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भारतीय मानक मसौदा

मोल्डबोर्ड हल — पशु चालित और ट्रैक्टर चालित — विशिष्ट और परीक्षण प्रक्रिया
(आई एस 2192 का तीसरा पुनरीक्षण)

Draft Indian Standard

**MOULDBOARD PLOUGH — ANIMAL DRAWN AND TRACTOR OPERATED —
SPECIFICATION AND TEST CODE**
(Third Revision of IS 2192)

ICS 65.060.35

Agricultural Machinery and Equipment
Sectional Committee, FAD 11

Last date for Comments: **28 August 2024**

FOREWORD

(Format clause will be added later)

Mouldboard plough is a primary tillage implement used for mechanical manipulation of soil. Mouldboard plough based on mode of operation are of two types - Tractor operated mould board plough and Animal drawn mouldboard plough. This standard was first published in 1962 covering the requirements of turn wrest type mould plough ploughs. Another Indian Standard IS 2226 covering requirements of fixed type mould board plough was also published in the same year. Subsequently in 1976, IS 2192 was revised and bifurcated into two parts, Part 1 covering the requirements of turn wrest type and Part 2 covering requirements of fixed type mould board plough which superseded IS 2226. In its second revision in 1998, as turn wrest mould board plough was no largely manufactured, its provision was withdrawn and both the standards were amalgamated into single standard covering requirements of fixed type only. Also, requirement of shares used in animal drawn mould board plough which were earlier covered in IS 6327 : 1971 'One way animal drawn mouldboard plough shares' were incorporated in the revised standard and IS 6327 was withdrawn.

Considering the major manufacturing and usage of tractor operated mouldboard plough among the farmers, the third revision of the standard has been undertaken to incorporate critical requirements of tractor operated MB plough. In this revision following modifications have been made:

1. Additional definitions related to ploughing and mouldboard plough have been incorporated.
2. Requirements of share for tractor operated MB plough earlier covered in IS 10691 : 1983 'Specification for share for tractor operated mould board ploughs' have been incorporated.
3. Raw material requirement of share for both types of plough has been updated.
4. Size, vertical and horizontal suction for tractor operated MB Plough has been added.
5. Hitching requirements for tractor operated MB Plough has also been added.
6. Laboratory and field performance test methods have been incorporated which were earlier covered in IS 6288 : 1971 'Test Code for Mould Board Ploughs'.

This standard supersedes both IS 10691 : 1983 and IS 6288 : 1971.

The figures given in the standard are meant to serve only as illustration and should not be considered as suggestive of any standard design.

In revision of this standard, assistance has been derived from the technical information provided by Agricultural Machinery Manufacturers Association (AMMA, India).

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

MOULDBOARD PLOUGH — ANIMAL DRAWN AND TRACTOR OPERATED — SPECIFICATION AND TEST CODE

(Third Revision of IS 2192)

1 SCOPE

This standard prescribes material, dimensions, test code and other requirements of animal drawn and tractor operated mouldboard plough.

2 REFERENCES

The Indian Standards listed below contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated there.

| <i>IS No.</i> | <i>Title</i> |
|---|---|
| IS 210: 2009 | Grey iron casting — Specification (<i>fifth revision</i>) |
| IS 399: 1963 | Classification of commercial timbers and their zonal distribution (<i>first revision</i>) |
| IS 1500 (Part 1) : 2019/ISO 6506-3 : 2014 | Metallic materials — Brinell hardness test: Part 1 Test method (<i>fifth revision</i>) |
| IS 1570 (Part 2/Sec 1): 1979 | Schedules for wrought steels: Part 2 carbon steels (Unalloyed Steels): Sec 1 wrought products (Other Than Wires) with specified chemical composition and related properties (<i>first revision</i>) |
| IS 9818 (Part 2): 1981 | Glossary of terms relating to tillage and intercultivation equipment: Part 2 Terms relating to equipment |
| IS 2720 (Part 5): 1985 | Method of test for soils: Part 5 Determination of liquid and plastic limit (<i>second revision</i>) |
| IS 2062 : 2011 | Hot rolled medium and high tensile structural steel — Specification (<i>seventh revision</i>) |
| FAD 11 (22451)WC | Drawbar for agricultural tractors — Link type — Specification (<i>first revision of IS 12953</i>) |

IS 17231 : 2019/ISO Agricultural wheeled tractors — Rear-mounted three-point linkage
730 : 2009 — Categories 1N, 1, 2N, 2, 3N, 3, 4N and 4

3 TERMINOLOGY

For the purpose of this standard, the definitions as given below and definitions provided in IS 9818 (Part 2) shall apply (*see* also Fig. 1, 2, 3, 4, and 5).

3.1 Soil Inversion — The process through which the furrow slice is inverted during ploughing.

3.2 Soil Pulverization — The process of breaking of soil into smaller aggregates.

3.3 Furrow Wall — An undisturbed soil surface by the side of a furrow.

3.4 Crown — The top portion of the turned furrow slice is called crown.

3.5 Back Furrow — A raised ridge left at centre of the strip of land when ploughing is done from centre to side is called back furrow.

3.6 Dead Furrow — An open trench left in between two adjacent strips of land after finishing the ploughing.

3.7 Scouring — The self-cleaning flow of soil over the surface of tillage tools through the sliding action.

3.8 Gauge Wheel (*see* Fig. 2) — An auxiliary wheel of an implement that maintains a uniform depth of working during field operation.

