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Friction stir spot welding — Aluminium —

Part 2: Design of weld joints

Soudage par friction-malaxage par points — Aluminium —

Partie 2: Conception des assemblages soudés

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by the IIW, *International Institute of Welding*, Commission III, *Resistance welding, solid state welding and allied joining processes*.

Any feedback, question or request for official interpretation related to any aspect of this document should be directed to IIW via your national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 18785 series can be found on the ISO website.

Introduction

Welding processes are widely used in the fabrication of engineered structures. During the second half of the twentieth century, fusion welding processes, wherein fusion is obtained by the melting of parent material and usually a filler metal, dominated the welding of large structures. In 1991, friction stir welding (FSW), which is carried out entirely in the solid phase (no melting), was invented.

Friction stir spot welding (FSSW) processes are spot-like variants of the FSW process. Unlike FSW, there is minimal or no traverse motion of the tool. In basic FSSW, the joint is created by plunging a rotating tool into the work piece and retracting the tool out of the overlapping sheets. Other FSSW variants include additional tool movements. Frictional heat is generated from the contact between the tool and the material to be welded resulting in softening of this material. The softened material is stirred to form a metallurgical connection which is aided by the forge action applied by the tool shoulder contacting the upper sheet surface.

The increasing use of FSSW has created the need for a FSSW standard in order to ensure that welding is carried out in the most effective way and that appropriate control is exercised over all aspects of the operation. The ISO 18785 series focuses on the FSSW of aluminium because, at the time this document was developed, the majority of commercial applications for FSW involved aluminium. Examples include railway cars, consumer products, food processing equipment, automotive components, aerospace structures, and marine vessels.

To be effective, welded structures should be free from serious problems in production and in service. To achieve that goal, it is necessary to provide controls from the design phase through material selection, fabrication, and inspection. For example, poor design can create serious and costly difficulties in the workshop, on site, or in service. Incorrect material selection can result in welding problems such as cracking. Welding procedures need to be correctly formulated and approved to avoid imperfections. To ensure the fabrication of a quality product, management needs to understand the sources of potential trouble and introduce appropriate quality and inspection procedures, and supervision should be implemented to ensure that the specified quality is achieved.

Friction stir spot welding — Aluminium —

Part 2: Design of weld joints

1 Scope

This document specifies the design requirements and provides design guidelines for friction stir spot welding.

In this document, the term "aluminium" refers to aluminium and its alloys.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2553, *Welding and allied processes — Symbolic representation on drawings — Welded joints*

ISO 18785-1, *Friction stir spot welding — Aluminium — Part 1: Vocabulary*

ISO 18785-5, *Friction stir spot welding — Aluminium — Part 5: Quality and inspection requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18785-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Design requirements

4.1 Documentation

The welded assembly shall be designed in accordance with defined requirements that support the end use of the product. Documentation, e.g. in the form of an engineering drawing, shall clearly define the essential information of the FSSW joint and any special requirements, such as fracture critical, durability critical, mission critical, or safety critical that are imposed over and above the general requirements. Essential process controls shall be defined to substantiate that all design requirements can be met by the welds that were produced in accordance with the qualified welding procedure specification (WPS) and inspection requirements.

Welding symbols shall be in accordance with ISO 2553.

4.2 Lap joint design

The design of the welded assembly shall take into account the necessary material property data. Some examples of weld geometries and designs are shown in Table 1.

