AIS-091 (Part 2)

AUTOMOTIVE INDUSTRY STANDARD

Requirements of Mechanical Couplings between Agricultural Tractor and Towed Vehicle and Vertical Load on the Coupling Point

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ON BEHALF OF
AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

September 2012

Status chart of the Standard to be used by the purchaser for updating the record

Sr. No.	Corrigenda	Amendment	Revision	Date	Remark	Misc.
General remarks :						

INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of critical parts for improved safety can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standard Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the secretariat of the AIS Committee, has published this standard. For better dissemination of this information ARAI may publish this document on their web site.

The mechanical couplings between agricultural tractor and towed vehicles (e.g. agricultural trailers) are an important safety critical component. This AIS is in line with Annexure IV of EEC Directive 89/173 as amended by 2006/26/EC (Mechanical couplings between tractor and towed vehicle and vertical load on the coupling point) and covers dimensional as well as strength requirements.

The AISC panel and the Automotive Industry Standard Committee (AISC) responsible for preparation of this standard is given in Annex E and F respectively.

Requirements of Mechanical Couplings between Agricultural Tractor and Towed Vehicle and Vertical Load on the Coupling Point

Requirements of Mechanical Couplings between Agricultural Tractor and Towed Vehicle and Vertical Load on the Coupling Point

0.0 SCOPE

0.1 This standard applies to mechanical couplings between agricultural tractor as defined in AIS-053 and towed vehicle and vertical load on coupling point.

1.0 REFERENCES

1.1	AIS-053	Automotive Vehicles - Types - Terminology
1.2	IS 12226	Agricultural Tractors - Power Tests for drawbar - Test procedure
1.3	ISO 6489/II	Agricultural vehicles - Mechanical Connections between Towed and Towing Vehicles - Part 2 - Specifications for Clevis Coupling
1.4	IS 12362 (Part 1)	Agricultural vehicles - Mechanical Connections on Towing Vehicles - Part 1: Hook Type
1.5	IS 12362 (Part 3)	Agricultural vehicles - Mechanical Connections on Towing Vehicles - Part 3: Tractor Drawbar

2.0 DEFINITIONS

2.1. '**Mechanical coupling between tractor and towed vehicle'** means the components installed on the tractor and on the towed vehicle in order to provide the mechanical coupling between those vehicles. Only mechanical coupling components for tractors are covered in this standard. Among the various types of mechanical coupling components for tractors a basic distinction is made between:

- Clevis type (see Figures 1 and 2 of Annex A),
- Towing hook (see Figure 3 of Annex A),
- Tractor drawbar (see Figure 4 of Annex A).

2.2. '**Type of mechanical coupling between tractor and towed vehicle'** means parts which do not differ from one another in such essential respects as:

2.2.1. Nature of mechanical coupling component,

2.2.2. Drawbar rings (40 mm and/or 50 mm diameter),

2.2.3. External shape, dimensions or mode of operation (e.g. automatic or non-automatic),

2.2.4. Material,

2.2.5. Value of D as defined in Annex B for the test performed using the dynamic method or the trailer mass as defined in Annex C for tests performed using the static method, and also the vertical load on the coupling point S.

2.3. '**Reference centre of mechanical coupling**' means the point on the pin axis which is equidistant from the wings in the case of a fork and the point resulting from the intersection of the plane of symmetry of the hook with the generatrix of the concave part of the hook at the level of contact with the ring when this is in the traction position.

2.4. '**Height above ground of mechanical coupling (h)**' means the distance between the horizontal plane through the reference centre of the mechanical coupling and the horizontal plane on which the wheels of the tractor are resting.

2.5. '**Projection of mechanical coupling (c)'** means the distance between the reference centre of the mechanical coupling component and the vertical plane passing through the axle on which the rear wheels of the tractor are mounted.

2.6. '**Vertical load on the coupling point (S)'** means the load transmitted, under static conditions on the reference centre of the mechanical coupling.

2.7. '**Automatic**' means a mechanical coupling component which closes and secures itself when the sliding mechanism for the drawbar rings is actuated, without further action.

2.8. '**Wheelbase of tractor (I)**' means the distance between the vertical planes perpendicular to the median longitudinal plane of the tractor passing through the axles of the tractor.

2.9. '**Weight on the front axle of the unladen tractor (a)**' means that part of the weight of the tractor, which, under static conditions, is transmitted on the ground by the front axle of the tractor.

3.0 GENERAL REQUIREMENTS

3.1. The mechanical coupling components may be designed to function automatically or non-automatically.

3.2. The mechanical coupling components on the tractor shall conform to the dimensional and strength requirements in para. 4.1 and para. 4.2 and the requirements for the vertical load on the coupling point in para. 4.3.