3.9 Land Wheel — A wheel provided on the plough, which runs on the unploughed land and takes some of the side forces.

3.10 Coulter — A device or small tool used to cut a small furrow slice vertically from the land in front of plough bottom during field operation.

3.11 Jointer — A device or miniature plough bottom, which cuts and turns a small furrow slice directly ahead of the plough bottom.

3.12 Pull — The total force exerted upon the implement by a power unit. It may or may not be horizontal. It is also expressed as kgf or kN.

3.13 Draft — The horizontal component of pull parallel to line of motion. It is expressed as kgf or kN.

3.14 Side Draft — The horizontal component of pull acting perpendicular to the line of motion. It is expressed as kgf or kN.

3.15 Specific Draft — The draft per unit area of tilled cross-section. It is expressed as kgf/m² or kN/m².

3.16 Power — The rate of doing work. It is expressed as hp or kW or kJ/s (1 watt = 1 joule/s = 1 Nm/s and 1 hp = 746 watt).

3.17 Drawbar Power — The power available at the drawbar of the tractor for pulling the trailed type implement at a uniform speed. It is expressed as hp or kW.

3.18 Theoretical Field Capacity — The rate of field coverage of the plough based on 100% of time at the rated speed and covering 100% of its rated width.

3.19 Effective field capacity — The actual area covered by the plough based on its total time consumed and its width.

3.20 Field Efficiency (E_f) — The ratio of effective field capacity and theoretical field capacity. It is generally expressed in per cent.

3.21 Trailed Implement — An implement pulled and guided from a single hitch point; but is never completely supported by power unit.

3.22 Semi-mounted Implement — An implement that is attached to a tractor at more than one point, responds directly to tractor steering and is partly supported by the tractor.

3.23 Mounted Implement — An implement completely supported by tractor when in raised position and is mounted on 3-point linkage.

3.24 Performance Index — The assessment of the overall performance, at a particular set of soil condition.

3.25 Testing Station — Any organization set up or approved by the government for the purpose of testing and releasing the test reports.

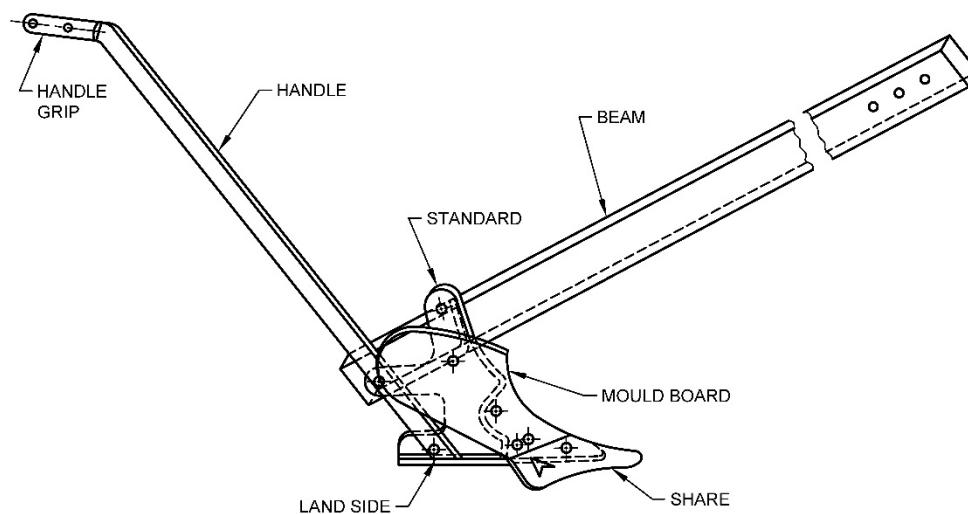


FIG. 1 NOMENCLATURE OF MAIN PARTS OF MOULDBOARD PLOUGH, FIXED TYPE (LONG BEAM)

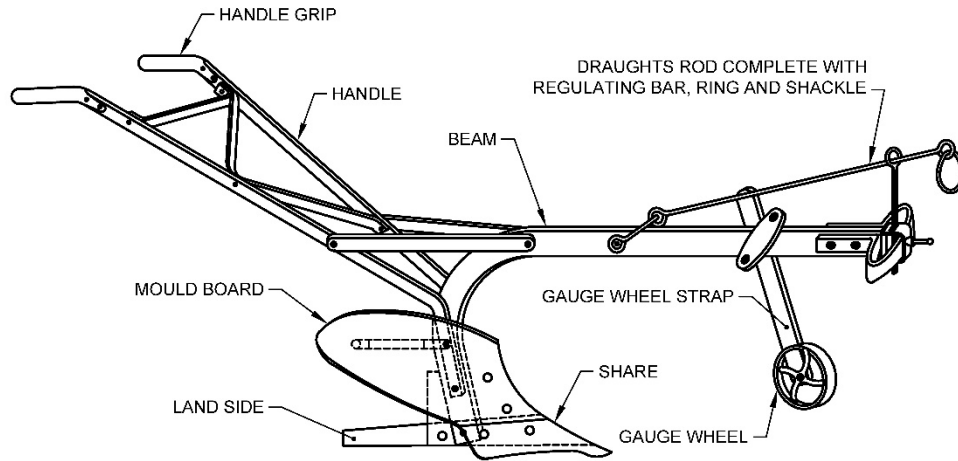


FIG. 2 NOMENCLATURE OF MAIN PARTS OF ANIMAL DRAWN MOULDBOARD PLOUGH, FIXED TYPE (SHORT BEAM)

