METAL ROOFING Presentation for AIA Learning Units

PAC-CLAD®

Petersen Aluminum

PRESENTATION OVERVIEW

- Brief History
- Structural Panels
- Architectural Panels
- Wind Load Testing
- Materials and Finishes
- Problem Areas
- AIA Learning Unit Exam

LEARNING OBJECTIVES

- By the time you have completed this unit, you will:
  - Have a better understanding of how to select the proper panel profile for a variety of applications.
  - Understand the process involved in wind-load testing of panels, including information on the specification of a wind-load tested system.
  - Gain a better understanding of the wide variety of metal substrates available for metal roof applications and their idiosyncrasies.
  - Gain understanding of metal finish systems including anodized, Kynar & polyester coatings.

BRIEF HISTORY

- 1000 BC: King Solomon's Temple
  - King Solomon's temple is one of the first known examples of a metal roof application.
- 1798: The Massachusetts State House
  - Includes a copper roof that was recently replaced after almost 200 years of service life.
- Zinc Mansards
  - Installed in Paris in the late 1800'S
- 1934: ARMCO Produced the first factory-formed panel for the Chicago Worlds Fair.
- 1969: Butler Manufacturing produced the first concealed fastener panel.

ARCHITECURAL vs STRUCTURAL

- A Metal roof can be used as either a structural, “single-ply” -like membrane or as a decorative architectural element
- 1/4:12 Pitch to 3:12 Pitch requires a **structural,essentially watertight panel**. These panels are typically called “**hydrostatic” panels**.
- 3:12+ pitch applications typically include panels that are “**hydrokinetic”** or **water shedding** panels

STRUCTURAL PANELS

- Suitable for low slopes / typically as low as 1/4 : 12
- Have been designed to resist the passage of water under **hydrostatic** pressure.
- Should be UL-90 rated
- Should include a floating clip for expansion / contraction.
- Steel expands 1”/100LF given a 100 degree temperature change
- Aluminum will expand 2”/100LF given a 100 degree temperature change

STRUCTURAL PANELS

- Initial cost typically higher than single-ply roofing
- Typically used in combination with “batt insulation”; may also require a thermal barrier such as a wood blocker.
- Overall life-cycle cost may be substantially lower due to low maintenance costs and life expectancy.

STRUCTURAL PANELS

- Maintenance typically includes:
  - Cleaning all gutters annually.
  - Annual inspection by maintenance personnel.
    - Annual wash down with a mild cleanser is suggested.

STRUCTURAL PANELS

- Typical applications include: Schools, industrial facilities, shopping centers, warehouse and prisons.
- Not recommended for roofs with an extraordinary number of penetrations and roofs subject to caustic environments unless properly coated.

STRUCTURAL PANELS

- Variations:
  - Factory Produced - Field Seamed
  - Field Produced - Field Seamed (Long Lengths)
  - Factory Produced - No Seaming Required (snaps in place)

STRUCTURAL PANELS

- All panels that are structural should be able to pass UL90 over an assembly equal to project requirements.
- Almost all have a self-centering clip (floating) clip to accommodate expansion/contraction.
- Most structural panels have been tested for Air Infiltration ASTM 1646 (old # ASTM 331) and Water Penetration ASTM 1680 (old # ASTM 283)..

