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Building construction machinery and equipment — Pile driving and extracting equipment — Terminology and commercial specifications

Machines et matériels pour la construction des bâtiments — Matériel de battage et d'extraction — Terminologie et spécifications commerciales

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11886 was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*.

Annex A of this International Standard is for information olnly.

Introduction

This International Standard has been developed in order to unify terms, definitions and commercial specifications referring to machines and equipment for pile driving or extracting.

It is intended for use by designers, producers, dealers and users of pile driving/extracting machines. It can also be of use in discussions on further standardization activities.

Building construction machinery and equipment — Pile driving and extracting equipment — Terminology and commercial specifications

1 Scope

This International Standard specifies terms and definitions of the main types of mechanical equipment for pile driving/extracting, such as pile arrangements on the construction site, pulling, installation of piles at the point of driving, driving and extraction of piles, pile head crushing, etc. Machines for non-mechanical processing, such as the injection of small piles with supporting fluids, are not dealt with in this International Standard.

NOTE Annex A shows examples of pile driving and extracting equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO/TR 12603, *Building construction machinery and equipment — Classification*

EN 996, *Piling equipment — Safety requirements*

3 Terms and definitions

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

3.1
piling equipment
complete assembly of machines and components designed for installation or extraction piles or other longitudinal elements

3.2
base carrier
carrier machine
machine that provides mobility for and supports the mass of the piling equipment, together with the pile

NOTE The carrier machine may also accommodate the necessary power source and controls of the piling equipment. It may be an adapted lift crane or earth-moving machine or other machine specifically designed or adapted for this purpose. There are crawler, wheel, rail-mounted and floating carriers. The carrier includes necessary mountings to connect the leader or other guiding system.

3.3
crawler-mounted carrier
machine whose mobility is achieved by mounting it on a tracked undercarriage

See Figures A.1, A.2 and A.3.

3.4
wheel-mounted carrier
machine whose mobility is achieved by mounting it on a wheel undercarriage

See Figures A.4 and A.5.

3.5
rail-mounted carrier
machine whose wheeled undercarriage runs on rails

See Figure A.6.

3.6
floating carrier
machine that is fixed to or can move on a floating pontoon

See Figure A.7.

3.7
leader
guiding system
structure for mounting of the pile installation and extracting equipment

NOTE The leader or other guiding system enables the pile installation and extracting equipment to be accurately guided and aligned with the pile. It allows full freedom of axial movement of pile installation and extracting equipment. Additionally it may provide guidance to the pile. The leader or guiding system may be attached to the carrier machine in number of ways for its mobility. Different designs of the leaders and guiding systems can be identified (e.g. direct-mounted, boom-supported, swinging, guide cage or free-riding).

3.8
direct-mounted leader
structure directly coupled to the carrier machine

NOTE The major weight of the leader, pile, etc., is taken by the leader attachment (see 3.13) near the bottom of the leader.

3.9
boom-supported leader
structure connected to the boom head of the carrier machine

NOTE 1 The leader may extend above the boom head of the carrier machine. The major weight of the leader, pile, etc., is taken by the leader attachment at its fixing with the boom head.

NOTE 2 A further steadying connection is made by another part of the leader attachment at the lower leader structure.

3.10
swinging leader
structure suspended from the carrier machine boom head

3.11
guide cage
structure that provides guidance to the pile installation or extraction equipment and allows some limited axial movement of it during piling operations

3.12
free-riding attachment
part fixed within the structure of the pile installation or extracting equipment

NOTE The free-riding attachment comprises such parts as pile sleeves, legs, inserts and clamping devices (see 3.34).

3.13
leader attachment
connection between the carrier machine and leader

NOTE Different connections can be used (e.g. universal joints, sliding or telescopic elements).

3.14
piling rig
carrier machine complete with leader attachment and leader, but without the pile installation and other equipment

3.15
pile installation and extraction equipment
machine designed to cause pile movement relative to the surrounding soil

NOTE 1 The movement is downwards for installation and upwards for extracting types of equipment.

NOTE 2 The machines for pile installation and extraction can be divided into three main groups: impacting, vibration and static types.

3.16
impact equipment
machine that produces the striking energy by raising the striking mass and dropping it on the pile with the aim of energy transfer in a relatively short time

3.17
impact hammer
machine that drives piles into the soil and operates according to the **impact equipment** (3.16) operation principle

NOTE The striking mass may impact on the pile directly or indirectly. In the case of indirect impact on the pile, there are interference assemblies between the striking mass and the pile, which may comprise an anvil together with any form of pile cap assembly (see 3.30 and 3.31). Depending on the power source, the following types of impact hammers can be identified: winch operated, steam/air operated, diesel or hydraulically powered and the others.

3.18
winch-operated impact hammer
machine in which the striking mass is raised by a wire rope on a winch or similar means

See Figure A.8.

3.19
steam/air-operated impact hammer
machine in which the striking mass is raised by air or steam pressure

See Figure A.9.

3.20
diesel-powered impact hammer
machine in which the striking mass is raised by the expansion of gases resulting from the combustion of fuel and air

See Figure A.10.

NOTE Normally this is a fuel diesel engine, but kerosene, methanol or other fluids may also be used.

3.21
hydraulically powered impact hammer
machine in which the striking mass is raised by hydraulic pressure

See Figure A.11.

3.22
impact extractor
machine that withdraws piles from the soil and operates according to the impact equipment operation principle, using the upwards kinetic energy of a rising mass

See Figure A.15.

NOTE The striking energy of an extractor is derived from the upwards kinetic energy of a rising mass being transferred to the head of a pile by means of a linkage, wire rope connection or other mechanical means. Depending on the power source and operation method, the following type of impact extractors can be identified: hydraulic, pneumatic, steam/air, electric and using expansion of gases resulting from the combustion of fuel and air.

3.23
impact extractor/hammer
machine that combines the functions of driving and extracting piles and operates according to the impact equipment operation principle

NOTE Common designs of the impact hammer/extractor machines are powered and operated hydraulically and electrically.

3.24
vibrator for piling equipment
machine that generates unidirectional vibrations and is used to install or extract piles

See Figures A.12 to A.14.

NOTE In most instances the vibrations are vertical. Vibration can be produced by eccentric masses or other means, while a device, placed above the vibratory body dampens the vibrations for the protection of the supporting carrier. The element to be installed into or extracted from the ground is rigidly held under the vibratory gearbox by mean of one or several clamps. However, for units designed for annular grip, the clamping device can be located on the side(s) of the vibratory gearbox(es). The vibratory unit vibrates the element, which in turn vibrates the ground around it; ground particles can then move in relation to each other. Friction between the element and the soil is therefore reduced and the element is either driven by its own weight added to that of the vibrator or extracted by a pull from the carrier. Common designs of the vibrators are powered and operated hydraulically and electrically.

3.25
electric vibrator for piling equipment
electrically powered machine that generates unidirectional vibrations to install or extract piles

See Figure A.12.

3.26
hydraulic vibrator for piling equipment
hydraulically powered machine that generates unidirectional vibrations to install or extract piles

See Figures A.13 and A.14.

3.27
static pile pushing/pulling device
machine essentially designed for installing or extracting sheet piles by applying a steady force to the pile

See Figure A.16.

NOTE The force is applied by means of several hydraulic jacks that are clamped on a number of sheet piles that have previously been installed into the ground. A movable device equipped with one or several jacks clamped on one or several sheet piles to be installed or extracted uses the reaction from the structure to press those sheet piles into the ground or extract them from the ground.

3.28
personal lift platform
personal lift system
assembly used either for normal operation of the piling equipment or for service, maintenance or repair work

3.29
piling accessories
auxiliary elements for the execution of pile driving and extracting

EXAMPLES Drive caps, helmets, plates, followers, clamping devices, pile guides, acoustic shrouds and shock/vibration absorbing devices, power packs/generators and personal lift systems.

3.30
drive cap
element located between the striking mass and the pile

NOTE A drive cap may be guided from a leader or contained within the structure of the piling equipment. It may incorporate cap filling or cushion material between the striking mass and the cap or other mechanical features, which influence the shape of the impact stress wave in the pile.

3.31
hammer helmet
pile cap provided with a recess on its underside to locate a pile and to accommodate additional cushioning material to protect the pile head from damage

3.32
plate
element located below a pile cap to enable larger profile piles to be driven

3.33
dolley
follower
interfacing part between the underside of the drive cap, helmet or plate and the pile head, to enable the pile to be installed deeper into the ground, or a larger diameter of pile to be accommodated

3.34
clamping device
assembly that can grip the pile and which allows the transmission of extraction force from an impact extractor, or forces from a pile pushing/pulling device

NOTE A clamping device is usually hydraulically or mechanically actuated and may also be integrated with the construction of the pile installation or extraction equipment.

