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Building construction machinery and equipment — Machinery for concrete surface floating and finishing —

Part 2: Safety requirements and verification

Machines et matériels pour la construction des bâtiments — Talocheuses-lisseuses de mortier —

Partie 2: Exigences de sécurité et de vérification

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Foreword

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

This second edition cancels and replaces the first edition (ISO 13105-2:2014), which has been technically revised. It also incorporates the Amendment ISO 13105-2:2014/Amd 1:2017.

The main changes are as follows:

— updated normative references;

— updated general requirements in 4.2;

— added NOTE in 4.2.11;

— updated A.1 and A.5;

— added Annex C.

A list of all parts in the ISO 13105 series can be found on the ISO website.

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 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 organisations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of this 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 type-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.

The ISO 13105 series deals with machinery designed for smoothing and finishing concrete on construction sites. These machines are commonly referred to as “power trowels”.

Building construction machinery and equipment — Machinery for concrete surface floating and finishing —

Part 2: Safety requirements and verification

1 Scope

This document specifies safety requirements for machines used for concrete surface floating and finishing. This includes pedestrian-controlled equipment and ride-on equipment.

This document is not applicable to:

— internal or external vibrators or ancillary equipment used with internal and external vibrators, e.g. air compressors, hydraulic power sources, and voltage transformers;

— remote-controlled or hand-held smoothing machines and self-acting (e.g. robotic) smoothing machines;

— strike-off type machines commonly known as screeds.

This document deals with significant hazards, hazardous situations, or hazardous events relevant to machinery for concrete surface floating and finishing (power trowels) when used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer.

This document is not applicable to machines which are 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 2631-1, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

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

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

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

ISO 11201, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13105-1, *Building construction machinery and equipment — Machinery for concrete surface floating and finishing — Part 1: Terms and commercial specifications*

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13766-1, *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, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 2: Additional EMC requirements for functional safety*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60309-1, *Plugs, socket-outlets and couplers for industrial purposes — Part 1: General requirements*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP code)*

ASTM E-1155, *Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers*

EN 50525-2-21, *Electric cables — Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U) — Part 2-21: Cables for general applications — Flexible cables with crosslinked elastomeric insulation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 13105-1, 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
nylon 6/6 substrate
polyhexamethylene adipamide material

Note 1 to entry: See ISO 1874-1 for more information.

4 Safety requirements and/or protective/risk reduction measures

4.1 Overview

Machinery shall conform to the safety requirements and/or protective/risk reduction measures of this clause.

In addition, the machine shall be designed according to the principles of ISO 12100 for relevant but not significant hazards (see Annex B), which are not dealt with by this document.

4.2 General requirements for all machines

4.2.1 Guarding of the rotating blades

A means shall be provided to protect the operator or bystanders from inadvertently coming in contact with rotating blades. The guarding device shall be designed so that the operator can visually see the interaction of the blades with the concrete surface and in conformity with the dimensions given in Annex C.

If the guarding device is constructed of tubes (or bars), there shall be a gap not exceeding 90 mm between the concentric tubes (or bars). See Figures C.1 and C.2. The distance between the tip of the blade and the outer edge of the guarding device shall be dependent on the type of machine and performance expected. For flotation of concrete close to a vertical wall, that difference can be near zero.

The lowest outer tube (or bar) of the blade guarding device shall be able to withstand an impact force, directed horizontally towards the guarding device, equal to two times the mass of the machine without exposing the blades to the deformation.

4.2.2 Blade guarding device ground clearance

The height of the lowest outer tube (or bar) of the blade guarding device with blades in the unpitched position shall not exceed 60 mm from the concrete surface. See Figures C.1 and C.2.

4.2.3 Blade pitch adjustment

Whenever practicable, the adjustment of the blade pitch shall be carried out from the normal operating position. Where this is neither possible nor practicable, means shall be provided to protect personnel from contact with the blade, e.g. blade lock or equivalent. Instructions for blade pitch adjustment shall be given in the operator's manual. See 6.1.2, t).