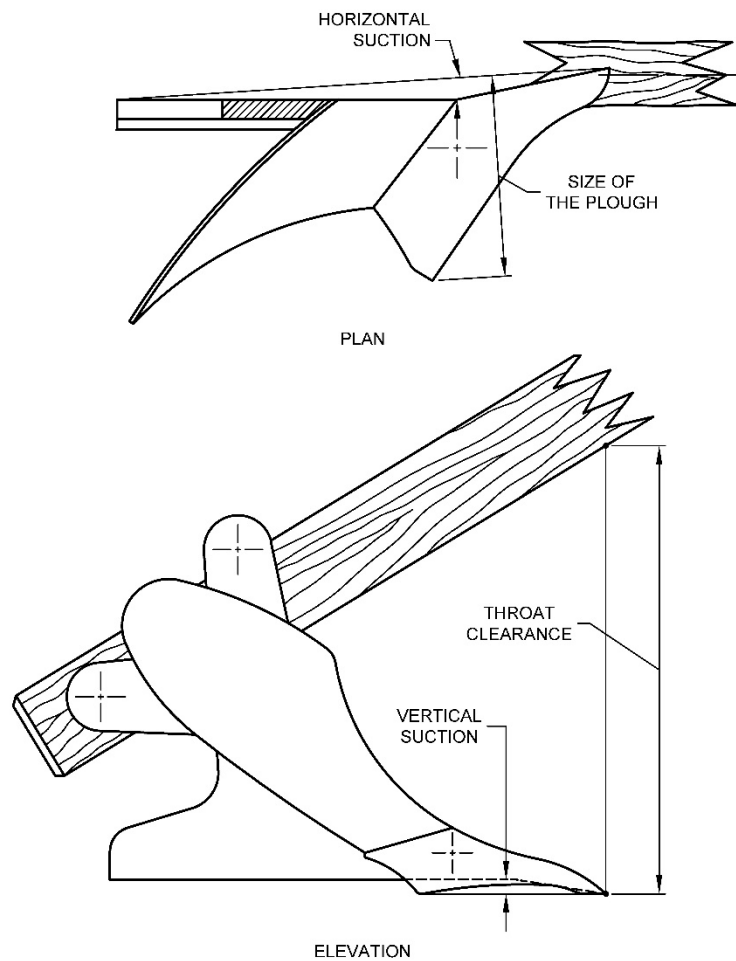


FIG. 3 MEASUREMENT OF SIZE, SUCTION AND CLEARANCE OF THE MOULDBOARD PLOUGH, FIXED TYPE

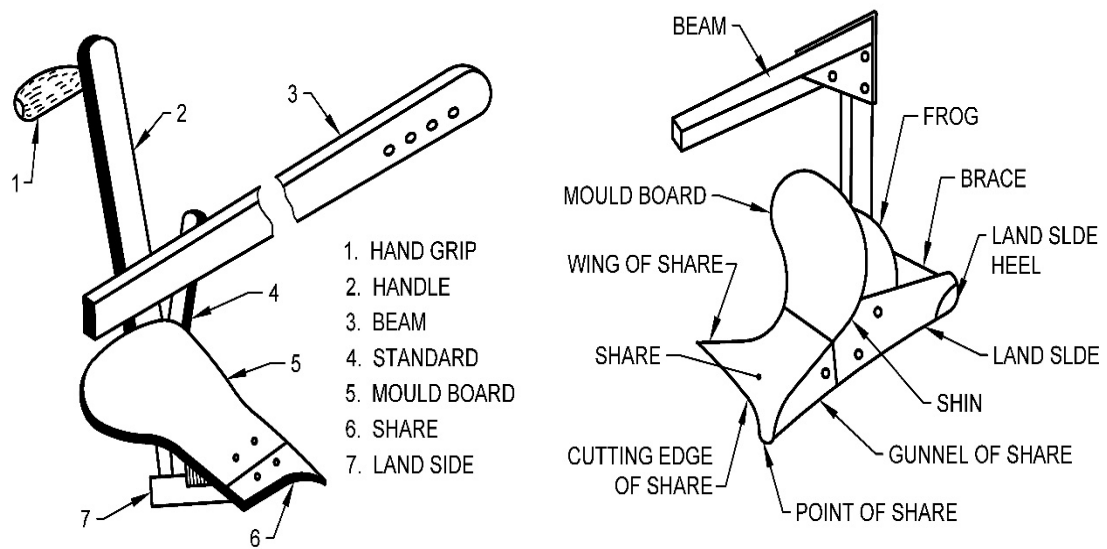


FIG. 4 COMPONENTS OF ANIMAL DRAWN MOULD BOARD PLOUGH

1. BEAM
2. TOP LINK CONNECTION
3. VERTICAL STUT
4. CROSS SHAFT
5. COULTER STOP
6. COULTER ARM
7. COULTER DISC
8. SCRAPER
9. SHARE POINT
10. SHARE WING
11. MOULD BOARD
12. VERTICAL BEAM

