INTERNATIONAL STANDARD

ISO 15794

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Bi-directional and multi-directional fork-lift trucks — Stability tests

Chariots élévateurs à fourche bi-directionnelle et multi-directionnelle — Essais de stabilité

Reference number
ISO 15794:2001(E)

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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.

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.

International Standard ISO 15794 was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 2, *Safety of powered industrial trucks*.

This International Standard has been prepared using EEC 89/240 Method 6 as a basis.

Bi-directional and multi-directional fork-lift trucks — Stability tests

1 Scope

This International Standard specifies basic tests to verify the stability of bi-directional and multi-directional fork-lift trucks with tiltable or non-tiltable mast or fork arms. It is applicable to trucks fitted with fork arms and/or attachments.

This International Standard is not applicable to trucks that handle suspended loads that can swing freely.

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 5353:1995, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point.*

ISO 5767:1992, *Industrial trucks operating in special condition of stacking with the mast tilted forward — Additional stability test.*

ISO 10658:1996, *Industrial trucks operating in special conditions of stacking with load laterally displaced by powered devices — Additional stability test.*

3 Purpose of tests

3.1 Normal operating conditions

The basic tests specified in this International Standard ensure that the type of truck specified has satisfactory stability when reasonably and appropriately used under normal operating conditions, as follows:

a) operating (travelling and stacking) on substantially firm, smooth, level and prepared surfaces;

b) travelling with the mast or fork arms tilted backwards and the load in the lowered (travelling) position;

c) stacking with the mast substantially vertical and the fork arms substantially horizontal;

d) operating with the load centre of gravity approximately on the centre plane of the truck.

3.2 Operating in conditions other than normal

When the operating conditions differ from those specified in 3.1, it is necessary to use either

a) a truck complying with other International Standards covering different specific conditions, such as ISO 5767 or ISO 10658, or

b) a truck whose stability has been agreed upon between the interested parties; this agreed stability shall not be less than that required by the tests specified for normal operating conditions in 3.1.

4 Stability tests

4.1 Test requirements

The stability of bi-directional and multi-directional fork-lift trucks shall be verified by one of the procedures specified in 4.2.

4.2 Verification procedure

4.2.1 Tilting platform

Use a test platform that can be tilted about one side. Place the truck being tested for stability on the initially horizontal test platform, in accordance with 4.3 and, successively, in each of the positions described in Table 3.

In each of the tests, tilt the test platform tilted slowly to the slope specified in Table 3. The truck is considered stable if it passes all tests without overturning. For the purposes of the tests, overturning is defined as the test platform slope value that, if increased, would cause the truck to overturn.

It is permissible in lateral tests for one load wheel to lose contact with the test platform. It is acceptable for parts of the structure or designed features to make contact with the test platform.

4.2.2 Fixed slope

Use fixed slopes with inclinations equivalent to the specified test slope. The slope surface shall be smooth and capable of supporting the truck mass with no deformation that could affect the test results.

Drive the truck under test onto the fixed slopes with the mast lowered and positioned as specified in Table 3. For each of the truck positions with an elevated load or load carrier, the mast shall be elevated smoothly to the position specified in Table 3.

4.2.3 Calculation

Compliance with the specified stability values may be determined by calculation methods verified by empirical data.

The calculated capacities shall take into account manufacturing variations and deflections of the mast, tyres, etc.

4.3 Test conditions

4.3.1 Condition of the truck

The tests shall be carried out on an operational truck.

The operator on rider-controlled trucks shall be simulated by an object having a mass of 90 kg if the stability during a test is thereby decreased. For a truck designed for operation with a standing operator, an object having a mass of 90 kg shall be secured with its centre of gravity 1 000 mm above the floor of the operator's platform at the centre of the position normally occupied by the operator. For a truck designed for operation by a seated operator, the centre of gravity of the object shall be secured 150 mm above the seat index point (SIP) as determined in accordance with ISO 5353, with the seat at the closest position to the midpoint of the adjustments provided.

Fuel tanks of internal combustion engine trucks shall be full if the stability is thereby decreased. All other tanks shall be filled to their correct operating levels, as applicable.

Tyres shall be inflated to the pressure specified by the truck manufacturer. Where tyre ballast is incorporated in the truck design, the use of ballast shall be in accordance with the truck manufacturer's instructions.

4.3.2 Position of truck on platform

The truck shall be placed on the test platform or slope, with the line MN parallel to the tilt axis, XY, of the test platform, in accordance with the positions shown in Table 3.

Tests shall be conducted on the side of the truck which is the less stable.