4.2.4 Electrical devices

4.2.4.1 Electrical contact of persons with live parts

4.2.4.1.1 Direct contact

Protection from direct contact with live parts shall be in accordance with IEC 60204-1:2016, 6.2.

4.2.4.1.2 Indirect contact

Protection from indirect contact with live parts shall be in accordance with IEC 60204-1:2016, 6.3.

4.2.4.2 External influences on electrical equipment

4.2.4.2.1 Damage to electrical equipment

The position of the electrical equipment in the machinery shall guarantee protection from mechanical damage to electrical equipment.

Flexible leads with insulation meeting specification H 07 RN-F or A 07 RN-F in accordance with EN 50525-2-21 or at least equivalent specification shall be used.

Plug devices shall be qualified for more difficult (rough) conditions in accordance with IEC 60309-1.

4.2.4.2.2 Protection from dust

Electrical components shall meet the dust protection requirements to IP-5X in accordance with IEC 60529:2001, 13.4.

4.2.4.2.3 Protection from water

Electrical components shall meet the water protection requirements to IP-X5 in accordance with IEC 60529:2001, 14.2.5.

4.2.4.3 Protection against residual voltages

Live parts having a residual voltage greater than 60 V after the supply has been disconnected shall be discharged to 60 V or less within a time period of 5 s after disconnection of the supply voltage, provided that this rate of discharge does not interfere with the proper functioning of the equipment.

4.2.4.4 Prevention of the occurrence of a touch voltage

For engine powered machines which generate electrical power above 60 V for accessories, the requirements of IEC 60204-1:2016, 6.3.2 shall apply.

4.2.4.5 Failure of electrical energy source

The machine shall be designed to prevent unintentional starting of the machine after re-energizing subsequent to the failure of electrical energy supply.

4.2.5 Hot parts

The machine shall be designed to minimize risk to the operator from inadvertent contact with hot parts in accordance with ISO 13732-1.

4.2.6 Operator exposure to harmful gases

Exhaust gases of the internal combustion engine shall be directed away from the operator.

4.2.7 Securing of machine parts

Machine parts (e.g. guards) shall be secured to prevent unintentional loosening or displacement during operation or machine lifting.

4.2.8 Means for lifting

For machines with a gross mass of 25 kg or greater, means for lifting (e.g. lifting points) the machine shall be provided. These provisions shall be arranged in such a way that the machine can be lifted, held, and lowered in a stable equilibrium state.

Lift points and devices shall be clearly identified on the machine per 6.3.2.

4.2.9 Provisions for securing during transport

Provisions shall be in place to secure the machine during transport (i.e. tie-downs, enclosed vehicle).

Securing points on the machine shall be clearly identified per 6.3.3.

4.2.10 Noise reduction

Noise reduction shall be an integral part of the design process, thus specifically taking into account measures at source. The procedure for measurement details shall be in accordance with Annex A.

4.2.11 Vibration reduction

Vibration reduction shall be an integral part of the design process, thus specifically taking into account measures at source. The procedure for measurement details shall be in accordance with Annex A.

NOTE Operators wearing certain styles of anti-vibration gloves, especially those in accordance with ISO 10819 can further reduce the impact of hand-arm vibration. Tests can be performed to state/mention the total percentage (%) tested wearing such gloves.

Emerging technologies, such as silica penetrating surface treatments applied during the concrete placing phase and during the trowelling phase have shown a significant reduction in typical concrete "stickiness" and resistance. These treatments allow the trowel to glide with less restrictions, reducing operator efforts in trowel control. These effects are noticed in both walk behind and rider trowels.

4.2.12 Electromagnetic compatibility (EMC)

The relevant EMC requirements shall be in accordance with ISO 13766-1 and ISO 13766-2.

4.3 Safety requirements for pedestrian-controlled machines

4.3.1 Handle

4.3.1.1 Horizontal distance from the handle to the most external guarding device bar (tube)

The horizontal distance from the controls at the handle to the most outside part of the protection device shall not be less than 900 mm. See Figure C.1.

