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Earth-moving machinery — Safety —

Part 12: Requirements for cable excavators

Engins de terrassement — Sécurité —

Partie 12: Exigences applicables aux pelles à câble

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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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html

This document was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

This second edition cancels and replaces the first edition (ISO 20474-12:2008), which has been technically revised with the following changes:

— normative references have been updated;

— references to national and regional provisions in the withdrawn ISO/TS 20474-14 have been deleted;

— new safety requirements and protective measures have been added, including requirements for the operator's protective guard.

It is intended to be used in conjunction with ISO 20474-1.

A list of all parts in the ISO 20474 series, published under the general title, *Earth-moving machinery — Safety,* can be found on the ISO website.

Introduction

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

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

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

ISO 20474 provides acceptable safety requirements for earth-moving machinery. This standard does not necessarily provide requirements to meet all national and regional regulatory provisions, e.g. Japan does not allow object handling with earth-moving machinery.

Earth-moving machinery — Safety —

Part 12: Requirements for cable excavators

1 Scope

This document gives the safety requirements specific to cable excavators as defined in ISO 6165. It is intended to be used in conjunction with ISO 20474-1, which specifies general safety requirements common to two or more earth-moving machine families. The specific requirements given in this document take precedence over the general requirements of ISO 20474-1.

This document deals with all significant hazards, hazardous situations and events relevant to the earth-moving machinery within its scope (see ISO 20474-1:2017, Annex A) when used as intended or under conditions of misuse reasonably foreseeable by the manufacturer. It specifies the appropriate technical measures for eliminating or reducing risks arising from relevant hazards, hazardous situations or events during commissioning, operation and maintenance.

It is applicable only to the machine itself if the cable excavator is intended for use in combination with other equipment or attachments such as drill rigs and those for pile driving or extracting and moving (e.g. rail-track, walking legs, pontoon, ship equipment or stationary undercarriages). It does not deal with the specific hazards relevant to such additional equipment or attachments.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4310, *Cranes — Test code and procedures*

ISO 5010, *Earth-moving machinery — Rubber-tyred machines — Steering requirements*

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

ISO 6014, *Earth-moving machinery — Determination of ground speed*

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

ISO 10262:1998, *Earth-moving machinery — Hydraulic excavators — Laboratory tests and performance requirements for operator protective guards*

ISO 15219, *Earth-moving machinery — Cable excavators — Terminology and commercial specifications*

IEC 60204-32, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines*

ISO 20474-1:2017, *Earth-moving machinery — Safety — Part 1: General requirements*

EN 791:1995, *Drill rigs — Safety*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20474-1, ISO 15219, and the following, apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
cable excavator
excavator having a wire-rope-operated upper structure designed primarily for excavation with a dragline bucket, front shovel or grab, used for compacting material with a compaction plate, for demolition work by hook or ball, and for material handling with special *equipment* (3.3) and *attachments* (3.2)

Note 1 to entry: See Annex B for illustrations.

Note 2 to entry: For the definition of *excavator*, see ISO 6165 or ISO 20474-5.

[SOURCE: ISO 6165:2012, 4.4.3, modified — By adding Notes 1 and 2.]

3.2
boom hoist system
boom system comprising lower, intermediate and head sections, and A-frame and boom hoist winch systems

3.3
lift system
main winch system used for earth-moving, demolition, compaction and object-handling (e.g. with hook assembly) applications

3.4
swing
rotation of the upper structure of an excavator in relation to a fixed reference frame on the ground

3.5
working swing revolution speed
turntable-swing speed, reached in a 180° revolution of the upper structure, with maximum rotation command input starting from a still position

Note 1 to entry: It is expressed in revolutions per minute (r/min).

3.6
deceleration swing angle
angle measured in degrees of swing while the swing motion is decelerated from working swing revolution speed to a complete stop

3.7
swing torque
torque which propels the upper structure relative to the undercarriage

Note 1 to entry: It is expressed in Newton metres (N · m).

3.8
swing service brake
device or system used to decelerate the rotation of the upper structure and to bring it to a stop at any position

EXAMPLE Frictional brake, electrically operated brake, hydrostatically or other hydraulically operated brake.

Note 1 to entry: See Annex A.

3.9
swing parking brake
device or system used to hold the stopped upper structure in any stationary position (e.g. transport position)

Note 1 to entry: See Annex A.

4 Safety requirements and protective measures

4.1 General

Cable excavators shall comply with the safety requirements and protective measures of ISO 20474-1, in as far as those are not modified by the specific requirements of this clause.

