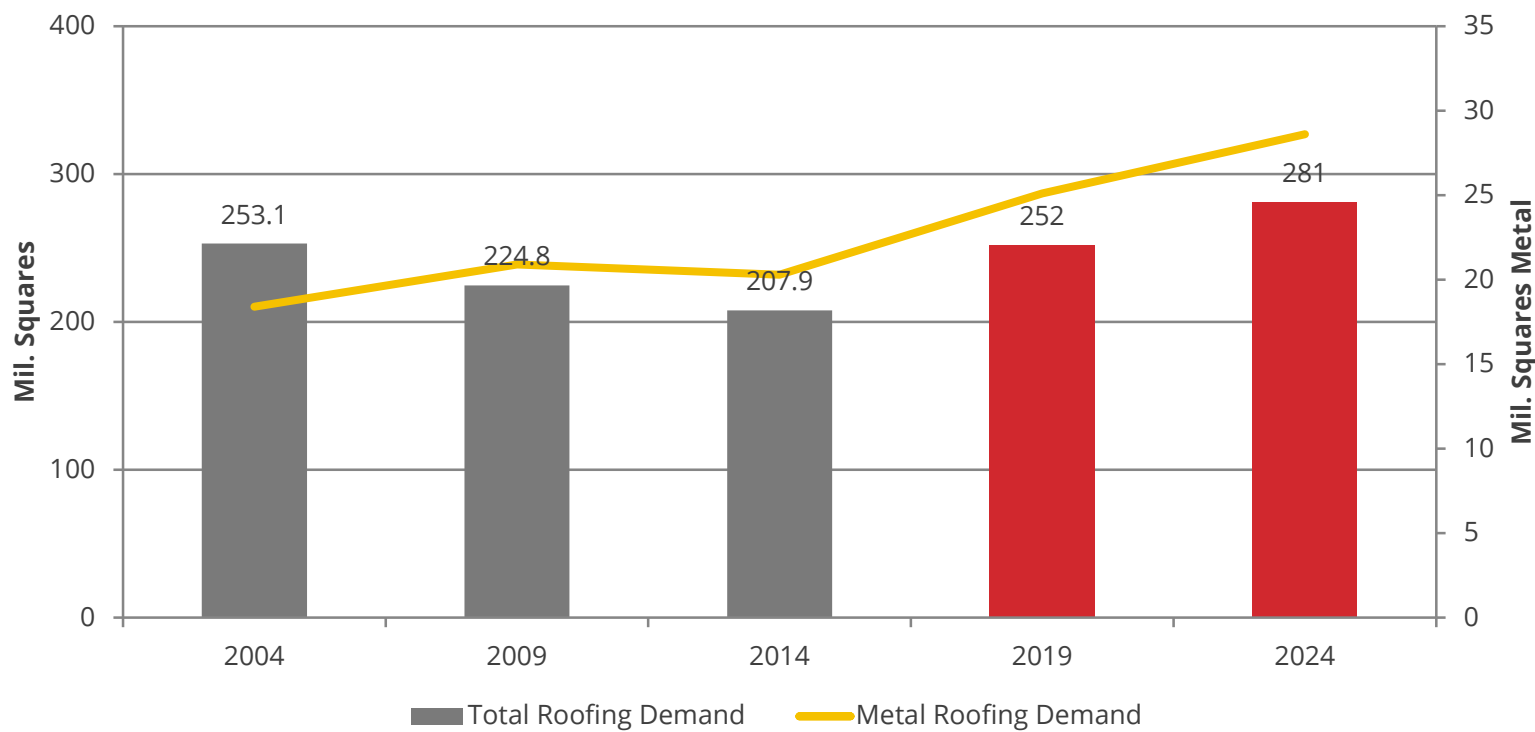
# LEARNING OBJECTIVES

Define and better understand:

- Market demands
- Benefits
- Various applications for retrofit roof systems
- Framing fundamentals
- Project considerations
- Assessing the existing roof
- Design considerations

# OVERALL ROOFING MARKET NEW CONSTRUCTION

**Expected Growth in Metal Roofing Demand**  
**Projected 2019 Market Size: 252 mil. squares**

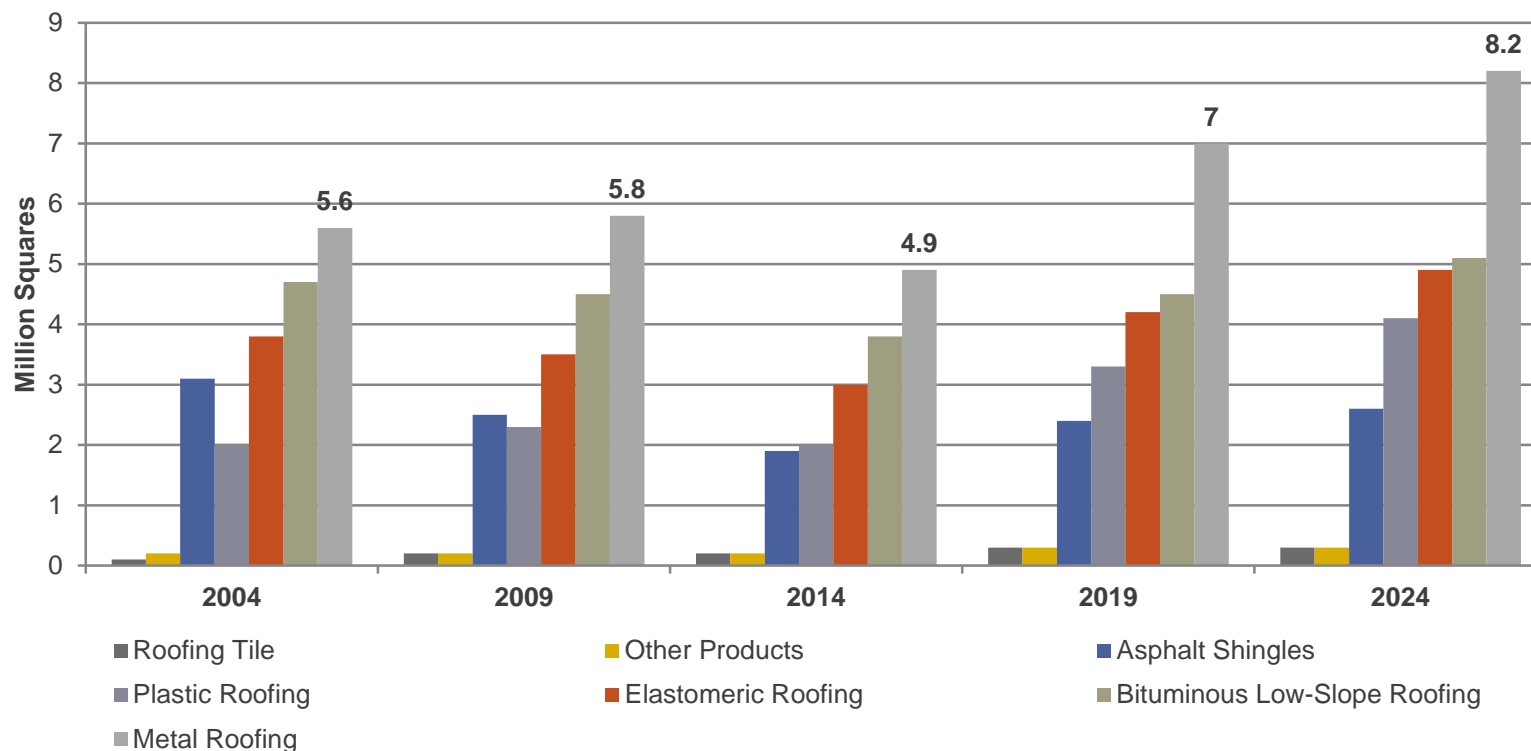


Source: 2015 Freedonia Roofing Report  
All data is in squares.

# OVERALL ROOFING MARKET

## NEW CONSTRUCTION

### New Nonresidential Roofing Demand by Product (million squares)

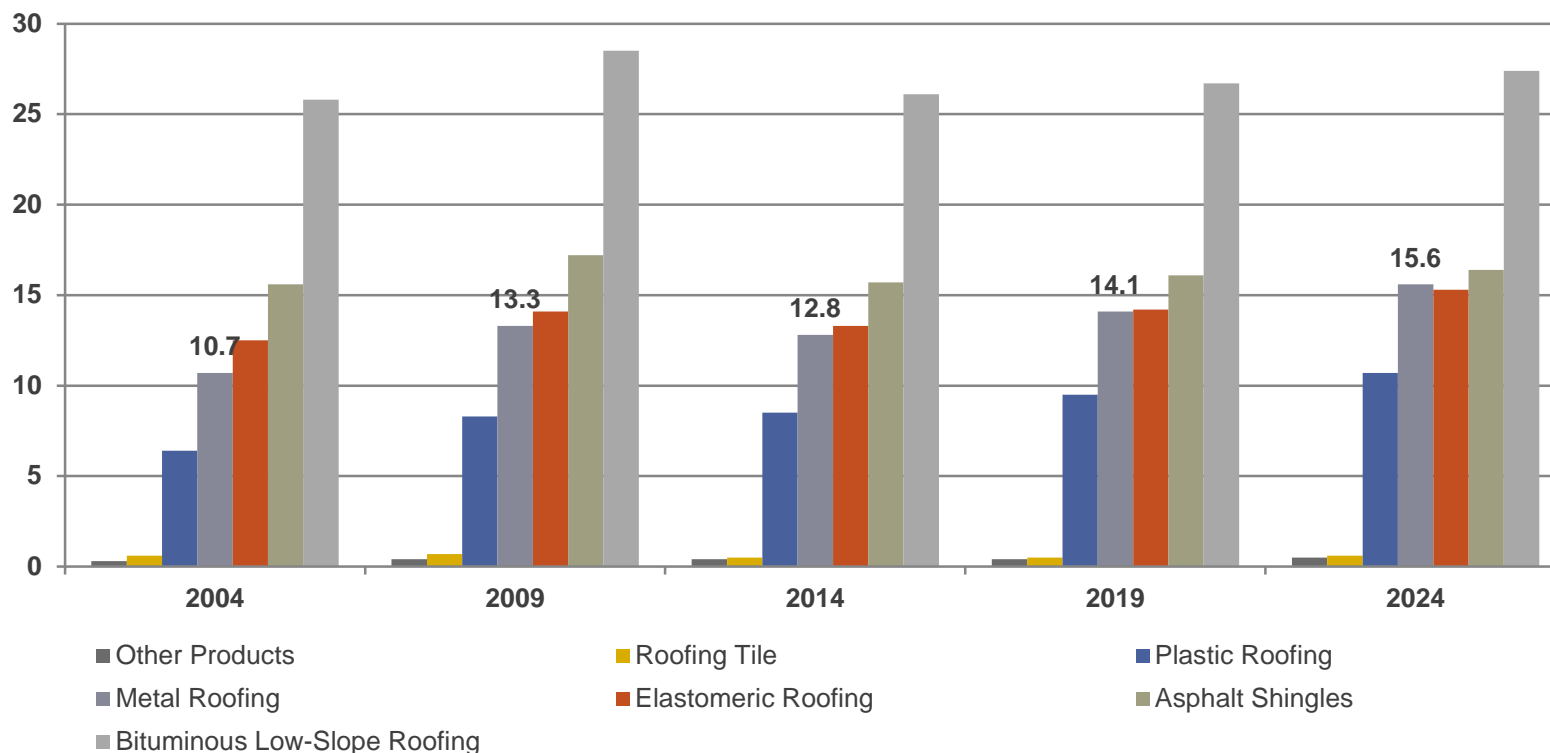


Source: 2015 Freedonia Roofing Report  
All data is in squares.

