INTERNATIONAL STANDARD

ISO 4305

Third edition
2014-04-01

Mobile cranes — Determination of stability

Grues mobiles — Détermination de la stabilité

Reference number
ISO 4305:2014(E)

Published in Switzerland

Contents

Page

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.

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. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 96, *Cranes*, Subcommittee SC 6, *Mobile cranes*.

This third edition cancels and replaces the second edition (ISO 4305:1991), which has been technically revised.

Mobile cranes — Determination of stability

1 Scope

This International Standard specifies the conditions to be taken into consideration when verifying the stability of a mobile crane by calculation, assuming that the crane is operating on a firm and level surface (up to 1 % gradient).

It applies to mobile cranes as defined in ISO 4306-2, i.e. appliances mounted on wheels (tires) or crawlers, with or without outriggers with the exception of loader cranes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4302, *Cranes — Wind load assessment*

ISO 4306-1, *Cranes — Vocabulary — Part 1: General*

ISO 4306-2, *Cranes — Vocabulary — Part 2: Mobile cranes*

ISO 4310:2009, *Cranes — Test code and procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4306-2 (except for boom, fly jib and mast mounted boom) apply.

3.1
fixed-length boom
boom of fixed operating length, the length of which can be varied by the addition or removal of inserts, but cannot be varied during the operating cycle

[SOURCE: ISO 4306-2:2012, 4.1, modified — The phrase “which length” has been changed to read “the length of which”.]

3.2
lattice boom
fixed-length boom of trussed construction

[SOURCE: ISO 4306-2:2012, 4.1.1]

3.3
telescoping boom
boom consisting of a base section from which one or more boom sections are telescoped for additional length

[SOURCE: ISO 4306-2:2012, 4.2]

3.4
mast-mounted boom
assembly comprising a boom mounted at or near the top of a vertical or almost vertical mast member

Note 1 to entry: The angle of the boom to mast may be changed during operation.

[SOURCE: ISO 4306-2:2012, 4.3]

3.5
fly jib
extension attached at or near the boom point or mast-mounted boom to provide additional boom length and an auxiliary hoisting means

Note 1 to entry: A fly jib is configured with a fixed angle to the boom.

[SOURCE: ISO 4306-2:2012, 4.4]

3.6
tipping angle
angle formed between the vertical plane through the tipping line (fulcrum) and the plane through the tipping line and the centre of gravity of the crane

Note 1 to entry: See Figures B.1 to B.6.

Note 2 to entry: Take into consideration the lifted load at the centre of the boom point or jib point sheaves to calculate the machine centre of gravity plus the load centre of gravity.

4 Calculations of stability

4.1 General

The calculations shall verify that the crane is stable under the following conditions:

a) the criteria specified in Table 1;

b) the criteria specified in Table 2;

c) the criteria specified in Table 3;

d) backward stability (see 4.3);

e) stability with out-of-service wind (see 4.4).

4.2 Criteria for stability

4.2.1 See Tables 1, 2 and 3.

4.2.2 Based on the criteria specified in Table 1, Table 2, and Table 3, it is intended that the stability-limited crane ratings shall be usable in a minimum wind speed of 8,3 m/s. Under special conditions where this requirement imposes a restriction on rated capacity, the manufacturer shall clearly specify the maximum wind speed included in the stability calculation.

Table 1 — Machine configuration stability calculation for applied load

Machine configuration/condition	Loading	Value to be taken into consideration[a]
On outriggers/crawlers[b]	Applied load	$1{,}25P + 0{,}1 \cdot F$
On wheels (tyres)[b]	Applied load	$1{,}33P + 0{,}1 \cdot F$
On crawlers with travel speed up to 0,1 m/s	Applied load	$1{,}25P + 0{,}1 \cdot F$
On crawlers with travel speed greater than 0,1 and less than or equal to 0,4 m/s	Applied load	$1{,}33P + 0{,}1 \cdot F$
On wheels (tyres) with travel speed up to 0,4 m/s	Applied load	$1{,}33P + 0{,}1 \cdot F$
On crawlers/wheels (tyres) with travel speed greater than 0,4 m/s	Applied load	$1{,}50P + 0{,}1 \cdot F$

[a] In these formulae:

P is the rated capacity (hoist medium load) as specified by the crane manufacturer for the various configurations of the crane. It shall be for the hoist medium load of the crane as defined by ISO 4306-1:2007, 6.1.5;

F is the load from the mass of the boom and fly jib referred to the boom head or fly jib head. (The determination of *F* is given in ISO 4310.)

