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Weldability — Metallic materials — General principles

Soudabilité — Matériaux métalliques — Principes généraux

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Foreword

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In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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ISO/TR 581 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 7, *Representation and terms*.

It cancels and replaces ISO 581:1980, which has been technically revised.

Weldability — Metallic materials — General principles

1 Scope

This Technical Report gives general principles related to the weldability of metallic materials. These principles apply to all welding processes and all different types of construction whatever properties they may have.

2 Weldability

2.1 General

A component consisting of metallic material is considered to be weldable by a given process when metallic continuity can be obtained by welding using a suitable welding procedure. At the same time, the welds shall comply with the requirements specified in regard to both their metallurgical and mechanical properties and their influence on the construction of which they form a part. Weldability is governed by three factors, namely material, design and production (see Figure 1).

Each of these factors is associated with different properties:

a) **Metallurgical weldability: material properties**

These are influenced primarily by production and to a minor extent by the design.

b) **Constructional weldability: design properties**

These are influenced primarily by the material and to a minor extent by production.

c) **Operative weldability: production properties**

These are influenced primarily by the design and to minor extent by the material.

Each of these sets of properties depends — like the weldability of a component — on material, design and production, but the importance of the influencing factors differs for each.

2.2 Metallurgical weldability

A material possesses Metallurgical Weldability if, in the course of the procedure adopted, the chemical, metallurgical and physical properties inherent in the material allow a weld to be made which satisfies the requirements of the application. The less the factors governed by the material have to be taken into account when determining the welding procedure for a given construction, the better is the Metallurgical Weldability of a material within a material group.

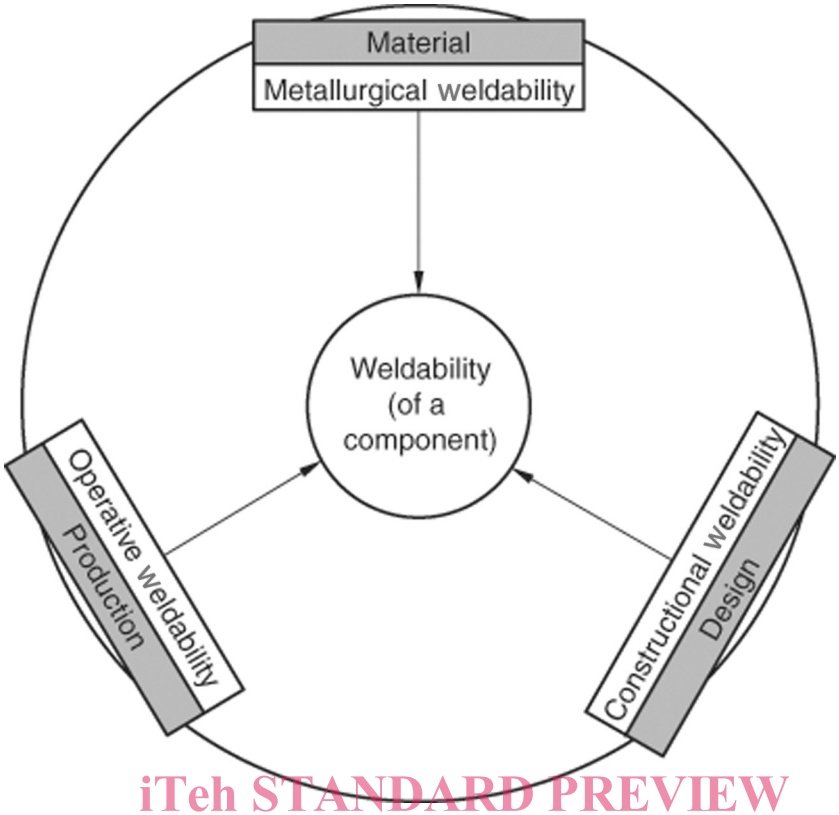

Figure 1 — Representation of weldability

Factors which influence metallurgical weldability include the following:

a) Chemical composition, critical for, e.g.,

- tendency to brittle fracture;
- tendency to ageing;
- tendency to hardening;
- tendency to hot cracking;
- behaviour of the molten pool;
- vaporization temperature;
- melting range.

b) Metallurgical properties governed by production methods, e.g. method of steelmaking and deoxidation, hot and cold working, heat treatment, critical for

- segregations;
- inclusions;
- anisotropy;

— grain size;

— formation of crystalline structure.

c) Physical properties, e.g.

— expansion behaviour;

— thermal conductivity;

— melting point;

— mechanical strength and toughness.

2.3 Constructional weldability

Constructional weldability exists in a construction if, using the material concerned, the component remains capable of functioning under the envisaged operating conditions by virtue of its design.

The less the factors governed by the design have to be taken into account when selecting the material for a specific welding procedure, the greater is the constructional weldability of a specific structure or component.

Factors which influence constructional weldability include the following:

a) Design of the construction, e.g.

— distribution of forces in the component;

— arrangement of welds;

— workpiece thickness;

— notch effect;

— differences in stiffness.

b) Conditions regarding loading, e.g.

— type and magnitude of stresses in the component;

— dimensional extent of stresses;

— speed of stressing;

— temperatures;

— corrosion.

2.4 Operative weldability

Operative weldability exists for a welding procedure if the welds envisaged for a particular construction can be made properly under the chosen conditions of production. The less the factors governed by the welding procedure have to be taken into account in designing a construction for a specific material, the better is the operative weldability of a procedure intended for a specific structure or component.

Factors which influence operative weldability include the following:

a) Preparation for welding, e.g.

- type of joint;
- shape of joint.

b) Welding procedure(s), including:

- welding process(es);
- types of filler materials/welding consumables;
- welding parameters;
- welding sequence;
- preheating;
- welding position(s);
- precautions taken with respect to unfavourable weather conditions.

c) Pre- and post-treatment, e.g.

- post weld heat treatment;
- mechanical treatment (e.g. grinding, machining, peening);
- chemical treatment (e.g. pickling).

3 Explanations

The uncertainty which had arisen in the terminology dealing with weldability, and the complex interaction of the various factors influencing weldability, made it necessary to define general principles related to weldability.

When constructions are being erected, the major task is to achieve the load-carrying capacity required for the purpose of use, and to combine this with adequate security and minimum cost. The weldability of the construction or of a component is assured if this is achieved. In order to satisfy this fundamental condition, it is essential to take account of three influencing factors, each of which can be of decisive importance, namely the material, the design and the procedure.