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Agricultural and forestry tractors — Roll-over protective structures on narrow-track wheeled tractors —

Part 1: Front-mounted ROPS

Tracteurs agricoles et forestiers — Structures de protection contre le retournement (ROPS) pour tracteurs à roues à voie étroite —

Partie 1: ROPS montées à l'avant

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12003-1 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 2, *Common tests*.

This second edition cancels and replaces the first edition (ISO 12003-1:2002), which has been technically revised.

ISO 12003 consists of the following parts, under the general title *Agricultural and forestry tractors — Roll-over protective structures on narrow-track wheeled tractors*:

— *Part 1: Front-mounted ROPS*

— *Part 2: Rear-mounted ROPS*

Introduction

Testing of roll-over protective structures (ROPS) for narrow-track tractors for agriculture and forestry aims at minimizing the likelihood of driver injury resulting from accidental overturning during normal operation (e.g. field work) of the tractor. The strength of the front-mounted ROPS is tested by applying either static or dynamic (impact) loads to simulate actual loads which may be imposed on the front-mounted ROPS when the tractor overturns either to the rear or to the side without free fall. The tests allow observations to be made on the strength of the front-mounted ROPS and the attachment brackets to the tractor and also of the tractor parts that may be affected by the load imposed on the front-mounted ROPS.

Provision is made to cover both tractors with the conventional forward facing driver's position only and those with a reversible driver's position, which is in agreement with the relevant OECD test code practice (Reference [5]). For tractors with a reversible driver's position, a clearance zone is defined to be the combined clearance zones for the two driving positions.

It is recognized that there may be designs of tractors, e.g. lawn-mowers, and certain forestry machines such as forwarders, for which this part of ISO 12003 is not appropriate.

NOTE For regular tractors, see ISO 3463[3] (dynamic test) and ISO 5700[4] (static test).

Agricultural and forestry tractors — Roll-over protective structures on narrow-track wheeled tractors —

Part 1: Front-mounted ROPS

1 Scope

This part of ISO 12003 specifies procedures for both the static and dynamic testing of roll-over protective structures (ROPS) front-mounted on narrow-track wheeled agricultural and forestry tractors. It defines the clearance zone and acceptance conditions for rigid or tiltable, front, two-post ROPS, including any associated rear fixtures, and is applicable to tractors so equipped having the following characteristics.

— A ground clearance of not more than 600 mm beneath the lowest points of the front- and rear-axle housings (not considering lower points on the axle differential).

— A fixed or adjustable minimum track width of one of the two axles of less than 1 150 mm when fitted with the widest specified tyres. It is understood that the axle mounted with the wider tyres is set at a track width of not more than 1 150 mm. It shall be possible to set the track width of the other axle in such a way that the outer edges of the narrower tyres do not extend beyond the outer edges of the tyres of the other axle. Where the two axles are fitted with rims and tyres of the same size, the fixed or adjustable track width of the two axles shall be less than 1 150 mm.

— A mass greater than 600 kg but less than 3 000 kg, unladen, including the ROPS and tyres of the largest size recommended by the manufacturer.

2 Normative references

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

ISO 630, *Structural steels — Plates, wide flats, bars, sections and profiles*

ISO 898-1:1999, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*

ISO 898-2:1992, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread*

ISO 2408, *Steel wire ropes for general purposes — Minimum requirements*

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

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASAE[1)] S313.3, *Soil Cone Penetrometer*

ASAE[1)] EP542, *Procedures for Using and Reporting Data Obtained with the Soil Cone Penetrometer*

3 Terms and definitions

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

3.1
roll-over protective structure
ROPS
framework protecting drivers of wheeled agricultural and forestry tractors, which minimizes the likelihood of driver injury resulting from accidental overturning during normal field work

NOTE The ROPS is characterized by the provision of space for a clearance zone, either inside the envelope of the structure or within a space bounded by a series of straight lines from the outer edges of the structure to any part of the tractor that might come into contact with the ground; it is capable of supporting the tractor in an overturned position.

3.2
front-mounted ROPS
two-post roll-over protective structure mounted on the tractor in front of the driver and with a reduced clearance zone

NOTE Compare with rear-mounted ROPS described in ISO 12003-2.

3.3
rear fixture
component such as the rear tyre (measured at its specified smallest diameter), mudguard or other rigid tractor components, or all of these, or a supplementary fixture of requisite width, height and strength installed behind the driver's seat, which completes the front-mounted ROPS' clearance zone for strength testing

3.4
tractor mass
mass of the unladen tractor in working order with tanks and radiator full, front-mounted ROPS and any equipment required for normal use

NOTE The operator, optional ballast weights, additional wheel equipment, and special equipment and tools are not included.

3.5
reference mass
mass, not less than the tractor mass, selected by the manufacturer for calculation of loading energies and forces to be applied in the tests

1) American Society of Agricultural Engineers.

3.6
longitudinal median plane
longitudinal plane of symmetry
zero Y plane
vertical plane Y passing through the mid-points of AB, perpendicular to AB, where, for each wheel, the vertical plane passing through its axis cuts the mid-plane of the wheel following a straight line Δ which meets the supporting surface of the vehicle at one point, and where A and B are two points thus defined which correspond to two wheels, both of which are either steering or powered wheels, situated respectively at the two ends of the same real or imaginary axle

See Figure 1.

NOTE 1 "Mid-plane of the wheel" designates the plane equidistant from the inner edges of the rim. In the case of dual wheels, the straight line Δ is, in this particular case, the intersection of the mid-plane of the dual wheels and the vertical plane passing through the axis of the axle pin.

NOTE 2 Adapted from ISO 612:1978[1], Clause 5.

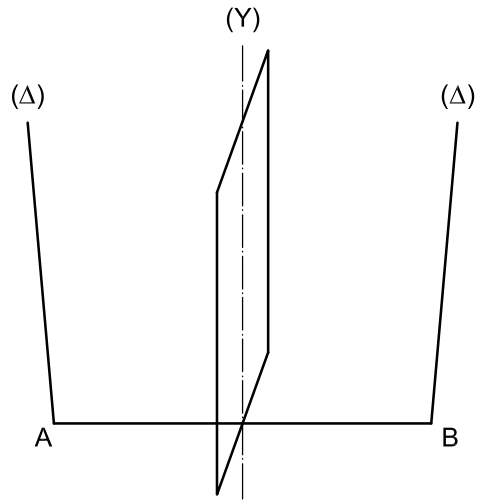


Figure 1 — Longitudinal median plane

3.7
reference plane
vertical plane, generally longitudinal to the tractor and passing through the seat index point and the steering-wheel centre

NOTE Normally this reference plane coincides with the longitudinal median plane of the tractor.

3.8
wheelbase
horizontal distance between the two vertical planes passing through the rotational centre-lines of the wheels, where one plane is for the front wheels and the other for the rear wheels

4 Symbols

See Table 1.

Table 1 — Symbols

Symbol	Description	Unit
a	Ratio of permanent deflection to elastic deflection measured at the point of impact during the dynamic tests	mm/mm
a_h	Half of the horizontal seat adjustment	mm
a_v	Half of the vertical seat adjustment	mm
B	Minimum overall width of the tractor	mm
B_b	Maximum outer width of the front-mounted ROPS	mm
D	Deflection of the front-mounted ROPS at the point of, and in line with, the load application (static test)	mm
D'	Deflection of calculated energy required	mm
E_i	Strain energy absorbed; area under F-D curve	J
E_{il}	Energy to be absorbed during longitudinal loading	J
E_{is}	Energy to be absorbed during side loading	J
F	Static load force	N
F_i	Force applied to the rear fixture	N
F'	Loading force for the calculated energy required	N
F_{max}	Maximum static load force occurring during loading, with the exception of overload	N
F_v	Vertical crushing force	N
H	Falling height of the pendulum block	mm
I	Moment of inertia about rear axle, whatever the mass of the rear wheels may be	$kg \cdot m^2$
L	Tractor reference wheelbase	mm
m	Tractor mass (see 3.4)	kg
m_t	Reference mass (see 3.5)	kg
NOTE See Annex C for characteristic tractor data symbols used in the calculation of non-continuous rolling.		

5 Preliminary tests

CAUTION — Some of the tests specified in this part of ISO 12003 involve the use of processes which could lead to a hazardous situation.

5.1 General requirements

5.1.1 Front-mounted ROPS may only be applied to tractors that satisfactorily complete both the lateral stability test and the non-continuous rolling test described in this clause.

5.1.2 The tractor shall be equipped with the front-mounted ROPS fitted in its upright (safety) position.

5.1.3 The tractor shall be equipped with tyres having the greatest diameter indicated by the manufacturer and the smallest cross-section for tyres of that diameter. The tyres shall not be liquid-ballasted and shall be inflated to the pressure recommended for field work.

5.1.4 The rear wheels shall be set to the narrowest track width; the front wheels shall be set as closely as possible to the same track width. If it is possible to have two front track settings which differ equally from the narrowest rear track setting, the wider of these two front track settings shall be selected.

5.1.5 All the tractor's tanks shall be filled or the liquids shall be replaced by an equivalent mass in the corresponding position.

5.1.6 All attachments used in the series production shall be fixed to the tractor in the normal position.

5.2 Lateral stability test

5.2.1 The tractor, prepared as specified above, shall be placed on a horizontal plane so that the tractor front-axle pivot point or, in the case of an articulated tractor, the horizontal pivot point between the two axles can move freely.

5.2.2 Using a jack or a hoist, tilt the part of the tractor which is rigidly connected to the axle that bears more than 50 % of the tractor's weight, while constantly measuring the angle of inclination. This angle shall be at least 38° at the moment when the tractor is resting in a state of unstable equilibrium with the wheels touching the ground. Perform the test once with the steering wheel turned to full right lock and once with the steering wheel turned to full left lock.

5.3 Non-continuous rolling test

5.3.1 General

This test is intended to demonstrate that the front-mounted ROPS, when fitted to the tractor, is capable of preventing continuous rolling of the tractor in the event of a lateral overturn on a slope with a gradient of 1 in 1,5. Two alternative procedures are provided to demonstrate non-continuous rolling behaviour in subclauses 5.3.2 and 5.3.3. It is necessary to perform only one of these procedures.

5.3.2 Demonstration of non-continuous rolling behaviour by means of the overturning test

5.3.2.1 The overturning test shall be carried out on a test slope at least 4 m long (see Figure 2). The surface shall be covered with an 18 cm layer of a material that, as measured in accordance with Standards ASAE S313.3 and ASAE EP542 relating to soil cone penetrometers, has a cone penetration index of:

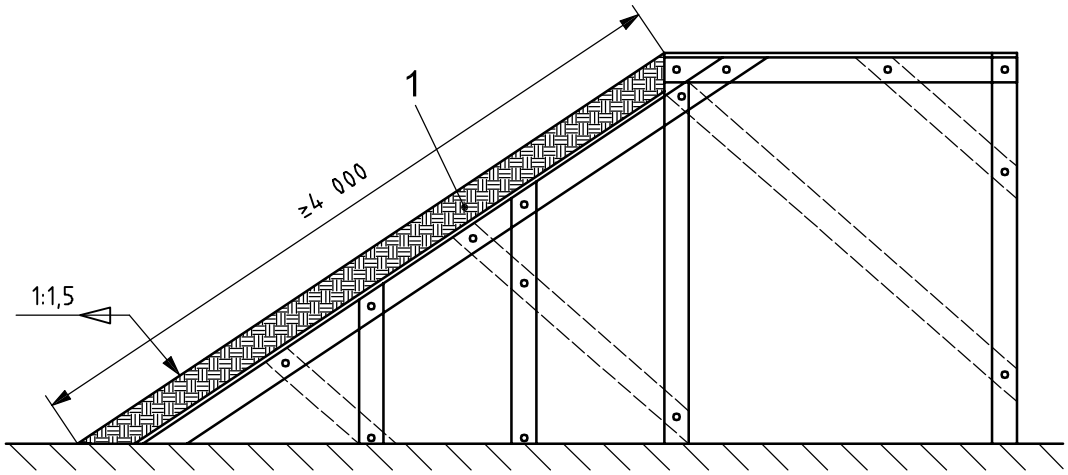
$$A_{CP} = 235 \pm 20$$

or

$$B_{CP} = 335 \pm 20$$

NOTE In the OECD Standard Code 6 and in Standard ASAE S313.3 the symbols for the cone penetration indices are A and B. These have been modified in this part of ISO 12003 in conformance with rules laid down in ISO/IEC Directives Part 2.