The value to be taken into consideration is intended to simulate the dynamic forces arising during normal controlled operation.

[b] These configurations take into consideration a non-travelling crane, which performs crane operations similar to luffing (booming), hoisting, telescoping and slewing.

Table 2 — Machine configuration stability calculation with wind load and dynamic effects

Machine configuration/condition	Loading	Value to be taken into consideration[a]
On outriggers/crawlers[b]	Applied load	$1{,}1 \cdot P$
	Wind load	$S \cdot W$
	Inertia forces	D
On wheels (tyres)[b]	Applied load	$1{,}17 \cdot P$
	Wind load	$S \cdot W$
	Inertia forces	D
On crawlers with travel speed up to 0,1 m/s	Applied load	$1{,}1 \cdot P$
	Wind load	$S \cdot W$
	Inertia forces	D
On crawlers with travel speed greater than 0,1 m/s and less than or equal to 0,4 m/s	Applied load	$1{,}17 \cdot P$
	Wind load	$S \cdot W$
	Inertia forces	D
On wheels (tyres) with travel speed up to 0,4 m/s	Applied load	$1{,}17 \cdot P$
	Wind load	$S \cdot W$
	Inertia forces	D
On crawlers/wheels (tyres) with travel speed greater than 0,4 m/s	Applied load	$1{,}33 \cdot P$
	Wind load	$S \cdot W$
	Inertia forces	D
With travel speed greater than 0,1 m/s, the total load on the support base on the side or end of the undercarriage supporting the least load [wheels (tyres), crawlers] shall be not less than 15 % of the total mass of the crane.		

[a] In this column:

D is the inertia force due to hoisting, telescoping, slewing, luffing or travel. For cranes having stepped controls, the actual values from inertia forces shall be used. For cranes having infinitely variable controls, the value of D shall be taken as 0.

S is a partial safety factor:

$S = 1{,}0$ for wind load on the suspended load P;

$S = 1{,}2$ for wind load on the crane structure(boom, jib, mast, etc.);

P is as defined in Table 1;

W is the effect of the in-service wind and shall be calculated in accordance with ISO 4302.

[b] These configurations take into consideration a non-travelling crane, which performs crane operations similar to luffing (booming), hoisting, telescoping and slewing.

Table 3 — Minimum values of tipping angle

Machine configuration/condition	Minimum tipping angle[a]
On outriggers/crawlers and crawlers with travel speed up to 0,1 m/s	4,0°
On wheels (tyres) without travelling	4,5°
On crawlers with travel speed greater than 0,1 m/s and equal to or less than 0,4 m/s	4,5°
On wheels (tyres) with travel speed equal to or less than 0,4 m/s	4,5°/5,5°[b]
On crawlers with travel speed greater than 0,4 m/s	5,0°
On wheels (tyres) with travel speed greater than 0,4 m/s	5,0°/6,0°[b]
Accelerations caused by the sudden start or the sudden stop of movements of the crane and/or the load could result in unintentional movements of the crane and/or the load (kinetic energy). In order to avoid tipping of the crane by such a cause, there shall be sufficient potential energy available. These dynamic effects have to be covered by a calculation. It is possible to use as an alternative the simplified calculation method with tipping angle. The verification shall be carried out for all capacities of the crane for the worst position in the most unfavourable direction.	

[a] The given minimum tipping angle values are valid for slopes of less than 1 %. Any inclination of the ground larger than 1 % shall be considered in the tipping calculations (method with tipping angle) and the slope angle used shall be stated in the load chart. The application point of the mass (of the load) shall be set at the height of the axis of the pulley head.

[b] If the flexibility of the wheels (tyres) is taken into account, the smaller values may be used.

4.3 Backward stability (with and without boom)

4.3.1 General

To retain a reasonable margin, counterweighting shall be limited by the mass distribution given below (in this subclause), application being under the following conditions:

— placed on a firm, level supporting surface (up to 1 % gradient);

— equipped with the shortest specified boom, set at its maximum recommended boom angle for that boom length;

— with hook, hook-block or other load-handling equipment resting on the ground;

— with boom removed from the crane;

— with outriggers free of the bearing surface for on-wheels (tyres) calculations;

— equipped with the longest specified boom, or boom and fly-jib combination set at its maximum recommended boom angle for that combination, and subjected to an in-service wind acting from the least-favourable direction.

