INTERNATIONAL STANDARD

ISO 3449

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Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements

Engins de terrassement — Structures de protection contre les chutes d'objets — Essais de laboratoire et critères de performance

Reference number
ISO 3449:1992(E)

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.

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.

International Standard ISO 3449 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Sub-Committee SC 2, *Safety requirements and human factors*.

This fourth edition cancels and replaces the third edition (ISO 3449:1984), of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard.

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Introduction

This International Standard provides performance criteria for falling object protective structures (FOPS). It recognizes that there are various classes and sizes of machines that operate in a variety of environmental conditions. Therefore, two levels of acceptance criteria are provided based upon end use. It is intended to assure operators of reasonable protection from falling objects of different sizes and masses under the conditions stated in 4.4.

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Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements

1 Scope

1.1 This International Standard specifies

a) the laboratory tests for measurement of structural characteristics, and

b) the performance requirements in a representive test,

of a falling-object protective structure (FOPS).

1.2 The laboratory tests are a means of testing the characteristics of the structures used to protect the operator from localized impact penetration and, indirectly, of the load-carrying capacity of the supporting structure to resist impact loading.

1.3 This International Standard establishes a consistent, repeatable means of evaluating characteristics of FOPS under loading and prescribes performance requirements for these structures under such loading in a representative test.

NOTE 1 For the purposes of this International Standard, "representative test" means a test of a specimen whose material, dimensional, and processing requirements are typical of those FOPS currently being produced.

1.4 This International Standard applies to the following types of operator-controlled machines, regardless of the type of steering system used, as defined in ISO 6165:

— crawler loaders, wheel loaders and backhoe loaders;

— crawler tractors and wheel tractors;

— graders;

— tractor-scrapers.

1.5 This International Standard does not apply to

— self-propelled compactors;

— drills;

— paving machines;

— machines having a power rating less than 15 kW (20 hp);

— belt loaders;

— excavators;

— cranes;

— drag lines.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 148:1983, *Steel — Charpy impact test (V-notch).*

ISO 898-1:1988, *Mechanical properties of fasteners — Part 1: Bolts, screws and studs.*

ISO 898-2:—[1], *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread.*

1) To be published. (Revision of ISO 898-2:1980)

ISO 3164:1979, *Earth-moving machinery — Laboratory evaluations of roll-over and falling-object protective structures — Specifications for the deflection-limiting volume.*

ISO 3411:1982, *Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope.*

ISO 3471-1:1986, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements — Part 1: Crawler, wheel loaders and tractors, backhoe loaders, graders, tractor scrapers, articulated steer dumpers.*

ISO 6165:1987, *Earth-moving machinery — Basic types — Vocabulary.*

3 Definitions and abbreviations

For the purposes of this International Standard, the following definitions and abbreviations apply.

3.1 falling-object protective structure (FOPS): A system of structural members arranged in such a way as to provide operators with reasonable protection from falling objects (for example, trees, rocks, small concrete blocks, hand tools, etc.).

3.2 roll-over protective structure (ROPS): System of structural members arranged on a machine in such a way as to accomplish its primary purpose of reducing the possibility of an operator, when wearing a seat belt, being crushed should his machine roll over. Structural members include any subframe, bracket, mounting, socket, bolt, pins, suspension or flexible shock absorber used to secure the system to the machine frame but excludes mounting provisions which are integral with the machine frame.

3.3 deflection-limiting volume (DLV): That volume, related to the operator, which serves to set limits and deflections permissible when performing laboratory evaluations of FOPS and ROPS. The volume, an approximation, is based on the seated dimensions of a large operator.

4 General

The following points are stated to aid in understanding the underlying principles, intention and application of this International Standard.

4.1 The FOPS can be integrated in the cab of the operator.

4.2 This evaluation procedure will not necessarily duplicate structural deformations due to a given actual impact of falling objects.

4.3 This evaluation procedure is generally destructive of the FOPS assembly, as permanent deformation is apt to occur.

4.4 Two acceptance levels are defined:

a) level I acceptance is intended for protection from falling bricks, small concrete blocks and hand tools encountered in operations such as highway maintenance, landscaping and other construction site services;

b) level II acceptance is intended for protection from falling trees or rocks for machines involved in site clearing, overhead demolition or forestry.

Although FOPS meeting these criteria do not give crush protection under all circumstances in which the machine could be struck from above, it is expected that penetration protection will be ensured under at least the following conditions: a round object dropped from a height sufficient to develop an energy of 1 365 J (level I) or a blunt object (see figure 1) dropped from a height sufficient to develop an energy of 11 600 J (level II).

NOTE 2 Drop height of a standard object is defined as a function of its mass. See figure 3.

4.5 The material temperature requirement of 6.3 is intended to be a base-line of measurement for testing, to ensure that the FOPS will have meaningful resistance to brittle fracture; it does not necessarily relate to operating conditions.

4.6 Because, in an actual situation involving a falling object, loading will be dynamic (possibly impact), the use of conventional "safety factors" based on static force loading should be treated with caution. The "safety factor" of a FOPS is related more to energy absorption capability and details of weld design and welding procedure than it is to static force resistance.

5 Laboratory tests

5.1 Apparatus

5.1.1 Solid steel or ductile iron or other sphere, having a mass of 45 kg (level I), with the sphere diameter not exceeding 250 mm or a **standard laboratory drop test object**, made of steel as shown in figure 1 (level II).

An optional drop test object is a sphere or ball with a maximum diameter of 400 mm and with the capability of developing an energy of 11 600 J for level II.