Dimensions in millimetres



Key

1 18 cm layer of material

Figure 2 — Rig for testing anti-roll properties

5.3.2.2 The tractor (prepared as described in 5.1) shall be tilted laterally with zero initial speed. For this purpose, the tractor is placed at the start of the test slope in such a way that the wheels on the downhill side rest on the slope and the tractor's median plane is parallel with the contour lines. After striking the surface of the test slope, the tractor may lift itself from the surface by pivoting about the upper corner of the front-mounted ROPS, but it shall not roll over. It shall fall back on the side which it first struck.

5.3.3 Demonstration of non-continuous rolling behaviour by calculation

Non-continuous rolling behaviour may also be demonstrated by complying with the requirements of Annex C.

6 Tractor and test preparation

6.1 Test methods

Tests can be performed in accordance with either the dynamic procedure or the static procedure. The two methods are determined to be equivalent.

6.2 General rules governing preparation for tests

6.2.1 The front-mounted ROPS shall conform to the series production specifications. It shall be attached in accordance with the manufacturer's recommended method to one of the tractors for which it is designed.

NOTE A complete tractor is not required for the static procedure; however, the front-mounted ROPS and parts of the tractor to which the front-mounted ROPS is attached represent an operating installation hereafter referred to as the assembly.

6.2.2 For both the static and dynamic procedures, the tractor as assembled (or the assembly) shall be fitted with all series production components which may affect the strength of the front-mounted ROPS or which may be necessary for the strength test.

6.2.3 All components of the tractor or the front-mounted ROPS, including weather protection, shall be supplied or described on drawings.

6.2.4 For the strength tests, all removable panels and detachable non-structural components shall be removed so that they do not contribute to the strength of the front-mounted ROPS.

6.2.5 The track width shall be adjusted so that the front-mounted ROPS will, as far as possible, not be supported by the tyres during the strength tests. If these tests are conducted according to the static procedure, the wheels may be removed.

7 Test apparatus and equipment

7.1 Apparatus for both dynamic and static testing

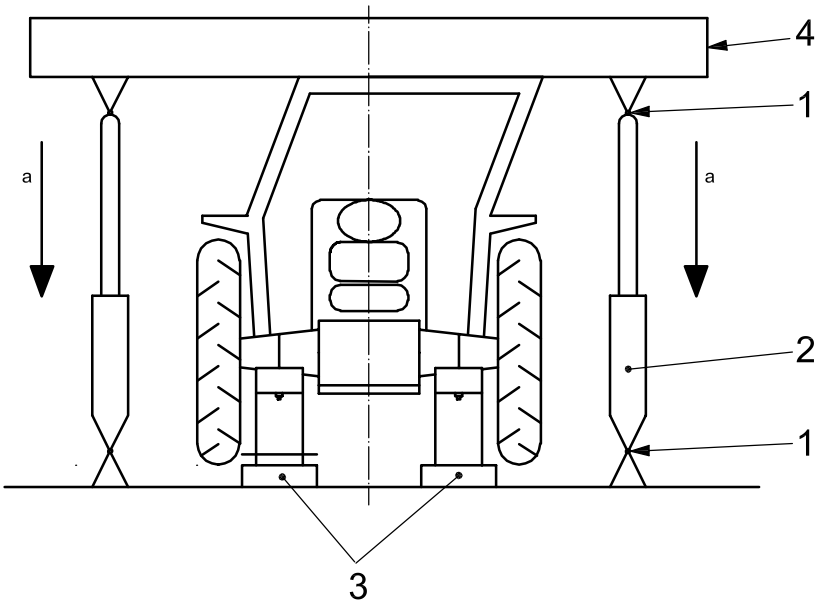
7.1.1 Clearance zone framework

Means to prove that the clearance zone has not been entered during the test: a measuring rig complying with Figures 10 and 11 can be used.

7.1.2 Apparatus for crushing tests

The crushing tests shall be carried out by means of the elements described in 7.1.2.1 to 7.1.2.3.

7.1.2.1 Means to apply downward force on the front-mounted ROPS, such as that shown in Figure 3, including a stiff beam with a width of 250 mm.



Key

1 universal pin joints
2 hydraulic cylinder
3 supports
4 crushing beam

[a] Direction of force.

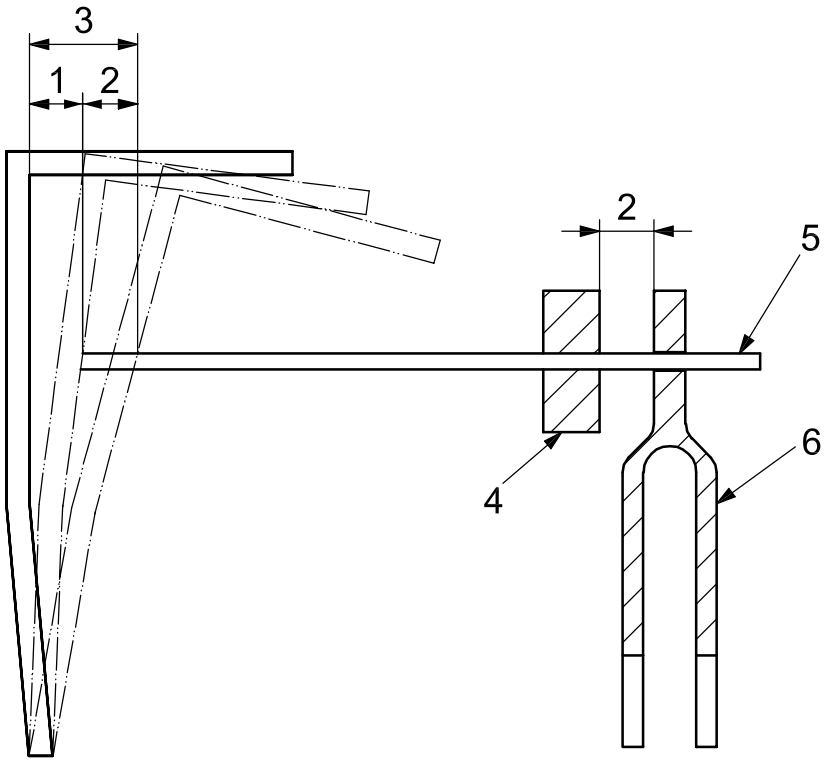
Figure 3 — Crushing rig — Example

7.1.2.2 Equipment to measure total vertical force applied.

7.1.2.3 Suitable axle stands, so that the tractor tyres do not bear the crushing force.

7.1.3 Device to measure elastic deflection

Device to measure elastic deflection, such as that shown in Figure 4, in a horizontal plane that coincides with the upper limiting surface of the clearance zone.



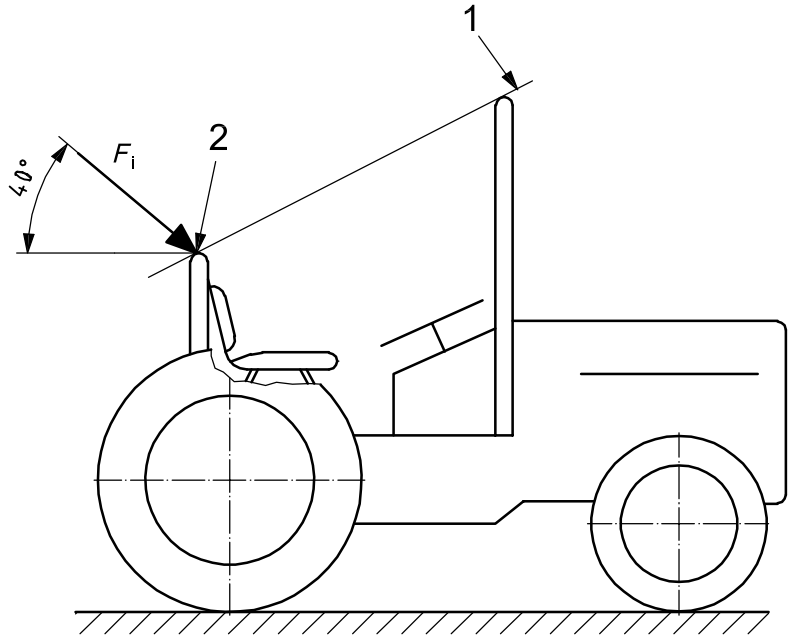
Key

1 permanent deflection
2 elastic deflection
3 total deflection
4 friction collar
5 horizontal rod attached to ROPS
6 vertical support attached to tractor chassis

Figure 4 — Apparatus for measuring elastic deflection — Example

7.1.4 Rear hard fixture test rig

A rig to apply a force as shown in Figure 5.



Key

1 simulated ground line

2 supplementary (rear) fixture

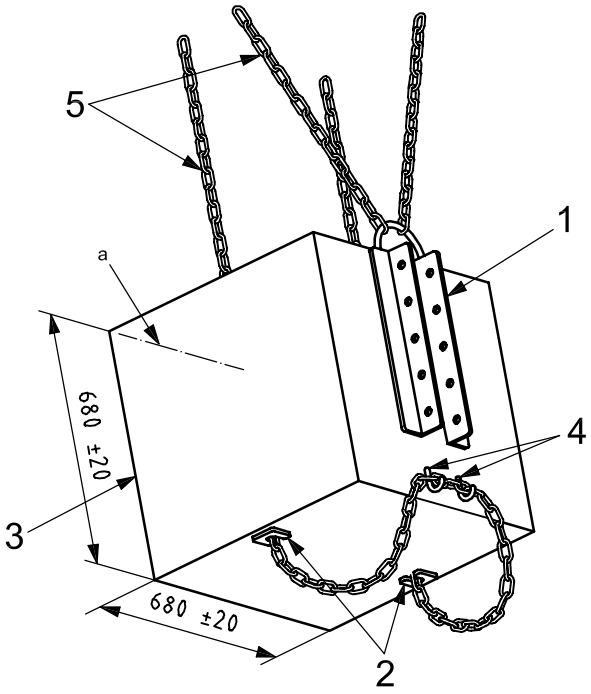
Figure 5 — Test force direction

7.2 Apparatus for dynamic testing

7.2.1 Device to strike a blow against the front-mounted ROPS

A pendulum block with mass of 2 000 kg. The pendulum block mass does not include the mass of the chains. The maximum chain mass shall be 100 kg. The dimensions of the block that shall be suspended from two chains from pivot points 6 m or more above ground level shall be as shown in Figure 6. The pendulum block centre of gravity shall coincide with its geometric centre. Means shall be provided for independently adjusting the height of the pendulum block and the angle between the pendulum block and the supporting chains or wire rope.

