

DESIGN OF METAL EDGE SYSTEMS FOR LOW SLOPE ROOFING

Presented by



For Those Who Design, Specify or Install Edge Materials Used With Low Slope Roofing Systems

INTRODUCTION

Recent studies of damage resulting from windstorms and hurricanes has shown that approximately 80% of *all* roofing failures occurred at the perimeter of the building. Whether coping or fascia metal is used, the need for engineered roof edge terminations capable of withstanding high wind load conditions cannot be over emphasized. A high performance, engineered edge metal system provides not only a weathertight seal at the building's perimeter, but also the design features encompassing both aesthetics and performance necessary to achieve the trouble-free security your clients invest in *and* expect!

Each year, 80% of all construction litigation involves water damage associated with a failed roof system resulting from wind and water leaks at the perimeter. Yet a quality roof edge design represents only 6% of the total cost of the entire roof assembly. Furthermore, it is estimated that nearly 80% of all edge metal furnished for low slope roofing systems in the United States is provided by roofing contractors or local fabricators offering no engineering criteria, or more importantly, no performance warranties to cover the event of failure.

This presentation will cover (i) the general design considerations and definitions of an engineered edge metal system, (ii) the recommended guidelines to follow in designing for wind loads and up-lift resistance, and (iii) the test methods employed by factory engineered systems to insure that the watertight integrity of the roof design meets the environmental conditions and wind resistance in which the building is located.

DISCLAIMER

The information contained in this presentation should be used in conjunction with the specifications and requirements of the manufacturers of the specific roofing materials, and the edge systems used in the roofing assembly. Consult the membrane manufacturer for specific recommendations for making the roof watertight at the edge. National Sheet Metal Systems, Inc, its employees and agents do not warrant that the information presented herein is proper and applicable under all conditions.

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The information contained herein is designed for single-ply, modified bitumen and built-up roofing systems. However, it can be applied to other types of roofing systems as well. While this presentation is intended as a reference for designers and roofing contractors, the design responsibility rests with the “designer of record.”

Roof edge systems serve aesthetic as well as performance functions for a building. They provide an attractive finish and very often they are a principal feature to the exterior of a building. Of course, no matter how good the metal edge system appears, it must act primarily as an effective mechanical termination and transition between the roof and other building components (such as parapet walls, vertical walls, corners, soffits and fascia boards).

Metal edge systems considered in this presentation are differentiated into two general types:

1. Copings/Caps: These are products which cover the tops of parapet walls, frequently with the roofing membrane terminated under them.
2. Horizontal Edges: These are products which complete the horizontal deck or membrane plane at its transition to a vertical wall drop, typically a 90 degree angle. Normally the roofing membrane is restricted by the edge via a mechanical gripping of the roofing between metal flanges, or by heat or solvent bonding between the roofing and treated metal.

Flow containment of asphalt should be considered with asphaltic systems in which warmed asphalt could melt and flow down the exterior of the building through horizontal edges. Termination products against vertical walls such as reglet/counterflashing and termination bars are not considered in this document.

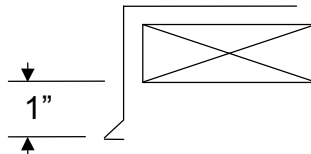
There are two general classes of materials covering nearly all perimeter systems. They are:

1. Extrusions: Shapes or designs made by forcing heated metal through precut custom dies. These designs are usually of a heavier gauge than formed products, but many extrusions must have a finish applied after manufacturing.
2. Formed Metal: Sheets of metal, usually steel, aluminum or copper, bent on press brakes or roll-forming equipment to match a desired design or configuration. Formed products are available in a variety of thickness and finishes.

DESIGN CONSIDERATIONS

A high performance roof edge system acts as a water seal at the edge of a building. It is also the means by which the roofing material is attached to the building at the perimeter. It must have enough holding power to prevent the membrane from pulling out at the edge under windy conditions, and itself must not come loose in a high wind. A loose edge system not only endangers people and adjacent property, it also exposes the roofing assembly to blow-off starting at the building's corners and progressing down the edge.

The metal roof edge may also function as an air seal, preventing air infiltration under the roofing membrane. To resist air infiltration, nailers should be sealed to the building with appropriate sealants. Where multiple or stacked nailers are used, they should be sealed to each other. The drip edge, or kick-out should extend a minimum of one inch below the nailer.



Additionally, materials used for the construction of metal edge systems must have sufficient internal strength and not be susceptible to excessive corrosive action. The edge system design should not detract from the aesthetics of the building because in many instances, it is a major design feature.

