Student Book
Inspecting Asphalt Shingle Roofs
Online Video Course
InterNACHI

This training will help you inspect asphalt composition shingles and identify defects and damage, as well as determine the sources of those problems as often as possible, and make good recommendations.

We'll learn some general standards and best practices related to shingle manufacture and installation, including the different types of shingles and their performance characteristics, and their related components.

Also covered are the general, industry-accepted methods for installation, where to look for defects, how to recognize them, and how to determine how serious they are. Using a forensic approach to inspecting asphalt shingles, you'll learn to compare what you see to what you know.

ASPHALT SHINGLE COMPONENTS

The terms "asphalt" shingle and "composition" shingle are general terms for the same thing.

The term “composition” is used because the shingles are a composite product made from either a fiberglass or a cellulose mat, and asphalt and minerals, as opposed to a single material, such as wood shingles or clay tiles.

All modern shingles manufactured in North America have mats made of interwoven fiberglass strands, so you may also hear them called "fiberglass" shingles. A modern shingle consists of a fiberglass mat embedded in asphalt, and covered with granules on the surface that faces the weather. The mat, asphalt and granules act together to form a durable, flexible and waterproof assembly.

In the past, shingles were also manufactured using mats made of cellulose-based materials, and these are called "organic" shingles.

Mat

The mat provides the reinforcement that gives shingles the strength to help resist splitting, tearing and pulling over the heads of fasteners.

Resistance to Heat and Humidity

Fiberglass shingles are designed to be resistant to heat and humidity. Warm air can hold more moisture than cold air. Because they absorb less moisture, fiberglass shingles deform less as they age, making them more stable in warm or damp climates.

Also, because the fiberglass mat does not absorb moisture, as fiberglass shingles age and lose volatiles, they deform less than cellulose shingles. “Volatiles” are compounds in asphalt that help keep shingles waterproof, flexible and durable, but which dissipate over time. Most volatile dissipation is due to evaporation from overheating.

Tim Prince

ORGANIC SHINGLES

Organic shingles have not been manufactured since about 2006.

Cellulose used for shingle mat comes from wood chips, and recycled cardboard, rags and paper.

Cellulose mat -- also called felt -- is typically thicker than fiberglass mat.

Because of their thicker, flexible, double-asphalt layer, organic shingles can be more durable in cold climates than fiberglass shingles.

Distortion

As organic shingles age, they slowly lose volatiles. Volatiles are compounds that boil at a low temperature. They dissipate over time, mostly from evaporation.

Volatiles are added into the asphalt mix to help make shingles flexible, durable and waterproof. Since their loss is mainly through evaporation, loss will happen more quickly in warm climates or in homes with poor roof ventilation.

As volatiles dissipate, the cellulose mat becomes dryer and more absorbent.

Absorbing moisture causes shingles to expand and distort.

Since organic shingles near the end of their life can hold considerably more moisture than fiberglass, they can exhibit extreme distortion.

ASPHALT

Asphalt Composition

Asphalt which is used to manufacture shingles may be blended by the shingle manufacturer, or it may be bought from an asphalt supplier already blended. The methods for mixing and applying asphalt are proprietary and manufacturers do not provide information about either process.

The performance characteristics of asphalt vary according to the type and proportion of ingredients added when the asphalt is mixed.

Thickness

The thickness of the asphalt layer affects shingle performance. Shingles with a thicker asphalt layer resist fracture better than similar shingles with a thinner layer.

Thickness varies among manufacturers, and even among different products by the same manufacturer.

Standards require a minimum of 15 pounds of asphalt for every 100 square feet of shingles. This is not per square of installed shingle, but of actual shingle material.

Back-Surfacing

“Back-surfacing” is a coat of finely pulverized mineral, such as talc, sand or limestone. Back-surfacing is applied to the backs of shingles to help keep them from sticking to manufacturing equipment during production and from sticking to each other, once they’re stacked. If you rub your finger on the back of the mat, you can feel the gritty back-surfacing.

Granules

Granules embedded into the weather surfaces of shingles are made from fine-grain, opaque, crushed rock particles. Opaque granules don’t allow light to pass through.

After being run through a screen to help ensure uniformity of size, they’re covered with a colored ceramic coating.

The uniformity with which granules are applied can affect the way they look on the roof.
Granules have four main purposes:

- They reflect sunlight, which helps keep the roof cool. Keeping the roof cool will help slow the loss of volatiles which keep shingles flexible, durable and waterproof. Reflecting sunlight also helps protect the asphalt from the damaging ultraviolet or UV radiation in sunlight.
- Granules add weight, which helps the adhesive strip to bond well and improves wind-resistance.
- They also make shingles more durable by protecting them from weathering and abrasion.
- Lastly, granules improve shingle fire-resistance.

Adhesive Strips

During manufacturing, an adhesive strip of asphalt-like material is applied to the upper surfaces of the shingles. Once shingles are installed, these strips are designed to soften from the heat of the sun and bond to the shingles in the course placed above them.

The adhesive strip is the most important component in providing wind resistance for a shingle roof. Bonding shingles to each other helps them resist uplift and keeps them lying flat so that they expose the minimum amount of surface for the wind to push against.

This bond also helps seal the roof against moisture intrusion and allows the shingles to act, to some degree, as a single, water-resistant membrane.

Cellophane Strips

In order to keep the adhesive strips from sticking to other shingles during storage, a strip of cellophane is installed on the underside of the shingles. These cellophane strips align with the adhesive strips while the shingles are in the package. Once shingles are installed, the cellophane strips no longer align with the adhesive, and the cellophane does not have to be removed. In fact, it should not be removed because it often carries printed information about the shingles.

Based on the information printed on this cellophane strip, you can see that this shingle manufactured by CertainTeed® complies with an ASTM Standard, and that it’s approved for installation in Dade County, Florida, which is a High Velocity Hurricane Zone.

TYPES of ASPHALT SHINGLES

During inspections of roofs with asphalt shingles, you may see one of four basic types: three-tab, laminated, interlocking, or single-piece shingles.

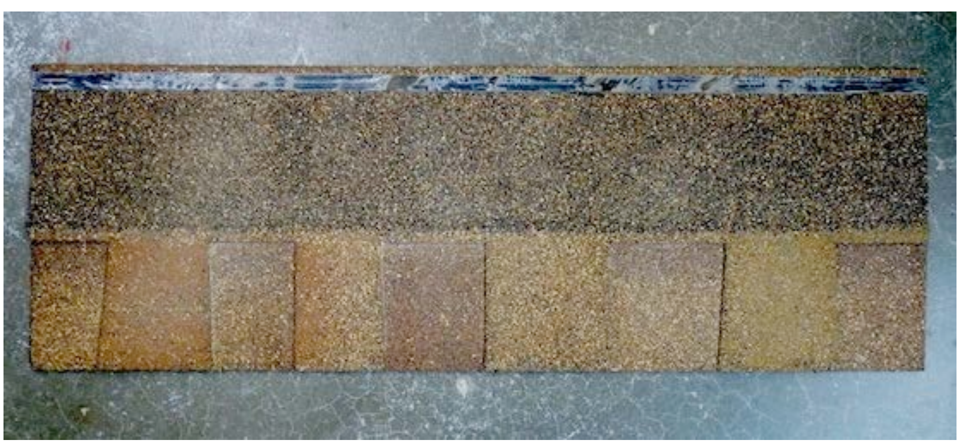
Three-Tab Shingles

This is a three-tab (or 3-tab) shingle. It's a type of strip shingle.

Its main identifying feature is two notches, called cutouts, which separate the lower part of the shingle into three tabs, as you can see here. A three-tab shingle is a single layer thick, usually 12 inches wide and 36 inches long. Metric shingles are a little larger but are less common in the U.S.

Three-tab shingles typically have warranties in the 20- to 30-year range, weigh 200 to 250 pounds per square, and are designed to survive winds of up to 60 miles per hour.

Laminated or Architectural/Dimensional Shingles



This is an example of a laminated shingle, also called an “architectural” or “dimensional” shingle. Both laminated and 3-tab shingles are considered to be strip shingles.

Laminated shingles consist of two or more shingle layers bonded together. The uppermost layers are smaller and cut into shapes.

This gives shingles a more three-dimensional appearance and makes them more interesting to look at. They're sometimes designed to mimic wood shakes.

Laminated shingles typically come in metric sizes, measuring about 39 x 13 inches.

Laminated shingles with 30- to 50-year warranties typically weigh 250 to 300 pounds per square, and are designed with a maximum wind resistance of 70 to 110 miles per hour.

High-Quality Laminated Shingles

Here's an example of a high-quality laminated shingle. Some of the more expensive laminated shingles may have up to five layers and weigh close to 500 pounds per square. These shingles may be designed to withstand winds of up to 130 miles per hour.

Interlocking Shingles

These are examples of the most common type of interlocking shingle. They're called T-locks. Although they're not installed anymore, many homes were roofed with T-locks.

T-lock shingles have no adhesive strip, so they rely on the interlocking profile and fasteners to hold them in place.

The manufacture of T-locks ended about 2006.

CALCULATING and PACKAGING SHINGLES

The amount of asphalt shingles required to cover a roof is calculated by the square. A square is an area 10x10 feet. Shingles are sold by the bundle, and a square may contain from three to six bundles, depending on the shingle design and exposure.

FIELD-CHECKING SHINGLE THICKNESS

The quality of asphalt shingles is generally reflected in the length of the warranty. You can get a good idea of the length of the warranty of strip shingles by checking the shingle thickness using a shingle gauge.

This device has a tapered slot lined with calibration marks that show the warranty connected with the shingle thickness. You won't be able to positively identify the warranty of the roof, but using the gauge allows you to get a good estimate.

Here's how you use it on a three-tab shingle.

When you use the gauge on a laminated shingle, you need to use it on a portion that's only one layer thick. Shingle gauges are less accurate on laminated shingles.

Make it clear that measuring the thickness of the shingle will identify the approximate length of the warranty, but does not accurately reflect the length of its expected service life.

PROBLEMS WITH ASPHALT SHINGLES

Let’s move on to diagnosing problems with asphalt shingles.

Generally speaking, people from three different industries are likely to be inspecting asphalt shingles: insurance claims adjusters; roofing contractors; and home inspectors.

Because of the many factors that can affect the condition of asphalt shingles, it’s not always clear whether a defective condition or functional damage exists. Conditions are not always obvious or either right or wrong.

Let's define the conditions that indicate functional damage or defective installation in asphalt shingles, as well as the criteria used during an inspection to determine whether functional damage exists.

Learning to diagnose roof conditions correctly will help those inspecting shingles to identify the source of the damage.

DEFINITION OF DAMAGE

Because inspections are so often connected with insurance claims, much of the criteria defined here is based on the standards of the insurance industry.

In this training course, “damage” is divided into two categories: functional damage and cosmetic damage.

Functional Damage

Functional damage is damage that insurance companies will pay for. It’s also called covered damage or payable damage.

Functional damage is that which either diminishes the ability of the roof to shed water, or shortens its long-term service life. This is called “premature failure.”

Cosmetic Damage

Cosmetic issues are visual issues, such as discoloration, problems with color blending, or damage that doesn’t meet the definition of functional damage. Some examples of cosmetic damage are general, uniform granule loss, or marring of the shingle surface.

With asphalt shingle roofs, insurance companies typically don’t pay for cosmetic damage.

LONG-TERM SERVICE LIFE

Many different forces and conditions affect the long-term service life of an asphalt shingle roof.

Shingle Quality

Shingle quality is one condition. High-quality shingles resist weathering and damage better than low-quality shingles. The quality and proportions of mat, asphalt and granules are all important variables. Thicker shingles and shingles with multiple layers last longer.

Proper Installation

The quality of the installation is important, too.

Following the manufacturer's recommendations helps maximize the long-term service life.

Manufacturers of a particular type of shingle know best how it will react to damaging and deteriorating forces. They're better equipped than an outside agency at choosing the installation method which will best maximize the shingles' long-term service life. This makes sense in light of the fact that manufacturers issue warranties and have to stand behind their products.

Contractors and installers who do not follow manufacturers' recommendations, but, instead, rely on their own past experience, may diminish the quality and workmanship of roofs so that the structures may not perform as well or last as long, had they followed the manufacturers' recommendations during installation.

Installation methods may not be limited to installation of the shingles themselves. Installation of the substrate, underlayment and/or flashing can also affect the long-term service life of a shingle roof.

Multiple Layers

During some roof inspections, you'll often find newer shingles installed right over old roof-covering materials. Multiple layers get hotter and hold heat longer, so shingles won't last as long, although the roof is less likely to leak. Shingles installed over other shingles will also not have a valid manufacturer's warranty.

Asphalt shingles may have been installed directly over wood shingles. This lowers their impact resistance, since there are likely more voids due to the uneven wood shingle surface.

Directional Orientation

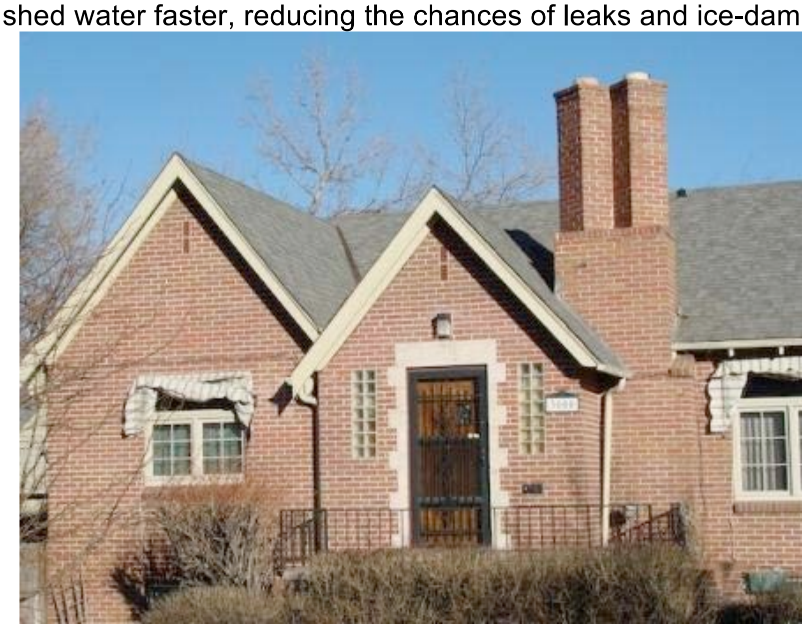
Sunlight deteriorates shingles. Expanses of roof that face south and southwest will get hotter, lose volatiles more quickly, and experience more extreme thermal cycling than slopes facing other directions.

Roof slopes that face the prevailing winds and storm approaches may also deteriorate more quickly than protected slopes.

Roof Design

Roof design features can affect the long-term service life of an asphalt shingle roof.

Steeper pitches shed water faster, reducing the chances of leaks and ice-dam formation.

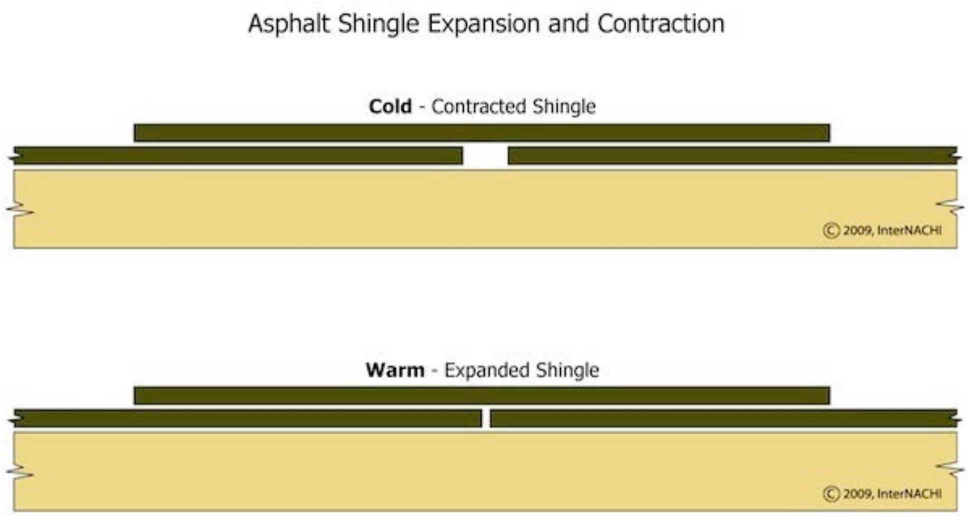


Design features that block roof drainage or cause runoff to slow or pool increase the chance of a roof leak.

Shingles on large, unbroken expanses of roof expand and contract more overall than those on smaller roof areas. Structural features that interrupt the sheathing, such as valleys, hips and dormers, help limit expansion and contraction. Large amounts of expansion and contraction can cause problems, especially when the materials that are fastened to each other, such as roof sheathing and asphalt shingles, expand and contract at different rates.

Thermal Cycling

"Thermal cycling" is the term used to describe the process whereby roofs get hot during day and cold during the night. When they get hot, all the roof components expand, including the shingles. When they get cold, they all contract.



As shingles age, they shrink. This is especially true of organic shingles. As they shrink over the warm part of the year and contract with the cold, shingles that bridge a joint between underlying shingles may split.

The greater the daily differences between high and low temperatures, the more all the roofing components will expand and contract. Roofs exposed to extreme thermal cycling will be less stable and will deteriorate more quickly than those exposed to less cycling.

The amount of thermal cycling experienced by shingles may be affected by:

- the climate zone;
- the number of shingle layers;
- the adequacy of attic ventilation;
- shingle color; and
- the properties of the granule coating.

Shingle Color

Shingle color can influence roof temperatures. The temperature difference between light-colored shingles and dark-colored shingles can be up to 40°.

Reducing the high temperatures that asphalt shingles reach each day can decrease thermal cycling and increase their long-term service life. Light-colored shingles installed on homes in hot climates will probably help extend the long-term service life of asphalt shingles.

Home Site Conditions

Different home site conditions can create different types of problems.

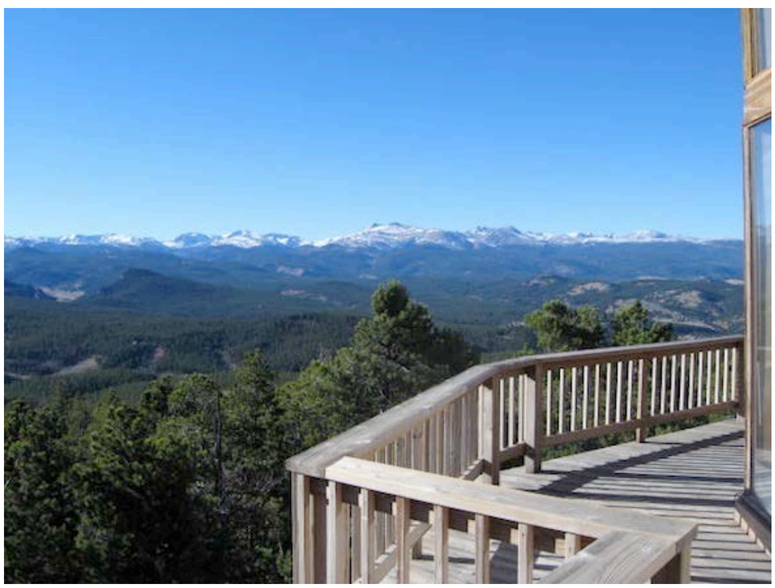
Overhanging tree branches rubbing on the shingles can cause abrasion or tear damage.

Roofs shaded by trees or mountains may stay cooler or may stay excessively moist, which can lead to microbial growth.

Local wildlife, such as squirrels and raccoons, can damage shingle roofs.

Leaves accumulated on the roof and in the gutters can hold moisture against the shingles, and prevent the roof from draining properly.

Elevation



Shingles on homes at higher elevations are exposed to more ultraviolet radiation than homes at lower elevations. Since UV radiation damages the asphalt layers of shingles, shingles installed at higher elevations may have a shorter long-term service life.

Quality of Maintenance

A roof may be poorly maintained for a number of reasons.

People may not understand the importance of maintenance, or they may not know what type of maintenance is required. They may not be able to perform the maintenance themselves, or they may not be able to afford to pay somebody else to do it. They may procrastinate; maintenance may just be low on their list of household priorities.

Failing to perform maintenance, such as cleaning the roof and gutters and repairing roof damage, can shorten the service life of the roof and damage home materials. You'll see plenty of deferred maintenance as you inspect roofs.

SOURCES of DAMAGE

You should have knowledge regarding the common causes of problems with asphalt shingles. These problems can have many different sources. There may be no single cause; the problem may be the result of a combination of factors.

There are six common, general sources of problems. The first is installation.

Installation

To recognize installation problems, you need to understand the fundamentals of installation, along with the properties and limitations of typical roofing materials. So many products and conditions exist that discussing them all lies beyond the scope of this training course.

Most shingles have to be installed according to the manufacturer's recommendations in order to perform as they were designed and for the manufacturer's warranty to remain in effect.

Installers sometimes assume that installation methods are the same for similar shingles made by different manufacturers. This is not always true, and this is a very important point: Similar shingles made by different manufacturers can have very different installation requirements.

Proper installation of asphalt shingles isn't limited only to the manufacturer's recommendations or even to the shingles. Shingles also depend on the proper installation of roof sheathing, underlayment and flashing. They all work together as a system.

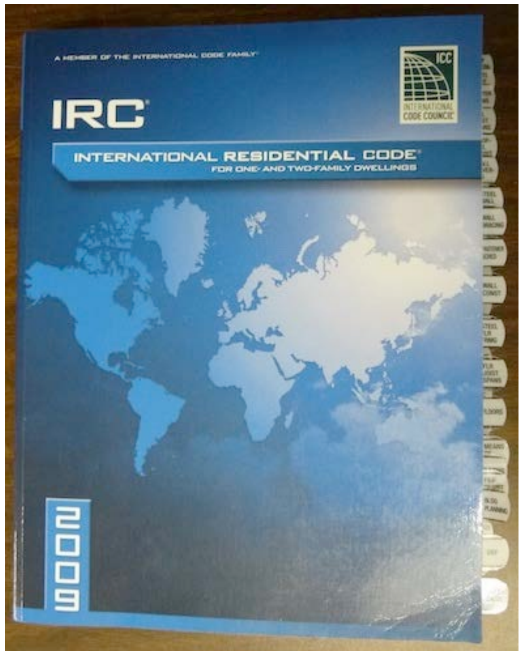
What constitutes proper installation of these three components varies according to who manufactured them and what part of North America the home is located in. Installation may be affected by building codes, too.

Building Codes

The organization or entity with the legal authority to regulate roofing installation is the authority having jurisdiction (AHJ). Typically, the AHJ is the local building department.

Jurisdictions -- whether they're states, provinces, counties or cities -- are free to adopt whatever building codes they choose, or adopt only part of a building code, or adopt no building code at all. AHJs typically defer to the manufacturers' recommendations concerning the installation of asphalt shingles.

A number of building codes exist.



The International Residential Code (IRC) is the building code most widely adopted in the U.S. It is updated every three years, so there are different versions. Before the IRC came into common use, the Uniform Building Code was widely used.