Dimensions in millimetres



Key

1 attachment for release mechanism
2 height adjustment
3 impact face
4 hooks to hold spare chain
5 pendulum chains

a Axis of centre of gravity.

Figure 6 — Illustration of pendulum block

7.2.2 Pendulum supports

The pendulum pivot points shall be rigidly fixed such that their displacement in any direction does not exceed 1 % of the height of fall.

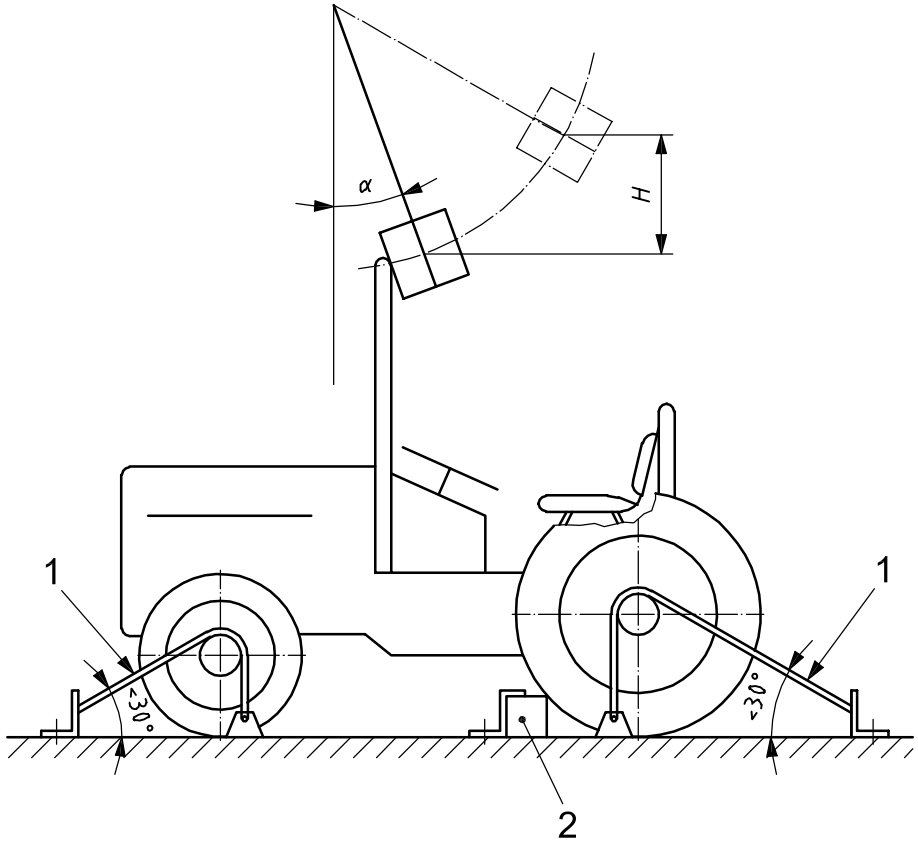
7.2.3 Means of lashing the tractor to the ground

The tractor shall be lashed, by means of steel wire ropes incorporating tensioning devices, to ground rails preferably spaced approximately 600 mm apart throughout the area immediately below the pivot points and extending for approximately 9 m along the pendulum block axis and approximately 1 800 mm to either side. The points of attachment of the lashings shall be approximately 2 000 mm behind the rear axle and 1 500 mm in front of the front axle. There shall be two lashings on each axle, one on each side of the median plane of the tractor. The lashings shall be of steel cable of 12,5 mm to 15 mm diameter, with a tensile strength of 1 100 MPa to 1 260 MPa, meeting the requirements of ISO 2408. Details of the lashing means are given in Figures 7, 8 and 9.

The front and rear wheels are not required to be in line if this is more convenient for attaching appropriate ropes.

7.2.4 Softwood beam

A softwood beam, of cross-section 150 mm × 150 mm, to restrain the rear wheels when striking from the front or rear, and to clamp against the side of the front and rear wheels when striking from the side, as shown in Figures 7, 8 and 9.



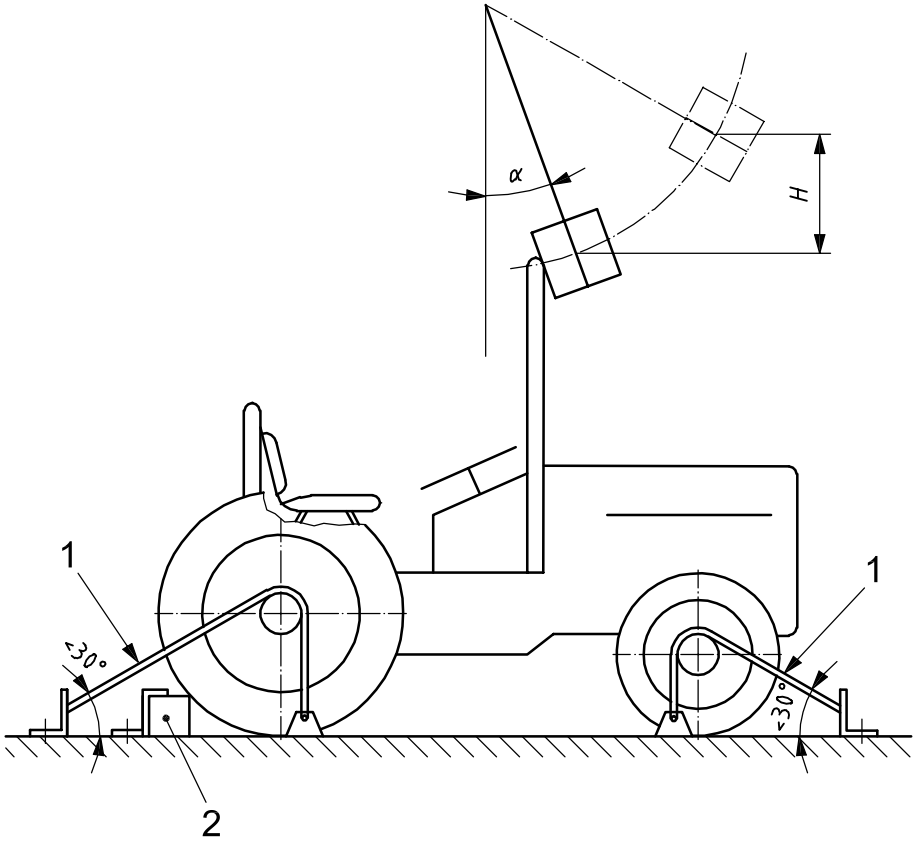
$$\alpha = \frac{m_t}{100} \leqslant 20°$$

Key

1 two lashings

2 wedging beam

Figure 7 — Lashing for rear impact test — Example



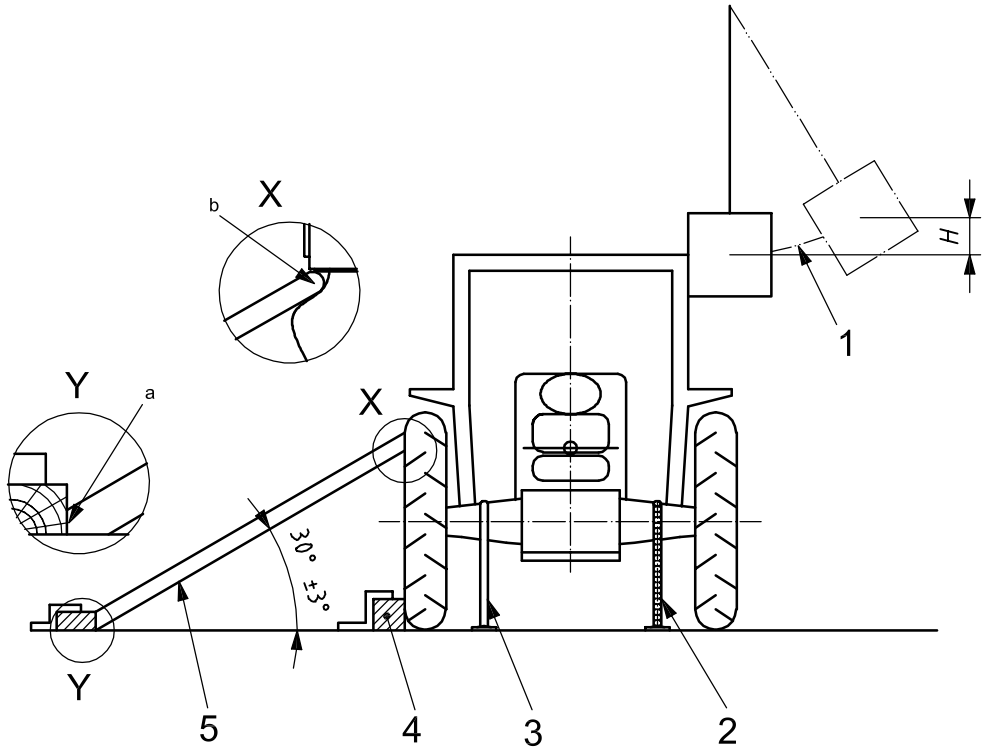
$$\alpha = \frac{m_t}{100} \leqslant 20°$$

Key

1 two lashings

2 wedging beam

Figure 8 — Lashing for front impact test — Example



Key

1 travel arc of pendulum block centre of gravity
2 lashing (see 7.2.3)
3 untensioned cable (optional)
4 150 mm square softwood beam
5 wooden prop

a Chamfered.
b Rounded to secure contact against rim.

Figure 9 — Lashing for side impact test — Example

7.2.5 Wooden prop

Wooden prop to restrain the opposite rear wheel when striking from the side as shown in Figure 9. Its length shall be 20 to 25 times its thickness and its width 2 to 3 times its thickness.

7.2.6 Props and lashings for articulated tractors

The central pivot of an articulated tractor shall be supported and lashed down as appropriate for all test procedures. For the side impact test procedure, the pivot shall also be propped from the side opposite the impact.

7.2.7 Tyre pressures and deflection

The tractor tyres shall not be liquid-ballasted and shall be inflated to the pressures prescribed by the tractor manufacturer for field work. The lashings shall be tensioned in each particular case such that the tyres undergo a deflection equal to 12 % of the tyre wall height (distance between the ground and the lowest point of the rim) before tensioning.

7.3 Apparatus for static testing

7.3.1 Material, equipment and attachment means of ensuring that the tractor chassis is firmly fixed to the ground (and supported), independently of the tyres, meeting the following requirements.

— Anchoring rails with the requisite track width and covering the necessary area for anchoring the tractor in all cases illustrated shall be rigidly attached to a non-yielding base near the test rig.

— The tractor shall be anchored to the rails by any suitable means (plates, wedges, wire ropes, jacks, etc.) so that the tractor cannot move during the tests. This requirement shall be checked during the test, by means of the usual devices for measuring length. If the tractor moves, the entire test shall be repeated, unless the system for measuring the deflections, taken into account for plotting the force versus deflection curve, is connected to the tractor.

7.3.2 Means of applying a horizontal force to the front-mounted ROPS, complying with the requirements of 7.3.2.1 to 7.3.2.4.

7.3.2.1 It shall be ensured that the load can be uniformly distributed normal to the direction of loading and along a stiff beam of length between 250 mm and 700 mm, in an exact multiple of 50 mm. The beam shall have a vertical face of 150 mm.

7.3.2.2 The edges of the beam in contact with the front-mounted ROPS shall be curved with a maximum radius of 50 mm.

7.3.2.3 Universal joints, or the equivalent, shall be incorporated to ensure that the loading device does not constrain the structure in rotation or translation in any direction other than the loading direction.

