It was only a few years ago that a “high” wind uplift rating was considered to be 90 psf, that most mechanically fastened membranes were less than 10 feet wide, the largest fastener diameter was a #14, and the only question asked about steel decking was its gauge. Back then, the roofing industry considered steel decking to be an existing structural element, and its influence on the performance of roofing systems was often neglected. The term “roof assembly” typically did not include the deck, but everything above it.

Today, uplift ratings of 135 psf and 150 psf are routinely found in most manufacturers’ approval listings, mechanically fastened membranes are commonly available in widths of 10’ and wider, #15 diameter fasteners are routinely installed, and the grade of a steel deck is as important as its thickness. It has now become imperative to include the steel decking and its attachment to the structure as part of the roofing assembly. Looking at the current state of the roofing industry, it is easy to see how this change has evolved.

In the industry, labor shortages and increased competition have driven contractors and system suppliers to focus on increasing system installation productivity. This has resulted in wider sheets requiring fewer seams, larger fasteners with reduced densities, and specialized systems for high wind uplift resistance. All these changes have increased the stresses imparted to steel decking, thereby requiring special design considerations for adequate field performance.

As an example, with a mechanically-attached 6.5-foot wide membrane fastened every 12 inches in the seams, the wind load transferred to the roof deck through each fastener is approximately 540 lbs. of uplift force (assuming a 90 psf design, 6’-wide seam, 6’ x 1’[12’] x 90 psf = 540 lbs.). The same 6.5’ sheet fastened every 18 inches results in 810 lbs. on each fastener. When the mechanically attached membrane is widened to 10 feet or 12 feet and fastened at 12 inches on center, the fasteners need to carry a minimum 855 lbs. and 1035 lbs. respectively.

The result is that the roof deck is also being asked to do more. Therefore, it is important that the roofing industry fully understand not only the membrane and fastener performance limits, but also acknowledge the limitations of the underlying structural deck.

Photo 1 – Typical steel deck over bar joist construction.

Steel Roof Deck Considerations

Steel is the most common roof deck type in the U.S. With the majority of uplift testing being conducted over steel decks, it is important to understand how they are rated and which design properties are important. To fully understand steel roof decking, four primary elements must be evaluated:

- Gauge (thickness),
- Type (profile),
- Coating, and
- Grade (strength).
In particular, the gauge, type, grade, and attachment of the steel deck influence the ability of the roof assembly to resist both wind uplift forces and rooftop loads.

**Gauge**

Gauge identifies the thickness of a steel deck and is the most commonly discussed of the four elements. Deck gauge plays an important role in fastener pullout resistance and consequently has an important role in the performance of mechanically fastened roofing systems. Table 1 provides the most common roof deck gauges and their decimal equivalents. The table also provides some comparative pull-out resistance for one manufacturer’s #15 fastener in Grade 80 steel (grades of steel will be discussed later in this article). The most commonly used steel deck for roofing is 22 gauge.

As shown in the table, pull-out resistance is greatly affected by gauge and increases by over 220% from 26 gauge to 18 gauge.
Table 2 — Deck Type Profiles

<table>
<thead>
<tr>
<th>Type</th>
<th>Narrow Rib (NR)</th>
<th>Intermediate Rib (IR)</th>
<th>Wide Rib (WR)</th>
<th>3&quot; Deep Rib (3DR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>1.5&quot; Min.</td>
<td>2.75&quot; Max.</td>
<td>2.5&quot; Max.</td>
<td>9/16&quot; Min.</td>
</tr>
<tr>
<td>Type F</td>
<td>3/8&quot; Min.</td>
<td>1&quot; Max.</td>
<td>1.5&quot; Min.</td>
<td>1.5&quot; Min.</td>
</tr>
</tbody>
</table>

**Type**

There are several steel deck profiles or types available on the market today. These decks are typically known as type “A” (or “NR”), “B” (or “WR”), “F” (or “IR”), or “N” (or “3DR”) deck. Table 2 provides some of the standard dimensions. These standards have been developed by the Steel Deck Institute (www.sdi.org) and are included in its Roof Deck Construction Handbook. The profile of the deck affects the rigidity or flexural strength, thereby affecting its ability to withstand the loads placed upon it. Generically speaking, the weakest profile is Type A, followed by Type F, Type B, and the strongest is Type N. Each of the deck types is typically available in 30- or 36-inch widths and with a 6-inch-on-center rib spacing. The exception is “N” deck, which is limited to a 24-inch width and has an 8-inch-on-center rib spacing. The most commonly used steel deck for roofing applications is Type B.

**Coating**

Generally speaking, steel roof deck has either a galvanized or a painted finish. Galvanized decking is designed for corrosion resistance and is typically used on buildings with a corrosive atmosphere inside (such as humidity or chemicals). Painted decking offers very little corrosion protection. The deck manufacturer should be consulted for recommendations on coating requirements specific to building usage.

Coating specifications for galvanized decking are covered in ASTM A-653. No coating specification exists for painted finishes. A common designation for galvanized roof deck is G-90, where the “G” indicates that the product is galvanized (i.e., a zinc coating has been applied), and the “90” designates the coating thickness. Thus, a G-90 deck is a galvanized deck with a minimum of .90 oz. per square foot of zinc coating (total applied to both surfaces of the steel).

**Grade**

The last, and perhaps the most confusing and least understood factor, is the steel deck’s strength or grade. Steel decking is manufactured by cold roll forming sheet steel into the desired profile. The grade is based on the steel composition and the added strength imparted during the manufacturing process. Depending on coating type, grade is covered by different standards: painted steel deck by ASTM A-1008; and galvanized steel deck by ASTM A-653. These two standards were revised in 2002, and among other items, grade terminology was changed from letters to numbers (Grade C became Grade 33 and Grade E.

