Improving the Wind Resistance of Roof Systems: Asphalt Shingle Roofs

Relatively few homes receive severe structural damage from hurricane and other severe winds. Those few which are severely structurally damaged, however, are often the subject of news coverage and dramatic photographs. These homes are mostly located in immediate beach front areas and represent a very small portion of the total homes damaged by hurricane wind. The vast majority of damaged homes are located inland from the immediate coast in towns, suburbs and cities.

The direct wind damage done to these homes mostly consists of the loss of shingles and other roof coverings. This is, in and of itself, minor damage. It results, however, in major losses due to the infiltration of rain water (both during and after the storm), which damages or destroys walls, floor coverings, ceilings, insulation, furniture, bedding, personal possessions and more.

Fortunately, steps can be taken to reduce the potential for this kind of damage to roofs and the resulting damage to building interiors.

In the summer of 1996, hurricanes Bertha and Fran while sparing most of South Carolina, caused extensive damage along the southern coast of North Carolina. Like hurricane Hugo, Bertha and Fran caused relatively limited structural damage, but damage to roof coverings was far more severe and widespread. In an effort to assess why roofing performed poorly, N.C. Sea Grant hazards specialist, Spencer Rogers, invited Thomas Smith, then research director of the National Roofing Contractors Association (NRCA) to visit the area. Smith, who participated in similar damage evaluations after Hurricane Andrew in south Florida and other hurricanes, spent three days inspecting the most damaged areas.

Following Smith's visit, the following construction guidelines, *Asphalt Shingle Roof System*, were prepared for Blue Sky, a residential construction mitigation project in North Carolina. The guidelines are intended to offer guidance to roofing contractors and homeowners on how to attach asphalt shingle roofs so they are more resistant to hurricane and other severe winds. Research engineers at the Clemson University Wind Load Test Facility worked with Blue Sky staff, the National Roofing Contractors Association Technical Services Department and the Certain Teed Corporation in the development of the guidelines.

Blue Sky Asphalt Shingle Roof System guidelines are not found in current building codes. They are voluntary methods that are intended to complement local codes. These guidelines provide roofing contractors with the opportunity to offer their customers an enhanced level of protection from roof damage due to storm winds and rain.

The guidelines should improve the performance of shingle roofs in high winds. But there is no practical way to make any roof hurricane-proof. More research on asphalt shingle roof performance in high wind conditions, should be forthcoming and may result in improved design and installation recommendations in the future.

Maintaining a watertight roofing system is critical to preventing damage in high wind and heavy rain events like hurricanes. The most common roofing material for houses in many areas of the country is the "three-tab" asphalt shingle. Even though winds in hurricanes Bertha and Fran were well below expected design speeds, shingle damage was widespread and frequently severe, resulting in interior water damage. Field investigations concluded that damage was caused by inadequate workmanship, standards and design. Some shingles were not installed properly, according to the manufacturers recommendations. For example, often shingles were attached with too few and/or improperly positioned nails. Although some shingle roofs performed well, it is apparent from Bertha, Fran, Hugo, Andrew and other hurricanes that adequate national standards to test and certify the wind resistance of roofing systems do not exist. Such standards, together with better quality assurance in the building process, are needed.

When high winds affect a building, it is well established that the highest forces occur along the building edges. On the roof, these locations are near the eaves, ridges, hips and rakes. Damage initiated on these edges can lead to progressive failure of the rest of the roofing. Blue Sky's Asphalt Shingle Roof System guideline is intended to improve the shingle attachment in these high-load areas.

To stop the initiation of damage, it is imperative to keep the exposed shingle tab sealed to the shingle below and to the rest of the roof deck. Applying roofing cement to the outer roof edges by hand, properly locating and applying nails in shingles and taking care to assure the shingle's self-sealing adhesive strip is properly secured will help keep the tabs from lifting. The guidelines include practices to reduce shingle blow-off and improve water resistance if some of the tabs are lifted.

Included in the guidelines is a recommendation to inspect the nailing of the plywood roof deck to the rafters or trusses whenever roof coverings are stripped off by the roofer and inspection is simpler. Renailing of plywood roof decking may not always be standard practice as a part of reroofing, but the addition of nails according to the recommended nailing schedule is an option which the homeowner should consider. Therefore, a table with recommended nail spacing is included in the guidelines.