7.3.2.4 The direction of the force (deviation from horizontal and vertical) shall be:

— at the start of test, under zero load: ± 2°;

— during test, under load: 10° above and 20° below the horizontal; these variations shall be kept to a minimum.

7.3.3 Equipment to measure force and deflection along the direction of application of the force and relative to the tractor chassis. To ensure accuracy, measurements shall be taken as continuous recordings. The measuring devices shall be located so as to record the force and deflection at the point of, and along the line of, loading.

8 Test procedures

8.1 General requirements

8.1.1 If during any test any part of the tractor restraining equipment breaks or moves, the test shall be restarted.

8.1.2 No repairs or adjustments to the tractor or front-mounted ROPS may be carried out during the tests.

8.1.3 The tractor gearbox shall be in neutral and the brakes off during the tests.

8.1.4 If the tractor is fitted with a suspension system between the tractor body and the wheels, it shall be blocked during the tests.

8.1.5 The side chosen for application of the first impact (dynamic test) or the first load (static test) on the rear of the structure shall be that which, in the opinion of the testing engineer, will result in the application of the series of impacts or loads under the most unfavourable conditions for the structure. The lateral impact or load and the rear impact or load shall be applied on both sides of the longitudinal median plane of the front-mounted ROPS. The front impact or load shall be applied on the same side of the longitudinal median plane of the front-mounted ROPS as the lateral impact or load.

8.1.6 The rear fixture or any other component behind the driver's seat forming part of the front-mounted ROPS shall be submitted to a static strength test procedure.

8.2 Test sequence

The sequence of tests, without prejudice to the additional tests mentioned in 8.4.4, 8.7 and 12.3 is as follows:

a) impact (dynamic test) or loading (static test) at the rear of the structure (see 8.4.1 or 8.5.1);

b) crushing (dynamic and static test) at the rear of the structure (see 8.6);

c) impact (dynamic test) or loading (static test) at the front of the structure (see 8.4.2 or 8.5.2);

d) impact (dynamic test) or loading (static test) at the side of the structure (see 8.4.3 or 8.5.3);

e) crushing (dynamic and static test) at the front of the structure (see 8.6);

f) rear hard fixture test (dynamic and static, see 8.3).

8.3 Rear fixture test procedure

Subject any rear fixture or rigid tractor component supplementing the front-mounted ROPS to a static load of:

$F_i = 15 m_t$ in newtons.

This load shall be applied to the rear fixture in the longitudinal median plane of the tractor, forward and downward at an angle of 40° (see Figure 5). Maintain this force for a least 5 s after the cessation of any visually detectable movement of the rear fixture.

8.4 Dynamic (impact) test procedures for front-mounted ROPS

8.4.1 Rear impact test procedure

8.4.1.1 The tractor shall be so placed in relation to the pendulum block that the block will strike the front-mounted ROPS when the impact face of the block and the supporting chains or wire ropes are at an angle with the vertical plane, α, equal to m_t/100 with a 20° maximum, unless, during deflection, the front-mounted ROPS at the point of contact forms a greater angle to the vertical. In this case, the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the front-mounted ROPS at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining at the angle defined above.

The suspended height of the block shall be adjusted and necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact is that part of the front-mounted ROPS likely to hit the ground first in a rearward overturning accident, normally the upper edge. The position of the centre of gravity of the block shall be one-sixth the width of the top of the front-mounted ROPS inwards from a vertical plan parallel to the median plane of the tractor touching the outside extremity of the top of the front-mounted ROPS.

If the structure is curved or protruding at this point, wedges enabling the impact to be applied thereon shall be added, without thereby reinforcing the structure.

8.4.1.2 The tractor shall be lashed to the ground by means of four wire ropes, one at each end of both axles, arranged as indicated in Figure 7. The spacing between the front and rear lashing points shall be such that the wire ropes make an angle of less than 30° with the ground. The rear lashings shall in addition be so arranged that the point of convergence of the two wire ropes is located in the vertical plane in which the centre of gravity of the pendulum block travels.

The wire ropes shall be tensioned so that the tyres undergo the deflections given in 7.2.7. With the wire ropes tensioned, the wedging beam shall be placed in front of and tight against the rear wheels and then fixed to the ground.

8.4.1.3 If the tractor is of the articulated type, the point of articulation shall, in addition, be supported by a wooden block at least 100 mm square and firmly lashed to the ground.

8.4.1.4 The pendulum block shall be pulled back so that the height, H, of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

— for tractors with a reference mass of less than 2 000 kg:

$$H = 25 + 0{,}07 m_t$$

— for tractors with a reference mass of 2 000 kg to 3 000 kg:

$$H = 125 + 0{,}02 m_t$$

8.4.1.5 For tractors with a reversible driving position (reversible seat and steering wheel), the same formulae shall apply.

8.4.1.6 The pendulum block shall be released and allowed to strike the front-mounted ROPS.

8.4.2 Front impact test procedure

8.4.2.1 The tractor shall be so placed in relation to the pendulum block that the block will strike the front-mounted ROPS when the impact face of the block and the supporting chains or wire ropes are at an angle with the vertical plane, α, equal to m_t/100 with a 20° maximum, unless, during deflection, the front-mounted ROPS at the point of contact forms a greater angle to the vertical. In this case, the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the front-mounted ROPS at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining at the angle defined above.

The suspended height of the pendulum block shall be adjusted and the necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact is that part of the front-mounted ROPS likely to hit the ground first if the tractor overturned sideways while travelling forward, normally the upper edge. The position of the centre of gravity of the block shall be 1/6 of the width of the top of the front-mounted ROPS inwards from a vertical plane parallel to the median plane of the tractor touching the outside extremity of the top of the front-mounted ROPS.

If the structure is curved or protruding at this point, wedges enabling the impact to be applied thereon shall be added, without thereby reinforcing the structure.

8.4.2.2 The tractor shall be lashed to the ground by means of four wire ropes, one at each end of both axles, arranged as indicated in Figure 8. The spacing between the front and rear lashing points shall be such that the wire ropes make an angle of less than 30° with the ground. The rear lashings shall in addition be so arranged that the point of convergence of the two wire ropes is located in the vertical plane in which the centre of gravity of the pendulum block travels.

The wire ropes shall be tensioned so that the tyres undergo the deflections given in 7.2.7. With the wire ropes tensioned, the wedging beam shall be placed behind and tight against the rear wheels and then fixed to the ground.

8.4.2.3 If the tractor is of the articulated type, the point of articulation shall, in addition, be supported by a wooden block at least 100 mm square and firmly lashed to the ground.

8.4.2.4 The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

— for tractors with a reference mass of less than 2 000 kg:

$$H = 25 + 0{,}07 m_t$$

— for tractors with a reference mass of 2 000 kg to 3 000 kg:

$$H = 125 + 0{,}02 m_t$$

8.4.2.5 For tractors with a reversible driving position (reversible seat and steering wheel), the height shall be whichever is greater of the formula applied above and that selected below:

$$H = 2{,}165 \times 10^{-8} m_t \times L^2$$

or

$$H = 5{,}73 \times 10^{-2} I$$

8.4.2.6 The pendulum block shall be released and allowed to strike the front-mounted ROPS.

8.4.3 Side impact test procedure

8.4.3.1 The tractor shall be so placed in relation to the pendulum block that the block will strike the front-mounted ROPS when the impact face of the block and the supporting chains or wire ropes are vertical unless, during deflection, the front-mounted ROPS at the point of contact forms an angle of less than 20° to the vertical. In this case, the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the front-mounted ROPS at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining vertical on impact.

The suspended height of the pendulum block shall be adjusted and necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact shall be that part of the front-mounted ROPS likely to hit the ground first in a sideways overturning accident.

8.4.3.2 The tractor wheels on the side which is to receive the impact shall be lashed to the ground by means of wire ropes passing over the corresponding ends of the front and rear axles. The wire ropes shall be tensioned to produce the tyre deflection values given in 7.2.7.

With the wire ropes tensioned, the wedging beam shall be placed on the ground, pushed tight against the tyres on the side opposite to that which is to receive the impact and then fixed to the ground. It may be necessary to use two beams or wedges if the outer sides of the front and rear tyres are not in the same vertical plane. The prop shall then be placed, as indicated in Figure 9, against the rim of the most heavily loaded wheel opposite to the point of impact, pushed firmly against the rim and then fixed at its base. The length of the prop shall be such that it makes an angle of 30° ± 3° with the ground when in position against the rim. In addition, its thickness shall, if possible, be between 20 and 25 times less than its length and between 2 and 3 times less than its width. The props shall be shaped at both ends as shown in the details in Figure 9.

8.4.3.3 If the tractor is of the articulated type, the point of articulation shall in addition be supported by a wooden block at least 100 mm square and laterally supported by a device similar to the prop pushed against the rear wheel, as in 8.4.3.2. The point of articulation shall then be lashed firmly to the ground.

8.4.3.4 The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

— for tractors with a reference mass of less than 2 000 kg:

$$H = \frac{(25 + 0{,}2m_t) \times (B_b + B)}{2B}$$

— for tractors with a reference mass of 2 000 kg to 3 000 kg:

$$H = \frac{(125 + 0{,}15m_t) \times (B_b + B)}{2B}$$

8.4.3.5 For tractors with a reversible seat position, either the preceding or the following formulae shall be used accordingly, whichever gives the greater result:

— for tractors with a reference mass of less than 2 000 kg:

$$H = 25 + 0{,}2m_t$$

— for tractors with a reference mass of 2 000 kg to 3 000 kg:

$$H = 125 + 0{,}15m_t$$

8.4.3.6 The pendulum block shall be released and allowed to strike the front-mounted ROPS.

8.4.4 Additional impact tests

If cracks or tears that cannot be considered negligible appear during an impact test, a second similar test, but with a height of fall of:

$$H' = \left(H \times 10^{-1}\right)(12 + 4a)(1 + 2a)^{-1}$$

shall be performed immediately after the impact test causing these cracks or tears to appear. The additional permanent deflection due to the second impact shall not exceed 30 % of the permanent deflection achieved during the first impact.

In order to be able to carry out this additional test, it is necessary to measure the elastic deflection during all impact tests.

8.5 Static test procedures for front-mounted ROPS

8.5.1 Rear loading

Apply the load horizontally in a vertical plane parallel to the tractor's reference plane. The load application point shall be that part of the front-mounted ROPS likely to hit the ground first in a rearward overturning accident, normally the upper edge. The vertical plane in which the load is applied shall be located at a distance of one-third of the external width of the upper part of the structure from the median plane. If the front-mounted ROPS is curved or protruding at this point, wedges enabling the load to be applied thereon shall be added, without thereby reinforcing the front mounted ROPS.

The tractor or assembly shall be lashed to the ground as described in 7.3.1.

The energy absorbed by the front-mounted ROPS during the test shall be at least:

$$E_{il} = 500 + 0,5m_t$$

For tractors with a reversible driving position (reversible seat and steering wheel), the same formula shall apply.

8.5.2 Front loading

Apply the load horizontally, in a vertical plane parallel to the tractor's reference plane and located at a distance of one-third of the external width of the upper part of the front-mounted ROPS from the reference plane. The load application point shall be that part of the front-mounted ROPS likely to hit the ground first if the tractor overturned sideways while travelling forward, normally the upper edge. If the structure is curved or protruding at this point, wedges enabling the load to be applied thereon shall be added, without thereby reinforcing the structure.