# OVERALL ROOFING MARKET

## REROOFING CONSTRUCTION

### Nonresidential Reroofing Demand by Product (million squares)



Source: 2015 Freedonia Roofing Report  
All data is in squares.

# WHAT IS RETROFIT?

Relative to the metal construction industry, the term means complete, fully-engineered structural roof systems used for:

- adding slope to existing buildings with flat or nearly flat roofs
- correcting problematic roof geometry
- reroofing over existing sloped roofs
- extending the life expectancy of a roofing system

# WHAT IS RETROFIT?

The systems include light-gauge support framing with metal roof/wall cladding





**BENEFITS OF RETROFITTING**

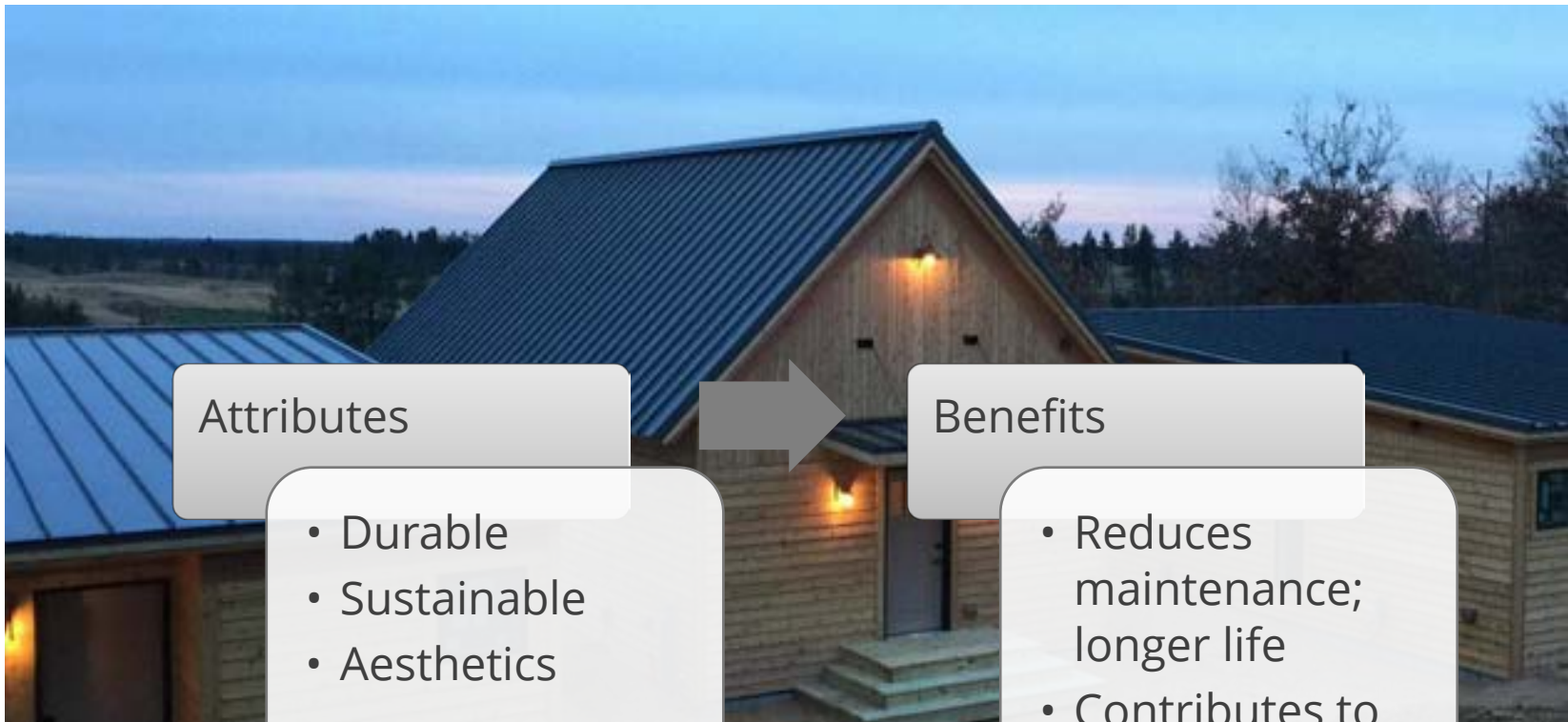
# **WHY RETROFIT WITH METAL?**

# WHEN TO RETROFIT

- Replace leaking roof
- Structural changes
- Correcting roof geometry
- Provide thermal upgrades
- Regulation/code requirements
- Aesthetics
- Adding Solar Power
- New building construction



# METAL ROOFING BENEFITS



## Attributes

- Durable
- Sustainable
- Aesthetics



## Benefits

- Reduces maintenance; longer life
- Contributes to LEED points
- Increases property value

# METAL ROOFING BENEFITS



## Attributes

- Available in cool colors
- Virtually 100% recyclable
- Long service life

## Benefits

- Reduces heat island effect
- Reduces land fill waste
- Life cycle performance

# METAL ROOFING BENEFITS

Each year, an estimated 9 to 10 million tons of asphalt roofing waste goes to U.S. landfills, costing more than \$400 million on disposal fees\*

A metal roofing retrofit eliminates the need to tear off the existing roof in most cases



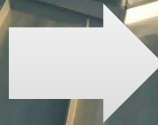
\*Source: Corps of Engineers 2007

# METAL ROOFING BENEFITS OVER SINGLE PLY



## Features

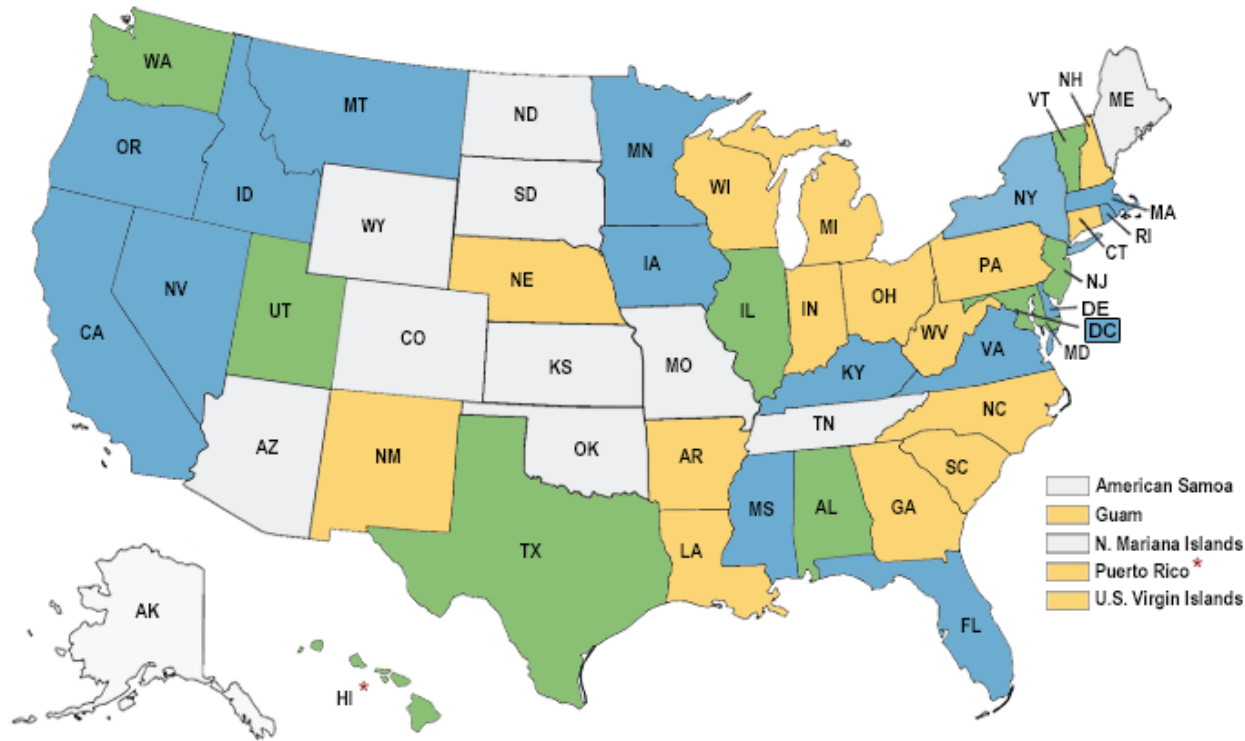
- Life expectancy
- Maintenance



## Benefits

- 41.6 vs. 20.5 years
- \$0.10 vs. \$0.26/ft<sup>2</sup>/yr

# IMPROVING OUR ENERGY EFFICIENCY



<b>9</b> ASHRAE 90.1-2013/2015 IECC, equivalent, or more energy efficient	<b>16</b> ASHRAE 90.1 - 2010/2012 IECC, equivalent, or more energy efficient	<b>18</b> ASHRAE 90.1 - 2007/2009 IECC, equivalent, or more energy efficient
<b>13</b> Older or less energy efficient than ASHRAE 90.1 - 2007/2009 IECC, or no statewide code.		

\* Adopted new Code to be effective at a later date

As of September 2016

# INITIAL COST VS. ENERGY & MAINTENANCE SAVINGS

High School

Winchester, Ind.

108,000 Square Feet

6" Insulated Attic

Ventilated

Existing Roof = BUR  
(asphalt)





