FROM GENERATION TO GENERATION: ISSUES AND PROBLEMS FACING THE STEEP-SLOPE ROOFING INDUSTRY

REID RIBBLE
Security Roofing & Siding Co.
Menasha, Wis.

DON SUMMERS
Specialty Roofing Inc.
Peoria, Ariz.

RICK OLSON
National Tile Roofing Manufacturers Association
Eugene, Ore.

JONATHAN GOODMAN
Security Roofing & Siding Co.
Menasha, Wis.

This paper describes issues and addresses problems facing the steep-slope roofing industry. It challenges the technological community to examine these issues and to offer solutions to the problems.

The paper includes issues facing the asphalt shingle industry, as well as concrete and clay tile, synthetic materials and metal roofing.

KEYWORDS

Asphalt shingles, concrete tile, design, fasteners, fiberglass, organic, metal roofing, synthetic materials, underlayments.

INTRODUCTION

The steep-roofing industry is facing problems which it can no longer endure. The manufacturing, contracting and design communities need to focus on improving these problems by visiting the production lines, entering the laboratories and trekking out into the field to study procedures and collect data. Once this is completed, the pursuit of solutions should be relentless.

Distinct problems that have existed for sometime are presented in the following pages. The industry's response to these problems is the one remaining variable yet unmeasured.

Asphalt shingles, concrete and clay tile, synthetic materials, and metal roofing systems have their own specific array of problems, which industry professionals must join together to solve.

ASPHALT SHINGLES

For purposes of this paper, the authors have grouped asphalt shingles into two categories: fiberglass-reinforced and organic-reinforced. Shingle weight will not be considered unless it relates to a specific issue regarding the failure mode of the material.

Cracking of Asphalt Shingles

Asphalt shingles made with a reinforcement of fiberglass or fiberglass/polyester composites have increased in popularity and usage during the last decade. Along with this increased usage has come increased problems. The Western States Roofing Contractors Association (WSRCA) initiated testing in 1991 to identify causes of the cracking/splitting phenomena with lightweight fiberglass shingles. This testing was prompted by field complaints of cracking/splitting.

Asphalt Roofing Manufacturers Association (ARMA), along with the WSRCA, has begun extensive research and analysis of in-service fiberglass reinforced asphalt shingles. Tests that examine asphalt pliability, the impact of thermal cycles, tear strength and others are all being closely studied.

Cracking/splitting of fiberglass shingles is possibly the most significant issue facing the asphalt shingle industry. Shingle cracking/splitting may also be the most important of all issues facing the asphalt shingle trade. When the enormous volume of installed fiberglass three-tab shingles are considered, the liability risk facing designers and installing contractors is great. If the shingle cracks, and water enters the building, a failure occurs. Reports of cracking/splitting occurring as early as six months into the in-service life of the roof have surfaced. The cracking/splitting of fiberglass shingles can be categorized into four distinct types: horizontal, vertical, random and in-line.

Horizontal Cracking/Splitting

Horizontal cracking/splitting appears most often with the square tab (no cut-out) design. This design has one continuous tab in contrast to the three-tab shingle. Horizontal cracking/splitting does occur in three-tab shingles, but with less frequency.

This cracking/splitting is evident in fiberglass shingles of varying weight and design. The crack usually occurs just below the butt edge of the shingle above and continues horizontally across the entire shingle. However, it has been observed to be much lower on the exposed tab as well.

Vertical Cracking/Splitting

Vertical cracking/splitting most typically occurs on the exposure directly above the joint of the lower shingles. This problem has surfaced in both square-tab and three-tab shingle designs. The shingle appears to crack from the bottom of this exposed tab and moves in an upward direction until it reaches the next shingle above. The crack typically terminates as it proceeds under the higher shingle. It may be possible, however, that the cracking occurs from the top down. More study is underway to further research this problem.

In-line Cracking/Splitting
In-line cracking/splitting occurs directly above joints of sheathing panels (e.g., plywood or oriented strand board (OSB)). This cracking/splitting can be both horizontal or vertical, depending on deck movement.

Random Cracking/Splitting
Random cracking/splitting typically occurs on the exposed tab of the shingles and does not follow a particular pattern. It first appears as surface crazing, and then as the shingle ages it completely cracks/splits in a random fashion.

Class "C" Cracking
Cracking of organic asphalt shingles present a lesser concern than their fiberglass counterparts. Reports of cracking/splitting (e.g., where the organic mat actually cracks/splits) are much more infrequent than in fiberglass shingles. The cracking appears to be limited to the surface of the asphalt. This is similar to the crazing you would see on the asphalt surface of a smooth-surfaced built-up roof. In its initial stages, the cracking does not affect the reinforcement of the shingle. However, as the shingle ages moisture will attack the organic mat. This attack, if severe, causes some premature damage to the reinforcement.