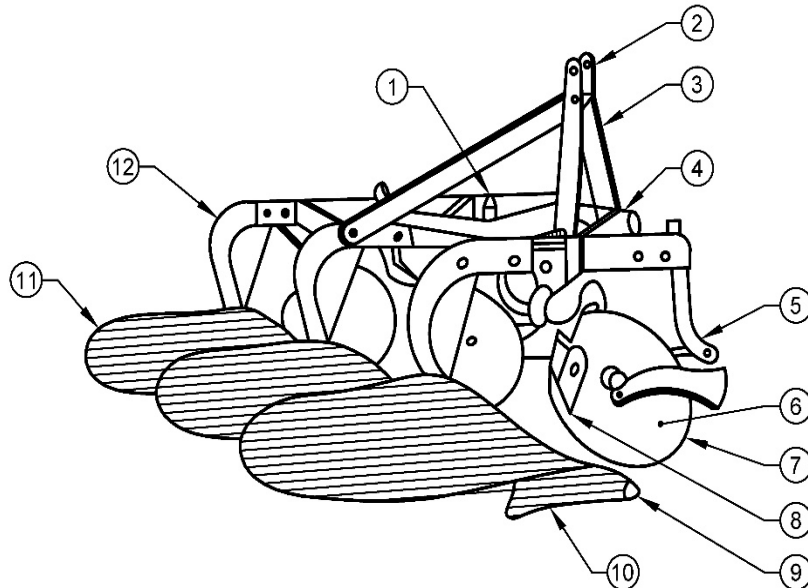


FIG. 5 COMPONENTS OF TRACTOR OPERATED 3-BOTTOM MOULD BOARD PLOUGH

4. TYPES OF SHARES

4.1 Share for Tractor Operated Mould Board Plough

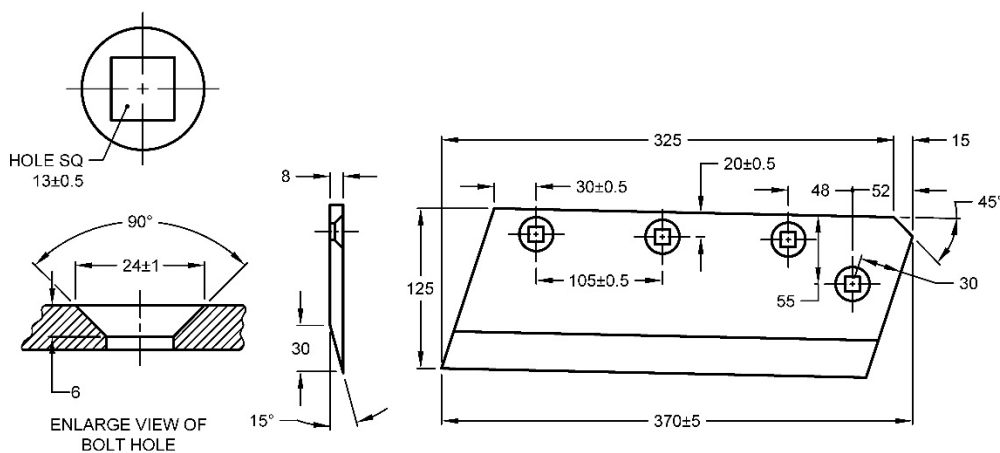
On the basis of the dimensions, the share shall be of the following 7 types:

- a) Type 1 (Fig. 6).
- b) Type 2 (Fig. 7),
- c) Type 3 (Fig. 8),
- d) Type 4 (Fig. 9),
- e) Type 5 (Fig. 10),
- f) Type 6 (Fig. 11), and
- g) Type 7 (Fig. 12)

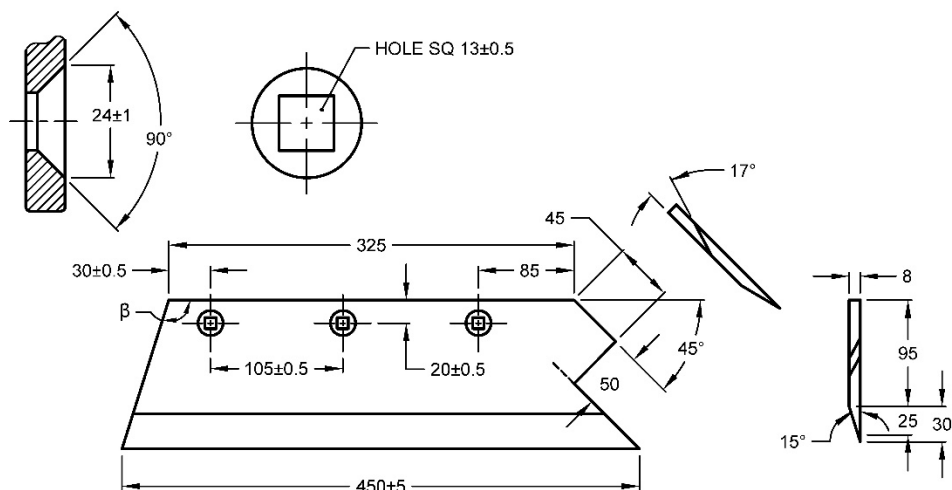
4.1.1 Dimensions and Tolerances

4.1.1.1 The dimensions of Types 1 to 7 tractor operated MB plough shares shall be as given in Fig. 6 to 12. The tolerances on the dimensions unless indicated otherwise, shall be ± 10 percent.