# LOW-SLOPE, HIGH-SLOPE, GEOMETRY ISSUES AND METAL ROOFOVERS

## RETROFIT APPLICATIONS



# LOW-SLOPE

Typically driven by economy

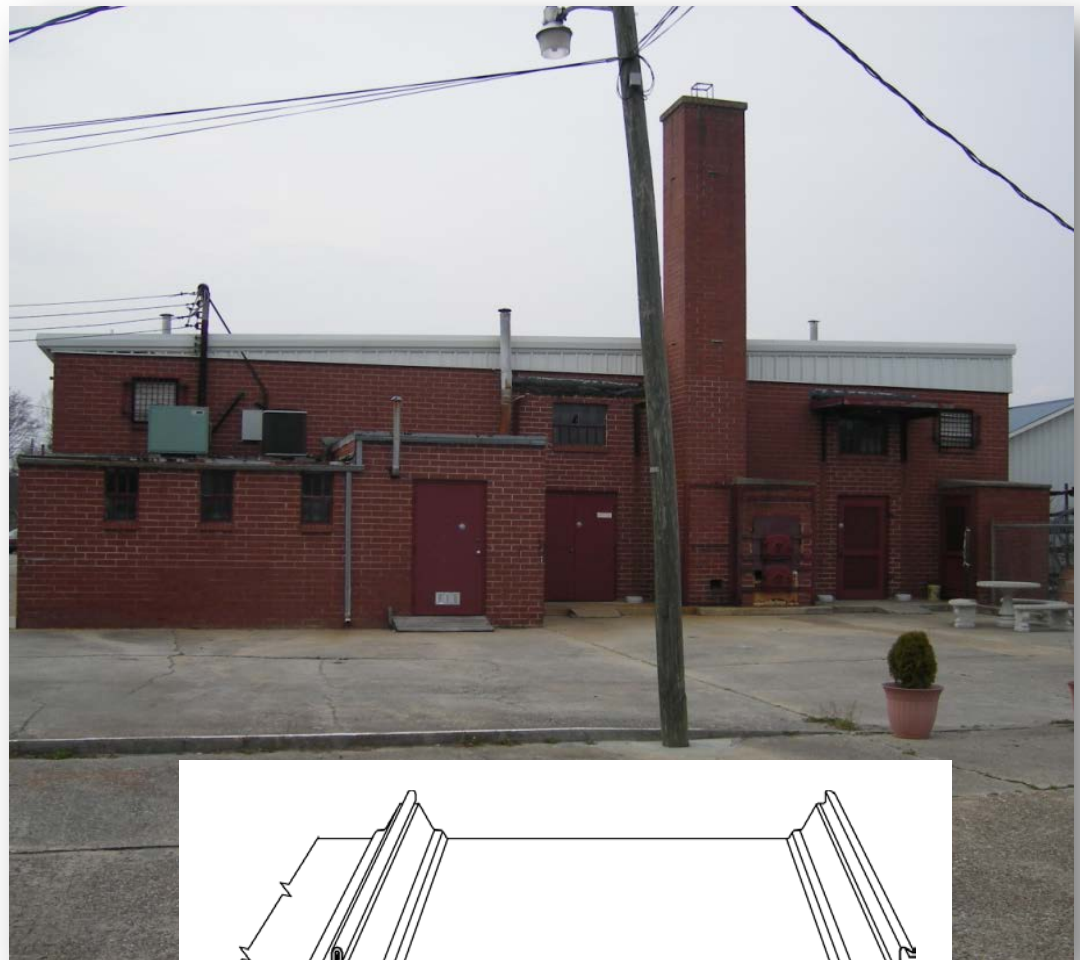
Designed to simply discharge rainwater

Does not really improve the “curb appeal” of the existing building

Roof slopes from  $\frac{1}{4}$  to 2:12

Common metal roof system is:

- Trapezoidal Standing Seam



## HIGH-SLOPE

Employed as a design element to beautify existing or during additions upgraded to match new construction

Roof slopes typically above 2:12



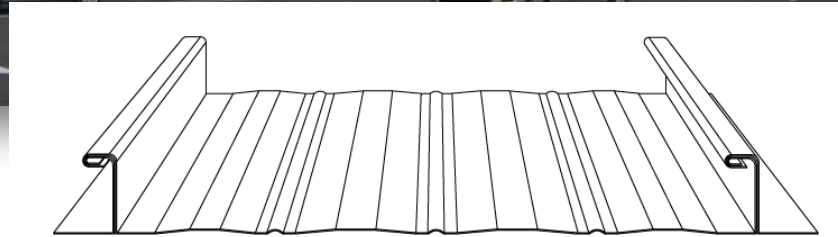
# HIGH-SLOPE

Embraced by schools and government for over two decades

Ideal for Cool Roof rated metal roof

Recommended metal roof system is:

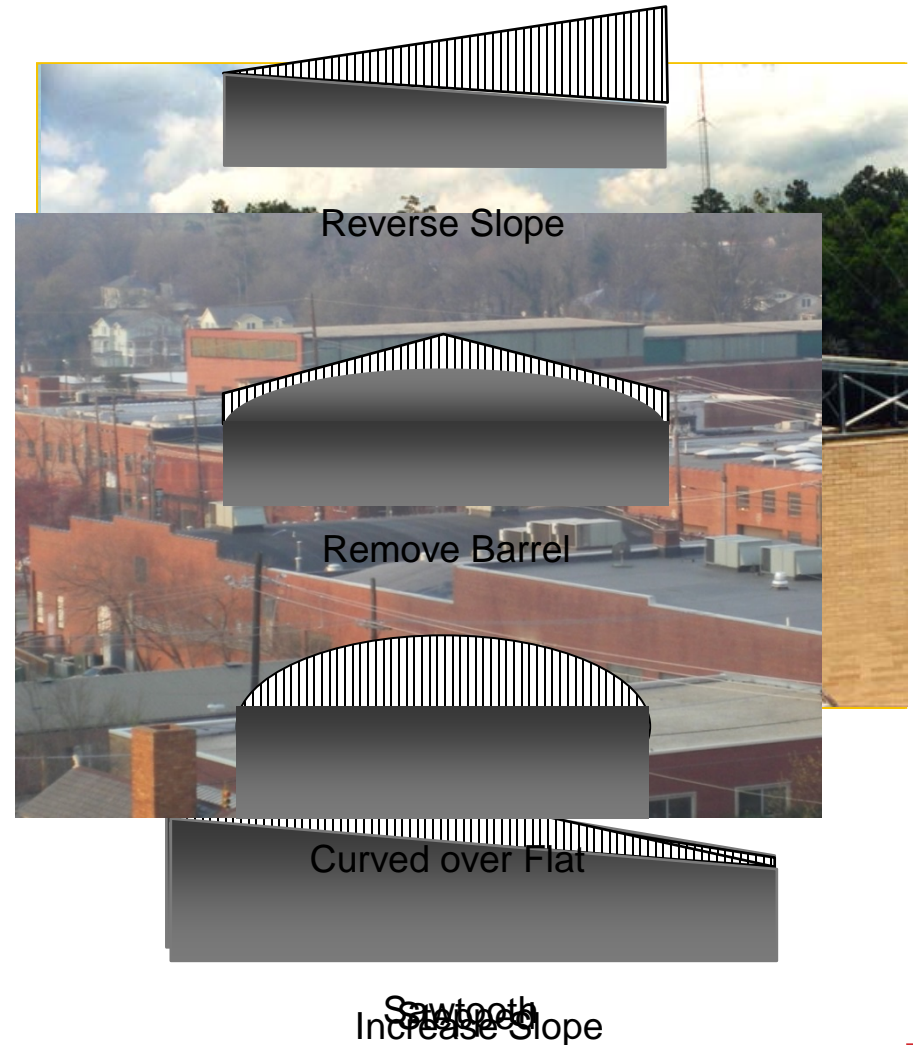
- Vertical Rib Standing Seam



# PROBLEMATIC ROOF CONDITIONS

Retrofit systems can be employed to:

- Correct undesirable issues with discharging rainwater
- Correct roof geometry Issues
  - Fill-ins and Crickets
  - Multi-Gable or Stepped
  - Increase Slope
  - Reverse Slope
  - Remove Barrel



# REROOFING OVER SLOPED ROOFS

When existing roof is replaced with a new long-term performance standing seam metal roof system (~40 yr)

- Metal over metal
- Metal over composition and other conventional membranes
- Wind Load and FM upgrades



**COMPONENTS, DESIGN AND LAYOUT**

# **FRAMING FUNDAMENTALS**



# BASE MEMBERS



Base Shoe



Angle Clip



Continuous Base



# COLUMNS

Typically cee-shaped

Sizes vary from 4" to 8"

Usually field cut from standard lengths

Also referred to as post or stanchion



Column

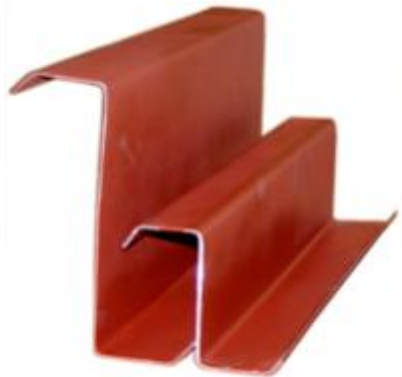
# PURLINS

Spaced to support roof membrane

Typically zee-shaped

Sizes vary from 3½" to 10"

Field cut or detailed to required lengths



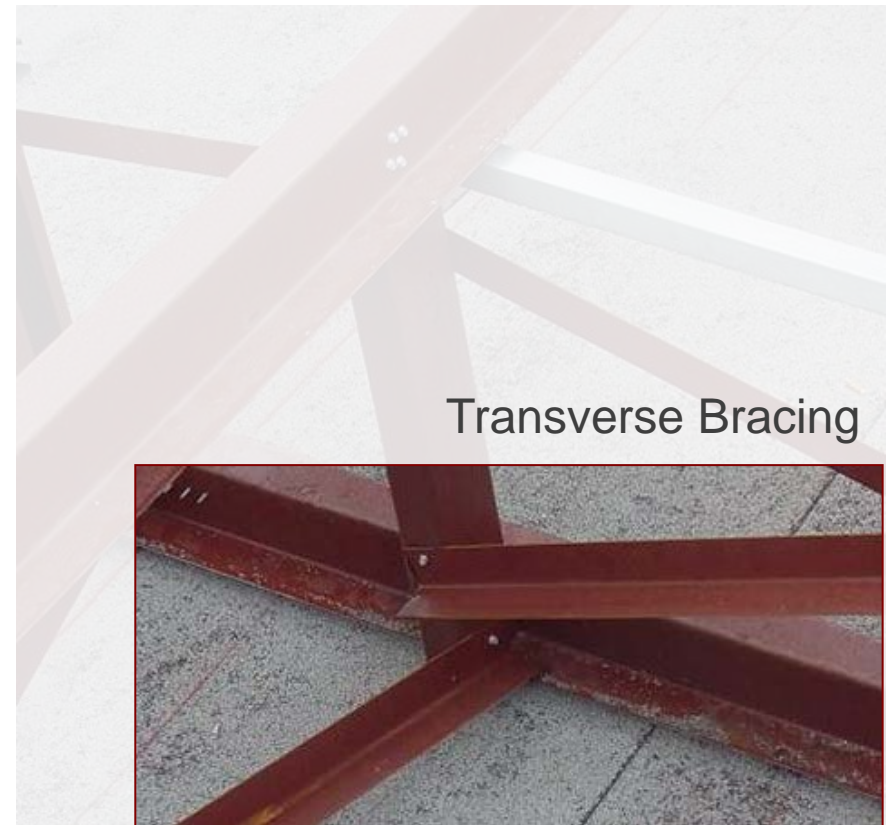
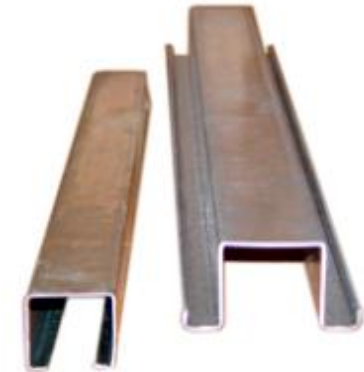
Purlin

# BRACING

Common members include:

Struts

- Transverse and Horizontal Vertical Bracing
- Diagonal Transverse and Longitudinal