The following factors must be considered as a matter of course whenever design of a roof edge system is contemplated:

- Security of the substrate that anchors the edge
- Holding power of the edge detail
- Material specifications

A. Wind Speed

Determination of the appropriate wind force category for your building site is based on wind speed, ground roughness factors and building height. The location of the edge metal detail on the building is also very important, since wind forces are increased at the building's corners.

The basic wind speed values to be used in your design calculations should be taken from the ANSI/ASCE 7-93¹ document or the local authority having jurisdiction. Wind speed is intensified by the effects of valleys and other unique topographic features, such as hills or escarpments, and should be accounted for in your design. Note: Wind speed data can be furnished by your local weather station or from the National Oceanic & Atmospheric Administration (NOAA). Where the design wind speed exceeds 120 miles

per hour above 33 feet (for Exposure “C”), the edge design should be based on the method approved by the authority having jurisdiction for the region.

B. Building Height

The building height should be measured from the ground level to the roof edge.

C. Roof Edge Regions

Wind forces near the corners of a building have greater intensity than in perimeter regions *between* corners. These regions are defined as follows:

1. “Corner”

The “corner region” is a distance from the building corner that is 10% of the minimum building width or 40% of the building height at the eaves (whichever is smaller), but not less than 4% of the minimum building width and not less than 3 feet.

2. “Perimeter”

The horizontal section of the roof edge located between corner regions.

D. Edge Conditions

Wind resistance of metal edge systems depends not only upon the attachment of the product to the building, but also upon the integrity of the nailer or substrate to which the edge system is attached.

E. Building Location

The surrounding terrain will influence the degree of exposure your building has to the wind. Classify the building into one of the following exposures:

- | | |
|--------------------|--|
| Exposure A: | Large city areas with a concentration of buildings over 70 feet high. |
| Exposure B: | Protected urban or suburban areas having trees or other surrounding terrain with closely spaced obstructions less than 70 feet high. |
| Exposure C: | Open terrain consisting of flat open country or grasslands with scattered obstructions less than 30 feet high, such as plains or beyond 1500 feet of a shoreline. |
| Exposure D: | Flat or unobstructed areas directly exposed to the wind, such as locations in coastal regions (within 1500 feet of the shoreline), or near large bodies of water where there is little or no protection from the wind. |

F. Galvanic Compatibility and Resistance

Most metals will corrode to some degree when exposed to the atmosphere. When dissimilar metals are in contact (in the presence of an electrolyte), the corrosion rate may be accelerated by an electrolytic reaction between them. Corrosion and strength must be considered in your choice of materials.

Corrosive potential can be roughly predicted by knowing the placement of the two metals in the Galvanic Series. The farther apart the metals are in the Galvanic Series, the greater the potential for corrosion. Metals adjacent to each other in the Series have little or no potential for corrosion.

Galvanic Series

Anodic or Least Noble (Corroded End)
Magnesium Zinc Aluminum Cadmium Steel Stainless Steel Lead Tin Copper Titanium Silver Gold
Cathodic or Most Noble (Protected End)

The metals high on the list are potentially corroded, while those low on the list are protected. Frequently, the corrosion rate of “sacrificed” metals will be low even if there is little potential for corrosion. Therefore, there will generally be little corrosion between metals which are close to each other on the list. However when they are in contact, the lower of the pair will be protected by the higher even if no perceptible corrosion is taking place.

Example: Steel, being lower on the list, will be protected by zinc which is “sacrificed” to save the steel. Even though there is potential for corrosion between zinc and steel, the rate of corrosion is minuscule so that the zinc lasts many years while electrolytically protecting the steel.

Pairs of metals such as aluminum and zinc or aluminum and stainless steel will show no perceptible corrosion between them because of their proximity to each other on the list. On the other hand, pairing copper with zinc or aluminum or even steel must be avoided because copper is far from them on the Galvanic Series, and the potential for corrosion is great. To avoid excessive galvanic corrosion between metals, the follow metal pairs are acceptable when dissimilar metals are used:

- Aluminum - Zinc
- Aluminum - Galvanized Steel
- Aluminum - Stainless Steel
- Copper - Stainless Steel
- Galvanized Steel - Stainless Steel

Metal edge systems of a single material are also acceptable if the face, clip, and fastener are all of the same material (e.g. aluminum). In extremely corrosive environments, such as salt water environments, chemical plants or paper mills, use of corrosion resistant materials should be strongly considered, and approved by the owner or specifier.