The specified mass distribution criteria shall be satisfied for each counterweight condition with the crane rotated to the least-stable positions permitted by the manufacturer.

4.3.2 Crawler-mounted cranes — Shortest boom at minimum radius

4.3.2.1 Crawler-mounted cranes — General

The total load on the tipping line on the side or end of the undercarriage supporting the least load shall not be less than 15 % of the total mass of the crane. If the above-mentioned criterion is not met for crawler cranes operating with retracted crawlers, the manufacturer shall state this in the crane cautionary information visible to the operator.

4.3.2.2 Crawler-mounted cranes — With boom structure removed

The total load on the tipping line on the side or end of the undercarriage supporting the least load shall not be less than 5 % of the total mass of the crane. If the above-mentioned criterion is not met for crawler cranes operating with retracted crawlers, the manufacturer shall state this in the crane cautionary information visible to the operator.

4.3.3 Wheel-mounted cranes — Shortest boom at minimum radius

4.3.3.1 Wheel-mounted cranes — General

With the longitudinal axis of the rotating superstructure of the crane at 90° to the longitudinal axis of the carrier, the total load on the wheels (tyres) or outriggers on the side of the carrier under the boom shall be not less than 15 % of the total mass of the crane.

With the longitudinal axis of the rotating superstructure of the crane in line with the longitudinal axis of the carrier, in either direction, the total load on the wheels (tyres) or outriggers under the lighter loaded end of the carrier shall be not less than 15 % of the total mass of the crane in the work area specified by the manufacturer, and not less than 10 % of the total mass of the crane in the area not specified as a work area. The on-wheels (tyres) limitations shall be met unless cautionary information visible to the operator is placed on the crane. This information shall state the operating conditions that require the outriggers to be set to maintain sufficient backward stability.

4.3.3.2 Wheel-mounted cranes — With boom structure removed

With the longitudinal axis of the rotating superstructure of the crane at 90° to the longitudinal axis of the carrier, the total load on all wheels (tyres) or outriggers on the side of the carrier supporting the least load shall be not less than 5 % of the total mass of the crane. With the longitudinal axis of the rotating superstructure of the crane in line with the longitudinal axis of the carrier, in either direction, the total load on the wheels (tyres) or outriggers under the lighter loaded end of the carrier shall be not less than 5 % of the total mass of the crane in the work area specified by the manufacturer, and not less than 5 % of the total mass of the crane in the area not specified as a work area. The on-wheels (tyres) limitations shall be met unless cautionary information visible to the operator is placed on the crane. This information shall state the operating conditions that require the outriggers to be set to maintain sufficient backward stability.

4.4 Stability with out-of-service wind

The manufacturer shall stipulate the special precautions to be taken by the user when the crane is out of service and the working limits when subjected to wind. (Wind load is specified in ISO 4302.)

4.5 Determination of stability

4.5.1 The value of *P* shall be such that, with loading conditions as given in Table 1 and Table 2, in neither case shall the overturning moment of the crane be greater than the stabilizing moment.

4.5.2 The calculations shall be carried out with the crane in the least-favourable position. Moreover, all the loads, dead loads, counterweights, accessories, etc., which have an influence on the stability, shall

be taken into consideration as being in the least-favourable condition as regards their value and their position.

4.5.3 Lines about which cranes on various mountings might tip and which are used to calculate the stabilizing moment are shown in Annex A. These are indicative only and in practice are dependent on particular details of individual designs.

4.5.4 Mobile crane tipping angle: the calculations shall show that the tipping angle for all rated capacities in all configurations slewed in the least-stable direction is greater than or equal to the given minimum tipping angle in Table 3. The tipping angle, α, is indicated in Figures B.1 to B.6 in Annex B. The backward tipping angle shall be calculated with the unloaded crane and attached boom/jib system with load blocks on the ground.