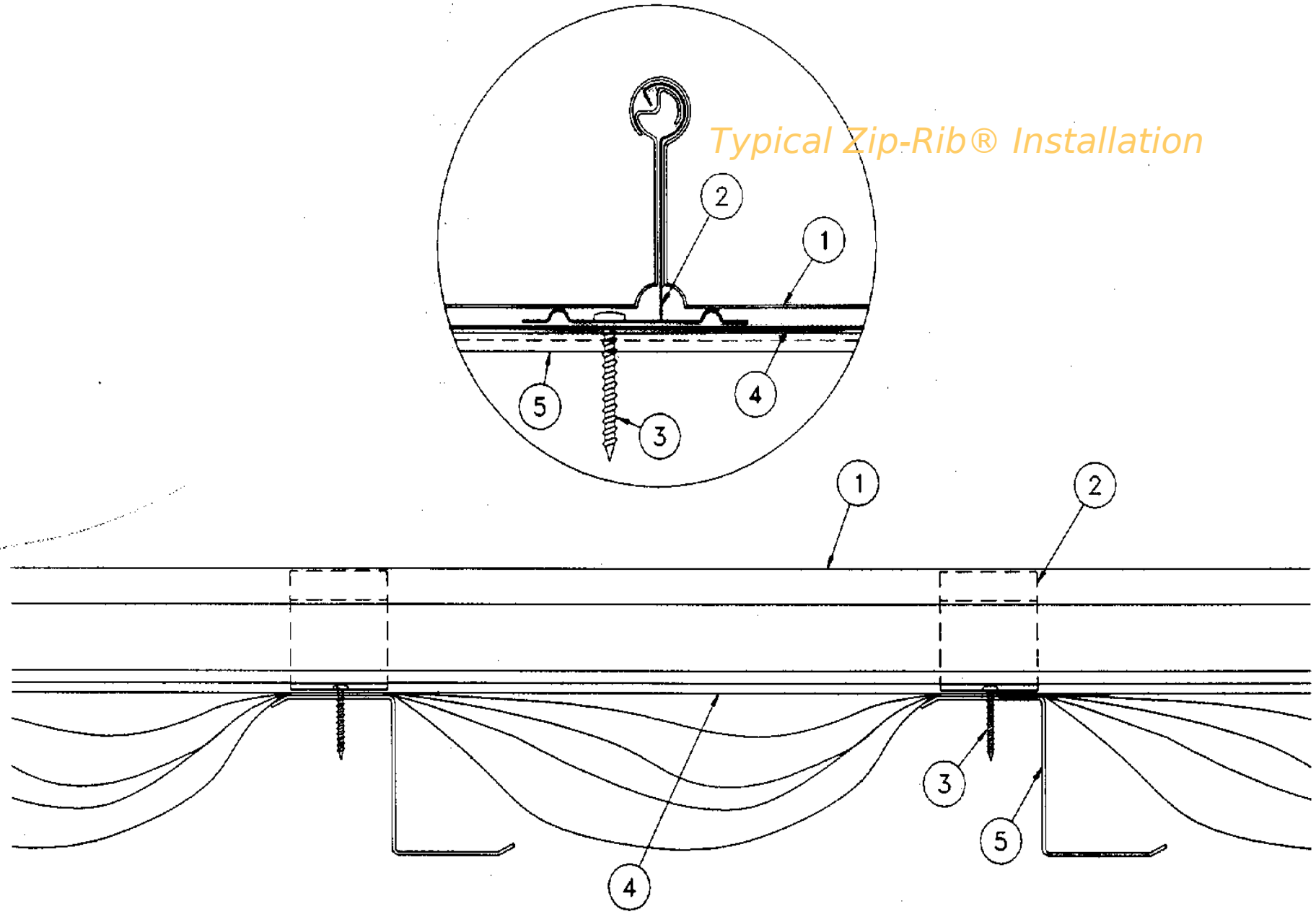
STRUCTURAL PANELS

- Some specifications (for example Army Corps of Engineers) require that panels be tested under ASTM E1592 requirements.
  - This test uses an air bag assembly to create a vacuum and accomplishes a static pressure or load. This test is taken to the failure point.
  - This test is generally **not** applicable to panels installed over solid substrates such as plywood.

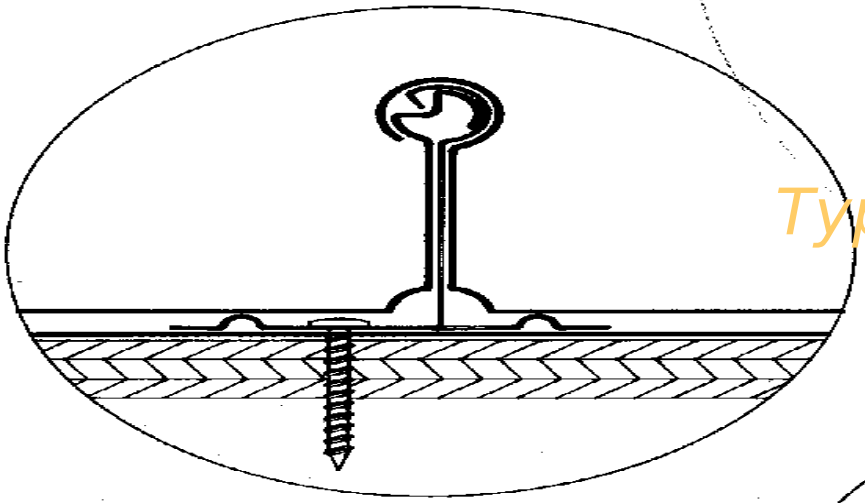
STRUCTURAL PANELS

- Structural panels, assembled over framing systems are frequently specified for re-roofing. On these applications, a framing system is constructed over the original roof. Total assembly typically may weigh as little as 2#/sf assuming the ballast has been removed. Resulting attic space may require installation of a new sprinkling system to satisfy code requirements.