3.3. The mechanical coupling components shall be so designed and made that in normal use they will continue to function satisfactorily and retain the characteristics prescribed by this standard.

3.4. All parts of mechanical coupling components shall be made of materials of a quality sufficient to withstand the tests referred to in para. 4.2 and shall have durable strength characteristics.

3.5. All the couplings and their locks shall be easy to engage and release and shall be so designed that under normal operating conditions no accidental de-coupling is possible. In automatic coupling components the locked position shall be secured in a form-locking manner by two independently functioning safety devices. However, the latter may be released using the same control device.

3.6. The drawbar ring shall be capable of tilting horizontally at least 60º on both sides of the longitudinal axis of a non-built-in coupling device. In addition, vertical mobility of 20º upwards and downwards is required at all times. (See also Annex A.) The angles of articulation shall not be attained at the same time.

3.7. The jaw shall permit the drawbar rings to swivel axially at least 90º to the right or left around the longitudinal axis of the coupling with a fixed braking momentum of between 30 and 150 Nm. The towing hook shall allow the drawbar ring to swivel axially at least 20º to the right or left around the longitudinal axis of the hook.

3.8 In order to prevent unintentional uncoupling from the hitch ring, the distance between the towing hook tip and the keeper (clamping device) shall not exceed 10 mm at the maximum design load.

4.0 SPECIAL REQUIREMENTS

4.1. Dimensions

The dimensions of the mechanical coupling components on the tractor shall comply with Annex A, Figures 1 to 4. Any dimensions may be chosen if not shown in these figures.

4.2. Strength

4.2.1. For the purposes of checking their strength the mechanical coupling components shall undergo a dynamic test under the conditions set out in Annex B or a static test under the conditions set out in Annex C.

4.2.2. The test shall not cause any permanent deformation, breaks or tears.

4.3. Vertical load on the coupling point (S)

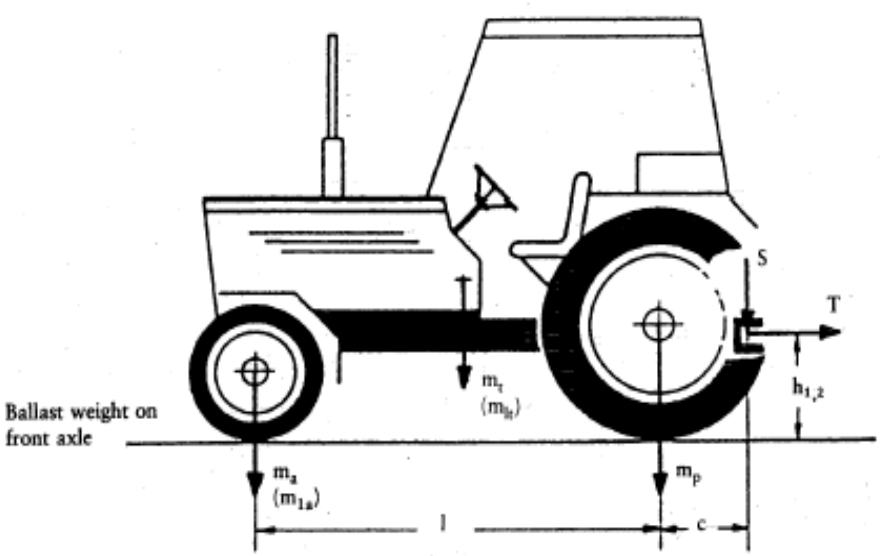
4.3.1. The maximum static vertical load is laid down by the manufacturer. In no case, however, shall it exceed 3 tonnes.

4.3.2. Conditions of acceptance:

4.3.2.1. The permissible static vertical load shall not exceed the technically permissible static vertical load recommended by the manufacturer of the tractor nor the static vertical load laid down for the towing device pursuant to component type-approval.

4.3.2.2. Whatever the state of loading of the tractor, the mass transmitted to the road by the wheels on the forward axle shall not be less than 20 % of the unladen mass of that tractor, but the maximum load on the rear axle shall not be exceeded.

4.4. **Height above the ground of the coupling device (h)**
(see figure below).



