

Attaching Metal Decking

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You don't have to reinvent the wheel to attach steel decking to the supporting structure.

THIS MONTH'S STEELWISE addresses common questions and answers about steel deck and its attachment to steel framing by welding.

What is required to accomplish the design and performance of welded deck fastening?

There are two things:

1. *The Engineer of Record (EOR) must state the filler metal strength requirements; and*
2. *The deck installation contractor must follow American Welding Society (AWS) D1.3 requirements for welding on sheet steel.*

To assist the EOR in determining the weld strength requirements for both roof deck and floor deck (composite and non-composite), the Steel Deck Institute (SDI) provides many publications, including:

- SDI *Diaphragm Design Manual*, 3rd Edition (DDM03)
- SDI *Manual of Construction with Steel Deck*, 2nd Edition (MOC2)
- SDI White Paper – *Arc-Puddle Welds and Weld Washers for Attachments in Steel Deck*, L.D. Luttrell, 2007
- ANSI/SDI-C1.0-2006 *Standard for Composite Steel Floor Deck*
- ANSI/SDI-NC1.0-2006 *Standard for Non-Composite Steel Floor Deck*
- ANSI/SDI-RD1.0-2006 *Standard for Steel Roof Deck*

All SDI publications and design procedures are available at www.sdi.org and reference the AWS D1.3 *Structural Welding Code – Sheet Steel* and the American Iron and Steel Institute's *North American Specification for the Design of Cold-Formed Steel Structural Members* (AISI S100-07) for weld design and installation. More information on those documents is available at www.aws.org and www.steel.org, respectively.

What must the EOR specify regarding welded connections for steel deck?

The EOR must specify:

- Support fastener pattern and weld size
- Required welding electrode
- Sidelap fastener size and spacing; this may be welds or mechanical fasteners

This information is then used by the deck manufacturer and the deck installer to ensure that the appropriate product is supplied.

To what requirements must the deck installation contractor then conform?

After the EOR has specified the steel deck welding requirements for strength, the deck installation contractor must adhere to the requirements of the contract. These usually require conformance to AWS D1.3, which covers weld design and installation for sheet steel. Welded steel deck installation also may include side laps, attachments to support steel at the ends and sides of deck material, curb plates, end plates and other items. These types of fillet weld connections may be welded using AWS D1.3 if support steel thickness is less than or equal to $\frac{3}{16}$ in. (5mm). For thicker support steel, the requirements in AWS D1.1 may be applicable. A code application matrix can be found in Table 1.1 of AWS D1.3.

Are Welding Procedure Specification (WPS) documents required for deck welding?

Yes. The deck installation contractor is responsible for following AWS D1.3 and Welding Procedure Specification (WPS) documents. A WPS is a detailed document provid-



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ing required variables for a specific welding application to assure repeatability by properly trained welders and welding operators. WPS documents must be written for all welds permitted as prequalified and all welds qualified in conformance with Clause 4 of AWS D1.3.

Each deck installation contractor is responsible for inspection and testing of WPS qualification tests and welder performance testing as described in AWS D1.3. Arc spot weld WPSs are not described in Clause 3 of AWS D1.3 and, therefore, must be qualified by testing and recorded on a Procedure Qualification Record (PQR). When PQR essential variables exceed those listed in AWS D1.3 Table 4.2, requalification is necessary.

Following is a comparison of qualified and prequalified WPS:

- A qualified WPS is one that has been proven by a procedure qualification test and is supported by a documented PQR. The procedure qualification test must demonstrate that welds made using the specific procedure can meet prescribed standards.
- Prequalification of a WPS is defined as being exempt from testing requirements detailed in Clause 4 of AWS D1.3. In order for a WPS to be prequalified, it must meet the applicable requirements of Clause 3 of AWS D1.3. The provisions of Clause 3 apply to welded connections between sheet to sheet and sheet to supporting structural members where the thickness of the supporting steel does not exceed $\frac{3}{16}$ in. (5mm).

What other requirements must be met when welding the deck?

Table A.1 in Annex A has been added to the 2008 issue of AWS D1.3 to provide requirements for welding sheet steels to AWS D1.1 other steel products. Applicable clauses and tables of AWS D1.3 and AWS D1.1 are listed in Annex A.

Is preheat used in deck welding?

Preheating to the requirements of AWS D1.1 is not practicable for welded deck attachments. The footnotes in AWS D1.3 Table A.1 allow exceptions for the preheating rules of AWS D1.1 Clause 5.6. Preheat exemption is possible for arc spot welding roof or floor deck to base materials listed in Group I or II in Table 3.1 in AWS D1.1. In all cases the WPS needs to be qualified by test. Additionally:

- The ambient temperature of the production environment must meet the requirements for preheat exemption rules. Non-low hydrogen SMAW electrodes may be used when ambient temperatures are equal to or greater than 32 °F (0 °C).
- Low hydrogen processes are acceptable for temperatures equal to or greater than 0 °F (-18 °C).
- Increasing amperage and arc time to ensure adequate weld size may be required; see AWS D1.3, Clause 5.4.1. A decrease in arc time or a decrease of more than 5% in amperage or melting rate requires requalification.

What inspection is required for deck welding?

Visual inspection is required to determine if a weld meets the acceptance criteria of AWS D1.3. It is the deck installation contractor's responsibility to ensure that all WPSs and welders are qualified. The EOR may accept previously qualified or prequalified WPS. However, if the EOR does not accept such evidence, the deck installation contractor must successfully complete the required tests prior to welding.

What is the most common filler metal used for welding steel deck?

