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Building construction machinery and equipment — External vibrators for concrete

Machines et matériels pour la construction des bâtiments — Vibrateurs externes pour le béton

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18652 was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*.

Building construction machinery and equipment — External vibrators for concrete

1 Scope

This International Standard defines terms and specifies the classification, performance requirements, test methods, designation and commercial specifications of external vibrators for concrete (hereinafter referred to as “vibrators”). It is applicable only to those power-driven external vibrators used for compacting concrete mix by vibration from the outside.

NOTE The use of external vibrators consists in their attachment to forms, vibration stands, vibration tables, surface vibrators and vibrating beams in order to compact the concrete mix.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2398:1995, *Rubber hose, textile-reinforced, for compressed air — Specification*

ISO 4414:1998, *Pneumatic fluid power — General rules relating to systems*

ISO 6150:1988, *Pneumatic fluid power — Cylindrical quick-action couplings for maximum working pressures of 10 bar, 16 bar and 25 bar (1 MPa, 1,6 MPa, and 2,5 MPa) — Plug connecting dimensions, specifications, application guidelines and testing*

ISO 7241-1, *Hydraulic fluid power — Quick-action couplings — Part 1: Dimensions and requirements*

ISO 8041, *Human response to vibration — Measuring instrumentation*

ISO 8331, *Rubber and plastics hoses and hose assemblies — Guide to selection, storage, use and maintenance*

ISO 11375:1998, *Building construction machinery and equipment — Terms and definitions*

ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

IEC 60034-1:2004, *Rotating electrical machines — Part 1: Rating and performance*

IEC 60034-5, *Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification*

IEC 60204-1:2000, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60745-1:2003, *Hand-held motor-operated electric tools — Safety — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11375 and the following apply.

3.1
electric external vibrator
vibrator in which the prime mover is an electric motor

NOTE The electric external vibrator is moved by a squirrel-cage, single- or three-phase induction motor on the shaft ends of which eccentric out-of-balance masses are fixed (for examples, see Figures A.1 and A.7).

3.2
pneumatic external vibrator
vibrator operating on the principle of bearingless turbine with pneumatic drive

NOTE 1 The pneumatic external vibrator has typically a rotary vibration generator in the form of a bushing or ball located in a housing, which rolls on a fixed axle. The vibrator set is composed of the vibrator itself, supply hose with on/off stopcock and various fixtures for use with metal and wooden-type shuttering. The on/off stopcock makes it possible to change the vibration parameters.

NOTE 2 For examples, see Figures A.2, A.3, A.8 and A.9.

3.3
hydraulic external vibrator
vibrator comprising a rotating eccentric mass directly coupled to a specially designed hydraulic motor

NOTE 1 The hydraulic external vibrator is supplied by a feeder containing hydraulic pump, pressure and flow controls, with the aim of the precise regulation of vibration frequency to suit requirements.

NOTE 2 For an example, see Figure A.4.

3.4
high-frequency external vibrator
HF external vibrator
vibrator operating at a frequency 70 Hz and above

NOTE High-frequency electric vibrators are typically squirrel-cage induction motors fed from convertors.

3.5
normal frequency external vibrator
NF external vibrator
vibrator operating at a frequency below 70 Hz

NOTE Normal frequency electric vibrators are typically squirrel-cage induction motors supplied with the current of a network frequency.

3.6
external vibrator of directed vibration
vibrator for generation of directed vibrations

NOTE For examples, see Figures A.10, A.11 and A.12.

3.7
single external vibrator of directed vibration
vibrator for generation of linear, vertical vibrations by special fixing on the hinge

NOTE For examples, see Figures A.10 b) and A.11.

3.8
double external vibrator of directed vibration
vibrator for generation of the linear directed vibrations and composed of two external vibrators rotating in opposite directions and joined by a gear

NOTE 1 These vibrators may be driven by an external motor or consist of two induction motors geared together and enclosed in a common housing.

NOTE 2 For examples, see Figures A.10 a) and A.12.

3.9
fixed external vibrator
vibrator fixed to the vibrating object directly by mean of treads

NOTE For examples, see Figures A.1, A.2 and A.5.

3.10
removable external vibrator
vibrator fixed to the vibrating object indirectly by means of a quick-action clamping and releasing device

NOTE For examples, see Figures A.3, A.6 and A.9.

3.11
external vibrator with external motor
vibrator driven by external electric motor or internal combustion engine

3.12
frequency and voltage converter for external vibrator
unit used for electric supply of the external vibrator with frequency higher than in power network and safety voltage

3.13
high-and-normal frequency generating set
unit composed of internal combustion engine, electric generator and frequency converter

4 Classification

Vibrators shall be classified according to frequency, power source and structure in accordance with Table 1.

Table 1 — Classification of external vibrators

Class	Frequency	Power source	Structure	Power W
NF	Normal	Electric motor	Fixed type Removable type	25, 35, 50, 75, 100, 150, 200, 250, 400, 550, 750, 1 100, 1 500, 1 700, 2 200, 3 000 4 000
HF	High			30, 50, 100, 150, 200, 300, 400, 550, 750, 1 000, 1 500, 2 000, 2 500
P	—	Pneumatic	Fixed type Removable type	—
H	—	Hydraulic	Fixed type Removable type	—

5 Structure

A vibrator's structure depends on the type of drive (electric, pneumatic, hydraulic), parameters (frequency and centrifugal force) and the method of fixing to the vibrating object. Examples of different vibrator structures are shown in Annex A.

6 Performance requirements

6.1 Frequency

Vibrators shall be classified according to their frequency, in accordance with Table 2, when subjected to the load test according to 8.2. The vibrator's frequency shall comply with the data as declared by its manufacturer.

