IIW C-III
Doc. III-1407-06

Proposed draft for ISO/DIS 25239-1
by IIW/C-III/SC III-B/WG-B1

Friction stir welding of aluminium
General requirements
Part 1
Vocabulary

15 September. 2006

IIW Commission III

This draft will be discussed to provide DIS version at the EWI meeting held on 13/14 November, 2006

ISO TC 44/SC IIW

Date:

ISO/CD 25239-1.7

ISO TC 44/SC IIW

Secretariat:

Friction stir welding of aluminium – General requirements — Part 1: Vocabulary

Élément introductif — Élément central — Partie 1: Élément complémentaire

Document type: International Standard
Document subtype:
Document stage: (30) Committee
Document language: E

G:\Backup98_Data_E\IIW Com_III\Quebec_meeting2006\ISO-DIS25239Drafts\ISO_Part 1 Draft 7 Vocabulary 8-10-06.doc STD Version 2.1c2

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning friction stir welding.

ISO takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the ISO that it is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Information may be obtained from:

TWI

Granta Park, Great Abington

Cambridge, CB1 6AL, UK

Tel: +44 (0)1223 891162

Fax: +44 (0)1223 892588

E-mail: twi@twi.co.uk

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 25239-1 was prepared by Technical Committee ISO/TC 44, Welding and allied processes, Subcommittee SC 10, Unification of requirements in the field of metal welding.

ISO 25239 consists of the following parts, under the general title Friction stir welding of aluminium – General requirements:

— *Part 1: Vocabulary*

— *Part 2: Design of weld joints*

— *Part 3: Qualification of friction stir welding operators*

— *Part 4: Specification and qualification of welding procedures*

— *Part 5: Quality and inspection requirements*

Introduction

Welding processes are widely used in fabrication of engineered structures. During the second half of the twentieth century, welding of large structures was dominated by fusion welding processes wherein fusion is obtained by melting of the base metal and, usually, a filler metal. Friction stir welding, originating in the last decade of the twentieth century, is carried out entirely in the solid phase (no melting). There is an increasing need for friction stir welding standards. This standard focuses on friction stir welding of aluminium because, at the time this standard was created, the majority of commercial applications for friction stir welding involved aluminium. Examples include railway cars, consumer products, food processing equipment, aerospace, and marine vessels. Welding strongly influences the cost of fabrication and quality of such products. The increasing use of friction stir welding has created the need for a friction stir welding standard in order to assure that welding is carried out in the most effective way and that appropriate control is exercised over all aspects of the operation.

To this end, ISO is publishing this standard, which comprises five Parts. The first Part, entitled, Vocabulary, presents those terms and definitions specific to friction stir welding.

The second Part, entitled, *Design of Weld Joints*, presents the design requirements for friction stir weld joints in aluminium.

The third Part, entitled, *Qualification of friction stir welding operators*, specifies the requirements for the approval of welding operators for the friction stir welding of aluminium.

The fourth Part, entitled, *Specification and qualification of welding procedures*, specifies the requirements for the specification and qualification of welding procedures for the friction stir welding of aluminium.

The fifth Part, entitled, *Quality and inspection requirements*, specifies a method to determine the capability of a manufacturer to use the friction stir welding process for production of aluminium products of the specified quality. It defines specific quality requirements but does not assign those requirements to any specific product group.

Friction stir welding of aluminium – General requirements — Part 1: Vocabulary

1 Scope

This Part of ISO 25239 defines friction stir welding terms and definitions. In this standard, the term aluminium refers to aluminium and its alloys.