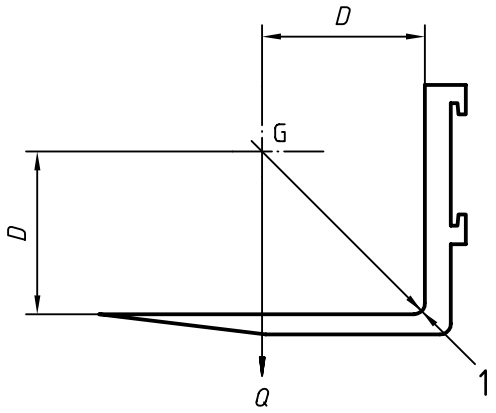
The truck wheel positions and general truck configurations in the diagrams are representative only and other arrangements are permissible provided the general principles relating to the test position are maintained.

4.3.3 Test load

The test load shall have a mass equivalent to the maximum load, Q, that the truck can elevate to its maximum lift height acting through the centre of gravity, G, nominally positioned at the standard load centre distance, D, as indicated on the capacity plate of the truck, both horizontally from the front face of the fork arm shank and vertically from the upper face of the fork arm blade (see Figure 1).

When additional lift heights, loads and load centre distances are to be indicated on the capacity plate, the truck shall meet the requirements established by the tests specified in this International Standard for these additional ratings.

The centre of gravity, G, of the test load shall be located on the centre plane between the mast uprights.



Key

D is the load centre distance
1 is a point (E) on the inside heel of the fork arm
G is the centre of gravity
Q is the load

Figure 1

Table 1 — Standard load centre distance

Load, Q kg	**Load centre distance**, D mm
$Q < 1\,000$	400
$1\,000 \leqslant Q \leqslant 4\,999$	500
$5\,000 \leqslant Q \leqslant 10\,000$	600
$Q > 10\,000$	600, 900, 1 200 or 1 500

4.3.4 Location of the truck on the test platform

The location of the truck on the test platform or slope shall be maintained during each test.

This may be achieved by application of parking or service brakes, which can be secured in the “on” position, or by wedging the wheels against the truck frame, ensuring however that the articulation is not affected.

Blocks (chocks) with a maximum height not exceeding the value indicated in Table 2 may be used, if necessary, to maintain the initial position of the truck on the test platform or slope. Blocks (chocks), if used, shall not artificially improve stability.

Table 2 — Height of blocks

Tyre outside diameter, d mm	**Height of blocks** max.
$d \leqslant 250$	25 mm
$250 < d \leqslant 500$	0,1 d
$d > 500$	50 mm

The coefficient of friction of the platform surface or slope may be increased if required by an appropriate friction-increasing material.

4.3.5 Position of front face of fork arm shank

Test 1 shall be conducted with the horizontal position of a load datum point (e.g. point E) unchanged when elevated from its lowered position (see Figure 4).

By means of a plumb line or other suitable equipment, set the mast vertical. Elevate the fork arms and specified test load to approximately 300 mm above the test platform. With the front face of the fork arm shank vertical, establish a point E (see Figure 2) on the fork arm or fork carrier having a fixed relationship to the centre of gravity (G), of the test load (see Figure 1). This point E shall be used to provide a reference datum (F) on the test platform (see Figure 2). When the mast is elevated, a new point F_1 on the test platform may occur (see Figure 3). This new point F_1 can be returned to the original location F (see Figure 4) by the following adjustments.

a) For trucks with tiltable masts, changes in the location of F_1 shall be corrected by varying the tilt of the mast or by retracting the mast or the fork arms within the limits provided by the design of the truck.

b) For trucks with non-tiltable masts, adjustments in the fork arms or fork carrier tilt (where provided) or retracting the mast may be used to correct for changes in location of point F_1 within the limits of tilt provided by the design of the truck.

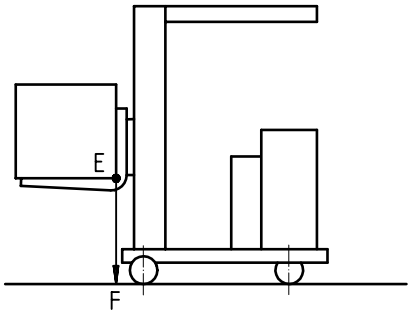
Adjustments cannot be made on trucks with non-tiltable masts, fork arms, fork carrier or retractable masts.

4.3.6 Lift height for tests simulating travelling

For tests simulating travelling, the upper face of the load platform or fork arms at the heels shall be positioned 300 mm from the ground or at the minimum height for transporting the load, whichever is the greater.