4.4.1. All tractors with a loaded mass exceeding 2.5 tonnes shall be fitted with a trailer coupling having a ground clearance satisfying one of the following relations:

$$h_1 \leq \frac{(m_a - 0.2*m_t)*l - (S*c)}{0.6*(0.8*m_t + S)}$$

or

$$h_2 \leq \frac{(m_{la} - 0.2*m_t)*l - (S*c)}{0.6*(0.8*m_{lt} - 0.2*m_t + S)}$$

where:

m_t: mass of the tractor (means the mass defined in IS 12226).

m_{lt}: mass of the tractor (means the mass defined in IS 12226) with ballast weight on the front axle,

m_a: weight on the front axle of the unladen tractor (means that part of the weight of the tractor, which, under static conditions, is transmitted on the ground by the front axle of the tractor.)

m_{la}: weight on the front axle of the tractor with ballast weight on the front axle, (means that part of the weight of the tractor, which, under static conditions, is transmitted on the ground by the front axle of the tractor)

l: tractor wheelbase (means the distance between the vertical planes perpendicular to the median longitudinal plane of the tractor passing through the axles of the tractor).

S: vertical load on the coupling point (means the load transmitted, under static conditions on the reference centre of the mechanical coupling).

c: distance between the reference centre of the mechanical coupling and the vertical plane passing through the axle of the rear wheels of the tractor (means the distance between the reference centre of the mechanical coupling component and the vertical plane passing through the axle on which the rear wheels of the tractor are mounted.)

5.0 TECHNICAL INFORMATION TO BE SUBMITTED BY THE DEVICE MANUFACTURER FOR APPROVAL OF A MECHANICAL COUPLING

5.1. An application for component type-approval for a tractor with respect to the coupling device shall be submitted by the manufacturer of the device or by his authorized representative. Additional information as given in Annex D shall be submitted.

5.2. For each type of mechanical coupling component the application shall be accompanied by the following documents and particulars:

- scale drawings of the coupling device (three copies). These drawings shall in particular show the required dimensions in detail as well as the measurements for mounting the device,
- a short technical description of the coupling device specifying the type of construction and the material used,
- a statement of the value of D as referred to in Annex B for the dynamic test or the value of T (traction force) as referred to in Annex C for the static test, and also the vertical load on the coupling point S,
- One or more sample devices as required by the technical service.

6.0 MARKINGS

6.1. Every mechanical coupling component conforming to the type for which component type-approval has been granted shall bear the following markings:

6.1.1. trade name or mark;

6.1.2 where the strength is checked in accordance with Annex B (dynamic test): permissible value of D, static vertical load value of S;

6.1.3 where the strength is checked in accordance with Annex C (static test): Towable mass and vertical load on the coupling point, S.

6.2. The data shall be clearly visible, easily legible and durable.

7.0 INSTRUCTIONS FOR USE

All mechanical couplings shall be accompanied by the manufacturer's instructions for use. These instructions shall include the values of D or T depending on which test was performed on the coupling.

8.0 NUMBER OF SAMPLES

Total 3 nos. of samples are required for carrying out all the above tests. However, different tests may be done on one and the same sample or less samples, if the manufacturer requests so.

ANNEX A

(See 2.1)