Table 2 — Frequency of external vibrators

Designation	Frequency
NF	Below 70 Hz
HF	70 Hz and above

6.2 Centrifugal force

A vibrator's prime mover shall be sufficient to drive the device, without losing speed, such that the declared centrifugal force is maintained continuously under the maximum load of intended use.

6.3 Rating time

The rating time of a vibrator shall be continuous. For electric external vibrators, an intermittent duty (rating class) specified according to IEC 60034-1:2004, 3.2 and 4.2, and agreed between the supplier and purchaser is permissible. The designation of these vibrators shall correspond to IEC 60745-1:2003, 7.2.

6.4 Current and power consumption

The current and power consumption of the electric vibrators, when subjected to a load according to 8.2, should comply with data declared by the manufacturer.

6.5 Safety requirements

6.5.1 General

External vibrators shall be designed and their components selected, applied, mounted and adjusted to provide safe operation. In the event of a failure, the safety of personnel shall be the prime consideration and damage to equipment and environment minimized. Possible modes of failure and intended operations and use shall be considered.

It is recommended that technical principles and specifications according to ISO 12100-2 for the design of vibrators in respect of their safety, be followed and used.

6.5.2 Electric external vibrators

6.5.2.1 General

These vibrators shall comply with the requirements of IEC 60204-1 and IEC 60034-1 unless otherwise specified in this International Standard and shall be constructed as far as possible in accordance with internationally accepted best design practice, as appropriate to the application.

6.5.2.2 Degree of protection

The vibrator cabling should be protected to at least IP 55 according to IEC 60034-5 due to exposure to water cleaning and fine dust.

6.5.2.3 Protection against overload

Overload protection of electric external vibrators shall be provided for each unit rated at more than 0,5 kW. For recommendations on overload protection, see IEC 60204-1:2000, 7.3.

6.5.2.4 Thermal performance

The temperature rise of properly mounted vibrators should remain within the limits of the insulation class according to IEC 60034-1:2004, section 7.

6.5.2.5 Earthing

The vibrators shall be provided with means for connecting a protective conductor or an earth conductor. A performance of these means shall comply with the requirements of IEC 60034-1:2004, 10.1.

6.5.2.6 Insulation resistance

The insulation resistance measured at 500 V d.c. between the power circuit conductors and the protective bonding circuit shall not be less that 1 MΩ, in accordance with IEC 60204-1:2000, 19.3.

6.5.2.7 Withstand voltage test

The electric external vibrator shall withstand a test voltage applied for a period of at least 1 s between the conductors of all circuits and the protective bonding circuit. The test voltage shall

— have a value of twice the rated supply voltage of the vibrator or 1 000 V, whichever is the greater,

— be at a frequency of 50 Hz, and

— be supplied from a transformer with a minimum rating of 500 VA.

See IEC 60034-1:2004, 8.1 or IEC 60204-1:2000, 19.4.

6.5.3 Pneumatic and hydraulic external vibrators

Pneumatic and hydraulic vibrators shall

— demonstrate correct operation in the operational test, and

— pass the pressure test at the maximum working pressure under all conditions of intended use.

Leakage and damage of a vibrator component should not cause a fluid ejection hazard.

The design of the vibrator systems shall be in accordance with ISO 4414.

Special attention should be given to any flexible hoses and quick-action couplings with which vibrators can be equipped. The hoses should comply with ISO 2398 and ISO 8331 and the couplings with ISO 6150 and ISO 7241-1.

6.5.4 Requirement for no-load test

During 2 min work the vibrator shall demonstrate correct operation. See 8.1 and Annex B.

6.5.5 Requirement for load test

During 30 min running the vibrator shall demonstrate correct operation. See 8.2 and Annex B.

7 Instruction handbook

The instruction handbook shall contain the information necessary for installation, operation and maintenance of the vibrator.

The following should be presented:

a) description;

b) technical characteristics;

c) diagram;

d) documents attesting that the vibrator complies with mandatory requirements;

e) information related to

- use,
- maintenance,
- transport, handling and storage,
- commissioning,
- hazards and measures related to safety, with special attention given to the need for periodical checking of the efficiency of electrical shock protection and prevention against hoses bursting (if any), and the determination of service life of hoses, and
- spare parts.

8 Test methods

8.1 No-load test

Place the vibrator horizontally on a vibration insulator, selected in accordance with the vibrator's mass (see B.1).

All parts should be securely held in their positions and prevented from loosening. Set the hoses to straight position.

Run the vibrator for 2 min.

The vibrator shall comply with the requirement of 6.5.4.

8.2 Load test

Select a cubic mass, made of steel or cast iron, according to Table 3 and use this as a payload to fix the vibrator during the test. For pneumatic and hydraulic drive vibrators, the payload mass selected should be based on the calculated power consumption.

Firmly connect the vibrator to the payload.

Place the vibrator with its payload horizontally on a vibration-insulation base (see Annex B) and activate the vibrator.

Run the vibrator for 30 min.

The vibrator shall comply with the requirement of 6.5.5.

Table 3 — Mass of payload for vibrator fixing during payload test

Class and motor output W	Mass [a] kg	Class and motor output W	Mass [a] kg
NF 25	5	NF 3 000	700
NF 35	5	NF 4 000	950
NF 50	10	HF 30	10
NF 75	15	HF 50	15
NF 100	20	HF 100	25
NF 150	30	HF 150	40
NF 200	50	HF 200	50
NF 250	60	HF 300	80
NF 400	100	HF 400	100
NF 550	120	HF 550	150
NF 750	200	HF 750	200
NF 1 100	250	HF 1 000	280
NF 1 500	350	HF 1 500	420
NF 1 700	400	HF 2 000	560
NF 2 200	500	HF 2 500	700
[a] Mass tolerance: 2,5 %.			