3.35
clamping device for vibrators
assembly that can grip the pile head and which allows the transmission of vibration from a vibrator

3.36
pile-handling device
unit that includes a remote release shackle for lifting the pile and pile threader for remotely positioning and assembling an adjacent interlocking pile

3.37
pile guide
unit fixed to, or guided by, the leader to provide location and support to the pile when at forward or backward inclinations

3.38
acoustic shroud
unit that can be provided to enclose part or all of the pilling equipment and pile to attenuate the emission of noise during the piling operation

3.39
shock/vibration-absorbing device
unit used with a vibrator or impact extractor to isolate the supporting crane from the forces being transmitted to the pile

NOTE Shock/vibration-absorbing devices are usually integral with the construction of the pile installation or extraction equipment.

3.40
pile
properly formed pole driven vertically into unfirm ground as the support for a superstructure

NOTE 1 Piles may be made of timber, concrete (precast or cast *in situ*), or steel (tubes or rolled sections).

NOTE 2 They may have an interlocking feature to enable pile sections to be joined together.

4 Commercial specifications

4.1 General characteristics of piling equipment

4.1.1 Main assemblies

For safety requirements for piling equipment, see EN 996.

For classification of piling equipment, see ISO/TR 12603.

Main assemblies shall be specified according to the type of the piling equipment. Examples of specifications are given in Figures A.1 to A.7.

4.1.2 Dimensional characteristics

4.1.2.1 **Overall dimensions in working position** (Figures A.1 to A.7)

The following characteristics shall be specified:

— total height, H (mm);

— lifting height maximum length of the pile, H_1 (mm);

— length, L (mm);

— width, W (mm).

4.1.2.2 Overall dimensions during transport

The following characteristics shall be specified:

— height, H_t (mm);

— length, L_t (mm);

— width, W_t (mm).

4.1.3 Maximum angles of pile inclination

The following angles shall be specified:

— to the front, φ_1 (deg);

— to the rear, φ_2 (deg);

— to the sides (left and right), φ_3 (deg).

4.1.4 Mass of the pile

The following characteristic shall be specified:

— maximum mass of the pile (kg).

4.1.5 Piling equipment mass parameters

The following characteristics shall be specified (referring to the piling equipment in standard configuration):

— operating mass (kg);

— mass during transport (kg);

— unit ground pressure (MPa).

4.1.6 Engine(s) power

The following characteristic shall be specified:

— engine power or total power of the engines installed (kW).

4.1.7 Carrier machine

4.1.7.1 Types of carrier machine (see Figures A.1 to A.7)

The following characteristics shall be specified:

— crawler crane;

— crawler excavator;

— crawler-mounted carrier;

— wheel-mounted carrier;

— rail-mounted carrier;

— floating carrier.

4.1.7.2 Power source of the carrier machine and its distribution

Specify combustion engine with

— mechanical,

— hydraulic,

— pneumatic, or

— electrical

power distribution to the moving parts.

4.1.7.3 Engine characteristics

The following characteristics shall be specified:

— engine brand and type;

— power (specify standard) (kW);

— cooling type.

4.1.7.4 Mass of the carrier machine

Specify the mass of the carrier machine (kg).

4.1.8 Pile installation and extracting equipment

4.1.8.1 Types of hammer

Specify whether the hammer is:

— winch operated;

— steam/air operated;

— diesel powered;

— hydraulically powered.

4.1.8.2 Power sources

Specify whether the power source is:

— combustion engine with hydraulic pump, air compressor, electric generator, etc., combined in a power pack;

— steam boiler or steam generator;

— direct diesel combustion system in the hammer;

— stationary supply or a local power network (e.g. industrial plants) with the power transmission by hoses or electric cables.

4.1.8.3 Power source data

The following characteristics shall be specified.

a) Combustion engine:

   — engine brand and type;

— power (specify standard) (kW);

— cooling type.

b) Steam boiler or steam generator:

— steaming capacity (kg/h).

c) Required characteristics of the power source in the case of a stationary supply:

— power (kW);

— air capacity (m^3/min).

4.1.8.4 Characteristic of winches

For any type of winch (pile winch, hammer winch or auxiliary winch) specify:

— max. wire rope pull (kN);

— max. wire rope speed (m/min).

4.2 Main characteristics of pile installation and extraction equipment

4.2.1 Impact hammers for pile driving

4.2.1.1 **Winch-operated impact hammer** (see Figure A.8)

The following characteristics shall be specified:

— mass (kg);

— length, H (mm);

— dimensions of the cross section, $B \times C$ (mm $\times$ mm);

— dimension from axis to face of leader (mm);

— position of centre of gravity, G (mm).

4.2.1.2 **Steam/air operated impact hammer** (see Figure A.9)

The following characteristics shall be specified:

— mass of the ram (kg);

— operating pressure (MPa);

— steam consumption (kg/h);

— air consumption (m^3/min);

— blow rate at maximum energy (min^{-1});

— impact energy (kN·m);

— hammer mass (kg);

— hammer length, H (mm);

— hammer width, W (mm);

— length of pile engagement, L (m);

— width of the clamping gap, B (mm);

— distance from the hammer axis to the face of the leader, E (mm);

— position of centre of gravity, G (mm);

— operating mode: single or double acting.

4.2.1.3 Diesel-powered impact hammer (see Figure A.10)

The following characteristics shall be specified:

— mass of the ram (kg);

— stroke of the ram (mm);

— impact energy (kN·m);

— blow rate at maximum energy (min^{-1});

— fuel consumption (l/h);

— lubricant consumption (l/h);

— hammer mass (kg);

— hammer length, H (mm);

— distance from the hammer axis to the face of the leader, E (mm);

— position of centre of gravity, G (mm).

4.2.1.4 Hydraulically powered impact hammer (see Figure A.11)

The following characteristics shall be specified:

— mass of the ram (kg);

— impact energy (kN·m);

— blow rate at maximum energy (min^{-1});

— hammer mass (kg);

— parameters of the hydraulic drive

  — power input (kW),

- flow rate (l/min),
- maximum pressure (MPa);

— hammer length, H (mm);

— dimensions of the cross section, $B \times C$ (mm × mm);

— distance from the hammer axis to the face of the leader, E (mm);

— position of centre of gravity, G (mm);

— operating mode: single or double acting.

4.2.2 Vibrators for piling equipment

4.2.2.1 **Electric vibrator** (see Figure A.12)

The following characteristics shall be specified:

— max. centrifugal force (kN);

— eccentric moment (N·m);

— vibration frequency (Hz);

— max. vibration amplitude (mm);

— max. extracting force (kN);

— max. clamping force (kN);

— number of vibrator electric motors
  - total power rating (kW),
  - revolutions (min^{-1}),
  - a.c. voltage (V),
  - current (A);

— min. capacity of power source (kV·A);

— total mass of the machine (kg);

— unbalanced mass of the vibrator rotor (kg);

— lifting capacity of the handling crane (kN);

— dimensions
  - overall height with the shock absorber, H (mm),
  - height without the shock absorber, H_1 (mm),

- length of the vibrator, A (mm),
- width of the vibrator, B (mm),
- width of the clamping jaws, C (mm),
- width of the clamping gap, D (mm),
- distance from the vibrator axis to the face of the leader, E (mm),
- width of the vibrator to the centre, F (mm).

4.2.2.2 **Hydraulic vibrator** (see Figure A.13)

The following characteristics shall be specified:

- centrifugal force (kN);
- eccentric moment (N·m);
- max. vibration amplitude (mm);
- vibration frequency (Hz);
- hydraulic flow rate (l/min);
- max. pressure (MPa);
- vibrator power (kW);
- max. clamping force (kN);
- max. extracting force (kN);
- lifting capacity of the handling crane (kN);
- unbalanced mass of the vibrator rotor (kg);
- total mass of the machine (kg);
- dimensions
  - overall height with the shock absorber, H (mm),
  - height without the shock absorber, H_1 (mm
  - length of the vibrator, A (mm),
  - width of the vibrator, B (mm),
  - width of the clamping jaws, C (mm),
  - width of the clamping gap, D (mm),
  - length of the vibrator to the centre, A_1 (mm).

4.2.2.3 Electric or hydraulic vibrators with the passage holder of the housing pipe (see Figure A.14)

The following characteristics shall be specified:

— centrifugal force (kN);

— eccentric moment (N·m);

— max. vibration amplitude (mm);

— vibration frequency (Hz);

— hydraulic flow rate (l/min);

— max. pressure (MPa);

— vibrator power (kW);

— max. clamping force (kN);

— max. extracting force (kN);

— dynamic mass (kg);

— total mass of the machine (kg);

— lifting capacity of the handling crane (kN);

— dimensions

  — overall height with the vibration absorber, H (mm),

  — height without the vibration absorber, H_1 (mm),

  — length of the vibrator, A (mm),

  — width of the vibrator, B (mm),

  — maximum diameter of the housing pipe, C (mm).