4.2 Operator's station

4.2.1 General

ISO 20474-1:2017, 4.3 shall apply, with the additions and modifications given in 4.2.2 and 4.2.3 below.

4.2.2 Roll-over protective structures (ROPS)

ISO 20474-1:2017, 4.3.3, does not apply to cable excavators.

4.2.3 Operator's protective guard

Cable excavators shall be designed such that an operator's protective structure (top and front guard) can be fitted.

A protective structure (top and front guard) shall be offered by the manufacturer and selected by the user according to the existing risk of the application. The protective structures shall be in accordance with ISO 10262:1998, 7.

4.3 Operator's controls and indicators

4.3.1 Controls for driving and steering

ISO 20474-1:2017, 4.5.1 and 4.6.1, shall apply, except that the movements of the controls for driving and steering do not need to correspond to the intended direction of movement if the upper structure is not in the normal driving direction.

4.3.2 Warning indicator

ISO 20474-1:2017, 4.5.1, shall apply. Additionally, warning indicators shall be provided at the operator station or other relevant location to indicate the activation of the free-fall operations (see 4.6.2) and to indicate the deactivation of the load moment limiting devices (see 4.7.1) during dragline bucket, grab and front shovel application.

4.4 Steering

ISO 20474-1:2017, 4.6, shall apply, with the following exceptions.

ISO 20474-1:2017, 4.6.2, shall apply only for rubber-tyred cable excavators with a travel speed of more than 30 km/h, measured according to ISO 6014.

For rubber-tyred machines with a travel speed ≤ 30 km/h, ISO 5010 shall apply, except for the requirements for emergency steering.

4.5 Swing brakes

Cable excavators shall be equipped with swing service and swing parking brake systems, which shall meet the requirements given in Annex A.

4.6 Lift system

4.6.1 Force-controlled operation (lifting, lowering)

The lift system of cable excavators shall be fitted with a brake that actuates immediately after the release of lever or pedal controls.

The brake system shall automatically actuate in case of a loss of energy or force-controlled lowering. There shall be no effect on the stability of the excavator during this operation.

The brake system shall be capable of holding the rated load as specified in 4.8.

4.6.2 Free-fall operation

The lift system of a cable excavator shall be fitted with a brake that actuates immediately after

— corresponding activation of the pedal control, or

— release of a hand-operated lever control.

The brake shall be so designed that a dynamic load and a progressive actuation is possible. The rope guide shall be so designed that an uncontrolled run-up or run-off of the rope is avoided.

4.6.3 Switchover

There shall be no load lowering in case of a switchover from force-controlled to free-fall operation.

4.6.4 Boom

The boom of a cable excavator shall be secured against repulsing in the case of a sudden release of the load.

The boom shall be equipped with a limit switch to avoid backward overload.

The connection (bolts) of the boom-pieces shall be so designed that mounting and disassembling can be carried out without the need for a person to remain under the boom.

4.6.5 Ropes

The ropes of cable excavators shall have safety factors in accordance with Table 1.

Table 1 — Safety factors of ropes

Attachments Dragline Grab Hook	Group 1					
	Lift or closing ropes	Digging ropes	Boom-holding ropes			
			Operating with load connected		Lifting boom without load	
			Active ropes	Static ropes	Active ropes	Static ropes
Safety factor[a]	3,55	3,0	3,55	3,0	3,05	3,0

[a] The factors are the relation between the minimum breaking force of the rope and the maximum static load of the cable excavator when used as intended.

4.6.6 Rope drum, rope pulley

4.6.6.1 General

The rope drum and rope pulley shall be built and designed so that damage to the rope and run-off or trip-out of the rope guide is avoided.

4.6.6.2 Rope drum

The ratio between the rope drum diameter and rope diameter shall be 1:20 at a minimum.

4.6.6.3 Rope pulley

The ratio between the rope pulley diameter and rope diameter shall be 1:22 at a minimum, measured at the thread of the groove. Exceptions to this are permitted for fair leads of drag ropes, rope guidance pulleys and auxiliary ropes, such as grab guidance rope, digging guidance rope, ballast guidance rope of fair leads.

4.6.6.4 Flanged wheel projection

The beaded edge of the winch drums shall be at least 1, 5 times the rope diameter.

4.7 Limiting devices

4.7.1 Load moment limiting device

The lift system and boom hoist system of cable excavators in object-handling applications shall have a load moment limiting device to avoid overload. The load moment limiting device shall be adjusted to the rated load as defined in 4.9 with a tolerance of +10 %. Operations that reduce the load moment shall be possible after the functioning of the load moment limiting device.