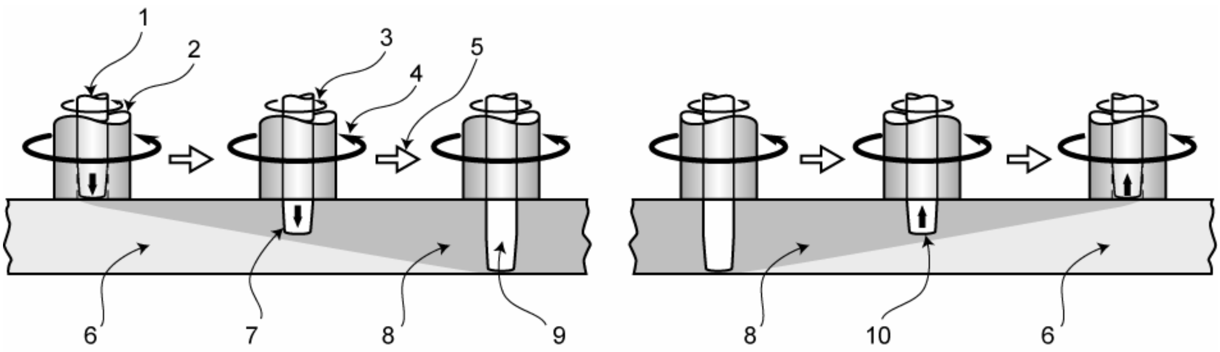
2 Terms and definitions

2.1
adjustable probe tool
probe that has an adjustable length and its rotation may be different from the shoulder during welding

NOTE 1 An adjustable probe may be used as a fixed probe.

NOTE 2 This tool enables joining to be accomplished without creating excessive toe flash at the start, or an exit hole at the finish.

See Figure 1



Key

1 Probe

2 Tool body

3 Direction of probe rotation

4 Direction of shoulder rotation

5 Direction of tool travel

6 Unwelded workpiece

7 Probe moving downward

8 Welded workpiece

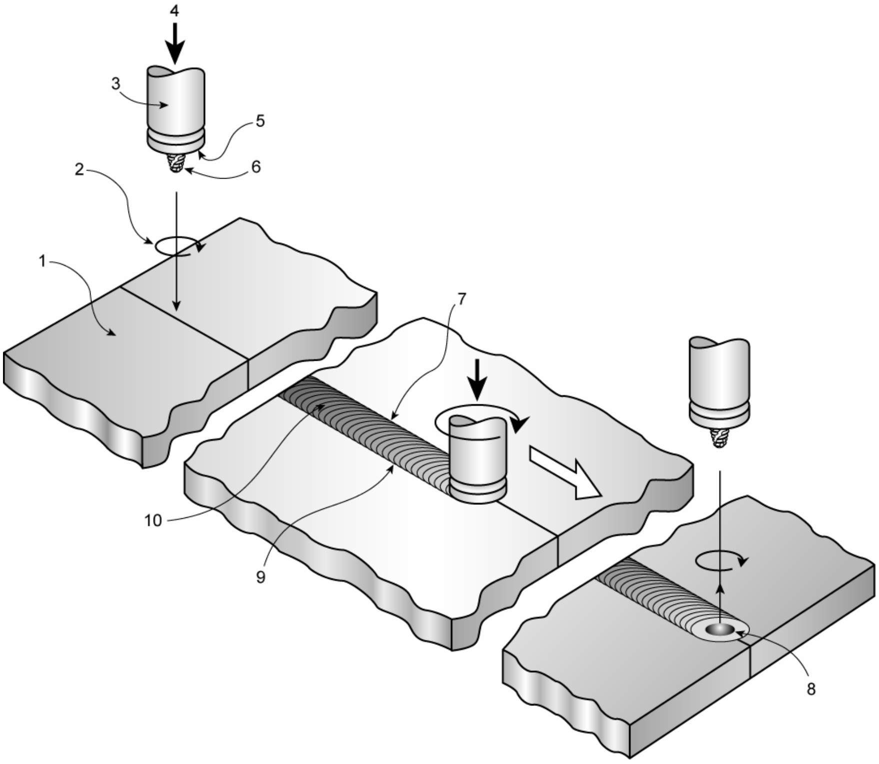
9 Probe at required position for welding

10 Probe moving upward

Figure 1 — Adjustable probe tool

2.2
advancing side
side of the weld where the direction of tool rotation is the same as the welding direction

See Figure 2.