The tractor or assembly shall be lashed to the ground as described in 7.3.1.

The energy absorbed by the front-mounted ROPS during the test shall be at least:

$$E_{il} = 500 + 0,5m_t$$

For tractors with a reversible driving position (reversible seat and steering wheel), either the preceding formula or one of the following formulae shall be used, whichever gives the greater result:

$$E_{il} = 2,165 \times 10^{-7} m_t \times L^2$$

or

$$E_{il} = 0,574 \times I$$

8.5.3 Side loading

Apply the side loading horizontally, in a vertical plane perpendicular to the tractor's median plane. The load application point shall be that part of the front-mounted ROPS likely to hit the ground first in a sideways overturning accident, normally the upper edge.

The assembly shall be lashed to the ground as described in 7.3.1.

The energy absorbed by the front-mounted ROPS during the test shall be at least:

$$E_{is} = \frac{1,75m_t\left(B_b + B\right)}{2B}$$

For tractors with a reversible driving position (reversible seat and steering wheel), either the preceding or the following formula shall be used, whichever gives the greater result:

$$E_{is} = 1,75m_t$$

8.6 Vertical crushing test procedure

Position the beam across the uppermost structural members of the front-mounted ROPS, with the resultant crushing forces located in the tractor's median plane (see Figure 3).

Apply a crushing force of $F_v = 20\ m_t$.

Maintain this force for at least 5 s after the cessation of any visually detectable movement of the front mounted ROPS.

8.7 Additional crushing tests

If cracks or tears that cannot be considered negligible appear during a crushing test, a second similar crushing test, but with a force of 1,2 F_V, shall be carried out immediately after the crushing test that caused the cracks or tears to appear.

8.8 Observations during testing

8.8.1 Fractures and cracks

After each test, all structural members, joints and fastening systems shall be visually examined for fractures or cracks. Small cracks in unimportant parts and any tears caused by the edges of the pendulum weight shall be ignored.

8.8.2 Clearance zone

During each test, an examination shall be made to ascertain whether any part of the front-mounted ROPS has entered the clearance zone (see Clause 10).

In addition, an examination shall be made to determine whether any part of the clearance zone is outside the protection of the front-mounted ROPS, i.e. were any part of the zone to come into contact with the ground in the event of the tractor overturning in the direction of impact. For this purpose, the front and rear tyres and track width setting shall be the smallest specified by the manufacturer.

8.8.3 Deflection

The elastic deflection to the side shall be measured at the height of the top of the clearance zone in the vertical plane passing through the point of impact. A device for measuring elastic deflection is shown in Figure 4.

After the final crushing test procedure has been carried out, the permanent deflection of the front-mounted ROPS shall be recorded. For this purpose, before the start of the test procedure, the position of the main front-mounted ROPS shall be noted.

9 Seat index point

The seat index point (SIP) shall be determined in accordance with ISO 5353.

For a suspended seat, the manufacturer's directions for setting the suspension shall be followed if provided. Otherwise, the seat suspension shall be set to the suspension mid-travel point. After the installation of the seat on the tractor, the seat index point (SIP) becomes a fixed point with respect to the tractor and does not move with the seat through its horizontal and vertical adjustment range.

10 Clearance zone

10.1 General

10.1.1 The reference plane is a vertical plane, generally longitudinal to the tractor and passing through the seat index point and the centre of the steering wheel. Normally the reference plane coincides with the longitudinal median plane of the tractor. This reference plane shall be assumed to move horizontally with the seat and steering wheel during loading but to remain perpendicular to the tractor or the floor of the front-mounted ROPS.

10.1.2 The reference line is the line contained in the reference plane that passes through a point located ($140 + a_h$) mm rearward and ($90 - a_v$) mm below the seat index point and the first point on the steering wheel rim that it intersects when brought to the horizontal (see Figure 10).

10.1.3 The clearance zone is illustrated in Figure 10. The zone is defined in relation to the reference plane, the reference line, the steering wheel and the seat index point (SIP). For purposes of establishing the clearance zone, the seat, if adjustable, shall be adjusted to its upper, rearmost position. For a suspended seat, the manufacturer's directions for setting the suspension shall be followed if provided. Otherwise, the seat suspension shall be set to the suspension mid-travel point. The clearance zone shall be defined on the basis of 10.2 and 10.3.

10.2 Clearance zone for tractors with a non-reversible seat

The zone of clearance is bounded by the planes listed in a) to k) when the tractor is on a horizontal surface and, where the steering wheel is adjustable, its position is adjusted for the middle position for driving:

a) a horizontal plane passing through a point ($90 - a_v$) mm below the seat index point;

b) two vertical planes 250 mm on either side of the reference plane, these vertical planes extending 300 mm upwards from the plane defined in a) and longitudinally at least 550 mm in front of the vertical plane perpendicular to the reference plane passing ($210 - a_h$) mm in front of the seat index point;

c) two vertical planes 200 mm on either side of the reference plane, these vertical planes extending 300 mm upwards from the plane defined in a) and longitudinally from the surface defined in k) to the vertical plane perpendicular to the reference plane passing ($210 - a_h$) mm in front of the seat index point;

d) an inclined plane perpendicular to the reference plane, parallel with and 400 mm above the reference line, extending backwards to the point where it intersects the vertical plane which is perpendicular to the reference plane and which passes through a point ($140 + a_h$) mm rearward of the seat index point;

e) an inclined plane, perpendicular to the reference plane, which meets the plane defined in d) and rests on the top of the seat back rest;

f) a vertical plane perpendicular to the reference plane, passing at least 40 mm forward of the steering-wheel and at least ($760 - a_h$) mm forward of the seat index point;

g) a cylindrical surface with its axis perpendicular to the reference plane, having a radius of 150 mm and tangential to the planes defined in d) and f);

h) two parallel inclined planes passing through the upper edges of the planes defined in b) with the inclined plane on the side where the impact is applied no closer than 100 mm to the reference plane above the zone of clearance;

i) two portions of the vertical plane perpendicular to the reference plane passing ($210 - a_h$) mm forward of the seat index point, both these part planes joining the rearmost limits of the planes defined in b) to the foremost limits of the planes defined in c);

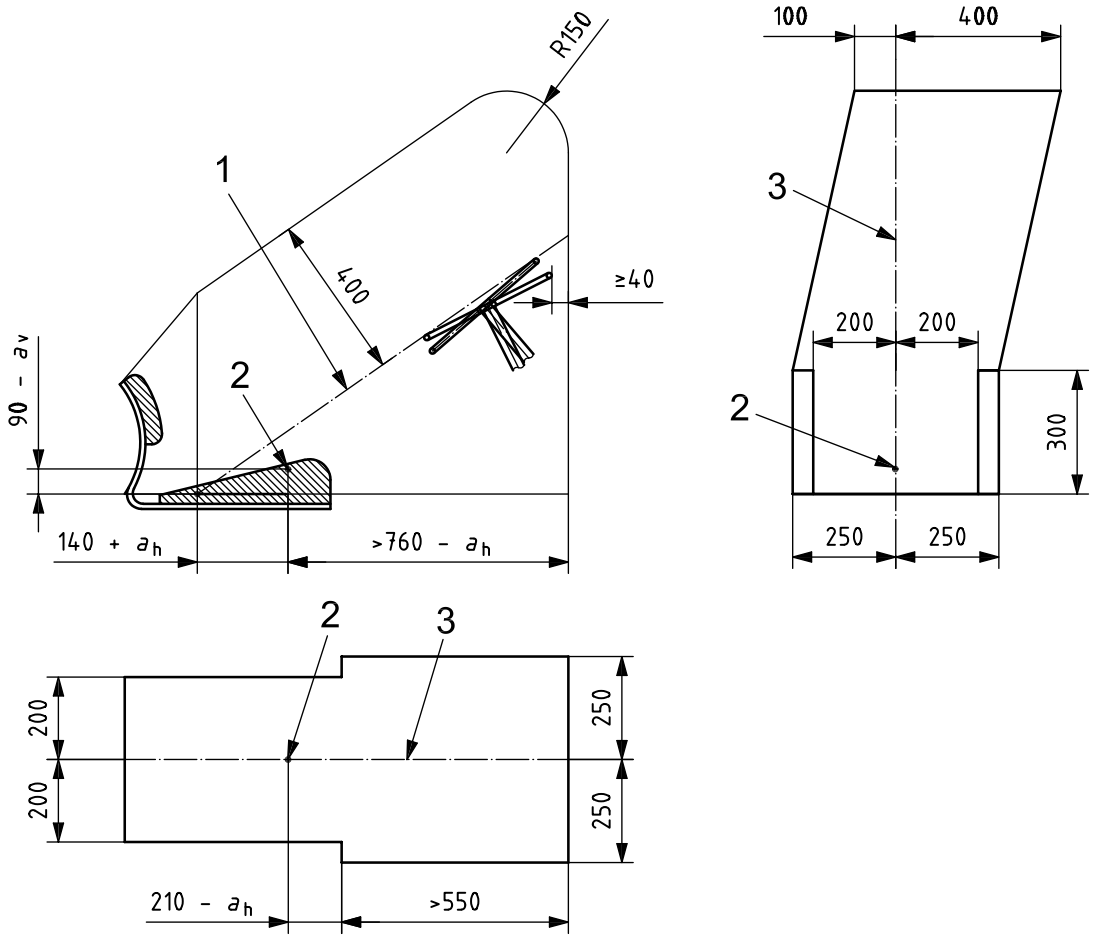
j) two portions of the horizontal plane passing 300 mm above the plane defined in a), both these part planes joining the uppermost limits of the vertical planes defined in c) to the lowermost limits of the oblique planes defined in h);

k) a curvilinear surface whose generating line is perpendicular to the reference plane and coincident with the seat backrest, whose top edge meets the bottom edge of the plane defined in d) and the bottom edge extends to the plane defined in a).

10.3 Clearance zone for tractors with a reversible driving position

For tractors with a reversible driving position (reversible seat and steering wheel), the zone of clearance is the envelope of the two clearance zones defined by the two different positions of the steering wheel and the seat (see Figure 11).

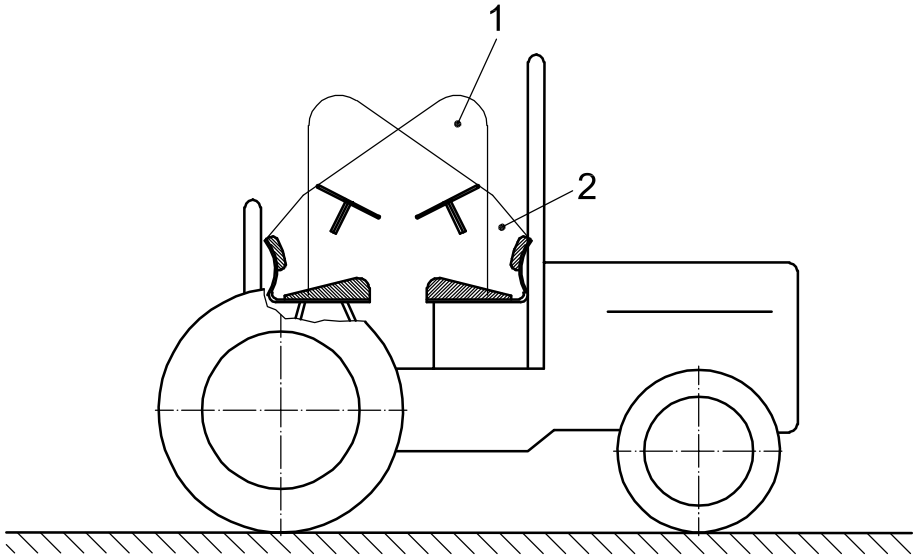
Dimensions in millimetres



Key

1 reference line
2 seat index point (SIP)
3 reference plane

Figure 10 — Clearance zone



Key

1 clearance zone – forward facing driver
2 clearance zone – rearward facing driver

Figure 11 — Clearance zone for tractors with a reversible seat position

11 Tolerances

Measurements during the tests shall be made to the following tolerances:

— linear dimensions: ± 3 mm

except for:

— tyre deflection: ± 1 mm

— structure deflection during horizontal loadings: ± 1 mm

— height of fall of pendulum block: ± 1 mm

— mass: ± 1 %

— force: ± 2 %

— angles: ± 2°

12 Acceptance conditions

12.1 General requirements

12.1.1 In order for the front-mounted ROPS to be accepted, it shall meet the requirements of this clause both during and after the tests.