The most common filler metal used for welding steel deck is an E6022 electrode. Most load tables for roof and non-composite (form) deck are based on a specified minimum yield strength of 33 ksi, although manufacturers may provide steels with higher yield



Although arc spot welds used to attach metal decking to the steel below have a visible outer diameter, which is what can be measured in the field, their strength is calculated on a smaller effective diameter. The weld sizes listed in most diaphragm tables are listed by the visible outer diameter for convenience.



More or fewer welds may be required at various places, such as seams, depending on location and the loading they will be expected to resist.

strengths. Accordingly, an E60XX electrode is the “matching” electrode, and the diaphragm design tables found in SDI DDM03 are based on this matching E60XX electrode for composite deck, roof deck, and non-composite floor deck with thicknesses of 22 gage or greater. Diaphragm design tables for non-composite floor deck with thicknesses of less than that are based on using a weld washer and E70XX electrodes, due to the higher strength material used for these thinner decks.

When should weld washers be used?

Weld washers should be specified for arc spot weld connections to the supporting steel framing when the deck is less than 0.028 in. thick. The 2007 SDI white paper by Luttrell (available for free download at www.sdi.org) is an excellent reference on arc spot welding both with and without weld washers.

How is the uplift resistance of arc spot welds determined?

SDI recommends the use of the weld strength provisions contained in AISI S100 for calculating weld strength to resist uplift. These calculations are easy and straightforward, and tabular values also can be obtained from many steel deck manufacturers.

How is the diameter of an arc spot weld determined?

Carefully, because arc spot welds have a “visible outer diameter,” but their strength is calculated on a smaller effective diameter. The visible outer diameter is what can be measured in the field. The effective diameter of the fused area is a function of the visible outer diameter and the total sheet thicknesses through which the weld is made. AISI S100 does a very good job of explaining this difference. The weld sizes listed in most diaphragm tables (including SDI DDM03) are listed by the visible outer diameter for convenience.

How are diaphragm strengths for welded steel floor and roof deck diaphragms determined?

All three ANSI/SDI standards recommend using SDI DDM03 for diaphragm design. Most steel deck manufacturers also provide diaphragm tables and design assistance.

What publication provides the design procedure for a steel roof deck subjected to both in-plane (diaphragm) shear and uplift?

SDI DDM03 contains a suggested method for combining uplift and shear forces on both welds and mechanical fasteners which allow the use of the diaphragm tables found in DDM03.

Can sidelap connections be welded or must mechanical fasteners be used?

Either arc spot welds or fillet welds can be used for sidelap fasteners. However, SDI does not recommend the use of welded sidelap connections for deck that is thinner than 20 gage. Instead, mechanical fasteners should be used for thinner gage material.

Can welds be made through multiple thicknesses of steel deck?

Arc spot welds can be made through multiple thicknesses of steel deck, as long as the total base metal (bare steel) thickness does not exceed 0.15 in.

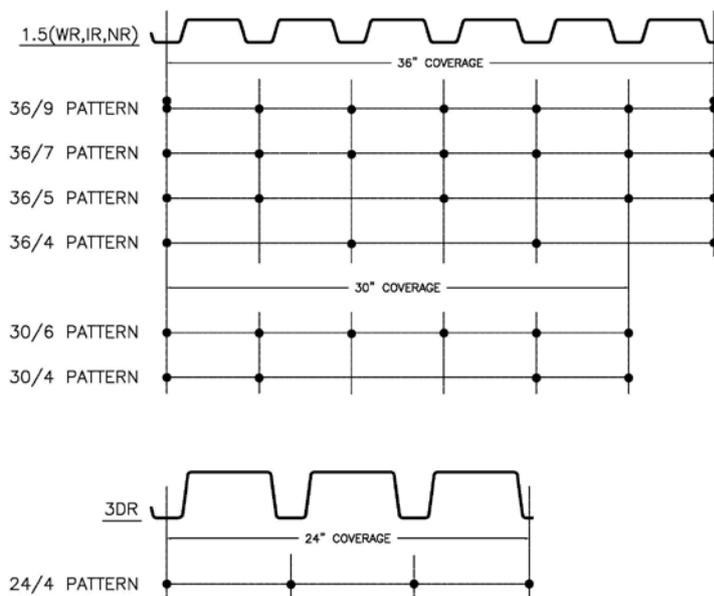


Figure 1: Typical Fastener Layout. Increasing the number of attachment points provides greater resistance to shear and uplift loads. Design guides provide capacities based on panel width (the first number) and the number and distribution of attachment points across that width.

What is the difference between an “arc spot weld” and a “puddle weld”?

These are the same thing. The proper name for this kind of weld is an “arc spot weld,” but it is commonly referred to as a “puddle weld.”

Where can I find information on common support weld patterns?

SDI DDM03 and the catalogues of many deck manufacturers illustrate common standard weld patterns for both roof and floor deck. Common weld patterns for roof deck are illustrated in Figure 1.

What testing can be specified to ensure that the welding procedure being used produces acceptable arc spot welds?

SDI MOC2 provides a “weld quality control test procedure,” which is based upon a simple cantilever test method. This test can be performed on the jobsite under ambient conditions to ensure that acceptable welds are produced.

Is it acceptable when the welding process produces some burn through holes in the deck at the support welds and sidelap welds?

Some burn through is to be expected and is not grounds for rejection of the work. Good metal-to-metal contact during welding will reduce, but cannot completely eliminate, burn through holes.

For more information, contact the AISC Steel Solutions Center at www.aisc.org/ssc.

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