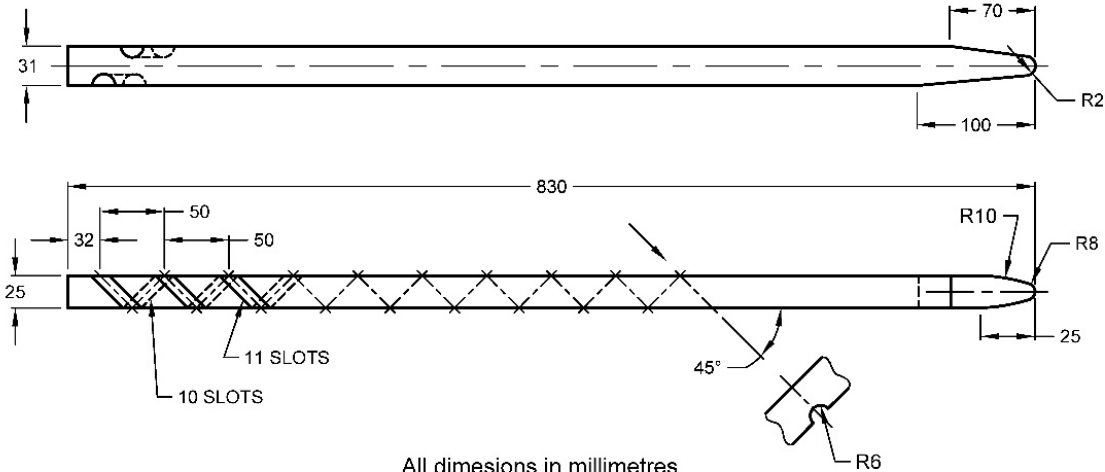
4.1.1.2 The dimensions of bar for plough share shall be in accordance with Fig. 7(a).



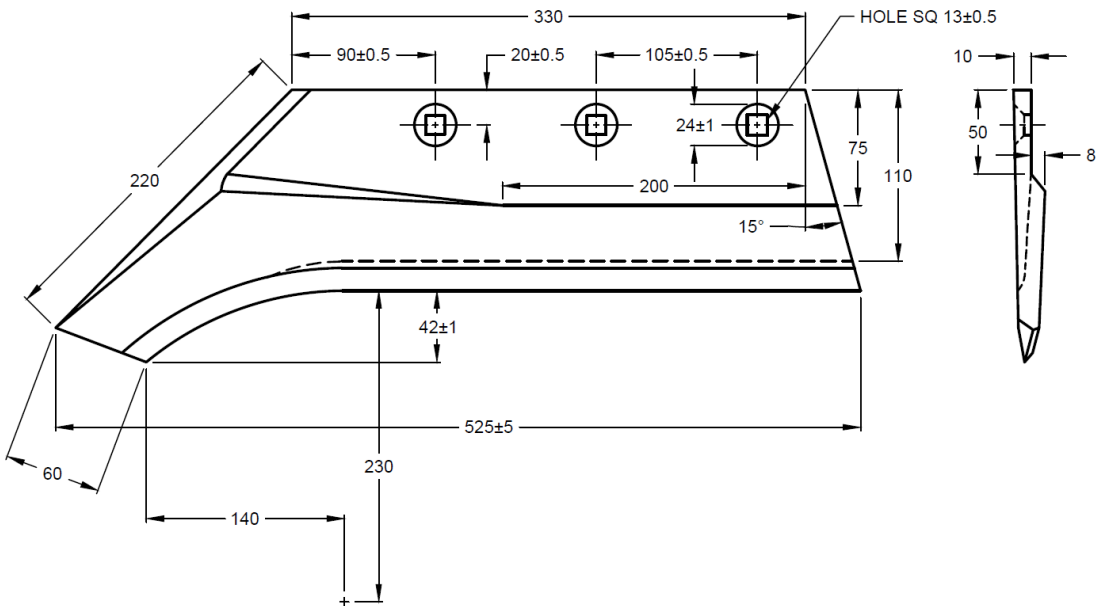
All dimensions in millimetres
FIG. 6 TYPE 1 SHARE



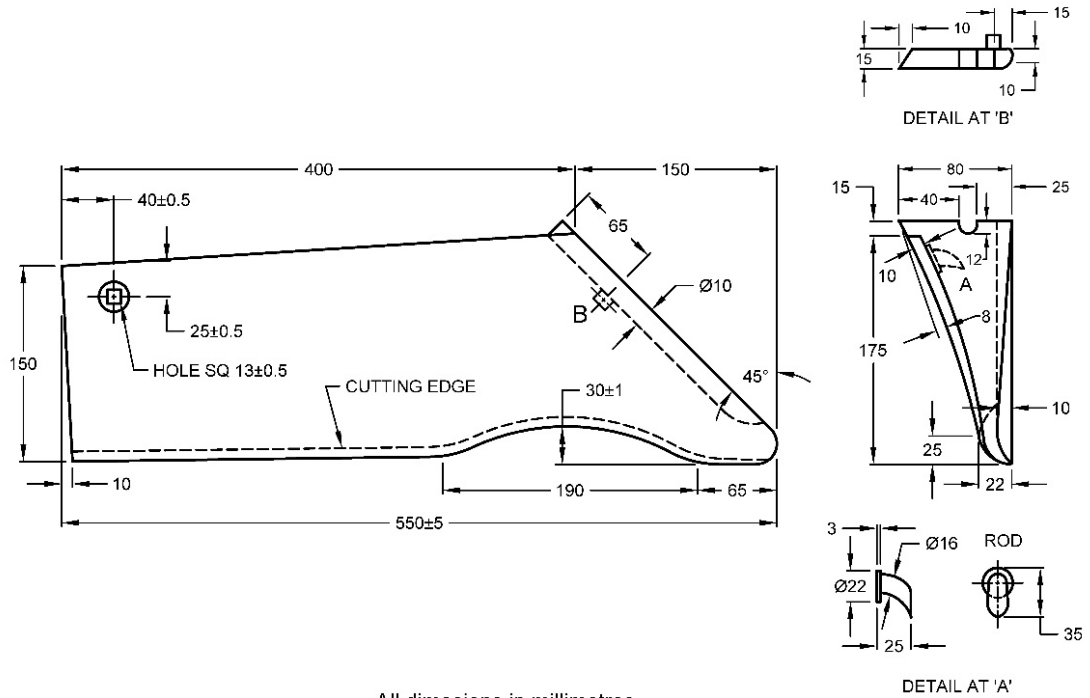
All dimensions in millimetres
FIG. 7 TYPE 2 SHARE



