

Earth-moving machinery — Safety —

Part 12 : Requirements for cable excavators

The European Standard EN 474-12:2006 has the status of a
British Standard

ICS 53.100

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 474-12:2006.

The UK participation in its preparation was entrusted by Technical Committee B/513, Construction equipment and plant and site safety, to Subcommittee B/513/1, Earth moving machinery (International).

A list of organizations represented on B/513/1 can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2007

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ISBN 978 0 580 50162 3

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

EN 474-12

NORME EUROPÉENNE

EUROPÄISCHE NORM

November 2006

ICS 53.100

English Version

Earth-moving machinery - Safety - Part 12: Requirements for cable excavators

Engins de terrassement - Sécurité - Partie 12: Prescriptions
applicables aux pelles à câbles

Erdbaumaschinen - Sicherheit - Teil 12: Anforderungen für
Seilbagger

This European Standard was approved by CEN on 17 April 2006.

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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Ref. No. EN 474-12:2006: E

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Foreword

This document (EN 474-12:2006) has been prepared by Technical Committee CEN/TC 151 "Construction equipment and building material machines — Safety", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2007, and conflicting national standards shall be withdrawn at the latest by November 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

For bibliographic references, see EN 474-1:2006.

EN 474 "Earth-moving machinery — Safety" comprises the following parts:

- Part 1: General requirements
- Part 2: Requirements for tractor-dozers
- Part 3: Requirements for loaders
- Part 4: Requirements for backhoe-loaders
- Part 5: Requirements for hydraulic excavators
- Part 6: Requirements for dumpers
- Part 7: Requirements for scrapers
- Part 8: Requirements for graders
- Part 9: Requirements for pipelayers
- Part 10: Requirements for trenchers
- Part 11: Requirements for earth and landfill compactors
- Part 12: Requirements for cable excavators

This European Standard is intended for use in combination with Part 1 of the series.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This part of EN 474 is a type C standard as stated in EN ISO 12100-1:2003.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this European Standard.

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

1 Scope

This part of EN 474 deals with all significant hazards, hazardous situations and events relevant to cable excavators as defined in EN ISO 6165:2006, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This European Standard applies also to cable excavators, their undercarriage and upper-structure, if intended for use in combination with other equipment or attachment, such as drill rigs, pile driving and extracting equipment and moving equipment (e.g. rail track, walking legs, pontoon, ship) or stationary undercarriage. This European Standard is not dealing with the specific hazards due to these additional equipment or attachment.

NOTE For these additional equipment or attachment, relevant specific European Standards should be considered where available, for example:

- for pile driving and extracting equipment: EN 996:1995;
- for drill rigs: EN 791:1995.

The requirements of this part are complementarily to the common requirements formulated in EN 474-1:2006.

This part does not repeat the requirements from EN 474-1:2006, but adds or replaces the requirements for application for cable excavators.

This part specifies the appropriate technical measures to eliminate or reduce risks arising from the significant hazards, hazardous situations and events during commissioning, operation and maintenance of the machinery in the scope.

This European Standard is not applicable to cable excavators manufactured before the date of publication of this European Standard by CEN.

2 Normative references

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

EN 474-1:2006, *Earth-moving machinery — Safety — Part 1: General requirements*

EN 791:1995, *Drill rigs — Safety*

EN 12643:1997, *Earth-moving machinery — Rubber-tyred machines — Steering requirements (ISO 5010:1992, modified)*

EN 60204-32:1998, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines (IEC 60204-32:1998)*

EN ISO 2867:2006, *Earth-moving machinery — Access systems (ISO 2867:2006)*

EN ISO 6165:2006, *Earth-moving machinery — Basic types — Identification and terms and definitions (ISO 6165:2006)*

EN ISO 7096:2000, *Earth moving machinery — Laboratory evaluation of operator seat vibration (ISO 7096:2000)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

ISO 4310:1981, *Cranes — Test code and procedures*

ISO 6014:1986, *Earth-moving machinery — Determination of ground speed*

ISO 7546:1983, *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 15219:2004, *Earth-moving machines — Cable excavators — Terminology and commercial specifications*

3 Terms and definitions, symbols and abbreviated terms

For the purposes of this European Standard, the terms and definitions given in EN 474-1:2006, EN ISO 12100-1:2003, , ISO 15219:2004 and the following apply.