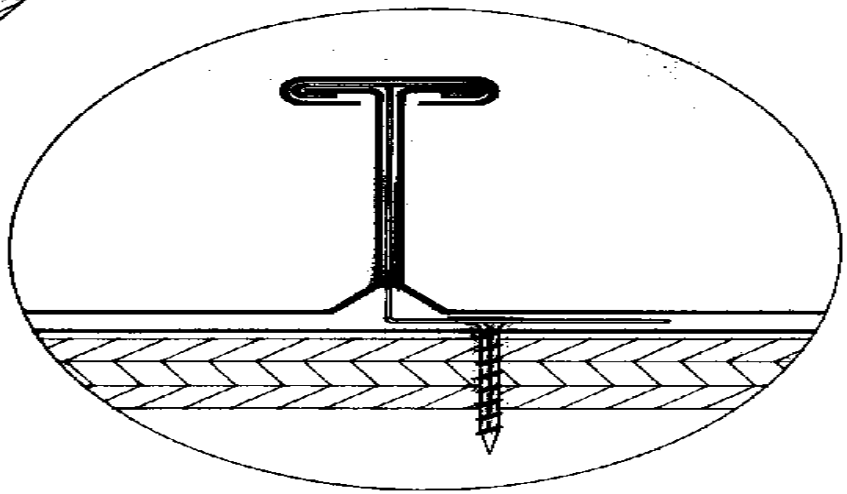
Typical Zip-Rib® Installation



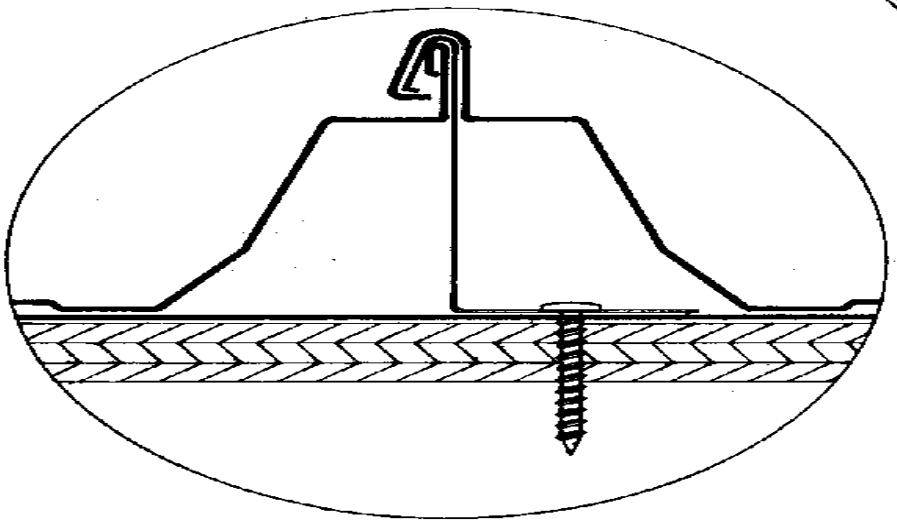
Typical Structural Profiles



ZIP—RIB



CLEAT SYSTEM



TRAPEZOIDAL SYSTEM

ARCHITECTURAL PANELS

- Typically preferred when the roof design is a visible, decorative element and an integral part of the overall building aesthetics.
- Solid underlayment is typical.
- 3:12 minimum pitch typically (dependent on profile; some profiles may perform down to 2:12 pitch)
- Typical substrates include:
  - metal decking
  - 5/8 (min) plywood or wafer board
  - oriented strand board (OSB) laminated to rigid insulation
  - or Z-purlins in conjunction with rigid insulation.

ARCHITECTURAL PANELS

- Span of Z-purlins may vary by panel and gauge.
- Some architectural panels are suitable for application over structural framing in canopy applications.
- Virtually all architectural panels feature concealed fasteners and clips.

ARCHITECTURAL PANELS

- Moisture barrier serves to direct any water that gets past flashing and/or the panel barrier off the roof.
- Products that are typically used are red rosin paper in conjunction with 2 plys of 15 # felt or 1 ply of 30 # felt; and/or peel & stick membrane. Red rosin is used under all copper applications and applications where significant expansion/contraction is anticipated.

ARCHITECTURAL PANELS

- Peel & stick membrane is recommended at valley, ridge, hip and eave areas.
- All architectural barrel vault application must have peel & stick membrane (e.g. ice & watershield®) as a base sheet.
- **All Underlayment should be shingled horizontally from <u>eave to ridge</u>.**

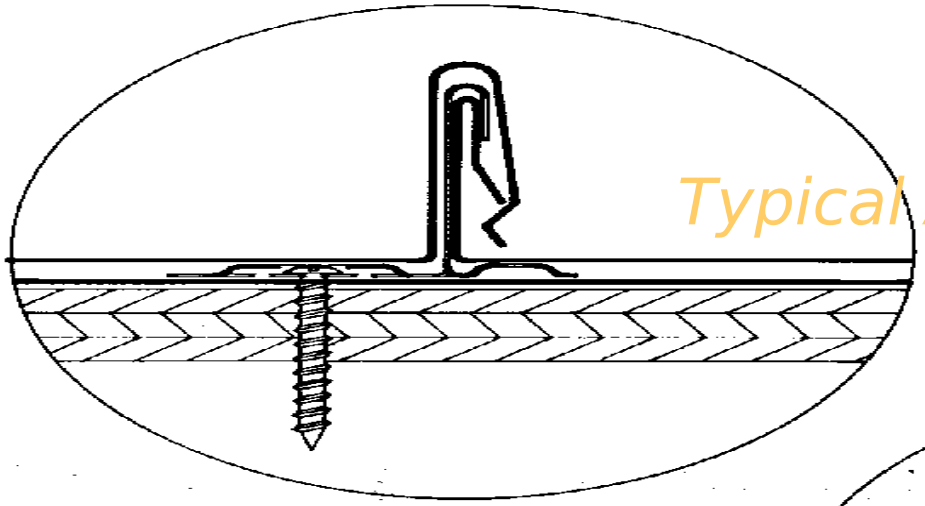
"Oil Canning" - Causes

- Oil Canning : The flatter the Underlayment the better the appearance of the project.
- Causes
  - Uneven substrate/Bad source material
  - Poorly adjusted rolling equipment
  - Overdriven fasteners
  - and/or Expansion/Contraction.

