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Earth-moving machinery — Hydraulic excavators and backhoe loaders — Methods of determining tool forces

Engins de terrassement — Pelles hydrauliques et chargeuses-pelleteuses — Méthodes de détermination des forces de l'outil

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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 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 6015 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 1, *Test methods relating to machine performance*.

This second edition cancels and replaces the first edition (ISO 6015:1989), which has been technically revised.

Earth-moving machinery — Hydraulic excavators and backhoe loaders — Methods of determining tool forces

1 Scope

This International Standard specifies methods for measuring and calculating the tool forces of earth-moving attachments fitted to hydraulic excavators and the hoe equipment of backhoe loaders. It is applicable to hydraulic excavators and backhoe loaders as defined in ISO 6165.

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 6016:1998, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 6746-1:2003, *Earth-moving machinery — Definitions of dimensions and codes — Part 1: Base machine*

ISO 7135:1993, *Earth-moving machinery — Hydraulic excavators — Terminology and commercial specifications*

ISO 7451:1997, *Earth-moving machinery — Volumetric ratings for hydraulic excavator buckets and backhoe loader buckets*

ISO 7546:1983, *Earth-moving machinery — Loader and front loading excavator buckets — Volumetric ratings*

ISO 9248:1992, *Earth-moving machinery — Units for dimensions, performance and capacities, and their measurement accuracies*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
tool force
force generated at the bucket lip or cutting edge, but not at the tips of the teeth, when operating the bucket or arm cylinders independently

3.2
arm cylinder tool force
force generated at the bucket lip with the arm cylinder positioned to provide a rotating moment around the arm pivot

NOTE The bucket lip moves towards the base machine when hoe equipment is used.

3.3
arm cylinder tool force at level crowd
⟨shovel equipment⟩ horizontal arm cylinder tool force generated by the arm cylinder at the bucket lip when the bucket's attitude is level and maintained parallel to the ground line and the lip is at the ground line

3.4
bucket cylinder tool force
tool force generated at the bucket lip with the bucket cylinder(s) positioned to provide a rotating moment to the bucket around its pivot

NOTE The bucket lip moves towards the base machine when hoe equipment is used and away from it when shovel equipment is used.

3.5
crowd tool force
⟨hydraulic excavators with telescoping boom⟩ tool force generated at the bucket lip when the telescoping boom is retracted

3.6
rated tool force
tool force, measured or calculated, that the manufacturer publishes

3.7
actual tool force
measured tool force generated at the bucket without tipping or sliding occurring

3.8
maximum [arm cylinder] [bucket cylinder] [crowd] tool force
largest measured or calculated tool force

3.9
grab [clamshell] closing force
force generated between the grab [clamshell] cutting edges or teeth tips when closing

3.10
maximum grab [clamshell] closing force
largest measured or calculated grab [clamshell] closing force

3.11
arm force radius
A
radius of the arc that passes through the bucket lip and whose centre is located at the arm pivot

See Figure 5.

3.12
bucket force radius
B
radius of the arc that passes through the bucket lip and whose centre is located at the bucket pivot

See Figure 6.

3.13
grab [clamshell] force radius
C
radius of the arc that passes through the grab or clamshell lip and whose centre is located at the grab or clamshell pivot

See Figure 7.

3.14
operating mass
OM
mass of the base machine with equipment and empty attachment as specified by the manufacturer, and with the operator (75 kg), full fuel tank and all fluid systems at the levels specified by the manufacturer

[ISO 6016:1998, definition 3.2.1]

3.15
working circuit hydraulic pressure
normal operating pressure applied to the specific circuit by the pump(s)

3.16
maximum relief circuit hydraulic pressure
maximum static pressure in a specific circuit limited by a relief valve at a flow no greater than 10 % of the rated circuit flow

3.17
hydraulic limit
condition when the tool forces are limited by maximum relief circuit pressure

3.18
tipping limit
condition when the tool forces are limited by the onset of tipping of the machine

3.19
slipping limit
condition when the tool forces are limited by the machine slipping on the test surface

4 Measurement methods

4.1 Test site and general

The test site shall consist of a level, hard surface, with anchor points and space for using the measuring devices specified in 4.2.1 to 4.2.3. For measurements made below the ground plane, a space below that plane is required for acceptance of the machine tool and the measurement devices, the anchorage and any auxiliary equipment.