Key

1 Workpiece
2 Direction of tool rotation
3 Tool
4 Downward force
5 Tool shoulder
6 Probe
7 Advancing side of weld
8 Exit hole
9 Retreating side of weld
10 Weld face

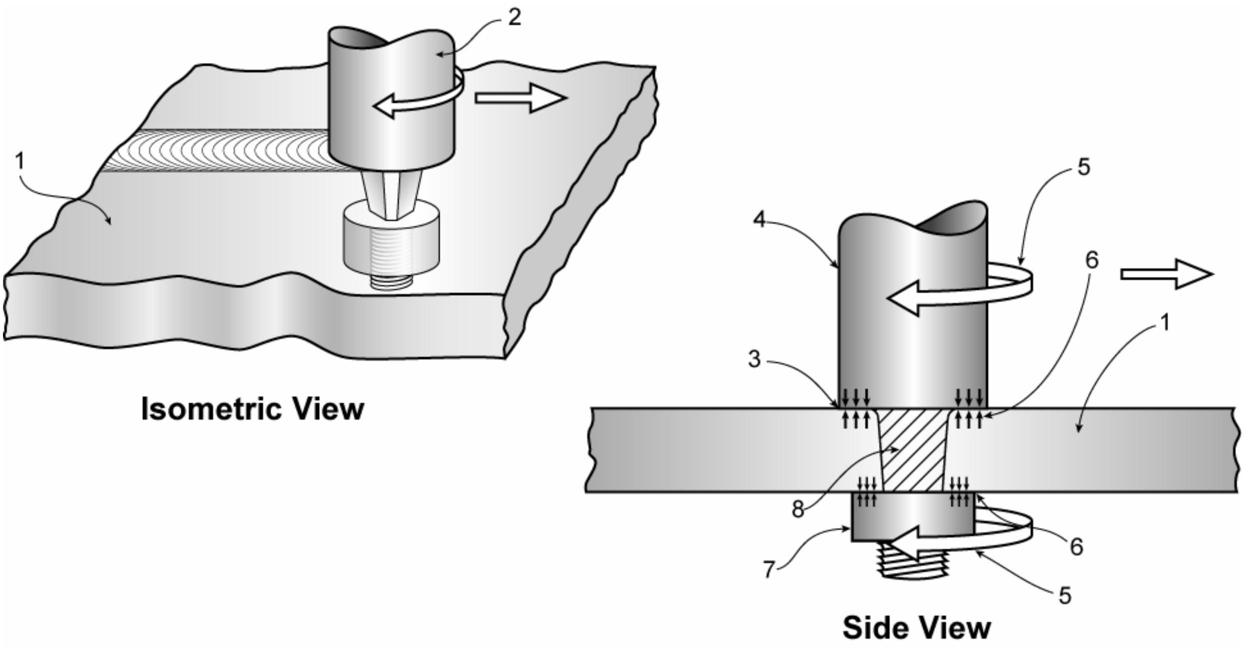
Figure 2 — Basic principle of friction stir welding

2.6
bobbin tool
tool with two shoulders separated by a fixed length or adjustable length probe

See Figure 3.

tool with two shoulders separated by a probe whose length can be adjusted during welding

NOTE The self reacting bobbin tool allows the shoulders to automatically maintain contact with the workpiece.



Key

1 Workpiece

2 Bobbin tool

3 Upper shoulder

4 Upper tool body

5 Direction of tool rotation

6 Lower tool shoulder

7 Lower tool body

8 Probe

Figure 3 — Bobbin tool

2.3
dwell time at end of weld
time interval after travel has stopped but before the rotating tool has begun to withdraw from the weld

2.4
dwell time at start of weld
time interval between when the rotating tool reaches its maximum depth in the parent material and the start of travel

2.5
exit hole
hole remaining at the end of a weld after the withdrawal of the tool

See Figures 2 and 8.

2.7
fixed probe
probe that has a fixed length protruding from the shoulder and its rotation is the same as the shoulder during welding

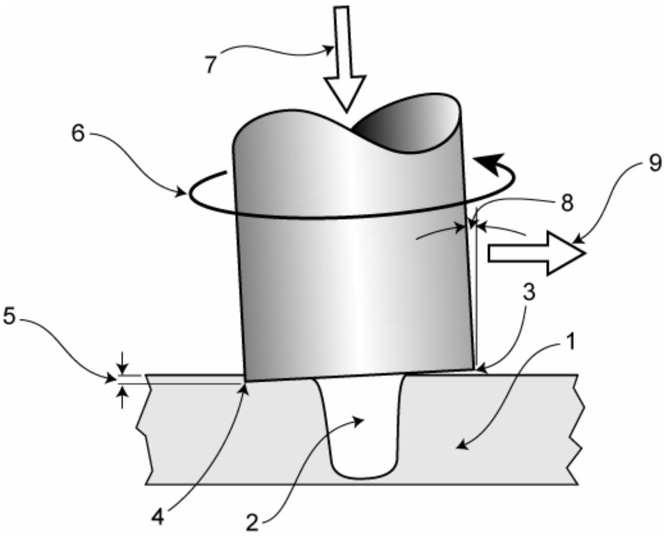
2.8
force control
method to provide the required force on the tool during welding

2.9
friction stir welding
joining process that produces a weld by friction heating and mixing material in the plastic state caused by a high speed rotating tool that traverses along the weld.