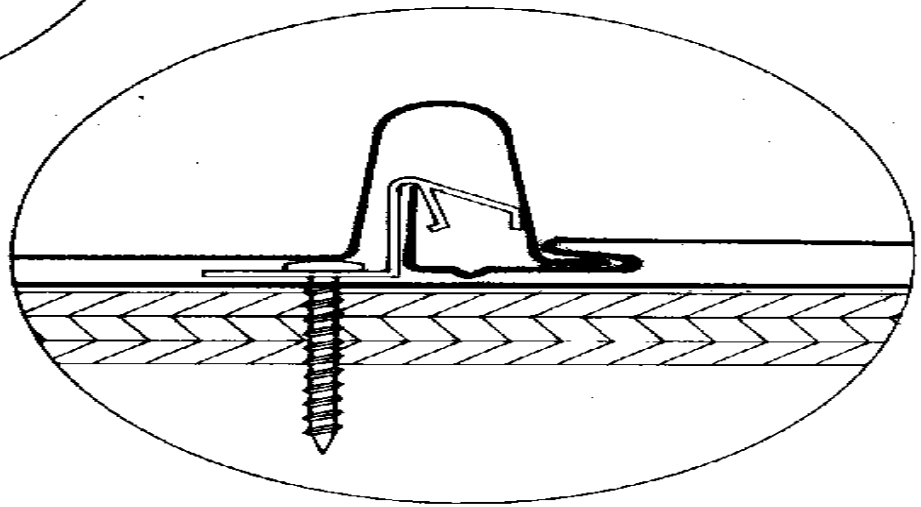
"Oil Canning" - Solutions

- Corrective Leveling: corrective leveling provides improved flatness
- Stucco Embossing: may minimize the appearance of oil-canning.
- Stiffener Beads/Striations: can be effective but may change aesthetics
- Backer Rod: Neoprene backer rod can be used to make up for unlevel substrate or "oil-canned" panels