4.3.7 Lift height for tests simulating stacking

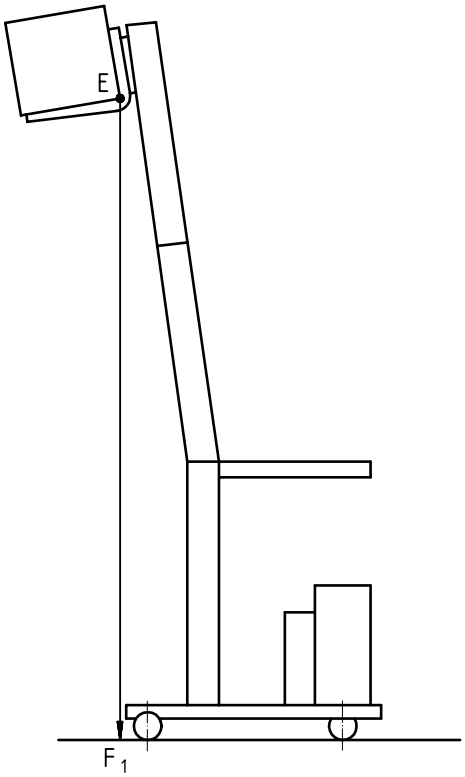
For tests simulating stacking, the lift height shall be measured between the surface of the tilting platform and the upper surface of the fork arm blade.



Key

F is the reference datum on test platform

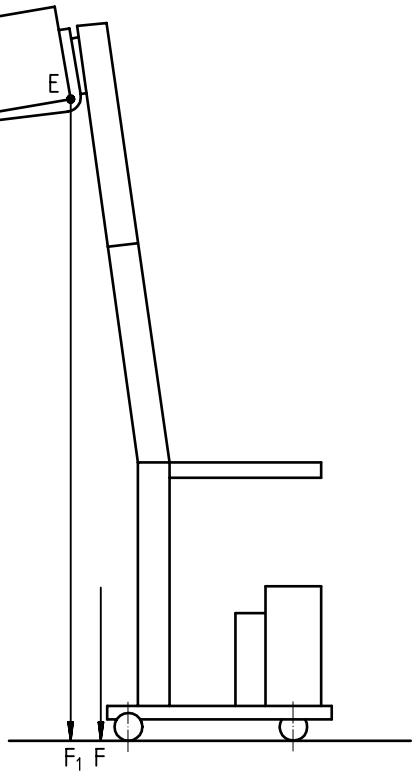
Figure 2



Key

F_1 is the new point on test platform

Figure 3



Key

F is the reference datum on test platform

F_1 is the new point on test platform

Figure 4

4.3.8 Safety precautions

Precautions shall be taken to prevent the truck overturning or displacement of the load during the tests. If the truck is prevented form overturning by rope lashing or chain, this shall be sufficiently slack to impose no appreciable restriction on the truck until the overturning point is reached.

Displacement of the test load shall be prevented by means such as:

a) firmly securing the test load to the load carrier or equivalent structure; or

b) suspending the test load near to the ground from an appropriate support placed on the fork arms so that the suspension point is at the point where the centre of gravity (G) of the test load would be if the test load was placed on the fork arms.

5 Stability tests for trucks with attachments

Trucks fitted with attachments other than fork arms shall be subject to the same stability tests.

For verification of the vertical position of the mast, a reference point with a fixed relationship to the centre of gravity (G) of the test load (see Figure 1) shall be chosen.

The test load shall be the actual load, at the specified load centre distance indicated for the attachment when used on the truck being tested.

The lift height required in the tests shall be measured between the surface of the tilting platform and the underside of the load in its approved handling position, or the underside of the load engaging means, whichever is the smaller.

Table 3 — Summary of tests

	Tests for longitudinal stability	
	Test 1	**Test 2**
Test of stability when	stacking	stacking
Test load	with	with
Load centre distance	D of test load	D of test load
Lift height	maximum (see 4.3.3)	maximum (see 4.3.3)
Position of carrying device	extended (where design permits)	retracted
Tilt of mast or fork arms	vertical (see 4.3.5)	position of least stability
Position on test platform	Figures 5 and 9 or 6 and 10 [a]	Figures 7 and 11 or 8 and 12 [a]
Test platform slope	4 % up to and excluding 5 000 kg	14 %
	3,5 % from 5 000 kg	