See Figure 2.

2.10
heel
that part of the tool shoulder that is at the rear of the tool relative to its forward motion

See Figure 4.



Key

1 Workpiece
2 Probe
3 Shoulder (leading edge)
4 Heel (shoulder trailing edge)
5 Heel plunge depth
6 Direction of tool rotation
7 Downward force
8 Tilt angle
9 Direction of welding

Figure 4 — Heel and heel plunge depth

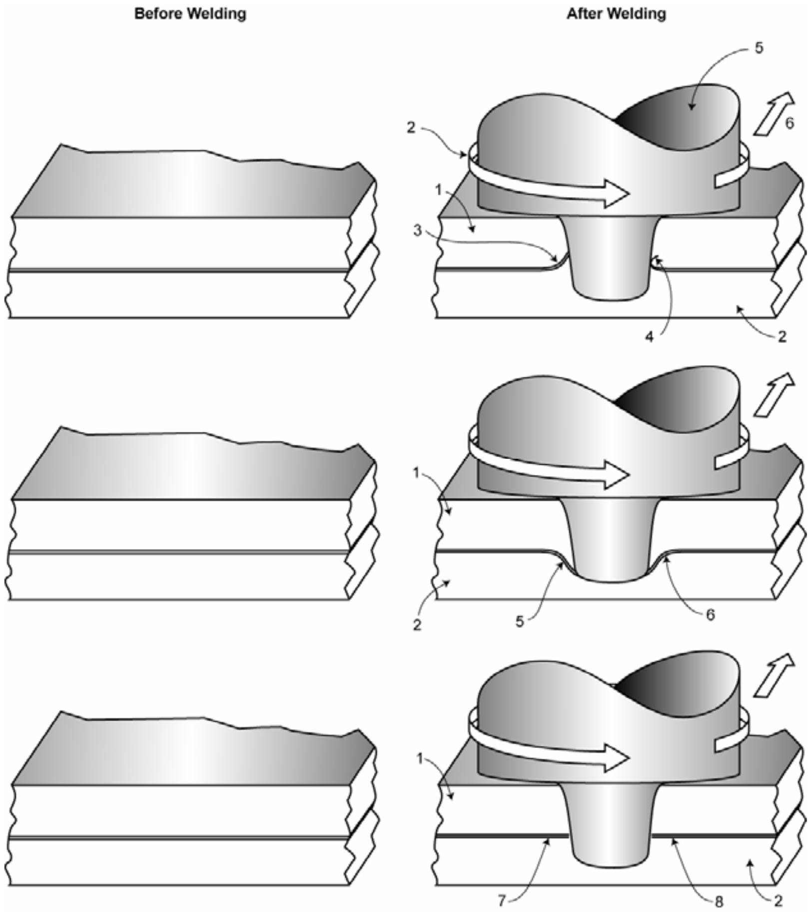
2.11
heel plunge depth
distance the heel extends into the parent material

See Figure 4.

2.12
hook
curved notch on the advancing side of a lap weld

See Figure 5, T3.

NOTE The hook can either turn upward or downward. In the top drawing in Figure 5, the hook turns upward.