All measurements shall be accurate to within ± 2 % or shall accord with an International Standard relative to test equipment accuracy.

In the preferred method, the force to be measured is applied directly to the force measuring device (4.2.1). If the force is applied via a pulley, its friction should be taken into account. The wire rope (4.2.4) should be as short as possible to minimize the affect on accuracy.

4.2 Test apparatus

4.2.1 Force measuring device, of accuracy according to ISO 9248.

4.2.2 Hydraulic oil pressure measuring device, of accuracy according to ISO 9248.

4.2.3 Instrument(s) for measuring linear dimensions, of accuracy according to ISO 9248.

4.2.4 Wire ropes and shackles, **pulley**, **safety chains and adjustable supporting frames**.

4.3 Preparation for testing

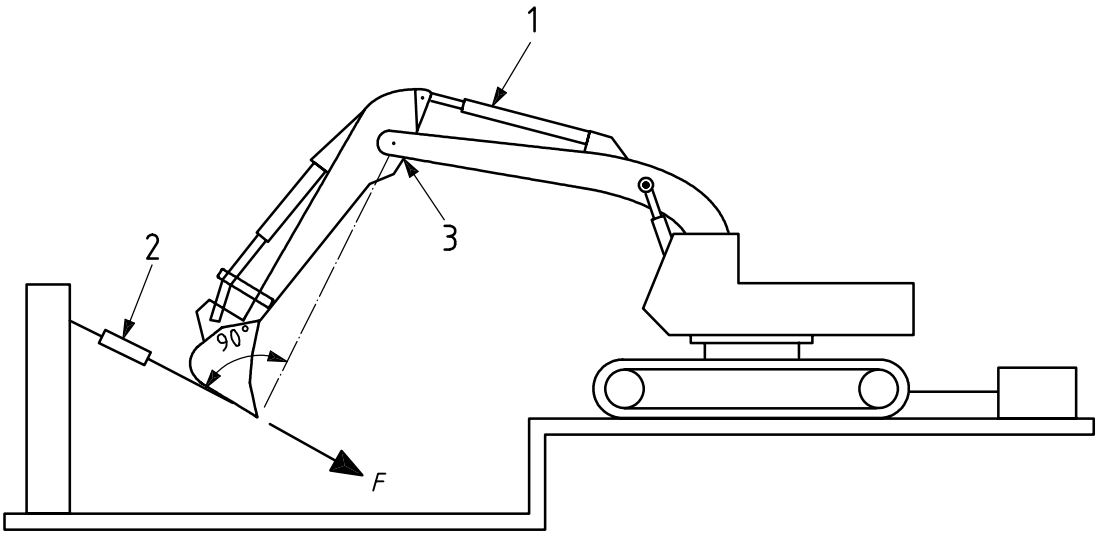
The machine shall be equipped according to ISO 6016.

The machine shall be fitted with the bucket, grab or clamshell and appropriate counterweights, and shall have the tyre pressure, and tyre ballast or track tension as specified by the manufacturer.