4.2.2.4 Pneumatic powered extractor (see Figure A.15)

The following characteristics shall be specified:

— mass of the piston (kg);

— impact frequency (min^{-1});

— air consumption (m^3/min);

— operating pressure (MPa);

— extraction energy (kN·m);

— extractor mass (kg);

— dimensions:

  — overall height with the shock absorber, H (mm),

  — extractor height without the shock absorber, H_1 (mm),

  — width of the clamping gap, D (mm).

4.2.3 Static pile pushing/pulling device

(For installing or extracting longitudinal sheet piles; see Figure A.16)

The following characteristics shall be specified:

— installing force (kN);

— cylinder stroke (mm);

— extraction force (kN);

— speed of installation (m/min);

— speed of extraction (m/min);

— max. adjusting tilt angles of main frame (deg)

  — to the front, φ_1

  — to the rear, φ_2

— operating pressure (MPa);

— total mass of the machine (kg);

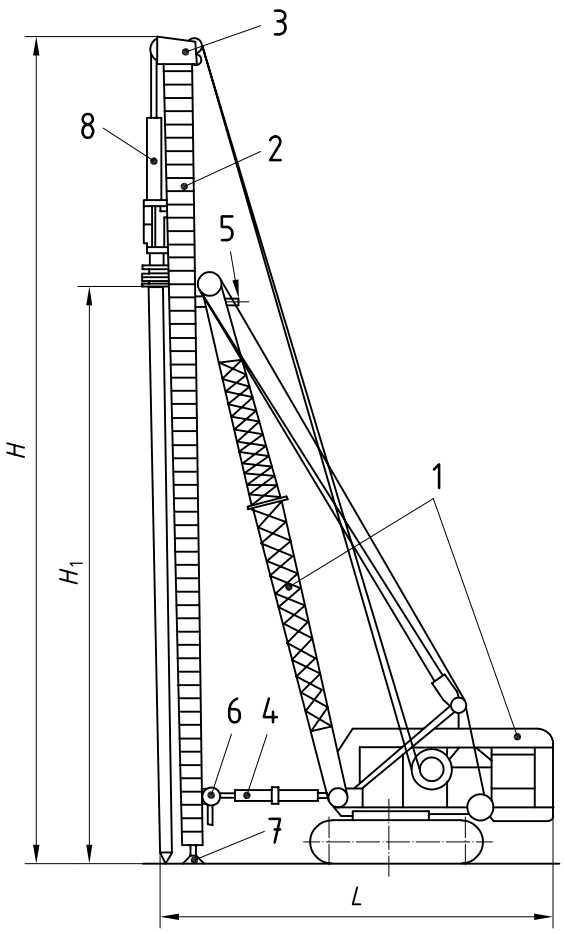
— dimensions

  — total height, H (mm),

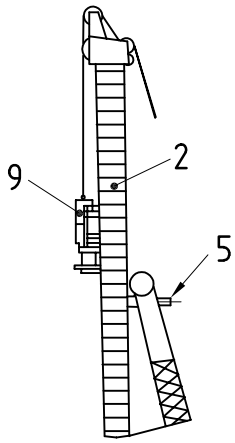
  — total width, A (mm).

Annex A
(informative)

Examples of pile driving and extracting equipment and assemblies



a) Diesel-powered impact hammer

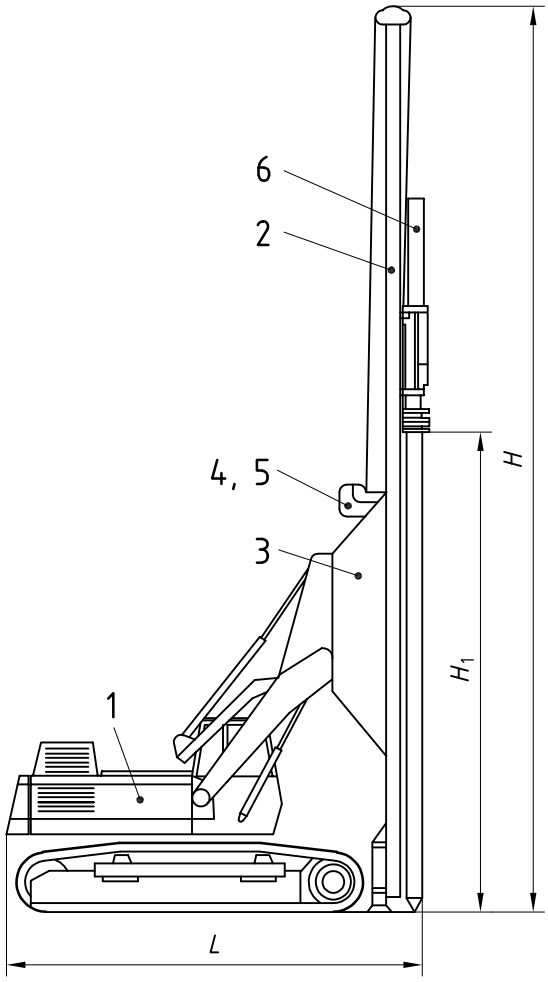


b) Winch-operated impact hammer

Key

1 Crawler crane
2 Boom-supported leader
3 Leader cathead
4 Leader attachment — lower stay
5 Leader attachment — upper swivel
6 Leader attachment — side-adjusting system
7 Leader foot
8 Diesel-powered hammer
9 Winch-operated impact hammer

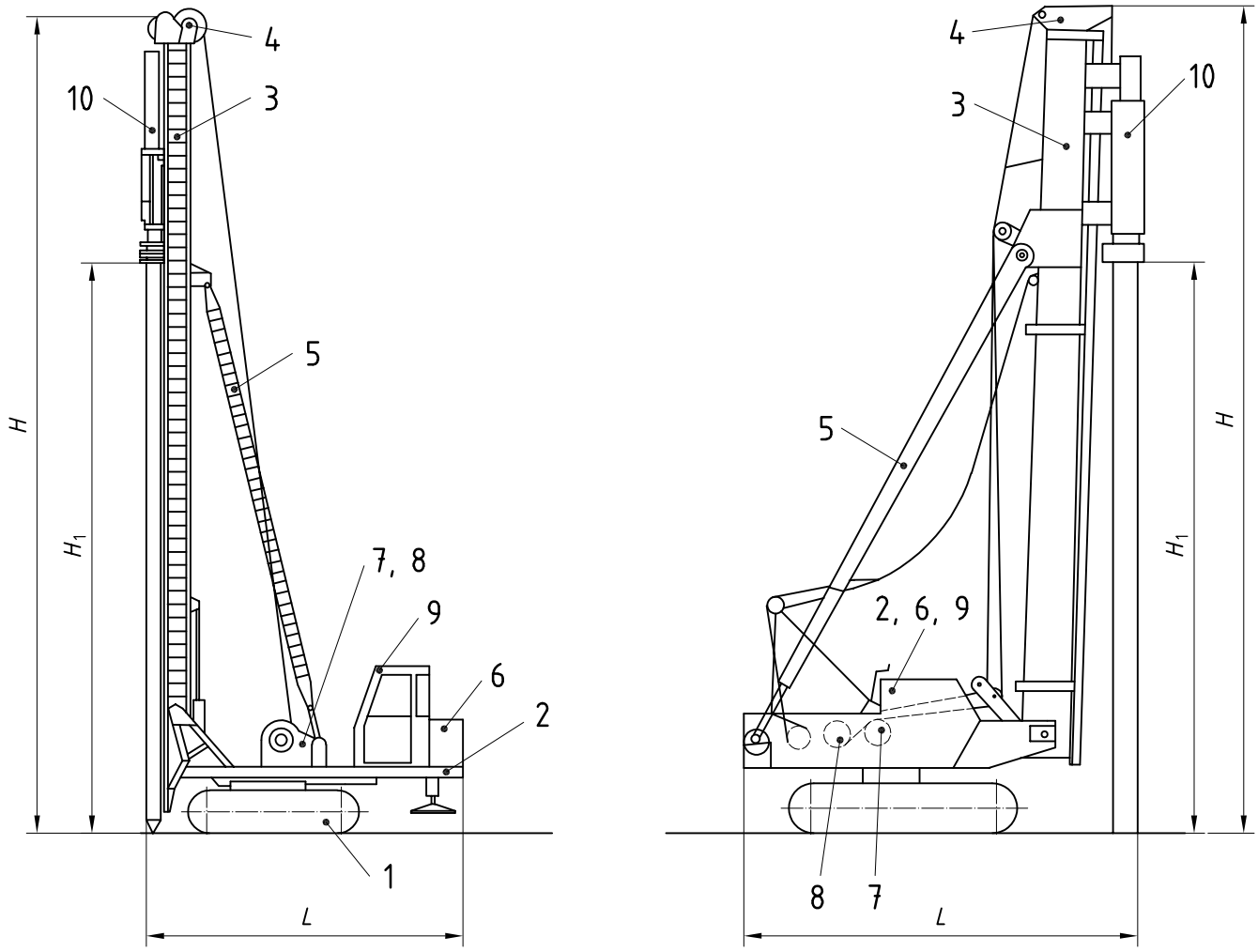
Figure A.1 — Piling equipment mounted on a crawler crane