	Tests for longitudinal stability		
	Test 3	**Test 4**	**Test 5**
Test of stability when	stacking	stacking	travelling
Test load	without	without	without
Load centre distance	—	—	—
Lift height	maximum	maximum	lowered (see 4.3.6)
Position of carrying device	retracted	retracted	retracted
Tilt of mast or fork arms	positioned so that the truck is in the condition of minimum stability		maximum backward tilt
Position on test platform	Figures 13 and 11 [a]	Figures 14 and 12	Figures 15 and 11 [b]
Test platform slope	14 % when one or no brakes, and 18 % when two brakes are fitted to the wheels at the operator's end of the truck	14 %	see Figure 16

	Tests for lateral stability
	Test 6
Test of stability when	travelling
Test load	without
Load centre distance	—
Lift height	lowered (see 4.3.6)
Position of carrying device	retracted
Tilt of mast or fork arms	maximum backward if stability is thereby reduced, otherwise vertical
Position on test platform	Figures 17, 18, 19, 20 (see [a]) and 21 to 30
Test platform slope	see Figure 43

Table 3 *(continued)*

	Tests for lateral stability	
	Test 7	**Test 8**
Test of stability when	travelling	stacking
Test load	with	with
Load centre distance	D of test load	D of test load
Lift height	lowered (see 4.3.6)	maximum (see 4.3.3)
Position of carrying device	retracted	retracted
Tilt of mast or fork arms	maximum backwards if stability is thereby reduced, otherwise vertical	
Position on test platform	Figures 31, 32, 35, 36 (see [a]) and 21 to 30	Figures 33, 34, 37, 38 (see [a]) and 21 to 30
Test platform slope	18 %	6 %

	Tests for lateral stability
	Test 9
Test of stability when	stacking
Test load	without
Load centre distance	—
Lift height	maximum
Position of carrying device	retracted
Tilt of mast or fork arms	maximum backwards if stability is thereby reduced, otherwise vertical
Position on test platform	Figures 39, 40, 41, 42 (see [a]) and 21 to 30
Test platform slope	8 %

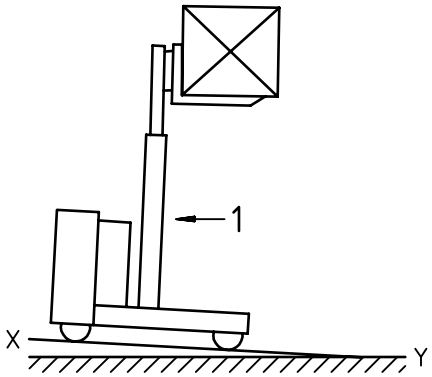
[a] The wheels shall be orientated to the straight-ahead position for non-retracting mast trucks and to the position of least stability for retracting mast trucks.

[b] The truck shall be placed on the platform with the fork arms generally directed away from the tilt axis of the platform and the truck in the position of least stability which need not be the cardinal position. The wheels shall be orientated so that their axes remain parallel to the platform tilt axis (as far as it is possible).

AB is the longitudinal centreline of the truck.

XY is the test platform tilt axis.

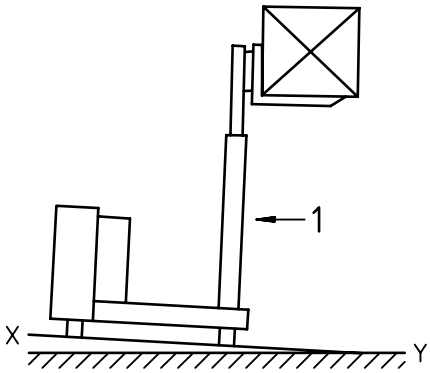
MN is the truck axis of original tilt.



Key

1 Without reach mechanism

Figure 5



Key

1 With reach mechanism

Figure 6

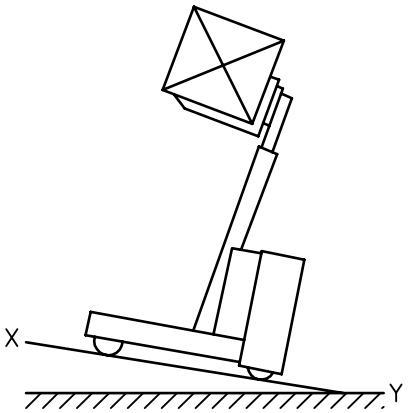


Figure 7

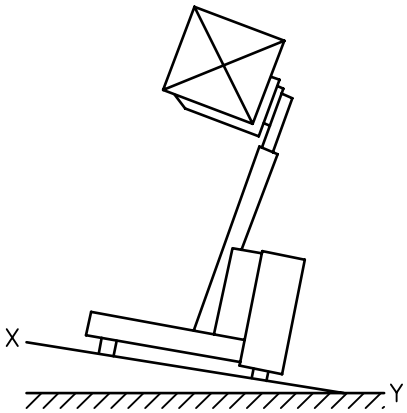
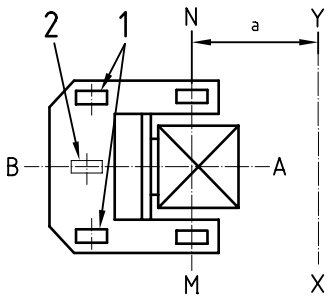