If the recommended roof deck nailing is not feasible for the entire roof or is cost-prohibitive for the homeowner, a less effective alternative is to nail the plywood panels closest to the roof edges and ridges where the forces are highest. In every case in which re-roofing involves the replacement of old roof covering materials, the roof panels should be inspected and, at a minimum, nails added to meet the present building code standard. Otherwise, even well attached shingles will be lost when the roof panels are blown from or sucked off the roof by storm winds.

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AAMM/IDCP
Construction Guideline

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ID# 1-06-NC
REV.# 3
DATE: 8/12/96

Asphalt Shingle Roof System

This guideline provides information for installing an asphalt shingle roof system including the underlayment on a sheathed roof deck. Nails with a minimum length of 1-1/4", #12 wire gage shank and 3/4" head diameter shall be used to attach asphalt roof shingles and underlayment. Nails must be properly driven with heads flush. Staples are not allowed. Do not install products in accordance with these guidelines if the manufacturer's recommendations are not consistent with these guidelines.

LOCATION:

Where design assumptions equal or exceed local building code requirements and in North Carolina.

DESIGN ASSUMPTIONS:

Roof Slope Range: 4:12 to 12:12

Maximum Mean Roof Height: 33'

Roof Deck Sheathing: 7/16" to 5/8" Wood Structural Sheathing (plywood or OSB), or 1" nominal thickness sheathing boards.

Asphalt Roof Shingle Selection: Three tab shingle complying with ASTM D 3462.

Corrosion Resistance of Nails: Hot dipped galvanized to 1 oz. per square foot, satisfaction of Dade County, FL, Standard PA-114, or better

PROBLEM STATEMENT:

Asphalt shingles can be removed by high winds. Removal forces and turbulence are higher at roof edges, requiring better nailing than is commonly practiced and hand-tabbing of some roof areas with roofing cement. The use of staples provides generally unsatisfactory results in high wind areas. The selection of asphalt shingles is made more difficult by the lack of nationally accepted standards for testing and evaluating high wind performance of installed asphalt shingle roof systems.

ALTERNATIVE/IMPROVEMENT:

Two-ply (full 1/2 lap) underlayment attached with low-profile, capped-head nails or metal disks under roofing nails improves water tightness of the underlayment, thereby reducing potential for water damage if asphalt shingles are damaged or removed during a wind storm. A six-nail pattern is provided to improve the performance of the asphalt roof shingle attachment. Hand tabbing of shingles at the rakes, at the ridge/hips, valleys and for the first course of shingles at the eaves reduces the likelihood of asphalt shingle blow off.

RATIONALE:

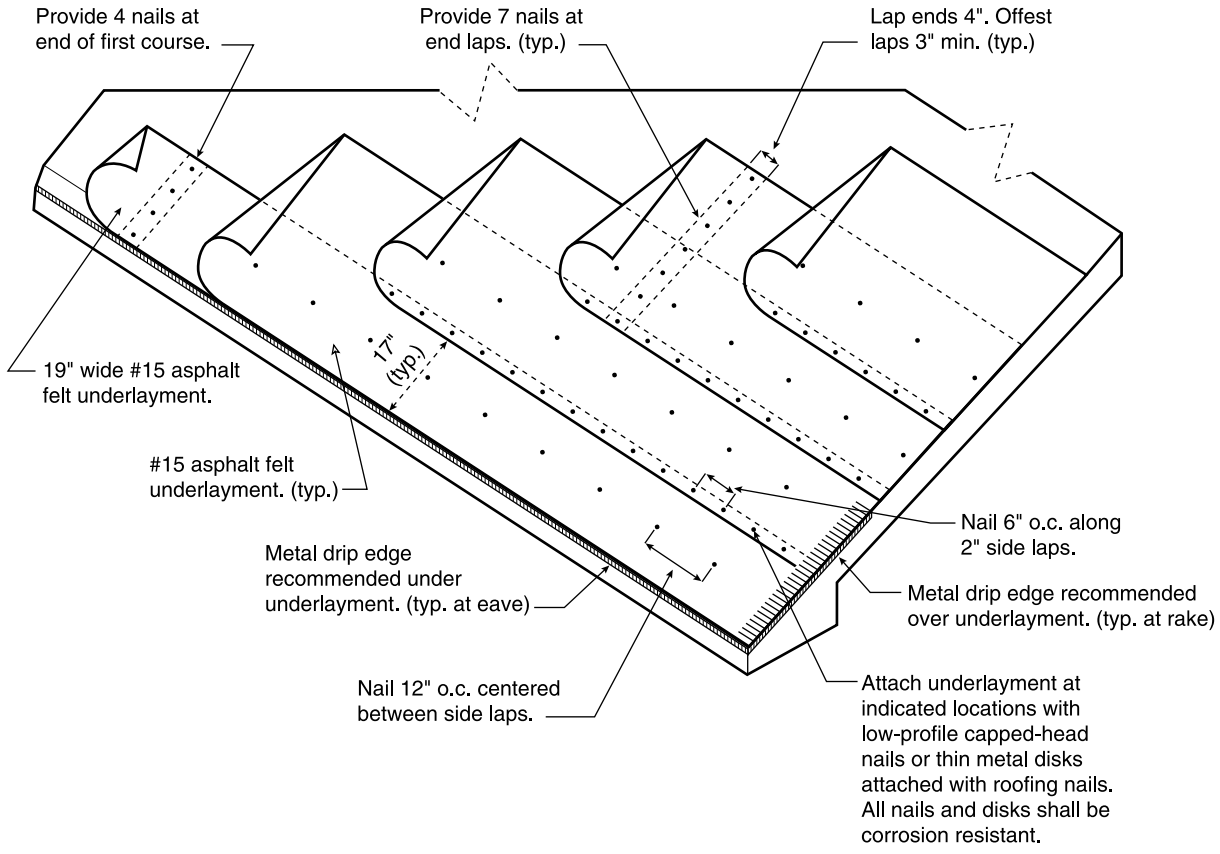
Requiring a two-ply underlayment, fastening asphalt shingles with a six-nail pattern and hand tabbing limited areas on the roof, provides substantial benefit at minimal increased cost by reducing the potential for asphalt shingle failure and water damage subsequent to any shingle damage or removal.

