The Code Corner

RLGA Technical Services

No. 6 — January 2005

Roofing

By Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP

Most owners and architects would say they select a roofing system for its ability to remain weathertight for the longest period of time. However, there are other factors that are taken into consideration when selecting a roofing system. These include appearance, reflectivity, fire resistance, wind resistance, and impact resistance. The first two factors are typically determined by design and sustainability requirements. The last three factors are primarily code-driven, but an owner's insurance company could dictate minimum requirements for one, two, or all three factors. Now that we've identified what aspects of selecting a roof the building code affects, how does the code implement its requirements? That's easy…Chapter 15 of the *International Building Code* (or, Chapter 38 in NFPA 5000).

Before we begin, I need to point out that the roofing chapters in the IBC and NFPA 5000 don't just address roof membranes; they also address the entire roof assembly and rooftop structures. The roof assembly includes roof slope, flashing, underlayment, and insulation. Rooftop structures pertain to cooling towers, spires, tanks, cupolas, etc., and will not be covered in the scope of this article.

Like most chapters in the IBC, the chapter on roofing is very prescriptive, meaning that it provides very specific requirements for most common roofing systems that have a proven history of good performance. Fortunately, the code doesn't limit roofing systems to those prescribed in the code. The chapter provides a means for approving roofing systems that do not have an applicable standard, or "where materials are of questionable suitability." This expands upon the basic alternate methods and materials (AMM) section in Chapter 1. Through these two sections, manufacturers can still develop new roofing products and still have those products used under currently adopted building codes. A good example to illustrate this is the use of thermoplastic polyolefin (TPO) roofing.

TPO, used since the early 1980's in the automobile industry, entered the single-ply roofing market in 1989 as an unreinforced membrane. In 1993, a reinforced membrane was introduced, and from there TPO roofing took off to lead the single-ply roofing industry. However, from a building code point of view, there was no standard, so manufacturers had to submit their products for approval, either to ICC's Evaluation Service, or another testing agency acceptable to the appropriate building official. Without the AMM process, TPO would have had a difficult, if not impossible, task getting specified. In 2003, ASTM developed a standard for TPO membranes, which will undoubtedly help the approval process. Over time, if it proves itself a well-performing roofing system, TPO could eventually be incorporated into the building code as a prescriptive roofing system, just like attactic polypropylene (APP) modified bituminous roofing was added in the 2003 IBC.

As previously stated, protection from the weather is a primary concern of owners and architects, and why shouldn't it be; that's the main purpose of the roof: protection from the weather. Building owners get really upset when they see water dripping from their ceilings. To highlight this basic need, the IBC provides broad-scope requirements in Section 1503 that address this very issue. Essentially, it states that roofs "shall serve to protect the building or structure," and adds that flashing be provided "to prevent moisture entering the wall and roof" through copings, moisture-permeable materials, roof-wall intersections, and penetrations. Part of keeping moisture from entering the building is the slope of the roof to provide drainage. The minimum roof slope is 1/4 inch in 12 inches (2% slope). Missing in the

IBC are the requirements for overflow drains and scuppers. But don't be disappointed, the requirements are now located solely in the *International Plumbing Code*.

Keeping water out of a building would be a difficult task to perform if the roofing is blown off, leaving the substrate and other building components exposed to the elements in a storm. Hurricane Andrew, which hit southern Florida in August of 1992, emphasized the need to keep roofs in place. As a result, the IBC now references Chapter 16 "Structural Design" for determining wind loads that roofing systems must withstand. Chapter 16 specifically references ASCE 7 for determining wind loads, but also allows wind loads to be determined using a simplified load method for qualified low-rise buildings. It will be interesting to see what impact the 2004 hurricanes will have on future editions of the IBC.

For wind uplift, the IBC also requires either Factory Mutual Global (FM) approval per FM 4450 or FM 4470, or be classified by Underwriter's Laboratory (UL) via tests UL 580 or UL 1897, for built-up, modified bitumen, mechanically fastened or fully adhered single-ply, and other membrane roof systems. The FM standards test for factors other than just wind uplift, such as fire, hail, leakage, foot traffic, and corrosion resistances, but only the wind uplift and hail resistance approvals are directly accepted under the IBC. However, FM 4470 uses ASTM E 108 for fire classification, which is referenced by the IBC, so, in a round about way, FM 4470 could also be used for fire classification. Additionally, the FM 4450 test incorporates FM 4470, therefore, any roofing system approved using FM 4450 is accepted by the IBC.

Another new inclusion in the IBC is the requirement for impact resistance for roofs with slopes less than 2 inches in 12 inches (16-2/3% slope). This is primarily for hail resistance, but it can be just as effective in preventing damage from the occasional dropped tool. The IBC provides several standards that are acceptable from ASTM, FM, and the Canadian General Standards Board (CGSB).