Wind Damage
Wind damage affects both organic and fiberglass roofing materials. The authors' experience, however, indicates that the materials are affected differently by wind. Fiberglass shingles seem to be less resistant to wind uplift.

Fiberglass shingles most frequently damaged by wind are broken off at the fastener. It is a recurrent observation to see fiberglass shingles in full pieces (usually several shingles stuck together by the sealant stripe) on the ground with gaping fastener holes. However, fiberglass shingles that have not properly sealed often break just below the fastener line. Observations show just the tab of the shingle on the ground with the remaining attached piece still fastened to the roof. The strength of the sealant stripe and the temperature when the shingles are installed may be variables needing closer scrutiny.

Organic shingles damaged by wind are frequently observed in whole pieces with the fastener pulled out of the structural deck, but still remaining in the shingles. It is less likely to see several organic shingles stuck together and blown off en masse.

Numerous building variables contribute to wind damage: slope, height, style of roof, (gable, hop, gambrel, etc.) edge design, attachment, structural deck type and geographic location. Each variable has unique consequences.

There are also numerous application factors that contribute to wind resistance. Temperature, fastener length, type and placement, and the strength of the sealant stripe all contribute to the performance of the shingle.

Fortunately, significant research is underway. Soon, new testing and analytical techniques will be available for the assessment of asphalt shingle wind resistance.[1]

Curling and Buckling
Curling and buckling of organic asphalt shingles is another issue to be addressed. This concern, which affects aesthetics, shingle life and wind resistance, is an important one. Any problem that negatively effects the appearance of a steep-slope roof merits serious consideration. Curling and buckling of asphalt shingles are one of two aesthetic issues we set before the industry leaders to address.

The most common characteristic is the raising and inward curling of the exposed corners of the tabs. They begin to curl inward toward the roof deck. This curling (often referred to as clawing) begins in some cases as early as 18 months.

Buckling of shingles, when the butt edge of the shingle actually buckles upward, occurs frequently on square tab shingles. But, buckling also occurs in traditional three-tab shingles. The buckles appear to be random across the roof surface and can raise up as high as one inch.

While the problem seems to be well understood,[2] the issue still prevails in climates where moisture-laden air is common.

Color Shading
Neither fiberglass nor organic shingles have the edge with this problem. Color shading can affect asphalt shingles of all styles, colors, weight and construction.

Color shading is an undesired variation in the uniformity of color. This variation is limited to off shades of the main color blend of the shingle. Manufacturers often attribute the problem to "granule press" in the manufacturing process. Color shading can also occur when the installing contractor has inappropriately "racked" the shingles; it has been a problem for steep roofing contractors for as long as the authors can remember.

Underlayment Wrinkling
The wrinkling of underlayment felt has become an important concern of roofing and building professionals. The concern is driven by both aesthetic and performance considerations.

Underlayment felt is often used to temporarily "dry-in" in building during construction of the roof. After the shingles are applied, it becomes a secondary protection for wind-driven rain, and snow and ice back up. The underlayment felt wrinkles when subjected to minimal moisture. Minimal moisture can be anything from dew to a light rainfall.

This wrinkling of the underlayment often affects the appearance of the newly installed asphalt shingles. The wrinkles telegraph through the shingles and often appear as color shading. The wrinkling can also affect the water-shedding properties of the roofing system. Underlayment felt that wrinkles severely enough to pull off of fasteners, or tear, can reduce the ability of the underlayment to resist moisture.

CLAY AND CONCRETE TILE AND SYNTHETIC MATERIALS

Like asphalt shingles, there are a number of issues facing the clay and concrete tile and synthetic tile segment of the roofing business. Color retention, underlayment, methods of attachment, wind resistance, freeze/thaw cycles and ice back up are all problems that need to be studied and solutions rendered.

The items above are included in the specific issues that the authors wish to address; that being the establishment

of industry-wide guidelines for acceptable design and installation practices. The second is to develop improved performance standards for clay tile, concrete tile and synthetic roofing materials, and the components used in their installation.

INSTALLATION PRACTICES

Attachment Concerns

There has been much debate over the issue of whether it is better to install clay and concrete tile using a batten system or "direct nail" system. Outside the United States, nearly all clay and concrete tile roof installations use the batten system without solid sheathing. However, in the United States, clay and concrete tile installations using a batten system are typically applied over solid sheathing. Many contractors have questioned whether the battens are superfluous since the tile can be directly nailed to the solid sheathing. As a result, "nail-on" and other "direct" application installations, like the "mortar-set" system prevalent in south Florida, have developed. Throughout the Southwest, where clay and concrete tile enjoy its greatest market share, "direct nail" application (i.e., no battens) has become increasingly popular.