4.3.1.2 Handle rotation

For engine-powered machines, a means shall be provided to automatically stop handle rotation in the event the handle is inadvertently released while the blades are in motion. The handle shall not turn more than 270° from the release position.

For electrically-powered machines, a means shall be provided to reduce power to 25 J or less in the event the handle is inadvertently released while the blades are in motion.

Means shall be provided to prevent the handle from rotating during engine start.

4.3.1.3 Loss of stability

The design of the handle shall take into consideration the maximum static and dynamic loads when used as intended.

4.3.1.4 Controls and adjustment

During normal operation, controlling or adjustment of machine shall only be possible from the operator's position by using the hand controls on the handle.

4.3.2 Unintentional starting of blades

If a disruption of power occurs, a means shall be provided, for example, a reset switch, to enable restarting of the blades but only after completing the restart procedure as defined by the manufacturer.

4.3.3 Hand operated starting devices

Engine-powered machines shall be equipped with a pull-type starting device.

The pull rope of pull-type starting device shall be securely attached to the starting device.

During and after engine start with the pull-type starting device, there shall be no automatic movement of the machine or its equipment.

4.4 Safety requirements for ride-on machines

4.4.1 Controls

4.4.1.1 General

During normal operation, operating of controls or adjustment of machine shall only be possible from the operator's position, with the operator in the seated position.

The pedal on the ride-on machine shall be so designed that unintentional motion activation while the operator is not in a position to control the machine is not possible.

4.4.1.2 Blade motion controls

When the blade motion control device is released, it shall return to a neutral position; and the blades shall automatically come to a stop.

After vacating the operator's seat, the blade rotation shall stop; and the speed of the engine shall be brought to idle; or the engine on the ride-on machine shall be automatically stopped.

4.4.1.3 Steering controls

Steering controls shall have neutral positions and automatically return to that position when the control is released by the operator.

The movement of controls on the ride-on machine shall represent the intended movement of the machine and prevent the movement of the machine in the wrong direction.

4.4.2 Hydraulic system (if equipped)

The hydraulic system shall be designed in accordance with ISO 4413. If leakage occurs either internally or externally, it shall not cause a hazard.

4.4.3 Pneumatic system (if equipped)

The pneumatic system shall be designed in accordance with ISO 4414. If leakage occurs either internally or externally, it shall not cause a hazard.

5 Verification of safety requirements and/or protective/risk reduction measures

This clause contains methods of testing of safety requirements stated in Clause 4. All safety measures of Clause 4 should contain self-evident means for verification.

If this means is not self-evident, either one or a combination of the following shall be used to verify that the requirements of Clause 4 have been met:

— measurement;

— visual examination;

— as appropriate, testing means of a method prescribed in this document referred to in any particular requirement.

6 Information for use

6.1 Operator's manual

6.1.1 General

An operator's manual shall be supplied with each machine.

6.1.2 Content

The operator's manual shall give instructions for operation and maintenance. The format and content shall be in accordance with ISO 12100:2010, 6.5.

In shall also include, as a minimum:

a) a description of the machine;

b) the machine specifications;

c) the intended use of the machine;

d) a description of the instrumentation and operator controls;

e) a statement as to the need for personal protection equipment, as appropriate;

f) information on the location of any pinch points on the machine that can cause injury during operation or routine maintenance;

g) instructions to stop the equipment and shut down power before performing any maintenance on the machine;

h) instructions that all guards shall be in place before operating the machine;

i) safety-relevant technical data;

j) an indication that the operator of the machine shall be trained and competent;

k) an indication that the operator and other personnel shall fully acquaint themselves with the operator's manual before operating the machine;

l) a description of the hazard zones around the machine and a warning that all personnel are to stay out of those zones;

m) hazard zones during machine operation or maintenance;

n) instructions regarding indoor use, or in confined spaces, as applicable;

o) operating instructions (e.g. use of intended access systems, proper use of each device, and check procedures);

p) the procedure for safe set-up, placing, and transportation of the machine;

q) operation and maintenance of the machine;

r) the sound power level of exterior noise and its test conditions;

s) the location and an explanation of all safety related signs affixed to the machine;

t) instructions for adjusting blade pitch;

u) any other safety-related items specified in Clause 4.