Key

1 Crawler excavator
2 Direct mounted leader
3 Leader attachment
4 Pile winch
5 Pile hammer winch
6 Diesel-powered impact hammer

Figure A.2 — Piling equipment mounted on a crawler excavator with diesel-powered impact hammer



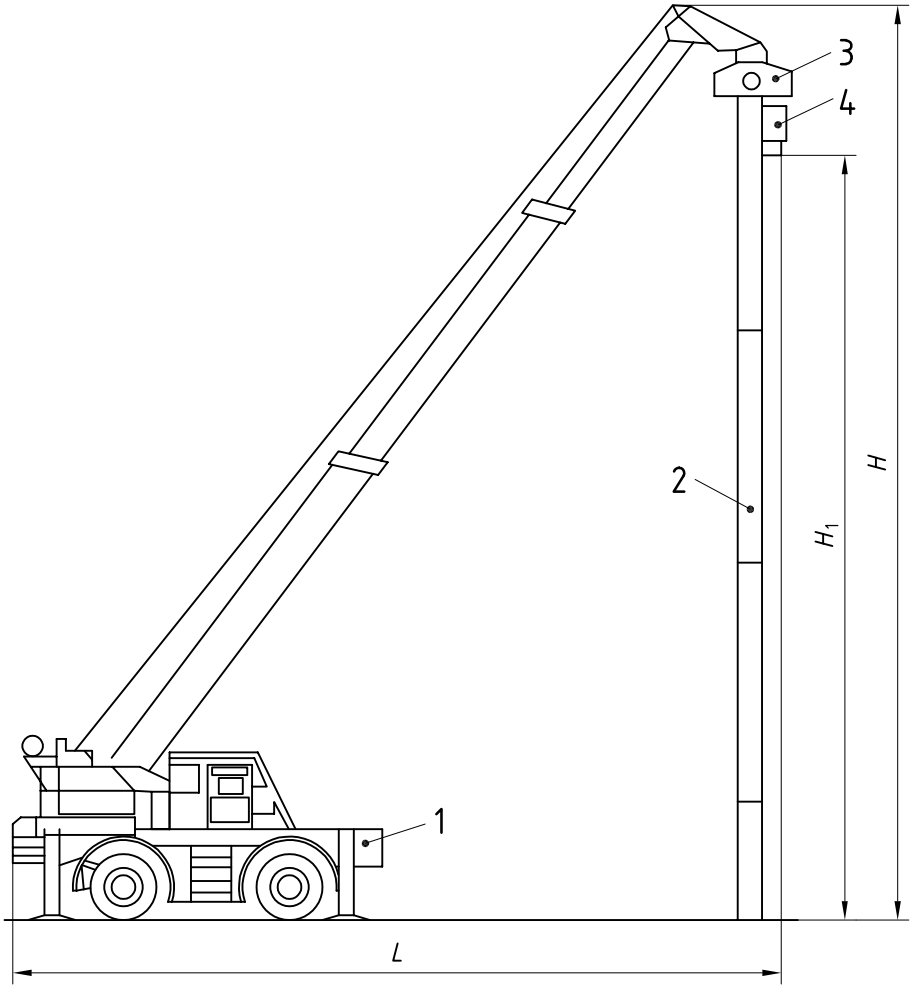
a) With erection in work-place by mean of hydraulic cylinders

b) With erection in work-place by mean of wire rope winches

Key

1 Crawler undercarriage
2 Carrier superstructure
3 Direct-mounted leader
4 Leader cathead
5 Backstays
6 Power unit
7 Pile winch
8 Impact hammer winch
9 Operator's cab
10 Pile installation equipment

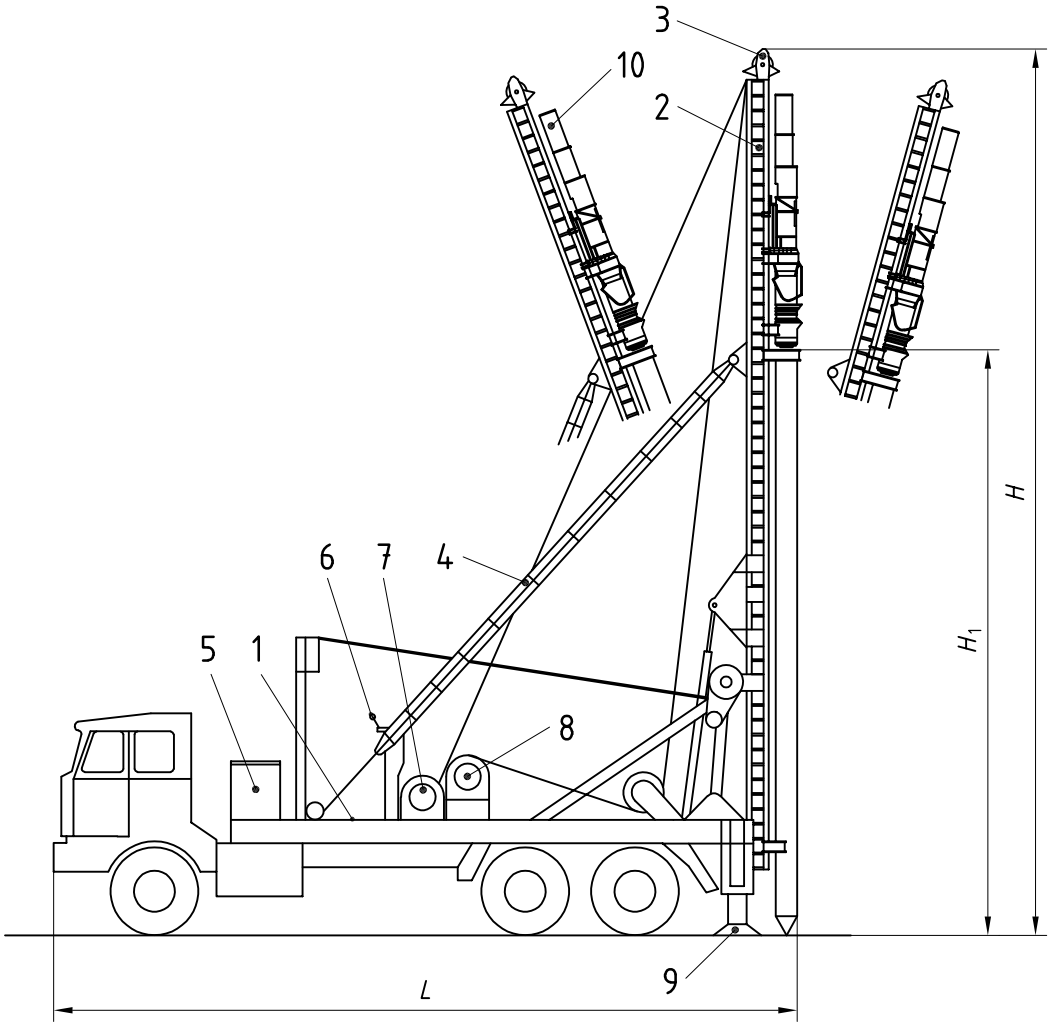
Figure A.3 — Two designs of piling equipment on crawler-mounted carriers