8.3 Frequency and acceleration measurements

Fix the vibrator to the payload under the same conditions as for the load test (see 8.2 and Annex B). For electric vibrators, the supply voltage value shall correspond to data specified by manufacturer. For pneumatic and hydraulic vibrators, air and oil pressures shall be at their nominal values.

Measure the frequency using either a vibration meter or stroboscope. In addition, a tachometer may be used for measurement of the motor speed. If a vibration meter is used, it shall be a single-axis accelerometer

designed to make general vibration measurements. Firmly fix to the payload or to the head of the vibrator's fixing screw.

Record the received measuring signals and process these into the required band spectrum, operating in real time.

For vibration meters and measurement apparatus, refer to ISO 8041.

The results of frequency measurements shall comply with the requirements of 6.1, while those of acceleration measurements shall comply with 6.5.5.

8.4 Centrifugal force evaluation

Calculate the centrifugal force from the formula:

$$F = \frac{m \times r \times \pi^2 \times n^2}{900\,000} = \frac{m \times r \times \pi^2 \times f^2}{250}$$

where

m is the unbalanced mass, expressed in kg;

r is the eccentric radius, expressed in mm;

n is the vibrator's revolutions, expressed in min^{-1};

f is the frequency, expressed in Hz.

Unbalanced mass may be determined by calculation or weighing on a scale in the position slewed to horizontal.

Eccentric radius value may be determined by any method, e.g. by calculation or, graphically, by suspending a flat unbalanced mass model in two different positions and drawing on it vertical lines passing through suspension points where they cross the eccentric radius location.

For the frequency measurement, see 8.3.

NOTE The centrifugal force can be measured directly by special instrument use, in which the vibrator can be suspended on a string system connected with load transducer to avoid a support reaction.

8.5 Current and power consumption measurement

Measure the current and power consumption measurement by means of general-use ammeters and wattmeters in accordance with 6.4.

8.6 Verification of safety requirements

8.6.1 Fixed and removable electrical external vibrators

8.6.1.1 Degree of protection

Test for characteristic numerals of the IP code using the method given in IEC 60034-5.

8.6.1.2 Protection against overload

Verify the effectiveness of the operation of the vibrator's protection against overload by overloading it and checking its switching-off action. Overloading may be realized by any method, e.g. by supplying the protection device with a current above the rated making value.

8.6.1.3 Thermal performance

Test thermal performance using the method given in IEC 60034-1:2004, section 7.

8.6.1.4 Earthing

Visually check the protective terminal in respect of its location and designation, and measure its cross-sectional area according to the requirements of IEC 60034-1:2004, 10.1.

8.6.1.5 Insulation value measurement

Measure the insulation value using the method given in IEC 60034-1:2004, 8.1.

8.6.2 Pneumatic and hydraulic external vibrators

Fix the vibrator to a payload. Check that the vibrator operates correctly under operational pressure and maximum working pressure.

Check the attesting documents on hose and quick-action coupling (if any) performance in accordance with 6.5.3.

8.6.3 Instruction handbook verification

Check that the content of the instruction handbook is in accordance with Clause 7.

9 Inspection and evaluation

The vibrators shall be inspected by carrying out the tests specified in Clause 8 and shall be accepted if the results satisfy the requirements of Clause 6.

10 Designation

The designation of the vibrator shall represent its frequency and/or power source and its power in accordance with Table 1. The letter code,

NF driven by normal frequency electric motor,

HF driven by high frequency electric motor,

P with pneumatic drive, or

H with hydraulic drive,

should be followed by the power (watts).

EXAMPLE A vibrator supplied with current of normal frequency, 750 W electromotor is designated by:

NF 750

11 Indication on type plate

The type plate shall carry, in a legible and indelible way, the following information and, in as far as possible, its dimensions shall allow this information to be contained on the plate.

a) Manufacturer's (or authorised representative's) name and address;

b) designation of type and serial number if any;

c) year of production;

d) frequency, in hertz;

e) power, in watts;

f) mass, in kilograms.

In addition, for electric external vibrators only:

— name of product and design, e.g. “Electric external vibrator NF 750”;

— voltage (V) and rated current (A);

— protective system — IP code;

— rating time — continuous or intermittent;

— other data provided for an electrical machine according to IEC 60034-1:2004, section 9.

In addition, for pneumatic external vibrators only:

— name of product and design, e.g. “Pneumatic external vibrator P 750”;

— maximal air pressure, in megapascals;

— rated air consumption, in litres per minute.

In addition, for hydraulic external vibrators only:

— name of product and design, e.g. “Hydraulic external vibrator H 750”;

— supplying hydraulic power units;

— maximum pressure, in megapascals, and

— pump output, in litres per minute.

12 Commercial specifications

In addition to the technical data specified in Clause 11, the following information should be also placed in the vibrator's commercial specification.

For electric external vibrators:

a) centrifugal forces on particular graduation positions, in daN;

b) overall and mounting dimensions (see Figures A.7, A.11 and A.12), in millimetres;

c) admissible position of the eccentric mass shaft (if appropriate);

d) ambient temperature (if appropriate), in degrees centigrade;

e) height of use above sea level (if appropriate) in metres;

f) class of electric insulation according to IEC 60034-1;

g) special execution for tropical or marine climate;

h) accessories (if any), including

- fixing bracket,
- quick-action clamping device,
- frequency and voltage converter,
- feeder box,
- motor switch with built-in cut-out,
- starter box with built-in overload cut-out,
- connecting plug,
- cable coupler socket connector plug, and
- fixing device for generation of directed vibration.