6.2 Safety and instructional signs

Safety labels shall be affixed so as to effectively warn against hazards that are not immediately obvious.

Warnings against obvious hazards shall be conspicuously affixed near the approach or vicinity of the hazard.

Any written or verbal information included in the label or added to the machine (e.g. by stencilling) shall be in the same language(s) as the operator's manual.

All machine safety labels shall be shown and explained in the operator's manual. It is preferred that the location of the label on the machine also be shown in the operator's manual.

NOTE Guidance for safety sign design can be taken from ISO 9244 for earth-moving machines.

6.3 Marking

6.3.1 General

Each machine shall, as a minimum, bear the following minimal information in a permanently legible and indelible condition throughout the expected life of the machine:

a) name and address of the manufacturer;

b) mandatory marking;

c) designation of series or type;

d) the serial number:

e) engine power (kW);

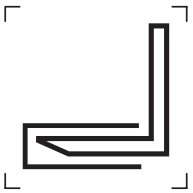
f) mass in kg of the most usual configuration.

6.3.2 Marking of lifting points and devices

Lifting points and devices shall clearly by marked as follows.

— Where lifting takes place using a lifting lug or device, ISO 7000-1368 or equivalent shall be used.

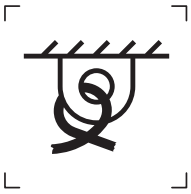
— Where lifting takes place using forklift pockets, ISO 7000-2869 or equivalent shall be used.



— Areas where lifting is not permitted with a forklift, the area shall be marked by ISO 7010-P006.

6.3.3 Marking of securing points on the machine for transport

Securing points on the machine for transport shall be clearly marked by ISO 7000-2069 or equivalent.



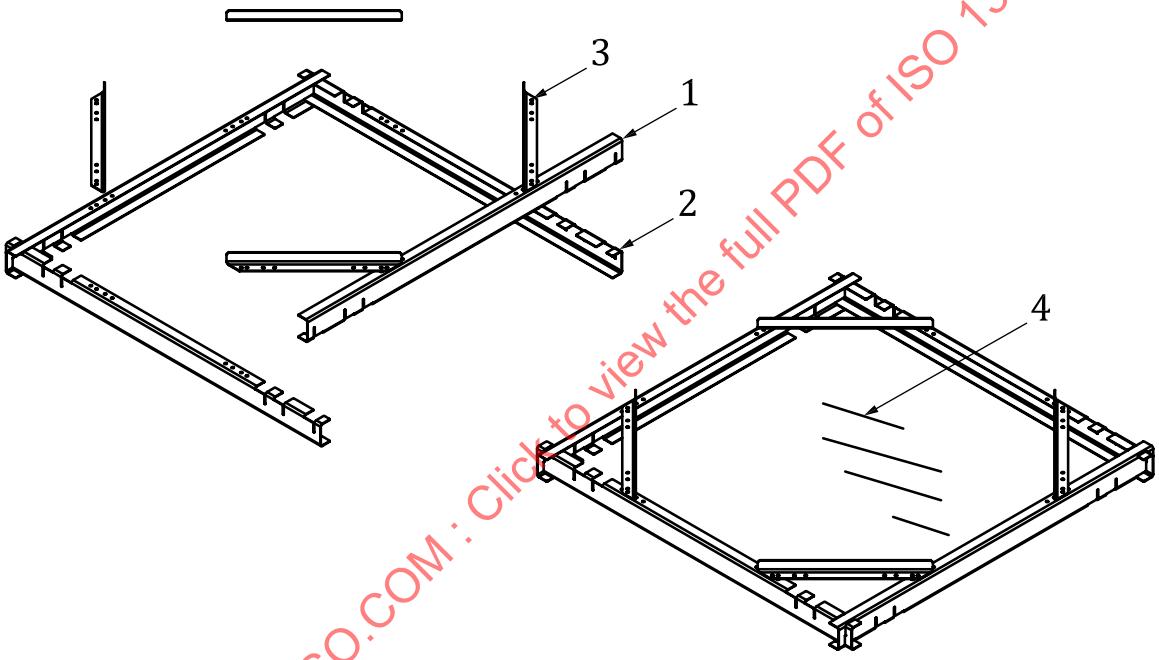
Annex A
(normative)

