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Numerical welding simulation — Execution and documentation

Simulation numérique de soudage — Exécution et documentation

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Foreword

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

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Introduction

This document is not intended for use in a specific industry or with a specific software. Commercial tools are not excluded. This document is beneficial for the design, manufacturing and assessment of a wide range of components if the physical phenomena, software and numerical methods meet the specifications of the scientific computational tools (SCTs) defined in Annex A.

This document can be used by industrial entities to define their requirements for specific applications of computational welding mechanics (CWM).

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Numerical welding simulation — Execution and documentation

1 Scope

This document specifies the execution, validation, verification and documentation of a numerical welding simulation within the field of computational welding mechanics (CWM) and performed with a scientific computational tool (SCT).

This document is applicable to the thermal and mechanical finite element analysis (FEA) of arc, laser and electron beam welding processes for the purpose of calculating the effects of welding processes, and in particular, residual stresses and distortion, in support of structural integrity assessment.

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/TR 25901-1, *Welding and allied processes — Vocabulary — Part 1: General terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 25901-1 and the following apply.

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

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

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

3.1
accuracy
closeness of agreement between a measured quantity value and a true quantity value of a measurand

Note 1 to entry: The term measurand is defined by the VIM (ISO/IEC Guide 99:2007, 2.3) as a “quantity intended to be measured”.

[SOURCE: ISO/IEC Guide 99 :2007, 2.13, modified — Note 1 to entry has been added.]

3.2
calculation strategy
set of modelling (and simulation) choices to perform a numerical simulation

Note 1 to entry: A calculation strategy defines the choice of physical models and of the coupling physics between models, the correlations, the discretization both spatial (mesh) and temporal (time step), the calculation options.

3.3
calibration
process of adjusting modelling parameter values of the scientific computing tool

Note 1 to entry: Calibration improves agreement between the calculated values and the reference values.

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3.4
distortion
permanent deformation resulting in a change in shape of a solid body

3.5
evaluation criteria
essential metrics used to assess and compare the relative significance of each phenomenon

Note 1 to entry: The importance rank of a particular phenomenon is a measure of its relative influence on the selected evaluation criteria.

Note 2 to entry: Adapted from Reference [17].

3.6
greedy algorithm
algorithm that follows the problem-solving heuristic of making the locally optimal choice at each stage

Note 1 to entry: In many cases, a greedy strategy does not produce an optimal solution, but a greedy heuristic can yield locally optimal solutions that approximate a globally optimal solution in a reasonable amount of time.

3.7
heat flux
rate at which thermal energy is transferred through a unit area of surface

3.8
heat source
<numerical> spatial and temporal numerical distribution of the thermal energy transferred to the weldment by the welding process

3.9
numerical simulation
implementation of one or more *scientific computing tools* (3.11), with calculation strategies (3.2) and input data, to produce numerical results describing the evolution of a physical situation

3.10
power density
amount of thermal power absorbed or generated per unit volume

3.11
scientific computing tool
SCT
software for *numerical simulation* (3.9) of physical phenomena

Note 1 to entry: An SCT may consist of one or more solvers and include pre- and post-processors.

Note 2 to entry: SCTs use computational methods to solve science and engineering problems.

Note 3 to entry: Refer to Annex A for technical specifications of SCTs.

3.12
reference scientific computing tool
scientific computing tool (3.11) for which the predictive performance is considered to be superior to that expected of the scientific computing tool to be validated

3.13
scope of utilization
situations and scenarios studied using the *scientific computing tool* (3.11) for computational welding mechanics

3.14
spatial discretization
distribution and type of the geometric units for subdividing the geometric model

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3.15
temporal discretization
step size and number of time units for subdividing the duration being modelled

3.16
validation case
data set considered to be pertinent and selected for carrying out separate effects or integral validation of a *scientific computing tool* (3.11)

Note 1 to entry: Data set can be experimental test, operating experience feedback, simulation using a reference scientific computing tool (3.12), analytical solution, etc.

3.17
validation experiment
experiment designed to validate the simulation results taking into account all relevant data and their uncertainty

3.18
validation file
document in which all the results of the validation of a *scientific computing tool* (3.11) are inventoried

3.19
verification file
document in which all the results of the verification of a *scientific computing tool* (3.11) are inventoried

4 Abbreviated terms

For the purposes of this document, the abbreviated terms given in Table 1 apply.

Table 1 — Abbreviated terms

Abbreviated term	Definition
2D	two dimensional
3D	three dimensional
CTE	coefficient of thermal expansion
CWM	computational weld mechanics
EBW	electron beam welding
FEA	finite element analysis
GMAW	gas metal arc welding
GTAW	gas tungsten arc welding
HAZ	heat-affected zone
PIRT	phenomena identification ranking table
PWHT	post weld heat treatment
QI	quantities of interest
SAW	submerged arc welding
SCT	scientific computation tool
SMAW	shielded metal arc welding
WPS	welding procedure specification
WPQR	welding procedure qualification record

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