Homes are only required to comply with building codes which were in effect at the time of the home's original construction, or when major work was performed. Homes are not required to be constantly upgraded to comply with newly enacted codes. Remodel work that requires building permits should comply with the building codes in effect at the time the remodel work is done. You should take the time to become familiar with the building codes that apply in your local service area. Regulations often vary from one jurisdiction to another.

UNDERLAYMENT

Let's discuss underlayment.

The IRC and Manufacturers' Recommendations

The IRC gives requirements that vary according to roof pitch and, very generally, with climate. Most major shingle manufacturers also have underlayment recommendations that are in agreement with IRC requirements.

Pitch Requirements

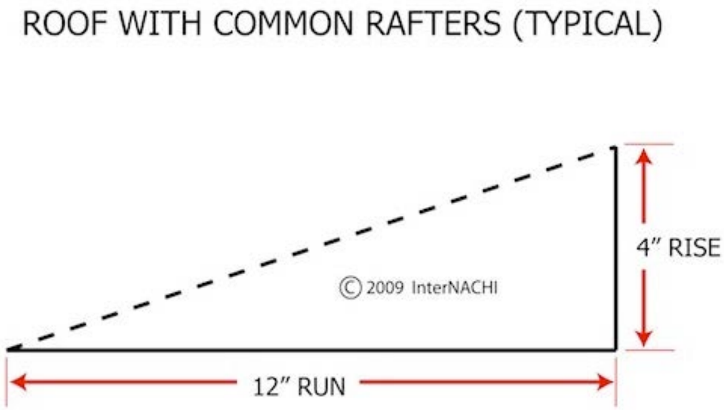
If you find underlayment missing on a roof with a pitch of less than 4:12, you're fairly safe in calling it a defect. Not all shingle manufacturers require underlayment on roofs with steep pitches, when "steep" is defined as 4:12 or more, so be careful about calling missing underlayment a defect. Installing underlayment is always a good idea, but missing underlayment may not be a defect.

Missing or improperly installed underlayment can void any warranty that might be in effect.

Underlayment Installation Requirements

The IRC and shingle manufacturers generally agree on underlayment requirements, which are the same for felt and synthetic types.

The limitations on underlayment installation vary with the pitch of the roof. The pitch of the roof is its angle of slope.



The angle of slope is described by the number of inches the roof rises in each horizontal foot. So, a roof that rises 4 inches vertically for every 12 inches of horizontal is said to have a 4:12 pitch.

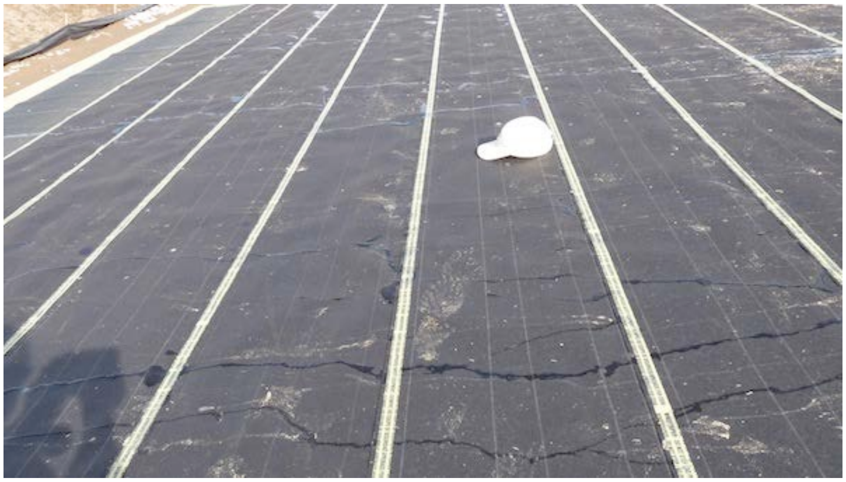
Steep-Slope Roofs

Typically, roofs with pitches of 4:12 and greater require only a single layer of underlayment, with upper courses overlapping lower courses a minimum of 2 inches. Underlayment is always installed starting at the lower roof edge, with upper courses overlapping the lower courses.

So, underlayment on steep-slope roofs should overlap 2 inches.

Low-Slope Roofs

Roof slopes of less than 4:12 down to 2:12 are called low-slope roofs. Two layers of underlayment are required for low-slope roofs. The first course is doubled. Above that, 36-inch wide strips are then applied to the roof in a shingle fashion, starting at the lower roof edge, and overlapping subsequent courses a minimum of 19 inches.

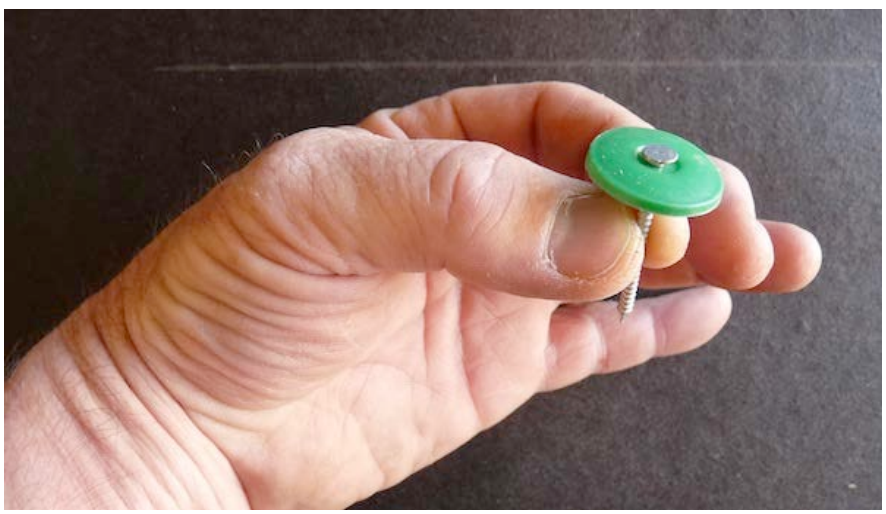


Overlapping 19 inches will ensure that the underlayment is at least two layers thick all over the roof.

So, underlayment on low-slope roofs should overlap 19 inches.

Remember that underlayment on steep-slope roofs should overlap 2 inches. Also, remember that asphalt shingles should never be installed on roofs having a slope of less that 2:12.

Fasteners



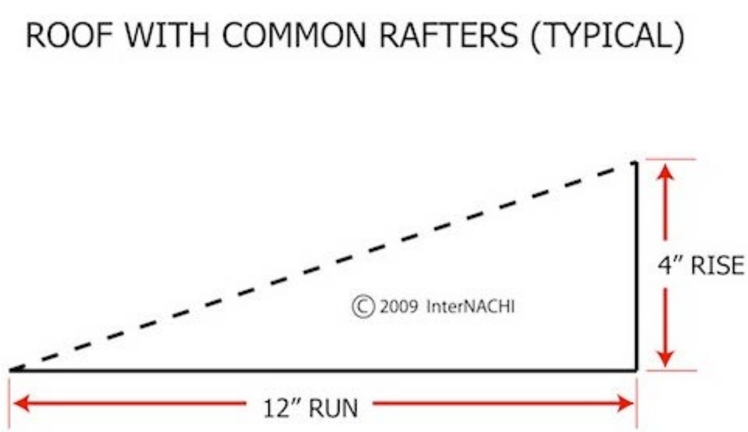
You may also see underlayment installed with plastic-cap nails, which are nails inserted through a plastic disk to increase holding strength, reduce the chance of tearing, and helps reduce slipping while walking on the roof surface.

In areas that are subject to high winds, underlayment is sometimes fastened with windstrips, which are designed to resist tearing.

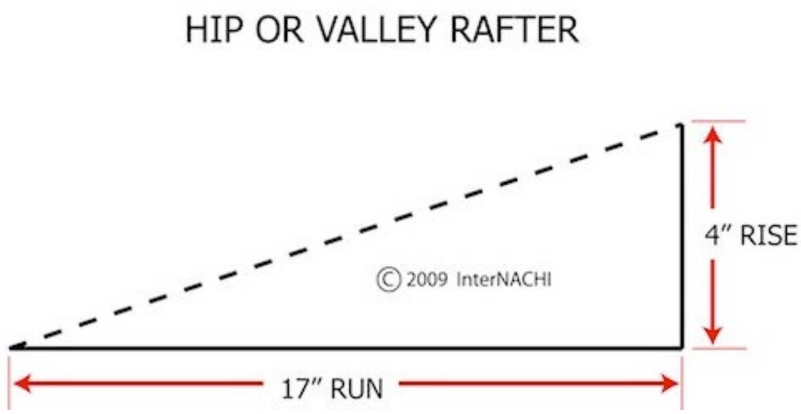
UNDERLAYMENT in VALLEYS

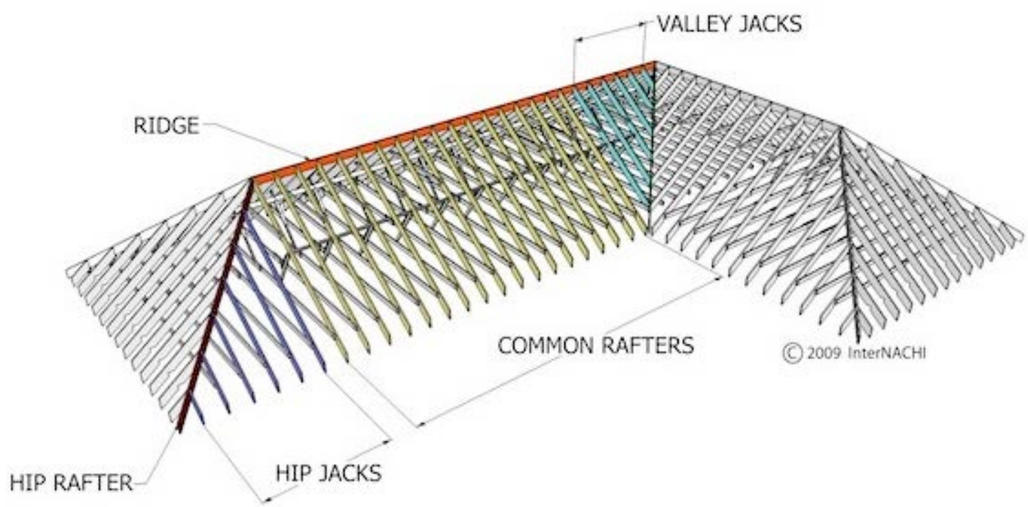
Valleys are created where two roof slopes meet. Valleys are especially vulnerable to leakage for three reasons:

1. **concentrated runoff:** The combined runoff from both roof slopes is concentrated in the valley, so valleys carry more runoff than other parts of the roof;
2. **interrupted roofing:** The roof-covering materials are interrupted by the change in roof direction. Any interruption in the roof-covering material increases the opportunity for leakage; and
3. **less slope:** Although they carry more runoff, valleys slope less than the surrounding roof, so, in addition to carrying more runoff, they drain it more slowly. The chances for leakage increase as the slope of the roof decreases.



Where the rest of the roof slopes at an angle, such as 4:12, where the roof rises 4 inches vertically in every 12 inches of horizontal run a valley would rise 4 inches vertically in every 17 inches of vertical run.





The reason for this is that, although valley rafters rise the same total distance as common rafters, they do it over a longer distance because valley rafters are oriented diagonally to the ridge, and common rafters are oriented perpendicular to the ridge.

Valley Lining

Different methods have been used over the years to line valleys. It can be difficult to tell exactly how the valley is lined on existing homes, so your best bet is to look at the lower end of the valley at the roof edge.

In newer construction or high-quality installation practices, the valley is often lined with self-adhesive underlayment, which comes with a peel-and-stick backing. Another method used is to line the valley with a layer of 90-pound underlayment, similar to roll roofing.

FLASHING, Part 1

IRC Requirements

The IRC doesn't give specific flashing details that have to be followed. It says that flashing has to be corrosion-resistant, and installed in a manner that prevents moisture entry.

Multiple methods can be used to install flashing correctly. You can check to see whether flashing was installed in a manner that will prevent moisture entry, and you can look for corrosion.

The IRC requires roof flashing to be installed in the following locations:

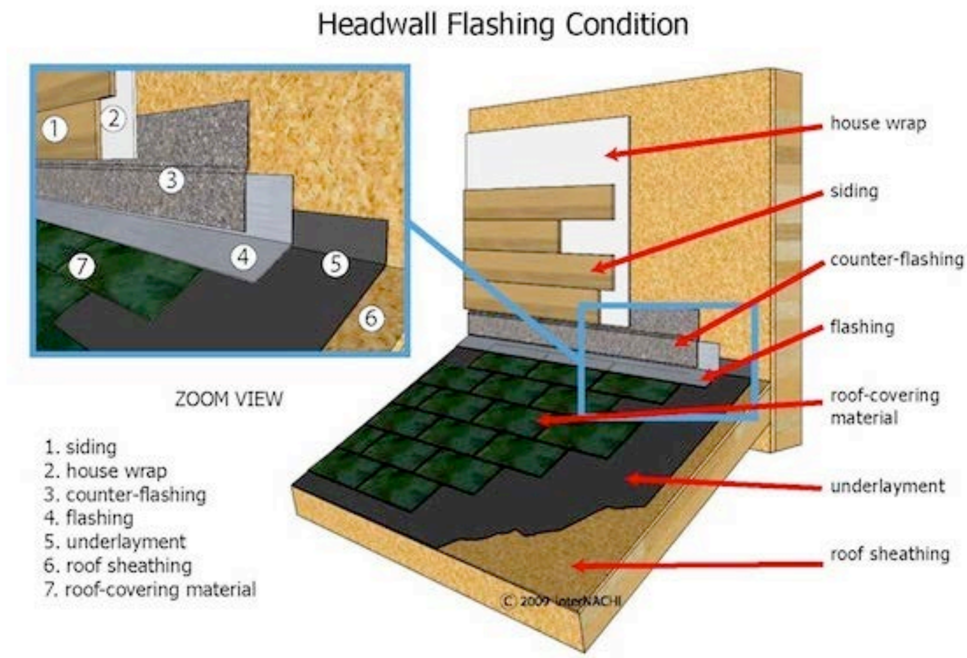
- headwall and sidewall areas (anywhere a roof meets a wall);
- changes in roof slope or direction, which includes changes in pitch, and places where roofs intersect to form hips or valleys; and
- around roof penetrations. "Penetrations" include anything that penetrates the roof, such as chimneys, vents and skylights.

Let's take a look at some of these areas in detail.

ROOF-WALL INTERSECTIONS

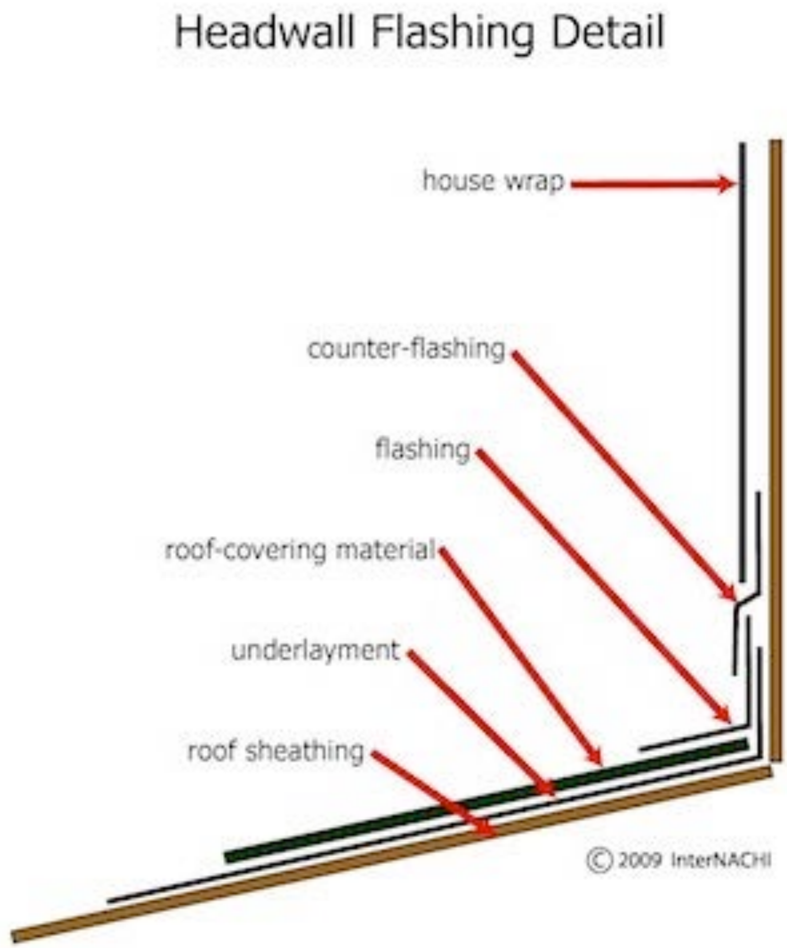
Places where roofs and walls intersect are called headwalls and sidewalls.

Headwall Flashing



A headwall is a junction where the top of a sloped roof meets a wall.

Headwall flashing should extend up behind the exterior wall covering and down over the shingles, as you see here. This image shows counter-flashing installed behind the siding. Sometimes, the exterior wall-covering material serves as the counter-flashing, and this is acceptable.



Flashing should always overlap the roof-covering material. However, for aesthetic reasons, on asphalt shingle roofs, the headwall flashing flange that extends down over the shingles is often covered with a course of shingle tabs.

Here, you see new construction where headwall flashing was installed behind the siding and is waiting for shingles to be installed. The flange that rests on the underlayment is only tacked. Shingle installers will pull the tacked nails and slide the shingles beneath the flashing.
Building codes give no minimum dimensions for headwall flashing that apply to every manufacturer and jurisdiction, so your concern is to check to see whether headwall flashing was installed in a manner that will keep the water out. Common flange sizes are 4x5 inches.

Headwall flashing typically comes bent to 120 degrees. It can be easily flattened for roofs with shallower pitches.

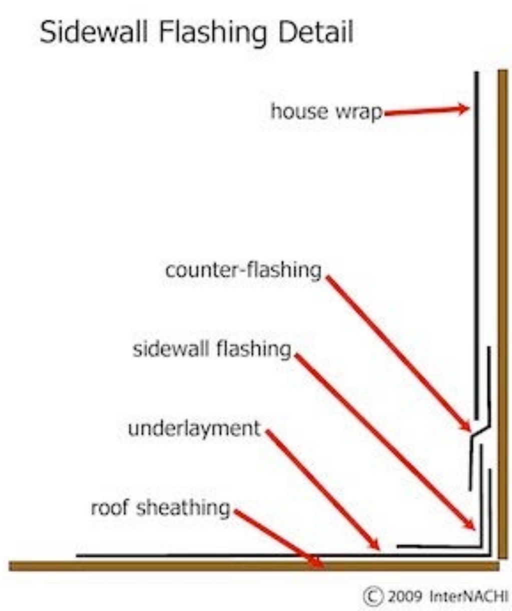
SIDEWALL FLASHING

A sidewall is a junction between a wall and a sloped portion of roof.

Step-Flashing

Sidewalls on roofs covered with asphalt shingles should always be flashed using step-flashing. A step-flashing is a short section of flashing that overlaps each shingle in the course below and is overlapped by each shingle in the course above.

Counter-Flashing



Except where walls are brick, the vertical part of the sidewall flashing should extend up behind the exterior wall-covering, just like with headwalls.

Although you may sometimes see counter-flashing installed, it's more common that the exterior wall covering acts as the counter-flashing. The exception is brick.

Sidewall Defects

If you see continuous, one-piece flashing used as sidewall flashing with shingles, it's a defective installation.

You'll see it fairly often because it's a common defect. It's easier to see in some situations than others.

You'll see sealant substituted for flashing in many different areas on roofs. Sealant will eventually dry, shrink and crack.

Correction is most easily accomplished when the roof is replaced.

The new step-flashing will need to have the vertical flange inserted behind the exterior wall covering. This might require cutting the wall siding up a couple of inches above the surface of the new sheathing.

Considering the age of this home, it may have been correctly flashed when it was first built, but the original flashing may have failed due to corrosion.

Wall-Covering Clearance

In both headwall and sidewall conditions, unless the exterior wall is brick, you should see a gap of at least 1½ inches between the bottom of the exterior wall-covering material and the top of the roof-covering material.

You'll often see siding and stucco installed right down on top of the shingles. Without a gap, the exterior wall-covering can wick up moisture from the roof. This can lead to decay, delamination, peeling paint, and other problems. This condition is especially common on roofs with multiple layers of shingles.

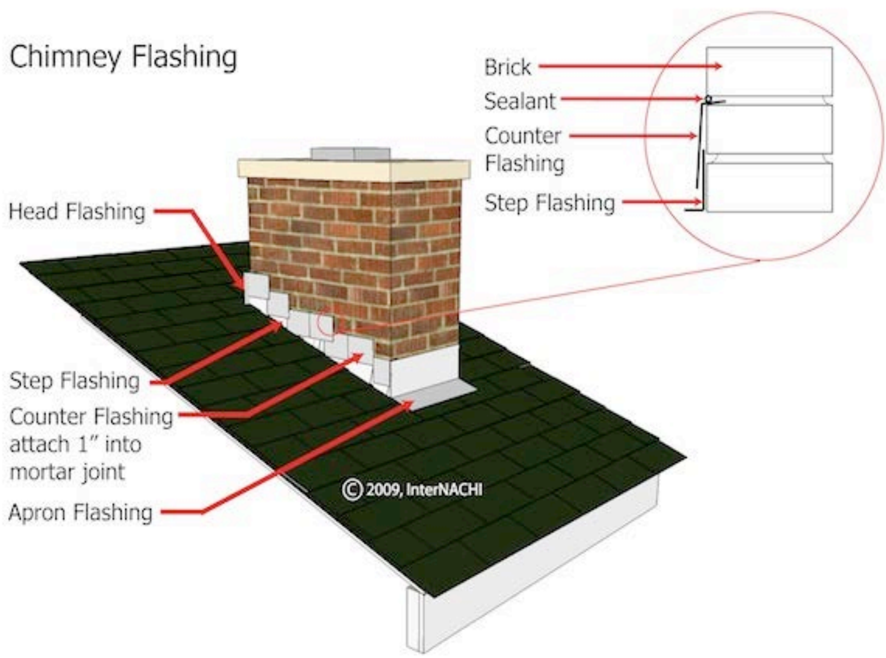
COUNTER-FLASHING

Counter-flashing is designed to prevent moisture from entering behind the vertical flange of headwall and sidewall flashing.

Sometimes, the exterior wall-covering material serves as the counter-flashing, and sometimes a separate counter-flashing may be installed. Counter-flashing is especially important where walls are brick or stone.

Counter-Flashing at Brick Walls

Headwall and sidewall flashing installation becomes more time-consuming to do correctly when the exterior wall covering is brick. It is also more expensive to do, which is why most of the counter-flashing you'll see at brick walls is poorly installed and relies on a sealant alone to prevent moisture intrusion. Sealant eventually dries, shrinks and cracks, leaving an avenue for moisture intrusion.



In brick, counter-flashing sections are inserted into slots cut into the mortar joints, which are then sealed.

Counter-Flashing at Stone Walls

Counter-flashing is also often poorly installed where sidewalls and headwalls are stone. Where stone veneer is installed over concrete block or framing, the vertical flange of the flashing should extend up behind the stone.