Noise and vibration tests

A.1 Test fixture construction for noise tests

The test fixture shall be designed so that it allows the pitching of the blades to cause sufficient drag on the engine(s) to prevent them from sputtering at full throttle. See Figure A.1.

The nylon 6/6 substrate test surface material referenced in A.2 shall be sized accordingly to fit within the rail system.



Key

1 rail (down) (2)
2 rail (up) (2)
3 isolator (4)
4 nylon 6/6 substrate test surface

Figure A.1 — Example text fixture for noise tests

A.2 Test surface

A synthetic polymer surface, for example, nylon 6/6 substrate, shall be used for the test to reduce the possibility of the trowel blades heating up and damaging the test substrate. A lubricant, for example, molybdenum disulphide, shall be used as an additive to reduce the coefficient of friction on the test surface.

A.3 Securing the machine to the test fixture

The machine being tested shall be positioned on the rail system so that the guard ring is sitting on each of the four rails with sufficient clearance so that the blades do not come in contact with the rail system. See Figure A.2.

Isolators shall be used to securely lock the machine into position on the rail system.

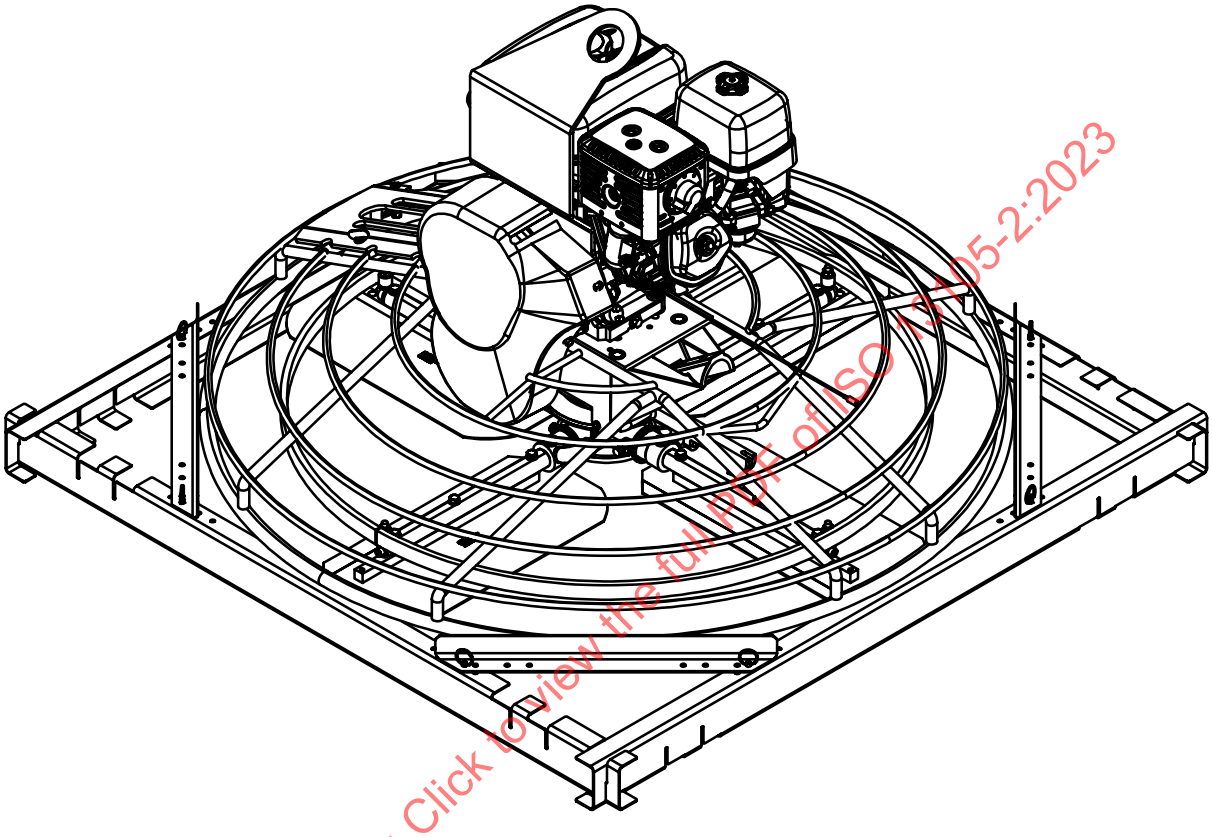


Figure A.2 — Example of machine secured to the test fixture

A.4 Sound measurement

A.4.1 General

The A-weighted sound power level measurements shall be tested in accordance with ISO 3744. The A-weighted sound pressure level measurements taken at the operator station shall be tested in accordance with ISO 11201.

A.4.2 Operating conditions during test

The equipment shall be positioned such that only the sound generated by the equipment being tested is measured.

A.4.3 Declaration of data

For both the A-weighted sound power level and the A-weighted sound pressure level at the operator workstation, there should be a dual number declaration by giving the measured value and K as defined in ISO 4871.