For pneumatic external vibrators:

a) overall and mounting dimensions (see Figures A.8 and A.9), in millimetres;

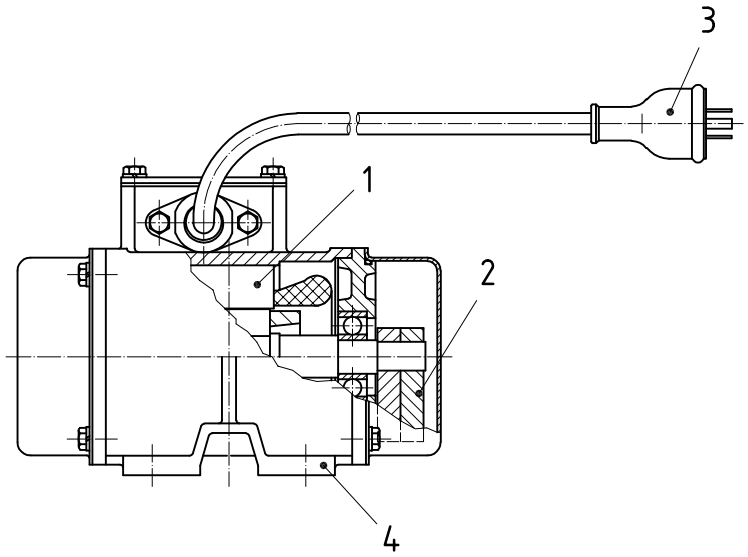
b) basic accessories — pneumatic hose with cut-off valve and quick-action coupling equipped with compressed air filter;

c) optional accessories — fixing brackets for vibrator's fixing on metal or wooden shuttering, various length hoses fitted with couplings to extend compressed air supply system.

For hydraulic external vibrators: accessories — hydraulic power feeding unit of required pressure and capacity.

Annex A
(informative)

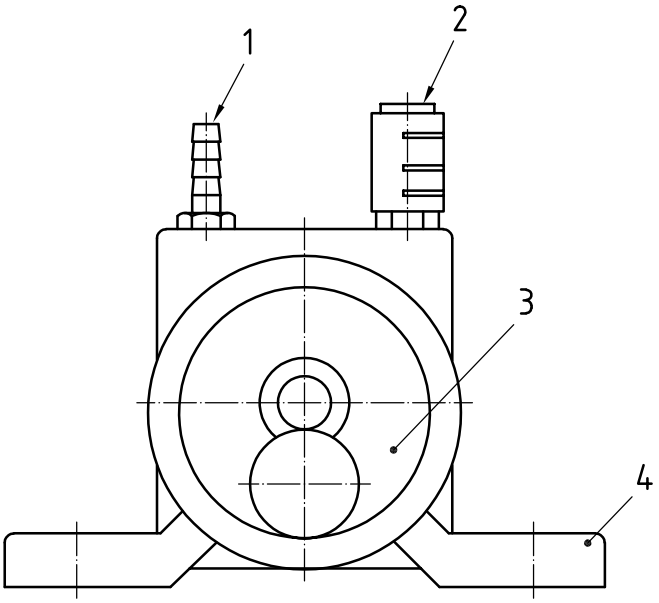
Structures and dimensional characteristics of external vibrators — Examples



Key

1 stator
2 eccentric mass
3 plug
4 fixture base

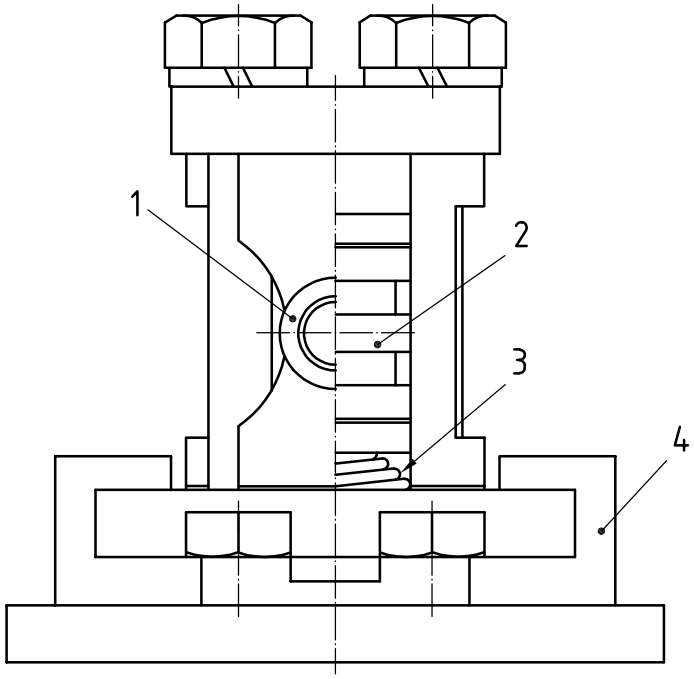
Figure A.1 — Structure of fixed-type electric external vibrator



