



SLOVENSKI STANDARD SIST EN ISO 26203-1:2011

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**Kovinski materiali - Natezni preskus pri velikih hitrostih deformacije - 1. del:
Sistem z elastičnim drogom (ISO 26203-1:2010)**

Metallic materials - Tensile testing at high strain rates - Part 1: Elastic-bar-type systems
(ISO 26203-1:2010)

Metallische Werkstoffe - Zugversuch bei hohen Dehngeschwindigkeiten - Teil 1:
Elastische Stoßwellentechnik (ISO 26203-1:2010)

Matériaux métalliques - Essai de traction à vitesses de déformation élevées - Partie 1:
Systèmes de type à barre élastique (ISO 26203-1:2010)

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Metallic materials - Tensile testing at high strain rates - Part 1: Elastic-bar-type systems (ISO 26203-1:2010)

Matériaux métalliques - Essai de traction à vitesses de déformation élevées - Partie 1: Systèmes de type à barre élastique (ISO 26203-1:2010)

Metallische Werkstoffe - Zugversuch bei hohen Dehngeschwindigkeiten - Teil 1: Elastische Stoßwellentechnik (ISO 26203-1:2010)

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Foreword

This document (EN ISO 26203-1:2010) has been prepared by Technical Committee ISO/TC 164 "Mechanical testing of metals" in collaboration with Technical Committee ECISS/TC 101 "Test methods for steel (other than chemical analysis)" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2010, and conflicting national standards shall be withdrawn at the latest by August 2010.

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INTERNATIONAL
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ISO
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**Metallic materials — Tensile testing at
high strain rates —**

Part 1:
Elastic-bar-type systems

*Matériaux métalliques — Essai de traction à vitesses de déformation
élevées —*

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Partie 1: Systèmes de type à barre élastique
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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.

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 26203-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 1, *Uniaxial testing*.

ISO 26203 consists of the following parts, under the general title *Metallic materials — Tensile testing at high strain rates*:

— *Part 1: Elastic-bar-type systems*

— *Part 2: Servo-hydraulic and other test systems*

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Introduction

Tensile testing of metallic sheet materials at high strain rates is important to achieve a reliable analysis of vehicle crashworthiness. During a crash event, the maximum strain rate often reaches 10^3 s^{-1} , at which the strength of the material can be significantly higher than that under quasi-static loading conditions. Thus, the reliability of crash simulation depends on the accuracy of the input data specifying the strain-rate sensitivity of the materials.

Although there are several methods for high-strain rate testing, solutions for three significant problems are required.

The first problem is the noise in the force measurement signal.

- The test force is generally detected at a measurement point on the force measurement device that is located some distance away from the test piece.
- Furthermore, the elastic wave which has already passed the measurement point returns there by reflection at the end of the force measurement device. If the testing time is comparable to the time for wave propagation through the force measurement device, the stress-strain curve may have large oscillations as a result of the superposition of the direct and indirect waves. In quasi-static testing, contrarily, the testing time is sufficiently long to have multiple round-trips of the elastic wave. Thus, the force reaches a saturated state and equilibrates at any point of the force measurement device.
- There are two opposing solutions for this problem.
 - The first solution is to use a short force measurement device which will reach the saturated state quickly. This approach is often adopted in the servo-hydraulic type system.
 - The second solution is to use a very long force measurement device which allows the completion of a test before the reflected wave returns to the measurement point. The elastic-bar type system is based on the latter approach.

The second problem is the need for rapid and accurate measurements of displacement or test piece elongation.

- Conventional extensometers are unsuitable because of their large inertia. Non-contact type methods such as optical and laser devices should be adopted. It is also acceptable to measure displacements using the theory of elastic wave propagation in a suitably-designed apparatus, examples of which are discussed in this document.
- The displacement of the bar end can be simply calculated from the same data as force measurement, i.e. the strain history at a known position on the bar. Thus, no assessment of machine stiffness is required in the elastic-bar-type system.

The last problem is the inhomogeneous section force distributed along the test piece.

- In quasi-static testing, a test piece with a long parallel section and large fillets is recommended to achieve a homogeneous uniaxial-stress state in the gauge section. In order to achieve a valid test with force equilibrium during the dynamic test, the test piece must be designed differently from the typically designed quasi-static test piece. Dynamic test pieces must generally be smaller in the dimension parallel to the loading axis than the test pieces typically used for quasi-static testing.

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The elastic-bar-type system can thus provide solutions for dynamic testing problems and is widely used to obtain accurate stress-strain curves at around 10^3 s^{-1} . The International Iron and Steel Institute developed the “Recommendations for Dynamic Tensile Testing of Sheet Steel” based on the interlaboratory test conducted by various laboratories. The interlaboratory test results show the high data quality obtained by the elastic-bar type system. The developed knowledge on the elastic-bar-type system is summarized in this part of ISO 26203; part 2 of ISO 26203 covers servo-hydraulic and other test systems used for high-strain-rate tensile testing.

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Metallic materials — Tensile testing at high strain rates —

Part 1: Elastic-bar-type systems

1 Scope

This International Standard specifies methods for testing metallic sheet materials to determine the stress-strain characteristics at high strain rates. This part of ISO 26203 covers the use of elastic-bar-type systems.

The strain-rate range between 10^{-3} to 10^3 s⁻¹ is considered to be the most relevant to vehicle crash events based on experimental and numerical calculations such as the Finite Element Analysis (FEA) work for crashworthiness.

In order to evaluate the crashworthiness of a vehicle with accuracy, reliable stress-strain characterization of metallic materials at strain rates higher than 10^{-3} s⁻¹ is essential.

This test method covers the strain-rate range above 10^2 s⁻¹.

NOTE 1 At strain rates lower than 10^{-1} s⁻¹, a quasi-static tensile testing machine that is specified in ISO 7500-1 and ISO 6892-1 can be applied.

NOTE 2 This testing method may be applied to tensile test-piece geometries other than the flat test pieces considered here.

2 Normative references

The following referenced documents are indispensable for the application 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 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

3 Principles

The stress-strain characteristics of metallic materials at high strain rates are evaluated.

At a strain rate higher than 10 s⁻¹, the signal of the loading force is greatly perturbed by multiple passages of waves reflected within the load cell that is used in the quasi-static test. Thus, special techniques are required for force measurement. This may be accomplished in two opposite ways:

- one is to lengthen the force measurement device in the loading direction, in order to finish the measurement before the elastic wave is reflected back from the other end (elastic-bar type systems);
- another way is to shorten the force measurement device, thus reducing the time needed to attain dynamic equilibrium within the force measurement device and realizing its higher natural frequency (servo-hydraulic type systems).