Longitudinal Bracing

# COMMON EXISTING ROOF ASSEMBLIES

## Wood framed

- Dimensional lumber
- Glue-laminated
- Heavy timber

## Structural concrete

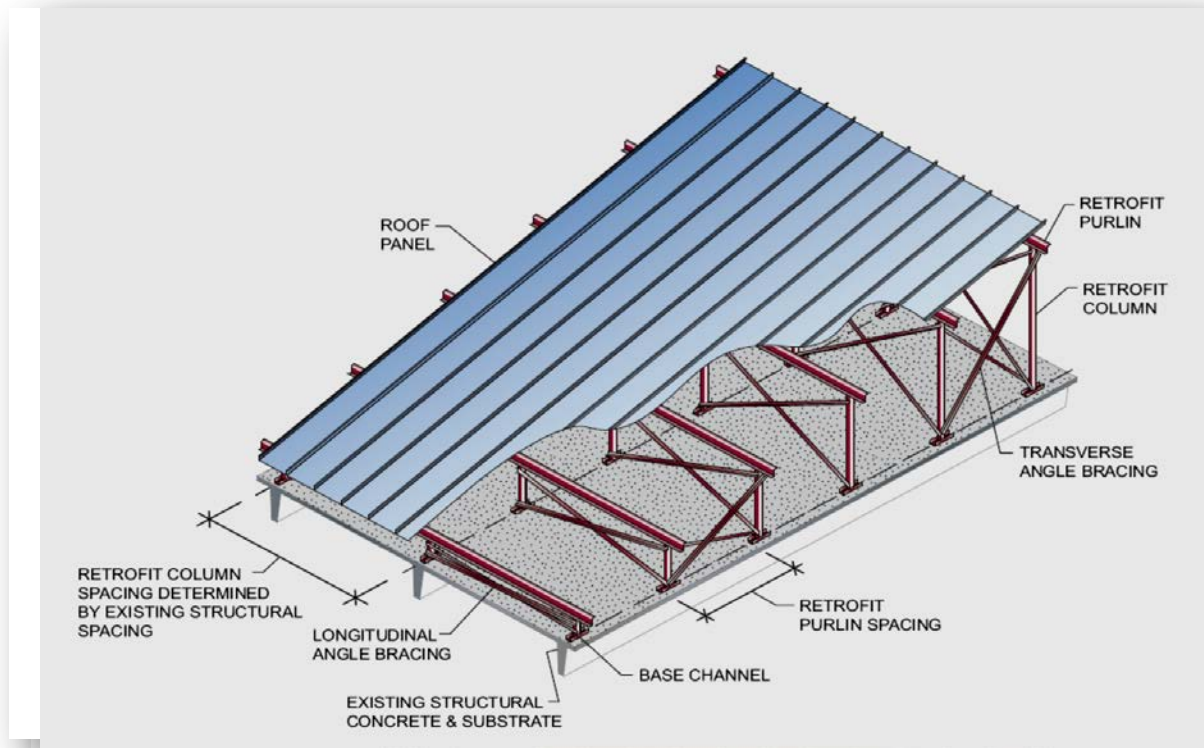
- Steel Beam and Deck
- Concrete Beam supported
- Concrete tee

## Steel framed

- Beam and metal deck
- Open-web joist and metal deck
- Bulb tee over joist with noise control solution
- Metal building systems
  - Purlin
  - Open-web joist

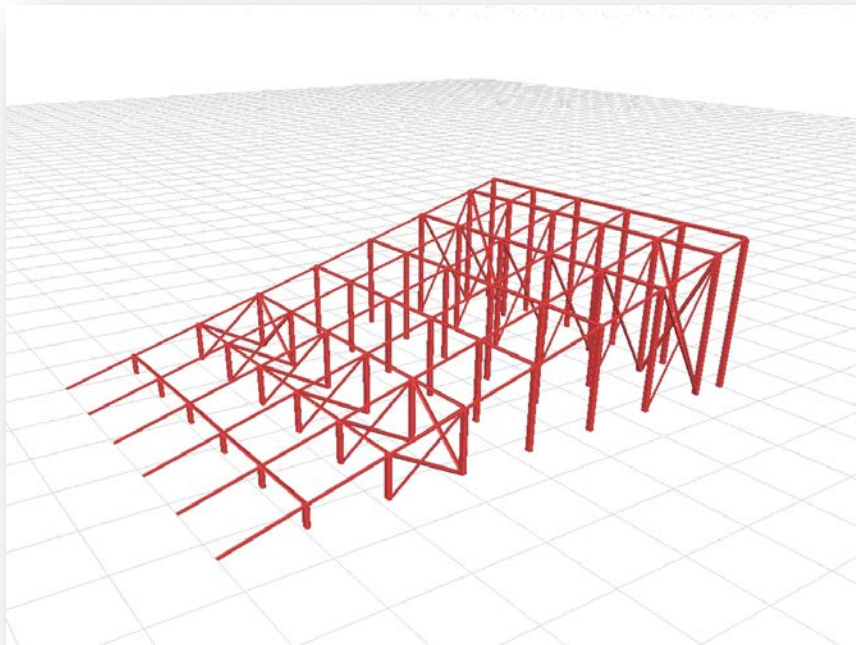
# FRAMING SYSTEM ADAPTABILITY

Systems can be designed to adapt to various existing roof assemblies and support systems



Concrete  
Wood

# UNDERSTANDING ROOF GRIDS



Most constructed using a primary and secondary structural grid layout, regardless of the support method or type of system employed

Retrofit framing systems employ a structural grid that imposes a series of concentrated point loads into the existing roof system

These two grid systems must be compatible to ensure the existing roof's structural integrity is maintained

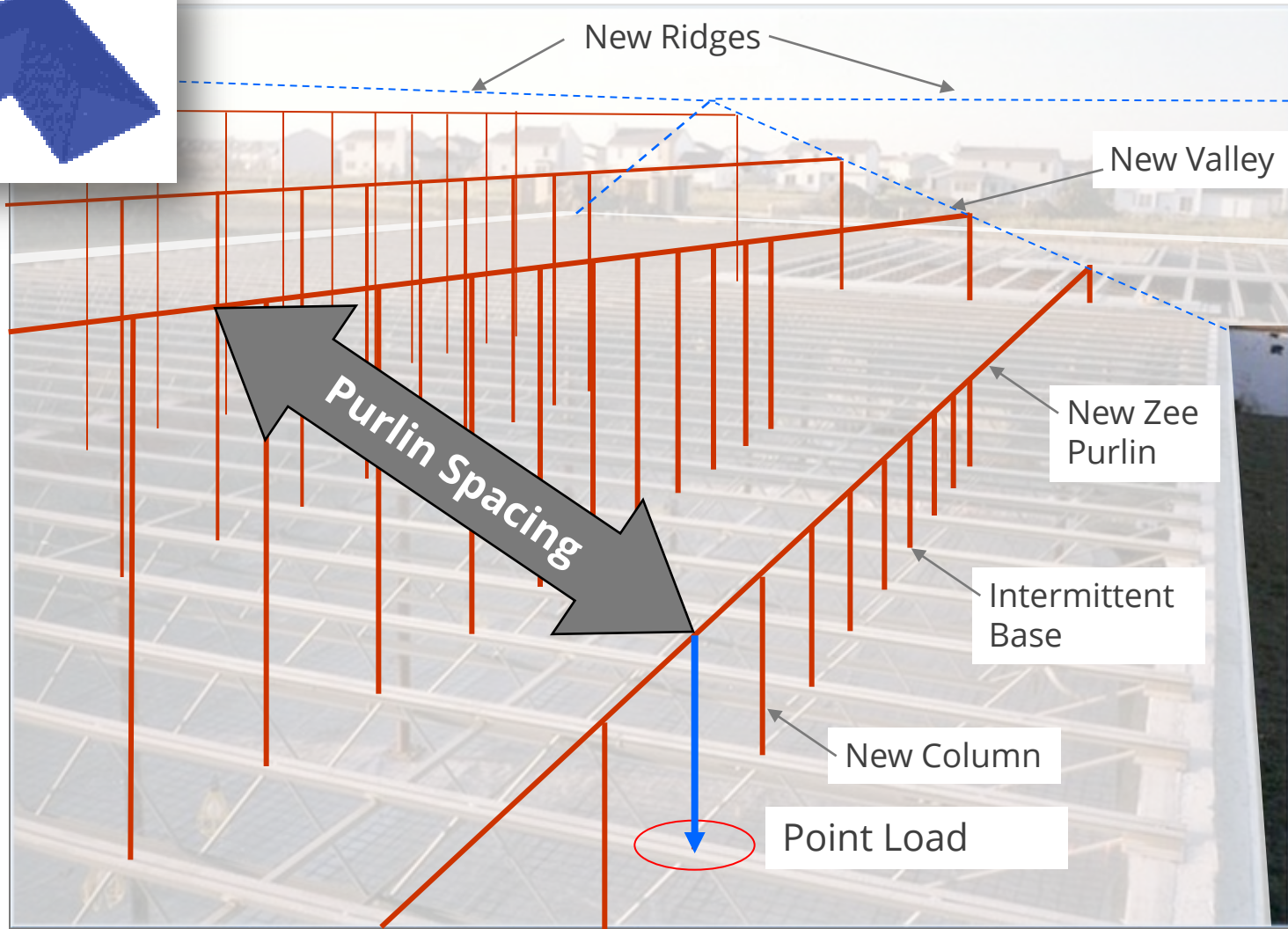
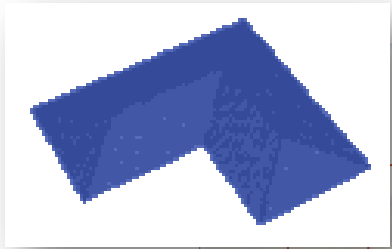
## PARALLEL FRAMING

- Base shoe or channel
- Usually field drilled for anchor installation
- Width varies based on column width

The type of base member is dictated by the existing roof's secondary structural span and orientation.



# PARALLEL FRAMING EXAMPLE





# PERPENDICULAR FRAMING

- Continuous Zee
- Usually field drilled for anchor installation
- Continuous base member spacing dictated by purlin spacing of new roof

The type of base member is dictated by the existing roof's secondary structural span and orientation.



