Australian Engineered Fasteners and Anchors Council (AEFAC)

Swinburne University of Technology

AEFAC Technical Note 12

CODE COMPLIANCE OF WELDED STITCH PLATE

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Scope

Welded stitch plate connections are relatively common precast wall connections in the Australian construction industry. The design and fabrication of these connections are not covered by a single Australian Design standard. A combined knowledge from different Australian standards, e.g., AS 5216, AS 3600, AS 4100 and AS/NZS 2327, needs to be used in designing such connections.

This brief technical note provides the basic requirements for designing and detailing welded stich plate connections. There are alternative connections in the marketplace, hence this is not an endorsement of this type of connection nor a promotion of others.

Background

Welded stitch plate connections are predominantly designed to transfer vertical shear forces between adjacent panels, which will then allow individual precast panels to act together as a single combined section (e.g., to form a box-shaped building core). The effectiveness of these connections to allow individual panels to act as a combined section is dependent on both the strength and stiffness of the welded stitch plate connections. The stiffness of the connection can be assessed using the procedure proposed by Menegon et al. (2020) and the strength can be assessed using the principles outlined in this technical note. Best practice advice is that designer's model (in finite element programs such as ETABS, Space Gas or Strand7) the precast core walls as individual panels that are discretely connected using line elements that have a stiffness value calibrated to match the stiffness of the specific stitch plate detail being adopted.

These connections can also be required to transmit other design actions (e.g., out-of-plane shear or sideways tension). These other design actions are relatively straight forward to assess and are outside the scope of this technical note.

Failure Modes

The design of welded stitch plate connections requires the designer to logically considered how the forces are transmitted through the connection and then appropriately design the different elements using the relevant clauses from a suite of different Australian Standards (see below). Under vertical shear the connections locally rotate and bend in double curvature to transfer the shear force from one panel to another, which is illustrated in Figure 1. This behaviour results in the development of both vertical and horizontal forces on the shear studs, which can be solved for using basic principles of structural engineering. The connections need to be designed for all the design actions that develop as a result of the load path illustrated in Figure 1, which include (but are not necessarily limited to, depending on the detailing of the connection) the following:

- Horizontal blow out failure due to rotation of the cast-in plates;
- Steel failure of studs (in shear);
- Stitch plate failure (plate in bending and shear);
- Weld failure between stitch plate and cast-in plates; and
- Failures related to durability and fire (particularly important when the connections are exposed).

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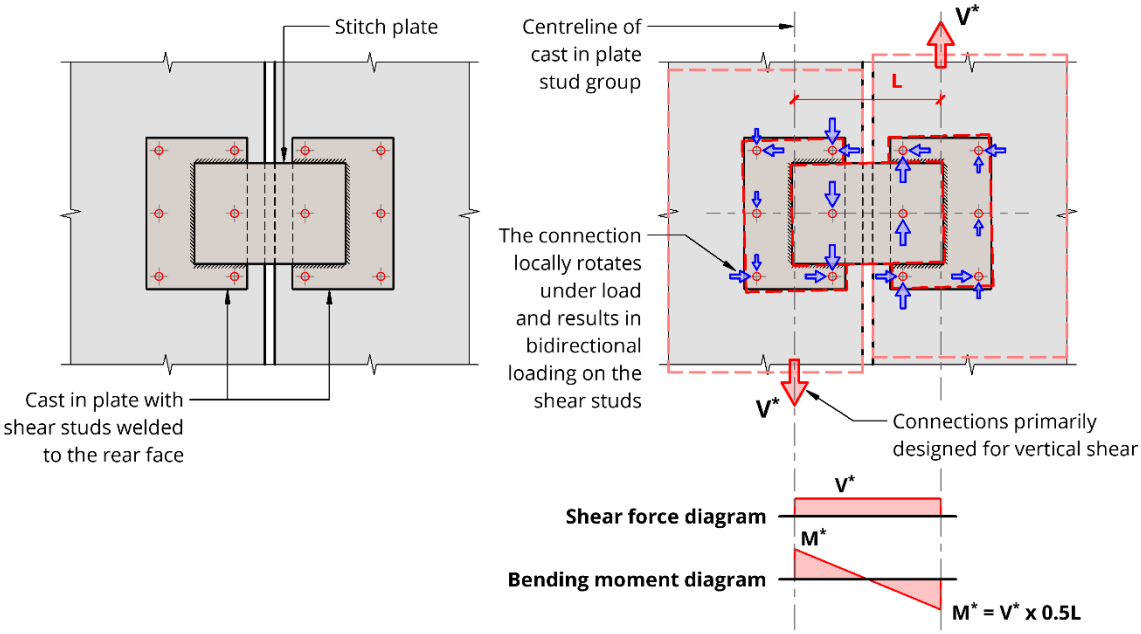

Figure 1: Load distribution from vertical shear forces.

Applicable Australian Standards

A combined knowledge from several Australian Standards is required for the design of stitch plate connections including:

- AS 5216 (for anchorage component such as horizontal blow out failure check and group effect);
- AS/NZS 2327 (for shear stud design);
- AS 3600 (for concrete component); and
- AS 4100 (for steel and welding components).