NOTE No technical data on noise emission are presently available to estimate the standard deviation of reproducibility for concrete and smoothing machines. Therefore, the values of the standard deviation of reproducibility for A-weighted levels stated in ISO 3744, namely 1,5 dB, and ISO 11201, namely 2,5 dB, can be regarded as interim upper boundaries and used for the determination of the uncertainty *K* when preparing the noise declaration. Investigations requiring a joint effort of manufacturers are necessary to determine a possibly lower value of the standard deviation of reproducibility, which will result in a lower value of the uncertainty *K*.

A.5 Vibration measurement

A.5.1 General

The test methods for measuring whole-body vibration shall be in accordance with ISO 2631-1. Pedestrian-operated power trowels shall be tested for total vibration energy as specified in A.5.5.

A.5.2 Blade position for ride-on machines

On ride-on machines with multiple rotors, the blade pitch shall be adjusted, so that all blades have the same pitch angle.

A.5.3 Operating conditions during test

The equipment shall be positioned such that only the vibration generated therefrom is measured.

A.5.4 Whole body vibration measurement for ride-on type power trowel

The use of a human body in the whole-body vibration measurement on a ride-on power trowel may be substituted by using a mass with a mass of 75 kg installed in the seat.

NOTE The mass value from the medium operator is taken from ISO 3411.

A.5.5 Vibration energy measurement for pedestrian-operated power trowel

The pedestrian-operated concrete flotation machine shall be tested for measurement of vibration energy as follows.

a) The surface area to be used for vibration test shall be free of debris and artefacts, and rendered to an *F* value of 90 to 100 per ASTM E-1155 with a confidence index of 85 to 115. This prevents any vibrations generated from the contact of the flotation blades with the test surface.

b) The machine to be tested shall be connected to a test fixture at the handles, as illustrated in Figure A.3.