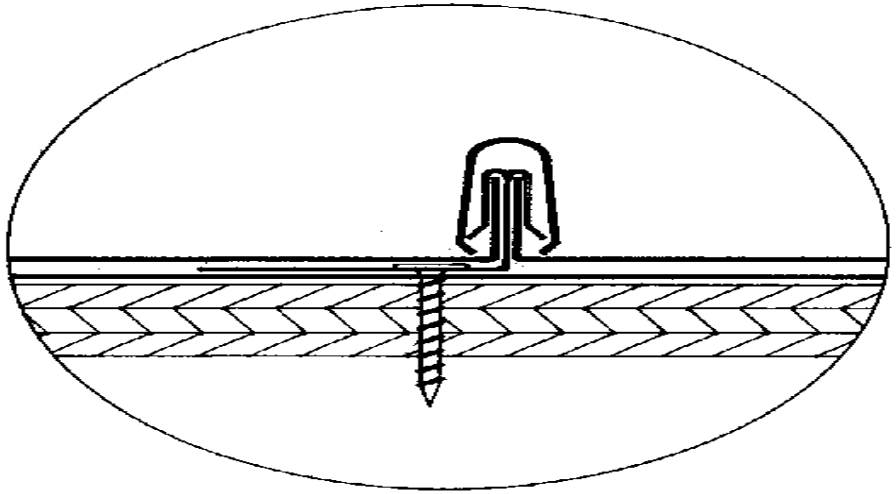
Typical Architectural Profiles



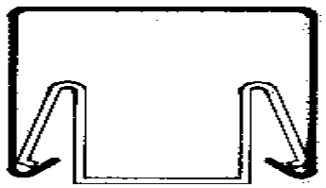
SNAP—SEAM



INTEGRAL STANDING SEAM

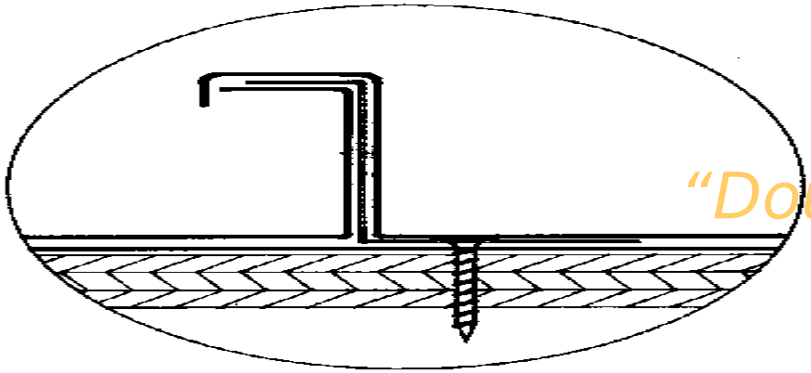


SNAP—ON STANDING SEAM

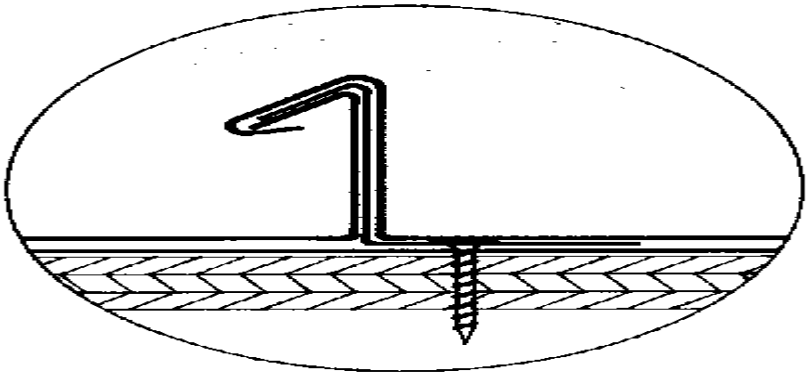


SNAP—ON BATTEN

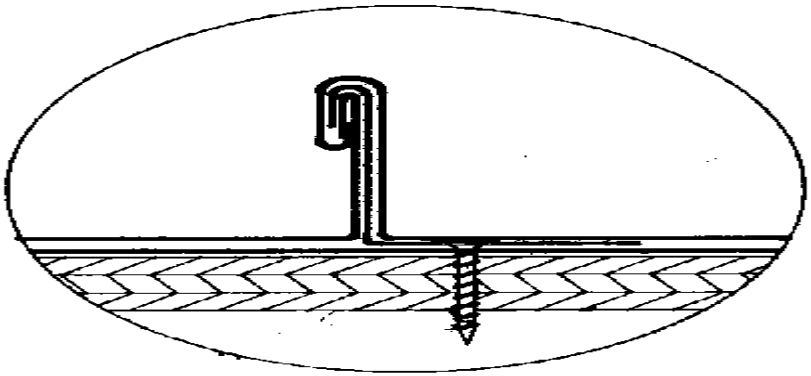
“Double-Lock Profile”



CRIMP SEAM
UNLOCKED



CRIMP SEAM
PARTIALLY LOCKED



CRIMP SEAM
FULLY LOCKED

SUMMARIZING STRUCTURAL vs ARCHITECTURAL PANELS

- Pitch 1/4 :12 to 3 : 12
  - Structural Panel is required.
- Pitch 3 : 12 +
  - Architectural Panel.
- Assembly : Purlins & Batt Insulation
  - Structural Panel. (Typical Metal Building Construction)
- Purlins 5’-0” on center
  - Requires Structural Panel
- Purlins 5’-0” on center with rigid insulation
  - Structural Panels/Some Architectural Profiles

SUMMARIZING STRUCTURAL vs ARCHITECTURAL PANELS

- Purlins 4’-0” on center
  - Structural Panel/Some Architectural Profiles
- Purlins 4’-0” on center with rigid insulation
  - Structural Panel/Some Architectural Profiles (min 24ga. Steel).
- Solid substrate with vapor barrier
  - Architectural panels appropriate (check roof pitch)

FACTORY FORMED vs FIELD FORMED ?

- Elements to consider when choosing between Factory-Formed and Field-Formed Panels
  - Factory Formed - Shipping restrictions over 55’-0” length
  - Job site storage space may require panels to be formed on site.
  - Field Conditions (condensation, dirt etc.) can result in quality compromises.
  - Tension leveling to prevent oil canning is not possible on field-formed panels.
  - Installer becomes manufacturer
  - performance ratings may be compromised (e.g. UL ratings, ASTM requirements etc.).

FACTORY FORMED vs FIELD FORMED ?

- Scratched Panels may lead to unwarrantable finish problems
- Craft Labor vs Field labor = field labor costs are generally higher
- Field forming is best suited for long length applications, radius panels.

WIND LOAD TESTING

- The requirement to provide a UL-90 rated roof assembly has found its way into many specifications. A UL-90 rated assembly is comprised of a specific panel, fastening system, substrate and miscellaneous installation requirements.
- The tested assembly will specify material type, maximum on-center dimension, clip spacing, metal gauge & fastener quantity
- The UL-90 rating is extended to all roof assemblies that have been able to pass UL's 4 1/2 hours of progressively higher application of positive and negative simulated wind uplift as per the UL 580 protocol.
- A UL-30, UL-60, or UL-90 rating may be achieved.

WIND LOAD TESTING

- UL Building -Roofing Materials & Systems Directory may be obtained by contacting
- UL @ 1-847-272-8800.
- Each assembly lists all components required to achieve a rated panel assembly.
  - Decking
  - Truss Spacing & type (2x4 or 2x6 etc)
  - Material (Steel, Aluminum etc.) & minimum approved gauge, tensile strength & grade
  - # of Fasteners, Clips & Spacing
  - Sealants required, vapor barrier and/or insulation

WIND LOAD TESTING

- If any single component does not meet the **minimum** requirement, the assembly will not qualify as a true, rated panel.
- We often see projects where the specifier has not reconciled the project requirements with that of the listed construction.
- It is also incumbent upon the installer to have a working knowledge of the complete assembly, particularly when offering substitutions.