12.1.2 For articulated tractors, the clearance zone shall remain protected at any angle of articulation of the tractor when overturned.

12.1.3 No part of the tractor shall enter the clearance zone (see Clause 10). No part shall strike the seat during tests.

12.1.4 No part of the clearance zone itself shall be outside the protection of the front-mounted ROPS, which would be the case were any part of the zone to come in contact with flat ground in the event of the tractor overturning in the direction from which the load was applied. For this purpose, the front and rear tyres, and track width setting shall be the smallest specified by the manufacturer.

NOTE It is the responsibility of the tractor manufacturer to ensure that other components not present during the ROPS test do not present a hazard to the operator in the event of an overturn by entering the clearance zone.

12.1.5 The front-mounted ROPS and the tractor shall be examined for cracks and tears after each test.

12.2 After impact loads

After impact loads have been applied, the following conditions shall be met.

a) There shall be no cracks in structural members, mounting components or tractor parts contributing to the strength of the front-mounted ROPS, except in accordance with the provisions of c).

b) There shall be no cracks in welds contributing to the strength of the front mounted ROPS or its mounting components (spot or tack-welding used for attaching cladding panels is normally excluded from this requirement).

c) Energy-absorbing tears in sheet-metal front-mounted ROPS components are acceptable, provided they are judged to have not significantly reduced the resistance to deflection of the front-mounted ROPS. Tears in sheet metal components caused by the edges of the pendulum block shall normally be ignored.

d) During side impact testing, the elastic deformation shall not exceed 250 mm in a horizontal plane coinciding with the upper limiting surface of the clearance zone.

12.3 After static horizontal loads

After static horizontal loads have been applied, the following condition shall be met.

a) At the point at which the required energy is met in each of the specified horizontal loading tests, the force shall exceed $0{,}8F_{\text{max}}$.

b) An overload test to determine the residual strength of the front-mounted ROPS, after a horizontal loading test which may have caused cracks, tears, or buckling, may be required in order to ensure adequate residual strength to resist a potential multiple upset accident, as follows (see Figures 12 to 14).

   1) An overload test shall be performed if the force drops by more than 3 % over the last 5 % of deflection attained while absorbing the required energy (see Figure 13).

   2) An overload test shall consist of a continuation of the horizontal loading in increments of 5 % of the original required energy up to a total of 20 % additional energy (see Figure 14).

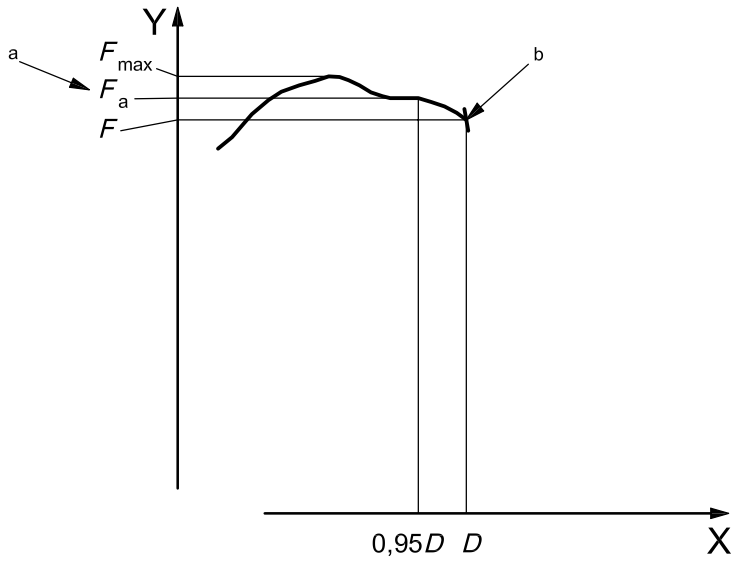
   3) The overload test shall be considered to have been successfully completed if, after the absorption of 5 %, 10 % or 15 % additional energy, the force drops by less than 3 % for each 5 % increment, and if the force is greater than $0{,}8F_{\text{max}}$.

   4) The overload test shall be considered to have been successfully completed if, after the absorption of 20 % additional energy, the force is greater than $0{,}8F_{\text{max}}$.

   5) Entry into the clearance zone or lack of protection of the clearance zone is permitted during the overload test. After removing the load, the front-mounted ROPS shall not be in the clearance zone and shall protect the clearance zone.

12.4 Cold weather embrittlement

If the front-mounted ROPS is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details which shall be given in the report. See Annex A.



Key

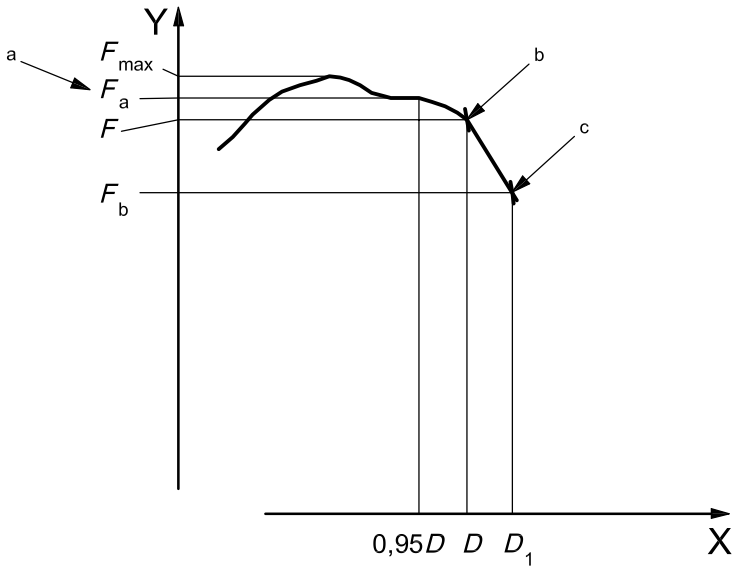
X deflection

Y static load force

a Locate F_a in relation to 0,95D.

b Overload test not necessary as $F_a \leqslant 1{,}03F$.

Figure 12 — Static load force — Deflection diagram, overload not necessary



Key

X deflection

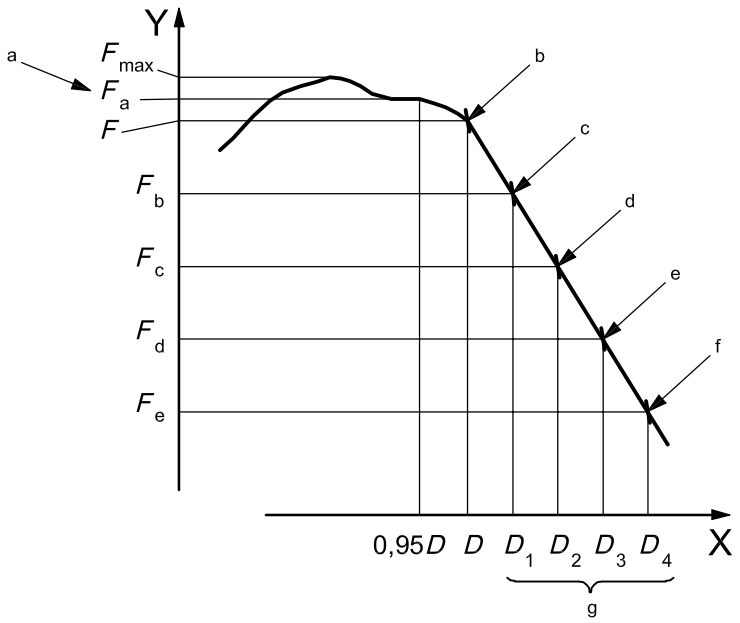
Y static load force

a Locate F_a in relation to 0,95D.

b Overload test necessary as $F_a > 1{,}03F$.

c Overload test performance satisfactory as $F_b > 0{,}97F$ and $F_b > 0{,}8F_{max}$.

Figure 13 — Static load force — Deflection diagram, overload test necessary



Key

X deflection

Y static load force

a Locate F_a in relation to 0,95D.

b Overload test necessary as $F_a > 1{,}03F$.

c $F_b < 0{,}97F$ therefore further overload necessary.

d $F_c < 0{,}97F_b$ therefore further overload necessary.

e $F_d < 0{,}97F_c$ therefore further overload necessary.

f Overload test performance satisfactory, if $F_e > 0{,}8F_{max}$.

g Failure at any stage when load drops below $0{,}8F_{max}$.

Figure 14 — Static load force — Deflection diagram, continuing overload test

13 Extension to other models

In the case of a front-mounted ROPS that has fulfilled the conditions required for acceptance (see Clause 12) and which is designed to be used on other tractor models, the test procedures specified in 6.1 need not be carried out on each tractor model, provided that the front-mounted ROPS and tractor under test comply with the following conditions, and that the test report refers to the previous test report.

a) The required energy shall not exceed the energy calculated for the original test by more than 5 %.

b) The attachment method and the tractor components to which attachment is made shall be identical or of equivalent strength.

c) Any components (e.g. mudguards, bonnet) that could provide support for the front-mounted ROPS shall be identical, or judged to give at least the same support.

d) The position and critical dimensions of the seat and the relative position of the tractor front-mounted ROPS shall be such that the clearance zone shall remain within the protection of the deflected front-mounted ROPS throughout all test procedures.

14 Labelling

If a label is required, it shall be durable and permanently attached to the main front-mounted ROPS such that it can be easily read. It shall be protected from damage and it shall contain at least the following information:

a) name and address of the manufacturer or constructor of the front-mounted ROPS;

b) identification number of the front-mounted ROPS;

c) make, model(s) or series number(s) of the tractor the structure is designed to fit;

d) reference to this part of ISO 12003, i.e. ISO 12003-1:2008, stating conformance with it.

15 Test report

The test report shall contain at least the information given in Annex B.

Annex A
(normative)

Requirements for providing resistance to brittle fracture of front-mounted ROPS at a reduced operation temperature

A.1 The following requirements and procedure are intended to provide strength and resistance to brittle fracture at reduced temperature. The following minimum material requirements shall be met in judging the front-mounted ROPS' suitability at reduced operating temperature in those countries requiring this additional operating protection. Resistance to brittle fracture at reduced temperatures may also be proved by successfully completing the dynamic test procedures specified in this part of ISO 12003 at a temperature of −18 °C or colder. If this method is chosen, the front-mounted ROPS and all mounting hardware shall be cooled to −18 °C or colder prior to beginning the dynamic test.

In certain countries, compliance with this annex is mandatory. A partial listing of these countries is given in Table A.1.