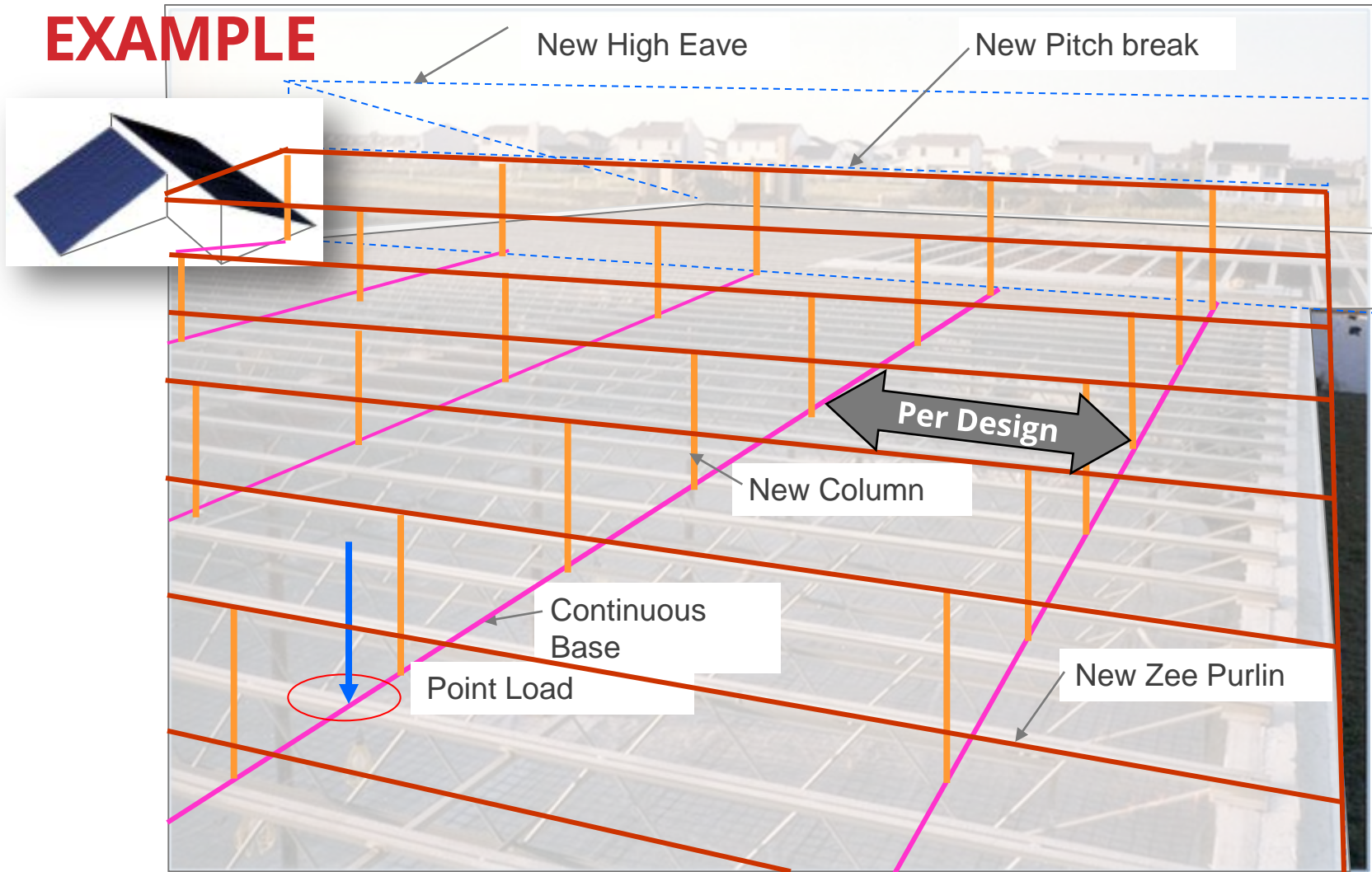
## ANCHORAGE INSTALLATION TIP

To reduce moisture penetration caused by anchors:

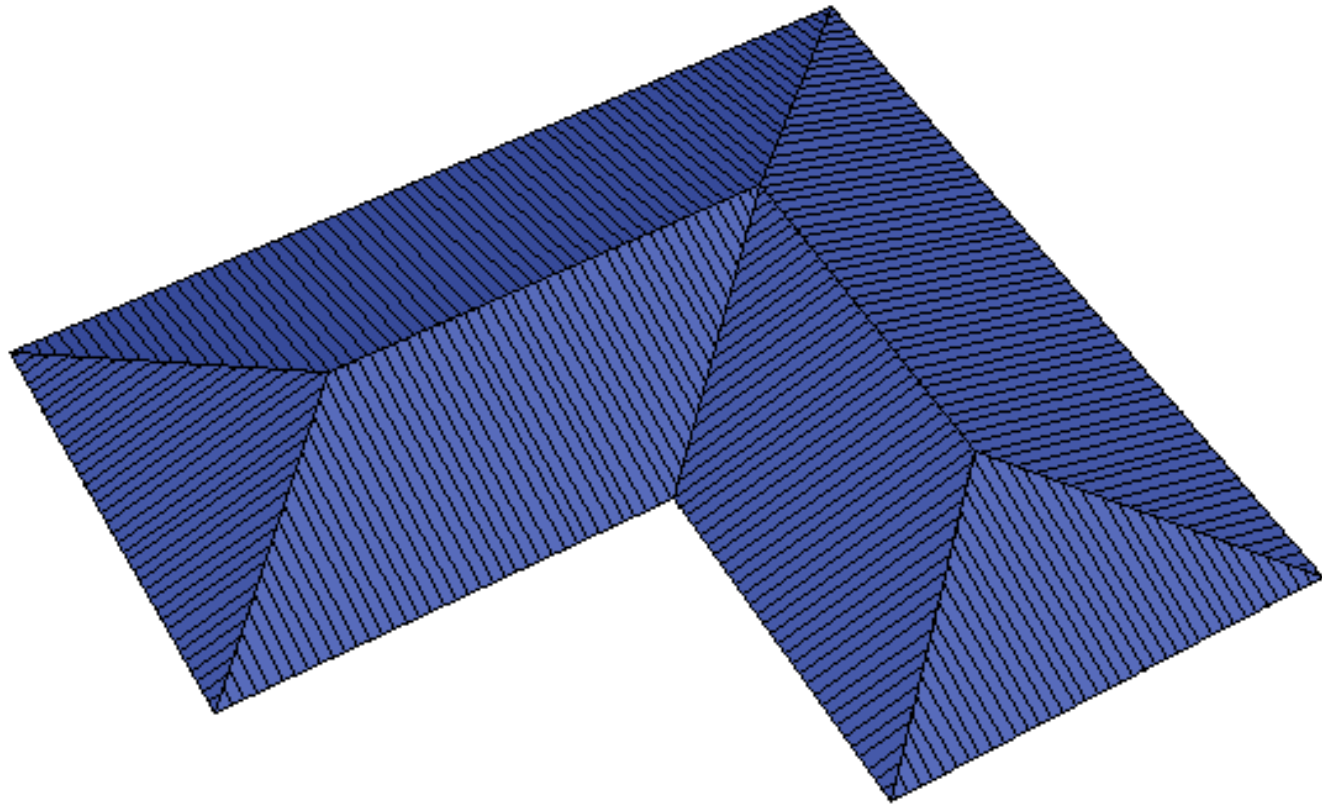
- Specify shims to elevate continuous base members so not to obstruct the existing drainage system
- Require all anchorage penetrations to be sealed with compatible sealant