Kickout Flashing

Where a wall extends past a roof eave, sidewall flashing stops at the edge of the eave, since this is where the sidewall condition ends. At the lower roof edge, sidewall flashing should extend out from the wall at least a couple of inches and be bent to an angle. This is called "kickout" flashing.

Except for a few manufacturers, in general are no minimum size requirements.

This particular kickout is bigger than most you'll see. Usually, the kickout is cut from a piece of the step-flashing.

The purpose of the kickout flashing is to prevent runoff from entering behind the exterior wall-covering where the flashing ends.

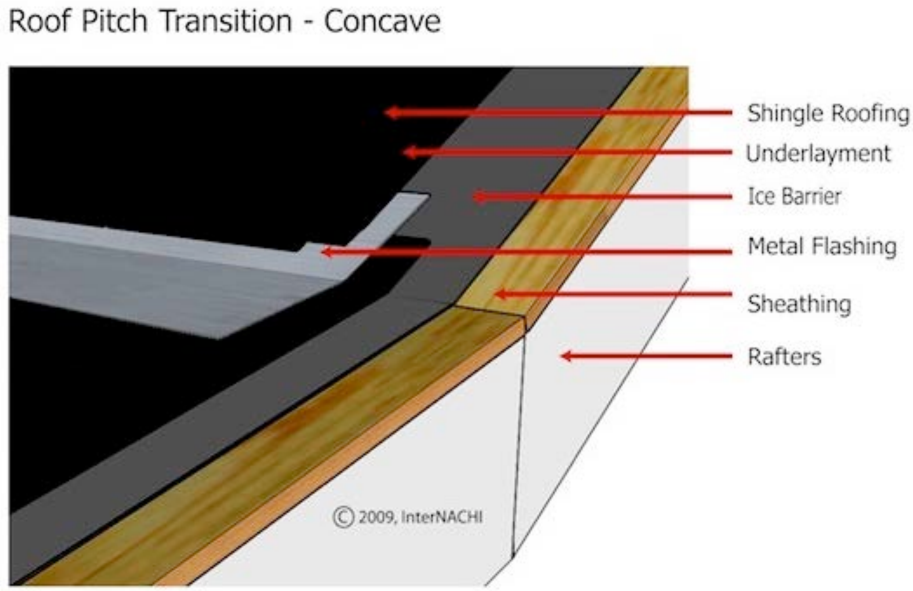
Kickout flashing is required regardless of the type of roof-covering material or exterior wall covering, with the exception of brick and concrete block, since sidewall flashing doesn't penetrate the wall with those types of coverings.

Water cascading down the sidewall joint needs to be diverted to the exterior of the siding when it reaches the edge of the roof. This kickout needs to have a sealant applied to make the kickout waterproof.

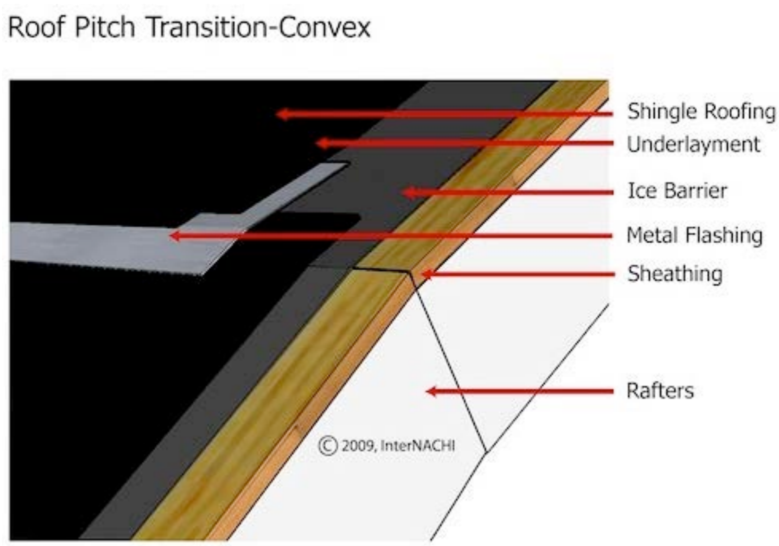
A kickout is easy to fabricate on site. A piece of step-flashing is cut partially through one flange, and the corner is clipped off.

Then, it's bent to shape and installed.

Changes in Pitch



The IRC calls for flashing to be installed in areas where the roof changes pitch. This includes areas at which the roof changes from steep to shallow, and has either a concave or a convex shape.



Drip-Edge Flashing

Drip-edge flashing is flashing installed around the edges of the roof to prevent roof leaks and wood decay of the roof sheathing and fascia. You'll see various flashing profiles used as drip edge. The type of profile you see isn't as important as whether the flashing keeps the water out.

Generally, underlayment should overlap the drip edge at the lower eave, and drip edge should overlap the underlayment on rakes (the sloped roof edge). You may see different profiles, but what's important is that the drip edge prevents moisture entry.

Roof Penetrations

The IRC requires flashing at roof penetrations, such as chimneys, vents and skylights. The flashing must be installed correctly and be in good condition.

A flashing detail common to all penetrations is that flashing is overlapped by the roof-covering material on the uphill side and overlaps the roof-covering material on the downhill side.

Skylights

You'll see skylight flashing installed using a number of methods, depending on the type of skylight, the age, and who installed it.

Some skylights come from the factory with flanges that fit against the roof and are relatively simple to install.

Curb-mounted skylights are mounted on a curb built from 2x4 or 2x6 on edge.

Flashing may be hand-fabricated.

Looking at a few key points will tell you about the quality of the installation. Above the skylight, shingles should stop an inch or so short of the skylight itself to create a melt-water channel. At the two uphill corners, the flashing should extend past the corner at least 1/8-inch. With asphalt shingles, the sides should have step-flashing -- not continuous flashing. At the downhill side, the flashing should overlap the shingles. At the uphill side, the flashing should be overlapped by the shingles.

SHINGLE INSTALLATION METHODS

Slope Limitations

Let's take a look at the actual shingle installation process.

Although we covered them in the articles on underlayment, the following points are worth repeating. There are slope limitations for asphalt shingles.

- On slopes 4:12 and greater, the underlayment should have a 2-inch overlap.
- On slopes from less than 4:12 to 2:12, the underlayment should overlap at least 19 inches.
- Asphalt shingles should never be installed on slopes less than 2:12.

VALLEYS

Valley Types

We know that valleys are especially vulnerable to leakage, so let's look at the different types and the methods used to construct them. You'll see two basic types of valleys: open and closed.

Open Valleys

Open valleys are those in which the roof-covering material stops several inches short of the centerline of the valley. The valley is protected from moisture intrusion by a lining. Today, most linings are made of metal. But in the past, and in low-end installations, roll roofing or a similar material is used.

Failed roll-roofing valley liners are common because roll roofing won't last nearly as long as metal.

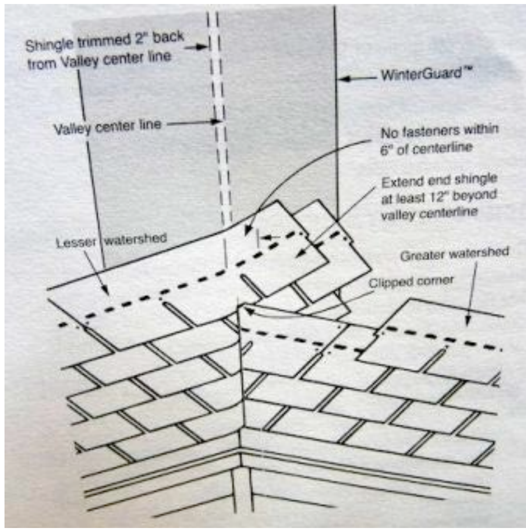
Closed Valleys

Closed valleys are those where shingles on one or both sides of the roof extend across the valley onto the adjacent roof slope.

You'll see two kinds of closed valleys: cut valleys, which the most common, and woven valleys.

Because valley linings for closed valleys are protected by the shingles, the linings are not exposed to weather, abrasion or impact, and may be made of thick underlayment or thinner metal than that used for open valleys.

Cut Valleys



Courtesy of CertainTeed®

With cut valleys, shingles from one roof slope extend several feet onto the adjacent slope, and shingles from the adjacent slope are cut parallel and just short of the center of the valley. In good installations, the top corner of the shingles are clipped to help route any cross-wash back into the valley.

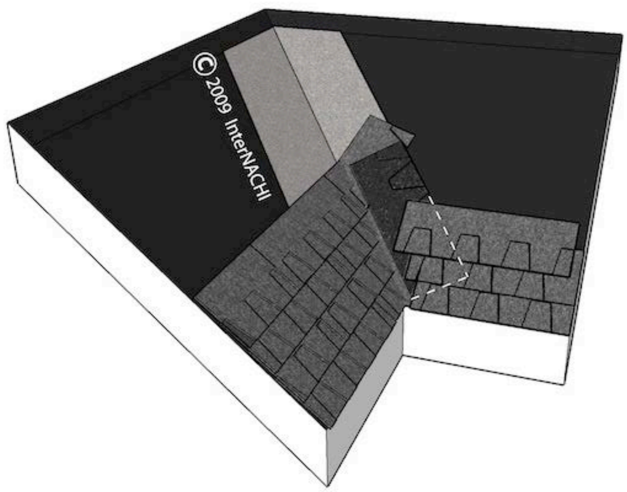
If one slope is steeper or larger than the other, shingles on the larger, steeper slope should be the ones cut parallel to the valley, and shingles on the less steep roof should run through. Since runoff from the smaller roof will be moving more slowly, the valley is less likely to leak due to cross-wash.

California-Cut Valley


Courtesy of Tim Pope

A type of cut valley common in many places appears cut, but it's not. It's sometimes called a "California-cut" valley.

CUT CALIFORNIA VALLEY

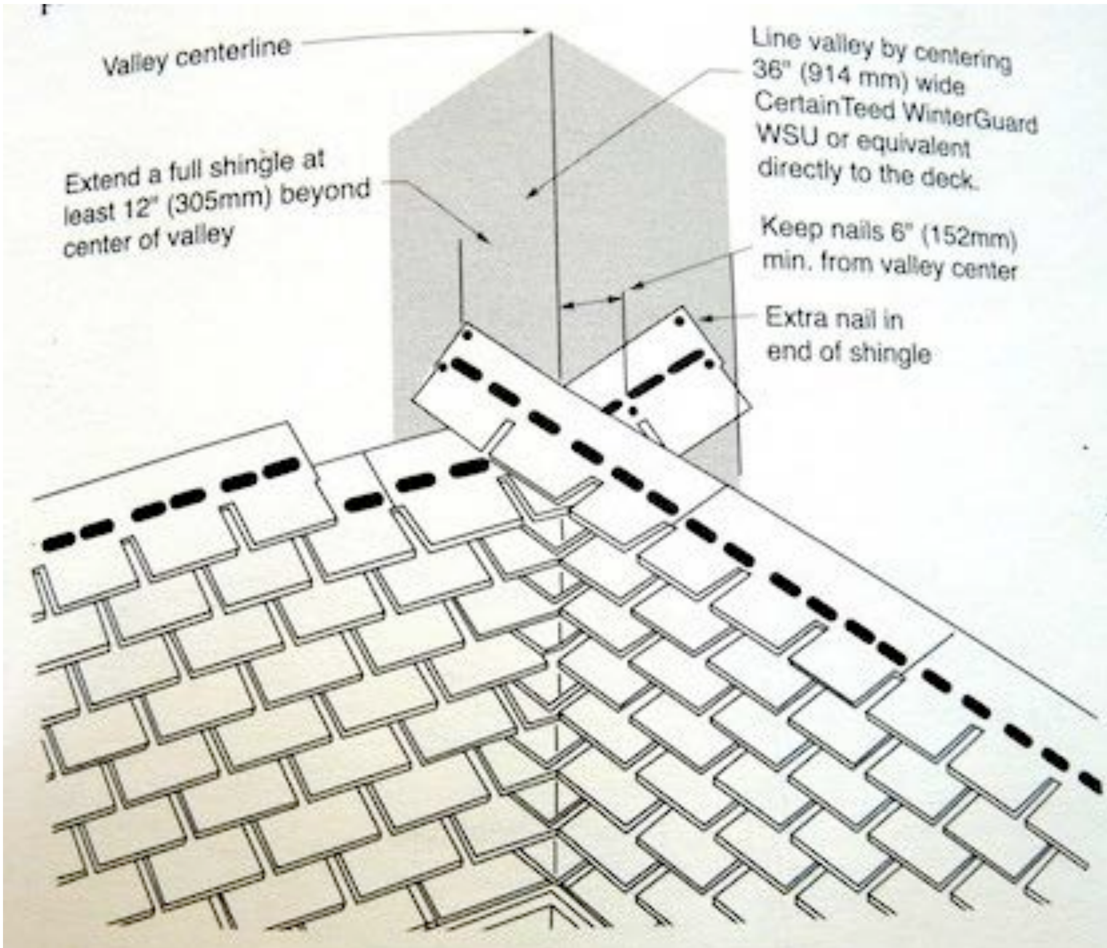


With the California-cut valley, shingles from the smaller roof slope are installed across the valley onto the adjacent slope. A valley shingle is then installed parallel to the centerline and offset a couple of inches.

Shingle courses are installed starting at the bottom. Each course is started at the valley, aligning the bottom corner of the first shingle on each course with the edge of the valley shingle nearest the valley centerline. Each course is terminated by cutting off the shingle at the rake.

As work progresses, additional valley shingles are added. To spot this type of valley, look at the bottom of the valley for the triangular shape of the butt of the first valley shingle installed.

Woven Valleys



Courtesy of CertainTeed®

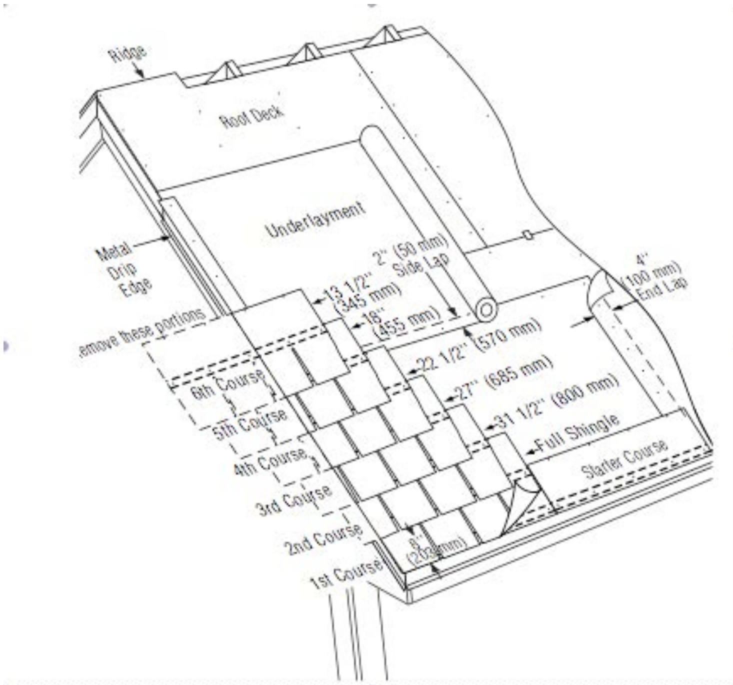
In roofs with woven valleys, shingles from both roof slopes run through onto the adjacent slope, alternating with each course. You'll see this done differently with different types of shingles. It should be done in a manner which will prevent runoff from penetrating the shingles.

Here are some concerns about woven valleys:

- Woven valleys should never be installed on a roof with a pitch of less than 4:12.
- Heavier shingles, such as laminated shingles, may not bend well across the valley and may fail prematurely by cracking.
- When you see woven valleys on older homes, examine the underside of the sheathing carefully for signs of leakage.
- On newer homes, also mention that it may void the manufacturer's warranty.

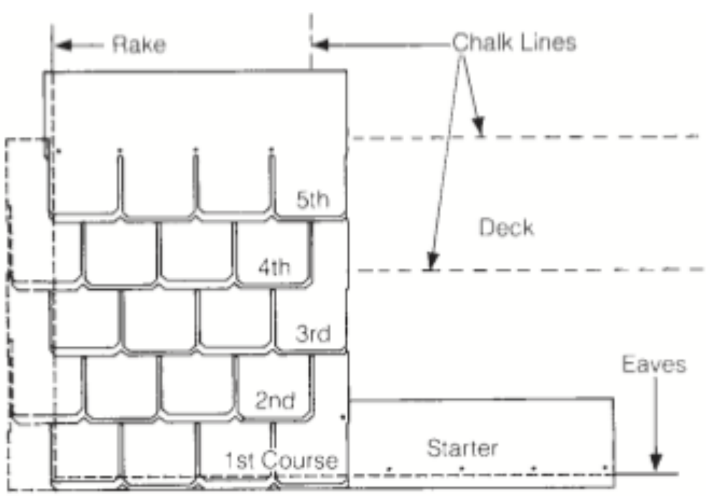
RACKING

Installing shingles vertically up the roof instead of using the traditional stair-step method is called "racking."



Courtesy of CertainTeed®

This diagram shows a conventional offset installation. The amount of offset varies with the model of shingle.



Courtesy of CertainTeed®

This diagram shows shingles installed using the racking method.

Racking is easy to recognize, once you know what to look for. On a racked roof, you'll see joints staggered straight up the roof.

Racking is widely perceived as always being an improper installation. This is often true, but not always. Some manufacturers list racking as an acceptable method of installation for certain types of their shingles, but they also mention that it's not the preferred method.

FASTENERS

One of the key components in the wind resistance of shingles is the fasteners that hold them to the roof.

How effectively fasteners hold shingles in place depends on four things:

- the type of fastener;
- proper fastener installation;
- fastener placement; and
- the holding power of the substrate.

Fastener Type

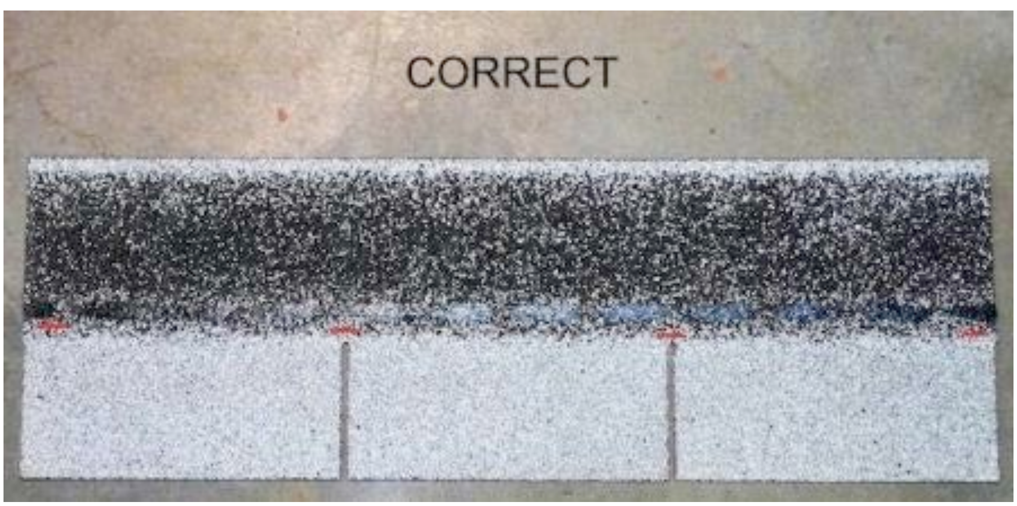
The type of fastener used to fasten the shingles is especially important in resisting wind uplift and pull-through. Fasteners for asphalt shingles should be roofing nails or staples. The head of a roofing nail or the crown of a staple is what actually holds a shingle in place.

Although both nails and staples have been used in the past, staples are often not recommended in areas subject to high winds, and they are not allowed in new construction by the IRC.

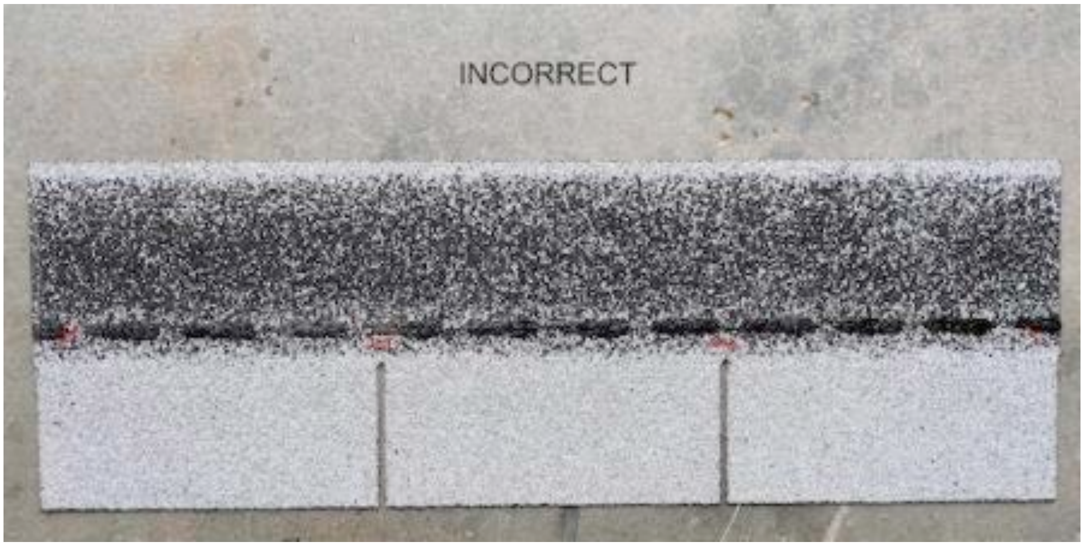
Shingles fastened with staples are often not warranted against wind blow-off.

Both nails and staples have sufficient strength to resist small uplift load on the shingles, as long as the tabs remain sealed. If staples are properly installed, they offer nearly the same wind resistance as nails.

The problem with staples is the orientation of the staple crown.



To hold properly, staples need to be installed with the crowns aligned with the long axis of the shingle. As an installer uses an air-powered staple gun, his natural tendency is to rotate his body.



Unless he also rotates his wrist at the same time, the orientation of the staple crowns will reflect this rotation.

This roof has staples that were poorly installed, and the shingles were poorly bonded, so their wind resistance was low.

The minimum staple crown width is 15/16-inch. Properly installed, stapled shingles will usually withstand wind speeds of up to 60 miles per hour. Upgrading the fastening system requires re-fastening the shingles with roofing nails. The shingles may need to be hand-sealed afterward, since the adhesive bond may not re-seal adequately.

Nails

Some shingle manufacturers specify that their shingles be fastened with nails. You won't know which shingles those are, so that's one more reason that confirming proper fastening exceeds the scope of your inspection.