DRAWING OF MECHANICAL COUPLING COMPONENTS

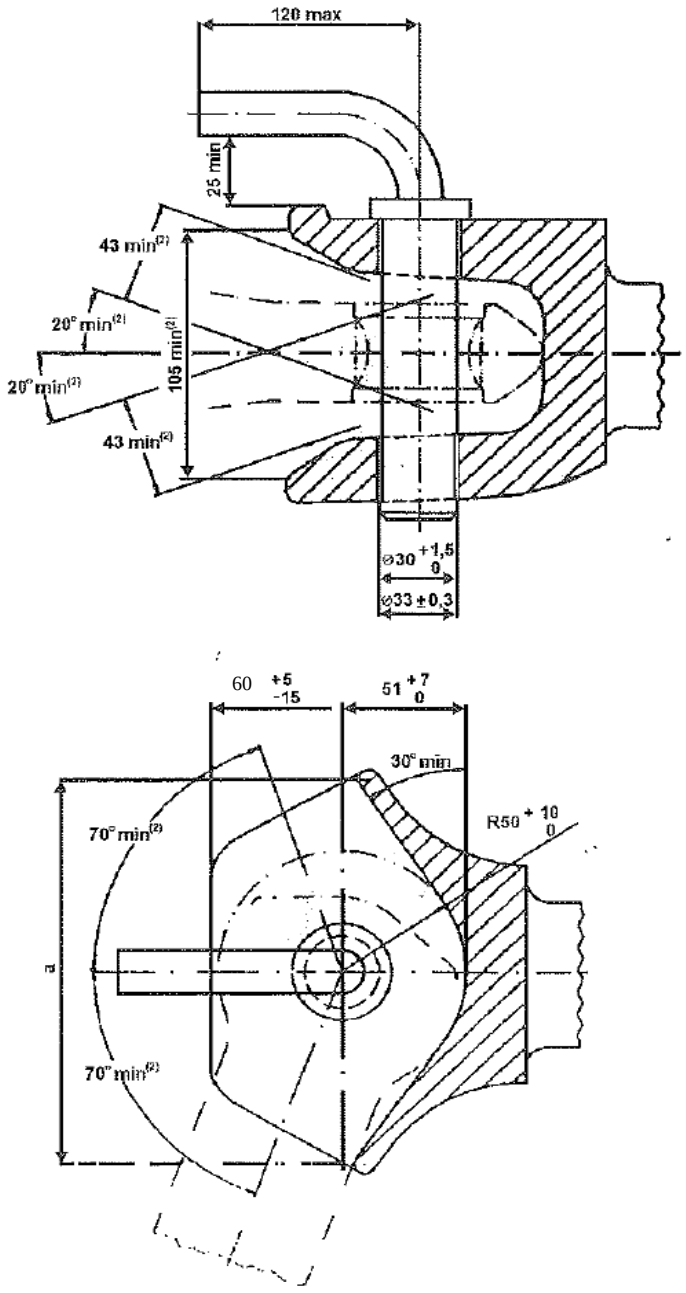


Figure 1a
Non-automatic trailer coupling, with cylindrical locking pin

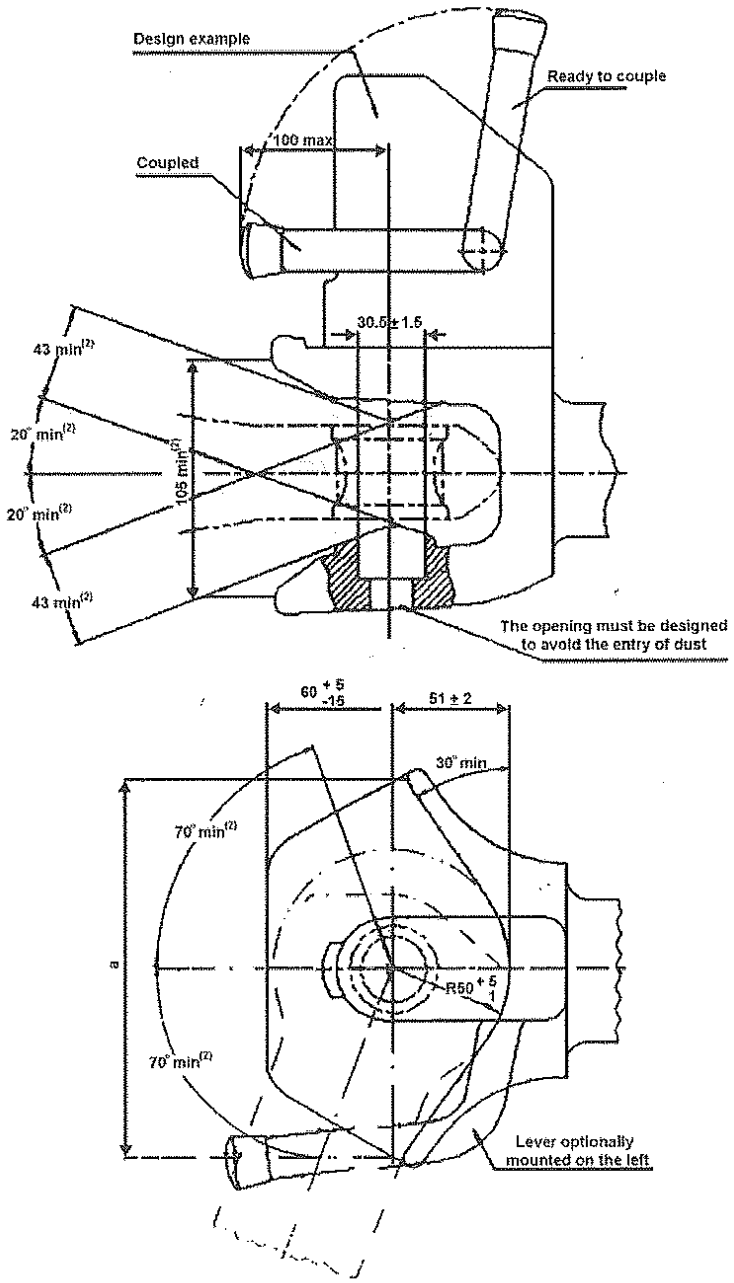


Figure 1b
Automatic trailer coupling, with cylindrical locking pin