Figure 8



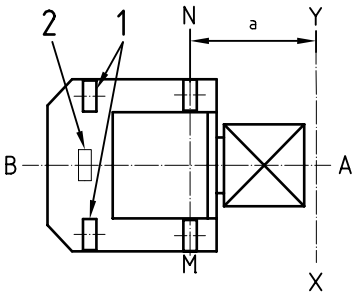
Key

1 Position for 4-wheeled truck

2 Position for 3-wheeled truck

a Parallel

Figure 9



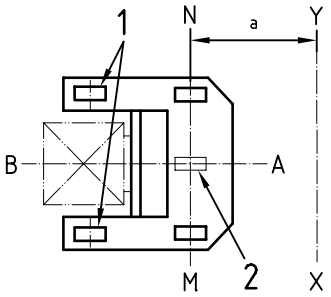
Key

1 Position for 4-wheeled truck

2 Position for 3-wheeled truck

a Parallel

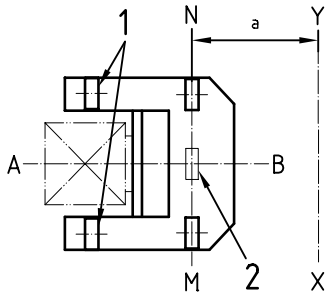
Figure 10



Key

1 Position for 4-wheeled truck
2 Position for 3-wheeled truck
a Parallel

Figure 11



Key

1 Position for 4-wheeled truck
2 Position for 3-wheeled truck
a Parallel

Figure 12

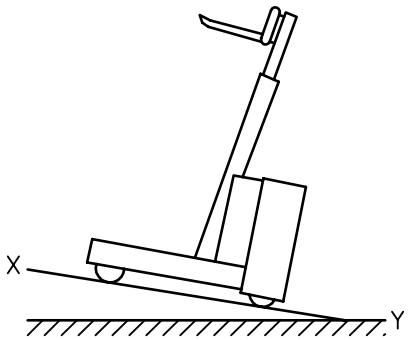


Figure 13

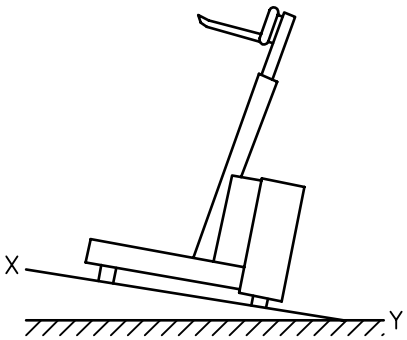


Figure 14

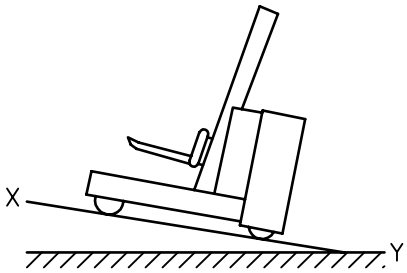
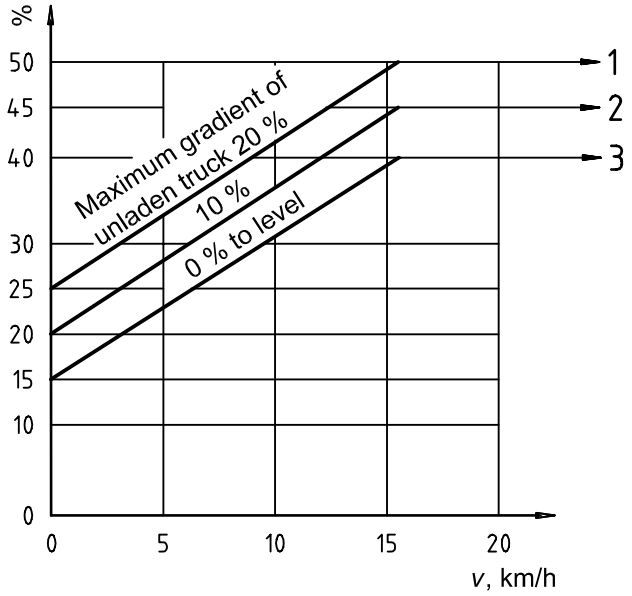


Figure 15



Key

1 $\left(\frac{20}{2} + 15 + 1{,}55\ v\right)\% - 50\ \%$ max.