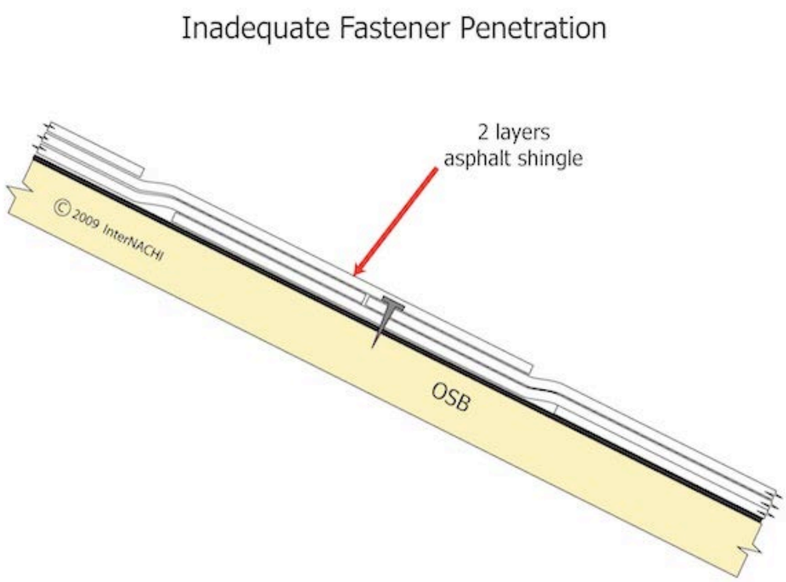
Nails should be corrosion-resistant. Corrosion-resistant nails include galvanized, copper, aluminum and stainless steel.

The minimum nail head diameter is 3/8-inch. Nails must be long enough to penetrate through the sheathing.

Properly Driven Fasteners

Depth of Penetration

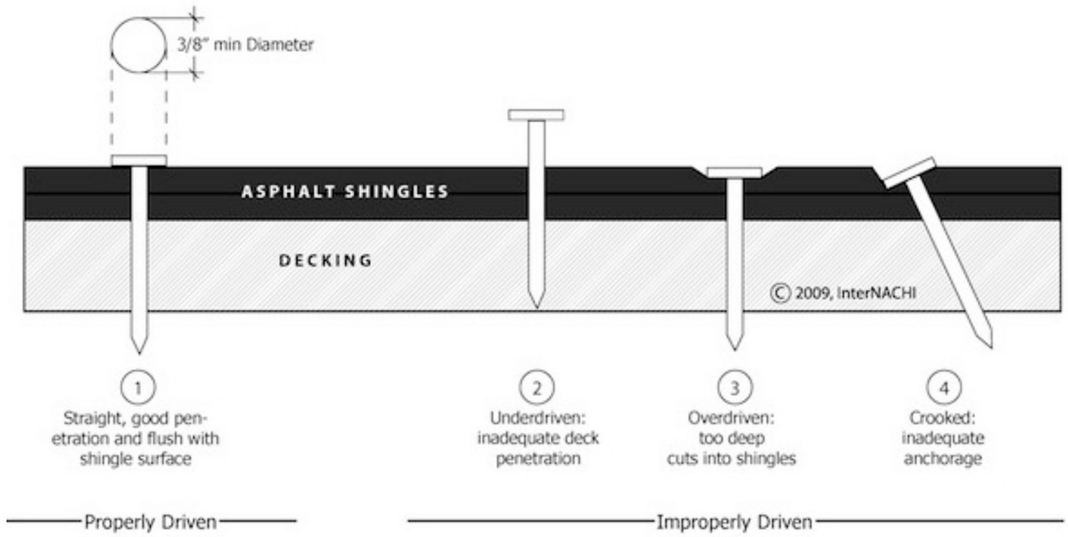
Whatever fasteners are used, they have to be of adequate length. Nails should penetrate a minimum of 3/4-inch (19mm) into the sheathing, or just through the roof sheathing if it's 1/2-inch plywood or OSB. Some manufacturers allow nails with less penetration above exposed soffits if extra nails are used.



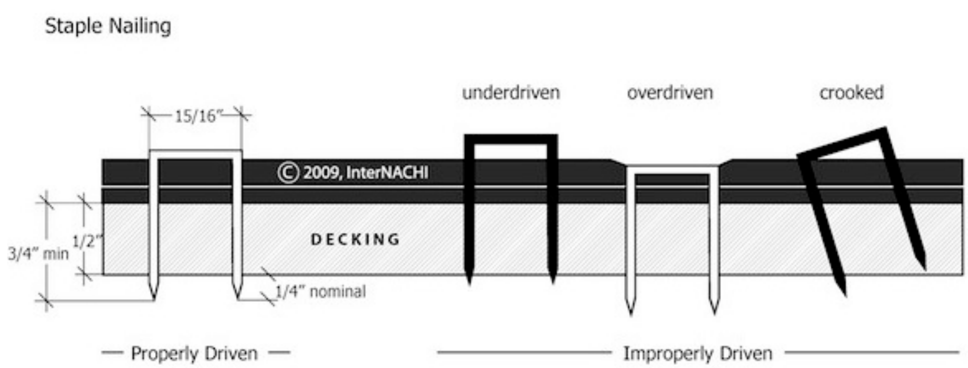
Longer nails are required under certain circumstances, such as:
- when new shingles are installed over existing shingles;
- when thicker shingles, such as high-end, multiple-layer laminated shingles, are used; and
- when fastening hip and ridge cap shingles or ridge vent cap shingles. This is especially true when a continuous ridge vent is installed.

If you see many loose or missing shingles, be sure to check the method of fastening.

Nails and staples have to be driven to the proper depth.



When nails are fastened with an air compressor-powered nail gun, it's not uncommon for nails to be over-driven. Over-driven nails cut into the shingles, reducing their wind resistance. Nails driven at an angle cause the same problem. Under-driven nails protrude and, over time, will wear a hole in the overlying shingle.

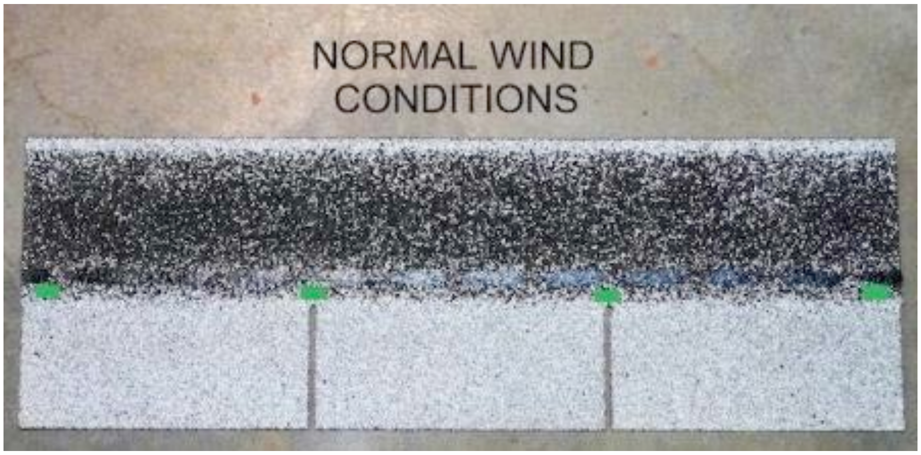


The same is true of staples. Over-driving, under-driving, and driving staples at an angle can be even more of a problem than with nails due to the shape of the staple crown. Again, with staples, proper crown orientation is crucial to maintaining wind resistance. Staples should be installed with the crowns parallel to the long edges of the shingles.

Fastener Placement

Fastener placement is specified by manufacturers, and it's often similar for similar types of shingles.

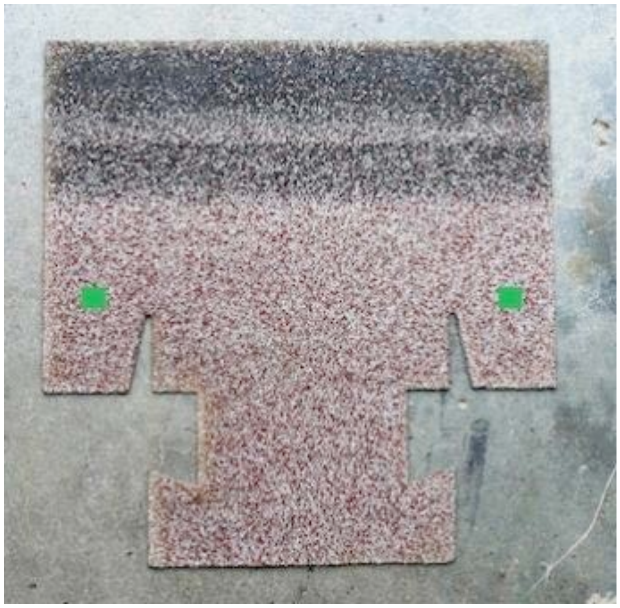
Conventional Pattern



The green areas on this 3-tab shingle show the typical nail placement on homes in areas with normal wind conditions.

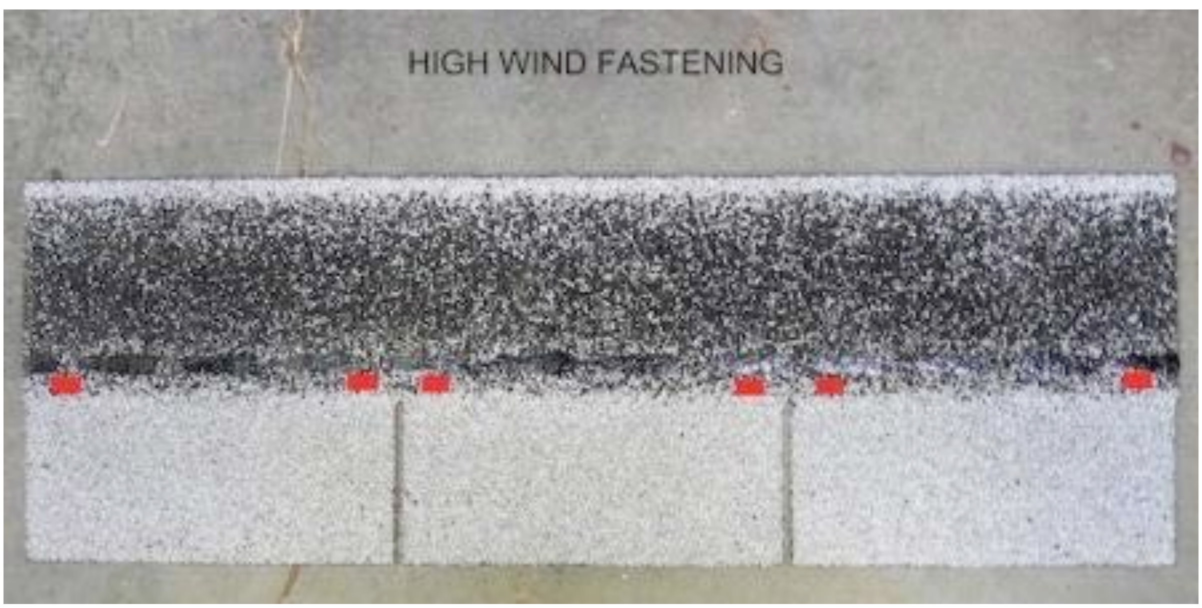
Typical 3-tab and laminate shingle installations require a total of four nails spaced evenly across the shingle.

Other types of shingles, such as this heavy laminate, have similar requirements for normal wind.



T-locks have different fastener placement requirements.

High Wind Pattern



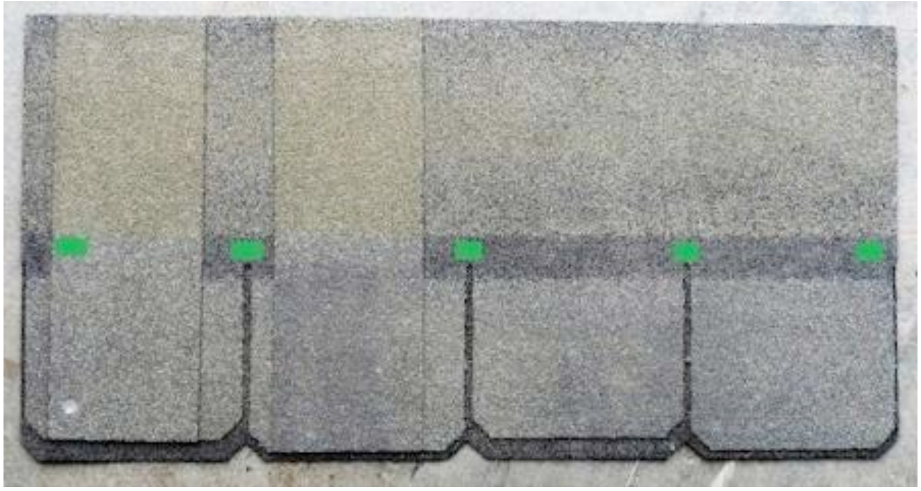
Some areas are designated as “high wind” by the local AHJ. Strip shingles in high-wind areas typically require a total of six nails. The high-wind schedule requires placing two nails instead of one at each of the inner positions. These nails should be 2 to 3 inches apart. The red areas here show nail placement for high-wind conditions.

Some rules apply to almost all shingles. Placing nails in the adhesive strip can cause the shingles to fail to seal properly, reducing their wind resistance.

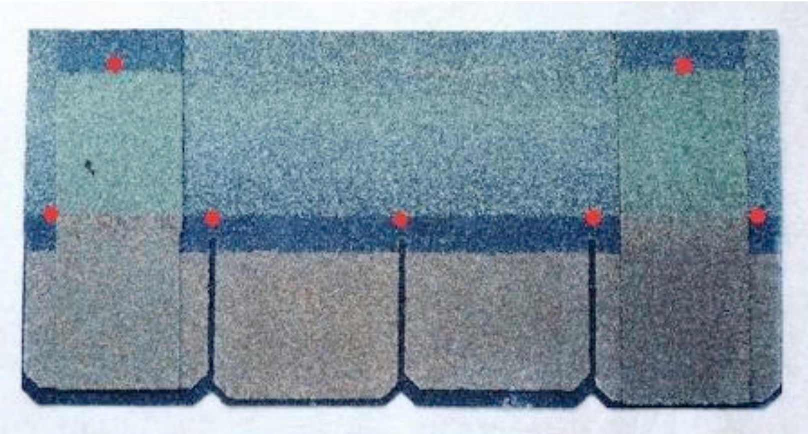
Placing fasteners above the adhesive strip, called “high-nailing,” will also reduce the shingle’s wind resistance.

On strip shingles, fastener placement should be limited to areas within the green strip.

High-nailing is common, and you should remember that, even though you’ll see it often, high-nailing is improper installation and should be described that way in the report. Correction involves placing nails in the proper locations and hand-sealing the affected shingles because, once the adhesive strips have been broken loose, they may not re-seal themselves adequately. If shingles are old and brittle, it may be impossible to re-fasten them without damaging them.



These heavy, laminated shingles have different fastening requirements. This is the recommended fastening for roofs with pitches less than 21:12.



For pitches greater than 21:12, the manufacturer requires additional nails within 1½ inches of the top of the shingle. You won’t see them unless you’re watching the roof being installed.

Exposed nails will corrode over time, and expansion and contraction may eventually expand the nail holes enough to allow leakage. Shingle manufacturers recommend replacing any shingles with exposed fasteners. They consider caulking nail heads to be a temporary repair.

Substrate Holding Power

Deteriorated roof decks can lose a lot of their power to hold fasteners. Decay is one of the most common causes. If you see shingle loss due to fastener withdrawal, look at the condition of the underlying roof deck, especially if the affected area is vulnerable to leakage, such as near a roof penetration.

Checking for Proper Fastening

Confirmation is impractical for two reasons. First, fastening schedules vary with different models of shingles. As an inspector, you won't know the fastening requirements unless you identify the manufacturer and model of the shingles on the roof, and research the fastening requirements. Maybe that information will still be available somewhere, but maybe not. Trying to find it may use up a lot of your time that your client may or may not pay for. Second, the only way to confirm proper fastening of an entire roof is to break the bonds of all the adhesive strips on the roof, and that will damage the roof. Breaking the bonds would seriously compromise the wind resistance of the roof and could easily damage it permanently.

If you want to check for proper fastening in a representative number of places, after breaking the bond, you'll need to hand-seal any affected shingles to help ensure that they fully re-bond. At best, it will take time for any bonds you break to re-seal. If the weather is cold, re-sealing may take months.

Before they bond, shingles have much lower wind resistance, so if you break the bonds of shingles and they blow off, you may be asked to pay for repairs. If a big wind comes up and blows the adhesive strip or roof cement full of dust and debris, the shingle will never fully bond. It's better if you don't break the bonds of any shingles. If you do, you may be liable for damage caused by reduced wind resistance.

RE-ROOFING OVER EXISTING SHINGLES

When it's time to install a new roof, homeowners face the choice of whether to have the existing shingles removed before installing new ones. Most jurisdictions limit the number of layers allowed on a roof before removal of all layers is required prior to installing new shingles. In most places, the maximum is two or three layers. In a few places, it's only one layer.
Installing new shingles over old has some disadvantages:

- It will void any manufacturer's warranty.
- Shingles will dissipate heat more slowly, which will shorten their lifespan.
- Shingles may radiate more heat into the living space, increasing cooling costs.
- "Telegraphing" can be an issue when new roofs are installed over old. The new shingles can conform to the older shingles beneath them and follow any humps or low spots. Telegraphing is even more obvious when asphalt shingles have been installed over wood shingles. As runoff flows down the roof, this unevenness can create areas of increased friction, which results in premature failure of the new roof over those areas.

It's important to understand that roofs with new shingles installed over old will not last as long as roofs with shingles installed over a proper substrate.

There are really only a couple of advantages to installing new shingles over old. One is the money saved by not having to pay for removal and disposal of the existing shingles. The other is the fact that the additional layers will reduce the chances of moisture finding its way through the shingles and causing leaks.

You can sometimes spot shingles installed over wood from the street because the roof looks sort of lumpy.

Usually, you can confirm it by looking at the roof edge at the eaves or rakes.

Reduced Impact Resistance

New shingles installed over existing shingles will be less impact-resistant. This is important in areas that experience significant hailstorms. Newer shingles installed over old roofing will not be as well-supported as when they're installed on a proper roof deck.

Areas where new shingles bridge the butts of old shingles are unsupported. Even these small voids make asphalt shingles more vulnerable to impact damage.

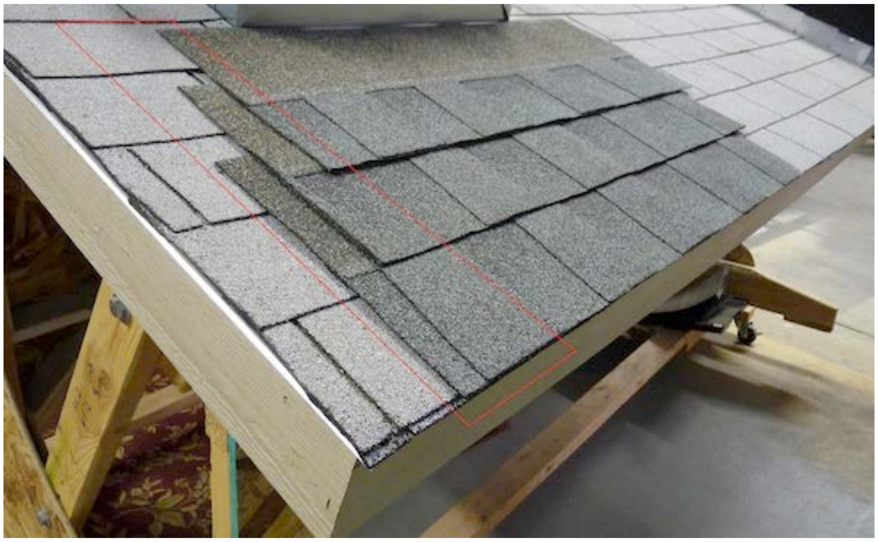
Bridging and Nesting

Bridging and nesting are methods for covering standard-size shingles, such as 3-tab, with a layer of larger, metric-size shingles, such as laminated shingles.

Bridging

Using the “bridging” method, shingles are installed starting at the lower edge of the roof as if they were being installed directly onto sheathing. They’re installed with the exposure recommended by the manufacturer. There will be unsupported areas beneath the new shingles where they bridge the butts of the old shingles, as you can see here. These voids are especially vulnerable to damage from impact.

In addition to reduced impact resistance, the underlying shingles may “telegraph through” the new shingles and become visible. They’ll look like horizontal ridges in the newer shingles.



In this example of bridged shingles, you can see the tops of new shingles overlapping the butts of the existing shingles.

Nesting

Using the “nesting” method, the tops of new shingles are butted against the lower edge of the old shingles in the course above. Although this method leaves less exposure, it reduces the chance that underlying shingles will telegraph through and become visible.

In this example of nested shingles, you can see the tops of new shingles butting the bottoms of the existing shingles.

ASPHALT SHINGLE WEATHERING

"Weathering" is a general term used to describe the effects on shingles of long-term exposure to the elements.

Weathered shingles aren't necessarily damaged shingles, although weathering will eventually damage shingles. Weathering is a natural process that causes shingles to deteriorate over time. The rate at which shingles weather can be affected by a number of things.

Shingle Quality
Low-quality shingles will fail before high-quality shingles. Quality can vary widely among manufacturers, and even within a single manufacturer's product line.

Structure Orientation
South-facing roof slopes have shorter lifespans due to increased thermal cycling and UV exposure. Some portions of the roof are affected by prevailing winds more than others.

Degree of Roof Slope
Flatter roofs have shorter lifespans because they shed moisture more slowly and are more directly exposed to UV radiation than roofs with steeper pitches.

Climate
Harsh climates shorten roof lifespans. Wind, moisture and thermal cycling all contribute to deterioration of roofing materials.

Thermal Cycling
Climates with large daily temperature swings shorten roof lifespans because they cause greater amounts of expansion and contraction. This increases the roof's rate of deterioration.

Roof Color
Darker roofs absorb more heat, which shortens shingle lifespan by accelerating the loss of volatiles and increasing thermal cycling.

Elevation
Homes at higher elevations are exposed to more UV radiation, which deteriorates most roof-covering materials, including asphalt shingles.

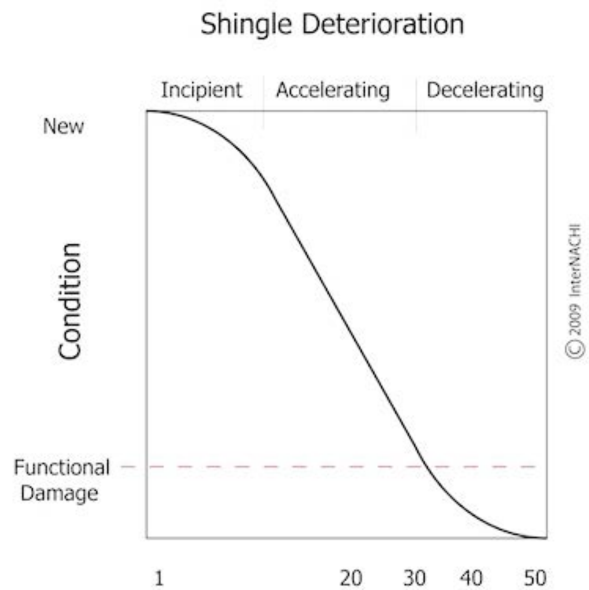
Roof Structure Ventilation
Poor ventilation of the roof structure shortens shingle lifespan by failing to keep shingles cool, resulting in accelerated loss of volatiles and greater amounts of thermal cycling.

