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**Building construction machinery  
and equipment — Self-loading  
mobile concrete mixers — Safety  
requirements and verification**

*Machines et matériels pour la construction des bâtiments —  
Malaxeurs à béton mobiles avec autochargeur — Exigences de  
sécurité et vérification*

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Published in Switzerland

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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 documents 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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*, Subcommittee SC 1, *Machinery and equipment for concrete work*.

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](http://www.iso.org/members.html).

## Introduction

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in the case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

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# Building construction machinery and equipment — Self-loading mobile concrete mixers — Safety requirements and verification

## 1 Scope

This document specifies general safety requirements for self-loading mobile concrete mixers (hereafter referred to as “machines”) as defined in ISO 18650-1:2021, with rigid or articulated wheeled chassis.

This document applies to machines which are designed for front or rear loading and are provided with a swinging frame where the rotating drum and the self-loading equipment (lift arms and bucket) are mounted on. Machines are also fitted with accessories such as water dosing means and a weighing system.

This document deals with all significant hazards, hazardous situations and events relevant to the machine when used as intended or under conditions of misuse reasonably foreseeable by the manufacturer.

This document is not applicable to the following:

- a) machines designed primarily for earth moving, such as loaders or dumpers (see applicable parts of the ISO 20474 series);
- b) truck mixers.

This document does not address hazards that can occur:

- during manufacture;
- when using machines on public roads, where specific local road regulations can apply;
- when operating in potentially explosive atmospheres.

This document is not applicable to machines manufactured before the date of its publication.

## 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 2860:1992, *Earth-moving machinery — Minimum access dimensions*

ISO 2867:2011, *Earth-moving machinery — Access systems*

ISO 3164:2013, *Earth-moving machinery — Laboratory evaluations of protective structures — Specifications for deflection-limiting volume*

ISO 3411:2007, *Earth-moving machinery — Physical dimensions of operators and minimum operator space envelope*

ISO 3449:2005, *Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements*

## ISO 6085:2023(E)

ISO 3450:2011, *Earth-moving machinery — Wheeled or high-speed rubber-tracked machines — Performance requirements and test procedures for brake systems*

ISO 3457:2003, *Earth-moving machinery — Guards — Definitions and requirements*

ISO 3471:2008, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements*

ISO 3776-1:2006, *Tractors and machinery for agriculture — Seat belts — Part 1: Anchorage location requirements*

ISO 3776-2:2013, *Tractors and machinery for agriculture — Seat belts — Part 2: Anchorage strength requirements*

ISO 3776-3:2009, *Tractors and machinery for agriculture — Seat belts — Part 3: Requirements for assemblies*

ISO 3795:1989, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 5006:2017, *Earth-moving machinery — Operator's field of view — Test method and performance criteria*

ISO 5010:2019, *Earth-moving machinery — Wheeled machines — Steering requirements*

ISO 6011:2003, *Earth-moving machinery — Visual display of machine operation*

ISO 6395:2008, *Earth-moving machinery — Determination of sound power level — Dynamic test conditions*

ISO 6396:2008, *Earth-moving machinery — Determination of emission sound pressure level at operator's position — Dynamic test conditions*

ISO 6682:1986, *Earth-moving machinery — Zones of comfort and reach for controls*

ISO 6682:1986/Amd 1:1989, *Earth-moving machinery — Zones of comfort and reach for controls — Amendment 1*

ISO 6683:2005, *Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests*

ISO 6750-1:2019, *Earth-moving machinery — Operator's manual — Part 1: Contents and format*

ISO 7000:2019, *Graphical symbols for use on equipment — Registered symbols*

ISO 7096:2020, *Earth-moving machinery — Laboratory evaluation of operator seat vibration*

ISO 9244:2008, *Earth-moving machinery — Machine safety labels — General principles*

ISO 9244:2008/Amd 1:2016, *Earth-moving machinery — Machine safety labels — General principles — Amendment 1*