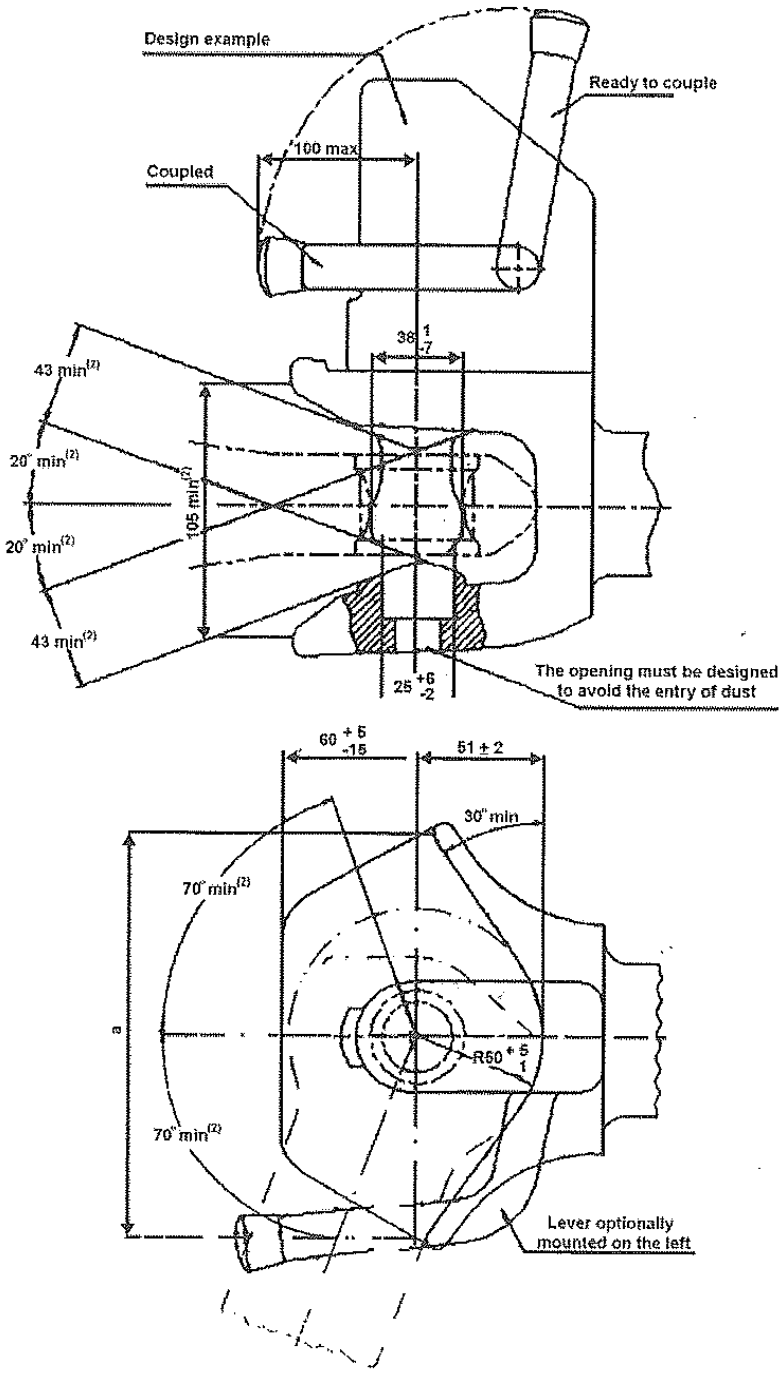


Figure 1c
Automatic trailer coupling, with cambered locking pin

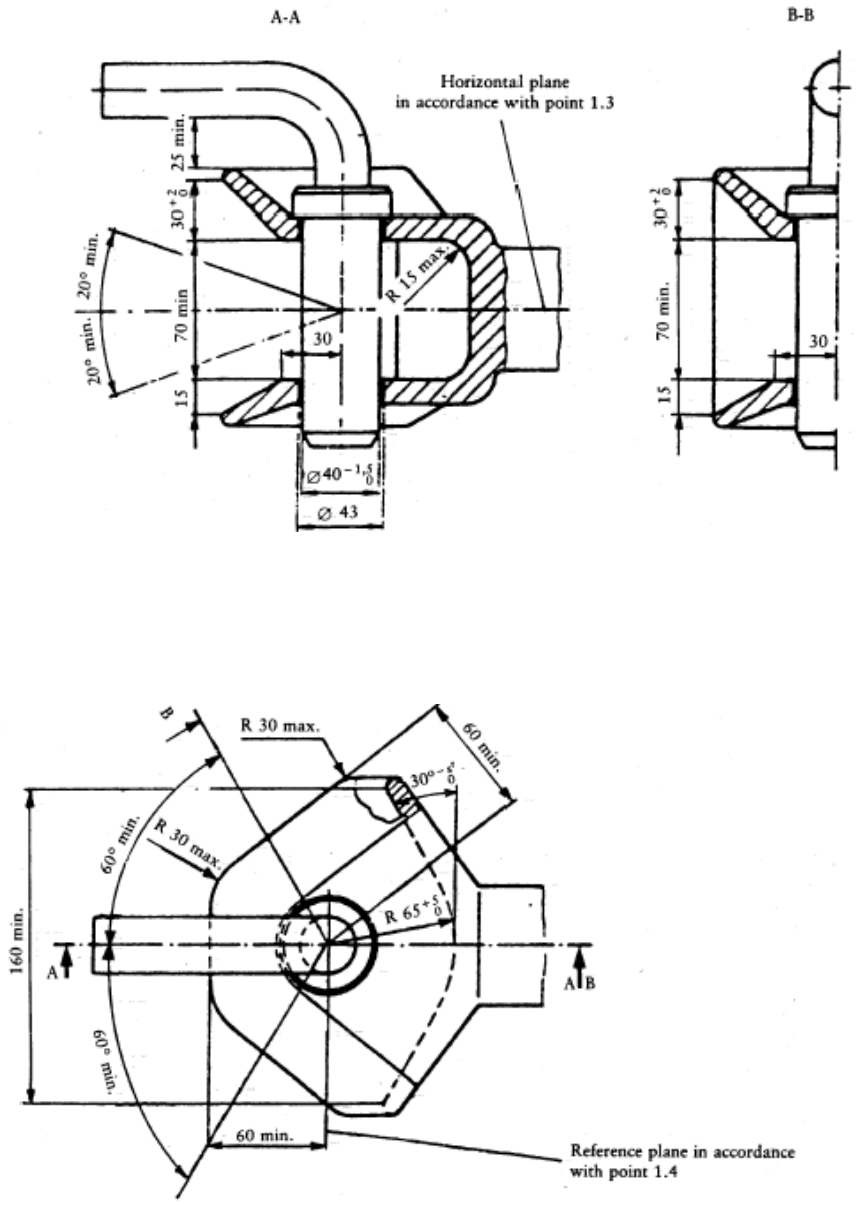
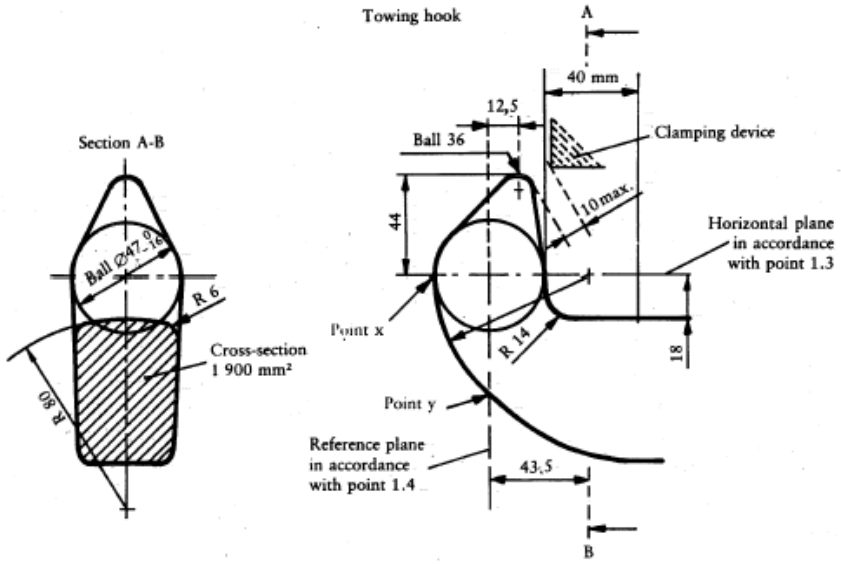


Figure 2
Non-automatic trailer coupling
Corresponds to ISO 6489/II of October 1980



No part of the towing hook may be outside radius r between point x and y

Figure 3
Angle of tilt in accordance with points 2.8 and 2.9
Corresponds to IS 12362 (Part 1): 1993

