Wind design for steep-slope roofs

Proper wind design is essential for performance

by Mark S. Graham

Proper wind design of steep-slope roof systems differs from low-slope roof systems. In the October 2025 issue, I provided an overview of the process and requirements for proper wind design of low-slope roof systems. This month, I address wind design for steep-slope roof systems. If you are involved in the sale, design or installation of steep-slope roof systems, it is important to know the requirements and process for proper wind design.

Code compliance

The International Building Code® requires steep-slope roof systems, except tile roof systems, to be designed to resist the code-prescribed design wind speed applicable to a building's specific location. In IBC 2024's Section 1609-Wind Loads, four basic wind speed maps provide ultimate design wind speeds based on a building's risk category. The lowest risk category, Risk Category I, applies to low-hazard, agricultural and storage buildings. The highest risk category, Risk

Category IV, applies to essential facilities, such as hospitals and police and fire stations.

The higher the risk category designation, the higher the code-prescribed ultimate design wind speed. For example, Chicago has an ultimate design wind speed of 100 mph for Risk Category I, 107 mph for Risk Category II, 114 mph for Risk Category III and 119 mph for Risk Category IV.

IBC 2024's Section 1609.3.1-Wind Speed Conversion provides an equation and table for converting the code's ultimate design wind speed (denoted as V) to allowable stress design wind speed (denoted as V_{asd}). V_{asd} is compatible with some code-prescribed resistance test methods and classifications.

IBC 2024's Section 1504.2-Wind Resistance of Asphalt Shingles provides minimum testing and classification requirements for asphalt shingles to resist ultimate design wind speed. Asphalt strip shingles with seal strips are required to be tested and classified according to ASTM D7158, "Standard Test Method for Wind Resistance of Asphalt Shingles (Uplift Force/Uplift Resistance Method)." ASTM D7158's Class D indicates passing ultimate design wind speed up to and including 116 mph. Class G indicates passing ultimate design wind speed up to and including 155 mph. Class H indicates passing ultimate design wind speed up to and including 194 mph.

The standard and code indicate ASTM D7158's classifications are limited to buildings in Exposure Category B or C with mean roof heights not exceeding 60 feet and no topographic wind speed-up effects. For buildings with roofs outside of any of these limitations, additional project-specific calculations are needed, and the shingle manufacturer should be consulted for the necessary data and further guidance.

For asphalt shingles that fall outside the scope of ASTM D7158, such as asphalt shingles without seal strips, testing and classification according to ASTM D3161, "Standard Test Method for Wind Resistance of Steep Slope Roofing Products (Fan-Induced Method)," is required. ASTM D3161's Class A indicates passing a test velocity of 60 mph. Class D indicates passing a test velocity of 90 mph. Class F indicates passing a test velocity of 110 mph.

IBC 2024's Table 1504.2-Classification of Steep Slope Roof Shingles Tested in Accordance with ASTM D3161 or D7158 provides the required minimum classifications based on the code's ultimate design wind speed or allowable stress design wind speed. The code's minimum ASTM D7158 classifications are consistent with the standard. However, the table allows ASTM D3161's classifications to be used for allowable stress design wind speed or ultimate design wind speed far greater than the test's passing velocities. For example, IBC 2024's table permits ASTM D3161's Class A testing to 60 mph and Class D testing to 90 mph to be used up to a V_{asd} of 100 mph or a V of 129 mph. ASTM D3161's Class F testing to 110 mph is permitted to be used up to a V_{asd} of 150 mph or a V of 194 mph.

The code also requires metal roof shingles, slate shingles and building-integrated photovoltaic shingles wind resistances to be tested using ASTM D3161 and comply with the classifications of Table 1504.2. As an alternative, metal roof shingles are permitted to be tested using ANSI/FM 4474, "American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures"; UL 580, "Standard for Tests for Uplift Resistance of Roof Assemblies"; or UL 1897, "Standard for Safety, Uplift Tests for Roof Covering Systems." These alternative test methods also apply to metal panel roof systems.

IBC 2024 does not provide specific guidance or requirements for determining the wind resistance of wood shake and shingle roof systems or synthetic roofing products. Some suppliers and manufacturers have ASTM D3161 testing available.