ISO 9533:2010, *Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria*

- ISO 10263-3:2009, *Earth-moving machinery — Operator enclosure environment — Part 3: Pressurization test method*
- ISO 10263-4:2009, *Earth-moving machinery — Operator enclosure environment — Part 4: Heating, ventilating and air conditioning (HVAC) test method and performance*
- ISO 10264:1990, *Earth-moving machinery — Key-locked starting systems*
- ISO 10532:1995, *Earth-moving machinery — Machine-mounted retrieval device — Performance requirements*
- ISO 10532:1995/Amd 1:2004, *Earth-moving machinery — Machine-mounted retrieval device — Performance requirements — Amendment 1*
- ISO 10533:1993, *Earth-moving machinery — Lift-arm support devices*
- ISO 10533:1993/Amd 1:2005, *Earth-moving machinery — Lift-arm support devices — Amendment 1*
- ISO 10570:2004, *Earth-moving machinery — Articulated frame lock — Performance requirements*
- ISO 10968:2020, *Earth-moving machinery — Operator's controls*
- ISO 11112:1995, *Earth-moving machinery — Operator's seat — Dimensions and requirements*
- ISO 11112:1995/Amd 1:2001, *Earth-moving machinery — Operator's seat — Dimensions and requirements — Amendment 1*
- ISO 11862:1993, *Earth-moving machinery — Auxiliary starting aid electrical connector*
- ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- ISO 12508:1994, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*
- ISO 12509:2004, *Earth-moving machinery — Lighting, signalling and marking lights, and reflex-reflector devices*
- ISO 13766-1:2018, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 1: General EMC requirements under typical electromagnetic environmental conditions*
- ISO 13766-2:2018, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 2: Additional EMC requirements for functional safety*
- ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design*
- ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*
- ISO 14120:2015, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*
- ISO 14990-1:2016, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 1: General requirements*
- ISO 14990-2:2016, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 2: Particular requirements for externally-powered machines*
- ISO 14990-3:2016, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 3: Particular requirements for self-powered machines*
- ISO 15817:2012, *Earth-moving machinery — Safety requirements for remote operator control systems*

ISO 15818:2017, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements*

ISO 16528-1:2007, *Boilers and pressure vessels — Part 1: Performance requirements*

ISO 16528-2:2007, *Boilers and pressure vessels — Part 2: Procedures for fulfilling the requirements of ISO 16528-1*

ISO 18650-1:2021, *Building construction machinery and equipment — Concrete mixers — Part 1: Commercial specifications*

ISO 21507:2010, *Earth-moving machinery — Performance requirements for non-metallic fuel tanks*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60529:1989/AMD1:1999, *Amendment 1 - Degrees of protection provided by enclosures (IP Code)*

IEC 60529:1989/AMD2:2013, *Amendment 2 - Degrees of protection provided by enclosures (IP Code)*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010, ISO 18650-1:2021 and the following 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

##### **self-loading equipment**

integral mounted bucket-supporting structure and linkage permanently fitted to the machine, enabling it to fill its own rotating drum with material

[SOURCE: ISO 20474-6:2017, 3.6, modified — In the definition, "dumper" has been replaced by "machine"; "open body" has been replaced by "rotating drum".]

#### 3.2

##### **operating mass**

mass of the machine, with rotating drum and *self-loading equipment* (3.1) empty, and with the operator (75 kg), full fuel tank and all fluid systems (i.e. hydraulic oil, transmission oil, engine oil, engine coolant) at the levels specified by the manufacturer and with empty water tank(s)

## 4 Safety requirements, protective measures and risk reduction

### 4.1 General

Machines shall conform to the safety requirements and protective and risk reduction measures stated in this clause. In addition, the machines shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document.

### 4.2 Access systems

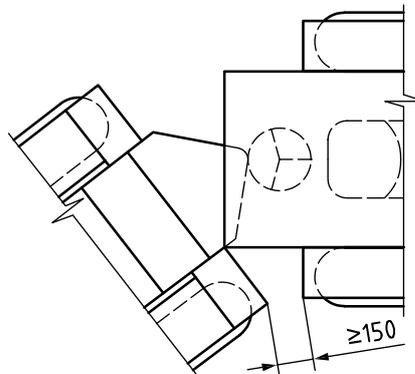
#### 4.2.1 General requirements

Access systems shall be provided to the operator's station(s) and to routine maintenance points. Access systems shall conform to ISO 2867:2011.

#### 4.2.2 Access to articulated machines

On machines with articulated frames and in the fully articulated steering position, a minimum clearance of 150 mm shall be provided between firm structures and components with relative movement in the path of the access systems to the operator's station, as illustrated in [Figure 1](#).

Dimensions in millimetres



**Figure 1 — Minimum clearance for access to operator's station on machines with articulated frame**

### 4.3 Operator's station

#### 4.3.1 General requirements

##### 4.3.1.1 Machinery equipment

Machines with a ready-concrete capacity greater than 2,5 m<sup>3</sup> shall have the possibility of being fitted with a cab.

##### 4.3.1.2 Minimum space

The minimum space available to the operator shall be as defined in ISO 3411:2007, with the following exceptions:

- dimension  $R_1$  as defined in ISO 3411:2007, Table 1, may be reduced to a minimum of 920 mm;
- the internal operator's space envelope width from the lower end of upper side walls of enclosure as defined in ISO 3411:2007 may be reduced to a minimum of 650 mm.

The minimum space and location of the controls at the operator's station shall meet the requirements of ISO 6682:1986 and ISO 6682:1986/Amd 1:1989.