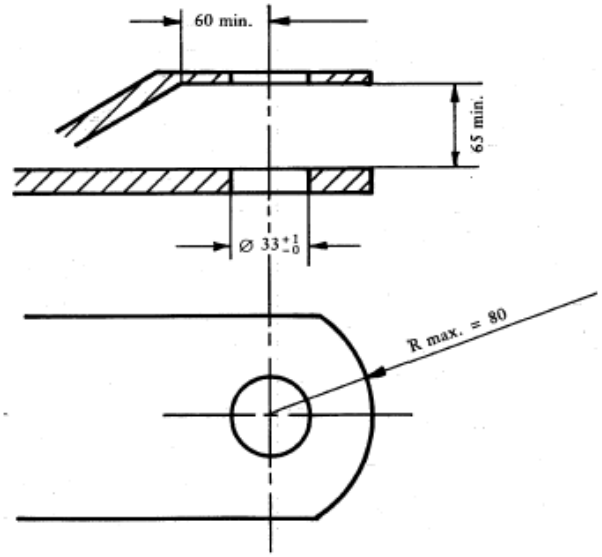


Figure 4
Tractor drawbar
Corresponds to IS 12362 (Part 3): 1994

ANNEX B

(See 2.2.5)

DYNAMIC TEST METHOD

1. TEST PROCEDURE

The strength of the mechanical coupling is to be established by alternating traction on a test bed. This method describes the fatigue test to be used on the complete mechanical coupling device, i.e. when fitted with all the parts needed for its installation the mechanical coupling is mounted and tested on a test bed.

The alternating forces are applied as far as possible sinusoidally (alternating and/or rising) with a load cycle depending on the material involved. No tears or breaks may occur during the test.

2. TEST CRITERIA

The horizontal force components in the longitudinal axis of the vehicle together with the vertical force components form the basis of the test loads. In so far as they are of secondary importance, horizontal force components at right angles to the longitudinal axis of the vehicle and also moments are not to be taken into consideration. The horizontal force components in the longitudinal axis of the vehicle are represented by a mathematically established representative force, the value D.

The following equation applied to the mechanical coupling:

$$D = g \cdot \frac{M_T \cdot M_R}{M_T + M_R}$$

Where:

M_T = the technically permissible total mass of the tractor,
M_R = the technically permissible total mass of the towed vehicles,
$g = 9.81\ m/s^2$.

The vertical force components at right angles to the track are expressed by the static vertical load S.

The technically permissible loads are given by the manufacturer.

3. TEST PROCEDURE

3.1. General requirements

The test force is applied to the mechanical coupling device being tested by means of an appropriate standard drawbar ring beneath an angle formed by the position of the vertical test load F_v *vis-à-vis* the horizontal test load F_h in the direction of the median longitudinal plane passing from top front to bottom rear.

The test force is applied at the usual point of contact between the mechanical coupling device and the drawbar ring.

The play between the coupling device and the ring shall be kept to a minimum.

In principle the test force is applied in an alternating manner around the zero point. With an alternating test force the resulting load is equal to zero.

Should the design of the coupling device (e.g. excessive play, towing hook) make it impossible to carry out the test with an alternating test load, the test load may also be applied on a rising basis in the direction of traction or pressure, whichever is the greater.

Where the test is carried out with a rising force curve, the test load is equal to the upper (highest) load, and the lower (smallest) load should not exceed 5 % of the upper load.

Care should be taken in the alternating force test to ensure that by suitable mounting of the test apparatus and choice of power conduction system no additional moments or forces arising at right angles to the test force are introduced; the angular error for the direction of force in the alternating force test should not exceed ± 1.5º; and for the rising force test the angle is set in the upper load position.

The test frequency shall not exceed 30 Hz. For components made of steel or steel casting the load cycle amounts to $2 * 10^6$. The subsequent tear test is carried out using the colour penetration method or similar method.

If springs and/or dampers are incorporated into the coupling parts, they are not to be removed during the test but may be replaced if, during the test, they are subject to strain under conditions which would not obtain during normal operation (e.g. heat action) and become damaged. Their behavior before, during and after the test shall be described in the test report.

3.2. **Test forces**

The test force consists in geometrical terms of the horizontal and vertical test components as follows:

$$F = \sqrt{F_h^2 + F_v^2}$$

where:

$F_h = \pm 0.6 * D$ in the case of alternating force,

or

$F_h = 1.0 * D$ in the case of rising force (traction or pressure),

$F_v = g * 1.5 * S$

S = static drawbar load (vertical force components on the track).

ANNEX C

(See 2.2.5)

COUPLING DEVICE
STATIC TEST METHOD

1. TEST SPECIFICATIONS

1.1. General

1.1.1. Subject to a check on its construction characteristics, the towing device shall undergo static tests in accordance with the requirements of points 1.2, 1.3 and 1.4.

1.2. Test preparation

The tests shall be carried out on a special machine, with the towing device and any structure coupling it to the body of the agricultural tractor attached to a rigid structure by means of the same components used to mount it on the agricultural tractor.