Annex A
(informative)

Tipping line of mobile cranes

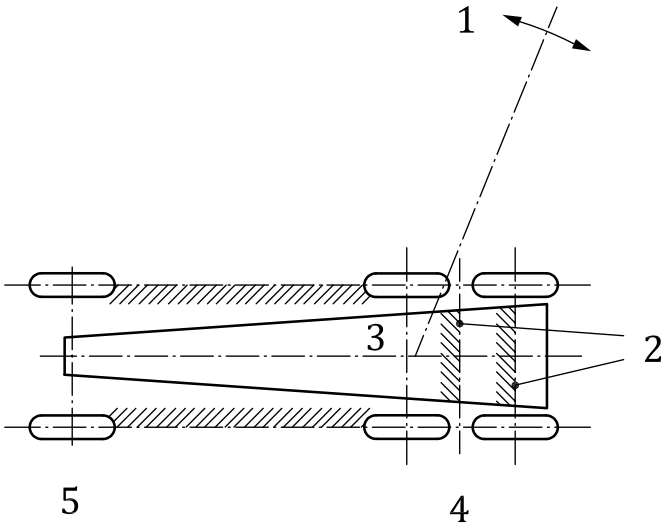
A.1 Cranes on wheels (tyres)

A.1.1 Crane on wheels (tyres) without suspension or with the suspension locked (see Figure A.1 and Figure A.2)

The tipping line is the line joining the points of contact of the wheels. For axles mounted on twin tyres, the following two cases should be considered:

a) in the case where the axle is fixed or blocked, the point of contact of the outer wheel;

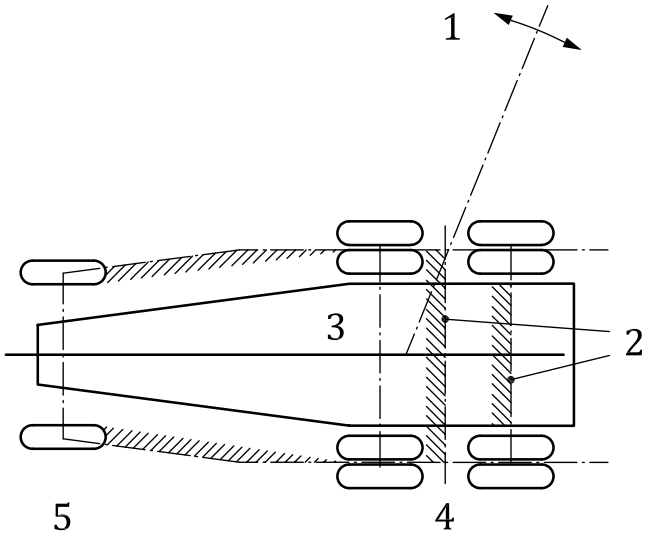
b) in the case where the wheel is on a rocking axle, the pivot axis of this rocking axle.



Key

1 boom
2 tipping line with oscillating or locked walking beam
3 chassis
4 rear axle
5 front axle

Figure A.1 — Crane on wheels with suspension locked and without suspension locked, single tyre



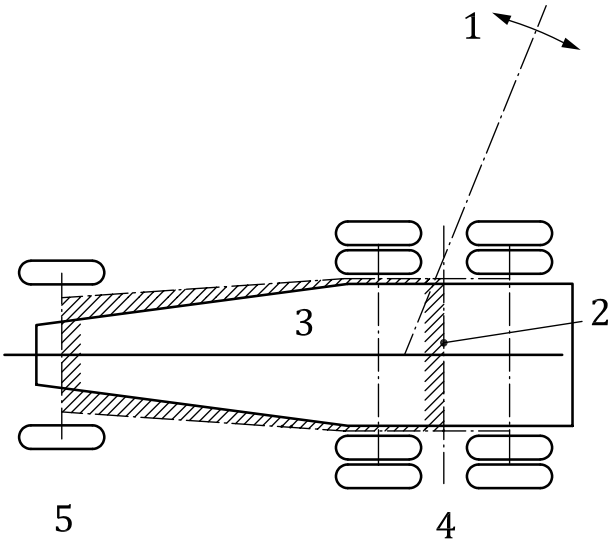
Key

1 boom
2 tipping line with oscillating or locked walking beam
3 chassis
4 rear axle
5 front axle

Figure A.2 — Crane on wheels with suspension locked and without suspension locked, twin tyres

A.1.2 Crane on wheels with the suspension unlocked (see Figure A.3)

The tipping line is the line joining the points of application of the suspension.