##### 4.3.1.3 Moving parts

The machine shall be designed so as to avoid accidental contact from the operating position with moving parts (e.g. wheels, tracks, working equipment, attachments) in accordance with [4.13.2](#).

##### 4.3.1.4 Engine exhaust

The engine exhaust system shall release the exhaust gas away from the operator and the air inlet of the cab.

## 4.3.1.5 Instruction storage

A space intended for the safekeeping of the operator's manual and other instructions shall be provided near the operator's station.

## 4.3.1.6 Sharp edges

The operator's working space within the operator's station (e.g. ceiling, inner walls, instrument panels, access to the operator's station) shall not present any sharp exposed edges or acute angles/corners. The radius of corners and the bluntness of edges shall conform to ISO 12508:1994, in order to avoid sharp edges (see also [4.13.5](#)).

## 4.3.2 Operator's station equipped with a cab

### 4.3.2.1 Climatic conditions

The cab shall protect the operator against foreseeable adverse climatic conditions. Provisions shall be made to install a ventilation system, an adjustable heating system and a system for defrosting windows. For details, see [4.3.2.5](#) to [4.3.2.7](#).

### 4.3.2.2 Pipes and hoses

Pipes and hoses that contain fluids at pressures exceeding 5 MPa or temperatures above 60 °C located inside the cab shall be guarded in accordance with ISO 3457:2003, Clause 9. See also [4.16.3](#).

Parts or components placed between pipes or hoses and the operator, which divert a hazardous spray of fluid, may be considered as a sufficient protection device.

### 4.3.2.3 Primary opening

A primary access opening shall be provided. The dimensions shall be in accordance with ISO 2867:2011.

### 4.3.2.4 Alternative opening

An alternative opening shall be provided on a side other than that of the primary opening. The dimensions shall be in accordance with ISO 2867:2011. A window panel or another door is acceptable if they are easy to open or remove without the use of keys or tools. Latches may be used if they can be opened from the inside without the use of keys or tools. The breaking of a suitable size of glass pane is considered to represent a suitable alternative opening, provided that the necessary pane hammer, immediately accessible to the operator, is provided and stored in the cab.

When the window panel is used as an emergency exit, it shall bear an appropriate marking. For example, see ISO 7010-E001 or ISO 7010-E002.

### 4.3.2.5 Heating system

A heating system, if fitted, shall conform to ISO 10263-4:2009. If the cab is not equipped with a pressurization system then ISO 10263-4:2009, 6.1.1 is not applicable.

### 4.3.2.6 Ventilation system

The ventilation system shall be capable of providing the cab with fresh air at a minimum of 43 m<sup>3</sup>/h.

### 4.3.2.7 Defrosting system

A defrosting system shall provide facilities for defrosting the front and rear windows, for example, by means of a heating system or a particular defrosting device.

A test method for windscreen defrosting systems is given in ISO 10263-5.

#### 4.3.2.8 Pressurization system

Where a cab is provided with a pressurization system, it shall be tested according to ISO 10263-3:2009 and shall provide an interior relative pressure of at least 50 Pa.

#### 4.3.2.9 Doors and windows

Doors, windows and flaps shall be securely held in their intended operating positions. Doors shall be retained at their intended operating positions by a positive engagement device in accordance with ISO 2867:2011, 5.6.

Windows shall be made of safety glass or other material that provides similar safety performance (see, for example, ECE R43).

The front window shall be fitted with motorized windscreen wipers and washers.

The rear window shall be fitted with motorized windscreen wipers and washers if direct or indirect visibility in this direction is required by the visibility requirements in 4.8.

#### 4.3.2.10 Interior lighting

The cab shall be fitted with a fixed interior lighting system and shall be able to function with the engine stopped, so that it is possible to illuminate the operator's station such that the operator's manual can be read.

### 4.3.3 Operator-protective structures

#### 4.3.3.1 General

Operator-protective structures shall conform to 4.3.3.2 and 4.3.3.3, except that structural members of the falling-object protective structure (FOPS) and the roll-over protective structure (ROPS) and the mounts which attach them to the machine frame when made from steel shall have one of the following Charpy V-notch impact strengths (see ISO 148-1 and ISO 148-2):

10 mm × 10 mm specimen: 11 J at -10 °C

10 mm × 7,5 mm specimen: 9,5 J at -10 °C

10 mm × 5 mm specimen: 7,5 J at -10 °C

10 mm × 2,5 mm specimen: 5,5 J at -10 °C

#### 4.3.3.2 Roll-over protective structure (ROPS)

Machines shall be equipped with a roll-over protective structure (ROPS). The ROPS shall conform to ISO 3471:2008. [Table 1](#) shall be applied to determine the values to be met when testing the ROPS.

