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Earth-moving machinery and machinery for forestry — Operator protective structures — Material performance requirements

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

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.

Introduction

This document provides consistent material performance requirements that can be used with all ISO/TC 127/SC 2 and ISO/TC 23/SC 15 operator protective structure standards, for example ISO 3449, ISO 3471, ISO 10262, ISO 12117, ISO 12117-2, ISO 8082-1, ISO 8082-2, ISO 8083, and ISO 8084. These operator protective structure standards were originally developed with the intent of having the same material performance requirements. Over the course of revising the different operator protective structure standards and creating new operator protective structure standards, modifications to the material performance requirements have resulted in some inconsistencies between the material performance requirements in these standards.

While the first edition of this document only covers material performance requirements for steel structural members, moving the material performance requirements to a separate standard can facilitate the development of performance for other materials such as plastic or aluminium to be included in future revisions.

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Earth-moving machinery and machinery for forestry — Operator protective structures — Material performance requirements

1 Scope

This document specifies the material performance requirements for structural members and fasteners used in operator protective structures for self-propelled earth-moving machinery and self-propelled machinery for forestry. Earth-moving machinery is defined in ISO 6165 and machinery for forestry is defined in ISO 6814.

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 898-2, *Fasteners — Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes*

3 Terms and definitions

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

operator protective structure

OPS

system of *structural members* (3.2) whose purpose is to provide an operator with reasonable protection from hazards related to machine tip-over, machine roll-over, falling objects, or penetrating objects

Note 1 to entry: These structural members can include any subframe, bracket, mounting, socket, bolt, pin, suspension or flexible shock absorber used to secure the system to the machine frame, but can exclude mounting provisions that are integral with the machine frame.

[SOURCE: ISO 6165:2022, 3.1.14, modified — “OPS” added as abbreviated term and Note 1 to entry changed.]

3.2

structural member

operator protective structure (OPS) (3.1) member designed to withstand applied force or absorb energy

Note 1 to entry: Structural members are material independent.

4 Requirements

4.1 General

OPS materials shall meet the requirements given in [Clause 4](#) as applicable.

4.2 Steel requirements

4.2.1 General

Steel structural members shall meet the requirements listed in [4.2.2](#) or [4.2.3](#); or alternatively, the requirements may be met by applying the loadings specified within the applicable OPS test document (e.g. ISO 3471, ISO 3449) with all structural members at, or below, $-18\text{ }^{\circ}\text{C}$.

NOTE 1 Other factors affect impact absorbed energy, e.g. direction of rolling, yield strength, grain orientation and welding. These factors are considered when selecting and using a steel.

NOTE 2 These requirements ensure that the OPS has meaningful resistance to brittle fracture.

NOTE 3 The structural members in the alternative described above, are conditioned to allow the full thickness of the material to reach the test temperature.

4.2.2 Steel structural members

Steel structural members shall be made of steels that meet or exceed one of the Charpy V-notch impact absorbed energy requirements in accordance with [Table 1](#), as tested per ISO 148-1. Either KV_2 or KV_8 hammers may be used in accordance with ISO 148-1.

NOTE The Charpy V-notch evaluation is primarily a quality control check and the indicated temperature does not directly relate to operating conditions.

Specimens are to be “longitudinal” and shall be taken from flat stock, tubular or structural sections before any processing (e.g. forming, welding) for use in the OPS. Specimens from tubular or structural sections shall be taken from the middle of the side of greatest dimension and shall not include weld. For round or tubular sections, the specimen should be taken from a location approximately 90° from the weld.

Table 1 — Minimum Charpy V-notch impact absorbed energy

Specimen size [mm]	Energy requirement [J]	
	at $-30\text{ }^{\circ}\text{C}$	at $-20\text{ }^{\circ}\text{C}$
10×10^a	11,0	27,5
10×9	10,0	25,0
10×8	9,5	24,0
$10 \times 7,5^a$	9,5	24,0
10×7	9,0	22,5
$10 \times 6,7$	8,5	21
10×6	8	20
10×5^a	7,5	19
10×4	7	17,5
$10 \times 3,3$	6	15
10×3	6	15
$10 \times 2,5^a$	5,5	14

^a Indicates preferred size. Specimen size shall be no less than the largest preferred size that the material will permit.

4.2.3 Thin steel structural members

Structural members less than or equal to 4,0 mm in thickness meeting the following shall be considered as meeting the Charpy V-notch impact absorbed energy requirements:

- steel of thickness less than or equal to 2,5 mm having a maximum carbon content of 0,20 %;
- steel of thickness greater than 2,5 mm but less than or equal to 4,0 mm having a maximum carbon content of 0,20 % and fully-killed with a grain size of 5 or finer according to ISO 643 or equivalent.

4.3 Fastener requirements

4.3.1 Bolts

Bolts used as part of the OPS shall be property class 8.8, 9.8 or 10.9 as specified in ISO 898-1, or equivalent.

4.3.2 Nuts

Nuts used as part of the OPS shall be property class 8 or 10 as specified in ISO 898-2, or equivalent.

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- [2] ISO 3449, *Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements*
- [3] ISO 3471, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements*
- [4] ISO 6165, *Earth-moving machinery — Basic types — Identification and vocabulary*
- [5] ISO 6814, *Machinery for forestry — Mobile and self-propelled machinery — Terms, definitions and classification*
- [6] ISO 8082-1, *Self-propelled machinery for forestry — Laboratory tests and performance requirements for roll-over protective structures — Part 1: General machines*
- [7] ISO 8082-2, *Self-propelled machinery for forestry — Laboratory tests and performance requirements for roll-over protective structures — Part 2: Machines having a rotating platform with a cab and boom on the platform*
- [8] ISO 8083, *Machinery for forestry — Falling-object protective structures (FOPS) — Laboratory tests and performance requirements*
- [9] ISO 10262, *Earth-moving machinery — Hydraulic excavators — Laboratory tests and performance requirements for operator protective guards*
- [10] ISO 12117, *Earth-moving machinery — Tip-over protection structure (TOPS) for compact excavators — Laboratory tests and performance requirements*
- [11] ISO 12117-2, *Earth-moving machinery — Laboratory tests and performance requirements for protective structures of excavators — Part 2: Roll-over protective structures (ROPS) for excavators of over 6 t*
- [11] ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*