Key

1 Near shoulder workpiece (top sheet)

2 Underneath workpiece (bottom sheet)

3 Retreating side, notch tip orientation towards shoulder side (top sheet)

4 Advancing side, notch tip orientation (hook feature) toward shoulder side (top sheet)

5 Retreating side, notch tip orientation away from shoulder side

6 Advancing side, notch tip orientation away from shoulder side

7 Retreating side, notch tip abrupt end

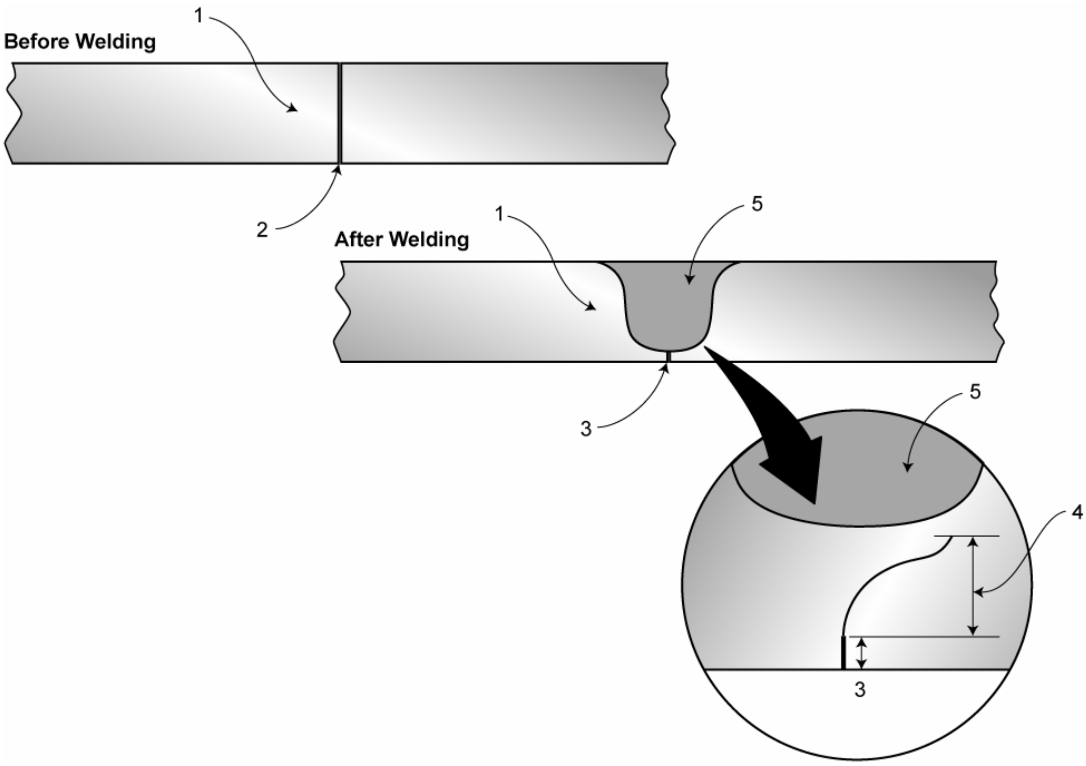
8 Advancing side, notch tip abrupt end

Figure 5 — Cross-section of friction stir lap weld showing various notch geometries.

2.13
incomplete penetration
imperfection where the full thickness of the joint has not been welded

See Figure 6.

NOTE Even though there is no bond, there is nominally extensive plastic deformation in this region. This type of imperfection usually has a morphology as shown in Figure 6.