Key

1 hose stem
2 silencer
3 ball
4 fixture base

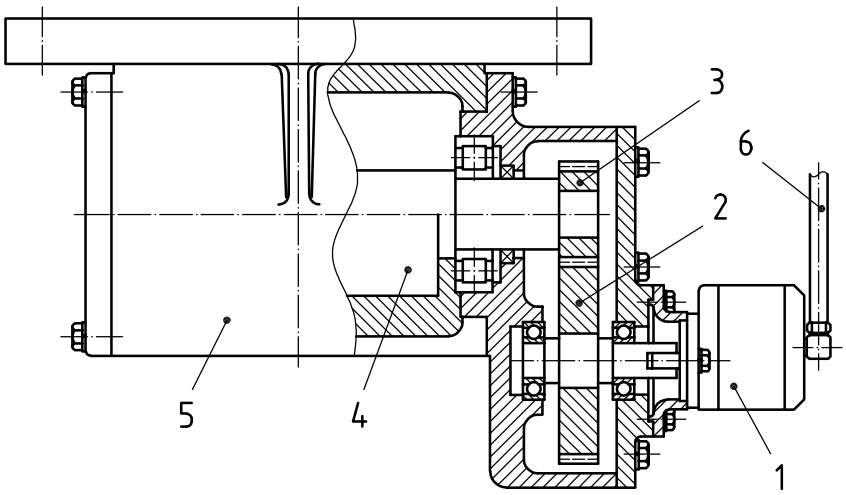
Figure A.2 — Structure of fixed-type pneumatic vibrator



Key

1 cylinder
2 piston
3 spring
4 fixture base

Figure A.3 — Structure of removable-type pneumatic external vibrator



Key

1 hydraulic motor
2 gear
3 toothed wheel mounted on rotor's shaft
4 eccentric mass
5 housing
6 hydraulic supply hose

Figure A.4 — Hydraulic external vibrator

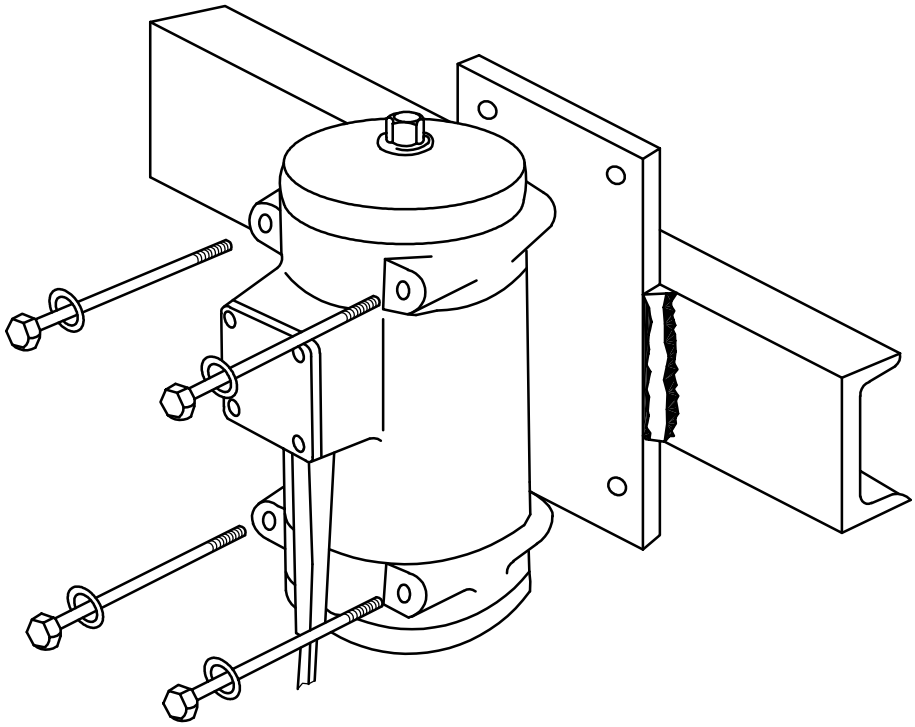
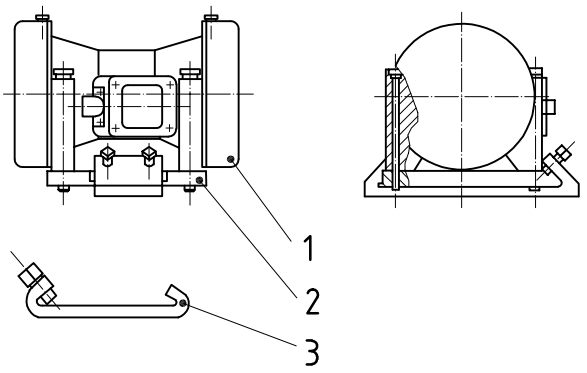
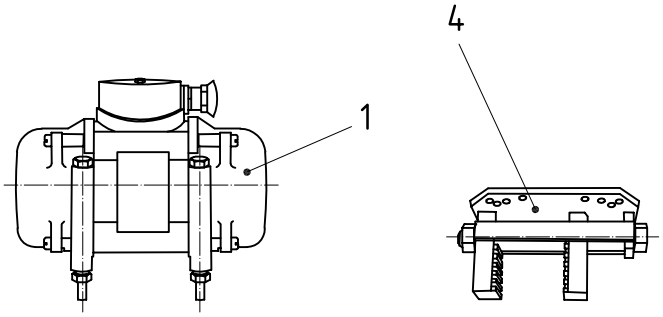