NOTE 1 The terms used for hydraulic excavators are defined in ISO 15219:2004 and illustrated in Annex C.

NOTE 2 Definitions used in EN and ISO standards referred to in this European Standard are also valid for this document..

3.1 cable excavator

excavator (see EN ISO 6165:2006), having a wire rope-operated upper structure primarily designed for excavating with a dragline bucket, a 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 and attachment

3.2 boom hoist system

consists of the boom (lower-, intermediate- and head-section), the A-frame system and the boom hoist winch system

3.3 lift system

consists of the main winch system used for earth-moving-, demolition-, compaction- and object-handling (e. g. with hook assembly) application

4 List of additional significant hazards

See Annex A

NOTE Annex A (normative) contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

5 Safety requirements and/or measures

5.1 General

Cable excavators shall comply with the requirements of EN 474-1:2006, as far as not modified or replaced by the requirements of this part.

5.2 Access

EN 474-1:2006, 5.2 applies with the following exception:

Dimension code G in Figure 2 of EN ISO 2867:2006 may be > 600 mm when the hand rails/handholds are placed in the door opening.

5.3 Operator's station

5.3.1 General

EN 474-1:2006, 5.3 applies with the following provision:

5.3.2 Roll-over protective structures (ROPS)

EN 474-1:2006, 5.3.3 does not apply for cable excavators.

5.3.3 Operator's protective guard

EN 474-1:2006, 5.3.4 is replaced by the following:

Cable excavators shall be designed so 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 (see Clause 7).

5.3.4 Operator's seat, vibrations

EN 474-1:2006, 5.4.1.4 applies with the following additions:

The seat shall meet the EN ISO 7096:2000 input spectral class EM 6.

5.4 Operator's controls and indicators

5.4.1 Controls for driving and steering

EN 474-1:2006, 5.5.1 d) and 5.6.1 apply with the following addition relating to controls for driving and steering.

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.

5.4.2 Warning indicator

EN 474-1:2006, 5.5.1 applies with the following additions:

Warning indicators shall be provided at the operator's station or other relevant location to indicate the activation of the free fall operations (see 5.7.2) and to indicate the deactivation of the load moment limiting devices (see 5.8.1) during dragline bucket, grab and front shovel application.

5.5 Steering

EN 474-1:2006, 5.6 applies with the following exception:

EN 474-1:2006, 5.6.2 applies only for rubber-tyred cable excavators with a travelling speed of more than 30 km/h measured according to ISO 6014:1986.

For rubber-tyred machines with a travel speed equal or lower than 30 km/h EN 12643:1997 shall be applied, except for the requirements for emergency steering.

5.6 Swing brakes

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

5.7 Lift system

5.7.1 Force controlled operation (lifting, lowering)

The lift system of cable excavators shall be fitted with a brake, which actuates immediately after releasing lever or pedal controls.

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

The brake system shall be capable to hold the rated load, as defined in 5.9.

5.7.2 Free fall operation

The lift system of cable excavators shall be fitted with a brake, which applies immediately after:

- corresponding activation of the pedal control, or
- release of 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.

5.7.3 Switch-over

There shall be no load lowering in case of switchover from the "force controlled lift/lowering" operation to the operation "free fall".

5.7.4 Boom

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

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

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

5.7.5 Ropes

The ropes of cable excavators shall have safety factors according to Table 1.

Table 1 — Safety factors of ropes

Attachments: Dragline Grab Hook	Group 1 ^a					
	Lift or closing ropes	Digging ropes	Boom-holding ropes			
			Operating with load connected		Lifting the boom without load	
			Active ropes	Static ropes	Active ropes	Static ropes
	3,55	3,0	3,55	3,0	3,05	3,0
^a Group 1: 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.						

5.7.6 Rope drum, rope pulley

5.7.6.1 General

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

5.7.6.2 Rope drum

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

5.7.6.3 Rope pulley

The relationship between the rope pulley diameter and the rope diameter shall be 1:22 at a minimum, measured at thread of groove. Exceptions from the above requirements can be made 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.

5.7.6.4 Flanged wheel projection

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

5.8 Limiting devices

5.8.1 Load moment limiting device

The lift system and boom hoist system of cable excavators in object handling application 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 5.9 with a tolerance of + 10 %. Operations, which will reduce the load moment, shall be possible after functioning of the load moment limiting device.