Since the trend seems to be away from batten installation and toward "direct-nail" installation, clay and concrete tile manufacturers need to further refine their product designs to optimize performance for this particular technique. Despite the trend, batten installations must still be used for roofs with steeper pitches. The pitch of the roof where manufacturers require the use of battens varies.

The method of attachment is also a concern with the various synthetic products available. These products are made with a variety of materials including plastics, metal and concrete. At this point there seems to be no uniform method of installation. Each manufacturer requires: differing underlayment felts, various types and frequency of fastening, and various details for valley and sidewall flashings.

Ventilation Concerns

Ventilation systems will be an installation issue of growing importance for both clay and concrete tile and synthetic materials. All building codes require appropriate attic ventilation systems. However, many residential structures have either inadequate or no attic ventilation at all. It has been the authors' experience that most building owners are presently unaware of the importance of attic ventilation. Awareness has been enhanced recently because attic ventilation can reduce energy costs. There are also structural concerns in attics that have been adversely affected by humidity, and where inadequate attic ventilation is present.

Since both saving money and protecting the environment are important issues in the 90s, one of the challenges for the industry as a whole is to effectively communicate the energy-saving and money-saving message to building owners and designers in order to increase demand for ventilation systems.

Additionally, the challenge for tile manufacturers is to provide technical support to contractors and builders so that attic ventilation system installations become simplified. Simplifying the installation will result in less chance of errors which, in turn, should lead to better performance of the ventilation system.

The technical community must also develop ventilation systems for all steep-slope roofing applications that meet current building code requirements. It is extremely difficult in certain applications (i.e., cathedral ceilings) to reach adequate ventilation ratios using the methods currently available. The problem is increased when building owners demand systems that are aesthetically pleasing, but not completely functional.[3]

Ventilation has another side benefit for clay and concrete tile and synthetic products; in some instances it can reduce ice buildup. Depending on weather conditions and other factors (i.e., slope of roof and amount of ventilation), the results of proper ventilation can be great. This ice buildup can slide down the slope of the roof and damage the tile as well as anything on the ground that may be in its falling path. While all materials are subject to damage, the damage to clay and concrete tile is most visible.

PRODUCT PERFORMANCE STANDARDS

Color Retention

The ability of a roofing material to retain its color has become a "hot issue" with today's fashion-minded buyer. The design community has specialists whose purpose is to coordinate color into the architectural design. A serious problem develops when the original color changes over short periods of time, or has unusual characteristics within its blend.

Most clay, concrete and synthetic tile are colored using natural raw materials. Subtle changes in color can occur because of this. Gradations in color will occur like those found in desert rock or green leaves on similar trees. The color of each tile will vary slightly depending on the differences in the mix of sand, cement, and the oxides (pigments) used. The only sure way to achieve uniform color would be to install a coat of paint on the surface of the tile. This would reduce the natural beauty of the tile as well as its durability.

Color fading and color change are frequently voiced complaints. This issue is different than the color shading of asphalt shingles in that severe loss or change of color occur. While "integral colored" tile, tile that is colored through the product, and coated tile offer similar initial aesthetics; age, heat and atmospheric conditions can affect the colors differently and in some instances drastically. Tile manufacturers should continue to work on the color quality of their tile. They must seek to prevent major color shifts between tiles of the same hue.

Contractors should be taught to properly and skillfully blend tiles so that the natural and unique beauty of the tile roof is best expressed. Most building owners chose these upscale products, in part, because of their distinctive look. With proper blending techniques, contractors can enhance the appearance of the roof, heightening the owners' satisfaction with the installation.

Underlayment

The types, number of plies and methods of attachment of underlayments vary greatly by region. Some areas of the country use conventional built-up roofing while others simply use a single layer of asphalt-saturated felt.

As more information about the durability of these materials becomes better known, the shortfalls in underlayment performance are sure to surface. It is common in many parts of the country to remove slate and tile because the underlayment no longer provides adequate water resistance. It seems reasonable that the use of better (longer lasting) underlayments should be considered. The use of more plies of underlayment felts, underlayment felt that meets ASTM D-226, or even modified bitumen roof membranes might all be solutions to this problem.

Technology in the low-slope roofing arena has advanced rapidly in the last few decades. Why then is our industry still primarily using technology developed decades ago for underlayment protection in tile roofing systems? This is especially surprising when failures in underlayments for tile and slate roofing systems are commonplace. Surely the technology exists that provides solutions to this problem. The industry needs to respond and design an underlayment system sufficient for the life of the primary roof covering.