Figure A.5 — Fastening of fixed-type electric external vibrator



a) Dovetail guidance form

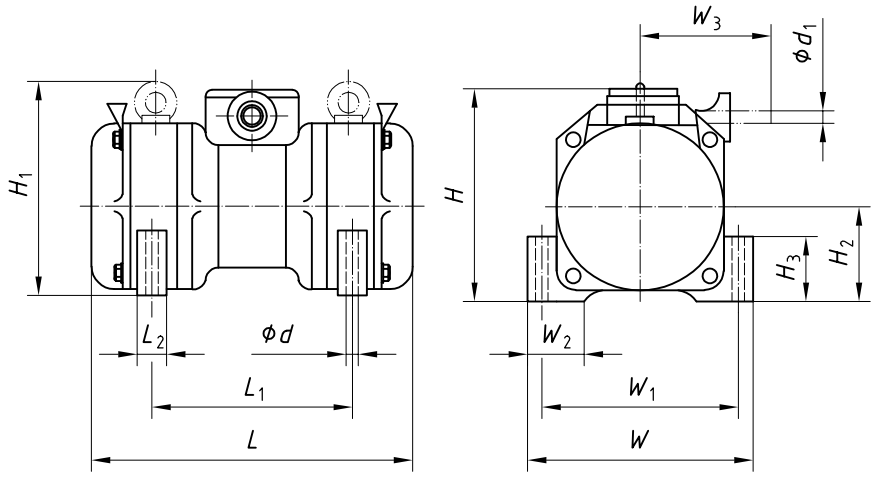


b) Cramp form

Key

1 external vibrator basic unit
2 base
3 quick-action clamping device
4 quick-action clamping device

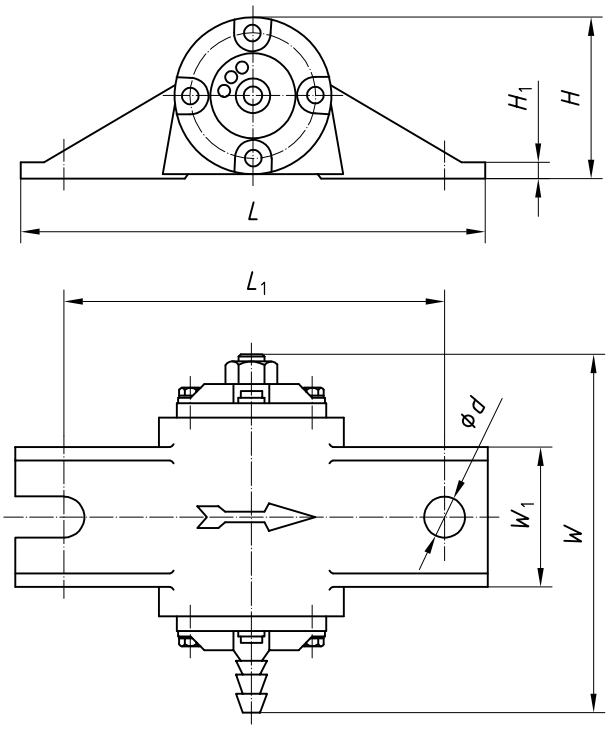
Figure A.6 — Two designs of quick-action clamping device for removable-type electric external vibrators



Key

L	overall length
$L_1 \times W_1$	spacing of fixing holes
d	diameter of fixing hole
L_2	length of lug
W	overall width
W_2	width of lug
H	overall height
H_1	height of vibrator with lifting eye
H_2	distance from base to vibrator's axis
d_1	diameter of power supplying cable
H_3	height of lug
d_1	diameter of hole in gland

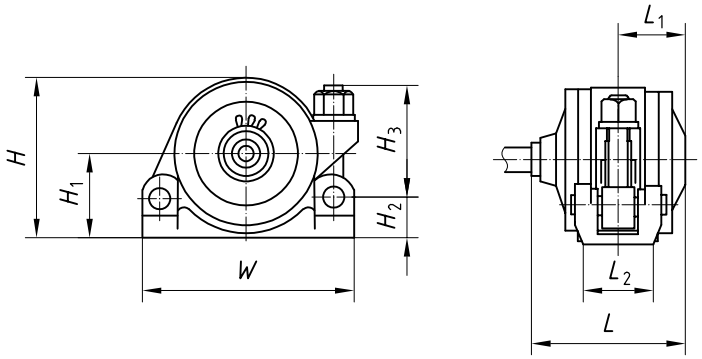
Figure A.7 — Overall and mounting dimensions of electric external vibrator



Key

L overall length
L_1 spacing of fixing holes
W overall width
W_1 width of lug
d diameter of fixing hole
H overall height
H_1 height of lug

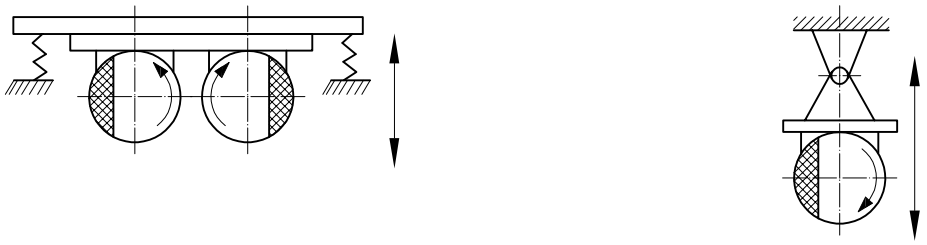
Figure A.8 — Overall and mounting dimensions of fixed-type pneumatic external vibrator



Key

L overall length
L_1 distance from vibrator's vertical axis to right edge
L_1 width of base
W overall width
H overall height
H_1 distance from base to vibrator's axis
H_2 distance from base to axis of rotation of fixing tread
H_3 useful length of fixing tread