5.8.2 Lift limiting switch

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

5.8.3 Limit switch for the boom hoist system

The boom hoist system of cable excavators 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.

5.9 Calculation of the lift capacity

5.9.1 Calculation method

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

- flat surface;
- hard surface (depth of penetration = 0);
- tipping line according to 5.5 of EN 791:1995;
- load test according to 3.3 of ISO 4310:1981.

The tipping load of a cable excavator P_{tip} shall be calculated as follows:

$$P_{tip} = \left(\frac{9,81 \times m \times X}{R} \right) \text{ [N]}$$

where

- m is the mass of the cable excavator including the mass of the equipment (e. g. boom, jib) [kg];
- X is the horizontal distance of the centre of gravity of m to the smallest tipping line according to 5.5 of EN 791:1995; [m]
- R is the horizontal distance from the application point of P to the smallest tipping line according to 5.5 of EN 791:1995; [m]
- F_i is the jib weight G or fly jib weight g reduced to the head of the jib or that of the fly jib (for calculation of F_i see 3.3.3.2 of ISO 4310:1981). [N].

The rated load of a cable excavator P_r shall be calculated as follows:

$$P_r = \frac{1}{1,25} \times (P_{tip} - 0,1 \times F_i) \text{ [N]}$$

5.9.2 Rated lift capacity table in object handling application

A table of the rated lift capacity established by the manufacturer shall be provided taking into account the conditions given in 5.9.1 and the test conditions as specified in 3.3.3.2 of ISO 4310:1981.

The table shall be available at the operator's station.

5.10 Requirements of safety related parts of the control system

EN 474-1:2006, 5.17.1 applies for all safety related parts and devices (see 5.7 and 5.8) required on cable excavators.

5.11 Stability

5.11.1 General

EN 474-1:2006, 5.11 applies with the following addition:

5.11.2 Stability in different applications

All rated lift capacity as defined hereafter are based on tests and/ or calculations of machines being level and on 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/capacity of the attachment.

To provide a sufficient stability the rated operating load at intended operations shall be determined in accordance with 5.11.3 to 5.11.5

5.11.3 Dragline bucket

The rated lift capacity for cable excavators in dragline bucket application shall be determined either by:

- a) 75 % of the tipping load P_{tip} as calculated according to 5.9.1, or
- b) maximum winch lift capacity

which ever is less.

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

5.11.4 Grab and front shovel

The rated lift capacity for cable excavators in grab and front shovel application shall be determined either by:

- a) 66 % of the tipping load P_{tip} as calculated according to 5.9.1, or
- b) maximum winch lift capacity.

which ever is less.

The volumetric rating of the front shovel shall be determined according to ISO 7546:1983.

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 and the grab shovel as well as the density of the material have to be taken into account where these attachments are selected for a specific application.

5.11.5 Object handling application

The rated lift capacity of cable excavators shall be determined as follows:

The rated load for object handling P_r shall be determined according to 5.9.1

5.12 Cable excavator with electrical power source

Cable excavators with electrical power source shall meet the requirements of EN 60204-32:1998 as far as the electrical power source and the electrically driven systems are concerned.

6 Verification of safety requirements/measures

EN 474-1:2006, Clause 6 applies with the following additions:

The lift system as specified in 5.7, the limiting devices as specified in 5.8, the calculation of the lift capacity as specified in 5.9, the requirements of safety related parts of the control system as specified in 5.10 and the stability in different applications as specified in 5.11 shall be verified by tests.

7 Information for use

7.1 Operation manual

EN 474-1:2006, 7.2 applies, with the following additions:

The operation manual shall contain the following information:

7.1.1 indication that all rated load lift capacities are based on the machine being on a level and firm 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;

7.1.2 advice/information about rated load lift capacity in relation to the various boom configurations;

7.1.3 safety instruction at which machine application a top and front guard for the operator is required (see 5.3.2);

- 7.1.4** advice/information regarding operation, adjustment and maintenance of the swing brake;
- 7.1.5** safety instructions for the force controlled operation and the free fall operation;
- 7.1.6** mounting and dismantling instructions;
- 7.1.7** advice/information regarding maintenance and check of ropes;
- 7.1.8** safety instructions for maintenance of the machine.