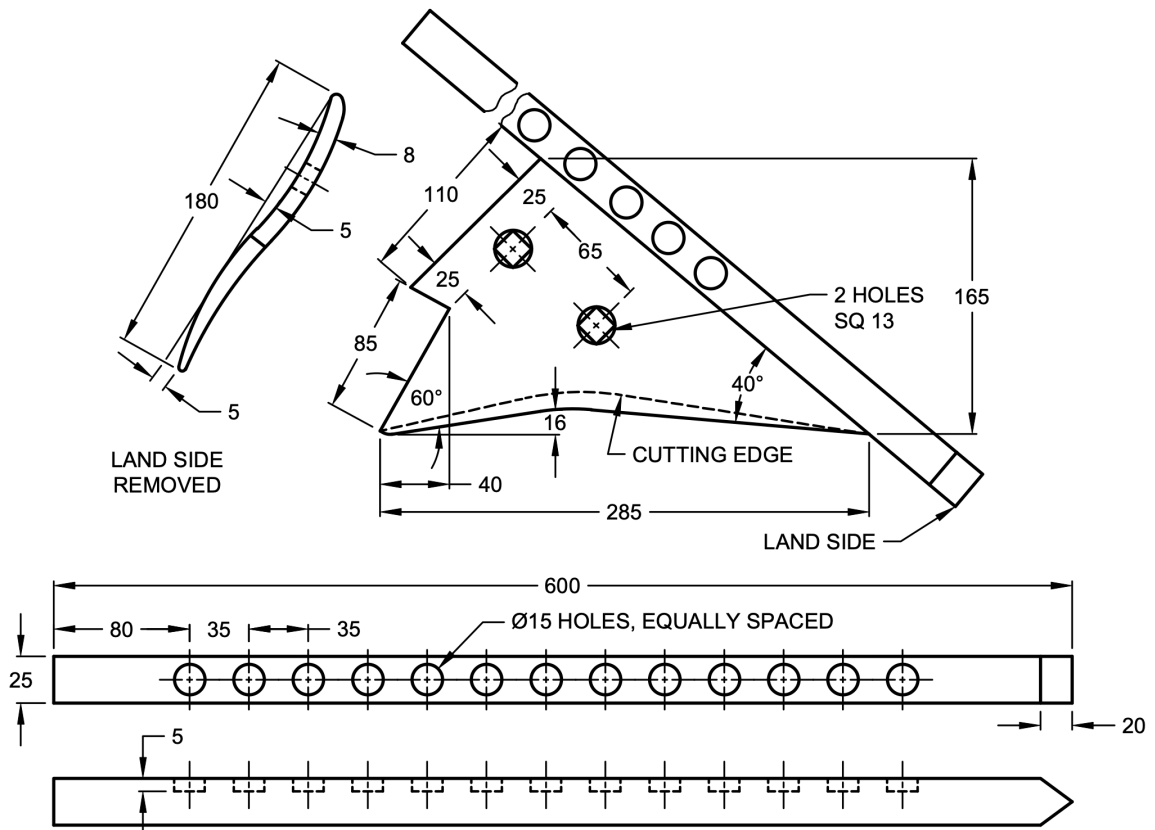
All dimensions in millimetres.
FIG. 7(a) BAR



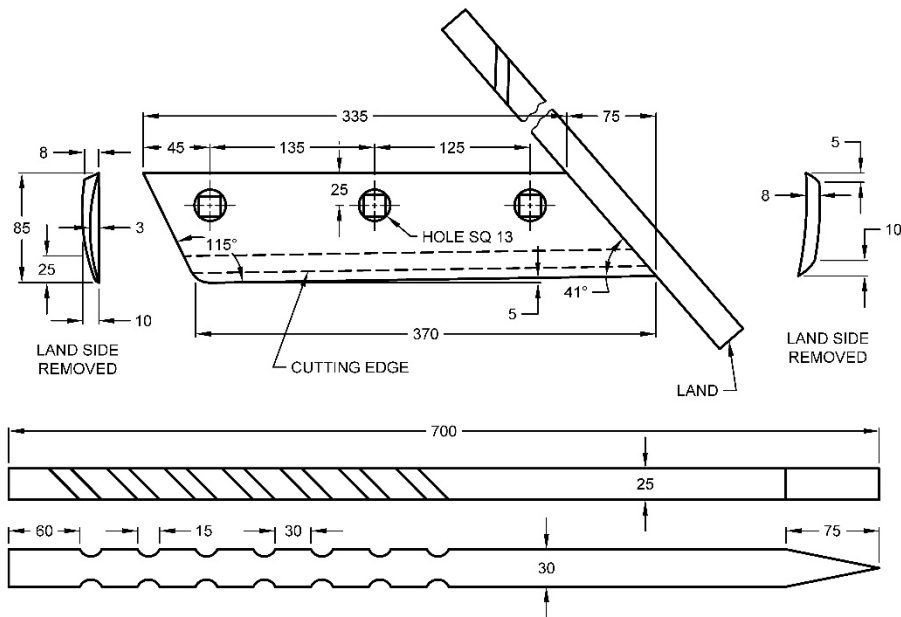
All dimensions in millimetres
FIG. 8 TYPE 3 SHARE



