



Stud Welding

Images courtesy of Metal Decks

Shear studs are commonly welded to steel elements when steel-concrete composite action is required. Used to develop composite action, shear studs must behave in a ductile manner and dependably transfer shear force between the steel and concrete elements. Shear studs can be welded directly to steel members, or through metal decking in the case of composite metal deck flooring.

The welding of shear studs in steel-concrete composite construction is governed by standards to ensure the appropriate quality of weld is achieved. This fact sheet introduces the key process control provisions of the relevant standards and the roles and responsibilities of the various parties associated with the stud welding process.

PROCESS

Studs are typically welded to structural sections using the drawn arc process. It involves initiating a weld current, lifting the stud to create an arc and a pool of molten metal, and plunging the stud into the pool until it solidifies. The molten metal is held in place by a ceramic ferrule, which also shields the arc (BCSA, 2012). This process is illustrated in figure 1.

The amperage and weld-cycle requirements depend on the stud diameter, the materials being joined, the presence of galvanizing on the metal decking, or the presence of moisture if wet-weather-capable welding equipment is used.

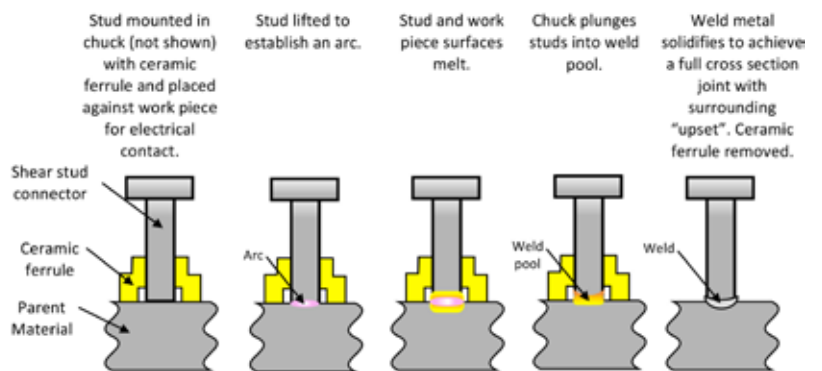


Figure 1: The drawn arc stud welding process. Image courtesy of the British Constructional Steelwork Association.



STANDARDS

The two standards that govern stud welding for structural applications are AS/NZS 5131 (Structural Steelwork – Fabrication and Erection (SA/SNZ:2016)) and AS/NZS 1554.2 (Structural Steel Welding – Part 2: Stud Welding (SA/SNZ,2003)).

AS/NZS 5131 is cited as an appropriate standard for demonstrating compliance of steel construction with the Building Code. The provisions of this standard, which are relevant for stud welding, are as follows:

1. All welding shall be carried out and managed under a suitable quality management system e.g. AS/NZS ISO 3834.
2. Stud welding shall be carried out in accordance with AS/NZS 1554.2.
3. Inspection and test plans are mandatory for construction category 3 and 4 projects, and may be specified by the design engineer for construction category 1 and 2 projects in the construction specification¹.
4. On completion of the inspection and testing regime, a test report shall be prepared.

¹AS/NZS 5131 features a risk-based categorisation of the structure, or elements of structure, into one of four construction categories (CC1-CC4). The provisions in this standard include general requirements applicable to all construction categories and specific construction category requirements.

AS/NZS 1554.2 includes requirements for the stud welding of steel studs to steel elements. The provisions cover requirements for stud and parent materials, qualifying weld procedures, stud welding operator qualifications, workmanship and testing.

QUALITY MANAGEMENT

AS/NZS 1554.2 requires the stud welding contractor to exercise process control before, during and after stud welding, and the three key requirements are:

1. USE OF QUALIFIED BASES

Only studs with qualified stud bases may be used and the process for qualification by the manufacturer is prescribed in the standard.

Prequalified condition: Studs that are shop or field applied in the flat position to a flat and horizontal surface are deemed prequalified within the extent of the manufacturer's stud-base qualification tests. It includes welding in flat position to clean steel surface only.

Non-prequalified conditions: These include welding in the position other than horizontal, through metal decking, sheet materials and/or surface coatings. The fabricator shall qualify the welding procedure for the application by testing. The welding procedure should include all information as relevant for the application considered such as welding position, base material coating type and thickness, decking sheet thickness etc. The test condition shall closely match the intended application, otherwise additional application qualification tests are required to qualify the procedure.

2. PREPRODUCTION TESTING

The appropriateness of the stud welding procedure (e.g. equipment settings) is established by pre-production testing and the requirements are dependent on whether the welding machine records weld-cycle parameters. The advantage of using weld-cycle parameter recording equipment is that the preproduction testing may be undertaken off site. If a non-weld-cycle parameter recording machine is used, preproduction testing must be undertaken on site at the beginning of each day. This must also occur if the shear stud diameter or type is changed.