For clay or concrete roof tiles, IBC 2024 requires wind and tornado load resistances to be determined by overturning resistance or wind tunnel testing. Section 1609.6.3-Rigid Tile provides the equation and limitations for determining tiles' overturning resistances. Tile manufacturers should be consulted regarding this calculation and their tiles' wind and tornado load resistances.

Closing thoughts

Proper wind design for steep-slope roof systems is a relatively complex undertaking, and you should be aware of the design procedures' and tested resistance classifications' limitations.

Of particular concern is the code's allowance for using ASTM D3161 classifications at code-prescribed design wind speeds well beyond their tested capabilities. The concept of testing a roofing product to, say, 110 mph, and expecting it to perform at a basic wind speed of 194 mph is disingenuous to me.

Also, except for clay and concrete tile roof systems and metal roof shingles tested using FM 4474, UL 580 or UL

1897 testing, asphalt shingles and other steep-slope products lack methodologies and specific data for resisting tornado loads. Because consideration of tornado loads is required by IBC 2024 and ASCE 7-22, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," this is of concern for Risk Category III and IV buildings in the tornado-prone region, which generally is east of the Rocky Mountains.

I encourage manufacturers of steep-slope roofing products to make their wind design criteria, including any limitations, more readily available to designers and installers. I also encourage manufacturers to expedite development of credible methodologies and specific data for their products' resistances to tornado loads to allow designers and contractors to use these products in a code-compliant manner where tornado design prevails.

If you need information regarding proper wind and tornado design for specific steep-slope roofing products, I encourage you to reach out to the specific products' manufacturers. NRCA members also are welcome to reach out to NRCA's Technical Services Section at nrca.net/contact or (847) 299-9070 for further assistance.

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NRCA offers CEU for architects, engineers and consultants

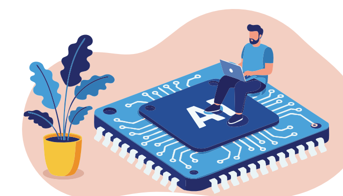
NRCA will offer Technical Update for A/E/C Members, a Power Hour exclusively for architect, engineer and consultant members, Feb. 18 at noon CST.

During the Power Hour, Mark Graham, NRCA's vice president of technical operations, will provide a members-only technical update session. The session offers 1 CEU and valuable insights into the latest industry developments.

Stay informed regarding topics such as code updates, ASCE 7 wind design applications and current technical challenges and engage in an interactive Q&A with your peers and NRCA experts.

Register for the Power Hour at nrca.net/events.

How companies can use AI



As more construction companies use artificial intelligence, it can be difficult to identify which tools will be most beneficial without costly programming, according to Construction Executive.

Automating back-office administrative and business development tasks can be a good place to start. Constructive Executive shares the following examples for how construction companies can implement AI.

1. **Quotes.** The traditional quoting process can be time-consuming and limit the number of bids a company can realistically pursue and win. Using past project data and a company's historical performance, AI quoting agents can read blueprints, identify specifications, quantify materials and generate cost estimations. This can increase bid volume and give estimators more time to focus on strategic pricing and client relationships.
2. **Data management.** Data often is spread across various IT systems, laptops and physical files, which makes it difficult to quickly access information. AI-driven data management centralizes and organizes all historical project data and can use advanced AI search capabilities to find the necessary information.
3. **Bids and requests for proposal.** Winning a large project requires a deep understanding of the project, client and market. It is time-consuming to manually research public bids and analyze a project's location. A bid and RFP AI agent can access and monitor all available public and private bids, gather additional data points about a project and analyze the local market, building history and regulatory environment. This can help a company produce a highly customized bid.
4. **Accounts payable and receivable.** These processes often are manual and can drain resources. AI can extract and verify data from invoices, cross-reference against purchase orders, flag discrepancies for review and send out automated payment reminders.
5. **Administrative automation.** In construction, administrative tasks can keep staff from crucial duties. AI now can handle tasks such as drafting routine safety updates, checking inventory levels and sending reminders about deadlines. This can help eliminate busy work and boost productivity.