Key

1 Workpiece

2 Joint

3 Original joint line – no plastic deformation

4 Original joint line – severe plastic deformation

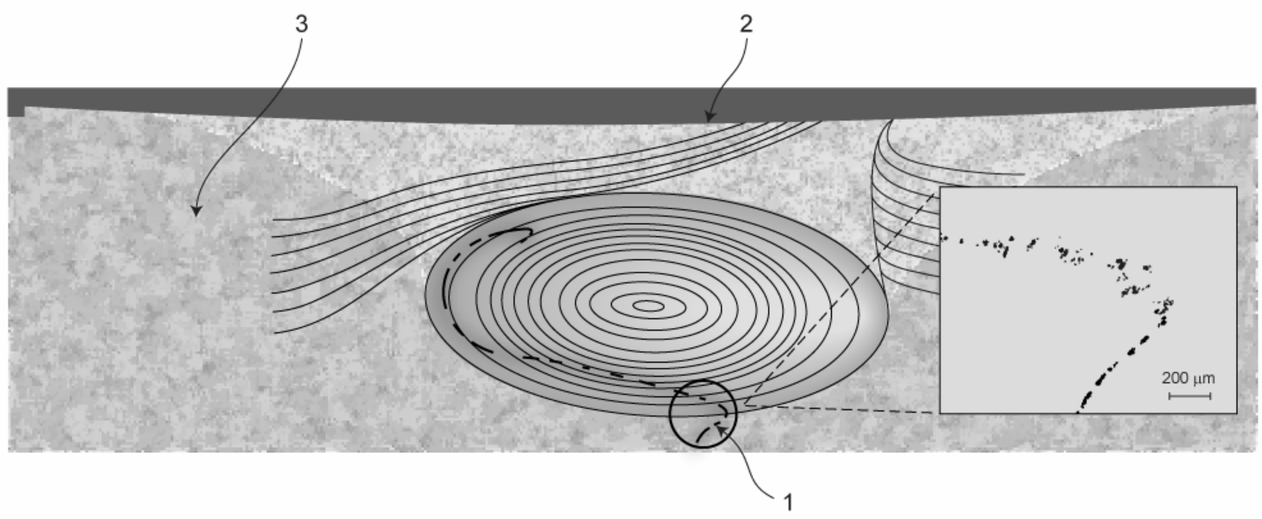
5 Weld

Figure 6 — Macrosection of a butt weld showing incomplete penetration.

2.14
joint line remnant
imperfection consisting of a semi-continuous layer of oxide in the weld

See Figure 7.

NOTE The severity of this imperfection depends upon its extent and the proximity of the adjacent oxide particles. Joint line remnants may have some effect on the mechanical performance of the joint.



Key

1 Joint line remnant

2 Face of weld

3 Workpiece

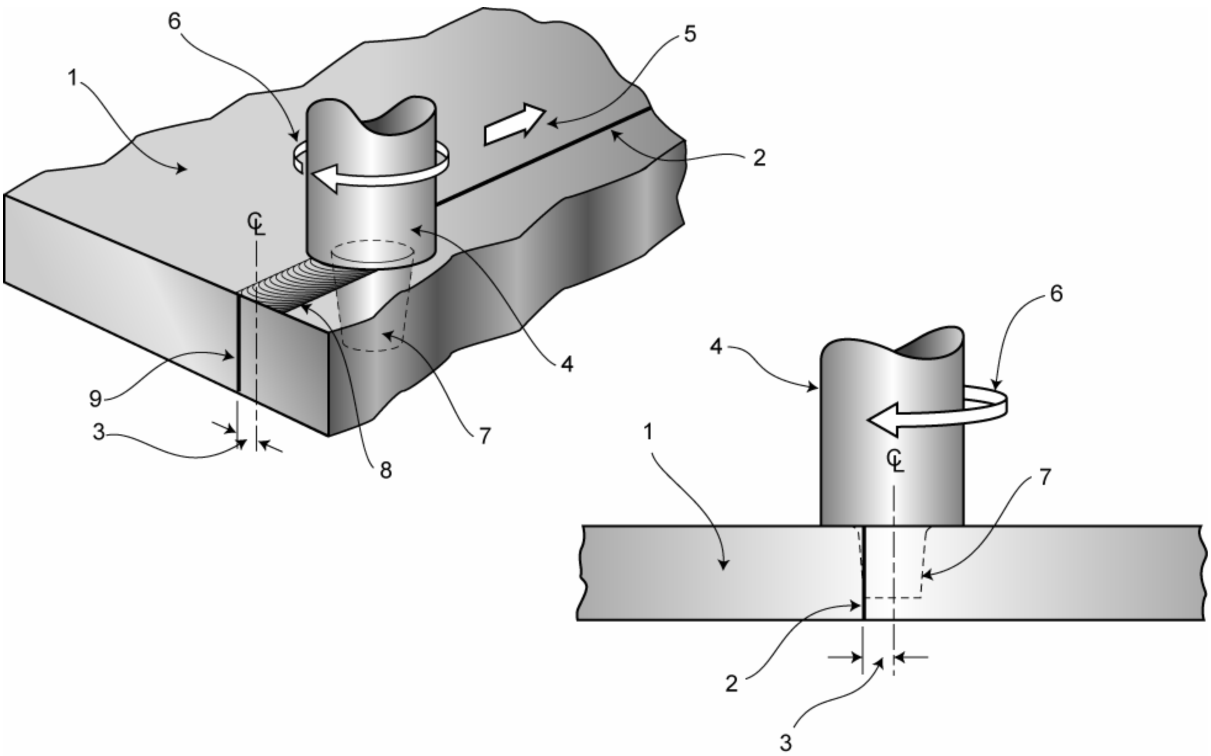
Figure 7 — Joint line remnant

2.15
lap joint sheet thinning
workpiece thickness minus the distance from the weld face to the end of the hook.