RE-ROOFING:

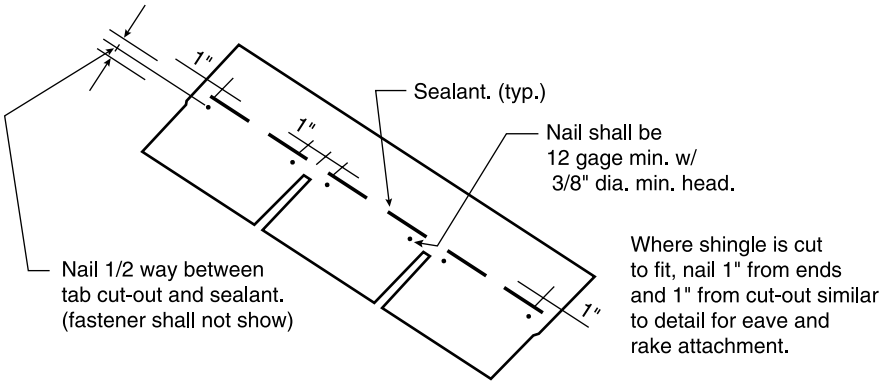
Remove old shingles and underlayment. Inspect roof sheathing for water or structural damage. Prior to installing new underlayment, inspect roof sheathing attachment and drive additional nails as necessary to meet schedule given in the table below.

SPACING OF NAILS ALONG ALL ROOF FRAMING AND BLOCKING			
Spacing of Roof Framing	8d Common Nail (0.131" x 2-1/2" long)	10d Box Nail (0.128" x 3" long)	Power Driven Nail (0.113" x 2-3/8" long)
16" o.c. or less	6" o.c.	6" o.c.	6" o.c.
24" o.c	4" o.c	4" o.c.	4" o.c.

