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Metallic materials — High strain rate torsion test at room temperature

Matériaux métalliques — Essai de torsion à haute vitesse de déformation à température ambiante

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Foreword

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This document was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*

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Introduction

In many dynamic events, such as punch forming, metal cutting, and vehicle collision, the metallic components are susceptible to dynamic impact loading, in which case the maximum strain rate of the order of 10^4 s^{-1} can be achieved. During this extreme loading condition, the strength of the material can be significantly higher than that under quasi-static loading conditions. The shear mechanical properties of metallic materials, such as yield strength, flow stress and failure strain are essential information for analysis of shear failure of components, and are also the basic data for construction of constitutive relations. The shear mechanical properties of many metallic materials depend also on strain rate as properties under uniaxial load. Therefore, to determine the shear mechanical properties of metallic materials at high strain rates by torsion test is also of great importance for engineering design, structural optimization, processing and evaluation of metallic structures. For additional information see

— ISO 26203-1, and

— ISO 26203-2.

The split Hopkinson (Kolsky) bar is one of the major test methods for measurement of mechanical properties of materials at high strain rates ($\geq 10^2$ s^{-1}). It is designed on the base of two assumptions, namely

a) one-dimensional elastic wave propagation in elastic bars, and

b) uniform distribution of stress–strain along the length of the short test piece.

The fundamental principle is as follows: a small test piece is sandwiched between two long elastic bars, which are used as loading and measuring devices by means of elastic stress wave propagation. On the one hand, the propagating waves on elastic bars load dynamically the test piece; on the other hand the force and displacement measurements of test piece can be calculated by measuring the elastic strain of the bars through gauges attached to the bars. The torsional split Hopkinson bar apparatus, one kind of split Hopkinson bar techniques, can provide solutions for dynamic torsional testing problems and is widely used to obtain accurate stress-strain curves at around 10^3 s^{-1}.

This document provides test method for the torsional split Hopkinson bar apparatus.

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1 Scope

This document specifies terms and definitions, symbols and designations, principle, apparatus, test piece, procedure, data processing, evaluation of test result, test report and other contents for the torsion test at high strain rates for metallic materials by using torsional split Hopkinson bar (TSHB).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 https://www.electropedia.org/

3.1
stress wave
strain wave
propagation of disturbance of stress (or strain) in a medium

Note 1 to entry: When a localized mechanical disturbance is applied suddenly into a deformable solid medium, the disturbance results in the variations of particle velocity, and also the variations of stress and strain states. The variations or disturbances of the stress and strain states propagate to the other parts of the medium in the form of waves. The resulting waves in the medium are due to mechanical stress (or strain) effects and, thus, these waves are called stress wave (or strain) wave.

3.2
elastic stress wave
elastic strain wave
stress wave or strain wave (3.1) propagating in an elastic medium

Note 1 to entry: When loading conditions result in stresses below the yield point of solid medium, the medium behaves elastically, and consequently the *stress wave or strain wave* (3.1) is elastic.

3.3
elastic torsional wave
type of propagation of rotation disturbance inducing shear deformation in elastic medium

Note 1 to entry: The direction of particle movement is perpendicular to the wave propagation direction.

3.4
wave front
moving surface which separates the disturbed from the undisturbed part in a medium

3.5
elastic torsional wave velocity
propagation velocity of *wave front* (3.4) of *elastic torsional wave* (3.3)

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