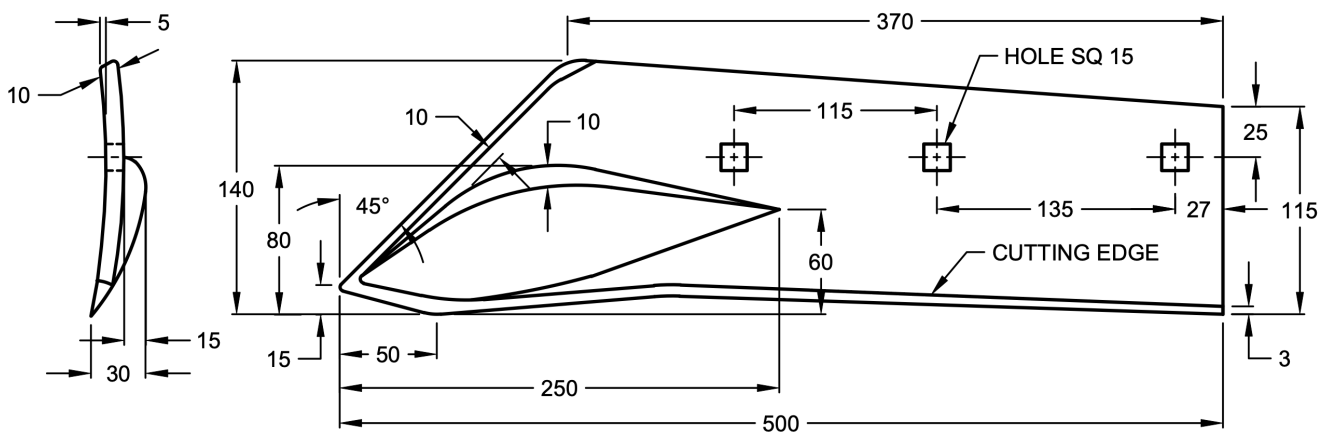
All dimensions in millimetres.
FIG. 9 TYPE 4 SHARE



All dimensions in millimetres
FIG. 10 TYPE 5 SHARE



All dimensions in millimetres
FIG. 11 TYPE 6 SHARE



All dimensions in millimetres
FIG. 12 TYPE 7 SHARE

4.2 Share for Animal Drawn Mould Board Plough

The essential dimensions of share of animal drawn mould board plough (see Fig. 13) shall be as given in Table 1.

Table 1 Dimensions of Animal Drawn Mouldboard Plough Share
(Clause 6.2)

| W mm ± 5 | A mm ± 0.5 | B mm ± 0.5 | C mm ± 0.5 | D mm ± 0.5 | E mm ± 1 | α | β |
|----------------|------------------|------------------|------------------|------------------|----------------|----------|-------------|
| 100 | 37.5 | 20 | 12.0 | - | Up to 16 | 15°- 20° | 115° - 120° |
| 125 | 50 | 20 | 12.0 | - | Up to 20 | 15°- 20° | 125° - 130° |
| 150 | 37.5 | | | 50 | | | |

| | | | | | | | | |
|-----|---|----|------|----|----------|----------|-----------|--|
| 175 | | | | | | | | |
| 200 | | | | | | | | |
| 225 | 5 | 25 | 12.0 | 95 | Up to 25 | 15°- 20° | 130°-125° | |
| 250 | | | | | | | | |

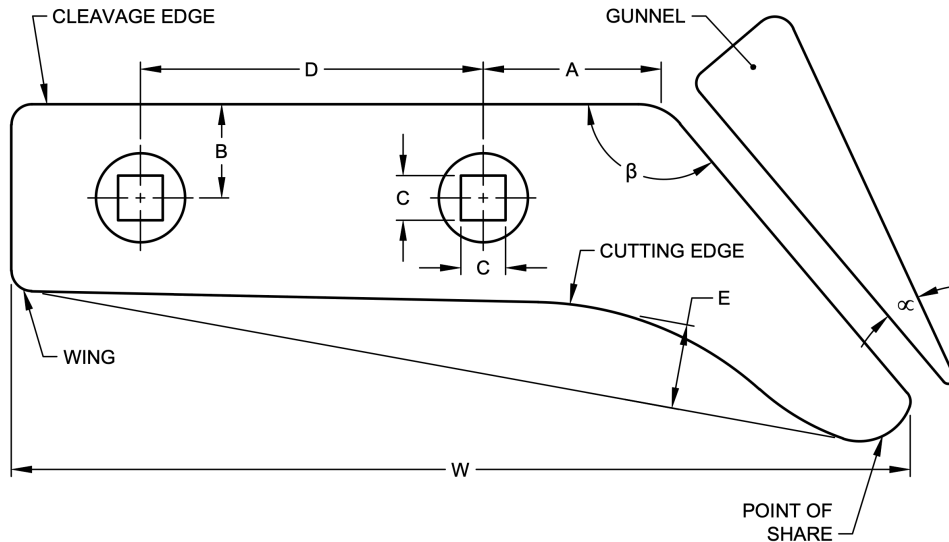


FIG. 13 ANIMAL DRAWN MOULD BOARD PLOUGH SHARE

5 MATERIAL

5.1 The share for both animal drawn and tractor operated MB plough shall be manufactured from chilled cast iron or high carbon steel conforming to Grade 75C6 [see IS 1570 (Part 2/Sec 1)] or boron steel conforming to grades 27MnCrB5/ 28MnCrB5/ 30MnCrB5. Steel conforming to grades EN 45/ EN 42/ EN 19/ EN 9/EN 8 or steel equivalent or better than grades provided may also be used.