Following closely behind weather protection in rank of importance is fire resistance. Fire resistance has been a staple of the roofing section through most editions of the *Uniform Building Code*. The IBC is no different, except that it goes even a little further. Roofs are classified according to their ability to resist promulgation of fire based on fire-test exposure. Two test methods for classifying roof assemblies are accepted by the IBC: ASTM E 108 and UL 790. These are virtually identical tests since UL adopted ASTM E 108 for their test. The tests will classify a roof as either A (severe exposure), B (moderate exposure), or C (light exposure). The most significant difference between the IBC and UBC is their application of roof classifications. The UBC required roof classifications based on building occupancy and type of construction. The IBC, on the other hand, applies classifications according to type of construction only, with some exceptions. Nonclassified roofs may be used on occupancies classified as R-3 (typically detached 1- and 2-family dwellings) or U (utility structures such as barns, sheds, etc.), provided they have a fire-separation distance of 6 feet. The IBC, by exception, automatically includes roofs of brick, masonry, slate, clay or concrete tiles, exposed concrete decks, and ferrous or copper shingles or sheets (aluminum is not included) as Class A roofs. Sheet metal roofs, including aluminum, are given a Class B rating.

There's growing concern regarding the use of wood shakes and shingles. The IBC still permits their use, but has added additional requirements pertaining to fire-retardant treatment, which is necessary to achieve one of the three class ratings. Weathering is the main culprit in why wood shakes and shingles contribute to the spread of fire in residential areas. Prior to testing for fire exposure, wood shakes and shingles must go through ASTM D 2898. Although this is identified as a "test" method, it actually prepares the wood shakes or shingles for the actual fire exposure test, ASTM E 108 or UL 790, by

"preweathering" them. Although some wood shakes and shingles have achieved a Class A rating, there is still a debate as to whether or not they're effective over time. Some communities, especially in California, have prohibited their use in their jurisdictions.

As discussed earlier in the article, the IBC relies primarily on prescriptive requirements for types of roofing assemblies included in the code. Specific requirements for each type of roofing vary depending on the individual characteristics of the roof system. Typically, these consist of deck requirements, deck slope, underlayment, flashing, attachment, material standards, and application. An interesting note to point out regarding application is the fact that both the IBC (Section 1506.1) and the NFPA 5000 (38.1.3.2) incorporate into their codes, by reference, the manufacturers' installation instructions; so, noncompliance with the manufacturer's instructions means noncompliance with the local building code. Prescriptive requirements provided in the IBC include the following roofing types:

- Asphalt shingles
- Clay and concrete tiles
- Metal roof panels and shingles
- Mineral-surfaced roll roofing
- Slate shingles
- Wood shingles and shakes
- Built-up roofs
- Modified bitumen roofs
- Thermoset (EPDM and CPSE) single-ply roofs
- Thermoplastic (PVC only) single-ply roofs
- Sprayed polyurethane foam roofs
- Liquid-applied roofs

Roofing insulation, when installed above the roof deck, must pass FM 4450 or UL 1256 as an assembly. However, foam plastic insulation that complies with the requirements of Chapter 26 "Plastic" do not need to pass those tests. In that chapter, the provision of a thermal barrier between the insulation and the interior of a building negates the need for the tests. Section 2603.4 requires a minimum of 0.5-inch gypsum board or equivalent, but an exception is provided in 2603.4.1.5 that permits exterior wood structural panel sheathing, 0.47 inches thick, with tongue and groove joints or other approved edge support. Class A, B, or C roofs that pass FM 4450 or UL 1256 also do not require a thermal barrier, unless included as a part of the test assembly. Fiberboard, when used as roof insulation, must comply with Chapter 23 "Wood." Chapter 23 provides material requirements for fiberboard, and states that fiberboard insulation must be protected by an approved roof covering.

Reroofing requires compliance with the roofing chapter, but there are a couple of leniencies provided. The first is the exception from complying with the minimum roof slopes for the prescriptive systems. The code permits reroofing at slopes lower than the 1/4 inch in 12 inches (2%), provided there is positive roof drainage. The second exception permits the addition of another roof system over an existing system without removal. Removal of an existing roof system is typically required when:

- it is deteriorated or is water soaked;
- it isn't an adequate base for the new roof system;
- its covering is wood shake, slate, clay, cement, or asbestos tile; or,
- it has two or more applications of any type of roof covering.

The second exception allows for separate roofing systems that have their own support structures and don't rely on existing roof coverings and structures for support, such as a structural metal panel system. Also,

metal shingles and panels, or concrete and clay tiles, can be installed over an existing wood shake roof when the entire surface is covered with gypsum board, mineral fiber, glass fiber, or other approved materials securely anchored in place.

Well known poet and diplomat, James Russell Lowell, once said "Compromise makes a good umbrella, but a poor roof." This quote, made in reference to statesmanship, can also be taken literally. If you compromise on your roof system, you've basically created an umbrella, because sooner, rather than later, you'll be all wet. The building code attempts to place every building on the same level with a "good" roof; one that has a proven history of satisfactory performance. But just complying with the code doesn't ensure a weathertight system. Quality of workmanship plays a big part in roofing performance. Hiring a skilled and licensed contractor that is competent in roofing systems is critical, so it is better to pay a little more now, than a lot later.

To comment on this article, suggest other topics, or submit a question regarding codes, contact the author at ron@specsandcodes.com.

About the Author: Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP, is an ICC Certified Building Plans Examiner, and is the principal of RLGA Technical Services located in Scottsdale, Arizona, which provides specifications and code consulting services to architects, engineers, owners, and product manufacturers. A 1984 graduate of the University of Arizona, Ron has over 23 years of experience with military, public, and private agencies.