*Source – Steel Deck Institute*
became Grade 80. Table 3 highlights various grade specifications and lists pullout values with one manufacturer’s #15 fastener. It is obvious from the table that grade can have a large effect on a fastener’s pull-out resistance.

Steel decking sold in the roofing market is commonly supplied without any certification as to grade, and this is where things get a little confusing. In reality, steel deck produced in the United States since the mid 1980s generally far exceeds the minimum specifications for Grade 33, and the majority of the decking will actually meet the requirements for Grade 80. Please note that this varies, especially in Canada, where most steel conforms to Grade 40 requirements.

**What Grade is it?**

The most often asked question from the field related to the grade of steel decking is: “How do I know if the steel deck on my project is Grade 33 or Grade 80?” The easiest way to know is to have the steel deck supplier certify the grade of steel. Typically, this is only possible on new installations; but in reality, it is often overlooked in project specifications. So what should be done to determine the suitability of a roofing installation over a steel deck when the exact grade is unknown?

One way is to take a very conservative approach and just assume the deck is Grade 33 and not install a system approved specifically for Grade 80 decks. This could add unnecessary cost to the project and slow down installation. Another approach is to have the deck tested by a laboratory for tensile strength. This would require physically cutting samples from the deck in question, which is not a very practical solution (particularly for...
Table 3 — Strengths for Structural Sheet Steel (A1008)

<table>
<thead>
<tr>
<th></th>
<th>Grade 33</th>
<th>Grade 40*</th>
<th>Grade 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparative Pull-Out Resistance**</td>
<td>488 lbs.</td>
<td>578 lbs.</td>
<td>689 lbs.</td>
</tr>
</tbody>
</table>

*Note most decks in roofing applications are labeled 33 or 80. **One manufacturer’s #15 fastener in 22 gauge decks.

help with the pullout testing, SPRI has developed a standard field test procedure that has been adopted by ANSI, as well as having been incorporated into FM’s assessment for many different fastening applications. This procedure is known as the ANSI/SPRI FX-1 test protocol.

Once the calculated load and physical pullout values are obtained, the suitability of the intended installation can be determined. The following example shows how this can be accomplished.

Example

A specification calls for a mechanically fastened, single-ply system to be installed that meets a 1-90 rating (meaning 90 psf of uplift pressure resistance). If the grade of steel decking is unknown, the following equation can be used to determine the amount of pullout resistance necessary per fastener to meet the uplift requirement.

\[
\text{uplift pressure (psf) x fastener row spacing (feet) x fastener spacing (feet) = pounds of pullout}
\]

For this example, let’s use 10-foot-wide membrane (assume 9.5 foot fastener row spacing) with fasteners spaced 1 foot on center along the row. (Note: The system being considered for use must be documented as having resisted 90 psf of uplift pressure over steel decking before proceeding any further.) The calculation would then be:

SPRI

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Founded in 1982, SPRI is the only organization that focuses on the total commercial roof system, facilitating communication among the suppliers of every element of the roof system and providing a forum for the discussion of technical issues.

SPRI is accredited by the American National Standards Institute (ANSI) as a standards canvasser. This allows SPRI to take its guidelines to the industry for review and ultimate acceptance as national consensus standards with full recognition by building code authorities, insurance underwriters, and industry professionals.

SPRI members meet on a regular basis to work on projects like these and many others. For more information, visit www.spri.org.
This calculation indicates that a fastener pull-out resistance of 855 pounds is needed in order for the intended system to meet the specification. The fastener would then be used to conduct pullouts on the project deck. If 855 pounds of resistance was obtained, the system could be considered suitable for installation over that specific steel deck. If 855 pounds was not obtained, an alternate system would need to be selected and a similar evaluation conducted.

Deck Attachment

Just as important as keeping the roofing system attached to the deck, is keeping the deck attached to a building’s structure. Two primary methods for deck attachment are available – welding or mechanical fastening. Both the Steel Deck Institute and Factory Mutual provide deck attachment guidelines. The Steel Deck Institute’s requirements can be found in its Roof Deck Construction Handbook. Factory Mutual’s requirements can be found in its Property Loss Prevention Data Sheets.

According to Factory Mutual’s Property Loss Prevention Data Sheet 1-29 (Revised 1/2002), steel roof decks with 1-90 (90 psf) requirements and below may be welded or fastened along all supports with 5/8” welds or approved fasteners every 12 inches in the field and every 6 inches in the corners and perimeters. Additionally, the side laps should be secured with stitch screws or with button punches. To meet FM requirements for some systems – typically those with uplift ratings greater than 90 psf or wider sheet widths – the deck may need to be mechanically fastened with screws, and the fastener density may also need to be increased. Purlin spacing may also limit the ratings achievable on any given project. These specific requirements may vary between roofing assemblies. Information on these requirements can be found in the individual system listings in FM’s Approval Guide or other testing report and should be followed to ensure that the deck is properly attached.

Summary

It is important that everyone involved in the design and installation community clearly understands the relationship between the roofing system and the steel deck. It is no longer appropriate to solely consider the materials from the deck up (commonly called the “roofing system”). Instead, consideration should be given to the “roofing assembly,” which includes the roofing system, the deck, and its attachment. The attachment of the steel decking to the building structure, as well as the attachment of the roofing assembly to the steel decking, are both critical factors in ensuring long-term field performance.

References