Annex A (normative)

List of additional significant hazards – Cable excavators

The list of hazards shown in Annex A of EN 474-1:2006 applies, with the following additions:

Table A.1 — List of additional significant hazards

No. ¹	Hazards	Relevant clauses of this European Standard
	Hazards, hazardous situations and hazardous events	
1	Mechanical hazards due to: — machine parts or working tools, e. g.: attachment, and/or equipment — object and log handling	5.3.3, 5.7, 5.8 5.9, 5.11
1.1	Crushing hazard	5.3.3 5.6 5.7, 5.8
16	Loss of stability/overturning the machine	5.7 5.9
16.1	Rated operating load with dragline equipment, object handling, and other applications	5.7, 5.9, 5.11
	Additional hazards, hazardous situations and hazardous events due to mobility	
18	Relating to travelling function	
18.4	Travelling function	5.4, 5.5
19	Linked to the operator's station on the machine	
19.1	Fall of persons during access to (or at/from) the operator's station	5.2
19.4	Mechanical hazards at the operator's station (s): a) fall of objects, penetration by objects b) moving upper-structure	5.3.3, 5.5, 5.10 5.6
19.7	Inadequate seating	5.3.4
20	Due to the control system	
20.3	Inadequate design of manual controls and their mode of operation	5.4, 5.5, 5.10
22	Due to the power source and to the transmission of power	5.12
25	Insufficient instructions for the operator (operation manual, signs, warnings, and markings)	7

¹ Number refers to Annex A of EN 474-1:2006.

Annex B (normative)

Requirements for cable excavator swing brakes

B.1 General

This annex specifies minimum performance criteria and methods of test for the swing service brake, swing parking brake and swing lock of cable excavators as defined in EN ISO 6165:2006.

B.2 Terms and definitions

B.2.1

swing

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

B.2.2

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, specified in revolutions per minute

B.2.3

deceleration swing angle

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

B.2.4

swing torque

torque which propels the upper structure relative to the undercarriage. The swing torque is specified in Nm

B.2.5

swing service brake

device or system to decelerate the rotation of the upper structure and to bring it to a stop at any position

NOTE It can be e. g. a frictional brake, electrically, hydrostatic or other hydraulically operating brake.

B.2.6

swing parking brake

device or system to hold the stopped upper structure in any stationary position (e. g. transport position)

B.2.7

swing lock

mechanically engaged device to hold the upper structure in a fixed position with respect to the undercarriage

B.3 Minimum performance

B.3.1 Swing drive system

B.3.1.1 Test-swing revolution speed

The test-swing revolution speed shall be the working swing revolution speed as defined in B.2.2.

B.3.1.2 Deceleration swing angle β_B

The deceleration swing angle β shall be less than the highest of the following values:

$$\beta_B = 90^\circ$$

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

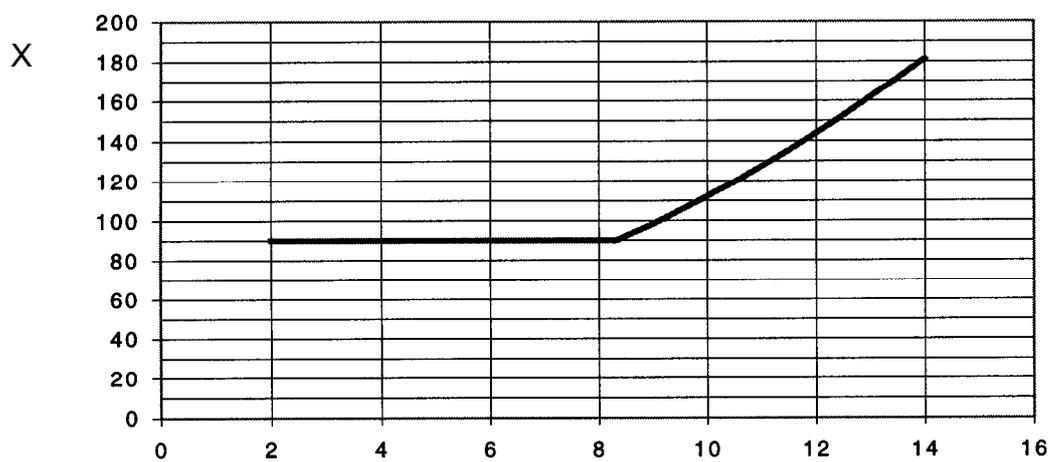
with

$$\beta_B = \text{deceleration swing angle [}^\circ\text{];}$$

$$n = n \quad \text{test-swing revolution speed [min}^{-1}\text{];}$$

$$n'_B = 250 \text{ [min}^{-2}\text{];}$$

$$\beta_{B0} = 40 \text{ [}^\circ\text{];}$$



Key

X Deceleration swing angle [°]

