Fastener coatings: which ones are best?

New standard provides criteria and test procedures

by S. Riaz Hasan

Roofing fasteners deteriorated by corrosion to the point that they are no longer able to keep a roof securely attached to a deck.

What is corrosion? It is the reaction of metal with an acid, oxygen or other compound resulting in the destruction of a metal surface. When iron rusts due to corrosion, it returns to its original state. In nature, iron ore, from which metal is deduced, is usually a crumbly compound with no appreciable strength. All metal fasteners, including the mechanical fasteners the roofing industry has come to rely on, are subjected to the natural process of corrosion unless something is done to prevent it.

Data compiled by the National Association of Corrosion Engineers and the National Bureau of Standards show that metallic corrosion costs the United States an estimated $168 billion a year, or 4.5 percent of the gross national product. An estimated 15 percent of that cost is avoidable by the application of the best known practices of corrosion control.

One of the most famous victims of corrosion was the Statue of Liberty. A century of fighting rust and high winds has not been easy for the 151-foot-tall statue. The monument was suffering from galvanic corrosion because of the proximity of the iron rib cage to the copper skin. Its rib cage bars were corroded and rust made the iron bars swell to the point that they were jamming against the copper skin. To restore "Ms. Liberty" to her former glory cost $62 million. The restoration includes a new stainless steel rib cage that is separated from the copper skin by teflon tape.

Corrosion has become a matter of concern in the roofing industry as well. Mechanical fasteners, which have replaced other forms of attachment, are being subjected to rusting, as are other roofing system components, when proper application guidelines are not practiced. The presence of moisture in the roofing systems and the rusting of fasteners may cause roofing systems to lose their ability to secure the roof to the deck.

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Fasteners used to fight fires

Mechanical fasteners were originally employed to make roof systems less combustible. Before the 1950s, most roofs were attached to the deck with a large amount of asphalt, a volatile petroleum byproduct. But in 1953, after a huge fire destroyed General Motors' Livonia, Mich., transmission plant, insurance companies realized that this method of attachment was a greater risk than they had extrapolated. Investigators who studied the disaster determined that the rooftop asphalt had helped fuel and spread the blaze.

In the search for better and safer attachment methods, the techniques of spot fastening with asphalt and attaching roofs with cold-applied adhesives were developed. These methods of attachment, along with the use of less combustible insulation, lowered the risk of fire, but they also produced weak attachments and the potential for roof blow-offs during high winds was increased. Factory Mutual (FM) wind loss statistics show that windstorm losses between 1971 and 1980 were $84 million.