WIND LOAD TESTING

- Portable roll formers can produce UL-90 rated panels - but to be in compliance, the panel operator must be registered by Underwriter's Laboratory as a participant in their field-follow up program and have a valid certificate (this is subject to renewal every 6 months).
- Clip/fastener performance is integral to overall panel performance. Clip/fastener pullout test results should be available from the panel manufacturer.

SUBSTRATES: Galvanized Steel

- Over 75 years of architectural application
- Grades (G-30, G-60, G-90 etc.) but G-90 is recommended for architectural applications
  - "G-rating" refers to the amount of zinc per/SF, per/side
    - for example, G-90 has .45oz. zinc per side.
- Available sold bare or coated with a paint finish.
- Accepts a wide variety of finishes.
- Low relative expansion and contraction.
- 24ga. is most common, ASTM 653 grade is required for UL-90 (formerly ASTM 446).
- Sacrificial properties of zinc enhance corrosion resistance.

SUBSTRATES: Galvalume

- Galvalume®: BIEC owns patent (ASTM 792)
- Alloy top coat combines aluminum for corrosion resistance and zinc for corrosion/sacrificial properties.
- Lesser sacrificial properties than Galvanized but better corrosion resistance in bare form.Galvalume has had problems with raw edge corrosion at cut or slit edges.
- Warranty available, generally in unpainted form.
- Accepts a wide variety of finishes.
- Keep bare Galvalume out of direct contact with lead, copper, graphite, green wood, wet or treated wood as it may be subject to galvanic corrosion.

SUBSTRATES: Aluminum

- Aluminum : Superior corrosion resistance, flatness & surface characteristics.
- Higher cost per sf, some price volatility.
- High recycled content
- 2Xs the expansion/contraction of steel.
  - may require modifications in flashing design
- Light weight per sf.
- Generally not available as a structural panel.
  - .032 typical gauge for panels
  - .050 for coping or gravel stops.

SUBSTRATES: Copper

- Noted for corrosion resistance.
- Ages to a rich patina color - chemicals can hasten this process.
- Oxide wash down - should be factored into trim design to prevent staining on adjacent surfaces. A drip edge is usually adequate for these purposes.
- Extremely volatile pricing, higher cost per sf.
- Soft metal, requires self supporting underlayment.
- 16oz is most common in architectural application.

SUBSTRATES: Stainless Steel

- Terne-Coated Stainless (TCS)
- “TCS” : Follansbee is the only manufacturer
- .015, .018 & .024 stainless steel with a coating of 80% zinc and 20% tin.
- Higher cost per sf
- Long Life - 75 years +
- Ages to a warm gray
- New product is called TCS-2 (Viromet).
- Architex

FINISHES: Anodized Aluminum

- Anodizing is the controlled oxidation of aluminum
  - Aluminum Oxide is one of the hardest surfaces known to man
- Color introduced using one of two methods.
  - A. Hardcoat (A42)
  - B. Two Step (A44)

Metal Finishes

Hardcoat Anodized

- A. Anodizing bath is chemically altered.
- B. Power level is boosted.
- C. Color depends on many variables:
  - Alloy
  - chemical bath composition
  - power (electricity) level
  - and time in the tank.

"Two-Step" Anodizing

- Newer process that offers lower cost, better color consistency, wider color range.
- Material is literally anodized twice; first to provide aluminum oxide and second to allow for the deposit of metal salts in porous surface.
- Tin, cobalt or copper salts are used in 2nd step to achieve color.
- Material is sealed in a hot water bath to complete the coating.
- Limited color range (typically bronze tones, gold or clear).

Kynar 500®/Hylar 5000®

- Originally developed for abrasive, corrosive environments, such as power plants and chemical plants.
- $PVDF^2$ is chemical composition
  - Kynar 500 manufactured by Atochem
  - Hylar 5000 manufactured by Ausimont
- Inherent qualities include, weathering properties, ultra violet resistance, formability, abrasion resistance & resistance to airborne pollutants.

Kynar 500®/Hylar 5000®

- This coating is Teflon®-like (low friction - self cleaning).
- Basic strength is its carbon-fluoride bond.
- Blendability lends a wide color range
- Its base is an opaque white resin though, which limits bright colors.

Kynar 500®/Hylar 5000®

- Kynar®500/Hylar 5000® is available under the following brand names from:
  - PPG = Duranar®
  - Valspar = Fluropon®
  - Morton = Fluroceram®
  - Lilly = Nubelar®
  - Akzo = Trinar®
- 1, 2, 3, & 4 coat formulations are available
  - (2-coat is considered standard).
- 2-coat metallic such as Fluropon Classic and Ultramet C use Mica.
- New product research includes 2-coat bright colors, metallics, waterborne primers and printed coats (Wood Grain, Patina Green).

Polyester Finishes

- Low cost - large color range including bright colors: Yellows, reds and blues.
- Ultra violet resistance (color fade) not as good as Kynar.
- Typical applications includes the metal building industry, sign industry and gas station canopies. Some come with 20 year warranty but check fine print.