1.3. Test instruments

The instruments used to record loads applied and movements shall have the following degree of accuracy:

- loads applied ± 50 daN,
- movements ± 0.01 mm.

1.4. Test procedure

1.4.1. The coupling device shall first be subjected to a pre-traction load which does not exceed 15 % of the traction test load defined in point 1.4.2.

1.4.1.1. The operation described in para. 1.4.1 shall be repeated at least twice, starting with a zero load, which is gradually increased until the value prescribed in para. 1.4.1, is reached, and then decreased to 500 daN; the settling load shall be maintained for at least 60 seconds.

1.4.2. The data recorded for plotting the load/deformation curve under traction, or the graph of that curve provided by the printer linked to the traction machine, shall be based on the application of increasing loads only, starting from 500 daN, in relation to the reference centre of the coupling device.

There shall be no breaks for values up to and including the traction test load which is established as 1.5 times the technically permissible trailer mass; in addition, the load/deformation curve shall show a smooth progression, without irregularities, in the interval between 500 daN and one third of the maximum traction load.

1.4.2.1. Permanent deformation is recorded on the load/deformation curve in relation to the load of 500 daN after the test load has been brought back to that value.

1.4.2.2. The permanent deformation value recorded shall not exceed 25 % of the maximum elastic deformation occurring.

1.5 The test referred to in para. 1.4.2 shall be preceded by a test in which an initial load of three times the maximum permissible vertical load recommended by the manufacturer is applied in a gradually increasing manner, starting from an initial load of 500 daN, to the reference centre of the coupling device.

During the test, deformation of the coupling device shall not exceed 10 % of the maximum elastic deformation occurring.

The check is carried out after removing the vertical load and returning to the initial load of 500 daN.

ANNEX D

(See 5.1)

TECHNICAL SPECIFICATION TO BE SUBMITTED BY COUPLING DEVICE / TRACTOR MANUFACTURER

1. Name of the tractors manufacturer
2. Address of the tractors manufacturer
3. Tractors model / variants
4. Manufacturer of coupling device
5. Type of coupling device
6. Sketch showing mounting and location of coupling device
7. Material of the coupling device
8. Capacity of coupling device

ANNEX E

(See Introduction)

COMPOSITION OF AISC PANEL ON AIS ON AGRICULTURAL TRACTOR SUBJECTS*

Convener	
Mr. T.C. Gopalan,	Tractor Manufacturers Association (TMA)
Members	**Representing**
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Mr. A. A. Badusha,	The Automotive Research Association of India (ARAI)
Mr. V. V. Shinde,	The Automotive Research Association of India (ARAI)
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Representative from	International Centre for Automotive Technology (ICAT)
Representative from	Vehicle Research and Development Establishment (VRDE)
Representative from	Central Farm Machinery Training & Testing Institute (CFMTTI)
Dr. N. Karuppaiah	National Automotive Testing and R&D Infrastructure Project (NATRIP)
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Shri Philip Koshy	John Deere Equipment Pvt. Ltd
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Shri K. K. Gandhi	Society of Indian Automobile Manufacturers (SIAM)
Mr. T. V. Singh	Bureau of Indian Standards (BIS)
Shri K. C. S Bisht	Bureau of Indian Standards (BIS)

* At the time of approval of this Automotive Industry Standard (AIS)

ANNEX F
(See introduction)

COMMITTEE COMPOSITION *
Automotive Industry Standards Committee

Chairman	
Shri Shrikant R. Marathe	Director, The Automotive Research Association of India, Pune
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Representative from	Ministry of Road Transport & Highways (Dept. of Road Transport & Highways), New Delhi
Representative from	Ministry of Heavy Industries & Public Enterprises (Department of Heavy Industry), New Delhi
Shri S. M. Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small & Medium Enterprises, New Delhi
Shri T. V. Singh	Bureau of Indian Standards, New Delhi
Director Shri D. P. Saste (Alternate)	Central Institute of Road Transport, Pune
Dr. M. O. Garg	Indian Institute of Petroleum, Dehra Dun
Director	Vehicles Research & Development Establishment, Ahmednagar
Representatives from	Society of Indian Automobile Manufacturers
Shri T. C. Gopalan	Tractor Manufacturers Association, New Delhi
Shri K.N.D. Nambudiripad	Automotive Components Manufacturers Association of India, New Delhi

Member Secretary
Mrs. Rashmi Urdhwareshe
Sr. Deputy Director
The Automotive Research Association of India, Pune

* At the time of approval of this Automotive Industry Standard (AIS)