# PERPENDICULAR FRAMING EXAMPLE

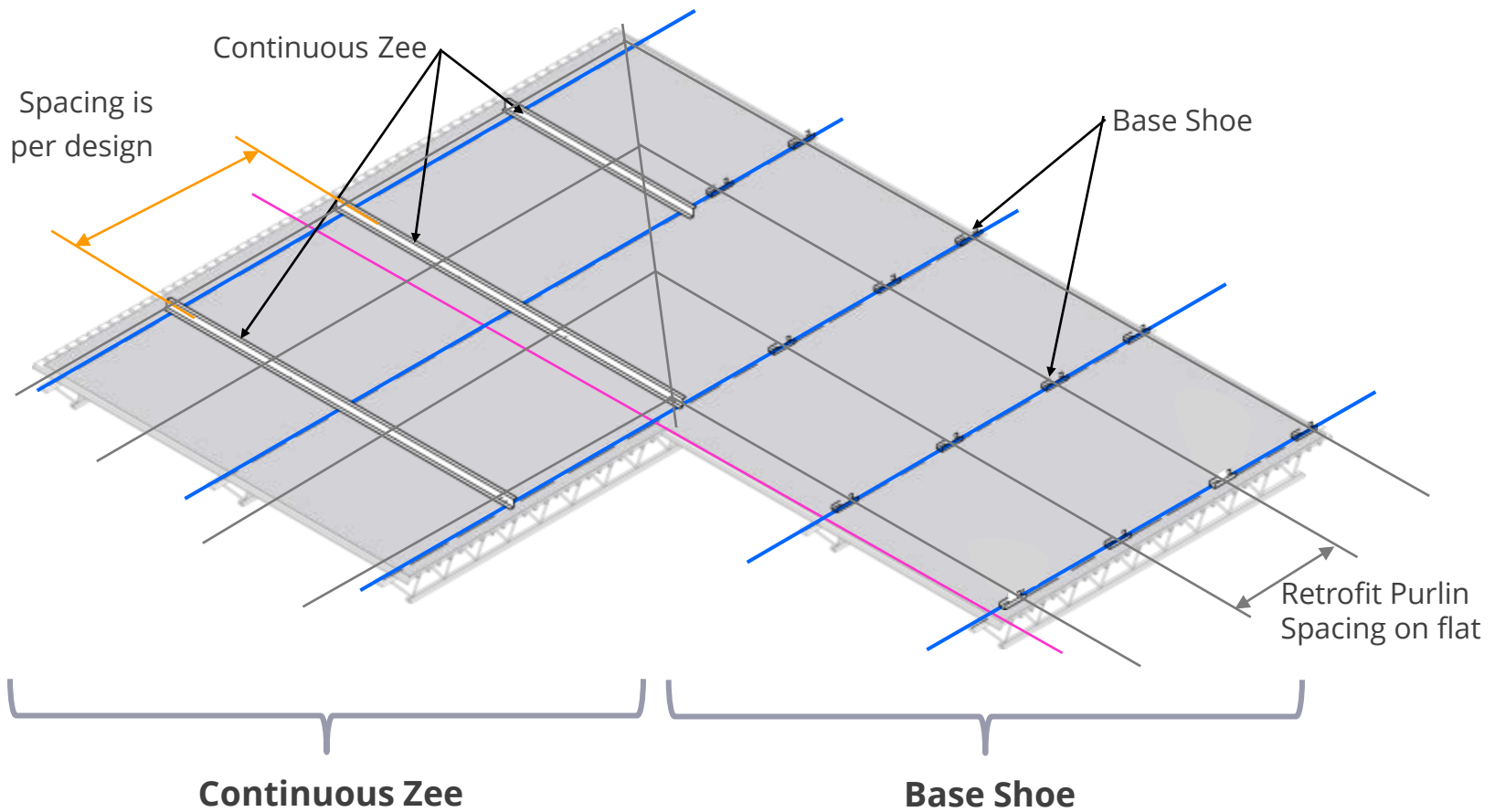


# FRAMING DESIGN



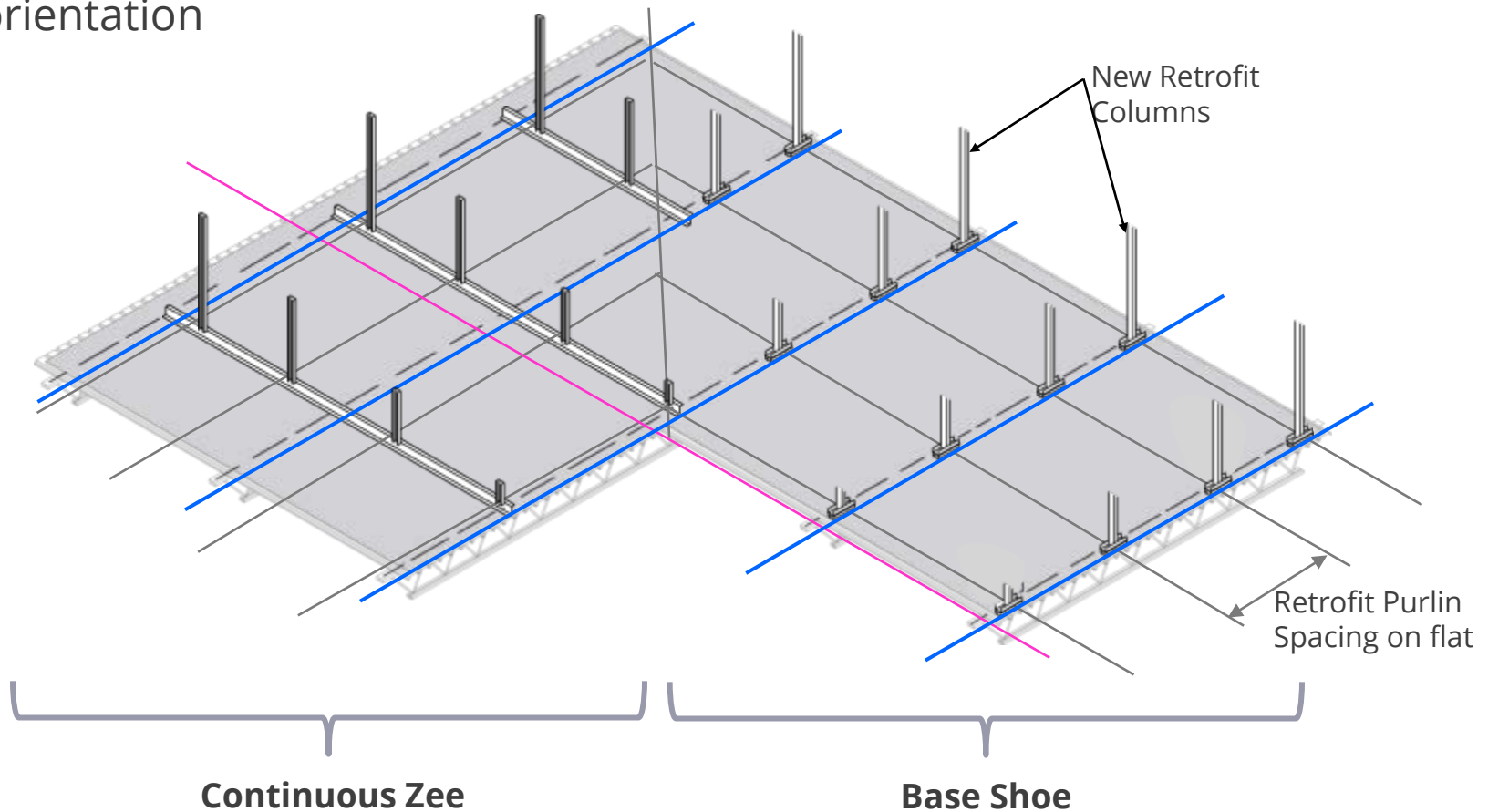
# LOAD DISTRIBUTION: BASE MEMBERS

Example shows both *continuous zee* and *base shoe* framing systems



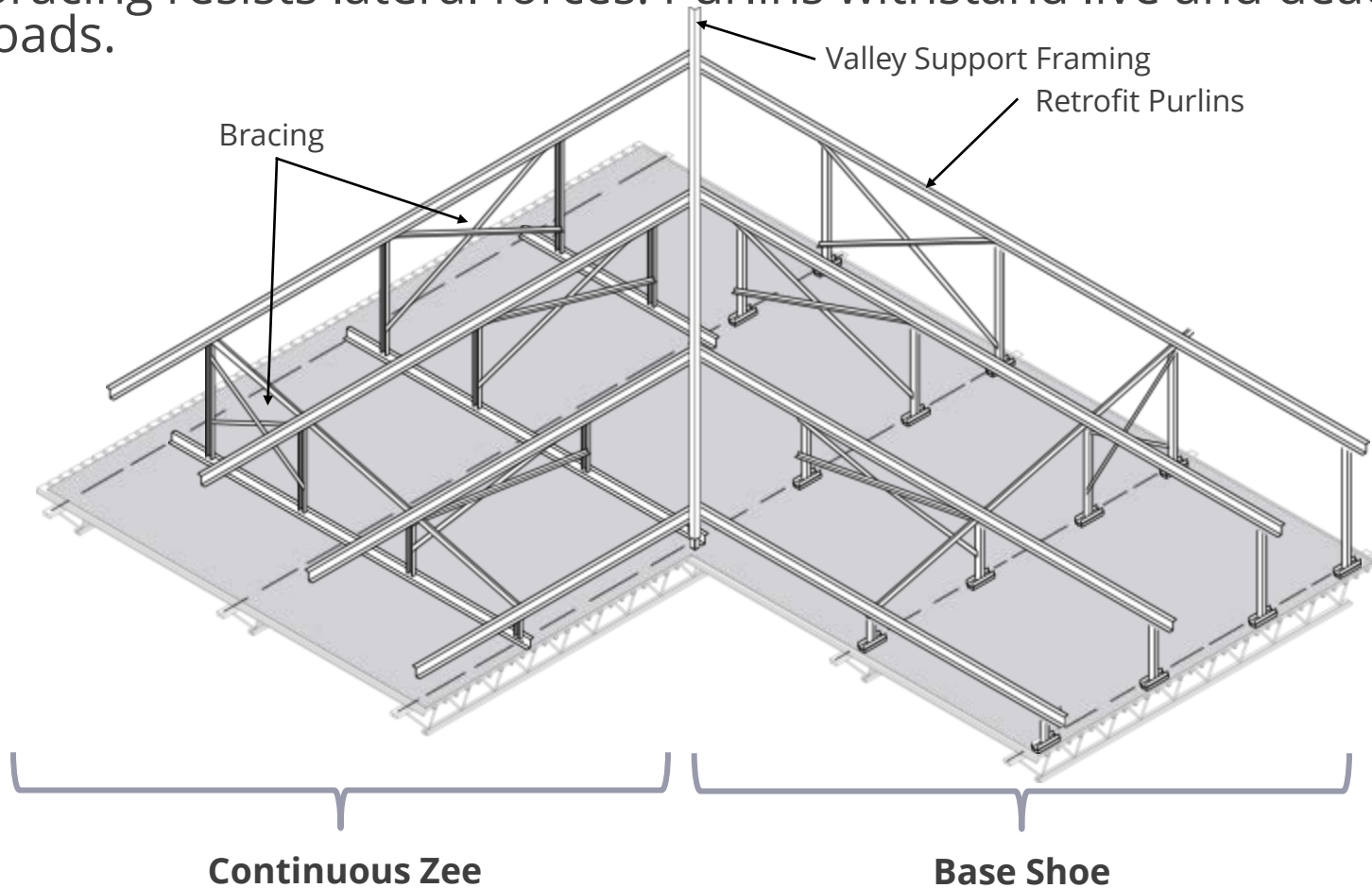
# LOAD DISTRIBUTION: VERTICAL FRAMING

Spacing is dictated by the existing roofs secondary spacing and span orientation



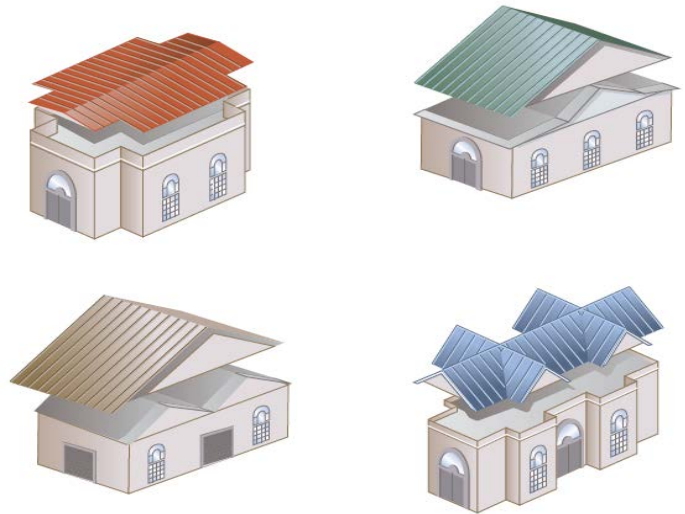
# LOAD DISTRIBUTION: BRACING AND PURLINS

Bracing resists lateral forces. Purlins withstand live and dead loads.



# REMEMBER:

The existing roof's physical footprint and other rooftop conditions will more than likely control the new roof's geometry.





# **ASSESSING THE EXISTING ROOF**

# PROJECT SCOPE CONSIDERATIONS

Define and Provide Existing Roof Plan

- Perimeter Conditions
- Rooftop Obstructions
- Roof Support System
- Substrate Assembly

Define and Provide New Roof Plan

- Ventilation System
- Insulation
- New Roof System

Perform pre-bid design analysis and testing

Partner with a manufacturer for expertise



# TESTING AND INSPECTION RESPONSIBILITY

The owner or design professional is accountable for the inspection and testing of the existing structure and for providing this information to the manufacturer.

Open-web Steel Joist Descriptive Data	Series					
	SJ, S J, H or K		L, LA, LJ or LH		Deep Span <sup>1</sup> DLJ or DLH	
	Vintage	Depths	Vintage	Depth	Vintage	Depth
Manufacture Date and Overall Depth	1930 – 1952 1952 – 1972 1972 - 1988	8" – 16" 8" – 24" 8" – 30"	1953 - 1988	18", 20", 24", 28", 32", 36", 40", 44" and 48"	1970 - 1988	52" – 72" in 4" increments
Standard End Bearing Depth	2½"		5"		5" for chords 10–17 7½" for chords 18–20	
Web Type	Round Bar		Angle		Angle	
Bridging Type	Horizontal or X-type		Horizontal or X-type		X-type	
Chord Geometry	Parallel Chords		Parallel or Single/Double Pitched		Parallel or Single/Double Pitched	
Chord Sizes and Type	Chord #	Chord Size				
	1	¾ x ¾ x ¼ or 1 x 1 x ¼				
	2	1 x 1 x ¼				
	3	1¼" x 1¼" x ¼				
	4	1½" x 1½" x ¼				
	5	1½ x 1½ x 7/32 or 1¼ x 1¼ x ¼				
	6	1½ x 1½ x 7/16				
	7	1¾ x 1¾ x 7/16				
	8	2 x 2 x 7/16 or 2 x 1 ½ x 7/16				
	9	2 x 2 x 3/16				
	10	2 x 1½ x ¼ or 2½ x 2 x 3/16				
11	2 x 2 x ¼					
Chord Hole Gage <sup>2</sup> (inches)	Chord #	Hole Gage				
	1	1½ - 1¾				
	2	1½				
	3	1¾				
	4	2½				
	5	2¼ - 2½				
	6	2¼				
	7	2½				
	8	2½				
	9	3				
	10	3 - 3½				
11	Varies					
Refer to SJI website or manual for specific information on these series of joists						