Do not use copper in conjunction with steel, zinc or aluminum.

Be sure that all fasteners are electrolytically compatible with the other roof edge system components.

G. Flatness

The thickness of the metal controls the flatness of the roof edge. Increasing the metal thickness can reduce the “oil-canning” effect on flat metal surfaces.

Minimum Metal Thicknesses for Flatness

Exposed Face	Galvanized Steel	Cold Rolled Copper	Formed Aluminum
Up to 4”	26 Ga.	16 oz	.032”
4”+ to 8”	24 Ga.	16 oz	.050”
8”+ to 10”	22 Ga.	20 oz	.063”
10”+ to 16”	20 Ga.	N/A	.080”

H. Importance Factor

Buildings fitting any of the criteria listed on the following page should have an “Importance Factor” applied to the wind design calculations.

Building Occupancy Importance Factors (Table 1)

NATURE OF OCCUPANCY	BUILDING CATEGORY
All buildings and structures except those listed below	I
Buildings and structures where the primary occupancy is one in which more than 300 people congregate in one area	II
Buildings and structures designated as essential facilities, including but not limited to: Hospitals and other medical facilities having surgery or medical treatment areas Fire, rescue and police stations Structures and equipment in government communication centers and other facilities required by emergency response Power stations and other utilities required in an emergency Structures having critical national defense capabilities Designated shelters for hurricanes	III
Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities	IV

Source: ASCE 7-93

The wind speed to be used in your calculations is the basic wind speed obtained from the ANSI/ASCE 7-93 document previously mentioned, multiplied by an importance factor from the following table:

Importance Factor (Table 2)

Building Category (From Table 1)	100 Miles From Hurricane Coastline	At Hurricane Coastline
I	1.00	1.05
II	1.07	1.11
III	1.07	1.11
IV	0.95	1.00

Example: Your “building” is a VA Hospital (Building Category III) located in Atlanta with wind speeds determined to be 80 mph. Using Table 2, Multiply 80 mph X 1.07 (importance factor) equals a *design wind speed* of 85.6 mph.

SYSTEM REQUIREMENTS

Resistance of metal edge systems to tear-off when secured to properly installed substrates is *very important* for wind resistance. The attachment of the wood nailer to the substrate should be sufficient to resist 100 pounds per foot. At outside building corners, nailer securement should be reinforced to resist at least 200 pounds per foot.

Although all roof edge systems should be tested according to the tests outlined herein, the following rules will generally produce roof edge designs with sufficient properties:

1. Fascias, copings, etc. should be secured with continuous hook strips of 24 ga. steel, .050" aluminum or metal of equivalent strength at the bottom of the face edge.
2. Hook strips or cleats should be secured with annular threaded nails long enough to penetrate the wood nailer at least 1 inch. Nail heads should be at least 3/16 inch in diameter.
3. Hook strips may be secured with minimum No. 8 screws, long enough to penetrate the nailer 3/4 inch or penetrate metal 3/8 inch.
4. Where velocity pressures are less than 45 lbs/sq.ft., hook strip fasteners should be placed no greater than 24 inches apart.
5. Where velocity pressures are greater than 45 lbs/sq.ft. they should be spaced every 16 inches or closer. Note: There are some manufacturers whose designs are tested to achieve positive hold-down at 12 inches o.c.
6. Where velocity pressures exceed 45 psf, add a screw through the back section (near the center) and at the center of each joint cover or splice plate.
7. Fastener frequency should be doubled in corner regions.
8. Nail heads should be larger than the narrowest dimension of the slotted holes.
9. Fascia and coping sections should be spaced to allow for expansion around the screw, and from piece to piece.
10. To ensure adequate holding, edge designs should include a drip edge which securely engages with the hook strip.

Wood nailers should be pressure treated lumber, minimum thickness 1 1/2 inch, and of sufficient width to extend at least 1/2 inch beyond the edge of the rear flange of the metal edge system used to secure the roofing membrane.

Nailers should be secured with corrosion resistant anchor bolts, countersunk into the wood nailer and attached with nuts and washers. Anchor bolts should be a minimum 1/2 inch diameter, and spaced no farther than 4 feet apart. If the wood nailer is wider than 6 inches, anchor bolts should be staggered to avoid splitting of the wood.