2 $\left(\frac{10}{2} + 15 + 1{,}55\ v\right)\% - 45\ \%$ max.

3 $\left(15 + 1{,}55\ v\right)\% - 40\ \%$ max.

NOTE The various values of the gradient in Figure 16, or those calculated using the appropriate formula, are applied according to the intended performance of the truck.

Thus, if designed for and intended solely for use on level floors, only the curve marked “0 % level” should be used for determining the slope of the test platform. If designed for and intended for travelling unladen up and down gradients of 10 %, the test platform slope value indicated by the “10 %” curve should be used, and similarly for the curve marked “20 %”.

If designed for and intended for travelling up and down gradients between the above curves, the test platform slope should be calculated using the following formula:

$$\alpha = 15 + 0{,}5\ i + 1{,}55\ v\ (40 + 0{,}5\ \%)\ \text{max.}$$

where

α is the test platform slope, expressed as a percentage (%);

i is the maximum gradient, expressed as a percentage (%) of the unladen truck;

v is the maximum speed of truck, in kilometres per hour, unladen, on smooth and level ground.

Figure 16

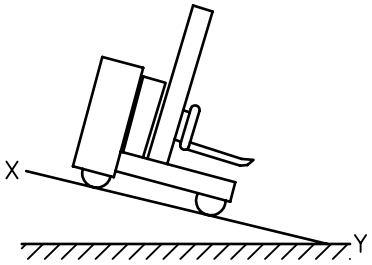


Figure 17

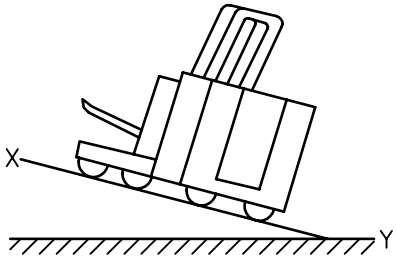


Figure 18

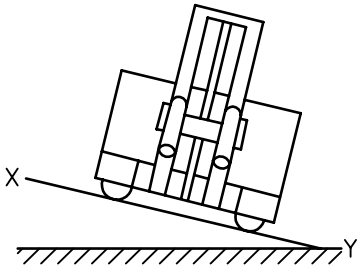


Figure 19

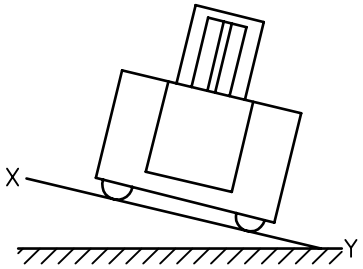
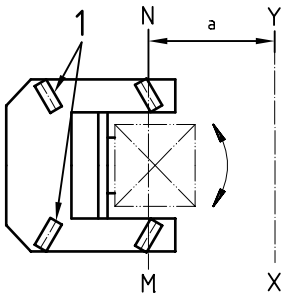