# EXISTING ROOF INFORMATION

## Detail

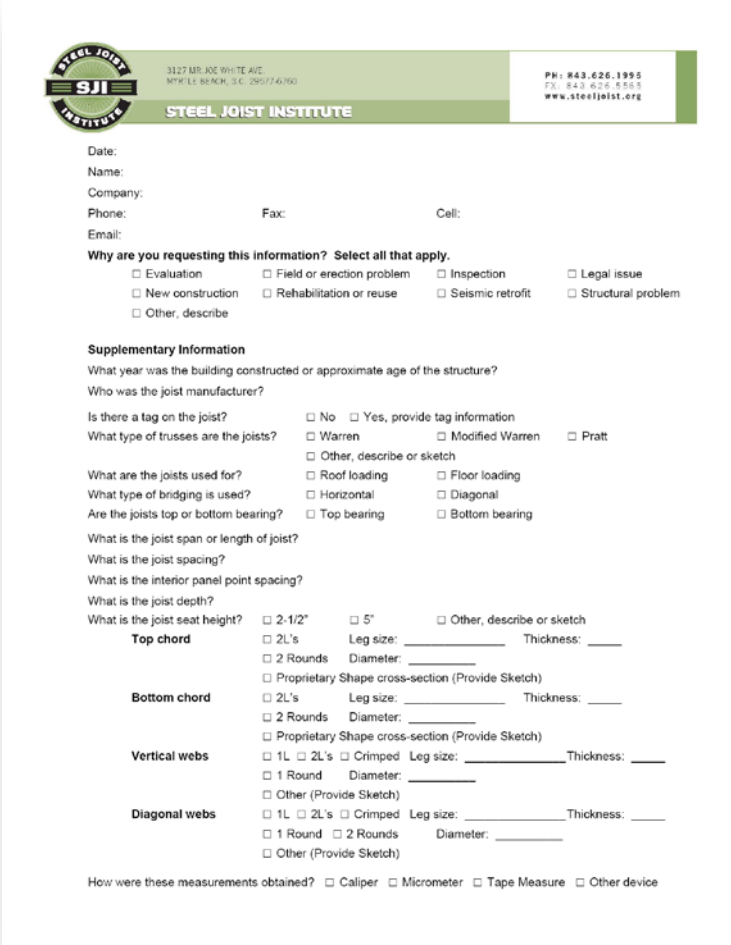
- Existing roof footprint
- Expansion joints
- Roof perimeter construction such as gravel stops and parapets
- Interior firewalls
- Existing drainage systems

Existing Roof Perimeter Condition (provide all that apply)				
<input type="checkbox"/> Not Applicable	<b>Gravel Stop</b>			
	Field Dimensions			
	"A"	"B" (if zero, write "0")		
	Will gravel stop be removed? <input type="checkbox"/> Yes <input type="checkbox"/> No If not, are we to conceal it with flashing? <input type="checkbox"/> Yes <input type="checkbox"/> No			
<input type="checkbox"/> Not Applicable	<b>Parapet Wall Condition</b>			
Coping Profile:				
<input type="checkbox"/> = As Shown				
<input type="checkbox"/> =				
<input type="checkbox"/> =				
<input type="checkbox"/> = Other (provide sketch)				
Field Dimensions				
"A"	"B"	"C"	"D"	"E"
Is this a structural load-bearing parapet? <input type="checkbox"/> Yes <input type="checkbox"/> No Please Note: Certain copings may not be suitable for framing attachment.				
Will parapet cap be removed? <input type="checkbox"/> Yes <input type="checkbox"/> No If not, are we to conceal it with flashing? <input type="checkbox"/> Yes <input type="checkbox"/> No				

# INSPECT THE EXISTING ROOF SYSTEM

For existing joists and their support identify:

- Type
- Size
- Spacing
- Span orientation



The image shows a form from the Steel Joist Institute for inspecting existing roof systems. The form includes contact information for the institute, a header with the SJI logo, and various sections for data entry. The sections include: Date, Name, Company, Phone, Fax, Cell, Email; a section for the reason for inspection with checkboxes for Evaluation, Field or erection problem, Inspection, Legal issue, New construction, Rehabilitation or reuse, Seismic retrofit, Structural problem, and Other; a Supplementary Information section with questions about building age, joist manufacturer, truss types, joist uses, bridging, bearing, span, spacing, and depth; and detailed sections for Top chord, Bottom chord, Vertical webs, and Diagonal webs, each with checkboxes for different materials and sizes and fields for leg size, diameter, and thickness. It also includes a question about how measurements were obtained.

**STEEL JOIST INSTITUTE**  
3127 MS. JCE WHITE AVE.  
MYRTLE BEACH, S.C. 29577-6700  
PH: 843.626.1995  
TX: 843.626.1555  
www.steeljoist.org

Date: \_\_\_\_\_  
Name: \_\_\_\_\_  
Company: \_\_\_\_\_  
Phone: \_\_\_\_\_ Fax: \_\_\_\_\_ Cell: \_\_\_\_\_  
Email: \_\_\_\_\_

**Why are you requesting this information? Select all that apply.**

Evaluation  Field or erection problem  Inspection  Legal issue  
 New construction  Rehabilitation or reuse  Seismic retrofit  Structural problem  
 Other, describe \_\_\_\_\_

**Supplementary Information**

What year was the building constructed or approximate age of the structure?  
Who was the joist manufacturer?  
Is there a tag on the joist?  No  Yes, provide tag information  
What type of trusses are the joists?  Warren  Modified Warren  Pratt  
 Other, describe or sketch \_\_\_\_\_  
What are the joists used for?  Roof loading  Floor loading  
What type of bridging is used?  Horizontal  Diagonal  
Are the joists top or bottom bearing?  Top bearing  Bottom bearing  
What is the joist span or length of joist?  
What is the joist spacing?  
What is the interior panel point spacing?  
What is the joist depth?  
What is the joist seat height?  2-1/2"  5"  Other, describe or sketch \_\_\_\_\_

**Top chord**  
 2L's Leg size: \_\_\_\_\_ Thickness: \_\_\_\_\_  
 2 Rounds Diameter: \_\_\_\_\_  
 Proprietary Shape cross-section (Provide Sketch)

**Bottom chord**  
 2L's Leg size: \_\_\_\_\_ Thickness: \_\_\_\_\_  
 2 Rounds Diameter: \_\_\_\_\_  
 Proprietary Shape cross-section (Provide Sketch)

**Vertical webs**  
 1L  2L's  Crimped Leg size: \_\_\_\_\_ Thickness: \_\_\_\_\_  
 1 Round Diameter: \_\_\_\_\_  
 Other (Provide Sketch)

**Diagonal webs**  
 1L  2L's  Crimped Leg size: \_\_\_\_\_ Thickness: \_\_\_\_\_  
 1 Round  2 Rounds Diameter: \_\_\_\_\_  
 Other (Provide Sketch)

How were these measurements obtained?  Caliper  Micrometer  Tape Measure  Other device

# INSPECT THE EXISTING ROOF SYSTEM

Determine all collateral loads on the exterior and interior of the existing building:

- HVAC
- Electrical
- Plumbing
- Ceilings
- Sprinkler, etc.

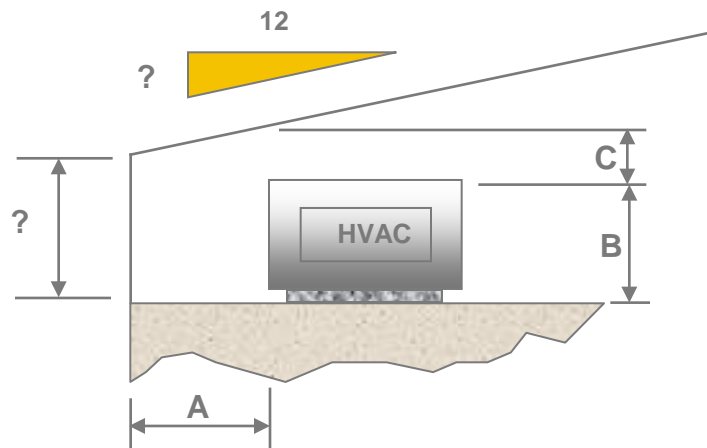


# INSPECT THE EXISTING ROOF SYSTEM

Locate Rooftop Equipment

- Electrical
- HVAC locations
- Plumbing

Document



# INSPECT THE EXISTING ROOF SYSTEM

Evaluate existing substrate for:

- Trapped moisture
- Deterioration
- Presence of harmful material (i.e. asbestos)





# INSPECT THE EXISTING ROOF SYSTEM

Conduct pull-out testing so anchorage requirements can be determined.



# COMPRESSIVE RESISTANCE TEST



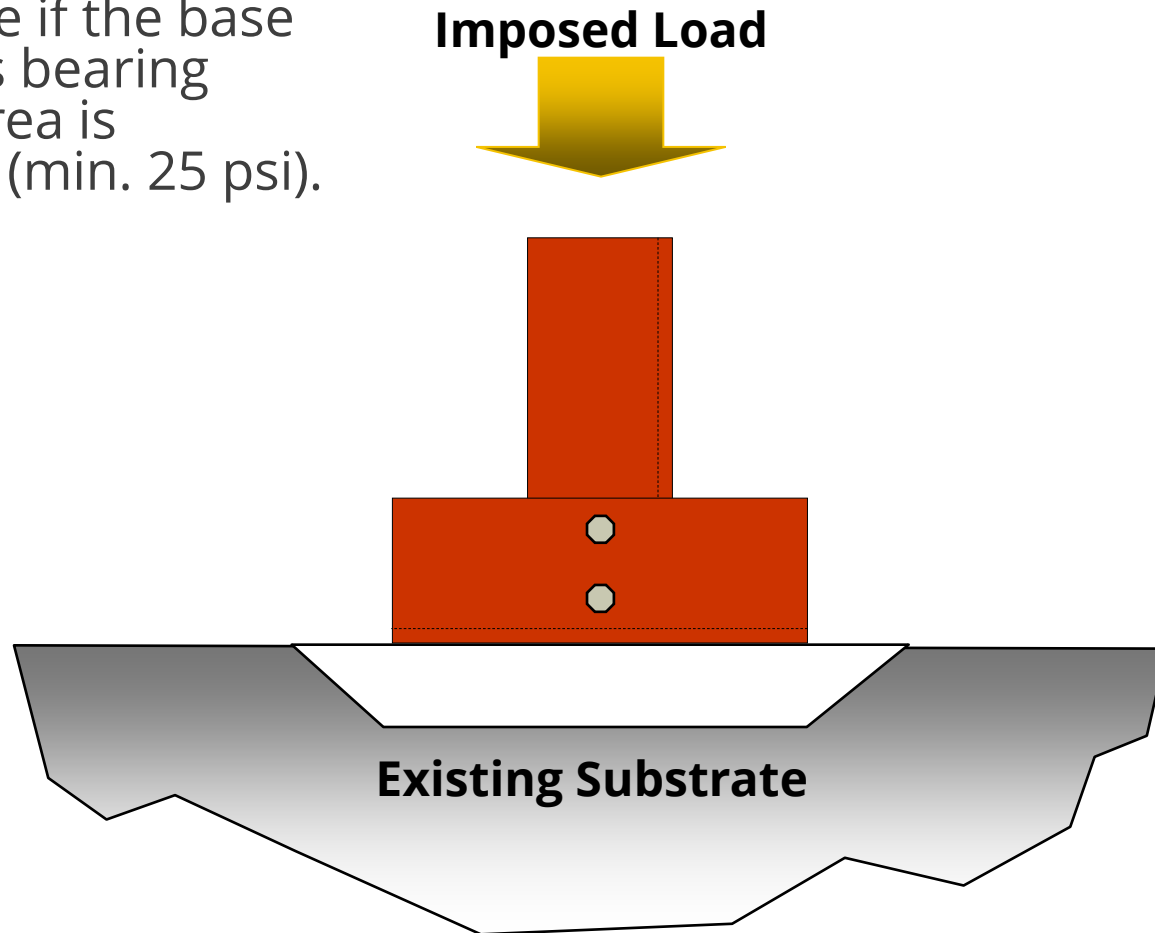
<b>Compressive Resistance (psi)</b>	
<b>Material Type</b>	
1/2" Wood Fiber Insulation	52
Expanded Perlite	30-40
Perlite Concrete (1:4 ratio)	300
Perlite Concrete (1:6 ratio)	125
Vermiculite Concrete (1:8)	70-125
Cellular Concrete over expanded polystyrene board (25 PSF dry density)	140
Cellular Foam Glass	90
Expanded Polystyrene Rigid Board (10% deformation)	5-40
Extruded Polystyrene	15-60
Polyisocyanurate (1")	25
Semi-rigid Spray foam (1")	0.7
Tectum (2 1/2")	238

# COMPRESSIVE STRENGTH

When retrofitting a roof, compression strength is defined as the ability of the existing roof substrate to resist the forces created by the attachment of the retrofit roof framing so that the underlying material is not crushed and excess deflection is not introduced in the new roof.