Photos courtesy of Buildex

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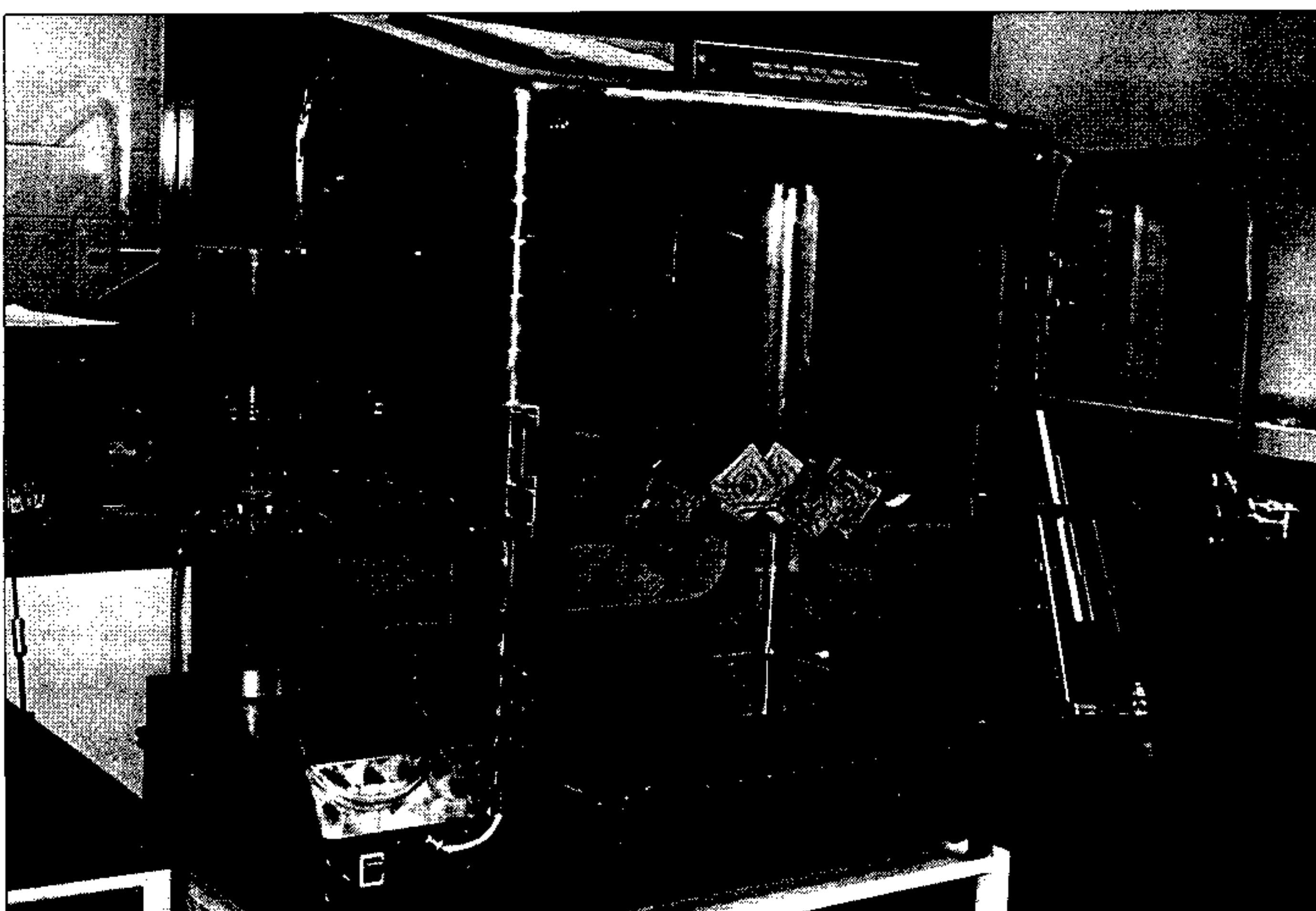
In 1975, a Chicago-based metal building fastener company developed mechanical fasteners for attaching insulation to a metal deck. The products were called accessory fasteners and they consisted of a metal plate and screw. These new products provided many advantages over asphalt attachment systems. They were clean and easy to install, and roofing contractors liked them because of their ease of application compared to hot asphalt. The primary benefit, however, was their increased holding strength. Because mechanical fasteners made roofs more wind-resistant, the industry began to require their use for perimeter attachment.

Further improvements in the fasteners and their methods of installation increased their popularity. Initially roofing fasteners were used only for new roofs. Eventually, contractors began using fasteners for reroofing as well. To supply the longer fasteners reroofing required, manufacturers began marketing products in lengths up to 12 inches. To drill into the gravel-filled BUR systems and thicker metal decks often encountered in reroofing, new drill points were developed. And stand-up installation tools were developed that lessened operator fatigue and provided proper alignment, particularly for the longer fasteners.

The growing use of mechanical fasteners in the roofing industry attracted the attention of other fastener manufacturers, and many of them began to supply products for this market.

In 1983, FM officially acknowledged the merit of a mechanically attached system. At the urging of NRCA and other industry organizations, FM stated that mechanical fastening was the only recommended method of attaching insulation to a metal deck. According to FM's test methods, roofs secured to steel decks with mechanical fasteners will remain attached under loads equaling 60 to 90 pounds per square foot. Under FM's rating system, these roofs receive an I-60 or I-90 rating. There is a common misunderstanding that I-60 and I-90 ratings mean that the roofs are able to withstand 60 and 90 mph winds. In reality, the ratings refer to the upward load developed by pressure differences inside the building that the rated roof should be able to withstand. Winds of approximately 88 mph produce a 60 psf load and 110-mph winds produce 90 psf.