Table 1 — Force and energy equations

Lateral load force, $F_L$	Lateral load energy, $U$	Vertical load force, $F_V$	Longitudinal load force, $F_L$
$60\,000 \left[ \frac{0,66(M + M_C)}{10\,000} \right]^{1,2}$	$12\,500 \left( \frac{M + 0,25M_C}{10\,000} \right)^{1,25}$	$19,61 \frac{(M + M_C)}{2}$	Not applicable
Key			
$M$ machine operating mass			
$M_C$ ready-concrete mass considering a concrete density of 2 300 kg/m <sup>3</sup>			

The test procedure of ISO 3471:2008 may be modified for lateral loading by ISO 3164:2013, 4.4.

#### 4.3.3.3 Falling-object protective structure (FOPS)

Machines shall be equipped with a falling-object protective structure (FOPS). The fitted FOPS shall be in accordance with level I of ISO 3449:2005.

### 4.4 Operator's seat

#### 4.4.1 General requirements

Machines shall be fitted with an adjustable seat that supports the operator in a position that allows the operator to control the machine under the intended operating conditions.

#### 4.4.2 Dimensions

The seat dimensions shall be in accordance with ISO 11112:1995 and ISO 11112:1995/Amd 1:2001.

#### 4.4.3 Adjustment

All adjustments to accommodate the operator's size shall conform to ISO 11112:1995 and ISO 11112:1995/Amd 1:2001 with the exception that the fore and aft adjustment may be reduced to  $\pm 35$  mm and the vertical adjustment is not required. Adjustments shall be possible without the use of any tool.

#### 4.4.4 Vibration

Suspended operator's seats shall meet the requirements of input spectral class EM1 or EM7 according to ISO 7096:2020 with regard to its ability to reduce the vibration transmitted to the operator.

#### 4.4.5 Restraint system

Machines shall have an operator restraint system in accordance with ISO 6683:2005 or ISO 3776-1:2006, ISO 3776-2:2013 and ISO 3776-3:2009, or equivalent.

### 4.5 Operator's controls and indicators

#### 4.5.1 General

The controls (hand levers, joysticks, pedals, switches, etc.) of the machine shall be chosen, designed, constructed and arranged in accordance with ISO 10968:2020 and the following requirements:

- the normal engine stop device shall be within the zone of reach as defined by ISO 6682:1986 and ISO 6682:1986/Amd 1:1989;

- when a control such as a keyboard or joystick control is designed and constructed to carry out several functions, the activated functions shall be clearly identified.

#### 4.5.2 Starting and stopping system

Machines shall be equipped with a starting and stopping device (e.g. key). The starting system shall conform to ISO 10264:1990 or have similar protection against unauthorized use.

Machines shall be so designed that movement of the machine shall not be possible, while starting or stopping the engine, without activating the controls.

#### 4.5.3 Inadvertent activation

Controls that can cause a hazard due to inadvertent activation shall be so arranged, deactivated or guarded as to minimize the risk — particularly while the operator is getting into or out of the operator's station. The deactivation device shall either be self-acting or shall act by compulsory actuation of the relevant device.

#### 4.5.4 Pedals

Pedals shall be of an appropriate size, shape and shall be adequately spaced. They shall have a slip-resistant surface and be easy to clean.

If the pedals of a machine have the same function (clutch, brake, and accelerator) as on a motor vehicle, they shall be arranged in the same manner to avoid the risk of confusion.

#### 4.5.5 Emergency loading equipment lowering

In case of a failure which does not permit to use the normal controls, it shall be possible to:

- lower the loading equipment to the ground;
- see the loading equipment lowering from the operator actuating position of the lowering control.

The means to lower the loading equipment may be located outside the operator's station and shall be described in the operation manual.

#### 4.5.6 Uncontrolled motion

Machine and loading equipment movement from the holding position due to drift or creep (e.g. by leaking) or when power supply stops, shall be limited to the extent that it cannot create a risk to exposed persons. This movement excludes actuation of the controls by the operator.

#### 4.5.7 Multiple operating positions

The use of the controls at one operating position shall preclude the use of the controls at the other operating positions, except the emergency stop and the water pump control.

Each additional operating position shall be provided with an emergency stop conforming to ISO 13850:2015. The emergency stop shall function in accordance with stop category 0.

Remote operator control systems used on machines shall be in accordance with ISO 15817:2012.

Means shall be provided to prevent hazardous movements of machines equipped with a reversible operating position during the changing of the operating position.

## 4.5.8 Visual displays, control panels, indicators and symbols

### 4.5.8.1 Visual displays and control panels

The operator shall be able to see from the operator's station, in either daylight or darkness, the necessary indicators allowing a check of the proper function of the machine. Glare shall be minimized.