# COMPRESSIVE RESISTANCE

Determine if the base member's bearing surface area is adequate (min. 25 psi).



# INSUFFICIENT COMPRESSIVE RESISTANCE

## Insulation/Deck Deterioration

- Remove membrane and insulation
- Inspect decking for possible damage (rust, rot, etc.)



# BID DOCUMENT SUMMARY

Provide

- Comprehensive roof plan
- Information on joists and their support
- Internal and external collateral loads
- Existing substrate assessment
- Pull-out test
- Compression resistance evaluation

# **DESIGN CONSIDERATIONS**

# ADDING INSULATION

Include the insulating values of the existing material in any R-Value requirement

\* Typically, older roof assemblies and materials do not offer adequate thermal protection

<b>Roof Assembly Calculation (Avg/SF)</b>	
<b>Existing Material</b>	<b>R-Value</b>
Roof Membrane	
Roof Deck	
Roof Insulation	
Ceiling	
Ceiling Insulation	
Total Existing R-Value =	
Add New Insulation =	
Total R-Value =	
Energy Code Minimum =	

<b>Thermal Values (Avg/SF)</b>	
<b>Material Type</b>	<b>R-Value</b>
<b>Roof Membrane</b>	
3-Ply Felt	0.24
3-Ply Felt with Gravel	0.33
5-Ply Felt	0.40
5-Ply Felt with Gravel	0.55
Single-ply Adhered	0.24
Single-ply Ballasted	0.37
Modified Bitumen	0.75
PVC Foam (per 1")	3.85
<b>Roof Insulation (per 1")</b>	
Fiberglass Batt	3.70
Foam Board	6.00
Loose Fill	2.2 – 3.5
Poured in Place	6.25
Rigid	2.78
Tectum	5.56
<b>Roof Deck</b>	
¾" Plywood	0.44
20 Gauge Metal	.0001
22 Gauge Metal	.0001
2" Gypsum Plank	1.80
Lightweight Concrete (1")	0.3 to 0.9
<b>Ceilings (insulation excluded)</b>	
Acoustic Tile	2.38
Lath and Plaster (1")	0.94
Suspended Tile	2.28



# VENTILATION

A properly designed ventilation system is crucial.

Consult a Mechanical Engineer to ensure proper ventilation



# EXTERNAL LOADS

Assess external loads including:

- Live Loads
- Wind Uplift
- Snow Loads
- Dead Loads
- Seismic Loads



# ADDITIONAL WEIGHT

Beware of unplanned snow drift loads on:

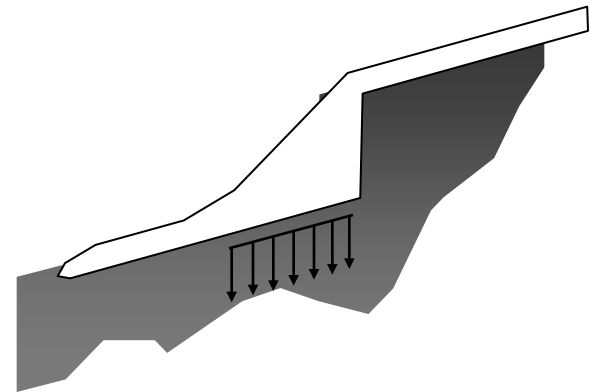
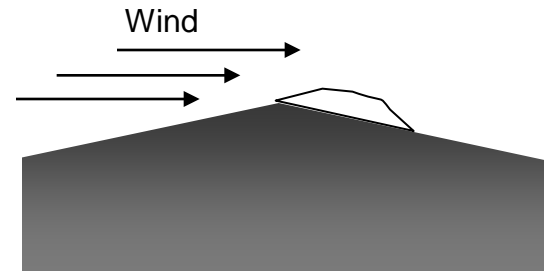
Ridges (unbalanced)

Valleys

Adjoining roof and wall

Penetrations caused by existing roof conditions

Adjacent buildings



The design professional should evaluate these added loads for required remediation of the existing structural system.

# ANCHORAGE REQUIREMENTS

Due to probable moisture content in the existing substrate, anchors should have a corrosion resistant coating

Anchor installation into steel and wood joists should be closely monitored



Characteristic

Wood or steel  
frame



Joist Type

Structural concrete



Strength and deck  
thickness

Anchor length



Thickness of  
existing roof  
assembly

Determined by:

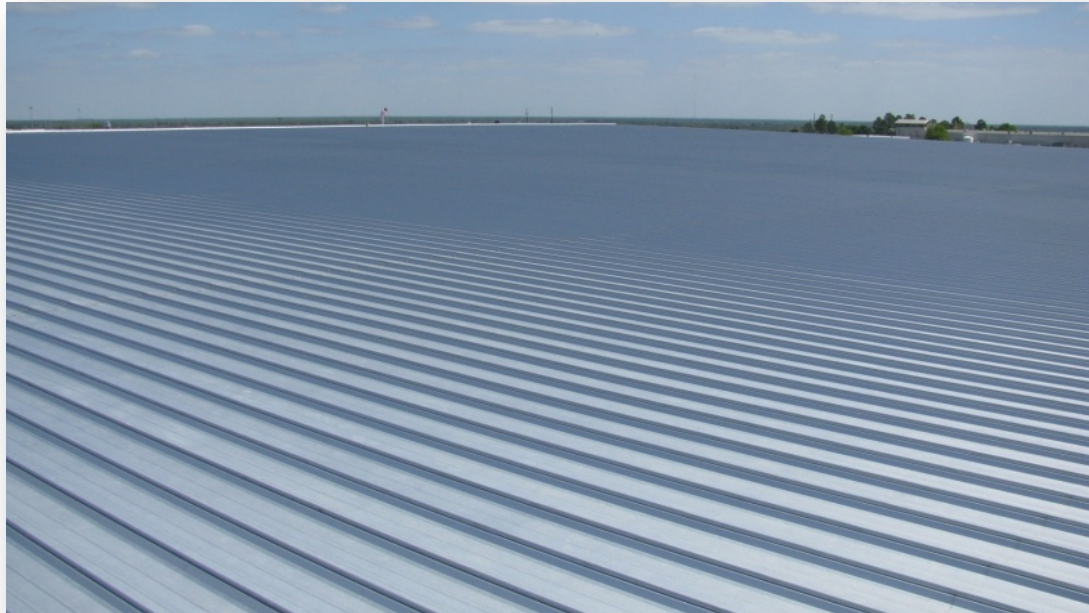
# FRAMING SYSTEM ANCHORAGE

Most retrofit failures are caused by improper anchorage.



# FRAMING SYSTEM ANCHORAGE

Make sure you enlist experienced registered professional engineers, manufacturers and installers to ensure the best results.



# **SELECTING THE RIGHT PARTNERS**

# QUALIFYING A MANUFACTURER

- Retrofit Design Manual in Place
- Certify Contractors
- Reliable  
Weathertightness  
Warranties





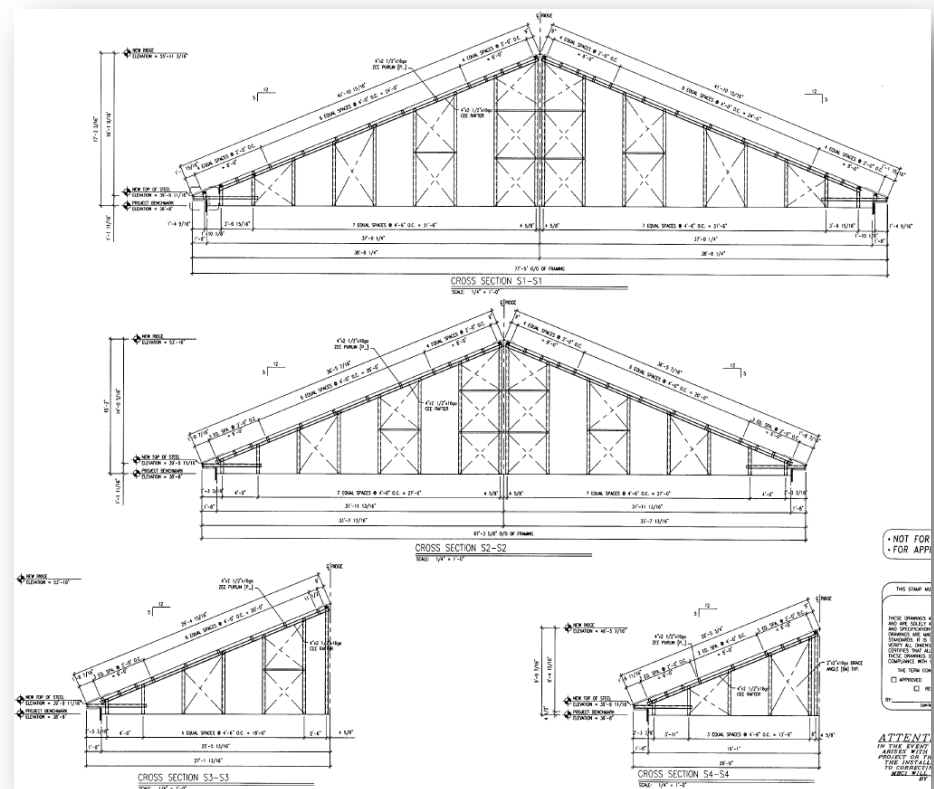
# RETROFIT MANUFACTURER

What should the retrofit system manufacturer provide you?

Framing layout drawings

Sealed design calculations including:

- Positive (gravity) and negative (wind uplift) imposed loads at each framing attachment location
- Lateral wind forces at gable ends and other vertical surfaces
- Shear requirements from bracing



# QUALIFYING A CONTRACTOR

- History of retrofit projects
- Certified by a manufacturer
- Insured and bondable

# PERFORMANCE WITH A PAYBACK

Retrofit metal roofing is the only roof replacement system that provides long-term reliable performance with a “payback”



# QUESTIONS?

**THIS CONCLUDES THE AMERICAN  
INSTITUTE OF ARCHITECTS CONTINUING  
EDUCATION SYSTEMS PROGRAM.**

**THANK YOU FOR YOUR ATTENDANCE**

# OTHER AIA PRESENTATIONS BY MBCI

## [MBCI.COM/METAL-INSTITUTE](http://MBCI.COM/METAL-INSTITUTE)

- Standing Seam Metal Roofing Seminar - 1 Hr
- Standing Seam Roof Design Details & Weathertightness – 3Hr
- Insulated Metal Panels – 1 Hr
- Retrofit Metal Roof Systems – Ensuring a Successful Project – 3 Hr
- The Devil Is In the Details – 1 Hr
- A Review Of Metal Panel Warranties – 1 Hr