This Kesternich cabinet has been opened during a drying cycle. The metal roofing fasteners and plates inside are being tested for corrosion resistance.

Reroofing causes problems

When contractors began to use mechanical fasteners for reroofing, it gave a tremendous boost to the industry, but the practice was not without its shortcomings. Moisture was often present in the old insulations these fasteners were being driven through. This meant that when new insulation was attached over old insulation, moisture was already present to corrode the fastener. The Single Ply Roofing Institute's fastener subcommittee does not recommend fastening through wet insulation. The committee is also deeply concerned about the structural integrity of the fastener if the watertight integrity of the roofing system is breached.

Roofing fastener technology began to evolve to meet this challenge. Non-corrosive plastic plates and corrosion-resistant coatings were introduced. A testing apparatus, called a Kesternich cabinet, was imported from West Germany to evaluate the products' corrosion resistance. The Kesternich cabinet was originally used to measure the corrosion resistance of metal used to make Volkswagen mufflers. Since 1975, this apparatus has been used to evaluate fastener coatings.

Increased awareness brings greater demands

The manufacturers' efforts to market their products' new corrosion resistance actually increased the roofing industry's awareness of the problem of fastener rusting. One company went so far as to show corroded fasteners in their advertisement titled "The Death of a Roof." This increased industry awareness led to greater demands for corrosion-resistant fasteners. Even fastener manufacturers who never thought they would have to coat their fasteners found it necessary to respond to the roofing industry's concerns.

As the number of coated products increased, the industry began to ask if all of these were long-life coatings. At the time it was difficult to tell because no criteria existed to evaluate them.

In August 1984, the Fastener Group under the umbrella of the Single Ply Roofing Institute (SPRI) set out to solve this problem. At that time, the Group established an objective to develop a corrosion test procedure for all metal components of mechanical fastening systems. In February 1985, the SPRI Fastener Subcommittee and FM came to agreement on a standard test procedure for testing the corrosion resistance of metal roofing fasteners. This test procedure is FM 4470, SPRI Corrosion Test Procedure and Guidelines for Roofing Fasteners. The procedure requires that:

- all metal roofing fasteners be tested in the Kesternich cabinet per modified DIN 50018 standard test procedure;
- fasteners be subjected to acidic atmosphere in the cabinet, completing a wet and dry cycle;
- fasteners remain in the acidic atmosphere for eight hours with the cabinet closed and 16 hours with the cabinet open (which is a drying cycle), completing one cycle (oxidation of metal or rusting of fasteners occurs during the drying cycle).

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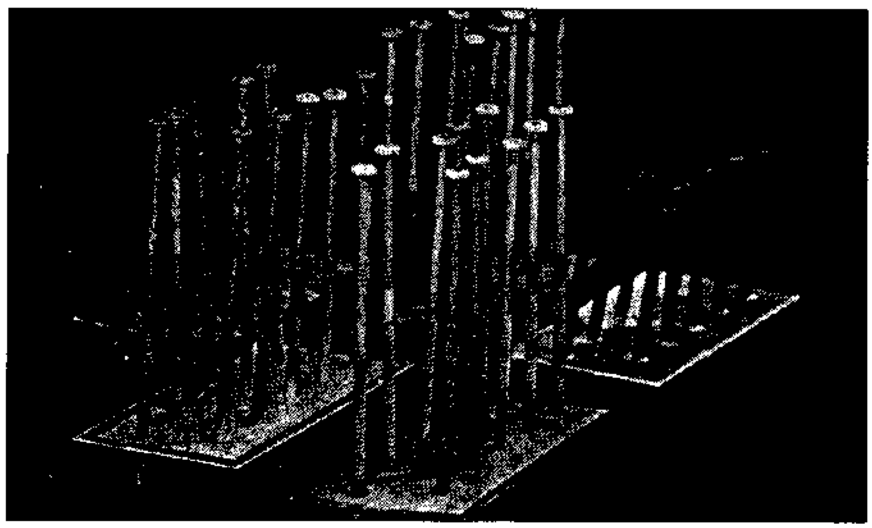


These roofing fasteners have been driven through a plate to hold them steady during a testing cycle in the Kesternich cabinet.