Y upperstructure-revolution [min⁻¹]

Figure B.1 — Swing service brake

B.3.2 Swing service brake

The swing service brake shall be capable to decelerate the upper structure to a complete stop from the test swing revolution as specified in B.3.1.1. A disconnection of the device/ system shall not be possible.

During 10 tests, the deceleration swing angle shall not exceed more than 20 % of the deceleration swing angle β as defined in B.3.1.2. These ten (10) tests shall be made in a sequence rate as rapidly as the swing acceleration and deceleration will allow.

B.3.3 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, without load, 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 and 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, e. g. spring friction brake.

B.4 Conditions for testing the 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 system 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 function as specified by the manufacturer.

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

The test to define the test swing revolution according to B.3.1.1 and deceleration swing angle according to B.3.1.2 shall be made with the working equipment extended to maximum radii and with the empty working tool in rollout position.

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

B.5 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.

Annex C (informative)

Illustrations

C.1 Standard applications

C.1.1 Crawler type cable excavator with lifting equipment

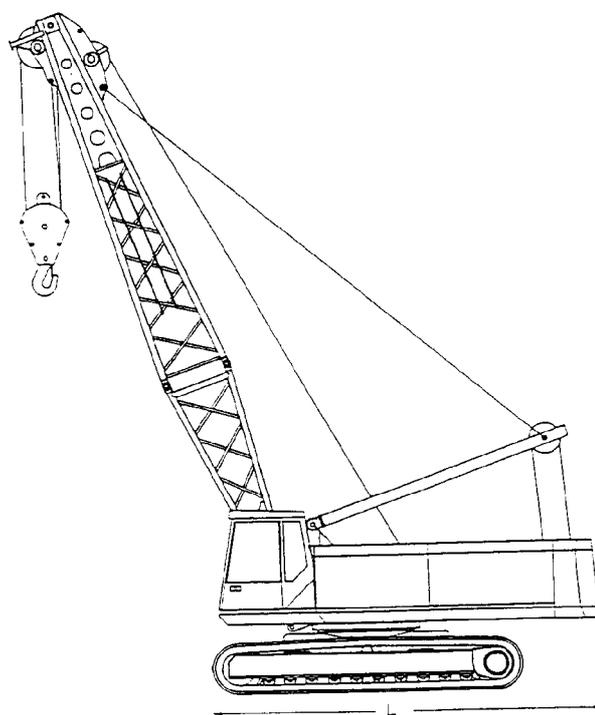


Figure C.1.1 — Crawler type cable excavator with lifting system

C.1.2 Crawler type cable excavator with dragline equipment

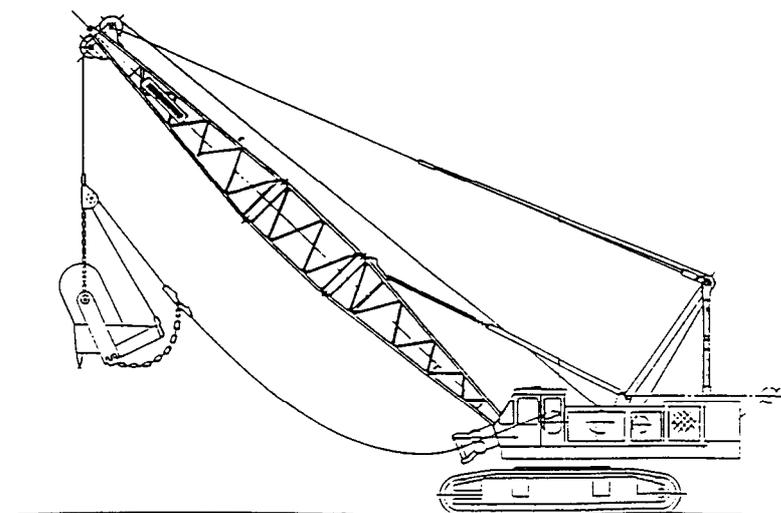


Figure C.1.2 — Crawler type cable excavator with dragline equipment

C.1.3 Crawler type cable excavator with grab equipment

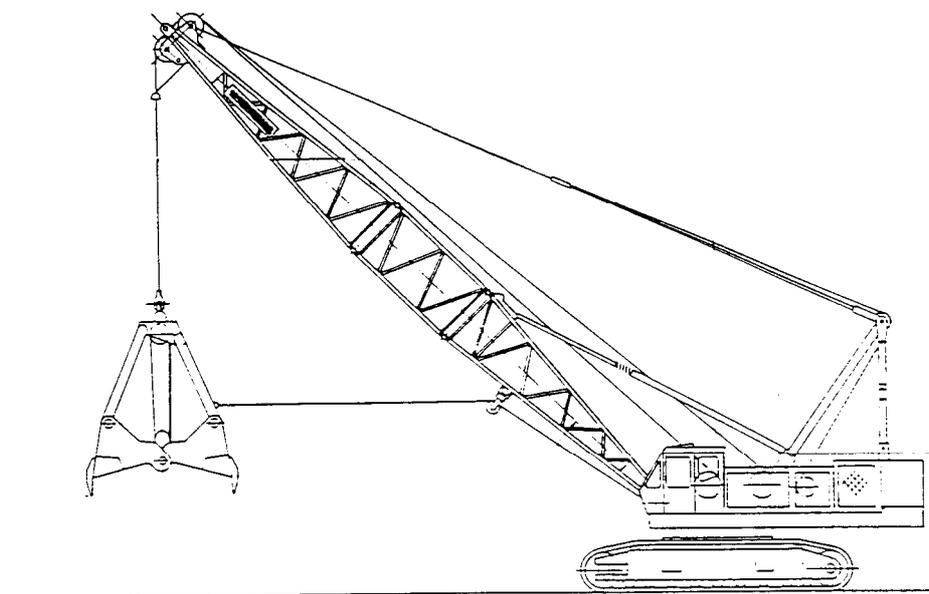


Figure C.1.3 — Crawler type cable excavator with grab equipment

C.2 Special applications

NOTE The safety requirements for these special applications are laid down in EN 791:1995 (see Figure C.2.1) and EN 996:1995 (see Figures C.2.2 and C.2.3).

C.2.1 Crawler type cable excavator with hole drilling equipment (casing oscillator)

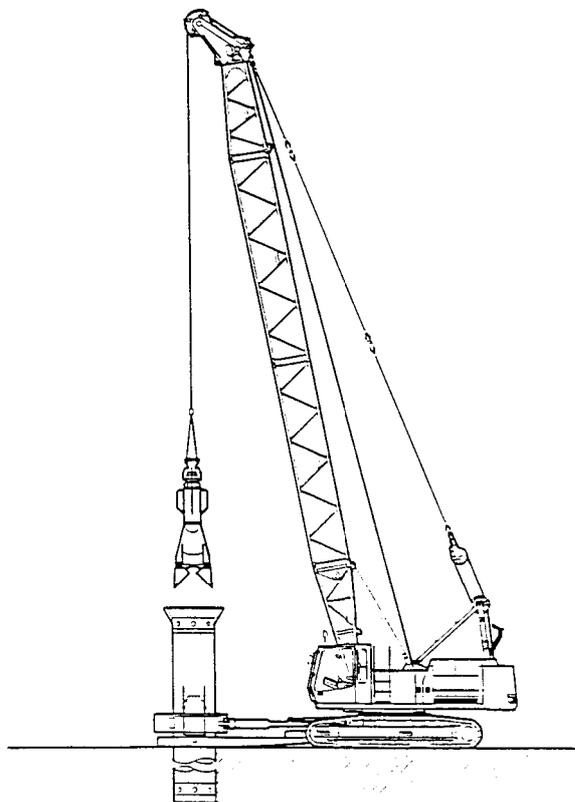


Figure C.2.1 — Crawler type excavator with hole drilling equipment (casing oscillator)

C.2.2 Crawler type cable excavator with piling equipment (hydraulic or diesel hammer)