UNDERLAYMENT LAYOUT



TYPICAL ASPHALT SHINGLE ATTACHMENT



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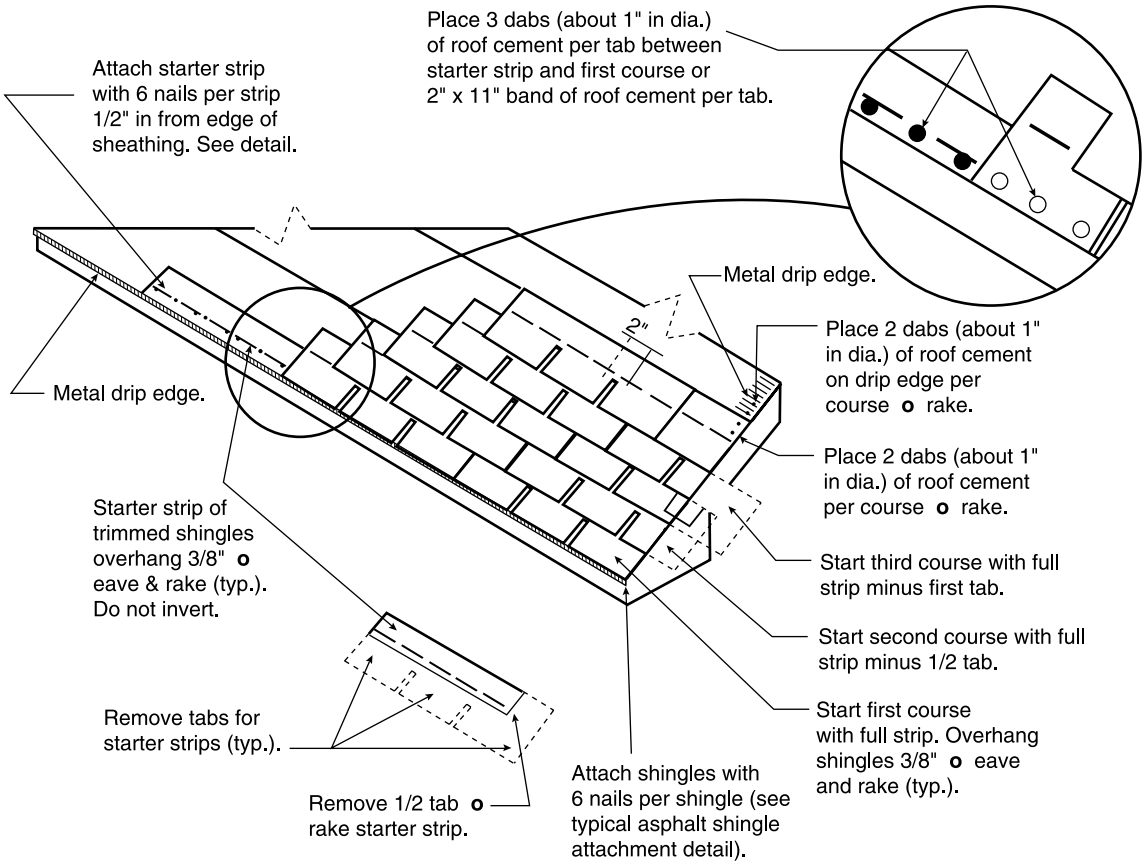
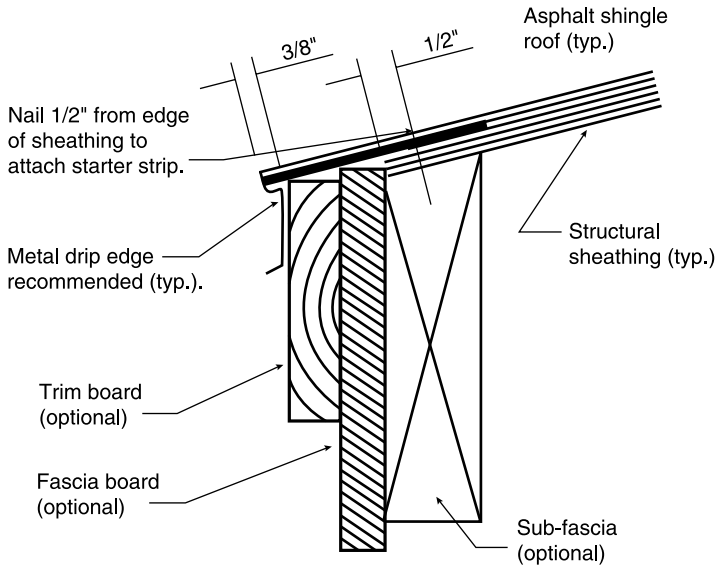
ASPHALT SHINGLE INSTALLATION

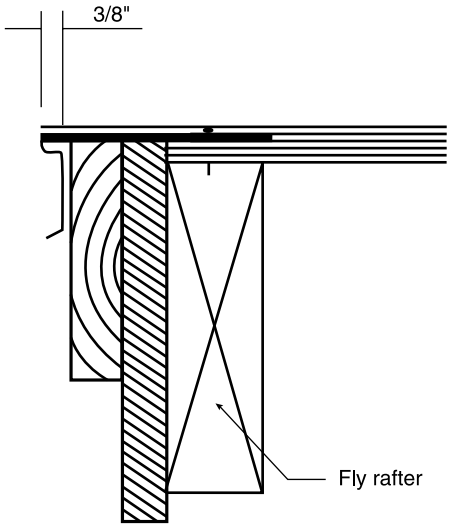


SECTION A-A EAVE DETAIL



SECTION B-B RAKE DETAIL

See Section A-A for Notes.