Key

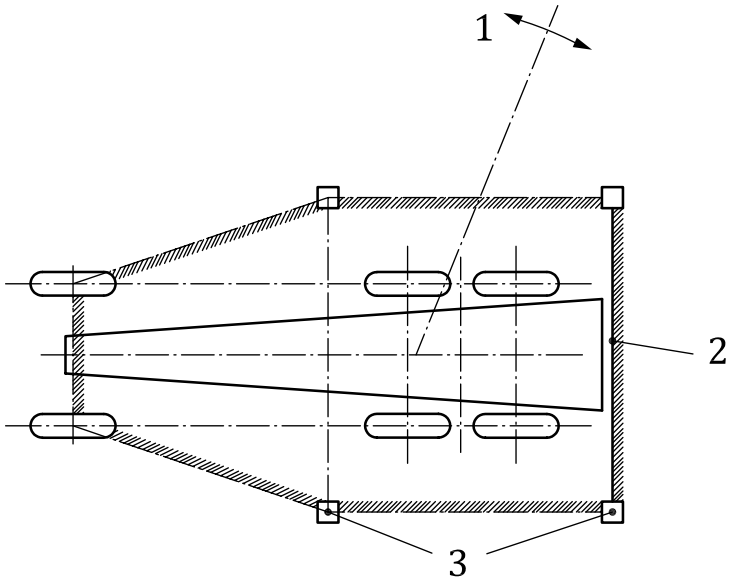
1 boom
2 tipping line with oscillating or locked walking beam
3 chassis
4 rear axle
5 front axle

Figure A.3 — Crane on wheels with the suspension unlocked

A.2 Cranes on outriggers

A.2.1 Crane on outriggers (see Figure A.4)

The tipping line is the line joining the centres of the support but, if flexible supporting surfaces exist besides the outriggers (such as wheels with pneumatic tyres), then these may be taken into account.



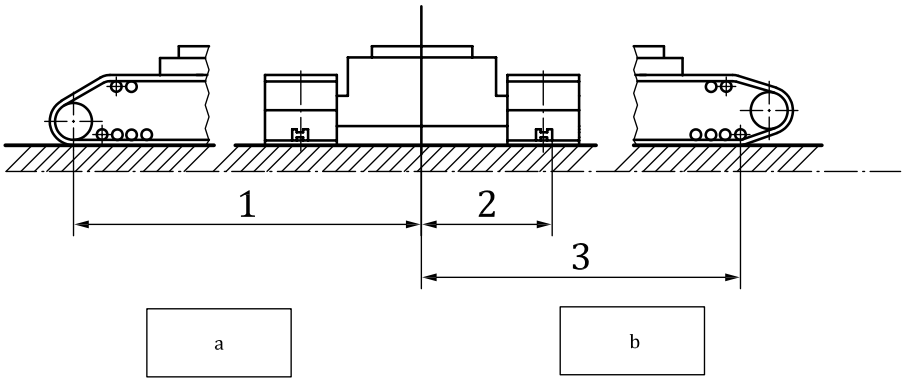
Key

1 boom
2 tipping line with outriggers extended
3 outriggers

Figure A.4 — Crane on outriggers

A.3 Cranes on crawlers (see Figure A.5)

The tipping lines for crawler cranes are as shown in Figure A.5.



Key

1 over end, non-elevated sprocket
2 over side
3 over end, elevated sprocket
a Example: non-elevated sprocket.
b Example: elevated sprocket.

Figure A.5 — Cranes on crawlers

The tipping line shown to the left of Figure A.5 is to be used for crawler cranes where the idler or drive sprockets are not elevated above the track support rollers. This tipping line may also be used when adequate blocking is placed under the elevated idler or elevated drive sprocket to prevent machine rocking (resultant capacities will be static).

The tipping line shown to the right of Figure A.5 is to be used for crawler cranes where the idler or drive sprockets are elevated above the track support rollers.

Annex B
(informative)