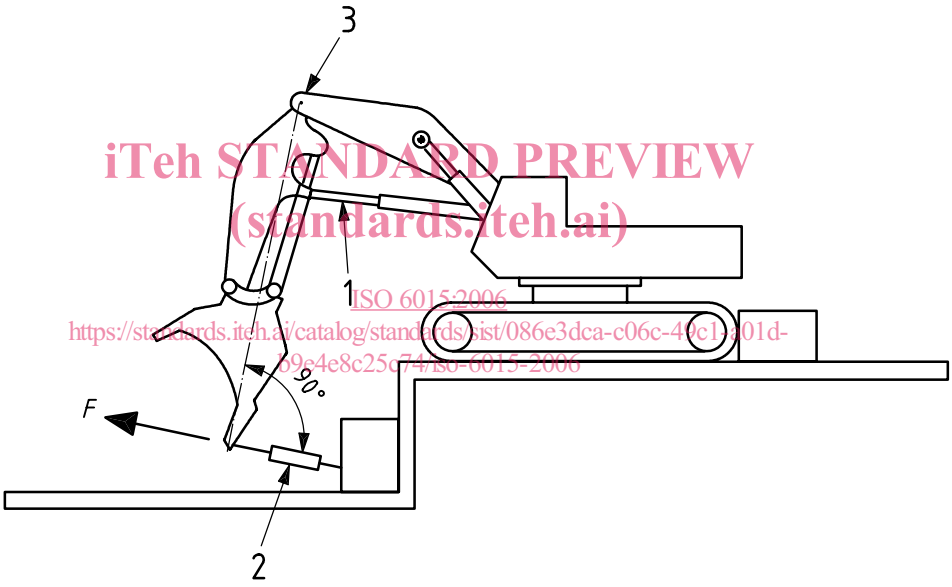
The hoe, shovel, grab or clamshell equipment for each test shall be as specified by the manufacturer.

Prior to testing, the engine and hydraulic system shall attain the normal operating temperature. The working circuit hydraulic pressure and maximum relief circuit hydraulic pressure shall then be checked for compliance with the manufacturer's ratings using the measuring device specified in 4.2.2.

The machine shall be positioned on the test site. The bucket or attachment shall be connected to a force measuring device (4.2.1), as shown in Figures 1, 2, 3, and 4.