### 4.5.8.2 Operating instrumentation

Control indicators for the safe and proper operation of the machine shall be in accordance with ISO 6011:2003 with respect to the use of colours and related aspects.

### 4.5.8.3 Symbols

Symbols used on visual displays and controls shall be in accordance with ISO 7000:2019.

### 4.5.8.4 Controls accessible from ground level

Controls that are not intended to be operated from the ground shall have means to minimize the possibility of actuating the controls from the ground.

EXAMPLE Protection by door, guard locking or interlocking systems.

## 4.6 Steering systems

### 4.6.1 General

The steering system shall be such that the movement of the steering control corresponds to the intended direction of steering.

For machines equipped with a swivelling seat (180°), the steering system shall be such that the movement of the steering control corresponds to the intended direction in both seat positions.

### 4.6.2 Wheeled machines

The steering system of machines with a travel speed greater than 20 km/h shall be in accordance with ISO 5010:2019, except that:

- the steering effort for normal steering test shall not exceed 250 N;
- the steering effort for secondary steering test shall not exceed 600 N or 350 N per hand in case of a steering wheel.

## 4.7 Brake systems

Machines shall be equipped with a service brake system, a secondary brake system and a parking brake system in accordance with requirements for rigid-frame dumpers or articulated-frame dumpers in ISO 3450:2011.

## 4.8 Visibility

### 4.8.1 Operator's field of view

Machines shall be designed so that the operator has sufficient visibility from the operator's station in relation to the travel and work areas of the machine necessary for its intended use. The performance criteria shall be in accordance with ISO 5006:2017 and [Table 2](#).

The machine shall be positioned on the test surface with the loading equipment located in the travel mode according to the manufacturer's specification (see ISO 5006:2017, 6.3).

**Table 2 — Visibility performance criteria and allowed eye spacing**

Dimensions in millimetres

Ready-concrete capacity (m <sup>3</sup> )	A	B	C	D	E	F	RB
<2,5	65	205	205	No specific criteria	No specific criteria	65	405
	0	1 × 1 300	1 × 1 300			1 × 1 500	300 and 1 × 400 <sup>a</sup>
≥2,5	65	205	205	No specific criteria	No specific criteria	65	405
	0	1 × 2 000	1 × 2 000			1 × 3 000	300 and 2 × 400 <sup>a</sup>

NOTE 1 No specific criteria are specified in this table when no significant hazards exist for the machine sector, e.g. due to machine speed, distance to the test circle, machine manoeuvrability.

NOTE 2 Sectors A to F and RB are defined in ISO 5006:2017.

NOTE 3 The first row is the allowed eye spacing. The second row is the allowed number and width of maskings.

<sup>a</sup> These requirements apply across sectors D, E, F.

#### 4.8.2 Lighting, signalling and marking lights, and reflex-reflector devices

Work lamps and reflex-reflector devices shall be provided in accordance with ISO 12509:2004. Lighting, signalling and marking lights, if provided, shall conform to the appropriate clauses of ISO 12509:2004.

#### 4.9 Warning devices and safety signs

Machines shall be equipped with:

- an audible warning device (horn) controlled from the operator's station and tested in accordance with ISO 9533:2010;
- safety signs and hazard pictorials in accordance with ISO 9244:2008 and ISO 9244:2008/Amd 1:2016.

#### 4.10 Tyres and rims

Machines shall have tyre and rim load performance adapted to the machine's purpose and application.

Rims shall have clear identification. See ISO 4250-3 for an example.

#### 4.11 Stability

Machines shall be designed and constructed so that stability is provided under all intended operating conditions including maintenance, assembling, dismantling, and transportation, as specified by the manufacturer in the operation manual.

Devices (e.g. outriggers, oscillating axle locking) intended to increase the stability of machines in working mode shall be fitted with interlocking devices or check valves which keep them in position in case of hose failure or in case of oil leakage.

## 4.12 Noise

### 4.12.1 Requirements for noise reduction

When designing machines, the available information and technical measures to control noise at source shall be taken into account.

NOTE Recommended practice for the design of low-noise machinery is given in ISO/TR 11688-1, while ISO/TR 11688-2 gives useful information on noise generation mechanisms in machinery.

### 4.12.2 Noise emission measurement

#### 4.12.2.1 Sound power level

The sound power level for the machine shall be measured according to ISO 6395:2008 and [4.12.2.3](#).

#### 4.12.2.2 Emission sound pressure level at the operator's station

The emission sound pressure level at the operator's station(s) shall be measured according to ISO 6396:2008 and [4.12.2.3](#).

#### 4.12.2.3 Measurement conditions

The following requirements shall be applied to determine the noise emission of machines.