Tipping angle of mobile cranes

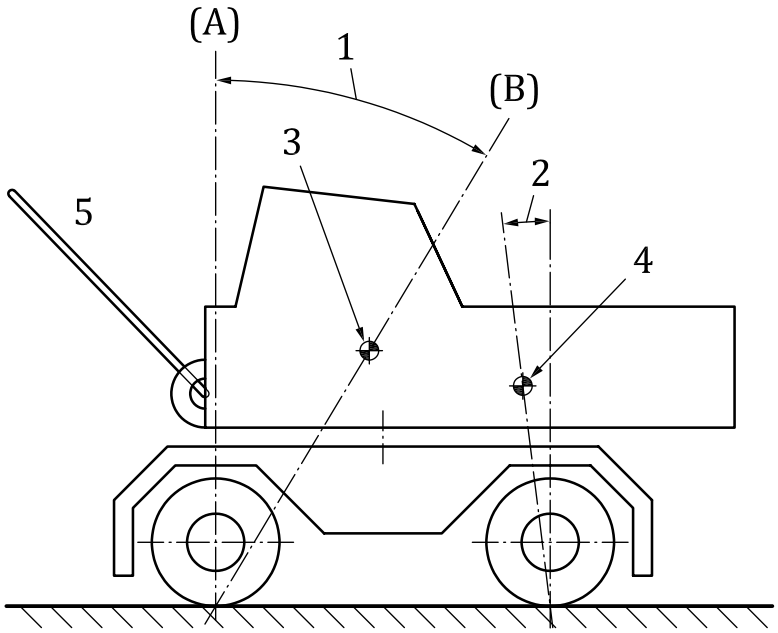
B.1 Cranes on wheels (tyres) (see Figures B.1 and B.2)

B.1.1 Crane on wheels

The tipping angle is the angle formed between the vertical plane (A) through the tipping line (fulcrum) and the plane (B) through the tipping line (fulcrum) and the centre of gravity of the crane (see Figures B.1 to B.6).

In the case where outriggers are used, the tipping line joins the point of contact of the outrigger cylinders (not shown).

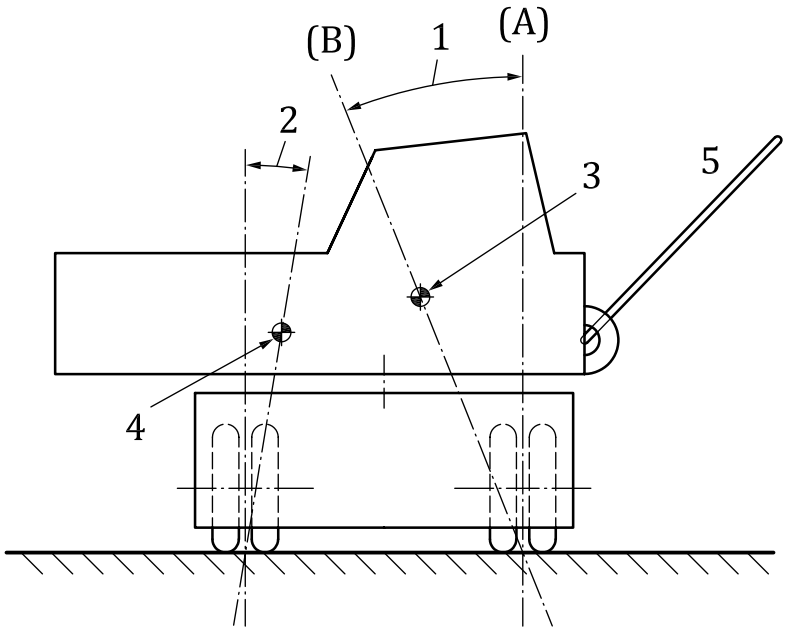
NOTE Place the lifted load at the centre of the boom point or jib point sheaves to calculate the centre of gravity of the machine plus the load.



Key

1 tipping angle with load, α_{WITH}
2 tipping angle without load, $\alpha_{WITHOUT}$
3 centre of gravity with load
4 centre of gravity without load
5 boom