Methods of Attachment

Both clay and concrete tile and synthetics are experiencing problems with the methods of attachment. Shifting tiles, broken tiles and wind damage can often be blamed on improper or insufficient attachment. There seems to be little consensus among manufacturers regarding attachment. Some building codes have specifically addressed the use of "hurricane clips" in very high wind areas, but for the most part, attachment is left to the whims of the roof system designer or contractor.

Type and location of fasteners, fastening of battens, and the use of clips to secure the butt edge of the tiles are all items of concern. Underlayments that do not last as long as the tile and fasteners that do not last long enough to insure attachment are also a problem.

This presents another issue; tiles that are broken from what appears to be wind uplift. Although scientific data is not available at this time to support the authors' "wind uplift" theory, investigation is needed. In many installations clay and concrete roofing tiles are not fastened. They are laid loose on batten strips, with every third or fifth course mechanically attached to the batten system.

Cracking of unattached concrete tiles has been observed. It may be that when the tiles go through cycles of uplift during wind storms, they are stressed to the point of breaking.

The batten system itself must also be examined. When tiles are either attached or laid loose onto battens, the batten then becomes a critical component concerning the attachment of the roof. Moisture from snow and ice back up, wind-driven rain, and condensation are all likely to affect the batten system. Do the battens perform adequately for long-term roofing systems? Is the use of pressure treated wood or metal battens better suited for this type of application?

METAL ROOFING SYSTEMS

Many of the issues addressed previously apply to metal roofing as well. Inadequate underlayments, poor methods of fastening, ineffectual prevention of ice back up and improper ventilation are all suitable issues needing solutions. There are two issues, however, that the authors wish to highlight in this paper. The first is color retention and the second is education of the design community.

Color Retention

Color retention problems have also plagued the metal roofing industry. Developments using ultraviolet resistant coatings have greatly decreased fading of most colors. However, for some types of paint coatings, color loss is still a very present and sometimes severe problem.

Building designers continue to ask for more color options. The manufacturing community has responded with more and more colors being available. Unfortunately, it is fairly common to see roofs of blue, brown and green experiencing excessive fading. Excessive fading may be defined as any fading that is easily recognizable by the human eye.

Uneven fading is another related problem. While it may be natural for southern or western exposures to fade at a rate more quickly than other exposures, it becomes an unacceptable problem when the fading is so significant that it ruins the aesthetics of the roof. This causes great concern for the roofing contractor and building owner.

Education

It seems that there are as many metal roof options available as there are designers to specify them. One problem is the consideration of unequal systems listed side by side as equals. There are significant differences both from performance standpoints as well as aesthetic considerations; not to mention cost disparity. Finish, thickness of panels, so called "snap together" panels versus mechanically seamed systems, and type of metal are all differences frequently seen specified together in an "or equal" specification. The problems are obvious to roofing contractors and building owners.

The roofing contractor is placed in the uncomfortable position of trying to select the system that might be used knowing that the owner might not be getting what he expects. The owners, on the other hand, are expecting equal performance from all the systems specified and are usually not equipped with the technical expertise to properly chose the roofing system.

At some point the metal roofing industry must educate the design community on the differences of each of these systems. It is not the purpose of this document to give the authors' opinion of which system is best utilized for any given application. However, it is extremely frustrating to see vastly different systems listed together in the "approved products" section of the specification book. It is also not unusual to see details from one manufacturer in the drawings that are unacceptable to other manufacturer's approved systems.

Additional Considerations

The issues and problems addressed in this paper are ones the authors have chosen to focus on. There are others that space will not allow. Warranties, identification of liability and the premature introduction of products into the marketplace are other issues of concern that were not addressed. Whatever the concerns, the industry should continue to identify, examine and correct them.

CONCLUSION

The dedication of the steep-slope roofing industry is envied by many and seconded by none. The challenges identified within the pages of this paper have great significance, but the list is not inclusive. Choose the problem most important to you. Enlist the expertise of those around you. The rewards of our success in the 1990s will have a lasting effect on generations to come.

REFERENCES

[1] Shaw, Donald E., "Better Uplift Resistance for Asphalt Shingles? The Answer May Be 'Blowing in the Wind'," *Professional Roofing*, pp. 30-32, January 1992.

[2] Cullen, William C., "The Evolution of Asphalt Shingles: Survival of the Fittest?," *Professional Roofing*, pp. R4-R8, June 1992.

[3] Carlson, James, "Alternative Sought for Applying Shingles Over Rigid Insulation," Q&A, *Professional Roofing*, pp. 72, March 1991.