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Fatigue — Fatigue testing of welded components — Guidance

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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.

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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.

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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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

ISO/TR 14345 was prepared by the International Institute of Welding, which has been approved as an international standardizing body in the field of welding by the ISO Council.

Requests for official interpretations of any aspect of this part of ISO/TR 14345 should be directed to the ISO Central Secretariat, who will forward them to the IIW Secretariat for an official response.

Introduction

Fatigue tests of welded specimens are the basis of all the main fatigue design codes and standards for welded components and structures. However, inevitably these are not fully comprehensive and there is a constant need for new data to extend them. Recognizing this, there is a growing tendency to allow the user to deviate from the rules by performing special fatigue tests to validate a design. This Technical Report addresses both these situations by providing guidance on the production of welded test specimens and their fatigue testing for producing data either for general application or to validate a specific design.

Welded metallic structures can be large and complex, incorporating many weld details and structural configurations. Furthermore, the loading that they are required to withstand in service can also be complex. Therefore, the scope for performing fatigue tests on full-scale welded structures under truly representative loading conditions is very limited, and usually expensive. Consequently, for both technical and economic reasons, it is rarely attempted. Instead, in many circumstances, it is sufficient to isolate individual weld details and incorporate them in small-scale specimens to test them. An important condition is that the resulting specimens should be realistic in terms of features in real structures that affect fatigue strength, such as material type, section thickness, plate preparation, weld type and welding conditions, residual stresses and the nature of the fatigue loading. This Technical Report provides guidance on the production and fatigue testing of specimens representing weld details. Reference is made to other IIW guidance on the fatigue testing of large-scale specimens representing sub-assemblies or structural components (Reference [1]); more detailed guidance on the loading required for variable-amplitude testing is given in Reference [2] and the statistical evaluation of fatigue data in Reference [3].

By its nature, this Technical Report covers two distinct disciplines, welding and mechanical testing. If reliable fatigue data are to be obtained, both need to be truly representative of practical conditions. Thus, the laboratory test specimens need to duplicate actual welded structures and the test conditions need to duplicate real-life loading and operating conditions. Apart from the provision of design data, use of the recommendations in this Technical Report is intended to facilitate comparison of fatigue test data and avoid biased statistics if results obtained from different sources are combined.

Use of this Technical Report is intended to allow, on the one hand, more adequate comparison of the results from different origins (e.g. same welded joint but from another workshop or testing laboratory) and, on the other hand, the plotting of more reliable fatigue curves for design purposes.

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1 Scope

This Technical Report gives guidance on best practice for fatigue testing under constant- or variable-amplitude loading of welded components in the medium- and high-cycle regimes, corresponding to applied loading that results in nominal stresses that do not exceed yield. Low-cycle fatigue testing under strain control is not specifically covered, although the same test specimens can be suitable for either low- or high-cycle fatigue testing. The different steps involved in the manufacture and preparation of the welded specimens and the final presentation and evaluation of the test results are also covered.

This Technical Report does not cover corrosion or high-temperature fatigue testing.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
failure criterion
specimen damage chosen for ending the test

2.2
flank angle
θ
contact angle between the weld face and the plate at the weld toe

2.3
irregularity factor
I
ratio of the number of mean crossings, N_0, with positive slope to number of peaks or valleys in the given load history, N_p

$$I = \frac{N_0}{N_p}$$

NOTE See Figure 1.

2.4 Maxima

2.4.1
maximum load range
ΔF_{max}
maximum load range encountered in a variable-amplitude applied load spectrum

2.4.2
maximum stress range
$\Delta\sigma_{max}$
maximum stress range encountered in a variable-amplitude applied stress spectrum