Key

1 Wheeled carrier
2 Swinging leader
3 Leader attachment — upper swivel
4 Pile installation equipment

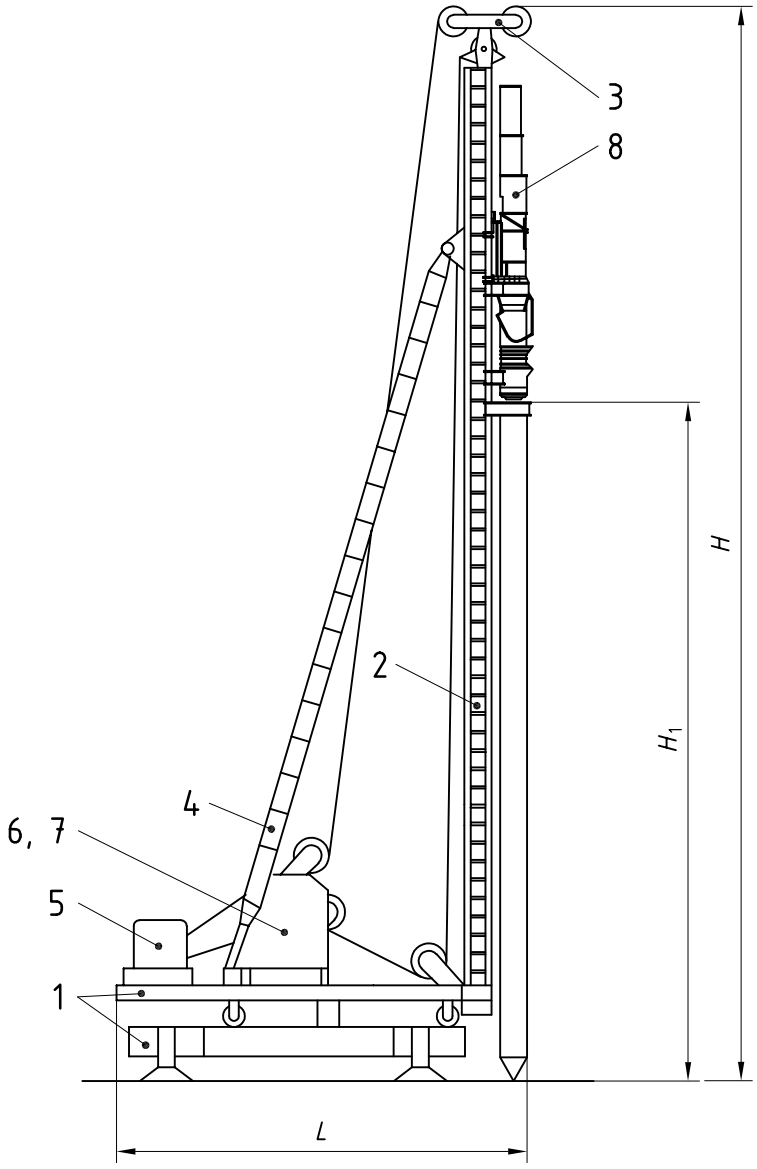
Figure A.4 — Piling equipment on a wheeled carrier



Key

1	Wheeled chassis	6	Control levels
2	Direct-mounted leader	7	Pile winch
3	Leader cathead	8	Impact hammer winch
4	Backstays	9	Outrigger supports
5	Power unit	10	Pile installation equipment

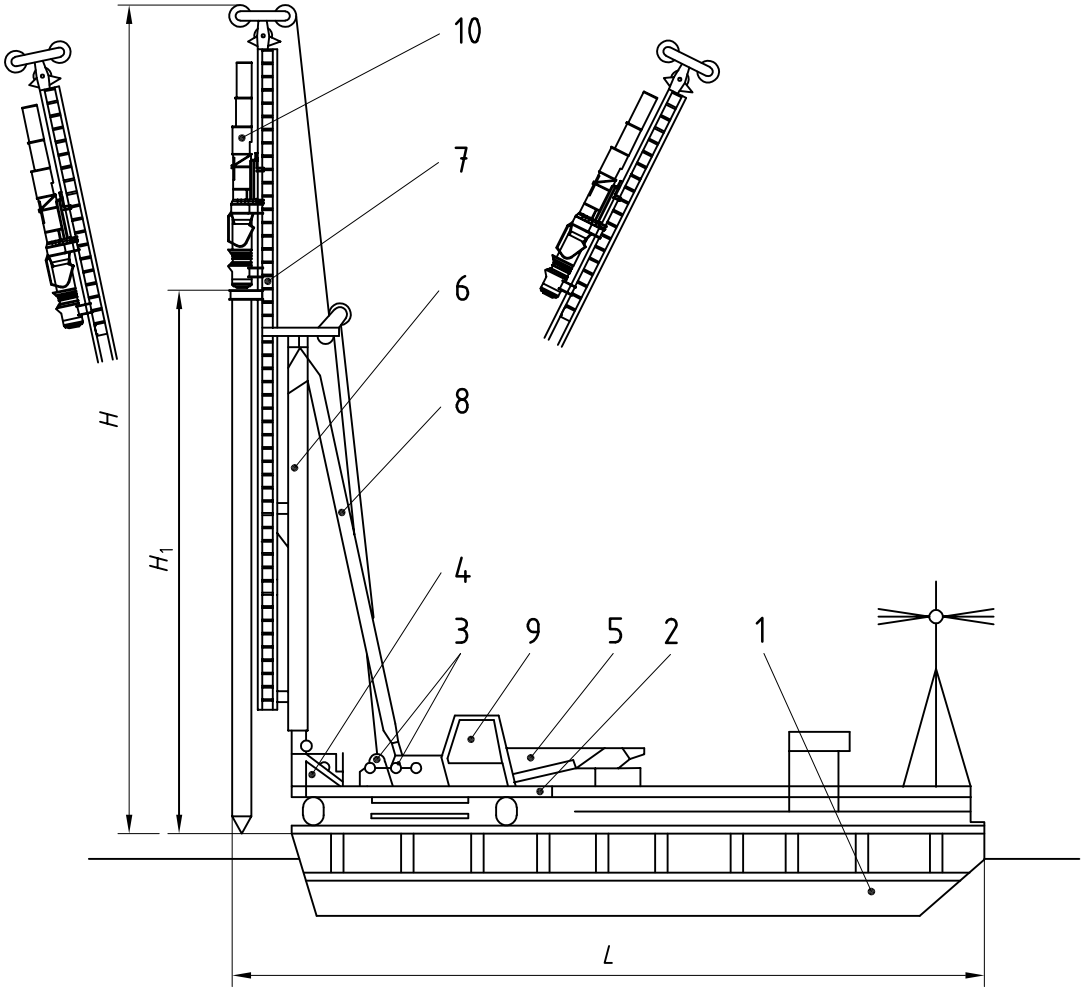
Figure A.5 — Piling equipment on a wheeled carrier with winch-operated impact hammer



Key

1	Rail-mounted carrier	5	Power unit
2	Direct-mounted leader	6	Pile winch
3	Leader cathead	7	Impact-hammer winch
4	Backstays	8	Pile installation equipment

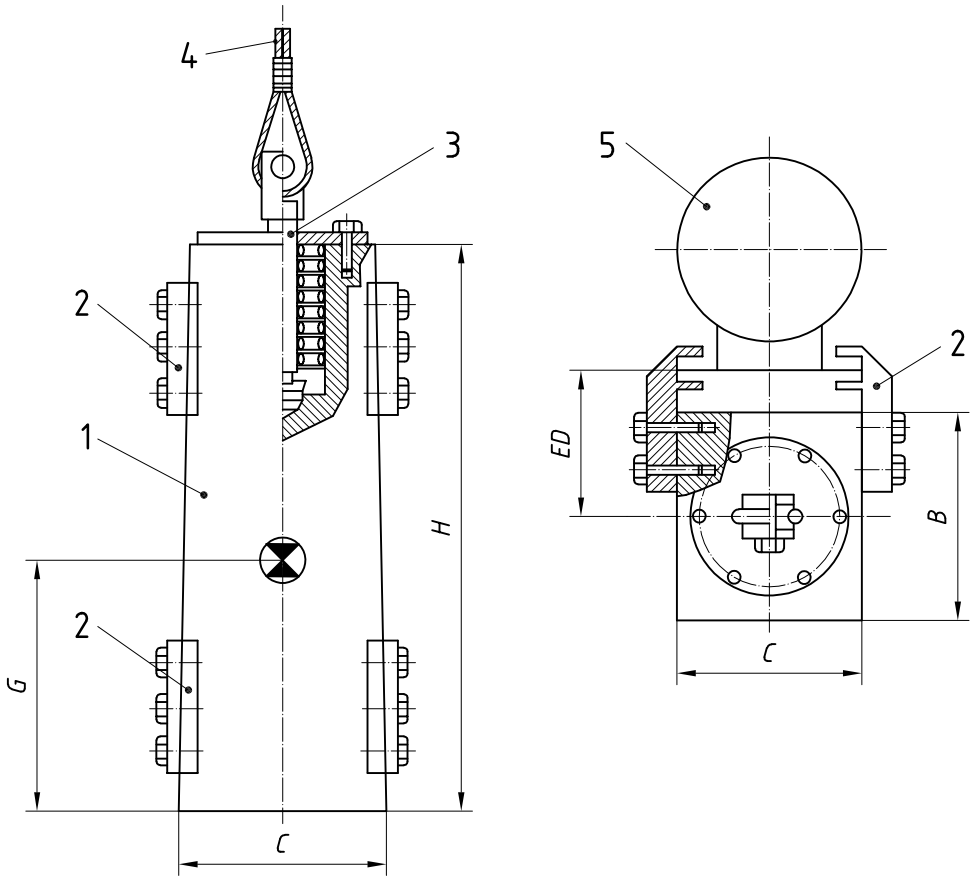
Figure A.6 — Piling equipment on a rail carrier with winch-operated impact hammer