Quality of Maintenance
Failure to repair damage and keep roofs clean can result in damage and deterioration from moisture intrusion and wind.

Now that you have a good idea of the kinds of conditions that contribute to deterioration, let's look at an overview of the process of deterioration.

ASPHALT SHINGLE LIFESPAN

Asphalt shingle lifespan is strongly affected by weathering. Even though the rate at which shingles weather varies, they still go through a generally predictable lifecycle.



The lifespan of asphalt shingles is related to the rate at which they deteriorate. The long-term deterioration pattern of an asphalt shingle can be broken into three parts:

- incipient deterioration;
- accelerating deterioration; and
- decelerating deterioration.

"Incipient" means "early," so incipient deterioration is the first stage. During the incipient stage, deterioration takes place very slowly.

As time passes, deterioration starts to worsen, and shingles enter a period of accelerating deterioration.

By the time the deterioration curve begins to flatten out and the decelerating period begins, the shingles have reached the point of functional failure. They're no longer protecting the roof and are trying hard to turn back into the raw materials from which they're manufactured.

SHINGLE SPLITTING

Let's examine the differences between splitting and cracking, and identify the different causes of splitting and the visual clues that aid in its identification.

Splitting vs. Cracking

The difference between splitting and cracking is that a split goes entirely through a shingle, and a crack is limited to the surface of the asphalt layer.

You may also see shingles that have been creased by the wind as tabs are bent past their capacity to flex. This creasing would be considered a crack unless it continued through the shingle.

THERMAL SPLITTING

Roof-Structure Assembly

A roof structure covered with asphalt shingles actually consists of two separate assemblies. The first assembly is formed by the roof sheathing fastened to the roof framing members, such as rafters, roof trusses, ridges and blocking. Together, these components form a single assembly: the roof deck.

The second assembly is formed by the shingles that are bonded to each other by adhesive strips and which, structurally, may act as one big shingle if the adhesive bond is strong enough.

These components are all attached to each other, so why not call them one assembly?

There are two reasons:

1. They typically consist of materials that expand and contract at significantly different rates. Rafter sheathing and roof trusses are made of wood and will react in a manner similar to changes in moisture and temperature.
2. They have different functions. The rafters and sheathing are part of the building structure and, when properly built and maintained, have a much longer design life than the roof-covering material. Roof framing is not designed to withstand direct exposure to weather.

These two assemblies expand and contract at different rates -- called differential movement -- because they're made of different materials.

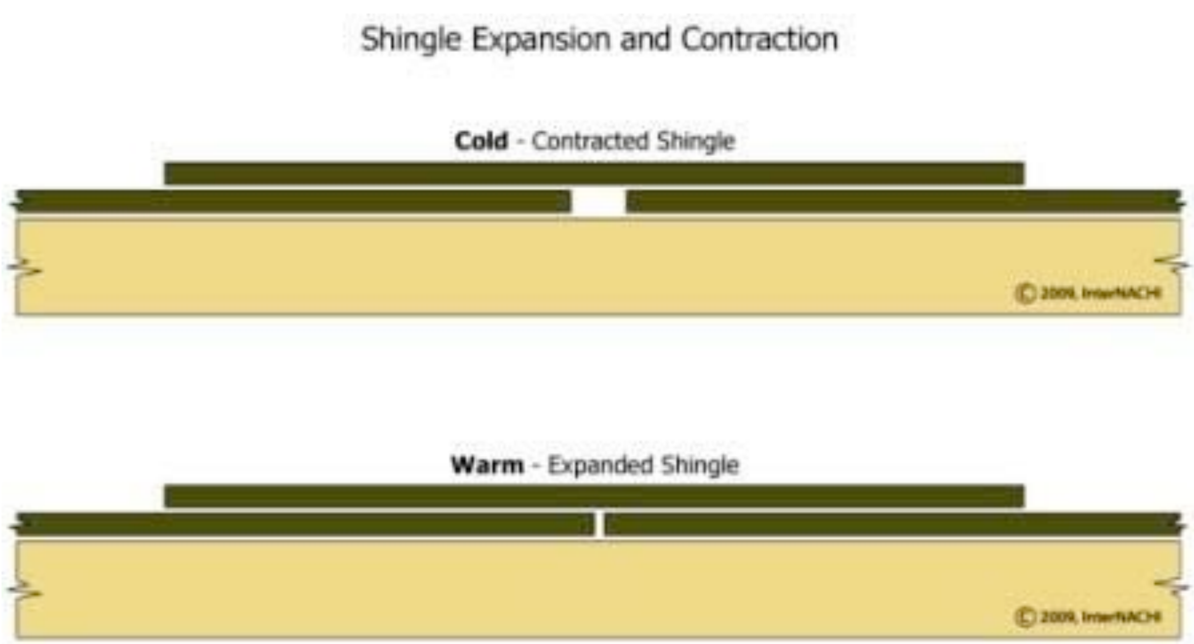
Now, remember that strongly bonded shingles can act as a single, unified membrane, and that these two independently moving assemblies are connected to each other with metal fasteners, such as staples or nails.

As the roof sheathing expands and contracts, it exerts forces on the shingles through the fasteners, stretching the shingles and compressing them. These conditions create stresses between the two assemblies that, if extreme enough, can result in shingle splitting or buckling.

Splitting Over Shingle Joints

Shingle splitting due to temperature-related expansion and contraction is called thermal splitting. Thermal splitting typically happens where shingles bridge the joints in the underlying layer of shingles.

If the adhesive strips bond shingles together strongly enough, the shingles on a roof slope can act almost as a single membrane.



As shingles warm and expand, the joints between them become smaller. As shingles cool and shrink, the joints between them grow wider.

The shingles that bridge those underlying joints are shrinking, too, and these bridging shingles becoming increasingly stressed as the entire bonded-shingle assembly continues to shrink.

If this stress exceeds a critical point, one of two things will happen:
1. If the strength of the bond of the adhesive strips exceeds the tensile strength of the shingles, the shingles bridging the joints will split, creating an opportunity for leakage to develop.
2. If the tensile strength of the shingles surpasses the strength of the adhesive bonds, the bonds will fail, drastically lowering the wind resistance of the shingles.

Thermal splitting over joints between shingles may form a diagonal pattern up the roof following the stair-step pattern of the offset joints created during installation, or it may appear randomly above joints in different parts of the roof.

Splitting above underlying shingle courses is more common with fiberglass shingles than with organic shingles because the adhesive bond of fiberglass shingles is usually stronger than the adhesive bond of organic shingles.

HAIL DAMAGE

Hail is one of the most common forms of environmental damage to roofing materials.

Hail damage is so widespread that in the U.S. alone, it costs close to $1 billion each year in insurance claims.

Impact Resistance

Underwriters Laboratories have developed standards and provide testing for asphalt shingles' resistance to impact. Shingles are rated Class 1 through 4, with Class 4 shingles having the highest resistance.

You will not be able to determine the impact rating of shingles by looking at them, although the impact rating is usually marked on the cellophane on the underside of the shingle.

There are several methods commonly used today:

- One method is to increase the weight of the mat used.
- Another method is to make the shingle thicker by increasing the thickness of the asphalt layer, or bonding layers of shingles together.
- A third method is to modify the asphalt mix by adding polymers. Polymers are chains of molecules that link to each other, often called cross-linked polymers. They can be used to improve the physical characteristics of a wide variety of materials. In asphalt shingles, they're added to the asphalt to improve shingle strength and impact resistance.

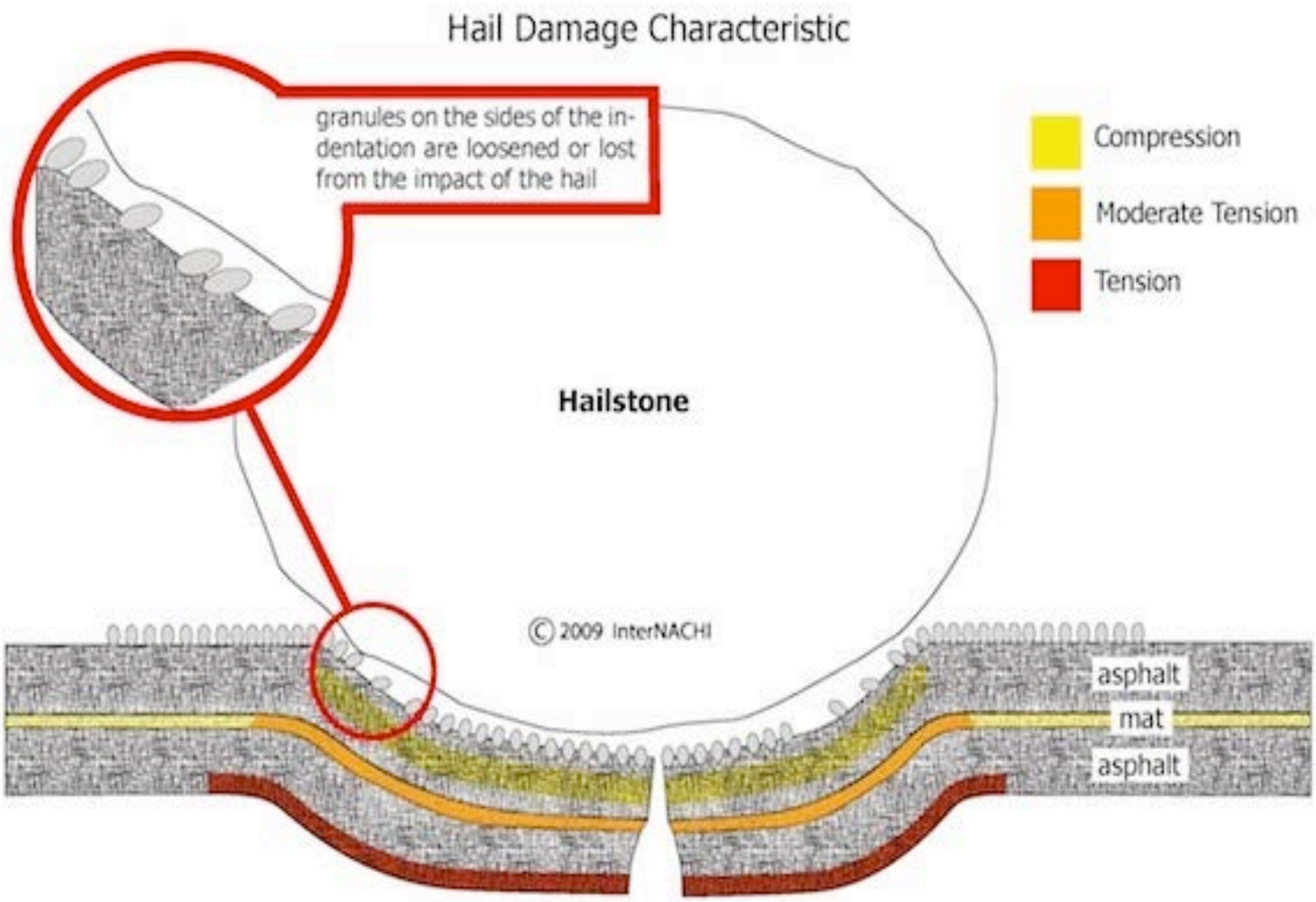
Let's look closely at what happens when a hailstone strikes an asphalt shingle. We'll assume that the hailstone hits at 90° to the surface.

Characteristics of Damage

The effects of hailstrikes on asphalt shingles vary according to the conditions at the time of the hailstorm. If hail is accompanied by rain, as is common in the U.S. in the Midwest and on the East Coast, the rain will cool the roof, making the asphalt harder. Hailstones striking rain-cooled, hard asphalt are more likely to loosen or displace granules.

On the West Coast, hail may not be accompanied by rain, so roofs may be hot and the asphalt may be soft when the hailstones hit. Hailstones striking hot, dry, softer asphalt are more likely to embed the granules deeper into the asphalt.

This doesn't mean that you'll see one condition as opposed to the other. It means that conditions during the hailstorm can influence the appearance of hail damage.

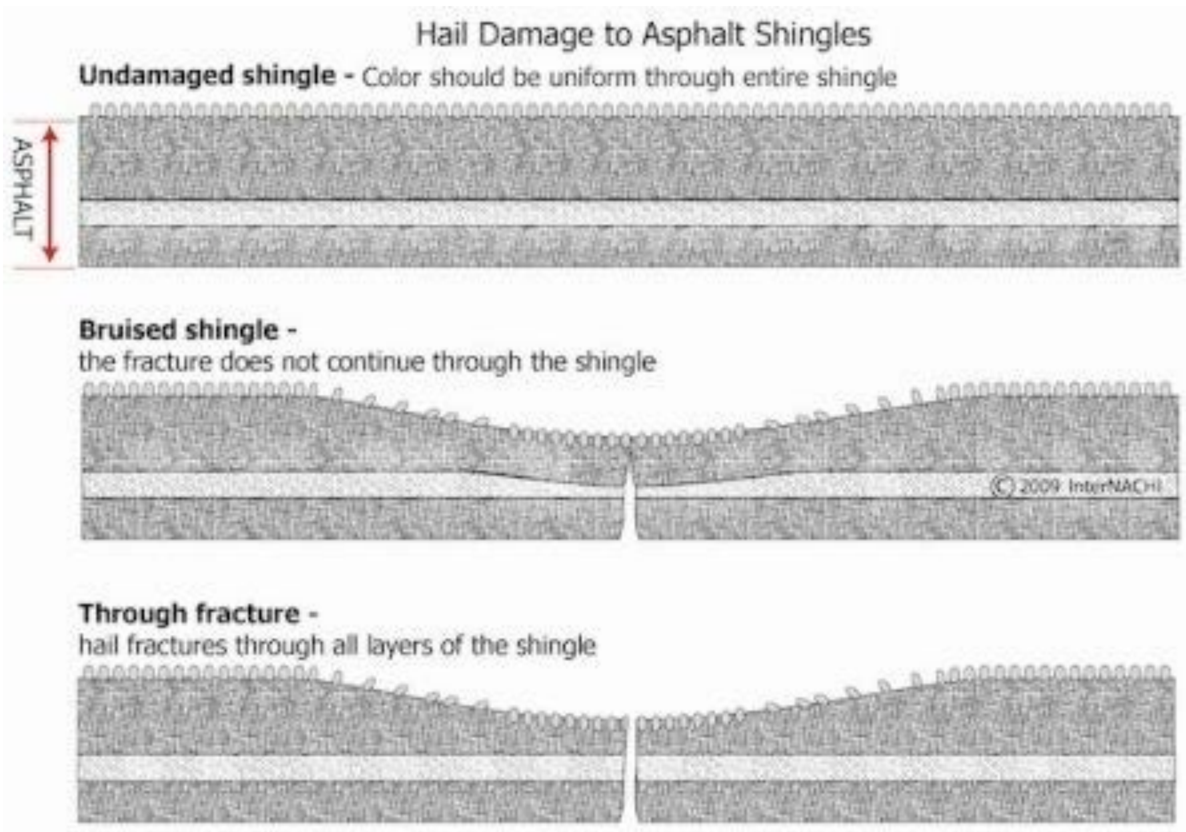


When the hailstone strikes, the shingle flexes downward. The top surface of the shingle is in vertical compression and the bottom is in horizontal tension. The bottom surface of the shingle has to expand in order to absorb the impact of the hailstone. This expansion creates tension, which is relieved by cracking. This crack is referred to as a fracture.

A shingle fracture starts at the bottom surface of the shingle and spreads toward the top surface. If the stress is great enough, the shingle will fracture clear through, from bottom to top. If the fracture extends through the mat, the shingle has suffered functional damage.

The amount of indentation in the image above has been exaggerated to illustrate the point.

Indentations are usually slight unless the shingle is fractured clear through, as you see here.



The hailstrike may not be severe enough to cause a fracture extending clear through the shingle. The fracture may extend through the mat but not reach the upper surface. This condition is called a bruise because it creates a soft spot on the shingle, which you can feel with your finger. It feels like the bruise on an apple. Bruises are functional damage.

Mat

Although the mat is only about 2% of the shingle's weight, it is a crucial component in determining the impact resistance of asphalt shingles. Thicker, heavier mats resist damage from impact more effectively than thinner ones. Mat thickness varies among manufacturers and among shingle types produced by the same manufacturer.

Again, a fractured mat is functional damage.

Asphalt Composition

Asphalt used for asphalt shingles varies in both quality and thickness, and these two properties can affect the severity of hail damage.

Poor-quality asphalt can be the result of poor-quality or improper ingredients used to manufacture the asphalt, or the ingredients may be used in the wrong proportions. Quality is also affected by the manufacturing methods.

Asphalt used in the manufacture of shingles may be blended by a shingle manufacturer or bought already blended from a supplier. The methods for mixing asphalt are proprietary and manufacturers do not publish this information. As an inspector, there’s no way for you to judge the quality of asphalt; you just need to be aware that the quality can vary.

The thickness of the asphalt that is applied to the mat varies among shingles produced by different manufacturers. Obviously, a thicker asphalt layer resists fracture more effectively than a shingle with thinner asphalt of similar properties.

A crack in the asphalt layer does not constitute functional damage. The crack must extend through the mat.

Lack of Studies

One of the key questions about the point at which functional damage occurs in asphalt shingles is the degree to which exposure of the asphalt surface causes premature failure. Determining this accurately would require long-term studies by a neutral third party on a large number of shingles. No such studies are publicly available and may not exist. There is no easy answer.

UV Radiation

The primary force that deteriorates exposed asphalt is ultraviolet or UV radiation. The degree to which it affects shingles depends on several things:

- asphalt quality. Low-quality asphalt is less resistant to deterioration;
- the percentage of granules missing. Due to the lack of available studies, disagreement exists concerning the amount of exposed asphalt that will significantly shorten the long-term service life of asphalt shingles. Some shingle manufacturers have issued technical bulletins stating that any granule loss will cause premature failure, but they haven’t published studies to support this claim; and
- the climate zone where the home is located. Asphalt shingles of similar design and quality are installed in widely differing climate zones across North America. The rate at which exposed asphalt deteriorates depends on the intensity of the UV radiation in each climate zone.

Roofs in areas that have a high number of sunny days each year are exposed to more UV radiation than homes in areas with fewer annual sunny days. Roofs at higher elevations are also exposed to more UV radiation. The angle of the roof's slope and the direction it faces also affect the amount of average, annual UV radiation received.

We know that UV radiation from sunlight deteriorates exposed asphalt. As a greater amount of asphalt is exposed, the chances of premature failure due to UV-ray deterioration increases. The chances for premature failure are not the same everywhere, but are influenced by:

- the amount of asphalt exposed;
- the quality of the shingle; and
- the average annual level of exposure to UV rays.

DAMAGE to the GRANULE LAYER

Functional Damage

A few missing granules do not constitute functional damage. Just the fact that you can see evidence of a hailstrike does not necessarily mean that shingles have been functionally compromised. That judgment call may be up to the claim adjuster, inspector or insurance company.

Granule loss certainly has to be visible to the observer to qualify as functional damage. If you have to bend down and squint and wonder whether or not you're looking at a hailstrike, granule loss is likely not severe enough to qualify as functional damage.

Hail damage to the granule layer is affected by a number of variables, including:

- the properties of the shingles;
- the properties of the hailstones;
- whether the hail is wind-driven; and
- the orientation of the roof slope to the direction of hail fall.

The ways that these variables combine affect the nature of the granule loss.

Asphalt Quality

The properties of the asphalt layer have a great effect on granule loss because the asphalt is what bonds the granules to the shingle's surface.

As asphalt ages and loses its volatiles and the bond between granules and asphalt deteriorates, it will take less impact-energy for hail to displace granules.

Shingles with old or poor-quality asphalt do not hold granules as well as shingles with newer, high-quality asphalt. This means that old shingles are more likely to lose granules when struck by hail. Even small hail can dislodge granules from older shingles. This is especially true when hail is accompanied by heavy rainwater runoff. Heavy runoff can erode loosened granules.

"Hitchhikers"

Shingles less than six months old can experience a lot of granule loss, although this early granule loss does not expose the asphalt.

When shingles are manufactured, in addition to granules embedded into the asphalt, some granules interlock with embedded granules but are not embedded themselves. A lot of these granules come loose during packaging, shipping and installation, but a lot are still attached after installation is completed. These are called “riders” or “hitchhikers.”

During the early part of a shingle's life, many of these excess granules will be loosened and washed off the roof by storms. Even fairly small hail can increase the rate at which new shingles shed these loosely attached hitchhikers.

Hailstone Properties

The amount of granule loss caused by a hailstrike is affected by the amount of impact-energy carried by the hailstone. The amount of damage done to the granule layer is related to the hail's properties, such as size, density, and free-fall velocity.

Wind-Driven Hail

Wind-driven hail carries more impact-energy, so it may cause more granule loss on older roofs. The condition of a shingle roof affects the amount of damage that hail will inflict. As shingles age and deteriorate, they become increasingly brittle and less able to absorb the impact of a hailstrike. Older shingles are damaged more easily than newer shingles.

Shingle quality is also a consideration. Given hail with identical impact-energy, thin, low-quality shingles will suffer damage before thick, high-quality shingles.

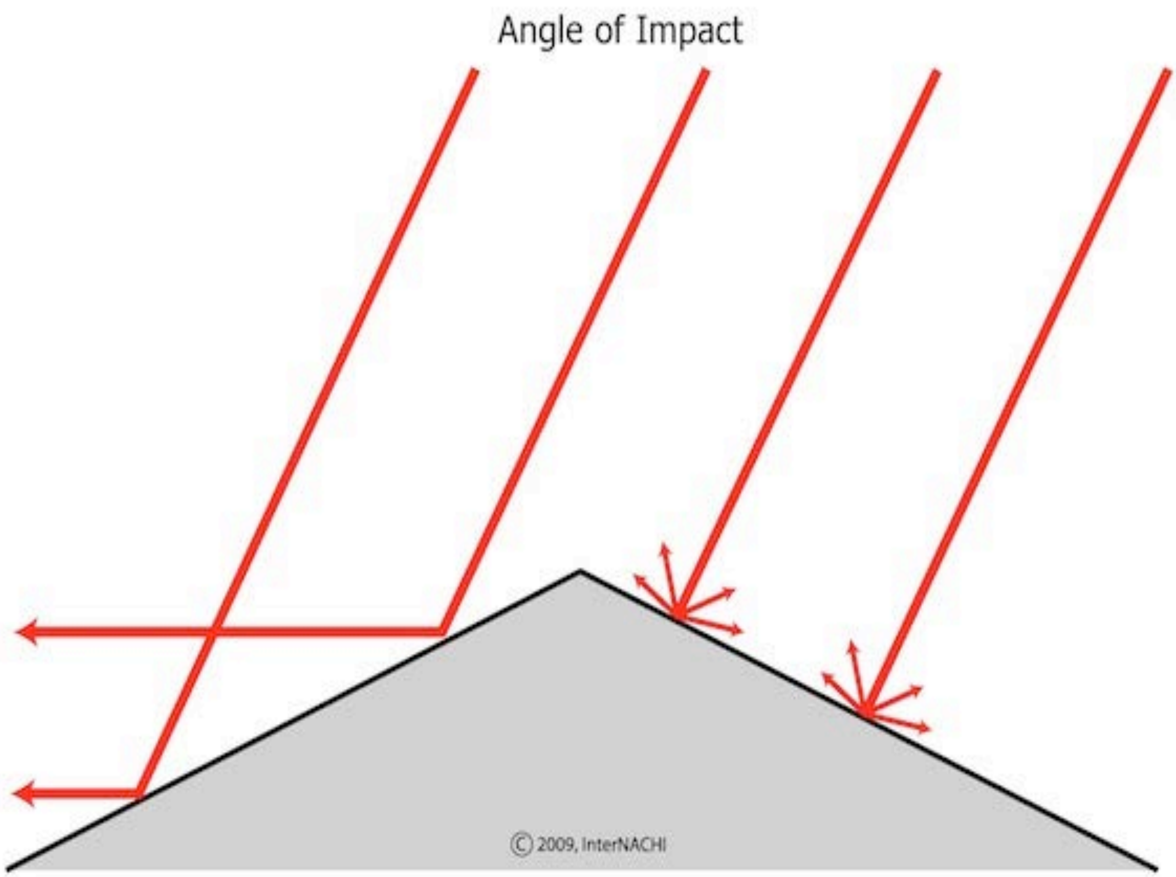
On older shingle roofs, many granules may be loose but still in place. These loose granules can be dislodged even by small hail. This is not considered hail damage because the granules were already loosened.

