How Effective Are Your Arc Spot Welds?

By Jeremy L. Achter, S.E., LEED AP

A n effective diaphragm is an essential component of a structurally sound building. The diaphragm provides lateral stability for the columns and/or bearing walls, braces the compression edge of floor framing members, and distributes wind and seismic forces to elements of the vertical lateral force-resisting system.

Diaphragms are divided into two main categories: rigid and flexible. Rigid diaphragms are often idealized as infinitely rigid plates that rotate about the center of rigidity and distribute loads based on the relative stiffness of each vertical lateral force-resisting element. Concrete slabs are often analyzed as rigid diaphragms. Flexible diaphragms experience distortion under the application of lateral loads and distribute those forces based on the geometric layout of the vertical lateral forces-resisting elements. Cold-formed steel decking without a concrete topping slab is generally considered a flexible diaphragm. Whether rigid or flexible, the connection of the diaphragm to the supporting structure is critical to the performance of the system.

Several different methods are used to attach cold-formed steel decking to the supporting structure: arc spot welds, shot-pins, or screws are the most common.

For flexible diaphragms, the demand is calculated for the required earthquake and wind loads in accordance with the adopted code. Manufacturer’s literature and ICC/IAPMO report’s contain shear capacity and flexibility factors the engineer can use to determine the needed metal deck gage and fastening pattern to achieve the required diaphragm stiffness and shear resistance.

Read either the footnotes of the Support Fastening section of the manufacturer’s literature or the corresponding ICC/IAPMO report’s contain shear capacity and flexibility factors the engineer can use to determine the needed metal deck gage and fastening pattern to achieve the required diaphragm stiffness and shear resistance.

Effective Diameters of ¾” Visible Arc Spot Welds (d=0.75”)

<table>
<thead>
<tr>
<th>Deck Gage and Thickness</th>
<th>One Layer of Sheet Steel (Typical in Field of Sheet)</th>
<th>Two Layers of Sheet Steel (Typical at End Laps)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gage</td>
<td>Thickness (inches)</td>
</tr>
<tr>
<td>22 gage</td>
<td>0.0295</td>
<td>0.0295</td>
</tr>
<tr>
<td>20 gage</td>
<td>0.0358</td>
<td>0.0358</td>
</tr>
<tr>
<td>18 gage</td>
<td>0.0474</td>
<td>0.0474</td>
</tr>
<tr>
<td>16 gage</td>
<td>0.0598</td>
<td>0.0598</td>
</tr>
</tbody>
</table>

diaphragm construction and indicate in the structural drawings that a ¾-inch diameter nominal arc spot weld is required.

Per section 2210.1.1 of the 2012 International Building Code, steel roof decks shall be designed and constructed in accordance with ANSI/SDI-RD1.0. Section 3.2 of ANSI/SDI-RD1.0 states that all welding of steel deck shall be in accordance with ANSI/ AWS D1.3. Figure 2.2 of AWS D1.3 provides the following equation for calculating the effective weld size of arc spot welds.

\[ d_e = 0.7d - 1.5t \]

where

\[ d_e = \text{Effective diameter of fused area at the plane of maximum shear transfer} \]
\[ d = \text{Visible diameter of the outer surface of the arc spot weld} \]
\[ t = \text{Total combined base steel thickness of sheets involved in shear transfer above the plane of maximum shear transfer} \]

The effective diameter is calculated, using the above equation, as follows:

This table indicates that the effective diameter of a ¾-inch visible arc spot weld does not comply with the ½-inch minimum required by the independent evaluation reports.

Since the writing of this article, AISI has published a new report on the resistance of arc spot welds loaded in shear and tension for building and construction. The information in this article has not been compared to, or reviewed against, the new report. The report can be found at www.steel.org.

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