Key

1	Pontoon	6	Mast
2	Slewing superstructure	7	Leader
3	Main winch	8	Backstays
4	Auxiliary winch	9	Operator's cab
5	Power unit	10	Pile installation equipment

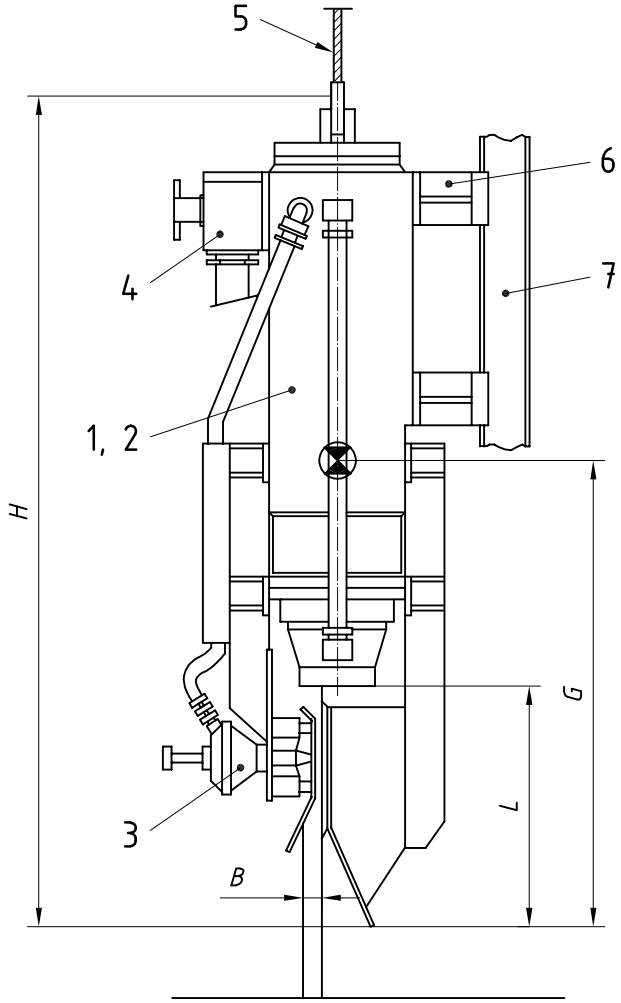
Figure A.7 — Piling equipment on a floating carrier with diesel-powered impact hammer



Key

1 Ram
2 Hammer guide
3 Winch rope damper
4 Handling sling
5 Leader of the piling equipment

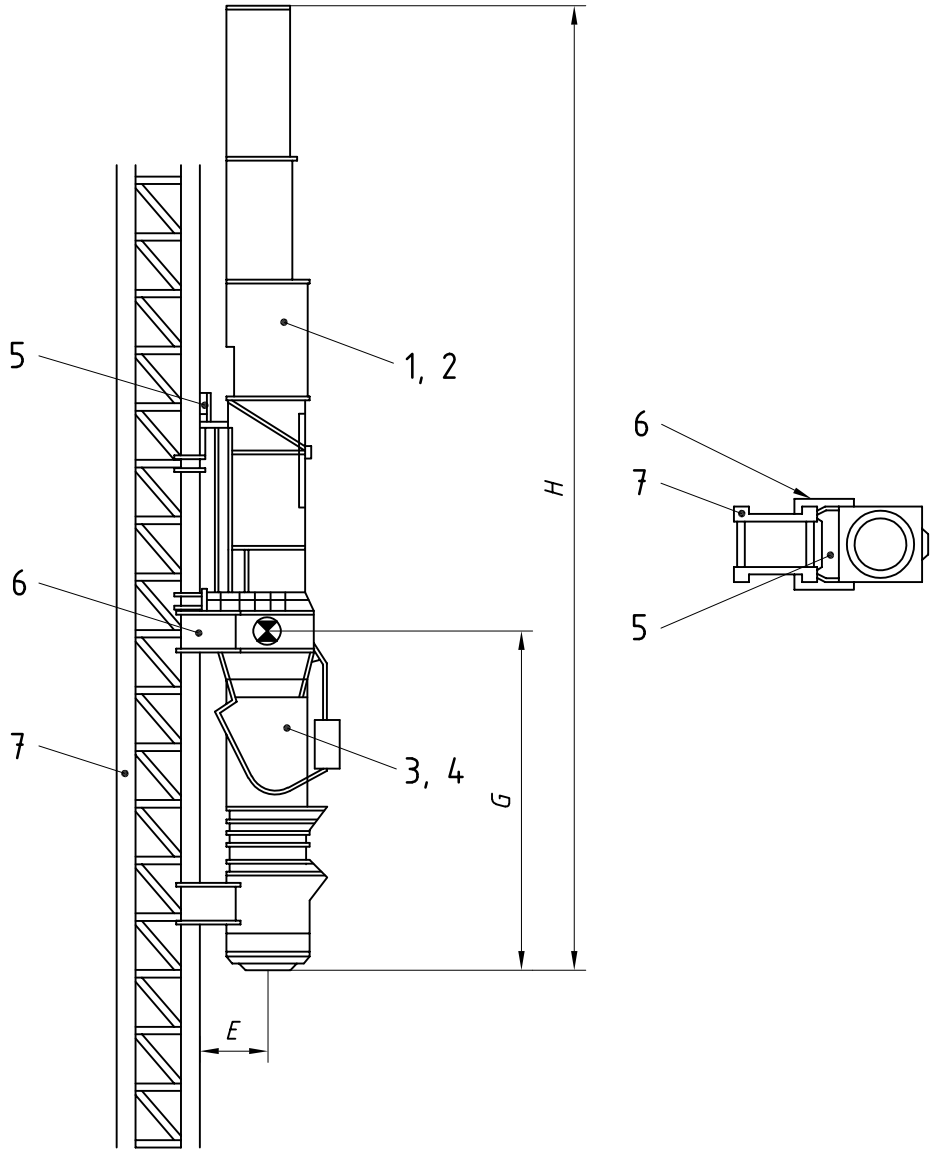
Figure A.8 — Winch-operated impact hammer



Key

1 Hammer body
2 Ram
3 Clamping device
4 Control valve
5 Handling sling
6 Hammer guide
7 Piling equipment leader

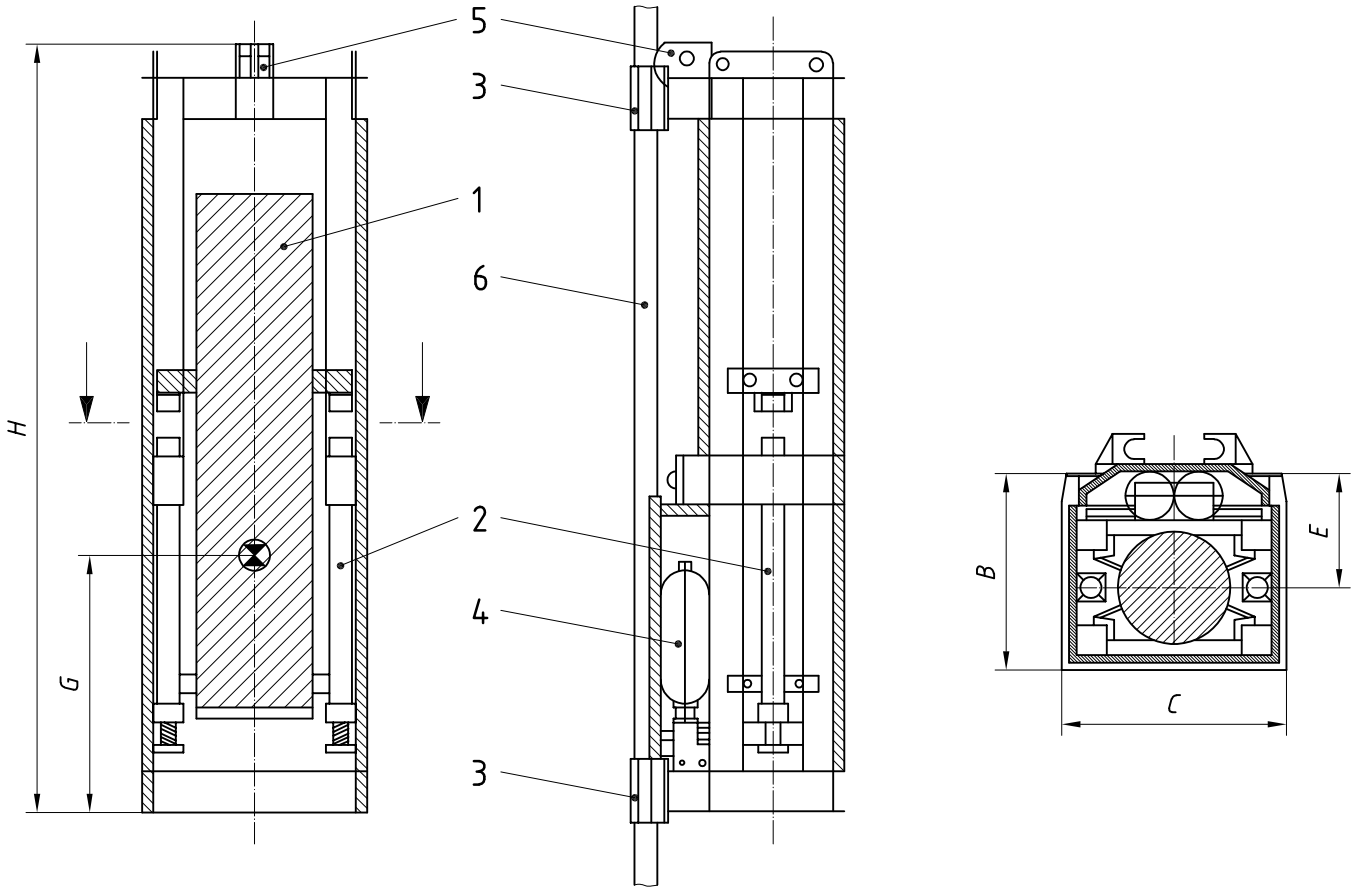
Figure A.9 — Steam/air-operated impact hammer