Area of Impact

The edges and cutouts of shingle tabs are more vulnerable to damage because the edges lack the support of a surrounding shingle. A few small, random, damaged areas near a shingle's edges are not a problem. Some insurance companies don't consider a shingle to be functionally damaged unless the damage reaches ½-inch in from the edge.

Regardless of whether it's at the edge or in the field of the shingle tabs, all significant damage to shingles within a test square should be considered in making your report.

Angle of Impact



Hailstones that hit shingles with a glancing blow do less damage than hailstones that hit shingles more directly.

Temperature

Shingles are more brittle and less able to absorb impact when they're cold. Low temperatures, especially below 50º F, leave shingles much more vulnerable to hail damage.

Substrate Support

The best substrate for asphalt shingles is a solid deck. Many manufacturers require a solid deck for their warranty to remain valid. Still, you'll see many homes with newer asphalt shingles installed over older asphalt shingles, and even over wood shingles or shakes.

Shingles installed over an existing layer of roofing are more likely to suffer hail damage because of poor underlying support. Areas where newer shingles bridge the butts of underlying shingles typically have gaps. These areas will be more easily damaged by hailstones.

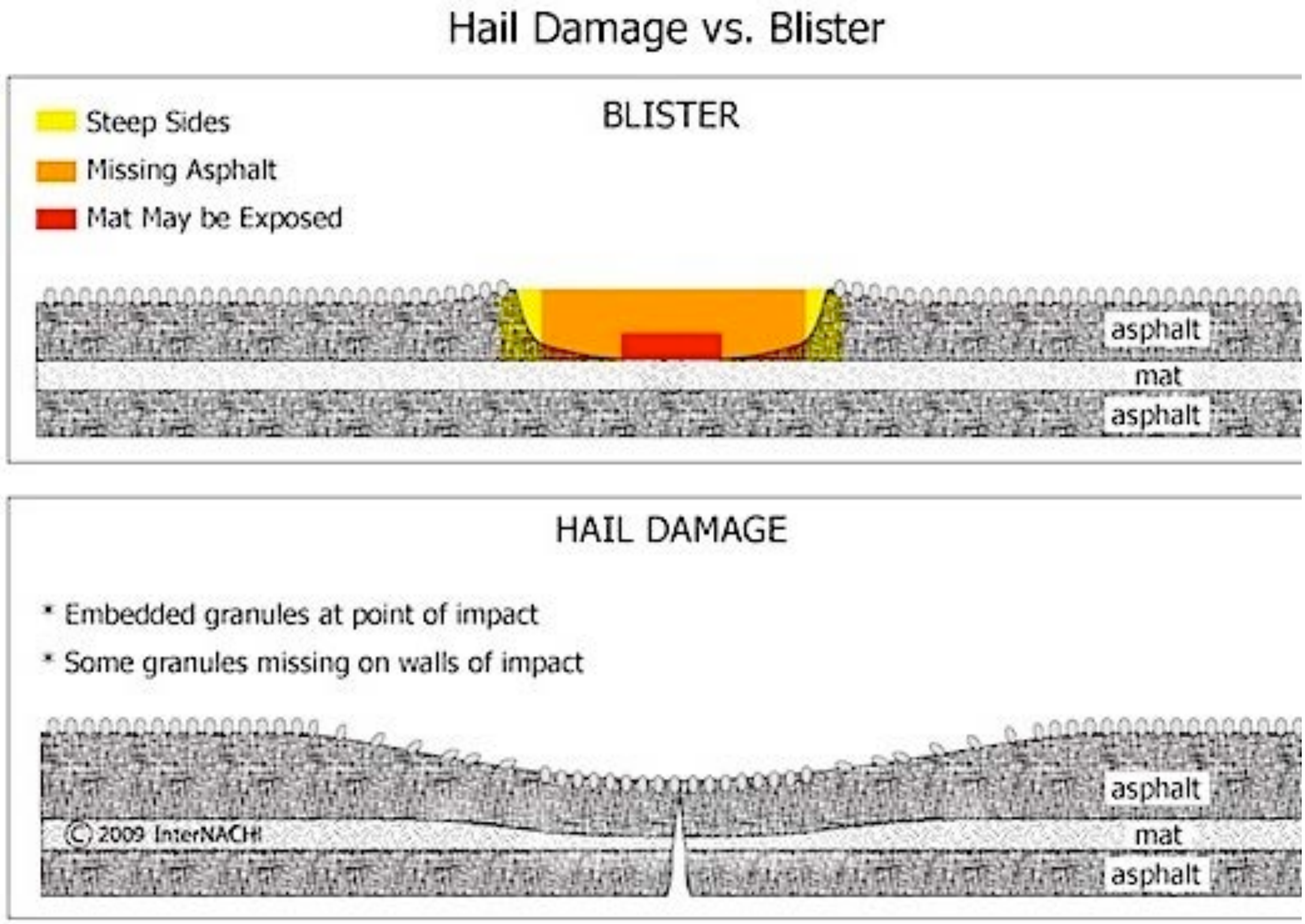
Cap shingles on ridges and hips are also more vulnerable to hail damage because they aren't supported as well as shingles installed directly on the roof deck.

Asphalt shingles installed over existing roofing materials have uneven support. The butts of existing shingles create voids beneath the new shingles. The parts of the newer shingles bridging the voids are more vulnerable to damage from hail than the parts of the shingles that have full support of a solid substrate beneath them.

Hail Damage vs. Blisters

Occasionally, damage from hail is mistaken for damage from blisters.

Blisters are caused by the expansion of volatile gasses escaping from the asphalt layer. Gas migrates to the shingle's surface where it forms bubbles. Eventually, the tops will erode away.



This illustration shows the difference in profile between a blister and a hailstrike. Blisters leave steep-sided pits or pockmarks that are usually missing some asphalt material. Sometimes, enough asphalt is missing that the mat is exposed. The surface of the shingle may be slightly raised around the perimeter of the pits.

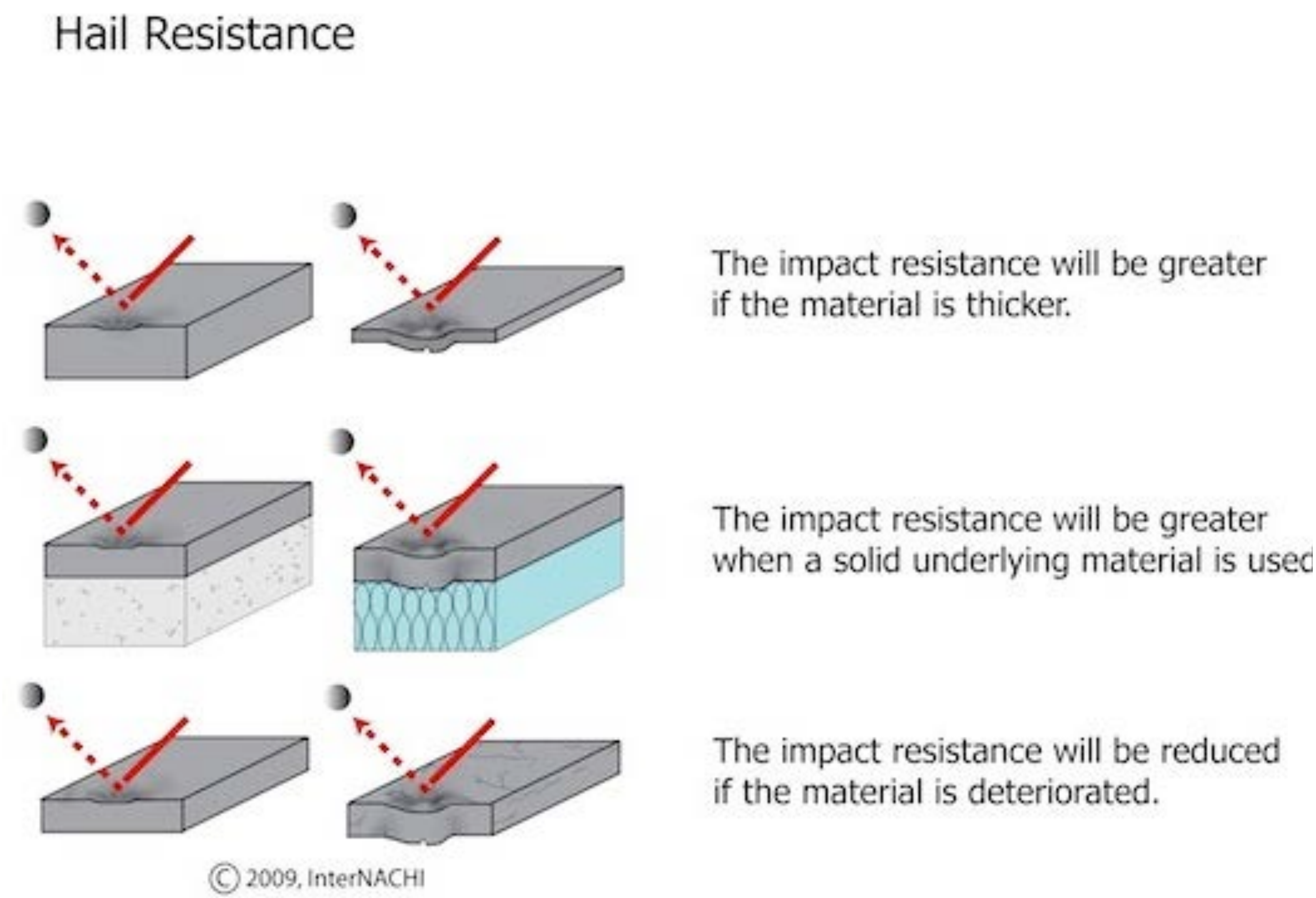
Hailstrikes usually leave very shallow indentations with very lightly sloped sides.

These photos show details of blisters in 3-tab fiberglass shingles. In the two photos above, you can see that the blisters are widespread.

The photo directly above includes a penny for perspective. You can clearly see the steep sides and the exposed mat. Because these shingles are 20 years old, this condition will likely not be covered by the manufacturer's warranty.

The two photos above show the obvious difference between hail damage and blister damage. Note the shallow depth of the indentation and the granules remaining in the area of hailstrike damage.

Material Properties
When you inspect a home for hail damage, you'll be looking at components made of a variety of materials with different properties. These properties affect the severity of hail damage.



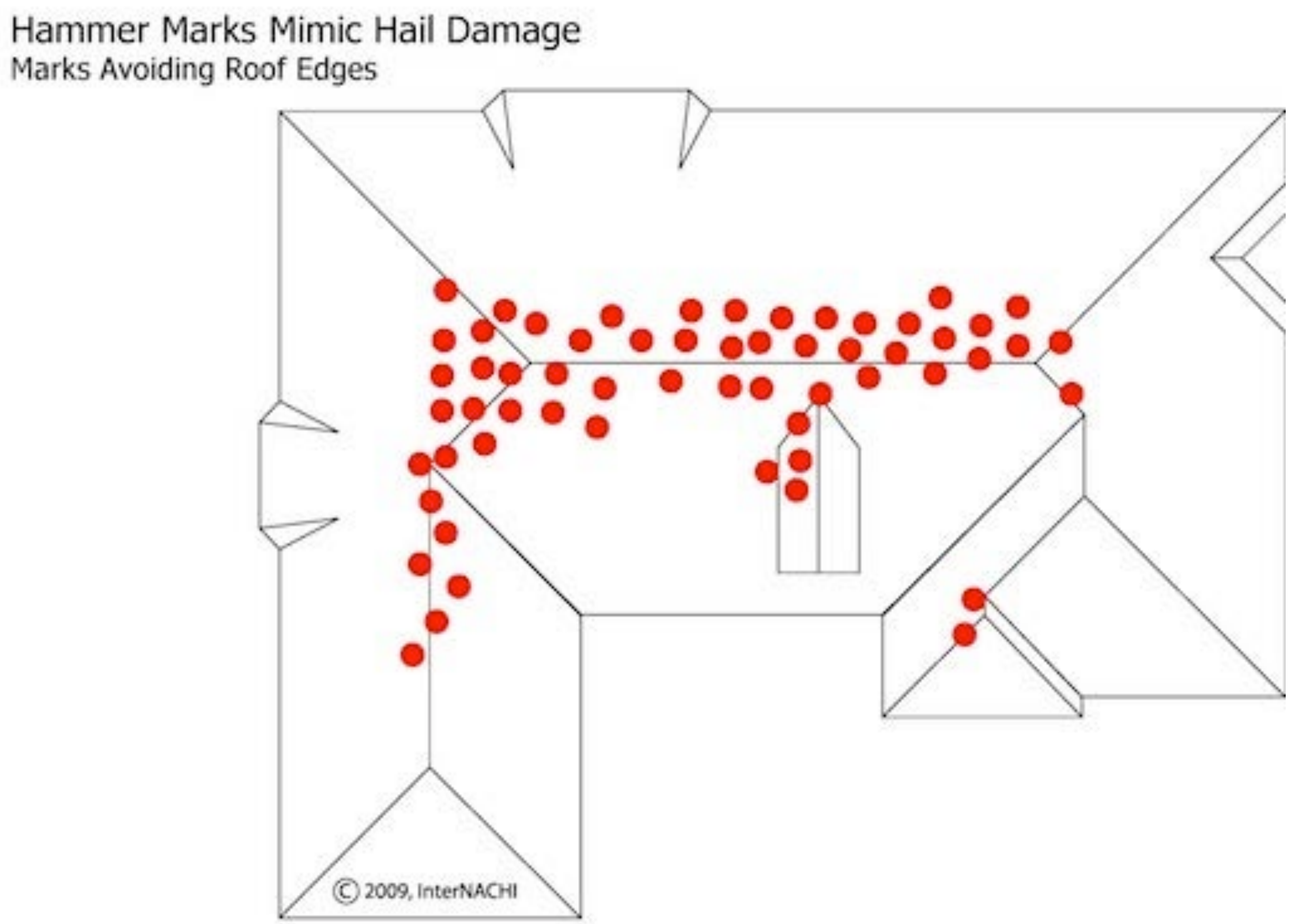
- Hard surfaces resist damage better than soft surfaces.
- Flexible materials absorb impact-energy and resist damage better than brittle materials.
- Surfaces that are well-supported resist damage better than poorly supported surfaces.
- Thicker material resists damage better than thinner material.
- Horizontal surfaces are more likely to be damaged than vertical surfaces because the angle of impact will be closer to 90°.

Intentional Damage

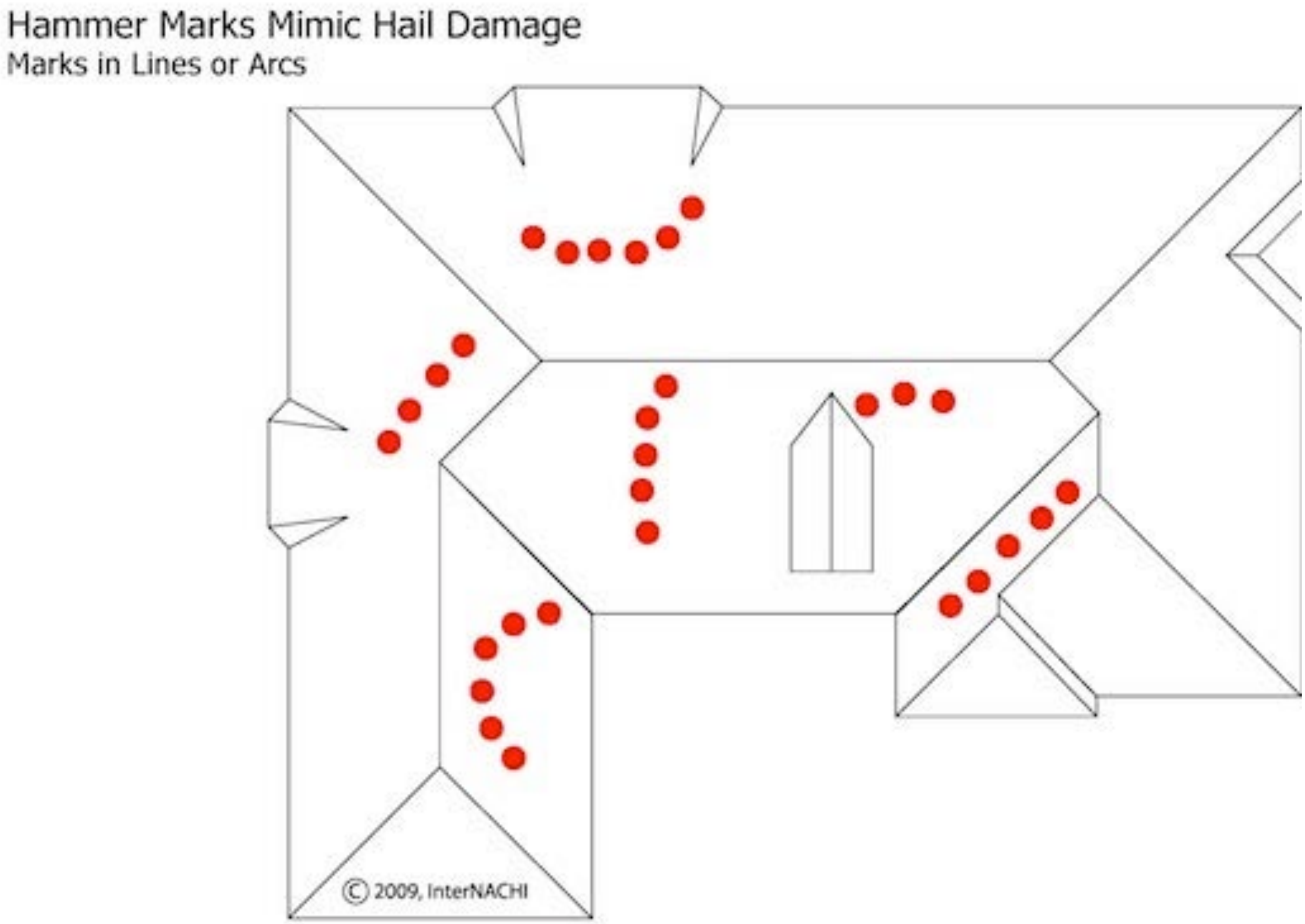
Not all damage that appears to have been caused by hail was actually inflicted by hail. Although it's not always necessary to identify the source of damage, it's important that you are able to differentiate between hail damage and damage from other sources.

Although it's rare, people have been known to use a number of different devices to try to replicate hail damage in an effort to fool insurance companies into paying for a new roof.

One way to spot these attempts is to look at the overall pattern of damage across the roof. Real hail impact is random. Intentional damage often has certain recognizable patterns.



Intentional damage is usually concentrated in certain areas, generally away from the roof's edges. People who create damage may be nervous about falling off the roof, so they stay closer to the roof's interior, where they feel safer.