Nailers should be secured either to masonry or to steel decking according to the following requirements:

A. Masonry

When embedded into masonry, anchor bolts should be bent 90 degrees at the base or have heads designed to prevent rotation and slipping out. When hollow block masonry is used at the roof line, cores and voids in the top coarse should be filled with full density concrete. When embedded into light aggregate block, anchor bolts should be embedded a minimum of 12 inches into concrete fill. When heavy aggregate blocks are used, bolts should be embedded a minimum of 8 inches.

B. Concrete and Gypsum Decks

Nailers *should not* be fastened to light weight concrete or gypsum decks. Instead, nailers should be anchored directly to wall structural members using fasteners whose size and locations meet the guidelines stated in Masonry "A" above.

C. Steel Deck

When nailers are anchored directly to steel decks, a steel angle should be installed to take the load. Attach the nailer to it with corrosion resistant anchor bolts that are securely attached to the steel angle. This angle should be specified according to the requirements of the local building codes.

When the deck is a minimum 22 ga. steel, the angle should be secured to the deck with fasteners having a minimum 360 pound pull-out rating. For lighter gauge decks, the fasteners should be tested for a minimum 360 pound pull-out with the type of deck specified. Fasteners should be installed on maximum 12 inch centers. Minimum 5/8 inch galvanized steel washers should be used under screw heads.

D. Additional Wood Members

Additional wood members, such as fascias, cant strips and stacked nailers, should be fastened with corrosion resistant screws having a pull-out resistance of at least 360 pounds per fastener. Screws should be staggered a maximum of 12 inches on center. Spacing should be a maximum of 6 inches on center in corner regions.

E. Nailerless Systems

When the metal edge system is attached directly to masonry or steel without the use of a nailer, its attachment should be tested to resist wind up-lift.

References

1. Minimum Design Loads for Buildings and Other Structures, ANSI/ASCE 7-93
American Society of Civil Engineers, New York, 1994
2. SPRI Fastener Corrosion Guidelines, 1988

Maintenance

The roofing membrane, its continuity, and the roof's attachment to the perimeter should be inspected periodically and repaired as needed. Roof debris which tends to collect along the roof perimeter should be removed to allow easy water runoff. Appliance attachments which may penetrate the water seal, induce electrolysis, or otherwise compromise the effectiveness of the roof edge system, should also be inspected and eliminated wherever possible.

DESIGN OPTIONS

The holding power of the metal edge detail is divided into two considerations:

1. The resistance of the edge to outward and upward forces which tend to blow or peel the edge system off the substrate.
2. The ability of the edge to resist the pull of the roof membrane inward towards the field of the roof.

High performance roof edge details should be selected from manufacturers who *certify* that the products they produce meet or exceed certain performance characteristics (based upon testing) of the building's design requirements.

Other designs may be used, provided they are *tested* and *certified* to meet the wind resistance and termination tests suggested in this document.

Calculation of Design Pressure

Design Pressure, **P**, is obtained by correcting the Theoretical Velocity Pressure, **q**, for a particular location on the building by use of a Pressure Coefficient, **C_p**.

$$P = C_p \times q$$

Velocity Pressure is the theoretical pressure imparted by the kinetic energy of the wind. In practice, aerodynamics will cause actual wind pressures to differ from theoretical values at certain locations on the building. A building with a flat, level (or slightly sloped) roof will experience greater forces at the corners and eaves than on interior roof surfaces because of "eddy effects" at the eaves.

Velocity Pressure:

The theoretical Velocity Pressure, **q**, for a particular building is obtained from Table 3 (on next page) utilizing the Building Exposure category previously discussed and determined under Design Considerations, Section E "BuildingLocation". Because of channeling between buildings and its possible effect upon the uplift at the roof edge, it is recommended that theoretical velocity pressures of Exposure "C" be used in locations defined as Exposure "A". Use Exposure "C" for all buildings with heights 60 ft. or less. Remember to first correct the documented wind speed for the Importance Factor of the building based upon the intended use of the structure.

Velocity Pressures at the Roof Edge (psf) Table 3

Exposure "B"

	Maximum Wind Speed						
Building Height	70 mph	80 mph	90 mph	100 mph	110 mph	120 mph	130 mph
0 - 20 ft	Use Exposure "C"						
> 20 - 40 ft							
> 40 - 60 ft	Use Exposure "C"						
> 60 - 80 ft							
> 80 -100 ft	13	17	21	26	32	38	45
> 100 -120 ft	14	18	23	29	35	42	49
> 120 -140 ft	15	20	25	30	37	44	52
> 140 -160 ft	16	20	26	32	39	46	54
> 160 -180 ft	16	21	27	33	40	48	56
> 180 -200 ft	17	22	28	35	42	50	59
	18	23	29	36	43	52	61