a) Hydraulic excavator fitted with hoe

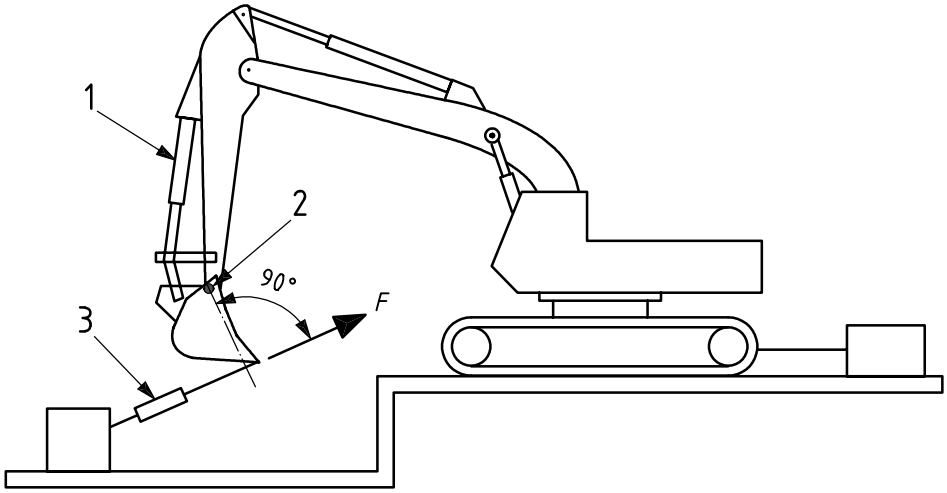


b) Hydraulic excavator fitted with shovel

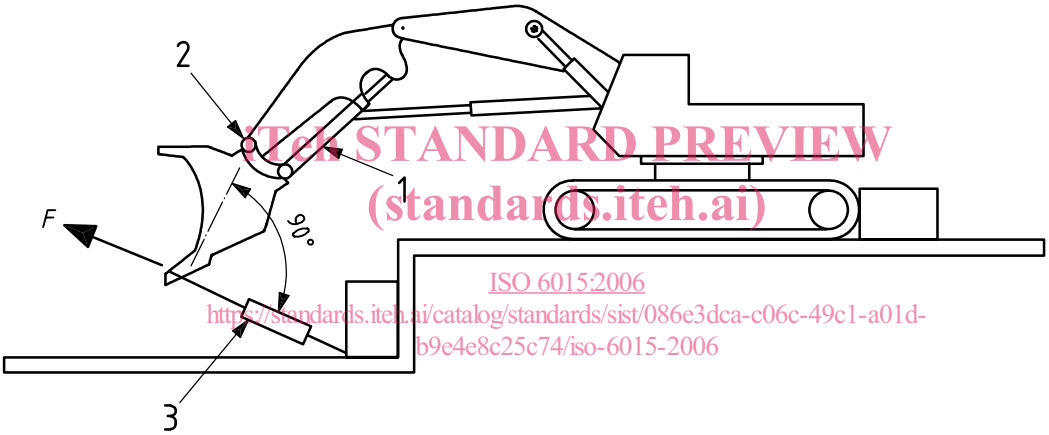
Key

F	tool force
1	arm cylinder
2	force measuring device (load cell)
3	arm pivot

Figure 1 — Typical arrangements for measuring maximum arm cylinder tool force (see 4.8.2)



a) Hydraulic excavator fitted with hoe

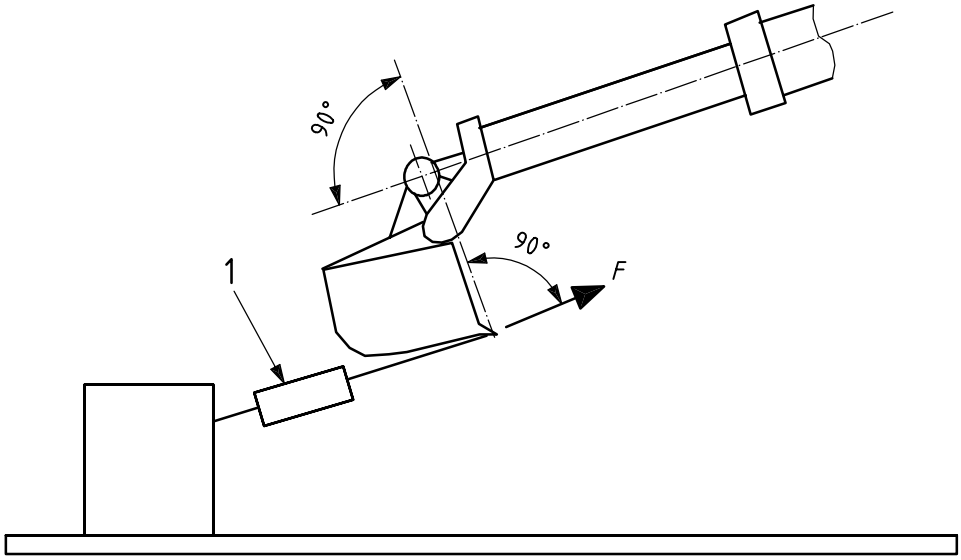


b) Hydraulic excavator fitted with shovel

Key

F	tool force
1	bucket cylinder
2	bucket pivot
3	force measuring device (load cell)

Figure 2 — Typical arrangements for measuring maximum bucket cylinder tool force (see 4.8.3)

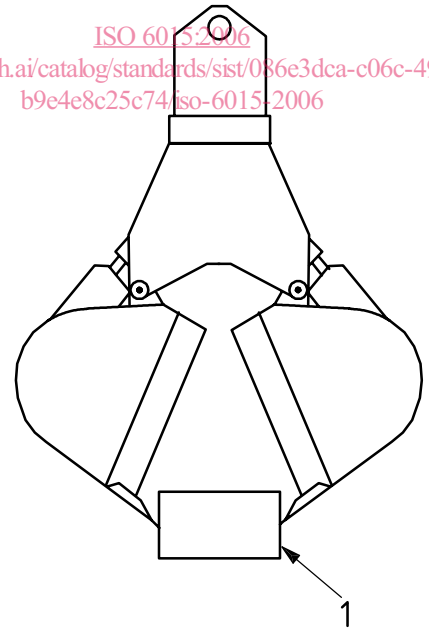


Key

F tool force

1 force measuring device (load cell)

Figure 3 — Hydraulic excavator fitted with telescoping boom — Typical arrangement for measuring maximum crowd tool force (see 4.8.4)



Key

1 force measuring device (load cell)

Figure 4 — Grab or clamshell attachment — Typical test arrangement for measuring grab/clamshell closing force (see 4.8.5)