Table A.1 — Countries for which proving cold weather embrittlement using the method described in this annex is mandatory

Country	Country code
Canada	CA
United States	US

NOTE The requirements and procedure in A.4 and A.5 are set forth as information until suitable International Standards are developed.

A.2 Bolts and nuts used to attach the ROPS to the machine frame and to connect structural parts of the ROPS shall be property class 8.8, 9.8 or 10.9 for bolts (in accordance with ISO 898-1:1999) and property class 8, 9 or 10 for nuts (in accordance with ISO 898-2:1992).

A.3 All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the front-mounted ROPS material as given in A.4.

A.4 Steel materials for structural members of the front-mounted ROPS shall be of controlled toughness, exhibiting minimum Charpy V-notch impact energy requirements as shown in Table A.2. Structural members that can be demonstrated to be in plane stress or which are subjected to sufficiently low strain rates, such that the possibility of brittle fracture is precluded in the event of a low temperature field upset, need not comply with this requirement.

NOTE Steel with an as-rolled thickness less than 2,5 mm and with a carbon content less than 0,2 % is considered to meet this requirement.

Structural members of the front-mounted ROPS made from materials other than steel shall have equivalent low temperature impact resistance. Specimens shall be "longitudinal" and taken from flat stock, or tubular or structural sections before forming or welding for use in the front-mounted ROPS. Specimens from tubular or structural sections shall be taken from the middle of the biggest side and shall not include welds.

A.5 The Charpy V-notch tests shall be carried out in accordance with the procedure in ASTM A370[2)], except that specimen sizes shall be in accordance with the dimensions given in Table A.2.

A.6 One alternative to this procedure is to use killed or semi-killed steel for which a specification shall be provided.

Table A.2 — Minimum Charpy V-notch energy requirements for front-mounted ROPS material at a specimen temperature of –20 °C and –30 °C

Specimen size	Absorbed energy	
	–30 °C	–20 °C
mm	J	J [b]
10 × 10 [a]	11	27,5
10 × 9	10	25
10 × 8	9,5	24
10 × 7,5 [a]	9,5	24
10 × 7	9	22,5
10 × 6,7	8,5	21
10 × 6	8	20
10 × 5 [a]	7,5	19
10 × 4	7	17,5
10 × 3,3	6	15
10 × 3	6	15
10 × 2,5 [a]	5,5	14

[a] Indicates preferred size. Specimen size shall be no less than the largest preferred size that the material will permit.

[b] The energy requirement at the temperature –20 °C is 2,5 times the value specified for –30 °C. Other factors affect impact energy strength, i.e. direction of rolling, yield strength, grain orientation and welding. These factors shall be considered when selecting and using a steel.

2) Reference to ASTM A370 is to be replaced as soon as a corresponding International Standard becomes available.

Annex B
(normative)

Test report for front-mounted ROPS

B.1 General

Units shown below, according to ISO 1000[2], shall be stated followed by national units in parentheses if necessary.

— Name and address of manufacturer of front-mounted ROPS:

— Submitted for test by:

— Make of front-mounted ROPS:

— Model of the front-mounted ROPS:

— Type of front-mounted ROPS (cab, frame, rear roll bar, cab with integrated frame, etc.):

— Date and location of test.

B.2 Specification of test tractor

B.2.1 Identification of tractor to which a front-mounted ROPS is fitted for the test

B.2.1.1 General

— Make of tractor:[3)]

— Model (trade name):

— Type [2 WD or 4 WD; rubber or steel tracks (if applicable); articulated 4 WD or articulated 4 WD with twin (dual) wheels (if applicable)]:

B.2.1.2 Numbers

— 1st serial No. or prototype:

— Serial No.:

B.2.1.3 Other specifications (if applicable)

— Model denomination(s) for other countries:

— Transmission type of gears × range:

— Speed version (30, 40 or other km/h):

— Manufacturer identification or technical type number:

3) Possibly different from tractor manufacturer's name.

B.2.2 Tractor mass

Front	kg
Rear	kg
Total	kg

— Reference mass used for calculating loading energies and crushing forces: kg

B.2.3 Wheelbase and moment of inertia

— Wheelbase of the tested tractor: mm

— Moment of inertia used for calculating impact energy at the rear: $kg \cdot m^2$

B.2.4 Minimum track and tyre sizes

	Minimum track mm	**Tyres**		
		Dimensions mm	**Diameter** mm	**Pressure** kPa
Front				
Rear				

B.2.5 Tractor seat

— Tractor with a reversible driving position (reversible seat and steering wheel): Yes/No

— Make/type/model of seat:

— Make/type/model of optional seat(s) and position(s) of the seat index point (SIP):

(Description of seat 1 and SIP position)

(Description of seat 2 and SIP position)

(Description of seat… and SIP position)

B.3 Specification of front-mounted ROPS

B.3.1 Photographs from side and rear showing mounting details including mudguards.

B.3.2 General arrangement drawing of the side and the rear of the structure including position of the seat index points (SIP) and details of mountings.

B.3.3 Brief description of the front-mounted ROPS comprising:

— type of construction;

— details of mountings;

— details of cladding and padding;

— means of access and escape;

— additional frame: Yes/No

B.3.4 Tiltable or not tiltable/folding or not folding structure

— Tiltable/not tiltable[4)]

If it is necessary to tilt with any tools, this should be stated as follows:

— Tiltable with tools/tiltable without tools[4)]

— Folding/not folding[4)]

If it is necessary to fold with any tools, this should be stated as follows:

— Folding with tools/folding without tools[4)]

B.3.5 Dimensions

Dimensions should be measured with the seat loaded as required by ISO 5353 to determine the seat index point, and then located as required by Clause 10 for determination of the clearance zone.

When the tractor is fitted with different optional seats or has a reversible driving position (reversible seat and steering wheel), the dimensions in relation to the seat index points shall be measured in each case (SIP 1, SIP 2, etc.).

— Height of roof members above the seat index point: mm

— Height of roof members above the tractor footplate: mm

— Interior width of the front-mounted ROPS ($810 + a_V$) mm above the seat index point: mm

— Interior width of the front-mounted ROPS vertically above the seat index point at the level of the centre of the steering-wheel: mm

— Distance from the centre of the steering-wheel to the right-hand side of the front-mounted ROPS: mm

— Distance from the centre of the steering-wheel to the left-hand side of the front-mounted ROPS: mm

— Minimum distance from the steering-wheel rim to the front-mounted ROPS: mm

— Width of the doorways:

  — at the top: mm

  — in the middle: mm

  — at the bottom: mm

4) Delete as appropriate.

— Height of the doorways:

  — above foot platforms: mm

  — above the highest mounting steps: mm

  — above the lowest mounting steps: mm

— Overall height of the tractor with the front-mounted ROPS fitted: mm

— Overall width of the front-mounted ROPS (if mudguards are included, this is to be stated): mm

— Horizontal distance from the seat index point to the rear of the front-mounted ROPS at a height of $(810 + a_v)$ mm above the seat index point: mm

— Minimum overall width of the tractor (B) mm

— Maximum outer width of the tractor (B_b) mm

B.3.6 Details of materials used in the construction of the front-mounted ROPS and specifications of steels used

Steel specifications shall be in conformity with ISO 630.

— Main frame: (parts – materials – sizes)

  — Is steel rimmed, semi-killed, killed?

  — Steel standard and reference:

— Mountings: (parts – materials – sizes)

  — Is steel rimmed, semi-killed, killed?

  — Steel standard and reference:

— Assembly and mounting bolts: (parts – sizes)

— Roof: (parts – materials – sizes)

— Cladding: (parts – materials – sizes)

— Glass: (type – grade – sizes)

B.3.7 Details of tractor manufacturer's reinforcements on original parts

B.4 Test results

B.4.1 Preliminary tests of lateral stability and non-continuous rolling

B.4.1.1 General

— Make/type/model of tractor to which the front-mounted ROPS is fitted:

When several tractors are subjected to preliminary tests of lateral stability and non-continuous rolling, this report presentation should be used for each tractor tested.

B.4.1.2 Lateral stability test

The tractor was resting on wheels touching the ground in a state of unstable equilibrium at an angle of at least 38° from the vertical; therefore, conditions for lateral stability were fulfilled.

B.4.1.3 Non-continuous rolling test

B.4.1.3.1 General

State method chosen, according to 5.3.1.

B.4.1.3.2 Demonstration of non-continuous rolling by means of the overturning test

The tractor was subjected to an overturning test and satisfied the acceptance conditions of 5.3.1.2. Therefore, it fulfils the requirements for the non-continuous rolling test.

B.4.1.3.3 Demonstration of non-continuous rolling by means of calculation

Without an overturning test, non-continuous rolling behaviour was demonstrated by calculation, on the basis of the following measurements:

— Height of centre of gravity:	H_1	m
— Horizontal distance between centre of gravity and front axle:	L_2	m
— Horizontal distance between the centre of gravity and rear axle:	L_3	m
— Height of the front tyres under full axle load:	D_2	m
— Height of the rear tyres under full axle load:	D_3	m
— Height at the point of impact:	H_6	m
— Horizontal distance between the centre of gravity and the vertical transverse plane through the impact point of the front-mounted ROPS (to be preceded by a minus sign if this point lies in front of the plane of the centre of gravity):	L_6	m
— Minimum width of the tractor:	B	m
— Width of the front-mounted ROPS between the right and left points of impact:	B_6	m
— Height of the engine bonnet:	H_7	m
— Width of the engine bonnet:	B_7	m
— Horizontal distance between the centre of gravity and the front corner of the engine bonnet:	L_7	m
— Height of the front-axle pivot:	H_0	m
— Rear track width:	S	m
— Rear tyre width:	B_0	m
— Front-axle swing angle from zero position to end of travel:	D_0	radian
— Tractor mass used for calculation:	m_c	kg
— Moment of inertia about the longitudinal axis through the centre of gravity:	Q	kg·m^2

The sum of track, S, and tyre width, B_0, shall be greater than the width, B_6, of the protective structure as follows:

$$S + B_0 - B_6 > 0$$

The tractor thus fulfils the conditions required for non-continuous rolling behaviour.

Lateral stability and non-continuous rolling tests being established in accordance with this part of ISO 12003, the front-mounted ROPS is eligible for the strength tests.

B.4.2 Impact/loading and crushing tests

B.4.2.1 Condition of tests

— Impact tests were carried out:

  — to the rear left/right

  — to the front right/left

  — to the side right/left

— Mass used for calculating impact energies and crushing forces: kg

— Wheelbase used for calculating energy at the rear: mm

— Moment of inertia used to calculate energy at the rear: $kg \cdot m^2$

— Energies and forces applied:

  — rear: kJ

  — front: kJ

  — side: kJ

  — crushing force: kN

  — during additional overload test: kN

— Force applied to rear fixture: kN

B.4.2.2 Permanent deflections measured after the tests

— Permanent deflections of the extremities of the protective structure measured after the series of tests:

— Back (forwards/backwards):

  — left-hand: mm

  — right-hand: mm

— Front (forwards/backwards):

  — left-hand: mm

  — right-hand: mm

— Sideways (to the left/to the right):

  — front: mm

  — rear: mm

— Top (downwards/upwards):

  — rear:

    — left-hand: mm

    — right-hand: mm

  — front:

    — left-hand: mm

    — right-hand: mm

Difference between total instantaneous deflection and residual deflection during:

— sideways impact test (dynamic test): mm

  or

— sideways loading test (static test): mm

Indication and results of any additional test.

Statement:

The acceptance conditions of these tests relative to the protection of the zone of clearance are fulfilled. The structure is a roll-over protective structure in accordance with this part of ISO 12003.