Exposure "C"

	Maximum Wind Speed						
Building Height	70 mph	80 mph	90 mph	100 mph	110 mph	120 mph	130 mph
0 - 20 ft	14	18	23	29	35	41	49
> 20 - 40 ft	16	21	27	33	40	48	56
> 40 - 60 ft	18	23	30	37	44	53	62
> 60 - 80 ft	19	25	32	39	47	56	66
> 80 -100 ft	20	26	33	41	50	59	69
> 100 -120 ft	21	27	35	43	52	61	72
> 120 -140 ft	22	28	36	44	54	64	75
> 140 -160 ft	22	29	37	46	55	66	77
> 160 -180 ft	23	30	38	47	57	67	79
> 180 -200 ft	23	31	39	48	58	69	80

Exposure "D"

	Maximum Wind Speed						
Building Height	70 mph	80 mph	90 mph	100 mph	110 mph	120 mph	130 mph
0 - 20 ft	Use Exposure "C"						
> 20 - 40 ft							
> 40 - 60 ft	Use Exposure "C"						
> 60 - 80 ft							
> 80 -100 ft	23	30	37	46	56	66	78
> 100 -120 ft	23	31	39	48	58	69	81
> 120 -140 ft	24	31	40	49	59	71	83
> 140 -160 ft	25	32	41	50	61	72	85
> 160 -180 ft	25	33	42	52	62	74	87
> 180 -200 ft	26	34	42	52	63	76	89
	26	34	43	54	65	77	90

Pressure Coefficients

Pressure Coefficients, **C_p**, are obtained from Table 4 (below), whose values are based upon common usage in literature and wind tunnel investigation.

**Recommended Pressure Coefficients
for Roof Edge Devices, Table 4**

Roof Perimeter Location	Pressure Coefficient C _p	Direction of Force
Within "Corner" Region	- 2.0 - 3.0	Outward Upward
Between "Corner" Areas	- 1.6 - 2.0	Outward Upward

In the above Table, "Outward" force is a horizontal force acting perpendicular to the building at the roof edge, tending to pull the roof edge off. "Upward" force is the vertical force acting to pull the roof edge up. The minus sign (-) indicates that the pressure is away from the building, tending to pull materials up or off.

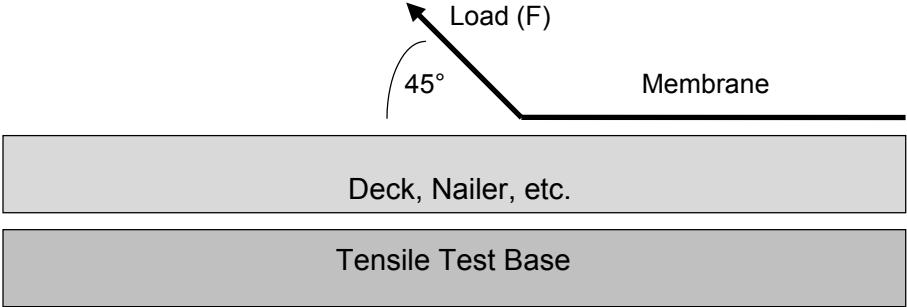
The following criteria are recommended as "minimums" for metal edge securement. Specific project conditions may require higher wind resistance, in which case the building designer should calculate (and design for) the required loads according to local building codes.

A. Membrane Attachment

The design of the metal edge system, when terminating the roofing system, should provide a minimum holding power of 100 pounds per foot, with the force measured in a direction of 45 degrees back onto the roof. SPRI Test Method RE-1 is a membrane termination test specifically for fascias that act as terminations for roofing membranes.

The metal edge system is the last anchor point to hold the roofing material in place should the membrane happen to separate from the roof deck during a high wind. When this happens, the roof system will put a load on the termination. For this reason, the roof edge must withstand a minimum force of 100 lbs/ft when tested using the RE-1 Method.

SPRI Test Method RE-1

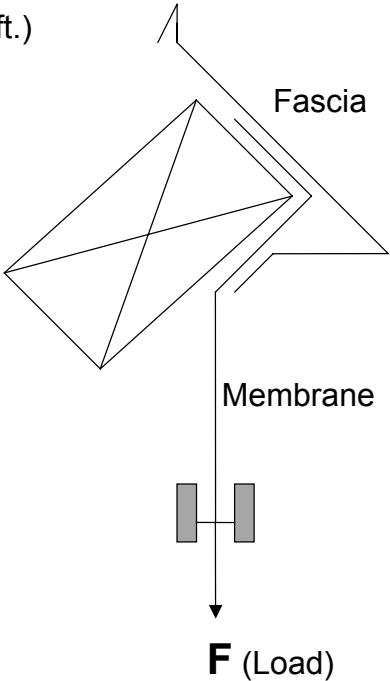


To test this condition, a 12” wide mock-up of the termination system shall be constructed and mounted on the base of a tensile testing device so the roofing material is pulled at a 45° angle to the roof deck, simulating a billowing roof membrane.