- a) The basic length,  $l$ , of the machine shall be determined disregarding the load lifting equipment.
- b) The drum shall be filled to its maximum capacity with 0 mm to 3 mm size sand with humidity between 4 % and 10 %.
- c) The measurement time shall not be less than 15 s.
- d) The drum shall rotate at the maximum rotational speed indicated by the manufacturer for the mixing mode.
- e) The transmission shall be set in neutral position.

## 4.13 Protective measures and devices

### 4.13.1 Hot parts

Parts which become hot in operation shall be designed, constructed, positioned or provided with a thermal guard to minimize the risk of contact with hot parts or hot surfaces in close proximity to the primary opening, operating position and maintenance area, in accordance with ISO 3457:2003.

For ergonomic data that can be used to establish temperature limit values for hot surfaces, see ISO 13732-1.

### 4.13.2 Moving parts

All moving parts that create a hazard shall be designed positioned or provided with protection to minimize the risk of crushing, shearing and cutting. ISO 13857:2019 shall be used in respect to safety distances to prevent hazard zones being reached.

Tempered glass does not fulfil the requirements of a protective device where a risk of crushing, shearing and cutting exist.

#### 4.13.3 Guards

Guards shall be in accordance with ISO 3457:2003.

Engine compartment panels are regarded as guards.

Movable guards shall be provided with means to remain in an open position up to a wind speed of 8 m/s.

Fixed guards that are to be removed as a part of routine maintenance procedures described in the operator's manual shall be fixed by systems that can be opened or removed only with tools. These guard-fixing systems shall remain attached to the guards or to the machinery when the guards are removed.

Where possible, fixed guards shall be unable to remain in place without their fixings.

#### 4.13.4 Articulated frame lock

Articulated machines shall be equipped with an articulated frame lock according to ISO 10570:2004.

#### 4.13.5 Sharp edges and acute angles

Sharp edges and acute angles shall be in accordance with ISO 12508:1994 in those areas that can be accessed during operation and routine maintenance, except for the area of the self-loading equipment necessary for the self-loading equipment to provide its function. See also [4.3.1.6](#).

#### 4.13.6 Fenders

Machines with a design speed according to ISO 6014, greater than 25 km/h, shall be provided with fenders in accordance with ISO 3457:2003.

Machines with a design speed according to ISO 6014, equal to or less than 25 km/h, shall be provided with fenders, if required, in accordance with ISO 3457:2003.

### 4.14 Retrieval, transportation, lifting and towing

#### 4.14.1 Common use

Points for retrieval, tying-down, lifting and towing may be the same if allowed by the configuration of the machine.

#### 4.14.2 Retrieval

Retrieval points shall be provided at the front or rear of the machines in accordance with ISO 10532:1995 and ISO 10532:1995/Amd 1:2004.

#### 4.14.3 Tying-down

Tying-down attachment points shall be in accordance with ISO 15818:2017.

#### 4.14.4 Lifting

Lifting attachment points shall be in accordance with ISO 15818:2017.

#### 4.14.5 Off-road towing

A towing point (e.g. hook, ear), if provided on the machine, shall be in accordance with ISO 10532:1995 and ISO 10532:1995/Amd 1:2004. The location, the permissible forces and the correct use when towing

another object (for example, scraper, disc, trailer), as well as the maximum towing speed and distance shall be clearly specified in the operator's manual.

#### **4.14.6 Transportation**

Moveable parts (e.g. load lifting equipment) that can cause a hazard during transportation or travelling shall have a means to be secured in their transport position.

Instructions for secure locking shall be provided in the operator's manual.

### **4.15 Electrical and electronic systems**

#### **4.15.1 General**

Electrical components and conductors shall be installed in such a way as to avoid damage from exposure to environmental conditions (corresponding to the intended use of the machine) that can cause deterioration.

Electrical component insulation shall have flame-retardant properties. Lead-through (for example, through frames and bulkheads) shall be protected from abrasion.

Electrical wires/cables not protected by over-current devices shall not be strapped in direct contact with pipes or hoses containing fuel.

Machines shall conform to the EMC requirements given in ISO 13766-1:2018 and ISO 13766-2:2018.

Machine utilizing on-board voltages in the ranges of 50 V to 36 kV AC r.m.s. (root mean square) and 75 V to 36 kV DC shall be in accordance with ISO 14990-1:2016, ISO 14990-2:2016 and ISO 14990-3:2016 as applicable.

#### **4.15.2 Degree of protection**

Depending on the location/installation of electrical and electronic components, the following degrees of protection are required:

- a) all components installed exterior to the machine or directly exposed to the environment shall have a minimum degree of protection in accordance with IEC 60529:1989, IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013, IP 55;
- b) all components installed in the operator's cab or protected against the environment, the protection shall be designed and executed to safeguard a correct function under expected and intended conditions.