Hammer Marks Mimic Hail Damage
Marks in Lines or Arcs
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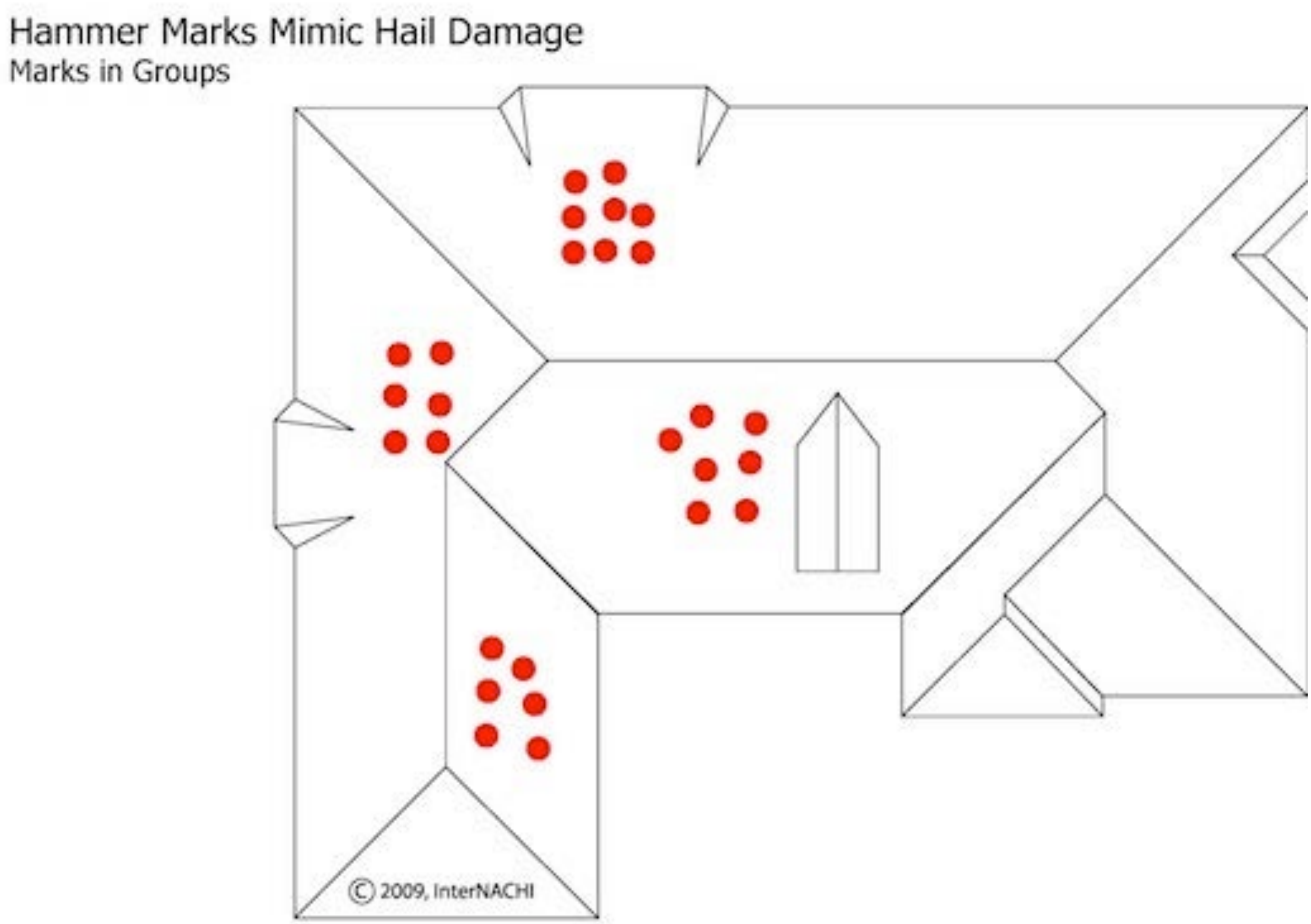
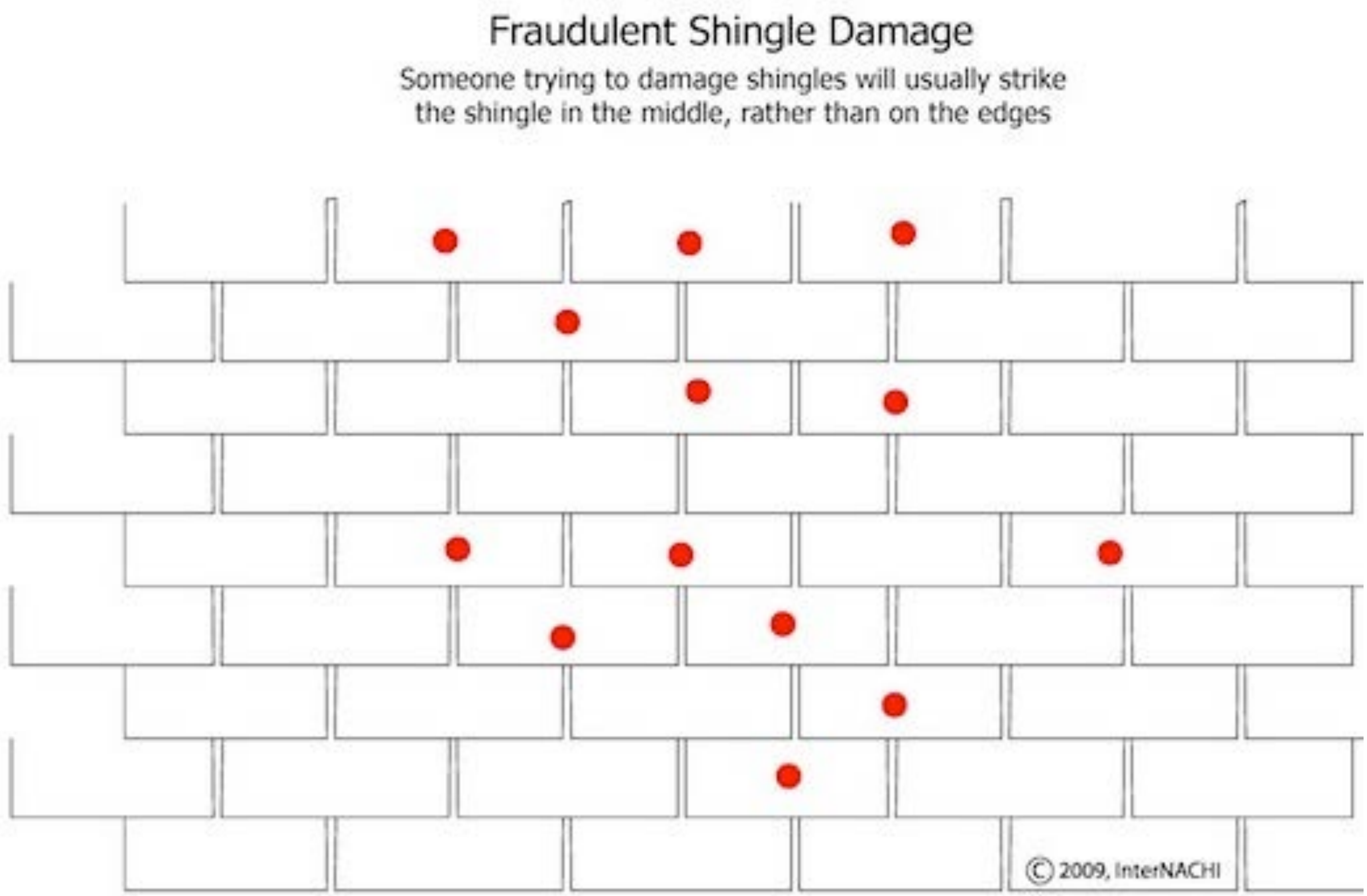
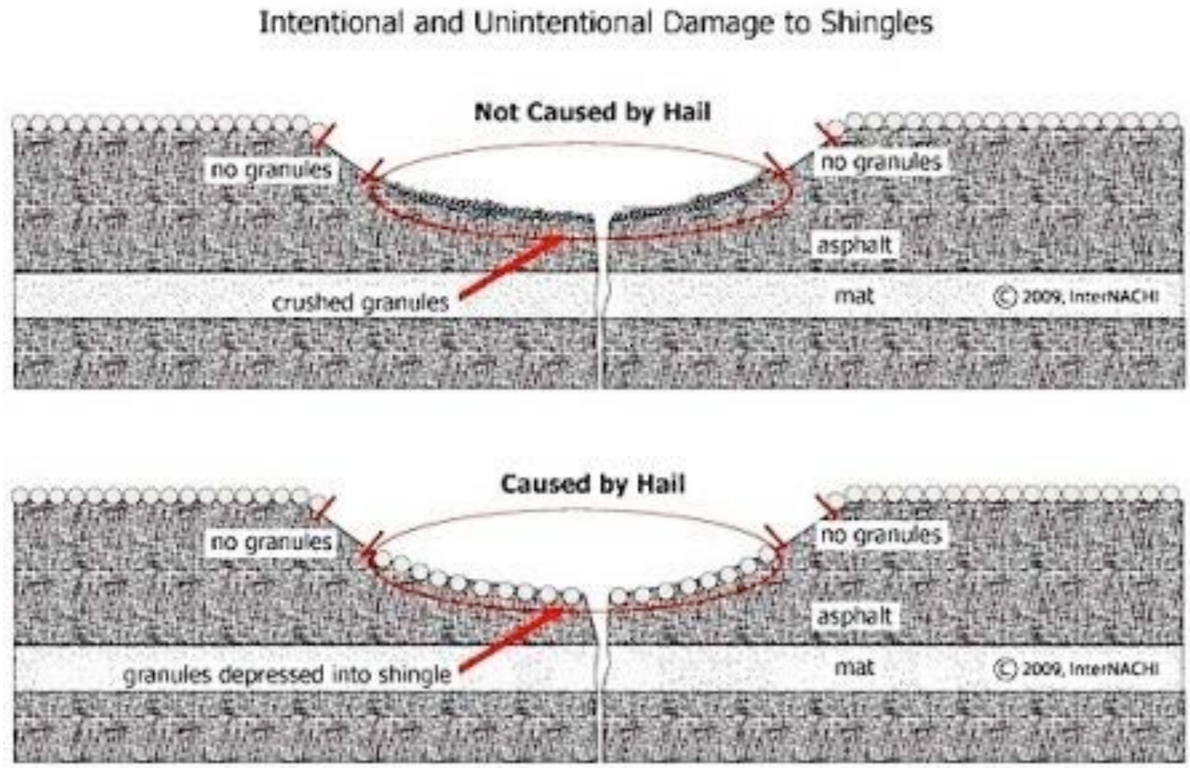


Intentional damage across the roof may form a recognizable pattern, such as an arc. It may appear in separated groups because the person creating the damage has hit different parts of the roof from the same convenient position.



Real hail damage does not always occur in the center of a shingle. Real hail may hit any part of a shingle, including the edge of the tabs and in the notch. Hailstrikes may overlap. Intentional damage is often located toward the middle of the tabs and with no more than one hit per tab.
In checking for intentional damage, you should first look at the overall roof for patterns that indicate intentional damage. If you find such suspicious patterns, you should look more closely at the individual damage marks for further evidence.



In looking closely at damage, you should be looking right down into the bottom of the indentation at the condition of the granules. Hailstones do not crush granules when they strike asphalt shingles. Instead, hailstones typically remove granules from the sides of the impact and force granules toward the center of the impact, deeper into the asphalt layer. This is a key point in differentiating hail damage from other types of damage.

Hailstone impact will not crush granules, but the impact from steel often will, though not always.

The photo above shows two strikes with a ball-peen hammer. The upper strike was made at a 90° angle to the shingle's surface. The granules were pressed further into the asphalt, but not crushed. The lower strike was made with a glancing blow, and you can see that the granules were crushed.

Because granules are made from light-colored stone, which has had a colored ceramic coating applied, crushed granules typically look like a light-colored powder, no matter what the color of the granules is.

They show the color of the stone, not the color of the coating.

It’s not always easy to identify the cause of damage. The appearance of damage left by hail can vary with the impact-energy of the strike, the properties of the hailstones, and the properties of the shingles that are hit.

Ball-Peen Hammers

Ball-peen hammers are the hammers of choice for those wanting to mimic hail damage, their advantages being that their heads are spherical, and they're available in the same diameter sizes as common hail.

Hailstone strikes from a single storm often vary quite a bit in appearance.

A steel hammer with a 1-inch-diameter head swung by a person intending to create damage usually carries more impact-energy than a hailstone of similar diameter. This means that an indentation made by a hammer is often deeper than one made by a hailstone.

Characteristics of Damage by Ball-Peen Hammers

Although steel often crushes granules, granule damage varies with the nature of the substrate and the angle of the blow. Just because you don't see crushed granules doesn't mean it's not hammer damage.

The photo above shows the uniformity common to ball-peen hammer damage. There's always the chance that someone will use hammers having different size diameters of balls, but the damage will still be fairly uniform.

Claw Hammers

People have also been known to use claw hammers to try to replicate hail damage to shingles. The damage is much more convincing when the round end of the hammer head is used, as opposed to the claw end, but the people who use these haven't yet discovered ball-peen hammers.

A blow with a claw hammer leaves a "frowny-face" mark where it fractures the shingle. Again, granules may or may not be crushed, depending on the nature of the substrate. Softer substrates may cushion the blow enough to prevent crushing.

The person swinging the hammer almost always over-rotates the hammer to avoid scraping their knuckles against the shingles. This means that the round, flat face of the hammer head doesn't hit the shingle squarely, but hits with the top edge.

It's also not unusual for the hammer to be tilted slightly to the left or right. In the damage shown here, the hammer was tilted slightly to the right, fracturing the mat along the right side of the damage, in addition to along the top.

Coins

Coins are sometimes used to scrape away granules in an attempt to mimic hail damage. If you look closely, coin edges usually leave visible grooves in the asphalt layer and will remove material, rather than indent it. It actually looks more like a blister than a hailstrike, since hail will embed granules, while a blister will usually shed them.

Golf Balls

In order to give you an idea of what damage looks like when someone uses a golf ball, we've used this golf-ball "whacker" device to damage these shingles. Examined closely, this damage appears similar to a hailstrike. The best evidence that this type of damage is not from hail would be to observe the uniformity and overall pattern of damage across the entire roof.

NON-INTENTIONAL, NON-HAIL DAMAGE

You'll encounter other types of damage to asphalt shingles that are not hail damage but may not be intentional damage, either. Although you won't always be able to identify the source, you can often tell enough from the damage's appearance and location to rule out hail or wind. Here are some examples.

Tool and Equipment Damage

Above is an example of screwdriver damage.

Here's damage caused by a utility knife.

These photos both show mechanical damage. Workmen on a roof often use a variety of tools and equipment. Hand tools, especially when they're dropped onto a hot roof, can gouge shingles, as will ladders.

Workmen may install equipment that can cause damage if it topples over or is moved accidentally. Common places to find this type of damage are around roof-mounted air conditioners, satellite dishes, and solar-heating and photovoltaic panels.

You don't need to positively identify the source of damage, but you should be able to tell the difference between hail damage and mechanical damage.

WIND DAMAGE

Studies and actual conditions have shown that asphalt shingles are capable of good performance under conditions of high wind, even though they often don't perform to their capacity. A large part of the problem is due to improper installation practices.

Based on current knowledge, the most important considerations for preventing wind damage, in order of importance, are:

1. a fully bonded adhesive strip;
2. the correct number of fasteners;
3. correct placement of the fasteners; and
4. the mechanical properties of the shingles.

Wind-Resistance Standards

Most of the information available today about asphalt shingles' wind resistance comes from research performed in developing manufacturing standards.

UL and ASTM wind-resistance standards for asphalt shingles have been used in the past.

The UL standard is widely considered to offer better information. According to this standard, shingles are rated as follows:

- Class D shingles are rated to 90 mph;
- Class G shingles are rated to 120 mph; and
- Class H shingles are rated to 150 mph.

The class that should be installed depends on the exposure in which the home is located. Although standards for wind resistance have been available since the mid-1960s, you won't be able to tell whether shingles comply just by looking at them. Some jurisdictions may require new homes to comply with standards that specify a minimum level of wind resistance. The only way to prove compliance is through documentation.

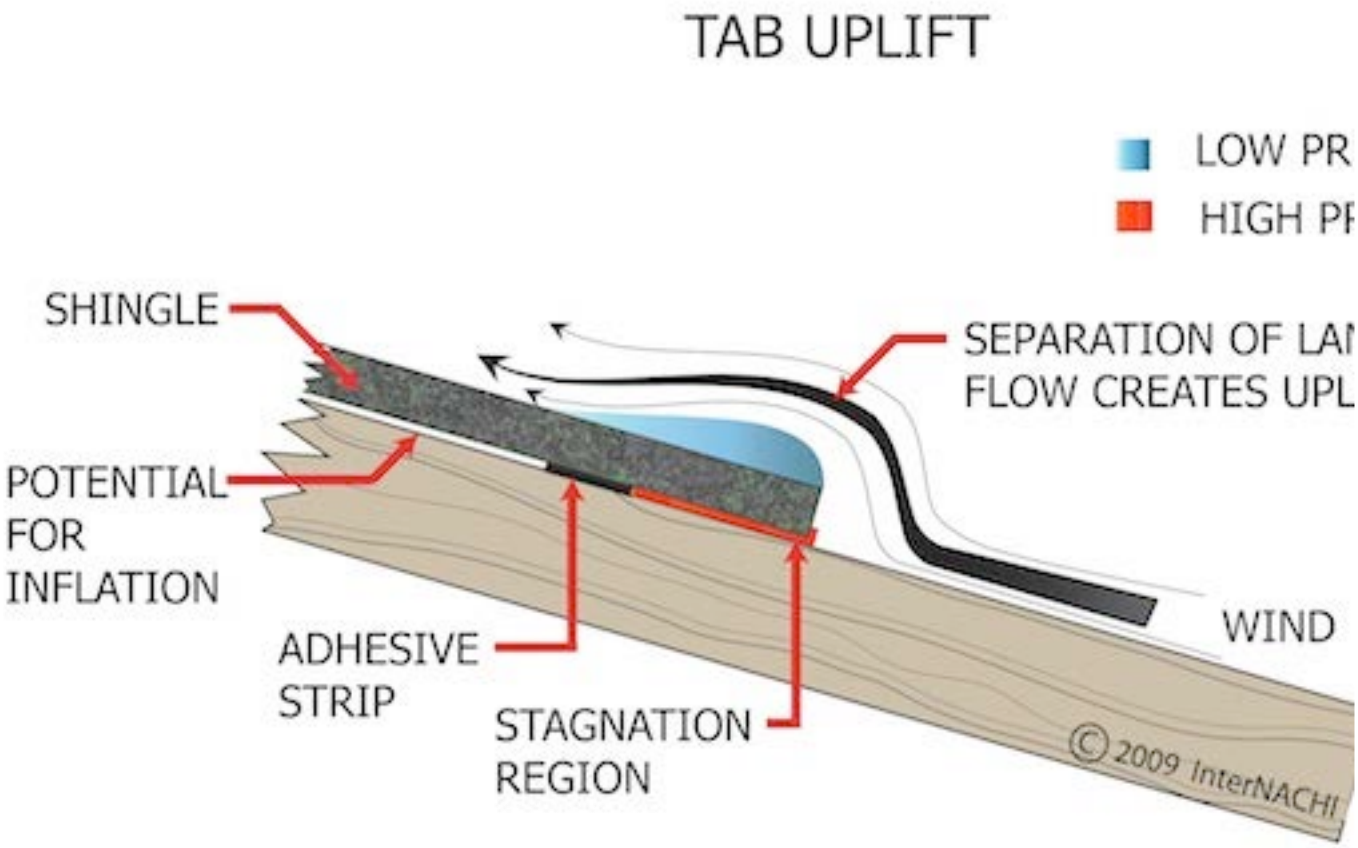
Wind Factors

The wind factors affecting asphalt shingle wind resistance are not constant. Wind varies in intensity, duration, direction and turbulence. Wind damage is also affected by the roof's geometry, with damage usually being worse at the roof's eaves, rakes and ridges. Shingle damage from wind is also affected by the age of the roof, and its temperature at the time of the windstorm.

Failure Modes

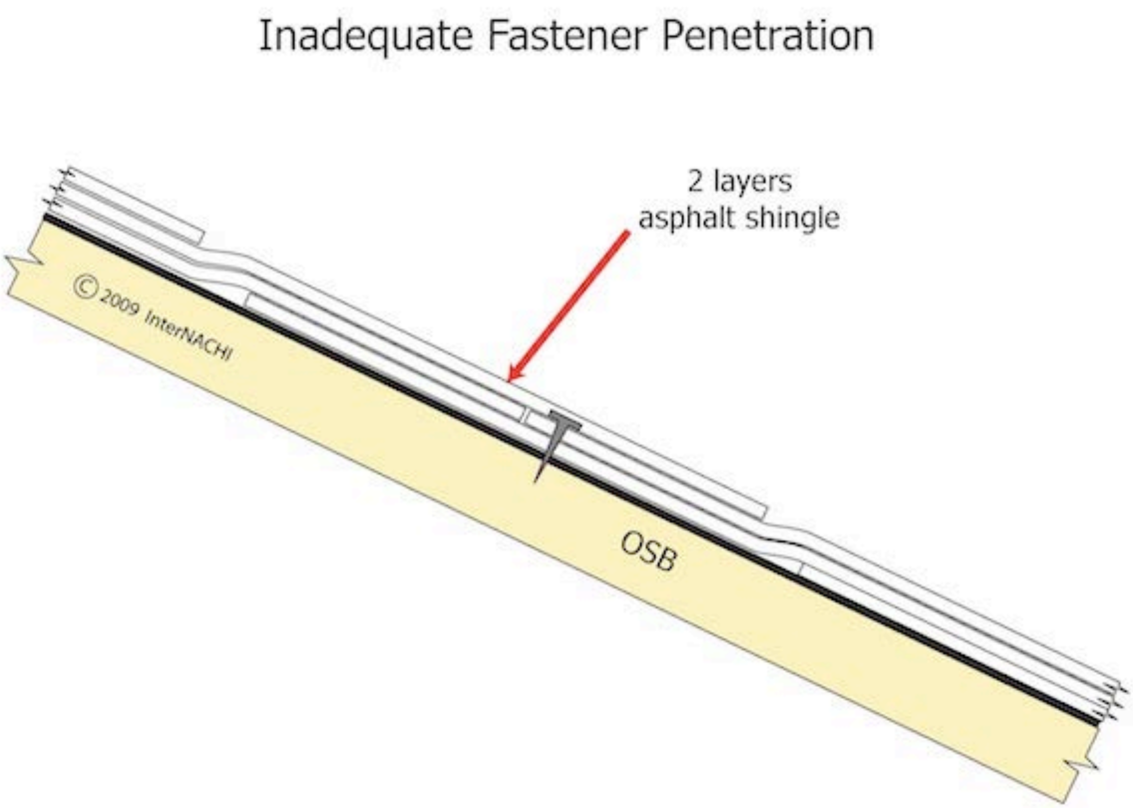
Wind damage to shingles generally follows a progression that starts with tab uplift, and can end with shingles being blown off the roof or suffering creased or torn tabs.

Tab Uplift



The wind force that has the greatest effect on shingles is wind that flows within 2 inches of their upper surfaces. As air flows over a shingle, high air pressure is created beneath the leading edge of the tab. At the same time, air that flows over the top creates an area of low pressure. If these two forces together are greater than the combined strength of the adhesive strip, along with the shingle's weight and stiffness, the result is tab uplift.

Once the edge of a tab is lifted, wind forces on the tab are greatly increased, and uplift then happens quickly because the wind suddenly has more exposed surface to push against.



If strip shingles are installed correctly, each fastener penetrates two shingles, and the shingles are fastened along two lines. The first line is just below the adhesive strips, and the second line is near the top of the shingles. If the wind is able to break the bond of the adhesive strip, the tabs will lift and bend upward as the wind tries to pull them over the heads of their fasteners. Also, as the tab is lifted by the wind, the adhesive strip of the shingle in the course above will be stressed by the bending motion.

Shingle Pull-Over

If the shingle pulls over the heads of the lower fasteners, uplift forces on the shingle will increase as the lifting shingle exposes even more surface area upon which the wind can act. Motion this extreme makes it likely that the adhesive strip of the shingle in the course above will be broken.

Creasing and Tearing

If the bond of the adhesive strip is broken but the shingle is not pulled over the head of the fastener, the tab may bend far enough to crease or tear.

Blow-Off

Shingles may become detached and blow completely off of the roof. This type of failure is often caused by poor bonding of the adhesive strips, resulting in tab-uplift forces that break the bonds completely. Wind can then lift the tab and enter beneath the affected shingle, increasing the uplift forces on that entire shingle.

If fasteners have been improperly placed, the wind may be able to pull the shingle over the heads of their fasteners, displacing the shingle or blowing it entirely off the roof.

In the photo above, you can see a number of creased shingles, indicating that the shingles were not bonded adequately. Where the shingles are missing, you can see in the course below that the shingles were high-nailed, actually with staples. High-nailing shingles drastically reduces the wind resistance of the roof. In this case, wind damage can be expected to continue.

Adhesive Strips

The single most important component for the prevention of tab-uplift and shingle failure due to wind is a fully bonded adhesive strip.

Understanding the importance of full bonding of the adhesive strip is key to inspecting asphalt composition shingle roofs in areas exposed to high winds. By bonding shingles to each other, the adhesive strip limits the area of shingle that is exposed to wind forces.

A shingle roof has maximum resistance when the wind is blowing at a 90° angle to the length of the shingle. This is the case when the wind is blowing straight at the eave. Under these conditions, the wind will be blowing at the tab edges, which are usually sealed along their entire length.

Wind blowing at a rake will be blowing at the ends of the shingles. In this situation, the portion of the adhesive strip facing the wind is typically a maximum of ¾-inch wide. This reduced area of sealant can leave shingles near the rake edge more vulnerable to damage.

Failure of adhesive strips can be caused by a number of different conditions:

- Shingles installed during cold months in cold regions of North America may not bond until mid-spring of the following year.
- Wind may blow dust or debris into the adhesive strip, contaminating it.
- Shingles that never experience direct sunlight due to shade from trees or topographical features, such as mountains, may never fully seal.
- In an effort to keep roofs cool and extend the shingles' service life, manufacturers have developed granule coatings that reflect sunlight more effectively than conventional coatings. In areas and situations in which the available sunlight only marginally warms the roof, highly reflective granule coatings may prevent adhesive strips from bonding adequately.