Key

1	Hammer body	5	Hammer lifting assembly
2	Ram	6	Hammer guide
3	Fuel pump	7	Piling equipment leader
4	Lubricant pump		

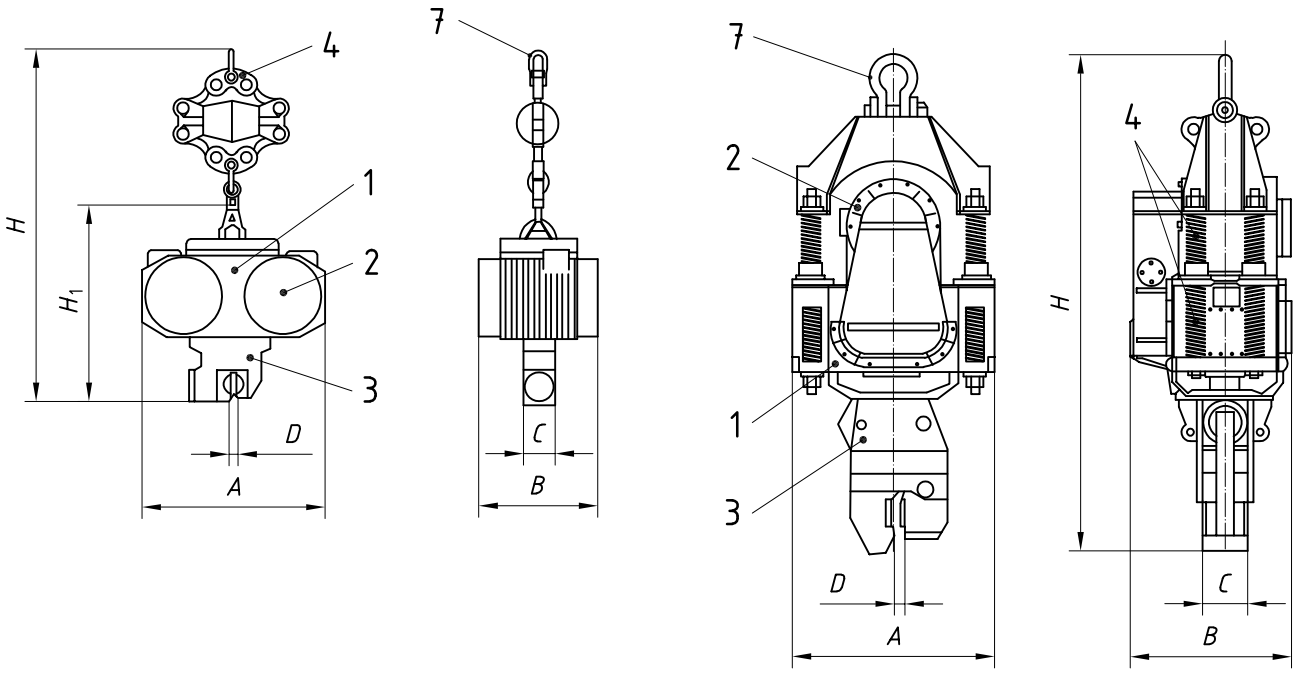
Figure A.10 — Piling equipment with diesel-powered impact hammer



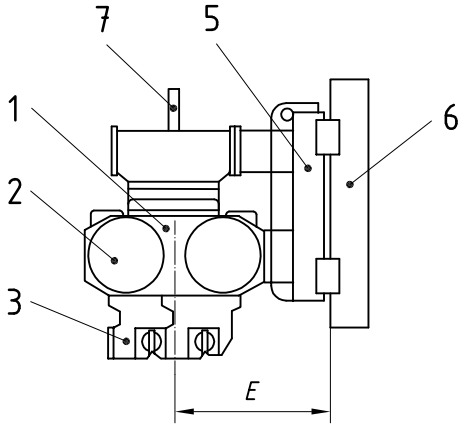
Key

1 Ram
2 Hydraulic lift cylinder
3 Hammer guide
4 Hydraulic accumulator
5 Hammer lifting assembly
6 Piling equipment leader

Figure A.11 — Piling equipment with hydraulically powered impact hammer



a) Vibrators suspended on crane wire rope

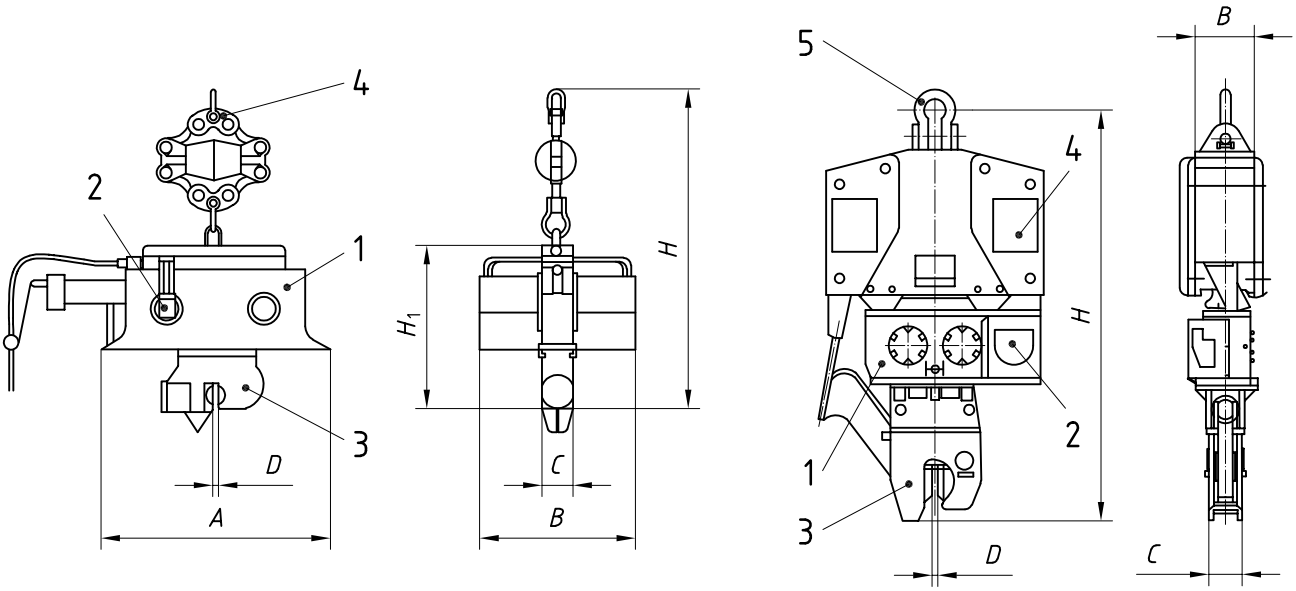


b) Vibrator installed on piling equipment leader

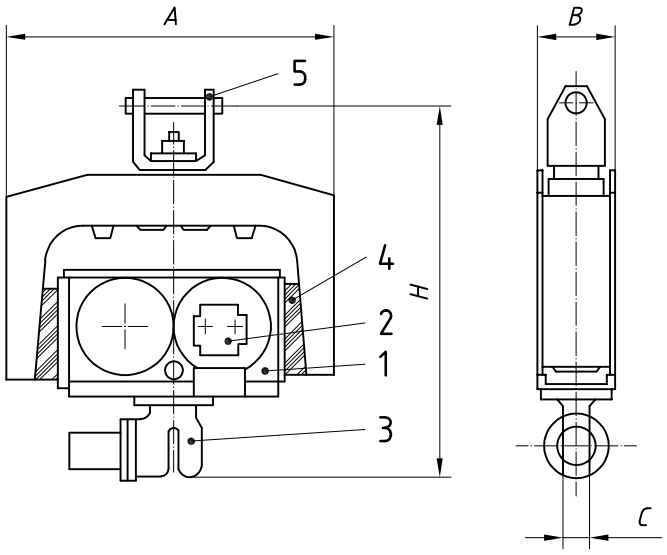
Key

1 Vibrator body
2 Electric motor
3 Clamping device
4 Shock absorber
5 Vibrator guide
6 Piling equipment leader
7 Vibrator lifting assembly