FINISH WARRANTIES

- Kynar ®
  - 20 years for coil applied product.
  - 5 years for spray applied product.
- Most important performance characteristic i s probably resistance to color fade
  - Expressed in ΔE " Hunter Units"
- On color fade, a **lower** number means **higher** performance.
  - 5 or better rating is expected for Kynar over 20 years.
  - 8 or better rating is typical for polyester over 20 years.

FINISH WARRANTIES

- Finish “chalking” is another measurement of finish performance. Chalking is the result of a breakdown of carbon bonds in the finish.
- Chalking is rated on a scale from 1 to 10. A higher number rating connotes better performance.
- 20-year performance rating for Kynar® is 8 or better.
- 20-year performance for polyester is 5 or better.
- **Coating thickness is critical** to proper finish performance

FINISH WARRANTIES

- Watch for prorated warranties and review carefully. Not all warranties offer the same coverage.
- Finish warranties should also reference:
  - Paint adhesion
  - Abrasion resistance
  - Chemical resistance

PROBLEM AREAS

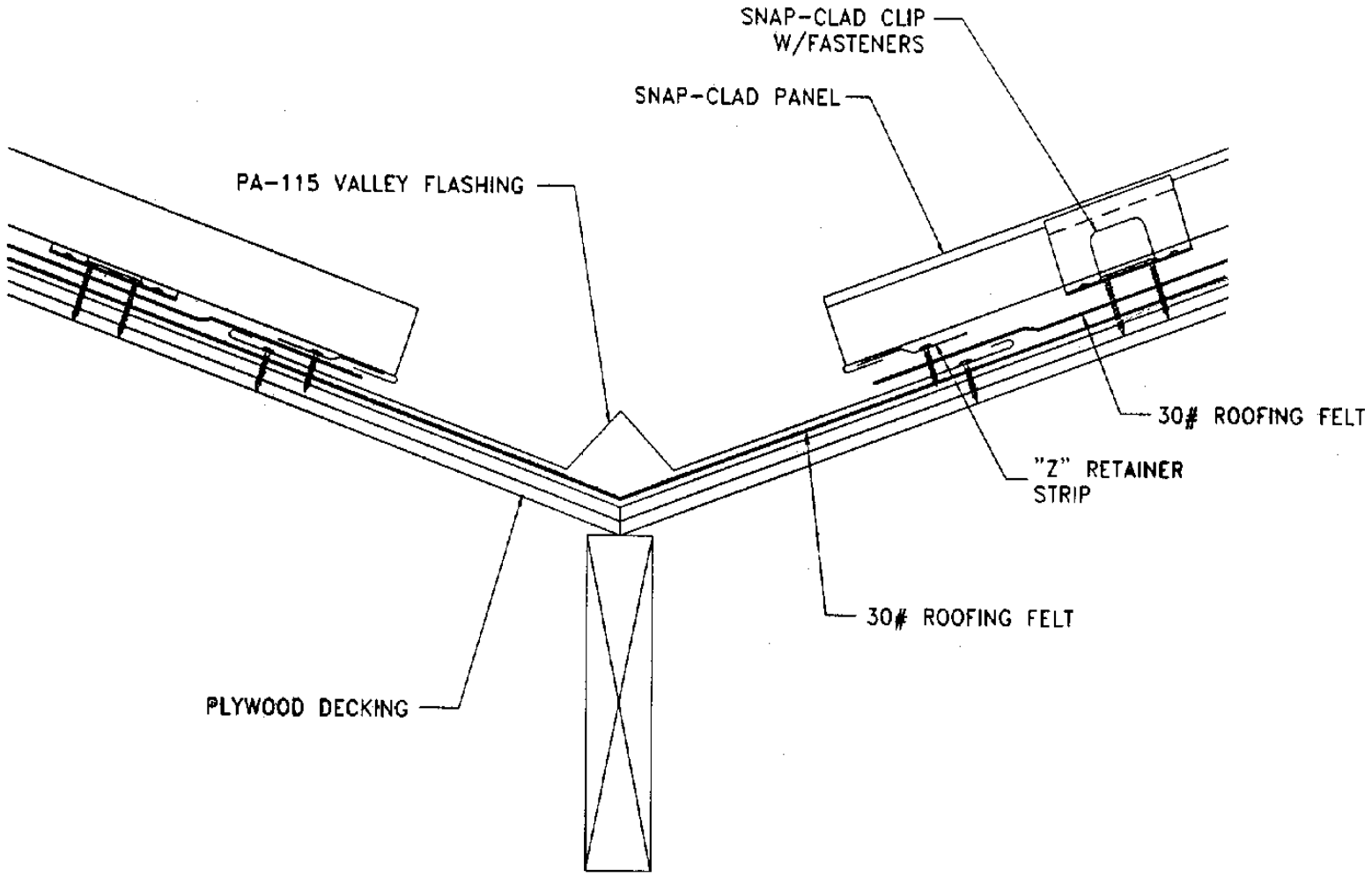
- The following are some of the most common examples of installation problems that we see:
  - Underlayment:
    - should be installed horizontally and staggered from eave to ridge.
  - Fasteners:
    - Typically a minimum of two fasteners per clip are required. This provides better hold down strength and prevents the clip from torquing around a single fastener.
  - Inadequate allowance in flashing design to accommodate expansion/contraction.