4.7.2 Lift limiting switch

Cable excavators in object-handling applications shall be equipped with a limiting switch for lifting movement. It shall be possible to lower the boom after activation of the lift-limiting switch.

4.7.3 Limit switch for the boom hoist system

The boom hoist system of a cable excavator shall be equipped with a limiting switch to avoid a backward overload of the boom. Boom lowering shall be possible after actuation of this limiting switch.

4.8 Calculation of the lift capacity

4.8.1 Calculation method

The calculation of the lift capacity of a cable excavator shall be made on the basis of the following criteria:

— flat surface;

— hard surface (depth of penetration = 0);

— tipping line in accordance with EN 791:1995, 5.5;

— load test according to ISO 4310.

Calculate the tipping load, P_{tip}, expressed in Newtons, as follows:

$$P_{tip} = \left(\frac{9,81 \cdot m \cdot X}{R} \right)$$

where

m is the mass of the cable excavator including the mass of the equipment (e.g. boom, jib), in kilograms (kg);

X is the horizontal distance of the centre of gravity of m to the smallest tipping line, in metres (m);

R is the horizontal distance from the application point of P to the smallest tipping line, in metres (m).

Calculate the rated load, P_r, expressed in Newtons, as follows:

$$P_r = \frac{1}{1,25} \times \left(P_{tip} - 0,1 \times F_i \right)$$

where

P_{tip} is the tipping load, expressed in Newtons;

F_i is the jib weight, G, or fly jib weight, g, reduced to the head of the jib or fly jib, calculated according to ISO 4310, in Newtons (N).

4.8.2 Rated load table for object-handling application

A table of the rated lift capacity established by the manufacturer shall be provided, taking into account the conditions given in 4.8.1 and the test conditions specified in ISO 4310.

The table shall be available at the operator station.

4.9 Safety-related parts of the control system

ISO 20474-1:2017, 4.17.1, shall apply for all safety-related parts and devices (see 4.6 and 4.7) required on the machine.

4.10 Stability

4.10.1 General

ISO 20474-1:2017, 4.11, shall apply with the following additions.

4.10.2 Stability in different applications

All rated capabilities as defined hereafter are based on tests or calculations on machines being level and on a firm supporting surface.

The mass of the load, its density and the location of its centre of gravity as well as the mass of the attachment shall be included in the determination of the rated operating load and the size or capacity of the attachment.

In order to provide sufficient stability, the rated operating load at the intended operation shall be determined in accordance with 4.10.3 to 4.10.5.

4.10.3 Dragline bucket

The capacity for cable excavators in dragline bucket applications shall be either

a) 75 % of the tipping load, P_{tip}, calculated according to 4.8.1, or

b) the maximum winch lift capacity,

whichever is the lesser of the two.

The volumetric rating of the dragline bucket shall be as specified by the manufacturer.

4.10.4 Grab and front shovel

The capacity of cable excavators in grab and front shovel applications shall be either

a) 66 % of the tipping load, P_{tip}, calculated according to 4.8.1, or

b) the maximum winch lift capacity,

whichever is the lesser of the two.

The volumetric rating of the front shovel shall be determined in accordance with ISO 7546.

The volumetric rating of the grab shall be as specified by the manufacturer.

NOTE The mass and the volumetric rating of the dragline bucket, the front shovel and the grab, as well as the density of the material, are taken into account where those attachments are selected for a specific application.

4.10.5 Object-handling applications

In determining the capacity of a cable excavator, the rated load, P_r, for object handling shall be determined according to 4.8.1.

4.11 Cable excavator with electrical power source

The electrical power source and electrically driven systems of cable excavators with an electrical power source shall be in accordance with IEC 60204-32.

5 Verification of safety requirements and protective measures

In addition, the lift system as specified in 4.6, limiting devices as specified in 4.7, the calculation of lift capacity according to 4.8, the requirements for safety-related parts of the control system as given in 4.9, and the stability in different applications as specified in 4.10, shall be verified by testing.

6 Information for use

ISO 20474-1:2017, 6.2, shall apply with the following additions:

— indication that all rated load lift capacities are based on the machine being on a firm and level supporting surface (for safe working loads, the user is expected to make due allowance for the particular job conditions such as soft or uneven ground, non-level conditions, side loads, hazardous conditions, experience of personnel);

— information about rated load lift capacity in relation to the various boom configurations;

— safety instructions as to the machine application for which a top and front guard for the operator is required;

— information regarding operation, adjustment and maintenance of the swing brake;

— safety instructions for force-controlled and the free-fall operations;

— information regarding maintenance and checking of ropes.