Figure B.1 — Tipping angle for boom in travelling direction

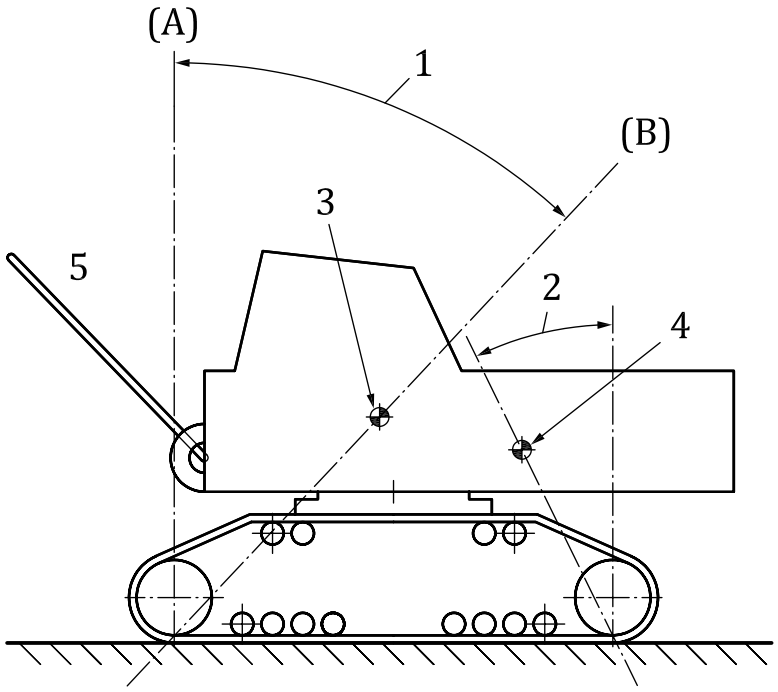


Key

1 tipping angle with load, α_{WITH}
2 tipping angle without load, $\alpha_{WITHOUT}$
3 centre of gravity with load
4 centre of gravity without load
5 boom

Figure B.2 — Tipping angle for boom in cross direction (over side of wheels, 90°)

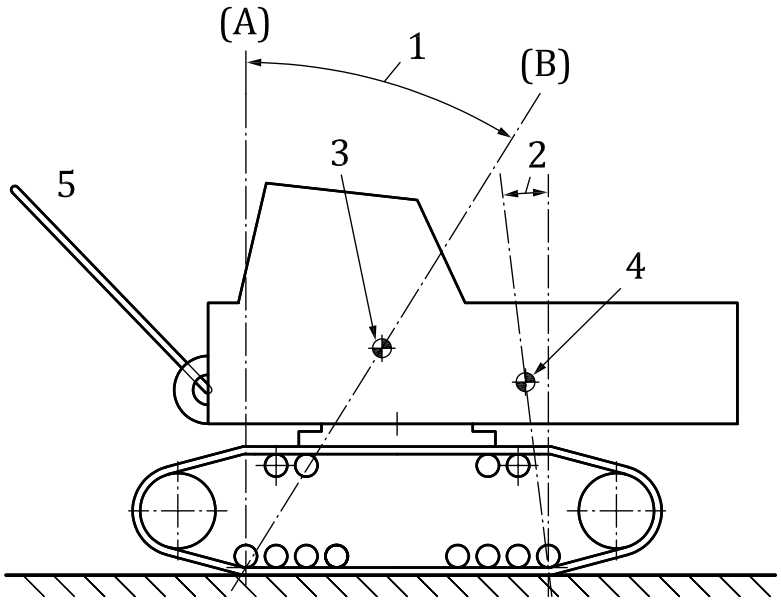
B.2 Cranes on crawlers (see Figures B.3 to B.6)



Key

1 tipping angle with load, α_{WITH}
2 tipping angle without load, $\alpha_{WITHOUT}$
3 centre of gravity with load
4 centre of gravity without load
5 boom

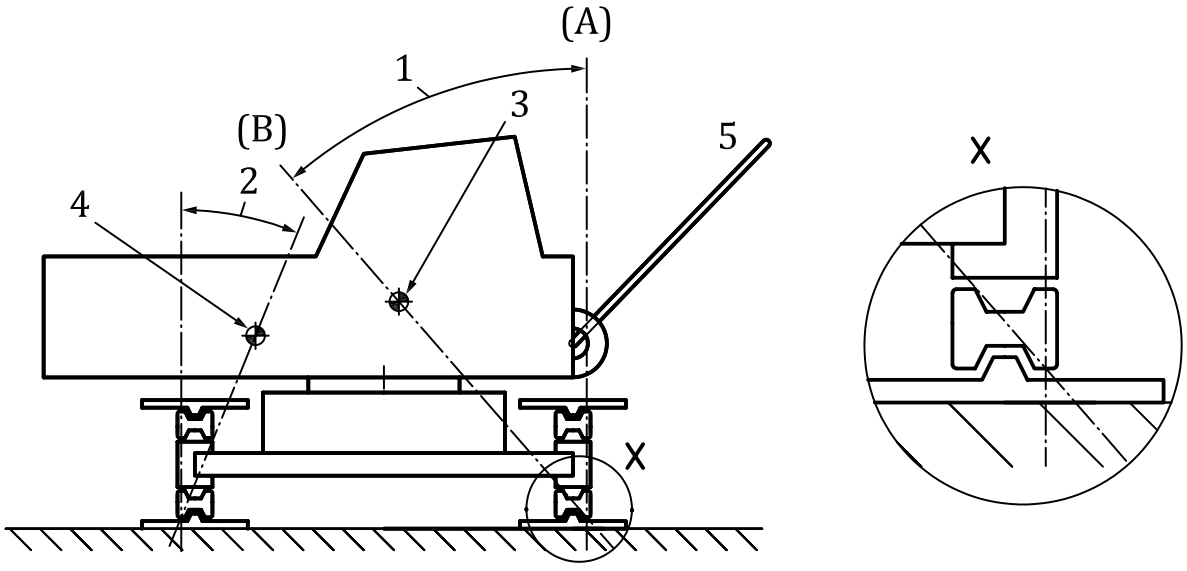
Figure B.3 — Tipping angle for boom in travelling direction, non-elevated sprocket