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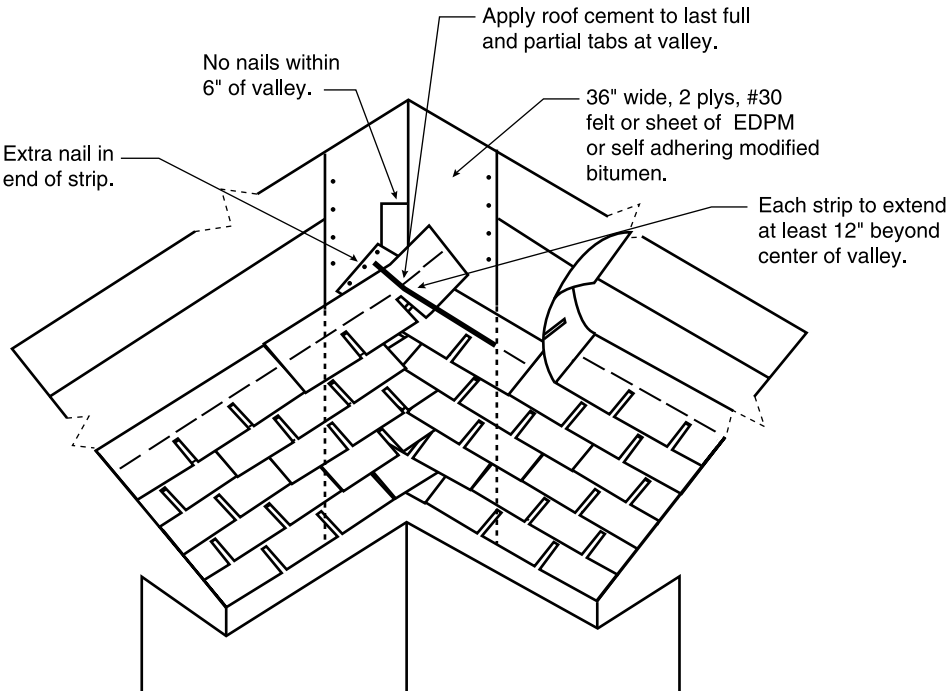
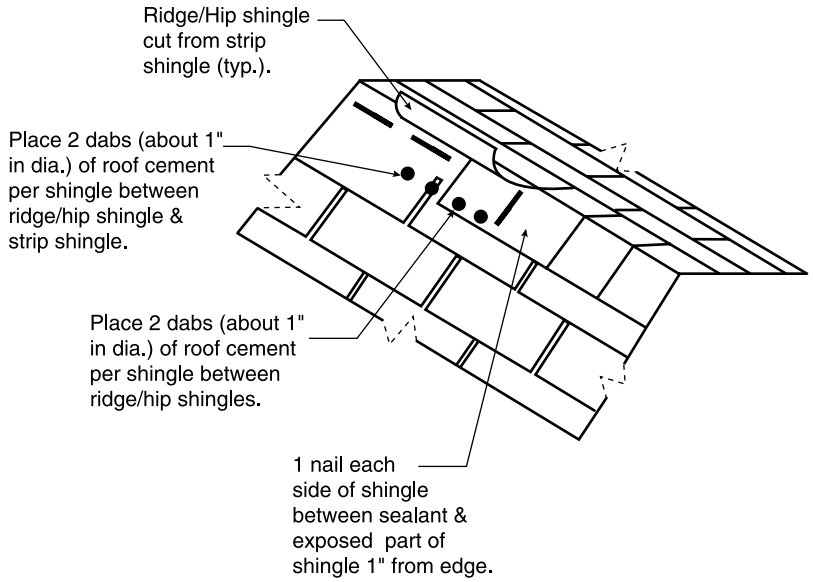
VALLEY DETAIL



RIDGE / HIP DETAIL



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