The jaws of the tensile tester are connected to two bars which clamp the membrane securely between them so that the load is distributed uniformly along the width of the membrane. The tensile tester is then loaded until failure occurs. Failure is defined as any event which allows the roofing material to come free of the metal edge system, or the metal edge to come free of its mount.

The roof edge termination’s “strength” is satisfactory if the test force (at failure) on a 12” wide sample exceeds 100 pounds.

**Fascia / Membrane Termination
Test Set Schematic
(Force = F = 100 lbs/ft.)**



B. Wind Resistance of Metal Edges

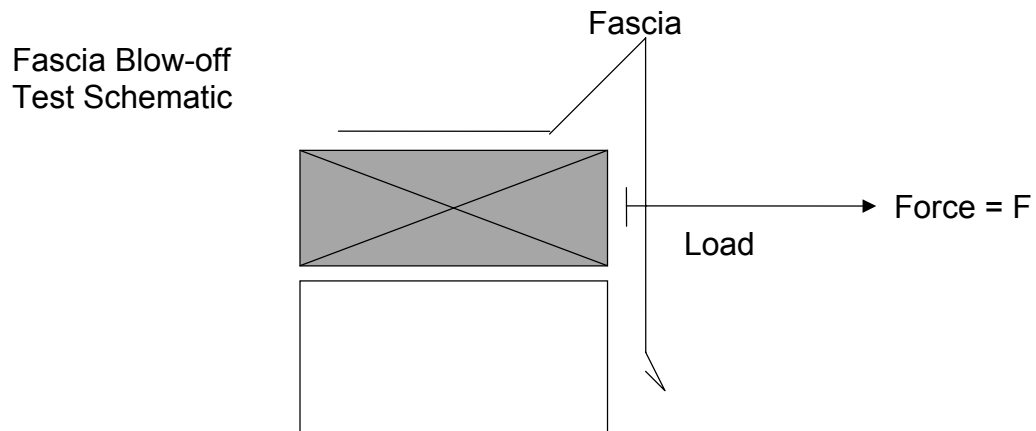
Metal edges are tested uni-directionally when they have an exposed horizontal component width less than half the face height. The exposed horizontal component is a horizontal top not covered by roofing membrane. When the exposed horizontal component is more than half the face height, use the test method prescribed for coping (to follow). Test results must meet or exceed the calculated design wind pressures. SPRI Test RE-2 is a test method for evaluating the blow-off resistance of metal edges.

SPRI Test Method RE-2

This test consists of creating negative pressure differences across a test specimen and observing deformations, the nature of any failures of principal or critical elements of the fascia system profile, or failure of members of the anchor system.

The increments of “load” application shall be chosen so that a sufficient number of observations may be made to determine the exact load at failure. The test apparatus shall be constructed so that the performance of individual components is unaffected by edge or end constraints on the test sample.

This test method is *standard procedure* for evaluating the structural performance under uniform static load. This test is intended to represent the effects of uniform loads on exterior metal fascia systems and any device or equipment capable of performing this test procedure within the tolerances is permitted. Test specimens shall be of sufficient size to determine the performance of all typical linear parts of the system. All parts of the test specimen shall be full size, using the same materials, details, methods of construction and anchoring devices (such as clips or cleats) as used on the actual building. The length of the specimen shall be at least 10 feet.



Loading shall be applied uniformly no greater than 12 inches o.c. to the vertical face of the fascia, and be on the horizontal centerline of the face. Loads shall be applied incrementally and held for not less than 60 seconds at each incremental load. Between incremental loads, loading should be reduced to zero. After a recovery period of not more than 5 minutes (at zero load), initiate the next higher incremental load. Loading shall proceed until the test specimen either fails or exceeds the required design pressure. The last sustained 60 second load *without failure* is the structural design value.