Figure 20

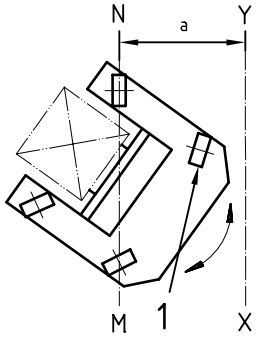


Key

1 Sprung castors or articulated axle

a Parallel

Figure 21

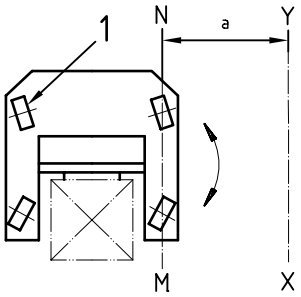


Key

1 Sprung castor or wheel

a Parallel

Figure 22

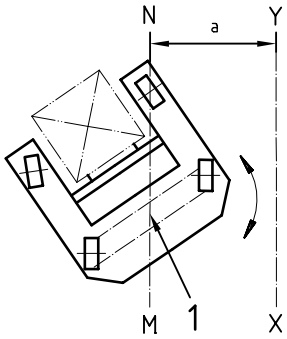


Key

1 Sprung castor or wheel

a Parallel

Figure 23

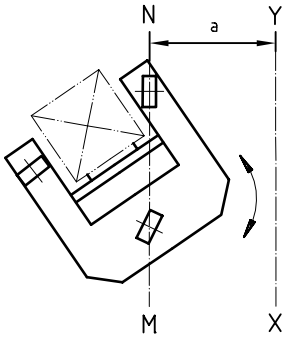


Key

1 Axle articulation point

a Parallel

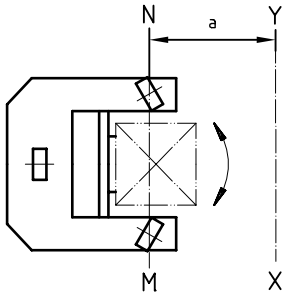
Figure 24



Key

a Parallel

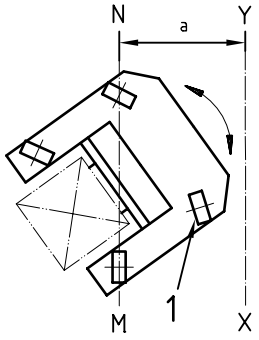
Figure 25



Key

a Parallel

Figure 26

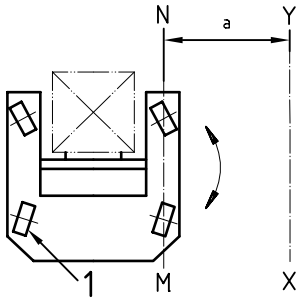


Key

1 Sprung castor or wheel

a Parallel

Figure 27

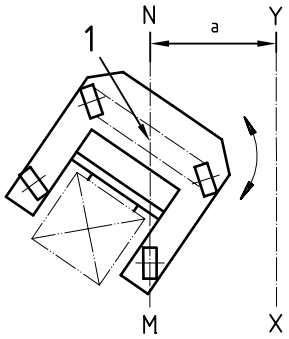


Key

1 Sprung castor or wheel

a Parallel

Figure 28

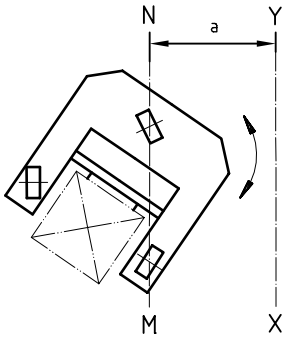


Key

1 Axle articulation point

a Parallel

Figure 29



Key

a Parallel

Figure 30

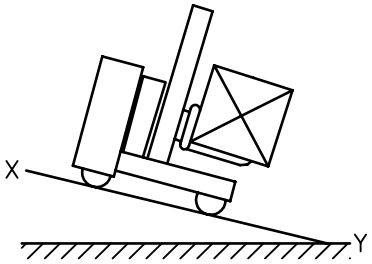


Figure 31

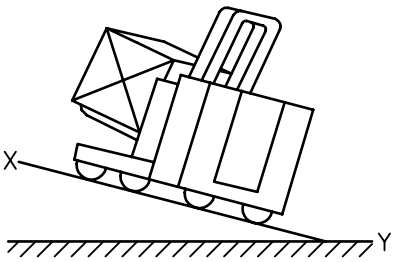


Figure 32

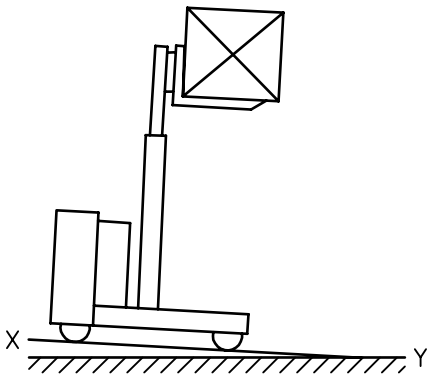


Figure 33

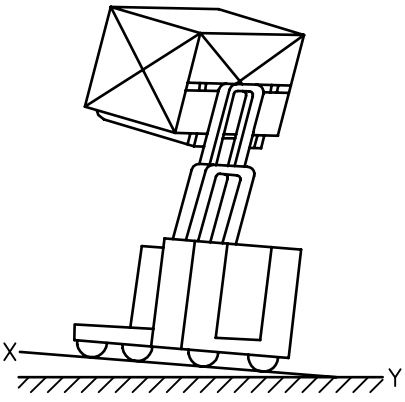
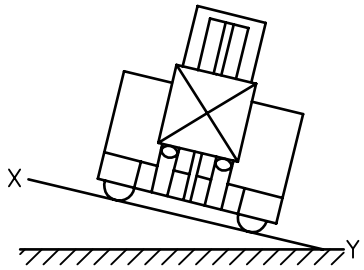


Figure 34



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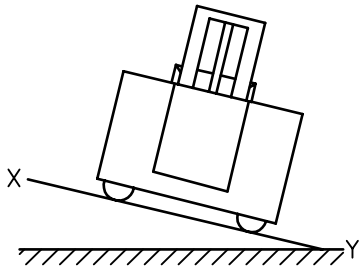