Figure A.12 — Electric vibrators



a) Vibrators suspended on crane wire rope

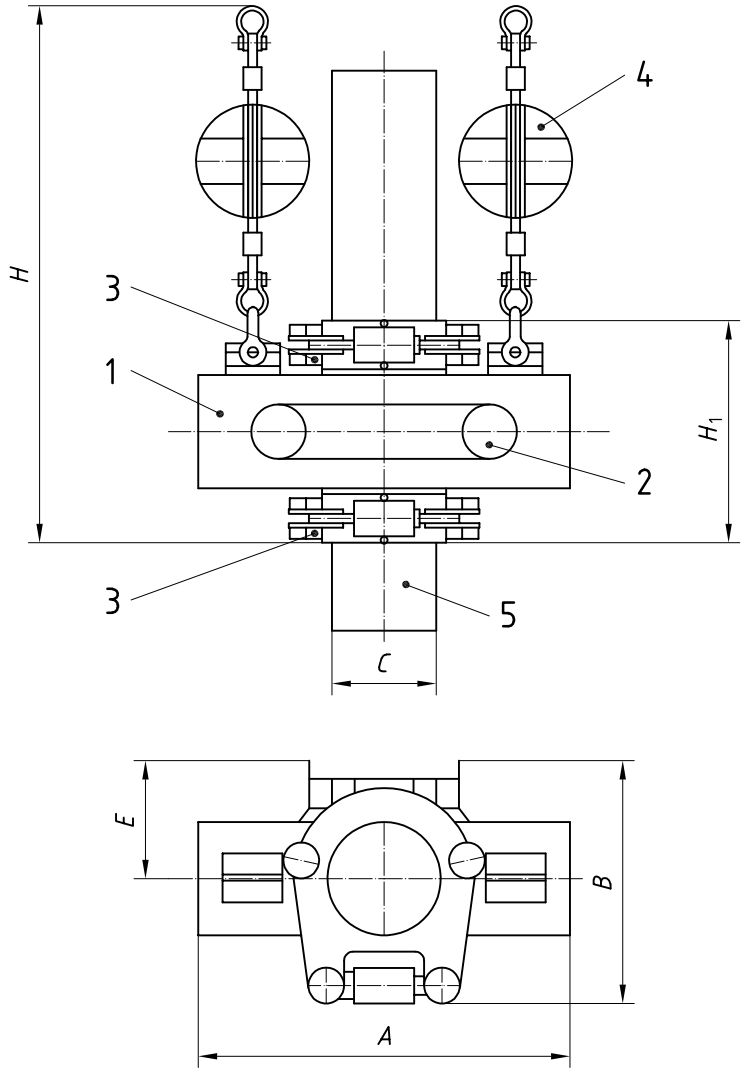


b) Vibrators installed on piling equipment leader

Key

1 Vibrator body
2 Hydraulic motors
3 Clamping device
4 Shock absorber
5 Vibrator lifting assembly

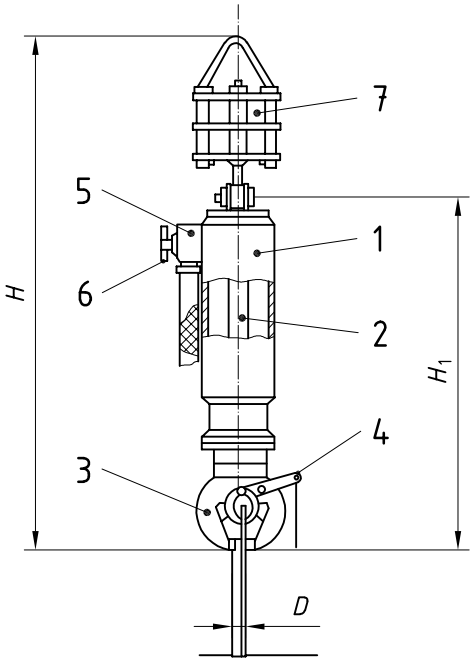
Figure A.13 — Hydraulic vibrators



Key

1 Vibrator body
2 Hydraulic motors
3 Hydraulic clamps
4 Shock absorber
5 Housing pipe

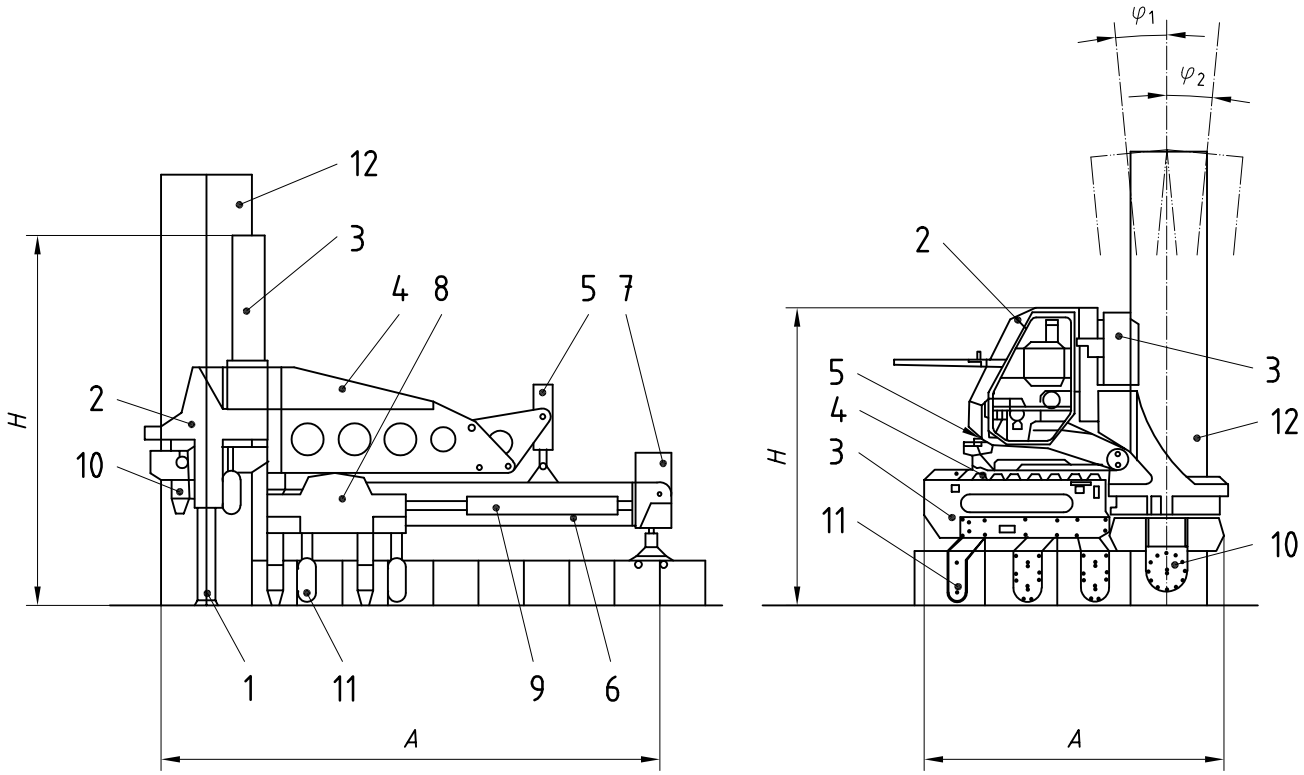
Figure A.14 — Hydraulic vibrator with the passage holder of the housing pipe, used for execution of reinforced concrete piles cast *in situ*



Key

1 Extractor body
2 Striking mass (ram)
3 Clamping device
4 Clamp release lever
5 Extractor control valve
6 Extractor control valve handle
7 Shock absorber

Figure A.15 — Pneumatic-powered impact extractor



Key

1	Front support	7	Grip guide support cylinder
2	Main frame	8	Grip body
3	Pushing/pulling cylinder	9	Grip travelling cylinder
4	Jib	10	Pushing/pulling jaws
5	Adjustment cylinder	11	Grips
6	Grip travel guide	12	Sheet pile

Figure A.16 — Two designs of static pile pushing/pulling devices for installing or extracting longitudinal sheet piles

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