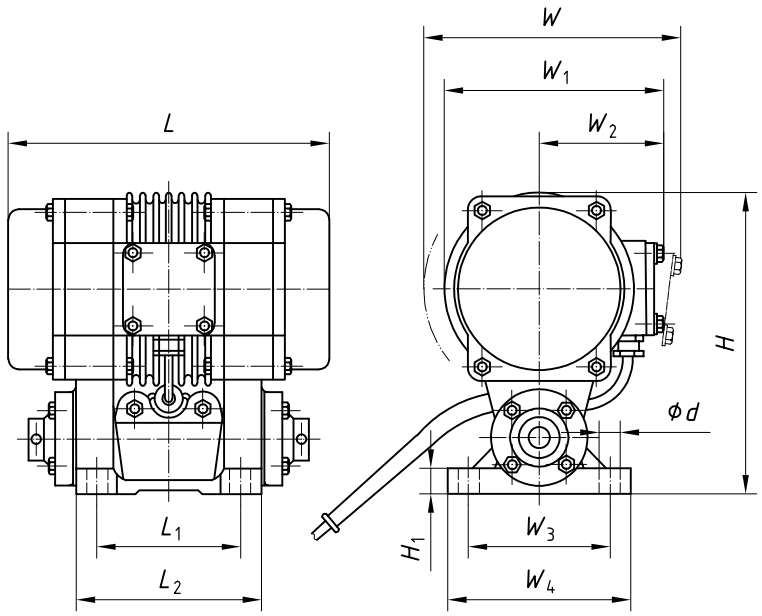
Figure A.9 — Overall and mounting dimensions of removable-type pneumatic vibrator



a) Two external vibrators rotating in opposite directions

b) External vibrator fixed on hinge

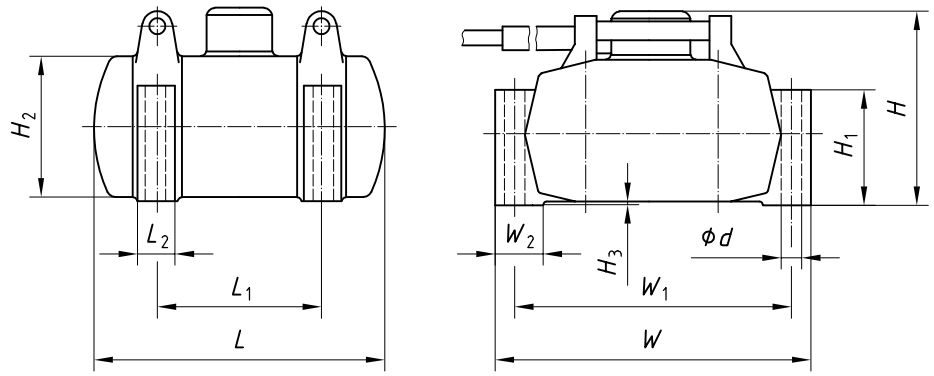
Figure A.10 — Principle of operation of external vibrators of directed vibration



Key

L	overall length
$L_1 \times W_1$	spacing of fixing holes
L_2	length of base
W	width of vibrator in operation
W_1	width of vibrator at rest
W_2	distance from vibrator's vertical axis to right edge
H	overall height
H_1	height of base
d	diameter of fixing hole

Figure A.11 — Dimensional characteristic of single external vibrator of directed vibration



Key

L	overall length
$L_1 \times W_1$	spacing of fixing holes
L_2	length of lug
W	overall width
W_2	width of lug
H	overall height
H_1	height of lug
H_2	height of vibrator housing
H_3	vertical distance between base and housing
d	diameter of fixing hole

Figure A.12 — Dimensional characteristics of double external vibrator of directed vibration

Annex B
(normative)

No-load and load tests for external vibrators — Insulators

B.1 No-load test

Smaller vibrators, of a mass up to 50 kg, shall be placed on a sponge mat of a minimum thickness of 50 mm, as shown in Figure B.1.

Larger vibrators, of a mass greater than 50 kg, shall be placed on a vibration insulator comprising two mats: sponge and spring (see Figure B.2, but without payload).

The technical characteristics of the sponge shall be in accordance with B.3.1.

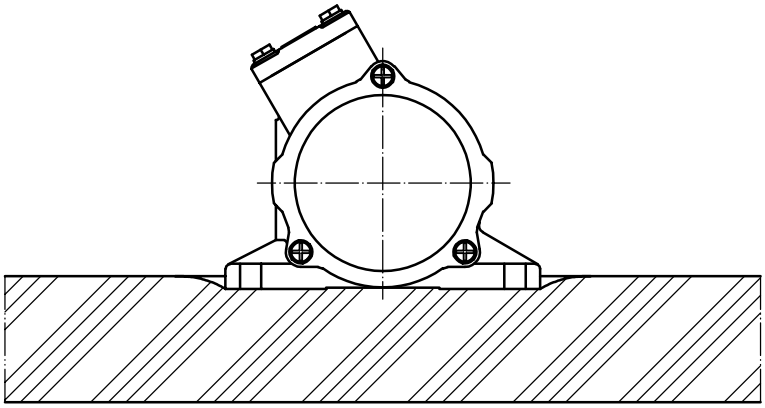


Figure B.1 — No-load test insulation — Mass of 50 kg

B.2 Load test

The vibrator with its payload shall be located on a vibration-insulation base selected according to their total mass such that the minimum acceleration is 30 m/s^2. Depending on the total mass value (= vibrator mass + payload mass), one of the following three types of vibration-insulation base shall be used:

a) Total mass less than 50 kg

Vibrator and payload are located on a sponge mat (see Figure B.1, but with payload added).

b) Total mass from 50 kg to 300 kg

Vibrator and payload are located on a vibration insulator consisting of a sponge mat and a spring mat (see Figure B.2).