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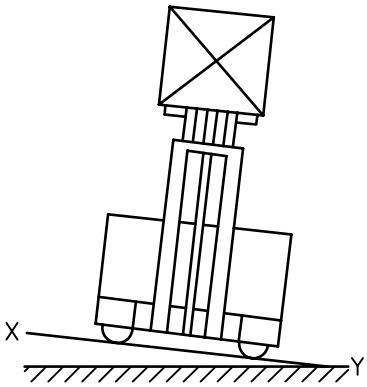


Figure 37

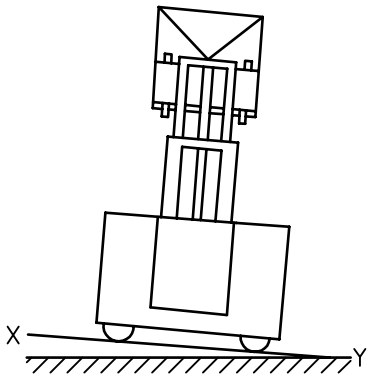


Figure 38

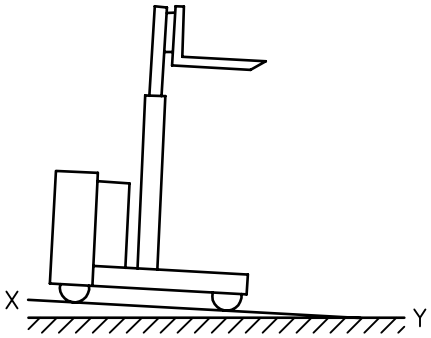


Figure 39

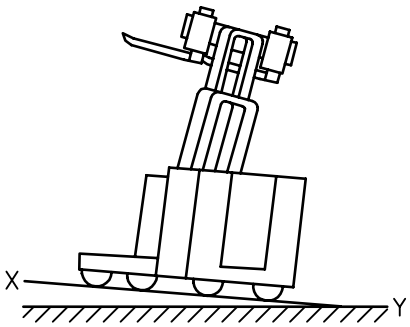


Figure 40

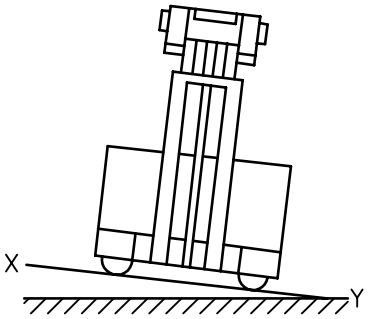


Figure 41

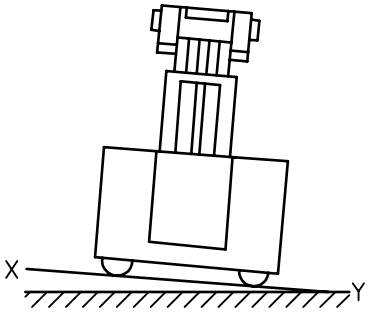
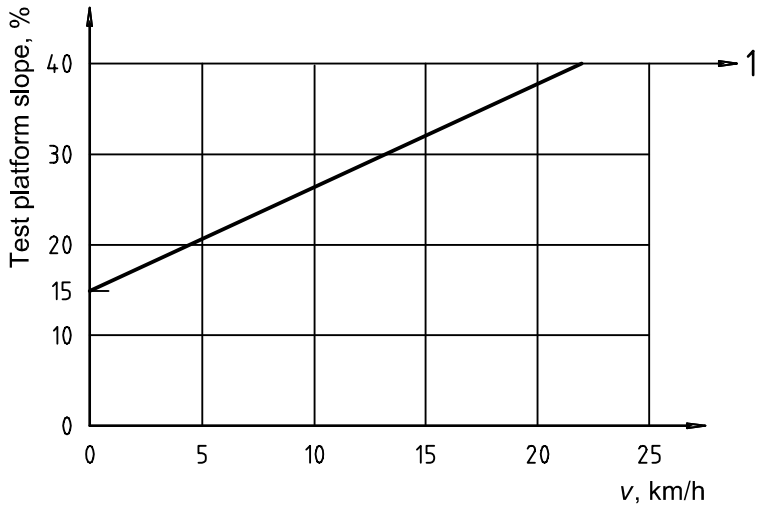


Figure 42



Key

1 $(15 + 1{,}1v)\,\%$ – 40 % max.

(v is the maximum speed of truck, in kilometres per hour, unladen, on smooth and level ground)

Figure 43

ICS 53.060

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