See Figure 5.

NOTE In Figure 5, the sheet thinning in the lap joint = T1 minus T2, or = T1 minus T3.

2.16
lateral offset
distance from the tool axis to the root face



Key

1 Workpiece
2 Joint
3 Lateral offset
4 Tool
5 Direction of welding
6 Direction of tool rotation
7 Probe
8 Weld face
9 Location of joint before welding

Figure 8 — Lateral offset showing the centerline of the tool not centered on the joint

2.17
position control
method to provide the required position of the tool during welding

2.18
probe
that part of the tool that extends into the workpiece to make the weld

See Figures 1 and 4.

NOTE The probe can be either fixed or adjustable.

2.19
retreating side
side of the weld where the direction of tool rotation is opposite to the welding direction

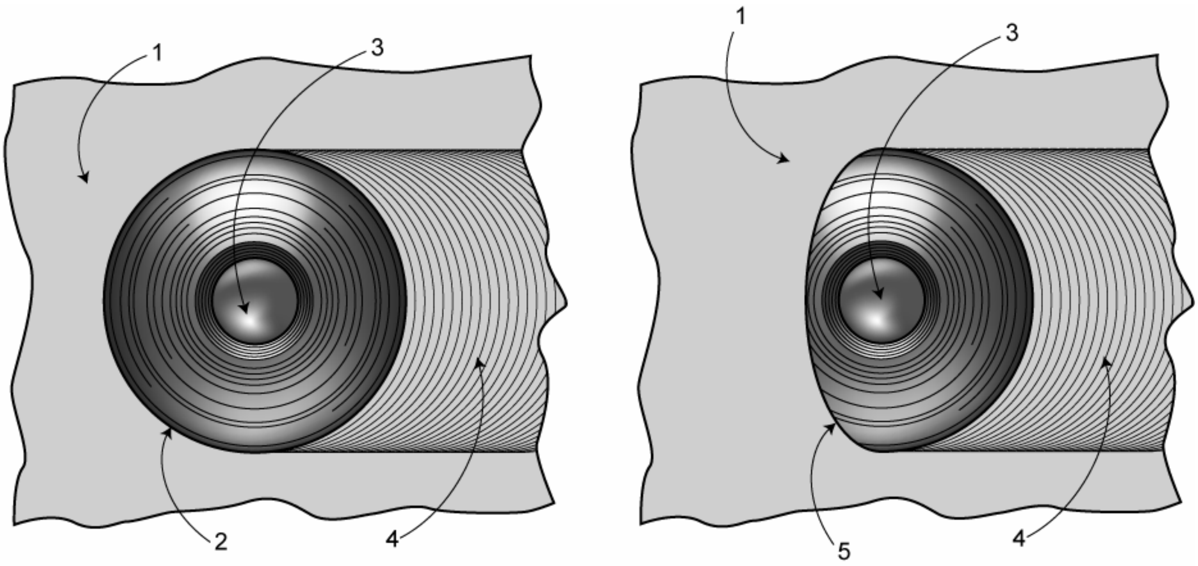
See Figure 2.

2.21
shoulder
surface of the tool that contacts the workpiece surface during welding

See Figure 2.

2.22
shoulder footprint
partially or fully formed ring surrounding the exit hole

See Figure 8.



Key

1 Workpiece
2 Shoulder footprint
3 Exit hole
4 Weld face
5 Partial shoulder footprint

Figure 9 — Tool shoulder footprint visible at the exit hole

2.23
toe flash
imperfection consisting of excessive metal protruding upward at the weld toe

2.24
tool
in friction stir welding, the rotating component that includes the shoulder and probe

2.25
tool plunge
inserting the tool into the workpiece in order to make a weld

2.26
underfill
depression resulting when the weld face is below the adjacent parent metal surface

NOTE This is a normal characteristic of the friction stir welding process.