Failure

Failure is defined as the occurrence of any of the following:

1. Loss of securement
2. Permanent deformation
3. Component failure that will not enable the fascia to perform as designed

Test Results

Record the force at the conditions described in Failure (above). This force is converted to pressure by dividing the area of the face:

$$\text{Pressure} = \frac{\text{Outward Force}}{(\text{Height of Face} \times \text{Length})}$$

- Force is measured in pounds force (lbf)
- Length is the test sample length in feet
- Height is in feet (inches/12)
- Pressure is in pounds per square foot (psf)

If test results exceed the design outward pressure, the fascia has acceptable wind blow-off resistance.

C. Wind Resistance of Coping

Copings should be tested bi-directionally (i.e. simultaneously on vertical and horizontal surfaces) on all faces. SPRI Test RE-3 is a method for testing blow-off resistance of copings. Test results must exceed the calculated design wind pressures.

SPRI Test Method RE-3

This test consists of creating negative pressure differences across a test specimen and observing deformations, the nature of any failures of principal or critical elements of the coping system profile, or failure of members of the anchor system.

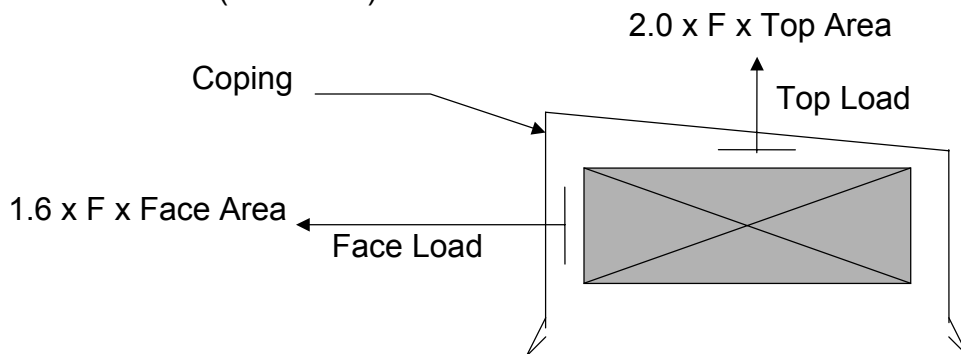
The increments of “load” application shall be chosen so that a sufficient number of observations may be made to determine the exact load at failure. The test apparatus shall be constructed so that the performance of individual components is unaffected by edge or end constraints on the test sample.

This test method is a *standard procedure* for evaluating the coping’s structural performance under uniform static load. This procedure is to represent the effects of uniform loads on exterior metal coping systems and any equipment capable of performing the test procedure within the tolerances is permitted. Test specimens shall be of sufficient size to determine the performance of all typical linear parts of the system. parts of the test specimen shall be full size, using the same materials, details, methods of construction and anchoring devices (such as clips or cleats) as used on the actual building. The length of the specimen shall be at least 10 feet.

Tested coping width and leg lengths must be at least as large as the largest dimension sold or specified, and gauges and material yield strength no greater than the least gauge and yield strength sold or specified.

Coping Bi-Directional - Test Set Schematic

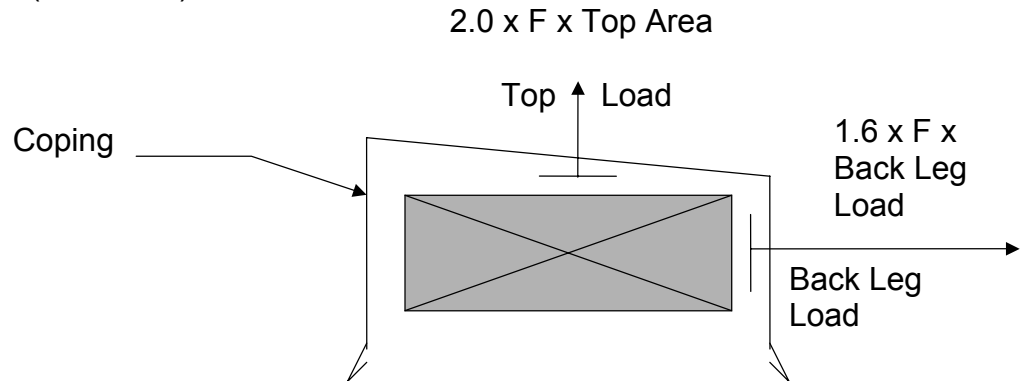
Test A: Top and Face Leg
(Force = F) to Failure



Forces on the face and side are in a ratio of
2.0 x Top Area : 1.6 x Face Leg Area