B.4.2.3 Curves (static test only)

A copy of the force/deflection curves derived during the tests shall be included.

If a horizontal overload test was required, the reason for the overload shall be described and the copy of additional force/deflection curves obtained during overload shall be included.

B.4.3 Cold weather performance (resistance to brittle fracture)

Method used to identify resistance to brittle fracture at reduced temperature:

Steel specifications shall be in conformity with ISO 630.

Steel specification: (reference and relevant standard)

Table B.1 — Tractors to which the protective structure is fitted

Test approval reference number:										
Make	Model	Type	Other specifi-cations where applicable	Mass			Tiltable	Wheel-base	Minimum track	
				Front	Rear	Total			Front	Rear
		2/4 WD etc.		kg	kg	kg	Yes/No	mm	mm	

B.5 Minor modification certificate

— Test reference number according to ISO 12003-1:

— Copy of the referenced original test report:

— Date and location of test:

— Date of approval:

— Modification reference number: MOD

Previous Modification Certificate (MOD.....) remains/does not remain valid.

B.5.1 Specification of the protective structure

— Frame or cab:

— Manufacturer:

— Submitted for test by:

— Make:

— Model:

— Type:

— Serial number from which modification applies:

B.5.2 Denomination of tractors to which the protective structure is fitted

Test approval reference number:										
Make	Model	Type	Other specifi-cations where applicable	Mass			Tiltable	Wheel-base	Minimum track	
				Front	Rear	Total			Front	Rear
		2/4 WD etc.		kg	kg	kg	Yes/No	mm	mm	

B.5.3 Details of Modifications

Since the original test report, the following modifications have been made:

.....

.....

.....

B.5.4 Statement

The effect of these modifications on the strength of the protective structure has been examined.

The modifications are considered not to affect the results of the original test.

The original test report therefore applies to the protective structure of the modified tractor.

Drafted on the responsibility of _____ who carried out the original test, this certificate is circulated as an annex to the original test report and subject to the same circulation.

Signature:

Date: Location:

Annex C
(normative)

Non-continuous rolling test procedure — Calculation method

C.1 General

A computer program for determining the continuous roll-over behaviour of a laterally overturning narrow-track tractor with a front-mounted ROPS is available in OECD standard Code 6[5]. See Figure C.1.

C.2 Required data

For the purpose of verifying non-continuous rolling by calculation, the characteristics listed in Table C.1 shall be ascertained (see also Figure C.2). The sum of S and B_0 shall be greater than B_6. Details on the method of measurement can be found in OECD standard Code 6[5].

Table C.1 — Measurements required for the non-continuous rolling calculation

Measurement	Parameter	Units
rear tyre width	B_0	m
width of front-mounted ROPS	B_6	m
width of engine bonnet	B_7	m
front-axle swing angel (from horizontal position to stop)	D_0	Radian
height of front tyres under full axle load	D_2	m
height of rear tyres under full axle load	D_3	m
height of front-axle pivot	H_0	m
height of centre of gravity	H_1	m
height at point of impact	H_6	m
height of engine bonnet	H_7	m
horizontal distance between the centre of gravity and the front axle	L_2	m
horizontal distance between the centre of gravity and the rear axle	L_3	m
horizontal distance between the centre of gravity and the vertical transverse plane through the impact point of the front-mounted ROPS (negative if this plane lies in front of the centre of gravity)	L_6	m
horizontal distance between the centre of gravity and the front top corner of the engine bonnet	L_7	m
tractor mass	m	kg
moment of inertia about the longitudinal axis through the centre of gravity	Q	kg·m^2
rear track width	S	m

C.3 Simplifying assumptions

For the purposes of calculation, the following simplifying assumptions can be made:

a) the stationary tractor with fully oscillated axle starts to turn over on a slope with a 1:1,5 gradient as soon as the centre of gravity is vertically above the axis of rotation;

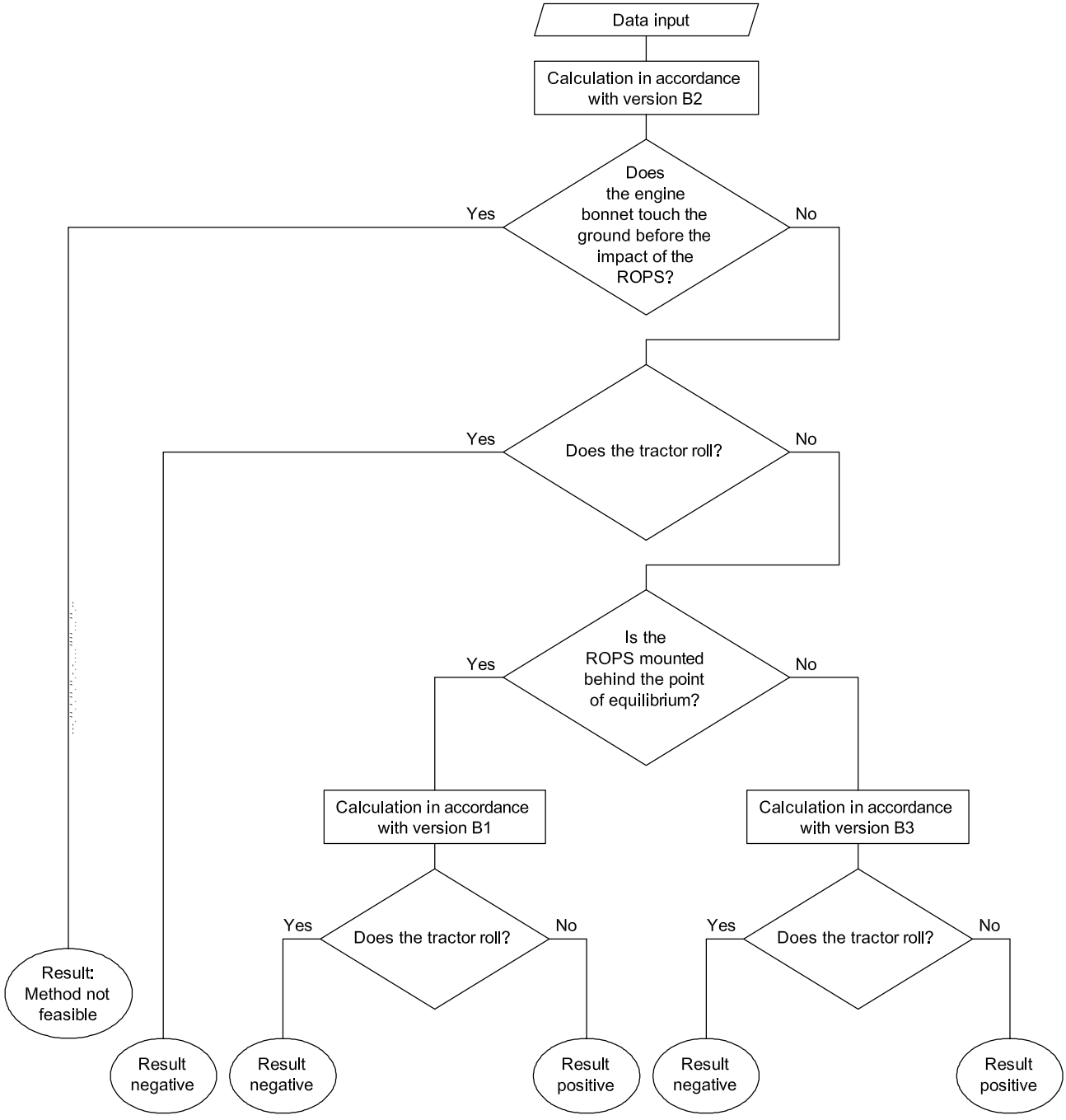
b) the axis of rotation is parallel to the tractor's longitudinal axis and passes through the centre of the contact areas of the downhill front and rear wheels;

c) the tractor does not slide downhill;

d) impact on the slope is partially elastic, with a coefficient of elasticity of $U = 0{,}2$;

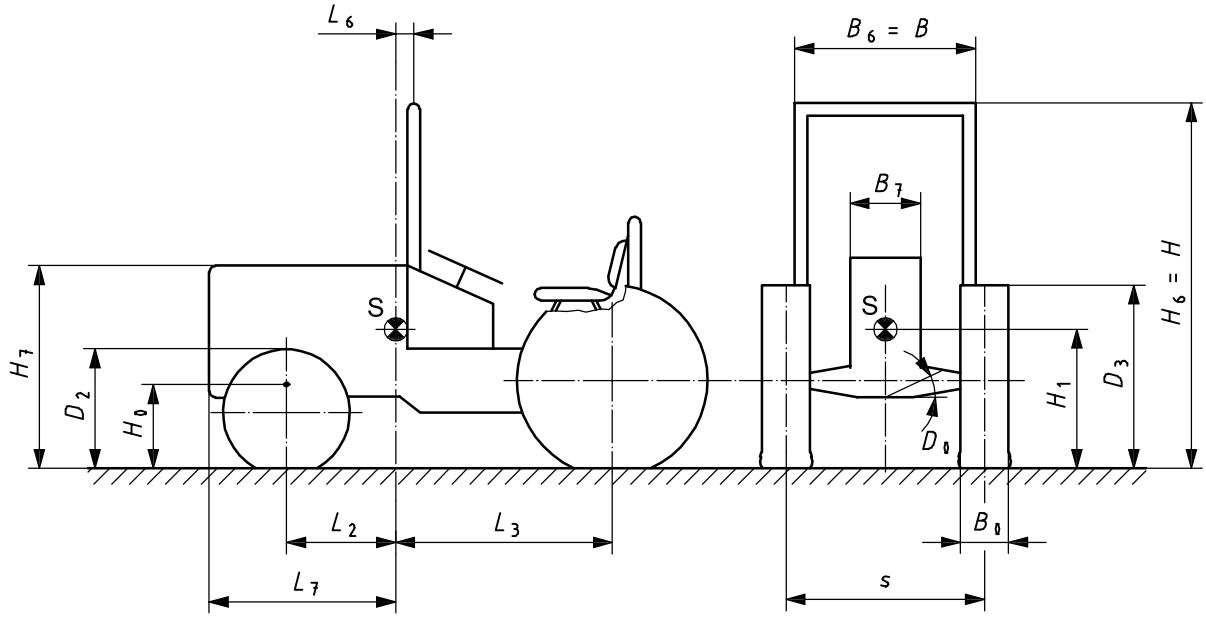
e) the depth of penetration into the surface of the slope and the deformation of the front-mounted ROPS together amounts to $T = 0{,}2$ m;

f) no other components of the tractor penetrate into the slope surface.



Version B1: Point of impact of ROPS behind longitudinally unstable equilibrium point
Version B2: Point of impact of ROPS near longitudinally unstable equilibrium point
Version B3: Point of impact of ROPS in front of longitudinally unstable equilibrium point

Figure C.1 — Flow diagram for determining continuous roll-over behaviour



NOTE D_2 and D_3 are measured under full axle load.

Figure C.2 — Characteristic tractor data for calculation of overturn behaviour

Bibliography

[1] ISO 612:1978, *Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions*

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[3] ISO 3463, *Tractors for agriculture and forestry — Roll-over protective structures (ROPS) — Dynamic test method and acceptance conditions*

[4] ISO 5700, *Tractors for agriculture and forestry — Roll-over protective structures (ROPS) — Static test method and acceptance conditions*

[5] OECD Standard Code 6, *OECD Standard Code for the official testing of front mounted roll-over protective structures on narrow-track wheeled agricultural and forestry tractors*

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