Annex A
(normative)

Requirements for cable excavator swing brakes

A.1 General

Annex A specifies minimum performance criteria and test methods for the swing service break and swing parking brake of cable excavators.

A.2 Minimum performance

A.2.1 Swing drive system

A.2.1.1 Test-swing revolution speed

The test-swing revolution speed shall be the working swing revolution speed.

A.2.1.2 Deceleration swing angle, β_B

The deceleration swing angle, β_B, shall be less than the higher of the following values:

$$\beta_B = 90°$$

or

$$\beta_B = \frac{n^2 \cdot 360}{2 \cdot n'_B} + \beta_{B0}$$

where

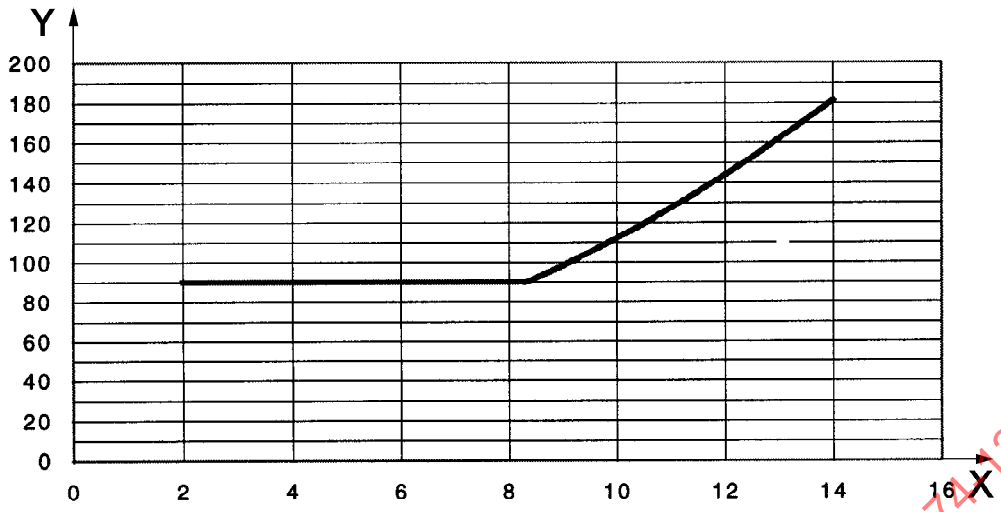
n is the test-swing revolution speed (min^{-1});

n'_B = 250 (min^{-2});

β_{B0} = 40°.

A.2.2 Swing service brake

The swing service brake shall be capable of decelerating the upper structure to a complete stop from the test swing revolution as specified in A.2.1.1. A disconnection of the swing service brake shall not be possible. See Figure A.1.



Key

X upperstructure revolutions, r/min^{-1}

Y deceleration swing angle, °

Figure A.1 — Swing service brake

During 10 tests, the deceleration swing angle shall not exceed more than 20 % of the deceleration swing angle, β_B, as specified in A.2.1.2. These tests shall be made at a sequence rate as rapid as the swing acceleration and deceleration allow.

A.2.3 Swing parking brake

The swing parking brake shall be capable of holding the upper structure for 30 min in the maximum slope and in the most unfavourable position of the upper structure as specified by the manufacturer. The working equipment shall be extended to maximum radii.

The swing parking brake shall apply automatically when the control for swinging is in neutral position, or shall be capable of being manually applied — with or without the engine running.

The swing parking brake shall remain effective when the source of energy fails.

The swing parking brake on cable excavators shall be fully mechanical.

EXAMPLE Spring friction brake.

A.3 Conditions for testing swing service brake

The tests shall be made with the standard equipment as specified by the manufacturer.

Outriggers and blade, if present, shall be placed on the ground in their working position as specified by the manufacturer.

All fluid systems shall be filled as specified by the manufacturer. The fuel tank shall be at least half-full. The swing system pressures shall be adjusted and shall function as specified by the manufacturer.

The machine shall be positioned on a flat surface with a maximum slope of ± 1 %.

The test used to determine the test swing revolution according to A.2.1.1 and deceleration swing angle according to A.2.1.2 shall be made with the working equipment extended to maximum radii and with the empty working tool in the rollout position.

The measurement starts with the actuation of the braking at test swing revolution speed.

A.4 Test report

The test report shall contain the following information:

— machine manufacturer;

— model and serial number;

— machine specification;

— result of the brake and holding tests.