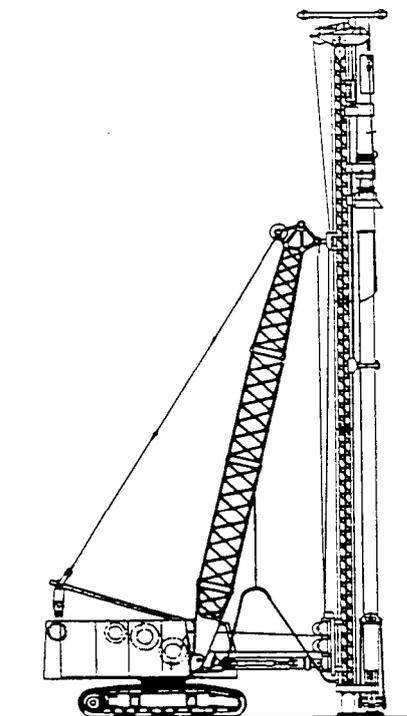


Figure C.2.2 — Crawler type cable excavator with piling equipment (hydraulic or diesel hammer)

C.2.3 Crawler type excavator with wall cutter equipment (diaphragm wall grab)

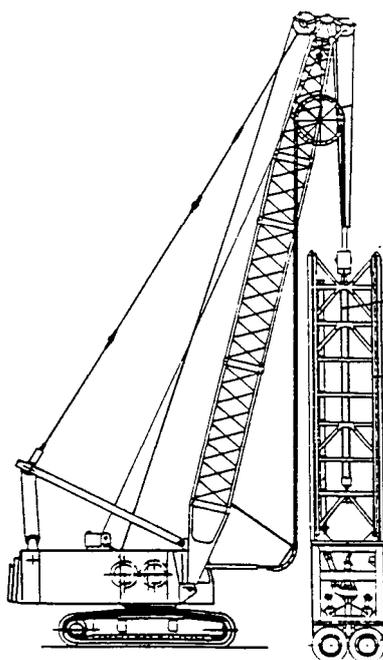


Figure C.2.3 — Crawler type excavator with wall cutter equipment (diaphragm wall grab)

C.3 Wheel type cable excavator in transport position for road travelling

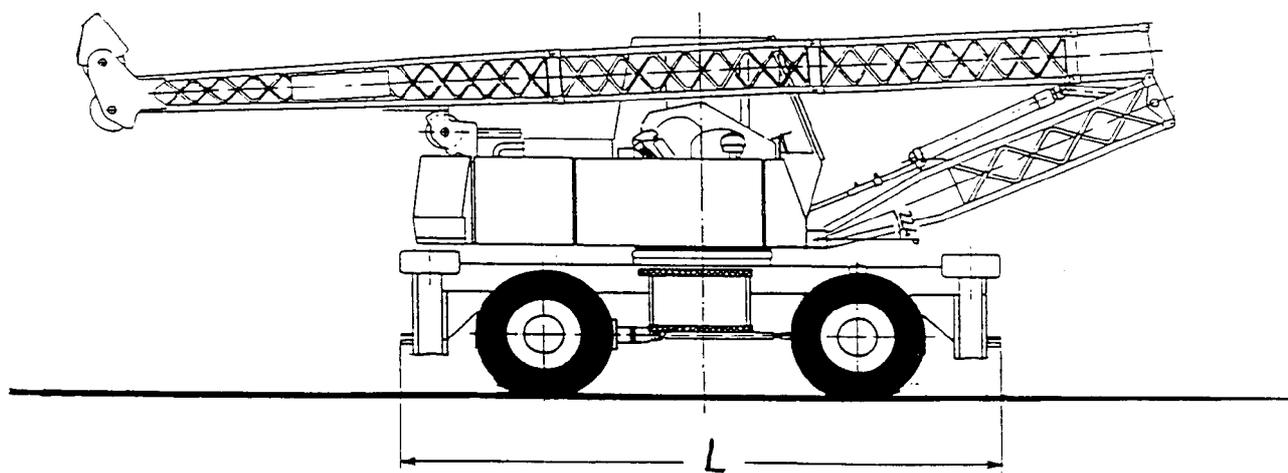


Figure C.3 — Wheel type cable excavator in transport position for road travelling

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 98/37/EC, amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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- [1] EN 996:1995, *Piling equipment — Safety requirements*
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