Electronic controls, connectors in control circuits, multi-pin connectors and control switches external to the cab, shall have a minimum protection of IP 55.

#### **4.15.3 Electrical connections**

In order to avoid incorrect connections, electrical wires and cables used to connect components in electric circuits shall be marked and identified. ISO 9247 should be used as guidance.

This requirement does not apply to the electrical circuits of anti-theft systems.

#### **4.15.4 Over-current protective devices**

Unless specifically designed to be unfused (e.g. starter motor, alternator, pre-heater), the fusing for the electrical equipment shall be as close as practical to the source. The protecting device for the load centre (e.g. fuse box, relay box) shall be near or adjacent to the battery. Protection devices should be sized to protect the wire sizes attached to them. If a harness is split (separated into multiple wires), then the

protection device shall also be placed immediately after the point of the split, unless protection device amperage rating prior to the split is sufficiently low to protect the wire sizes after the split.

#### 4.15.5 Batteries

The battery location should have an easy access. Batteries should be easily removable.

Batteries shall be firmly attached in a ventilated space. The batteries shall be provided with measures for safe handling.

Batteries and battery locations shall be designed and built or covered to minimize any hazard to the operator caused by battery acid or acid vapours in the event of a machine overturn.

Live parts (not connected to the frame) and connectors shall be covered with insulation material.

#### 4.15.6 Battery disconnection

It shall be possible to disconnect batteries easily (e.g. quick coupling, accessible isolator switch). The symbol ISO 7000-2063 shall be used for identification. See [Figure 2](#).



Figure 2 — Battery disconnection symbol (ISO 7000-2063)

The disconnection system shall be capable of being locked (e.g. padlock) if reconnection can endanger persons.

#### 4.15.7 Electrical connectors for auxiliary starting aids

If electrical connectors for auxiliary starting aids or power supply are mounted on the machine, the connectors shall be in accordance with ISO 11862:1993.

#### 4.15.8 Electric sockets for lighting

An electric socket intended for the connection of a lighting device for maintenance use shall be provided on the machine and shall be easily accessible.

Voltage of electrical socket shall be marked.

The design of the sockets shall prevent incorrect connection.

### 4.16 Pressurized systems

#### 4.16.1 General requirements

Pressurized equipment shall be designed in accordance with ISO 4413:2010 or ISO 4414:2010 as appropriate.

#### 4.16.2 Hydraulic lines

Hydraulic lines (e.g. pipes, hoses and fittings) shall be located and, if necessary, restrained so as to minimize deterioration, e.g. through contact with hot surfaces, sharp edges and other damage causing sources. Visual inspection of hydraulic lines, other than those located inside frames, shall be possible.

#### 4.16.3 Hydraulic hose assemblies

Hydraulic hose assemblies containing fluid at a pressure of more than 5 MPa (50 bar) or at a temperature of more than 60 °C, and which are located within 1,0 m from any surface of the deflection limiting volume (DLV) as defined in ISO 3164:2013, shall be guarded in accordance with ISO 3457:2003 (see also [4.3.2.2](#)).

Any part or component that diverts a possible jet of fluid may be regarded as providing sufficient protection.

Hydraulic hose assemblies intended to withstand a pressure of more than 15 MPa (150 bar) shall not be fitted with reusable fittings, unless they require the use of dedicated tooling (such as a press) and are parts authorized by the manufacturer of the machine.

#### 4.16.4 Air pressure vessels

Simple pressure vessels shall be designed and tested in accordance with ISO 16528-1:2007 and ISO 16528-2:2007.

### 4.17 Fuel tanks and hydraulic oil tanks

#### 4.17.1 General requirements

Fuel and hydraulic tanks shall be provided with a fluid level indicator. Pressure in the tanks exceeding the specified pressure shall be automatically compensated by a suitable device (vent, safety valve, etc.).

#### 4.17.2 Filler openings

Filler openings of tanks (except window washer tanks) shall:

- a) be easily accessible for filling;
- b) have provisions for lockable filler caps except for filler caps located inside lockable compartments (e.g. engine compartment) or caps that can only be opened with a special tool;
- c) be located outside the cab.

#### 4.17.3 Fuel tanks

Non-metallic fuel tanks shall meet the requirements of ISO 21507:2010.

Metallic fuel tanks shall meet the strength test, including the elevated pressure and temperature test if required, and the inversion test in accordance with ISO 21507:2010.

### 4.18 Fire protection

#### 4.18.1 Fire resistance

The interior, upholstery and insulation of the cab and other parts of the machine where insulation materials are used shall be made of flame-retardant materials. The burning rate shall not exceed 200 mm/min, tested in accordance with ISO 3795:1989.