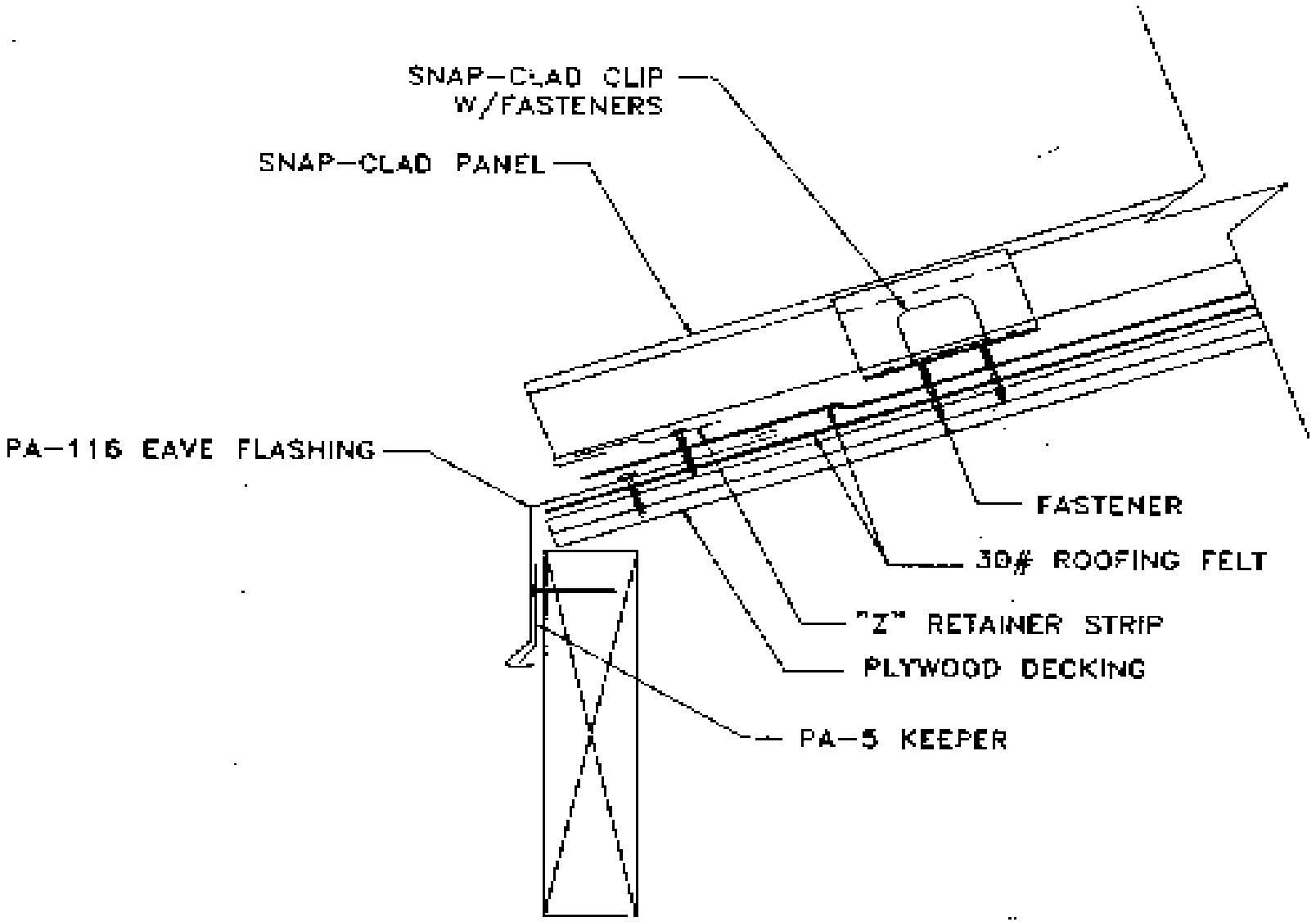
PROBLEM AREAS

- Not stripping in eave trim properly.
  - Felt underlayment should be stripped in after the metal eave trim is installed.
- Job site damage
  - surface scratches resulting from roof traffic
- Job site storage.
  - Material should be stored in a clean, dry place
- Valley flashing not adequate.
  - Valley flashing is determinant upon roof pitch, panel length and expected snow/rainfall

PROBLEM AREAS

- Clip spacing
  - Proper clip spacing is necessary to insure proper performance of the complete system. Consult manufacturer's details for clip spacing requirements. This may also be found in the UL Roof Systems Directory.


SNAP-CLAD CLIP
W/FASTENERS
SNAP-CLAD PANEL
PA-115 VALLEY FLASHING
30# ROOFING FELT
"Z" RETAINER
STRIP
30# ROOFING FELT
PLYWOOD DECKING


SNAP-CLAD CLIP
W/FASTENERS
SNAP-CLAD PANEL
PA-116 EAVE FLASHING
FASTENER
30# ROOFING FELT
"Z" RETAINER STRIP
PLYWOOD DECKING
PA-5 KEEPER