3. QUALIFIED STUD WELDING OPERATORS

All stud welding shall be undertaken by qualified stud welding operators. The fabricator shall provide evidence acceptable to the principal that the stud welding operators are suitably qualified and have sufficient training and experience to satisfy the requirements of AS/NZS 1554.2.

TESTING

POST-WELD TESTING

The post-weld test requirements in AS/NZS 1554.2 include mandatory stud bend testing by the stud welding operator if certain performance requirements are not met and additional random stud bend testing if specified by the design engineer. The operator performance-related testing requirements are dependent on whether the welding machine records weld-cycle parameters.

OPERATOR TESTING

1. Stud welding machine records weld-cycle parameters

Any studs for which the current setting varies more than 10 percent from the target value shall be subject to a 15-degree bend test. The stud is considered acceptable for use if there is no sign of fracture in the weld or base material after bending.

2. Stud welding machine does not record weld-cycle parameters

All studs produced by equipment that does not record weld-cycle parameters must exhibit a full 360-degree flash. The flash is the weld metal expelled at the base of the stud. All studs that do not exhibit a full flash shall either be replaced or repaired by adding a fillet weld in the place of the missing flash. Studs repaired by fillet welding shall be subject to a 15-degree bend test.

ADDITIONAL TESTING

The design engineer may specify random bend testing in addition to the testing noted above and AS/NZS 1554.2 recommends sampling regimes for this. Alternatively, the construction reviewer may undertake ring testing, which is defined in AS/NZS 1554.2 (SA/SNZ, 2003) p5 as:

“Tapping a stud with 3kg (approximately) hammer in the direction of the beam – if the stud gives a ‘ring’ sound, it passes the test; if it gives a ‘dead’ sound, it fails the test.”



ROLES AND RESPONSIBILITIES

The AS/NZS 1554.2 provisions specify or imply particular roles and responsibilities for various parties to ensure the quality of stud welds.

DESIGN ENGINEER

It is recommended that the design engineer addresses the following matters in the construction specification:

1. Specify stud welding to the requirements of AS/NZS 5131 and AS/NZS 1554.2.
2. Resolve any matters related to AS/NZS 1554.2 Appendix A with the stud welder prior to commencement of work. Request that the stud welding contractor submits documentation demonstrating compliance with the process control and quality management requirements of AS/NZS 1554.2 and AS/NZS 5131.
3. Request shear stud material test certificates.
4. Specify additional stud bend testing if warranted by the project risk.
5. Specify a stud welding inspection and test plan for construction category 2 projects.
6. Request a Producer Statement (PS3) at completion of the stud welding contract.

STUD WELDING CONTRACTOR

1. Resolve any matters related to AS/NZS 1554.2 Appendix A with the design engineer prior to commencement of work.
2. Comply with the Quality Management System AS/NZS ISO 3834 Part 2 or 3 (as applicable for construction category).
3. Comply with AS/NZS 1554.2.
4. Operate this Quality Management System during stud welding operations, including undertaking inspection and testing as per the inspection and test plan.
5. Develop and qualify welding procedure for the intended application.
6. Verify that the test data recorded in the welding procedure matches all the conditions intended for the non-prequalified stud applications.
7. Provide welding supervision.
8. Qualify stud welding operators.
9. Perform inspection and testing before, during and after welding (testing of finished studs).
10. Perform pre-production testing.
11. Prepare an inspection and test plan for review by the construction reviewer.
12. Prepare an inspection report.
13. Develop and qualify a suitable repair procedure.
14. Issue a Producer Statement (PS3) at the satisfactory completion of the work.

CONSTRUCTION REVIEWER

1. Review the inspection and test plan, and the documented evidence of compliance, with the AS/NZS 1554.2 process control and AS/NZS 5131 Quality Management System requirements prior to stud welding operations commencing.
NB, the construction reviewer may require a weld inspection company to assist in reviewing the compliance document supplied by the stud welding contractor.
2. Establish compliance of the proposed stud welding procedure with the intended application e.g. welding through metal decking.
3. Review shear stud material test certificates.
4. Visually check bend testing requirements (preproduction and additional quality control, if specified by the design engineer) are being followed (HERA, 2003).
5. Undertake ring testing (if required).
6. Where weld-cycle parameter recording equipment is used, obtain details of how the stud welding operator relates the locations of studs to weld records. This is important to identify stud welds for which the current setting during welding varied more than 10 percent from the target value (HERA, 2003).

BUILDER

1. Undertake due diligence of potential stud welding contractors to ensure they meet the requirements of AS/NZS 5131 and AS/NZS 1554.2.
2. Ensure the stud welding contractor follows their quality management system requirements, particularly inspection and testing.

The most simple and reliable means of establishing compliance with the requirements of AS/NZS 5131 and AS/NZS 1554.2 are to use a company certified under the HERA Certification Ltd Steel Fabricator Certification Scheme (SFC). For a list of SFC-qualified fabricators, visit www.scnz.org.



Need help? For stud welding enquires, contact SCNZ or the HERA Welding Centre.

Acknowledgement

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For information about becoming a member, contact SCNZ

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