#### 4.18.2 Fire extinguisher

Machines with a ready-concrete capacity greater than 2,5 m<sup>3</sup> shall have space for the installation of a fire extinguisher, easily accessible to the operator.

## 4.19 Rotating drum and related equipment

### 4.19.1 General

The rotating drum shall not present any exposed parts that can cause a hazard during rotation. Those parts which can be reached by an operator on the ground shall have a minimum distance of 40 mm from the drum. This distance may be reduced if such parts are fitted with an additional guard providing for a maximum opening of 10 mm.

The drum shall be marked with visual indications (e.g. stripes of a different colour) to clear warning when it is rotating.

An alternative opening accessible from the outside with the use of tools shall be provided on the drum to discharge material in case of failure. It shall have a diameter not exceeding 350 mm.

### 4.19.2 Rollers

Rollers which can be reached by an operator on the ground shall be provided with guards conforming to ISO 14120:2015, with maximum openings of 10 mm.

### 4.19.3 Loading equipment

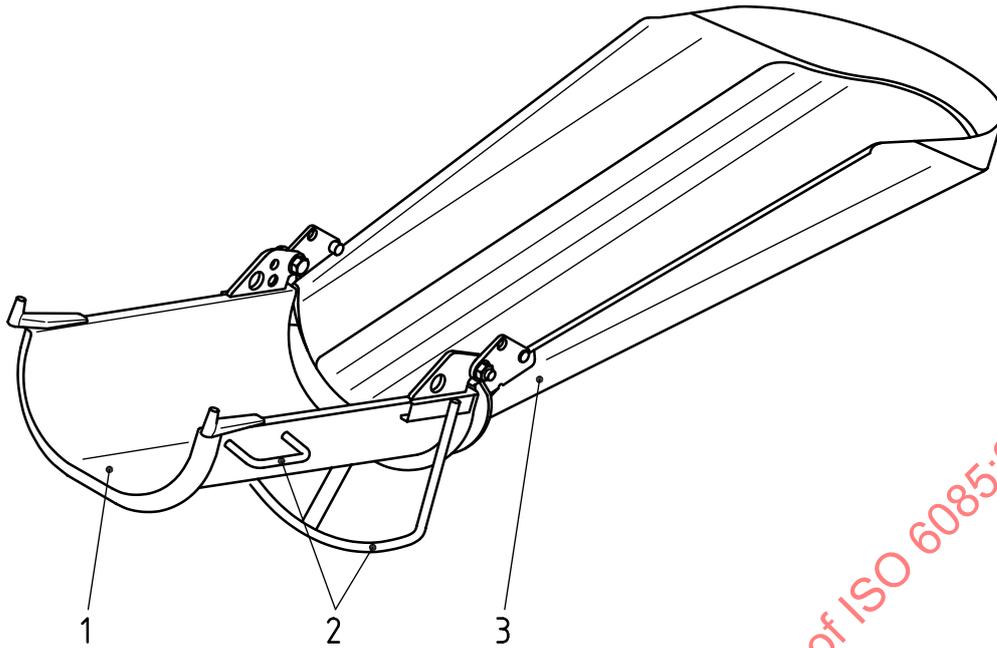
Means shall be provided to prevent inadvertent lowering of the lift arms.

The maximum lowering speed of the outer part of the loading equipment in the event of failure to the hydraulic hoses shall be less than 0,75 m/s, measured in unladen condition.

### 4.19.4 Discharging chute

It shall be possible to easily direction the discharging chute by manual or hydraulic means.

Foldable chutes shall be lockable in the folded position and they shall be equipped with handles to prevent crushing of the operator's fingers during use (see [Figure 3](#)).



**Key**

- 1 foldable part
- 2 handles
- 3 fixed part

**Figure 3 — Example of foldable chute**

**4.19.5 Cleaning system**

Machines shall be equipped with a built-in system for drum cleaning.

**4.20 Maintenance**

**4.20.1 General**

Machines shall be designed and built so that routine lubrication and maintenance operations can be carried out safely, whenever possible with the engine stopped. Where it is only possible to undertake checks or maintenance with the engine running, the safe procedure shall be described in the operator's manual.

Openings intended for maintenance purposes shall conform to ISO 2860:1992.

If practical, the design of the machine shall permit lubrication and filling of tanks from the ground.

**4.20.2 Routine maintenance**

Components that require routine maintenance shall be easily accessible for checking and changing.

A lockable storage box shall be provided on the machine for tools and accessories as recommended by the manufacturer.

**4.20.3 Support devices**

Machines which require the equipment to be held in the elevated position for maintenance shall be provided with a support device in accordance with ISO 10533:1993 and ISO 10533:1993/Amd 1:2005 or designed to withstand at least 1,5 times the mass of the equipment.