Table 1 — Examples of weld geometries and designs for FSSW lap joints

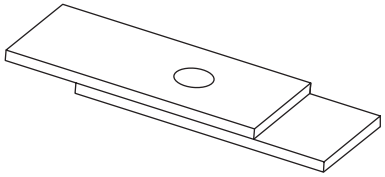
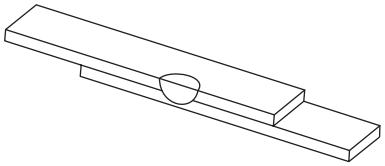
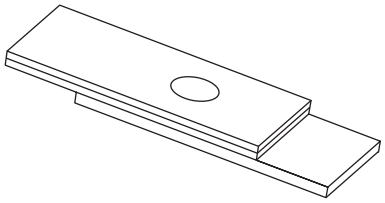
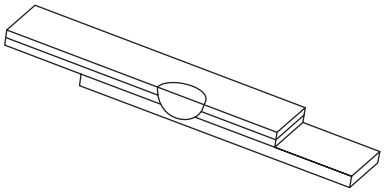
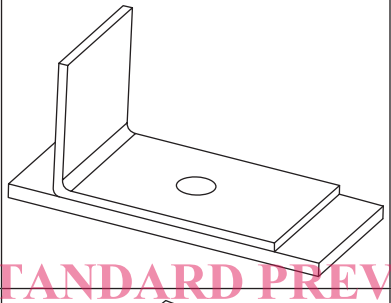
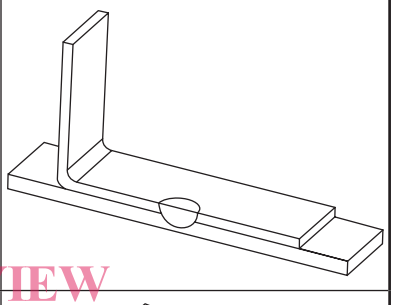
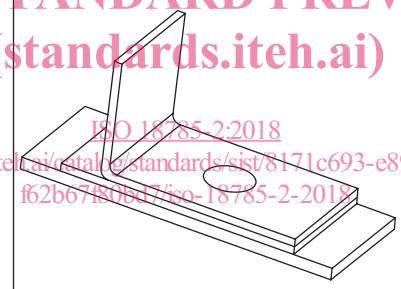
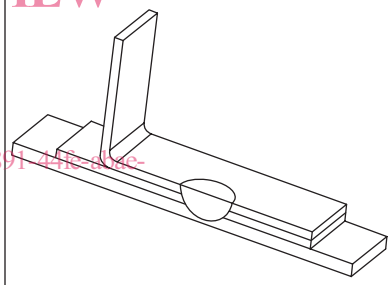
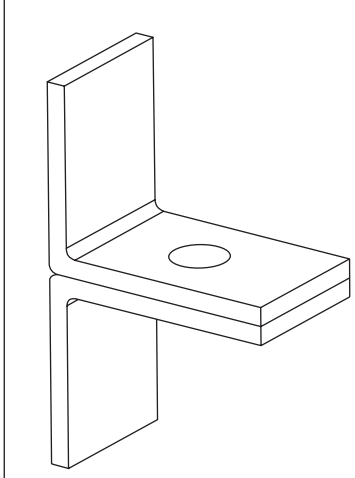
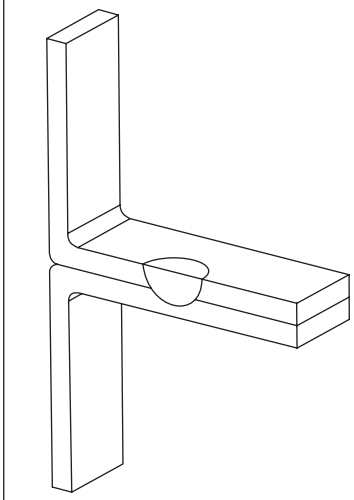
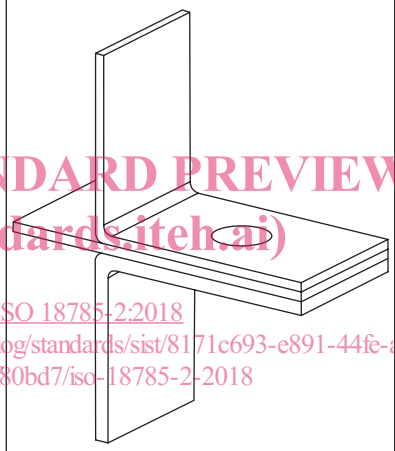
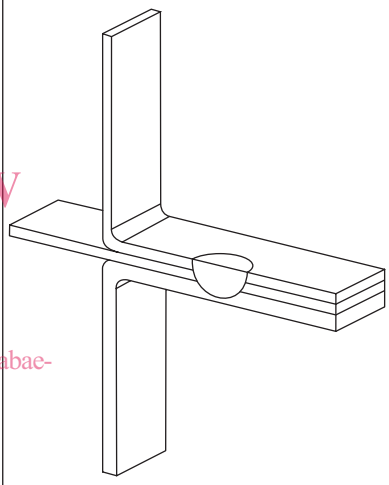
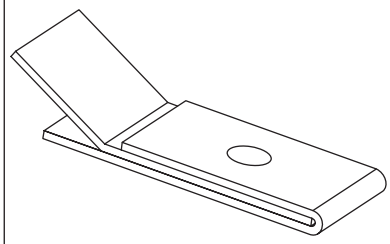
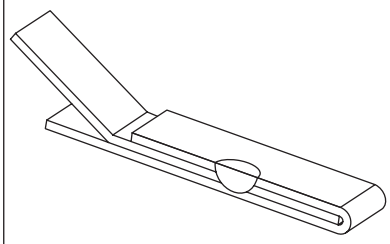
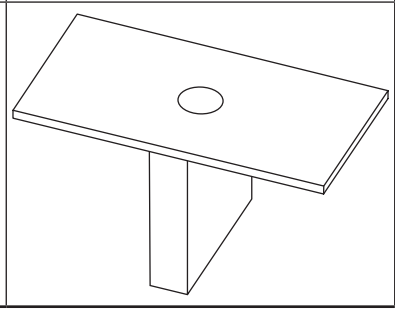
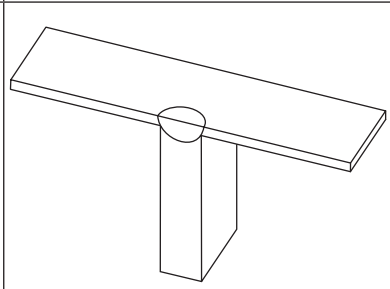
Joint design	Full joint	Welded cross section
Basic lap		
Multi-layer lap		
L-stiffener		
Multi-layer L-stiffener		

Table 1 *(continued)*

Joint design	Full joint	Welded cross section
Double L		
Multi-layer Double L		
Hem		
Stake		

The distance from the centreline of the tool to the edge of each overlapping member and the distance between each weld shall be done in accordance with customer specifications, e.g. in an engineering drawing, and be specified in the WPS.

The plunge force and/or depth of penetration of the probe (or the shoulder in case of refill FSSW) into the lap connection shall also be specified in the WPS.