Coping Bi-Directional - Test Set Schematic

Test B: Top and Back Leg
(Force = F) to Failure



Forces on the face and side are in a ratio of
 $2.0 \times \text{Top Area} : 1.6 \times \text{Face Leg Area}$

Loading shall be applied uniformly no greater than 12" o.c. to the top of the coping and to one of the faces simultaneously, in the proportions that are represented by the pressure coefficients and the size of the exposed surfaces. Loads shall be on parallel horizontal center lines of the faces. Loads shall be applied incrementally and held for not less than 60 seconds at each incremental load. Between incremental loads, the loading should be reduced to zero. After a recovery period of not more than 5 minutes (at zero load), initiate the next higher incremental load. Loading shall proceed until the test specimen either fails or exceeds the required design pressure. The last sustained 60 second load *without failure* is the structural design value.

Both face and back legs must be tested in this manner. Separate test samples must be used for testing the face and back legs; one sample to test the face while loading the top, and the other to test the back leg while loading the top.

Failure

Failure is defined as the occurrence of any of the following:

1. Loss of securement
2. Permanent deformation
3. Component failure that will not enable the coping to perform as designed.

Test Results

Record the upward and outward forces at the conditions described in failure (above). These forces are converted to pressure values by dividing by the area of the surface upon which they act:

$$\text{Upward Pressure} = \frac{\text{Upward Force}}{(\text{Width} \times \text{Length})}$$

$$\text{Outward Pressure} = \frac{\text{Outward Force}}{(\text{Height of Face} \times \text{Length})}$$

- Pressure is in pounds per square foot
- Force is measured in pounds force
- Length is the test sample length in feet
- Width is the horizontal width of the coping in feet (inches/12)
- Height of face is in feet (inches/12). "Face" refers to the back leg or face leg.

If the test results exceed both the design upward and outward wind pressures, the coping has acceptable wind blow-off resistance.

Wind Design Example:

Consider a 95 foot high suburban conference-type hotel building in a southeast coastal region, having a design wind speed of 90 mph. The Exposure Factor for such a building according to the definitions discussed on page (4) would be Exposure "C".

The Importance Factor from Table 1, page (7) would be that of a Category II building (occupancy by more than 300 people in one room). The Importance Factor is used to adjust the basic wind speed (90 mph) as follows:

$$\text{Basic Wind Speed} \times \text{Importance Factor} = \text{Design Wind Speed}$$

$$90 \text{ mph} \quad \times \quad 1.11 \quad = \quad 100 \text{ mph}$$

Consulting Table 3, page 11 for Exposure "C" at 100 mph, the Velocity Pressure for a 95 foot structure at 100 mph is 41 psf. Applying Pressure Coefficients from Table 4, page 12 to this Velocity Pressure we the following design forces:

Example Calculations

Roof Perimeter Location	Design Pressure	Direction of Force
Within "Corner" Region	-2.0 x 41 = -82 psf -3.0 x 41 = -123 psf	Outward Upward
Between "Corner" Areas	-1.6 x 41 = -66 psf -2.0 x 41 = -82 psf	Outward Upward

In this case, a coping must be tested to withstand 66 psf outward force and 82 psf uplift force, with corners capable of withstanding 82 psf outward and 123 psf uplift.

If the perimeter were a gravel stop instead of a coping, it would be required to withstand an outward design force of 66 psf with corners capable of resisting 82 psf, for a 12 inch high gravel stop.

If the gravel stop had a 6 inch face, the required design resistance would be: $0.5 \text{ sq.ft./ft.} \times 66 \text{ lb/sq.ft.} = 33 \text{ lb/ft}$ in the main run and $0.5 \text{ sq.ft./ft.} \times 82 \text{ lb/sq.ft.} = 41 \text{ lb/ft}$ in corner regions

Furthermore, the gravel stop must be tested to restrain a 45° pull of 100 pounds per foot by the roofing membrane.

Conclusion

To provide your clients with long-term, watertight roofing designs *and* proper roof edge performance, specifiers should incorporate the testing guidelines and design considerations discussed in this document. Premanufactured roof edge systems, like those offered by National Sheet Metal Systems, Inc., provide design professionals with the testing, written assurance and performance warranties needed to protect *the edge* as required. The value your clients expect from their investments should never be compromised by specifying or accepting roof edge details that do not meet the guidelines discussed herein.

Accepting substitutions for specified, high performance roof edge systems without the certification that they meet the criteria presented in document, exposes your company to roofing failures and possibly the damaged reputation that goes with it. Is the perceived savings of accepting inferior materials really worth it?