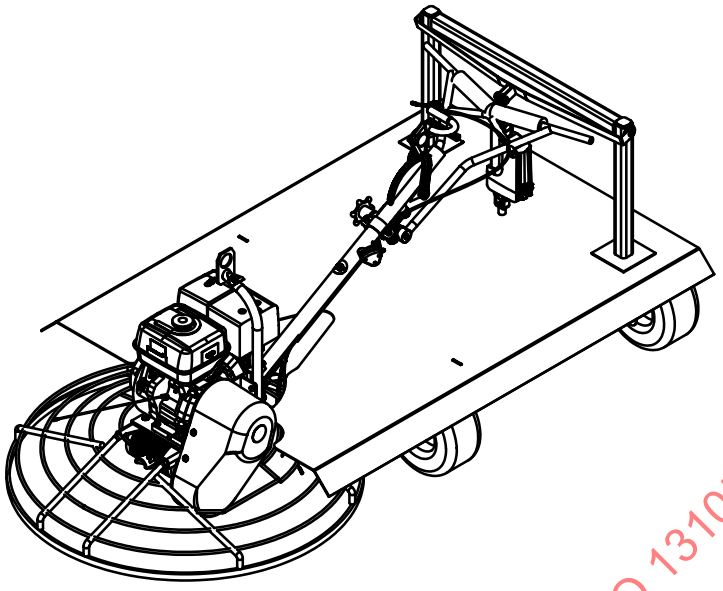


Figure A.3 — Example of pedestrian operated machine secured to the test fixture for vibration measurement

c) Flotation blade pitch is set to just where the blades start making a line contact with the concrete. This is the normal accepted mode of operation of the pedestrian-operated trowelling machine in the concrete flotation industry. Prime mover RPM (rotations per minute) is set to full speed.

d) A ballast weight shall be kept on the test fixture in order to counterbalance the effects of the weight of the machine.

e) Upward or downward pressure shall be applied to the handle via a calibrated system that allows for smooth movement of the machine to the left, or to the right, respectively. During the test the machine should move, along with the test fixture, in a straight line, at a constant velocity, on the test surface.

f) Quantification of the total system vibration should be done as the total amount of vibrational energy generated in the machine, as close to the source of vibration as possible. That shall be the location of the tri-axial accelerometer.

g) The vibration measurement data shall be acquired by a high sampling speed (> 7 000 samples per second) data acquisition system for all three axes for a period of approximately 30 s.

h) The following mathematical operation shall be carried out.

   1) Retrieve the data to form arrays of samples for each axis.

   2) Convert the acquired data to a 'g' value from m/s^2 if not already available in that form.

   3) Remove DC bias from the data – per classical definition of vibration.

   4) Obtain a fast Fourier transform from the data for each axis.

   5) Compute the RMS (root mean square) power spectral density for each axis by multiplying each sample in each array with its complex conjugate, multiplying by ½, and then dividing by the width of the frequency interval. PSD (power spectral density) is expressed in g^2/Hz versus Hz for acceleration data.

   6) Compute the sum of the PSD on each axis up to the limiting frequency.

   7) The RMS PSD of the whole system is given by the sum of all magnitudes at each frequency multiplied by the width of the frequency interval.

Annex B
(informative)

List of significant hazards

The machine should be designed such that it is fit for its purpose or function and can be adjusted and maintained without putting persons at risk when it is used under conditions foreseen by the manufacturer.

To properly design a product and cover all specific safety requirements, the manufacturer should:

— identify the hazards that apply to the product and perform risk assessments;

— design and construct the product taking into account these assessments.

The aim of this procedure is to eliminate or reduce the risk of accidents throughout the foreseeable lifetime of the machinery, including the phases of assembling and dismantling, in which the risk of accidents can also arise from foreseeable abnormal situations.

In selecting the most appropriate methods, the manufacturer should apply the following principles, in the order given:

a) eliminate or reduce risks as much as possible by design (inherently safe machinery design and construction);

b) take the necessary protection measures in relation to risks that cannot be eliminated by design;

c) inform users of the residual risks due to any shortcomings of the protection measures adopted;

d) indicate whether any particular training is required;

e) specify any need to provide personal protection equipment (PPE).

The machine should be designed to prevent abnormal use, wherever possible, if such use would engender risk. In other cases, the instructions should draw the user's attention to ways in which experience has shown the machine should not be used.

The hazards listed in Table B.1 can be applicable and can involve risks to persons if not addressed. The corresponding requirements offer guidance to limit the risk or reduce these hazards.