Important items for consideration

There could be several site-specific requirements to be considered in design and fabricating the connection. Some of those requirements are:

- Design capacities should be calculated considering all possible failure modes and they should be equal to or greater than the corresponding design actions.
- All the products used in the connection should be fit for purpose.
- Quality of the individual items should be checked. Quality assurance from all stakeholders involved (such as designers and manufacturers/suppliers) should be maintained.
- Installation should be in accordance with the product supplier and/or designer's detailing.
- If the connection is exposed to external weather conditions, the durability of the connection should be considered. The level of environmental deterioration and protection depends on the level of exposure.
- Differential settlement should be considered in designing the connection.
- Fire resistance requirements of the connection and post-fire assessment should be considered.

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- From a design point of view, there are several other innovative connections commercially available for the same purpose. Manufacturers/suppliers should be consulted for project specific requirements.
- General purpose (GP) welds should be specified where possible in lieu of structural purpose (SP) welds because it is difficult to control QA procedures on site (e.g. outside of a warehouse manufacturing environment). However, if SP welds are required non-invasive testing should be specified (e.g., visual examination, ultrasonic testing or magnetic particle testing).
- Thermal expansion should be considered in designing and detailing the connection.
- The geometry of the connection can be critical to the connection performance. The precast shop detailer needs to accurately produce shop drawings using the dimensions and tolerances specified in the design documents.
- Examples of critical dimensions and important detailing considerations are illustrated in Figure 2.

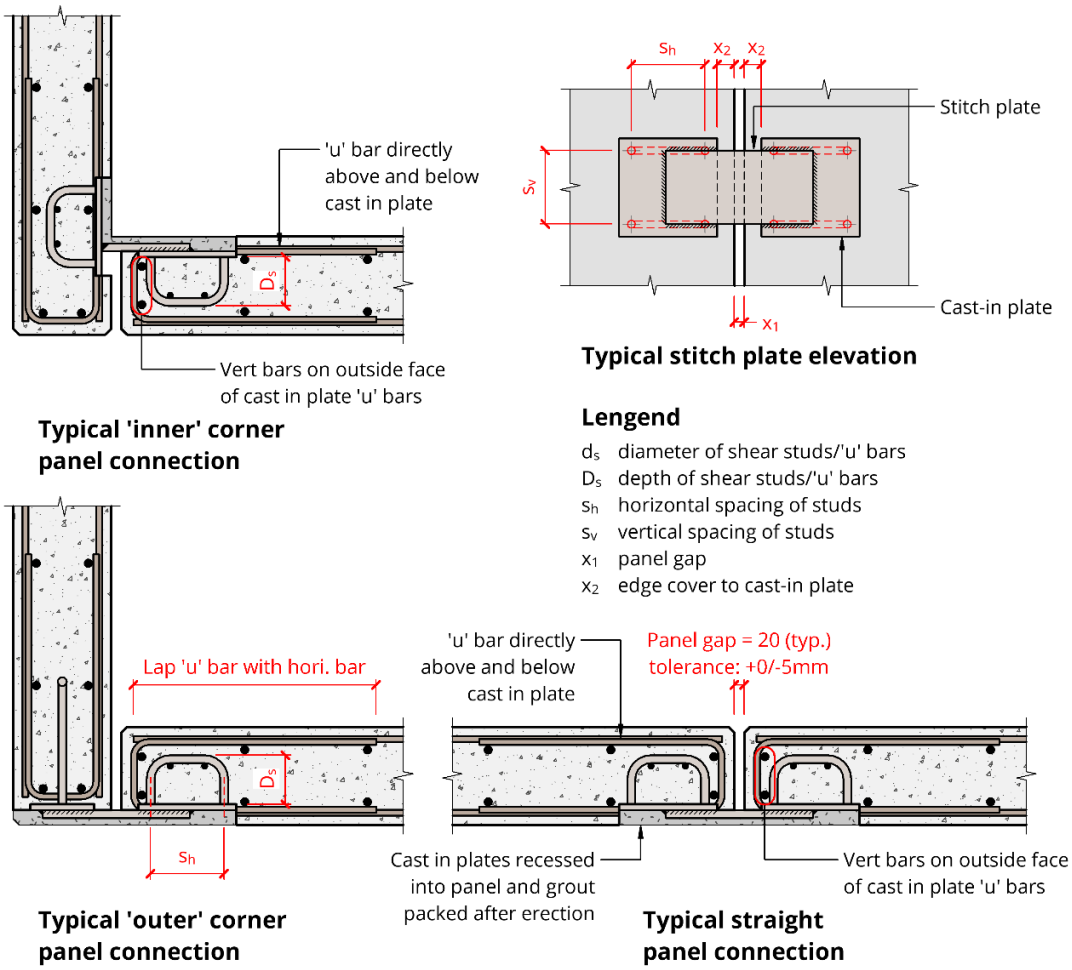

Figure 2: Welded stitch plate good detailing and critical dimensions.

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References

Menegon, S.J., Wilson, J.L., Lam, N.T.K. and Gad, E.F., Experimental Testing of Innovative Panel-to-Panel Connections for Precast Concrete Building Cores, Engineering Structures, 2020.

Standards Australia, AS 3600: Concrete structures, SAI Global, Sydney, 2018

Standards Australia, AS 4100: Steel structures, SAI Global, Sydney, 2020

Standards Australia, AS 5216: Design of post-installed and cast-in fastenings in concrete, SAI Global, Sydney, 2021

Standards Australia, AS/NZS 2327: Composite structures - Composite steel-concrete construction in buildings, SAI Global, Sydney, 2017

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