To pass the evaluation, the specification requires that fasteners not accumulate more than 15 percent red rust after 15 cycles in the Kesternich cabinet. Concrete and wood roofing fasteners are subjected to the same corrosion test procedure.

A Technical Bulletin released jointly by NRCA, the Roofing Insulation Committee of the Thermal Insulation Manufacturers Association and SPRI in February 1986 refers to this procedure. The Bulletin, which was prepared in cooperation with many organizations, also advises roofing contractors to use only long-life coated fasteners.

The main purpose of this test method is to separate good fasteners from very bad ones.

The industry's questions answered

At a recent presentation describing the new corrosion standard, many questions were asked by the contractors, specifiers and distributors in the audience. The highlights of this discussion are summarized in the following questions and answers.

Q How will you measure red rust?

A It will be measured visually, using the approved criteria to determine the acceptability of the fastener. The percentage of red rust accumulated during the test procedure will be determined by averaging the amount present on 10 fasteners.

Q How accurately can you measure 15 percent red rust?

A Here is where judgment and experience come into use. The main purpose of this test method is to separate good fasteners from very bad ones without penalizing marginally performing fasteners. A fastener is very bad if it accumulates more than 50 percent rust after 15 cycles.

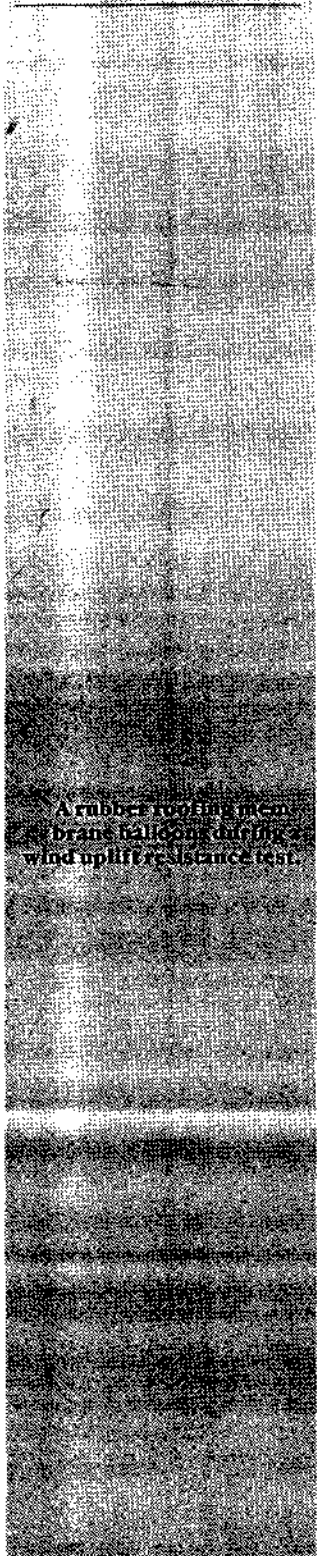
Q Is there any correlation between this test and the outside environment?

A To date, there has been no correlation study comparing this test and the outside environment. The test is extremely accelerated. Fasteners do not corrode at this rate outside. People in the industry would like to conduct a field study to monitor the effect of marine, industrial, heavy industrial and rural environments on fastener assemblies.

Q Will a fastener fail in a roof if it has 15 percent red rust?

A Tests have shown that even 100 percent surface red rust does not decrease the structural strength of a fastener. However, long-term (continuous) corrosion and excessive deterioration of the fastener body may cause a decline of fastener strength.

The roofing fastener industry has made remarkable progress in the last 30 years. New products have made great headway in the industry. Anti-pushout plastic plates, non-penetrating gypsum and Tectum fasteners and stainless steel fasteners are just the latest of a long list of new products. Because of mechanical fasteners, roofs are more durable now than 30 years ago, and, it is hoped, some of these long-life coated fasteners will take those roofs into the 21st century.



A rubber roofing membrane balloons during a wind uplift resistance test.