Transfer

Sometimes, only part of an adhesive strip may fail and a section of the adhesive strip may remain fully bonded. Wind may be strong enough to break the overlying shingle tab loose from the underlying shingle to which it’s bonded. The shingle may delaminate at the fully bonded section.

When this happens, a divot may be pulled loose and remain attached to the opposing shingle. This is called transfer because part of one shingle is transferred to another. Both shingles should be replaced.

Inflation

Wind may break the bond of the adhesive strips, but it may not be strong enough to crease or tear the shingle tabs. One of the ways this can happen is when wind is able to enter the space between the shingles and underlayment. This is most likely to happen when wind is blowing against a rake rather than against an eave. In this situation, the wind can inflate this space, raising the air pressure to the point at which the bonds of the adhesive strips fail.

If the weather is warm enough, the adhesive strips may re-bond. If the weather is too cold, or if the quality of the adhesive strips is poor, or if the adhesive strips have become contaminated by dust and dirt, the adhesive strips will likely not re-bond and the shingles will need to be hand-sealed.

TYPES of SHINGLE DAMAGE

Creased or Broken Tabs

Once the bond of the adhesive strip is broken, wind may be able to lift and bend the shingle tabs to the point that they crease or tear.

Low-quality and older shingles will crease and tear at low wind speeds.

It's rare that inland, non-tornado wind can break the bond of a fully bonded shingle tab. Bear in mind that just because the underside of a shingle is stained with adhesive does not prove that the adhesive strip ever bonded fully. Under certain circumstances, adhesive can be thinned by excessive heat, causing the tab to separate prior to final curing.

If a bond of the adhesive strip is broken by wind, it's often because the shingle never completely bonded along its full length. Typically, a poorly bonded section will be lifted by wind, and this will gradually cause the remaining sections to fail. Sections of the bond may be compromised by fasteners installed in the adhesive strip or by debris.

Debris

Another potential problem with failure of the adhesive strip's bond is that debris, such as dust and dirt, may be blown into the adhesive strip. This can limit or prevent shingle tabs from bonding, leaving them more vulnerable to wind damage.

Shingles with adhesive strips contaminated by debris may need to be hand-sealed.

Shingle Blow-Off

If wind blows hard enough, it may be able to pull shingles over the heads of fasteners. Poor installation practices, such as over-driving or placing fasteners improperly, increase the chances of shingle blow-off.

Once the adhesive strips fail, the ability of the shingles to remain in place will rely more on the fasteners. If the wind blows hard enough, it may be able to pull shingles over the heads of fasteners.

FASTENERS

Jurisdictional Requirements

The type of fasteners that can be used on new construction may be limited by jurisdictional requirements. Areas that commonly experience hurricane-force winds typically don't allow staples to be used.

Fastener Types

The type of fastener used to fasten the shingles is especially important for resisting wind uplift and pull-through. Fasteners for asphalt shingles should be roofing nails or staples. The head of a roofing nail and the crown of a staple are the parts that actually hold the shingles in place. The minimum width for the staple crown is 15/16-inch.

Although both nails and staples have historically been used to secure shingles, staples are usually not recommended in areas subject to high winds, and they're also not allowed by most building codes in new construction.

Fastening shingles with staples may void the manufacturer's warranty against wind damage. Both nails and staples have sufficient strength to resist the small uplift load on the fasteners as long as the adhesive strips are fully bonded. If staples are properly installed, they offer close to the same resistance to wind as nails.

Staples

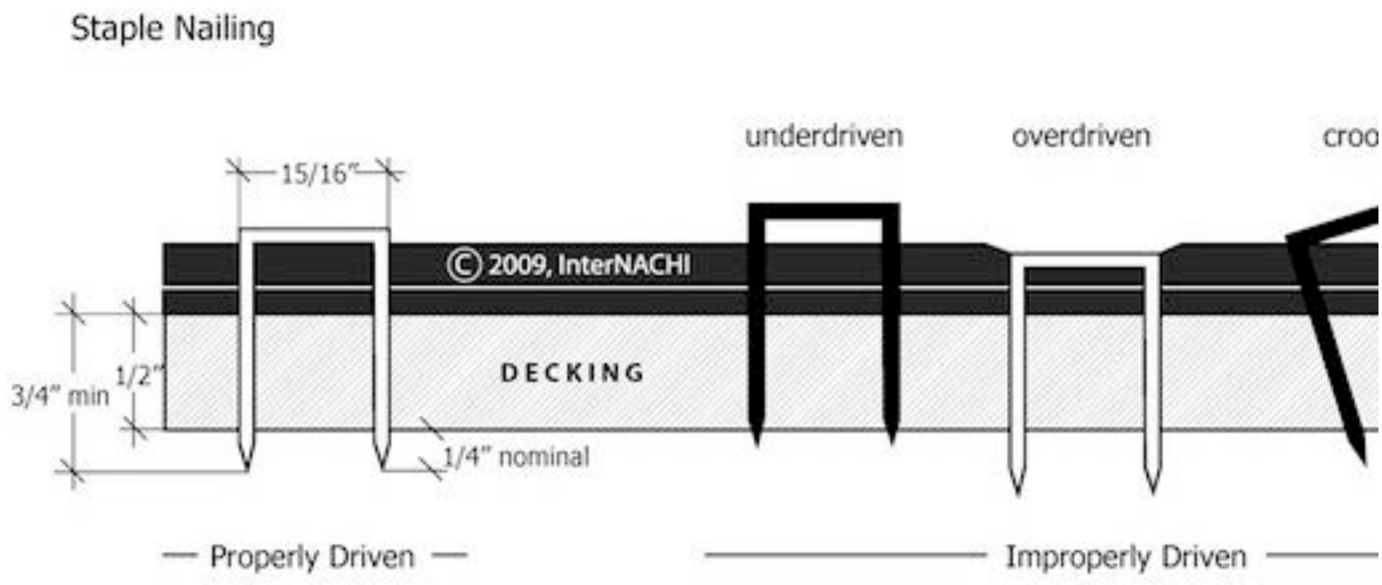
The problem with staples is orientation. As an installer uses an air-compressor staple gun, his natural tendency is to rotate his body. Unless he also rotates his wrist at the same time, the orientation of the staple crowns will reflect this rotation.

Properly installed, stapled shingles will usually withstand wind speeds of up to 60 mph. Upgrading the fastening system requires re-fastening the shingles with roofing nails. The shingles may need to be hand-sealed afterward because the adhesive bond may not re-seal adequately.

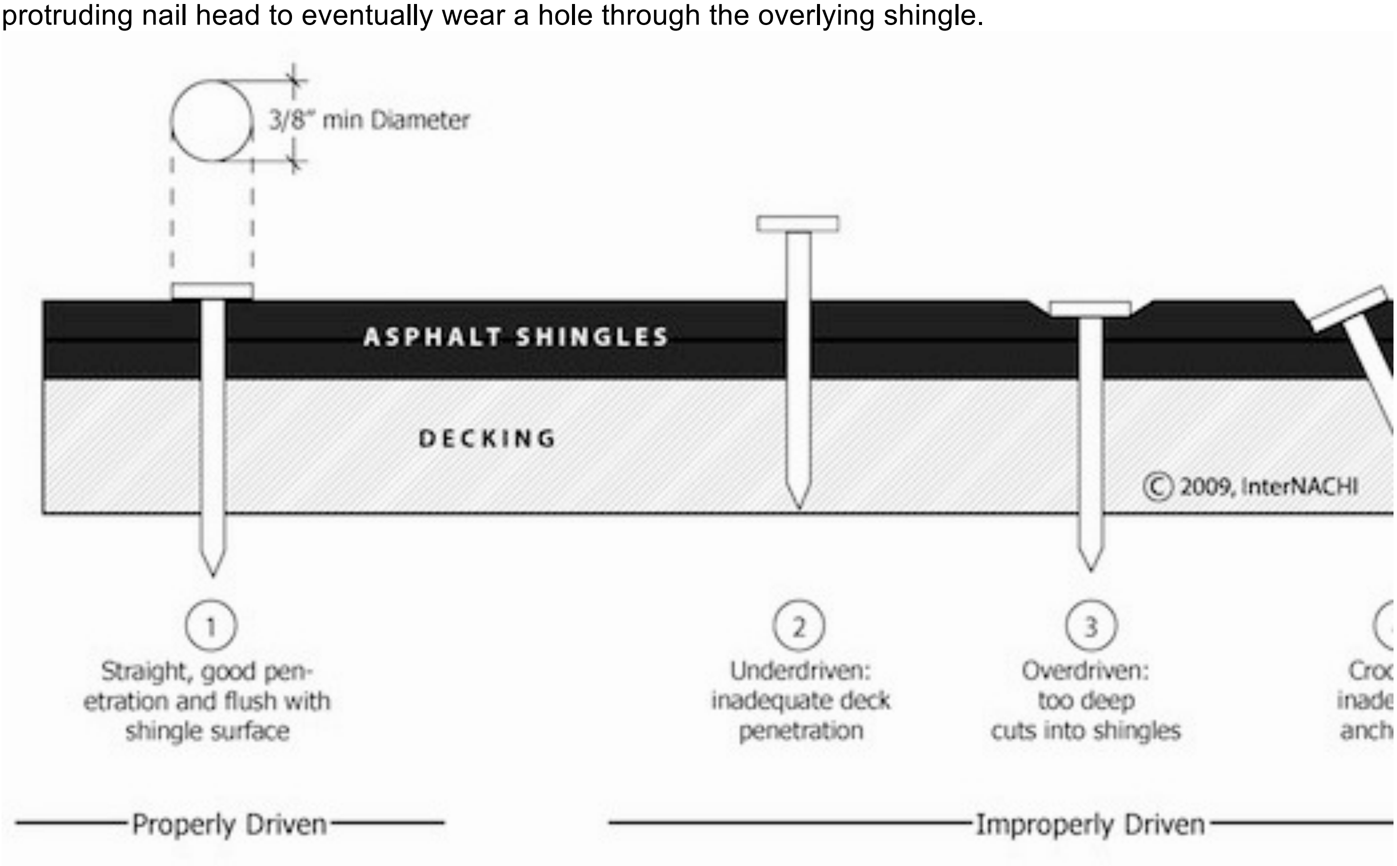
Nails

Some shingle manufacturers specify that their shingles be fastened with nails. Nails should be corrosion-resistant, wide-head roofing nails of the proper length. Corrosion-resistant nails can be made of galvanized steel, copper, aluminum or stainless steel.

Proper Fastener Installation



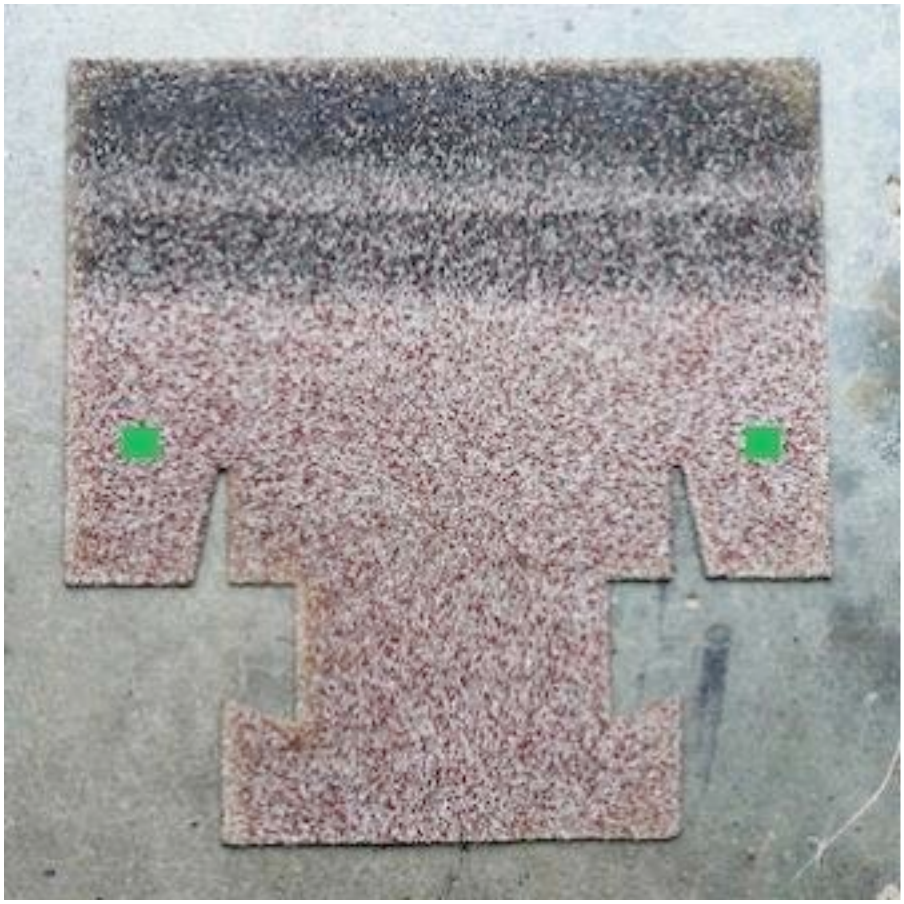
Fasteners should not be over-driven, which will cause them to cut part-way through the shingle and lower its wind resistance. They should also not be under-driven, which will cause the protruding nail head to eventually wear a hole through the overlying shingle.



Fasteners driven at an angle can cause both problems, depending on how deeply they're driven.

Fastener Placement

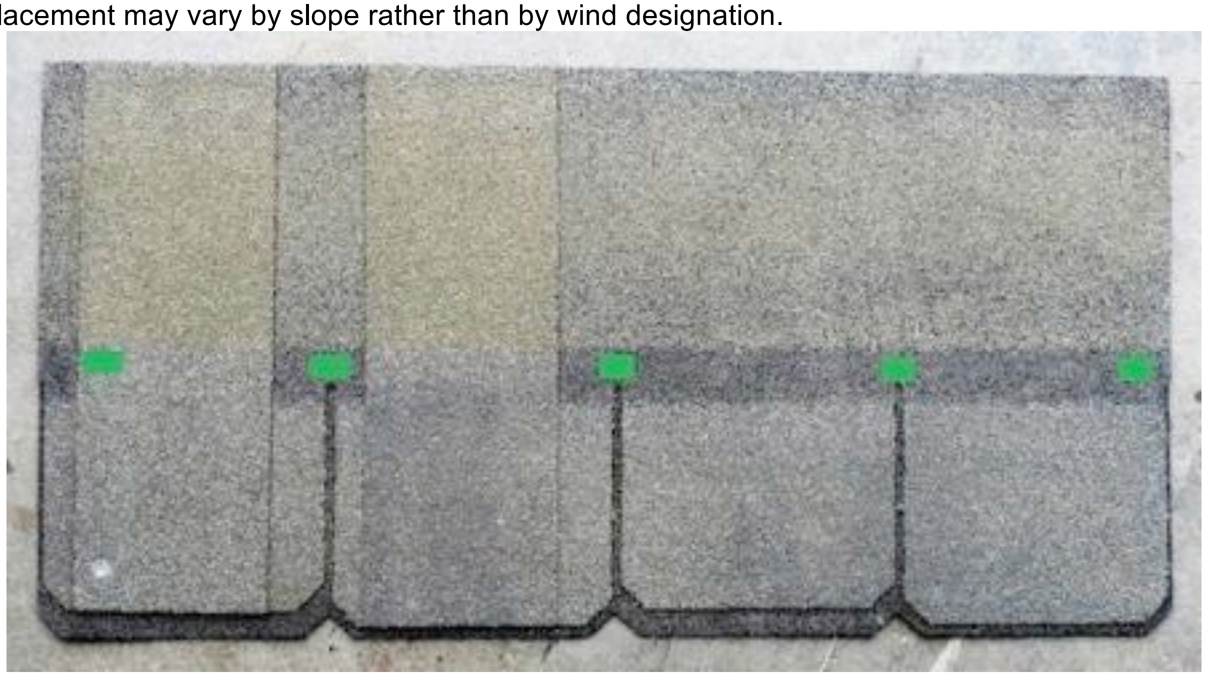
Fasteners should be placed according to the manufacturer's instructions. Generally, they should be installed below the adhesive strip, equally spaced across the shingle, and placed in slightly from the ends.



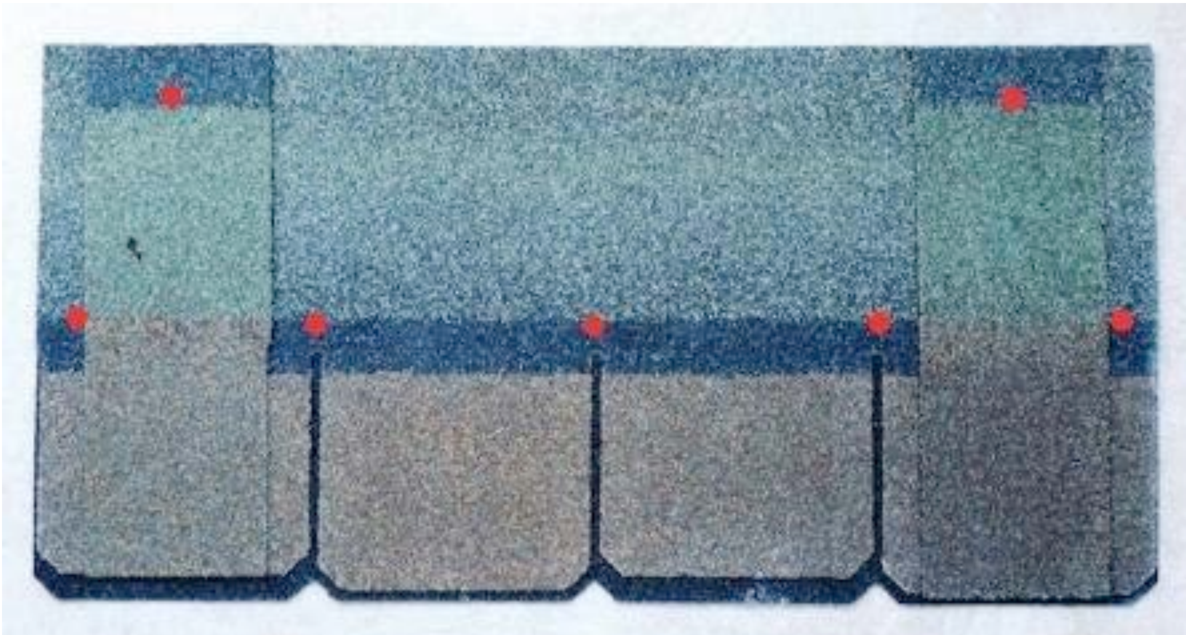
T-lock shingles have their own requirements for fastener placement.

Shingles in areas designated as high-wind areas should have additional fasteners installed at the two inner positions, as shown in the two photos above.

Heavy architectural shingles often have different fastening requirements. The fastener placement may vary by slope rather than by wind designation.



This picture shows standard-slope fastening.

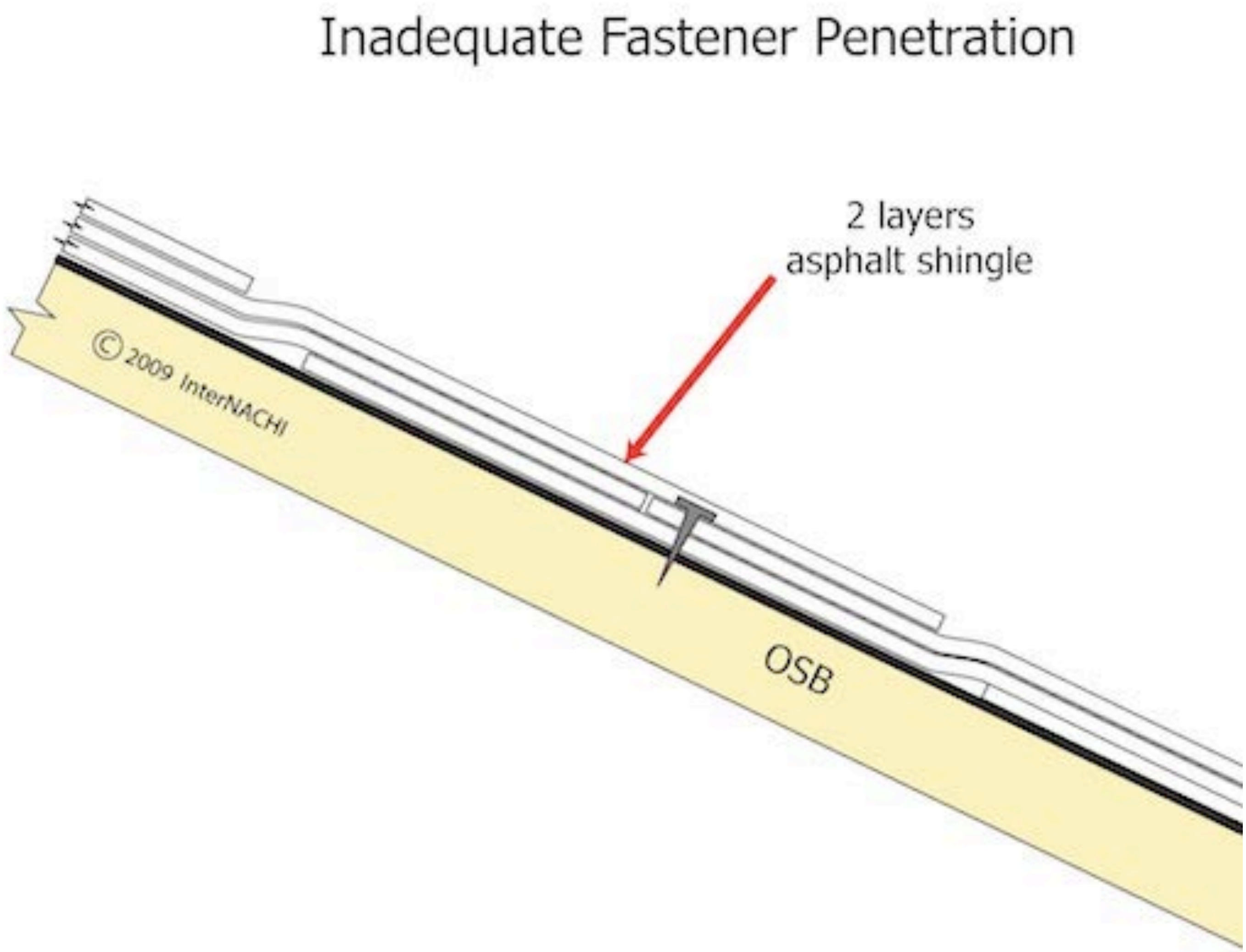


This picture shows steep-slope fastening.

The Holding Power of the Substrate

The holding power of the substrate affects the holding power of the fasteners. Decayed or rotten sheathing will not anchor fasteners well.

Inadequate Penetration



Fasteners should be long enough to completely penetrate the roof deck. This can be a problem when newer shingles have been installed over old ones, as well as with ridge and hip cap shingles, and with continuous ridge vents.

We've come to the end of this training video.