Key

1 tipping angle with load, α_{WITH}
2 tipping angle without load, $\alpha_{WITHOUT}$
3 centre of gravity with load
4 centre of gravity without load
5 boom

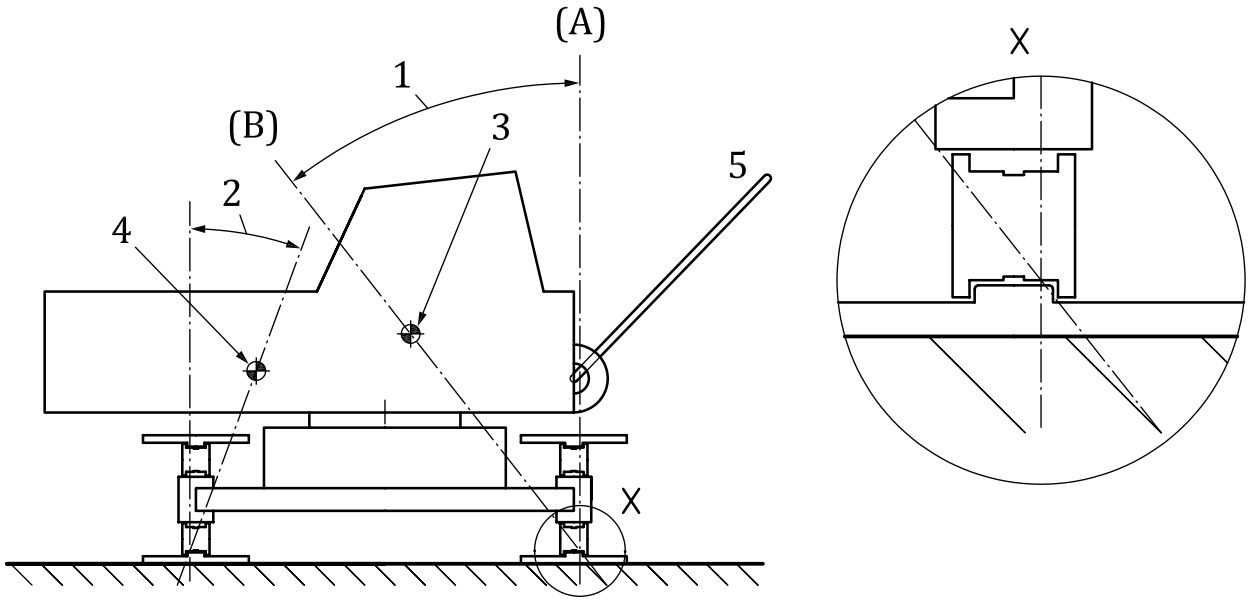
Figure B.4 — Tipping angle for boom in travelling direction, elevated sprocket



Key

1 tipping angle with load, α_{WITH}
2 tipping angle without load, $\alpha_{WITHOUT}$
3 centre of gravity with load
4 centre of gravity without load
5 boom

Figure B.5 — Tipping angle for boom in cross direction (over side), track support roller design A



Key

1 tipping angle with load, α_{WITH}
2 tipping angle without load, $\alpha_{WITHOUT}$
3 centre of gravity with load
4 centre of gravity without load
5 boom

Figure B.6 — Tipping angle for boom in cross direction (over side), track support roller design B

ICS 53.020.20

Price based on 17 pages