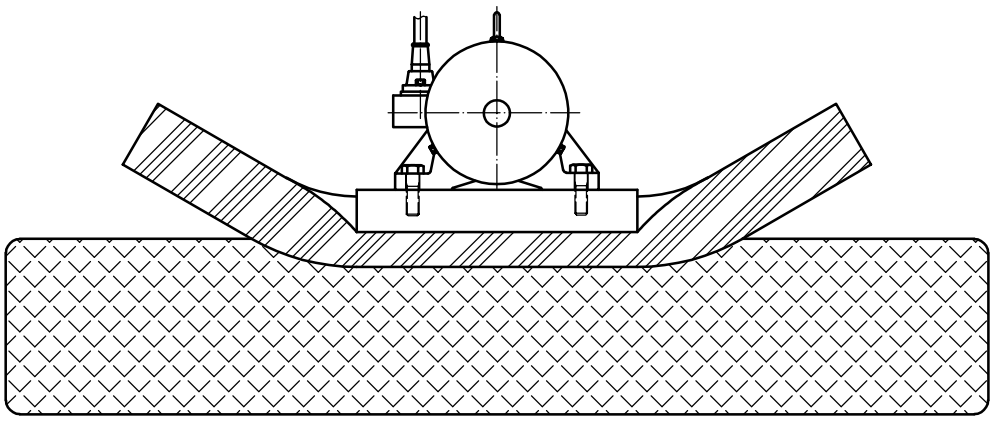


Figure B.2 — Load test insulation — Total mass 50 kg to 300 kg

c) Total mass greater than 300 kg

Vibrator and payload are located on four air springs (see Figure B.3) with technical characteristics according to B.3.2. Alternatively, other types of supporting elastic parts (e.g. rubber cylinders) with similar characteristics may be used.

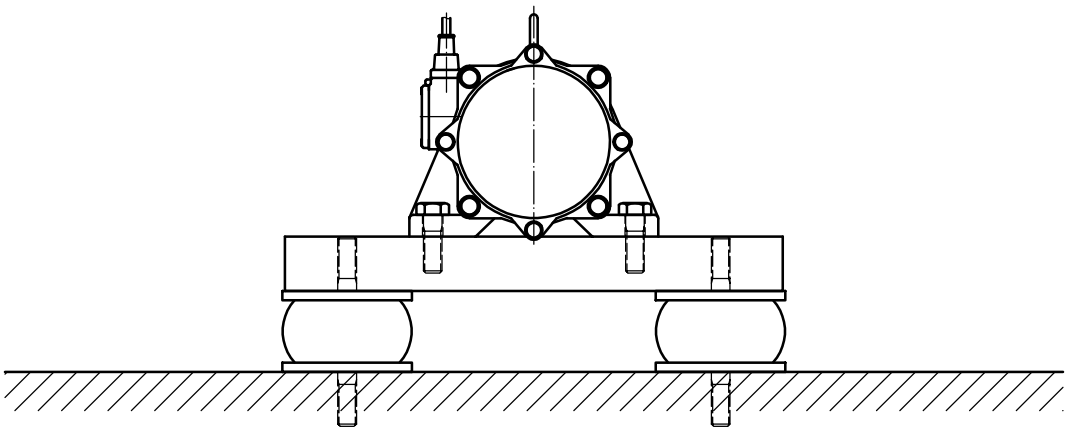


Figure B.3 — Layout of vibrator in load test — Total mass > 300 kg

B.3 Characteristics of vibration insulators

B.3.1 Sponge mat

The technical characteristics of the sponge shall be in accordance with Table B.1. The recommended size of the mat is 150 × 1 000 × 2 000 mm.

Table B.1 — Sponge-mat characteristics

Material	Density	Hardness	Tear strength	Tensile strength	Elongation	Rebound co-efficiency	Remained compression deflection
	kg/m^3	N	N/cm	kPa	%	%	%
Foamed urethane rubber	15,0 ± 1,5	75 ± 15	⩾ 2,0	⩾ 70	⩾ 120	⩾ 35	⩽ 6,0

B.3.2 Air springs

The technical characteristics of each air spring shall be in accordance with Figure B.4 and Table B.2.

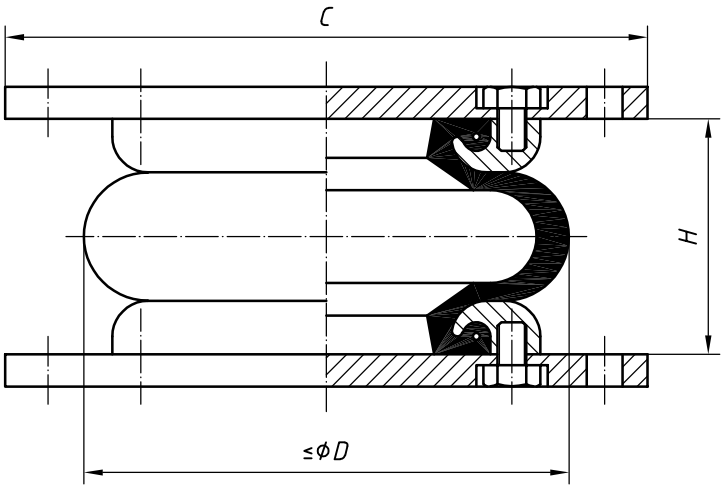


Figure B.4 — Main dimensions of air spring

Table B.2 — Air-spring characteristics

Standard inner pressure	Payload	Spring constant	Natural frequency	Height H			Maximum diameter of bellows D_{max}	Size of end plate C
MPa	kN	kN/m	Hz	mm			mm	mm
				minimum	normal	maximum		
0,4	5,5	150	2,6	45	102	125	205	180

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