NOTE — The sulphur and phosphorus content shall not be more than 0.05 percent each.

5.2 The material for bar point (share used in tractor operated MB plough) shall be 40C8 or 55C8 [see IS 1570 (Part 2/Sec 1)]. Steel conforming to EN 19/EN 42/EN 42J may be also used.

5.3 The material of construction for components other than the share shall be cast iron preferably conforming to Grade 200 of IS 210 or mild steel preferably conforming to IS 2062. Well-seasoned hardwood (see IS 399) may also be used for beam, handle and handle grip in case of animal drawn mould board plough.

5.4 The material of construction of various components shall be declared by the manufacturer.

6 HARDNESS

6.1 The chilled cast iron shares shall have a hardness of 320 to 400 HB when tested in accordance with IS 1500 (Part 1) and depth of chilling shall be not less than 1.5 mm.

NOTE — In case of through hardening material special treatment is not required for cutting edge.

6.2 The cutting edge of steel share shall be hardened and tempered to give a hardness of 320 to 400 HB when tested in accordance with 1500 (Part 1).

6.3 Cast iron components, other than share, shall have the hardness in range of 160 to 220 HB [*see* 1500 (Part 1)].

7 DIMENSIONS

7.1 The size of plough (*see* Fig. 3) shall be 100, 125, 150, 175, 200, 225 and 250 mm for animal drawn mould board plough. The minimum size of tractor operated mould plough shall be 200 mm. The tolerance on all the sizes shall be ± 5 mm.

7.2 The horizontal and vertical suction (*see* Fig. 3) shall be in the range of 3 mm to 12 mm for animal drawn mould board plough and 6 mm to 15 mm for tractor operated mould board plough. These shall be declared by the manufacturer. The suction shall not differ by ± 2 mm of the declared value.

7.3 When the plough is set at its working position, the throat clearance (*see* Fig. 3) shall be at least twice the size of the plough (*see* 6.1). The throat clearance should, as far as possible, be adjustable.

7.4 The animal drawn plough shall be provided with one or two handles. If two handles are provided, the distance between handle grips shall be between 550 mm and 650 mm.

NOTE— Based on anthropometry survey conducted by CIAE, Bhopal, in case of animal drawn MB plough, it is recommended to provide vertical distance between ground and the handle between 650 and 950 mm and the diameter of handle from 32 mm to 36 mm.

7.5 When the plough is set at its working position, the vertical distance between ground and the centre of grip shall be between 900 mm and 1100 mm. The distance should preferably be adjustable.

7.6 The handle grip provided in animal drawn plough shall be circular or oval in cross section. The diameter or minor axis shall be between 25 mm and 35 mm. The length of the grip shall be not less than 125 mm.

7.7 The gauge wheel, if provided, shall be not less than 150 mm in diameter and its face width not less than 50 mm.

7.8 The gap between the cleavage edges of the share and the mouldboard shall be not more than 2 mm.

8 OTHER REQUIREMENTS

8.1 The cutting edge of the share shall be bevelled to a distance not more than 20 mm. The thickness of the cutting edge shall be between 0.5 to 3 mm and should be uniform, as far as possible.

8.2 The counter sunk bolts of 10 mm minimum size shall be used for fixing the share with the frog. As far as possible, the bolt of M 10 size should be used.

8.3 The thickness of sheet used in the manufacture of share should be 10 mm min. The tolerance for nominal thickness of sheet shall be ± 10 percent. Thickness of mould board should be 6 mm, minimum.

8.4 In case of animal drawn plough two holes shall be punched in shares of size 200 mm to 250 mm and one hole shall be punched in shares of size 100 mm. Shares of size 125 mm to 175 mm may have either one or two holes as specified by the purchaser.

8.5 All the components of the MB plough should preferably be detachable.

8.6 The head of the fasteners, coming in contact with soil, shall be flush with the working surface. As far as possible bolt of 10 mm size should be used for all fastening to facilitate the use of minimum number of tools.

8.7 If desired by the purchaser, the plough shall be provided either with left or right hand soil turning arrangement.

8.8 The gauge wheel, if provided, shall roll smoothly on its axis. The height of the wheels should be adjustable.

8.9 When the plough is set at its working position and is placed on a plane surface, its bearing points (point of share, wing and heel of the landside) should touch the ground and the plough shall be well balanced.

8.10 Tapered roller or ball bearings of suitable sizes shall be provided in, furrow wheel or land wheel. The bearings should be reasonably dust-proof and properly aligned

8.11 Mould board should be provided with the scraper. Arrangement for adjusting the gap of the scrapers shall be made.

8.12 The arrangement for lubrication of moving parts shall be made. Provision of grease nipples in plough bottom and wheels should be preferred.

8.13 In trailed-type MB ploughs, transport wheels may be provided for transportation from one place to other.

8.14 Hitching Arrangements

8.14.1 In trailed-type tractor operated MB ploughs, the drawbar should be manufactured in such a manner that it conforms to the requirements of tractor drawbar as given in FAD 11 (22451) WC.

8.14.2 In mounted-type disc ploughs, dimensions of hitch points should be such that they conform to the requirements of three-point linkage as given in IS 17231.

8.15 Cross bar with crank position for hitching point shall be provided.

8.16 Trailing type ploughs shall be provided with a suitable mechanism for depth adjustment.

8.17 Operational and maintenance manuals and a set of tools including adjustable wrench and grease gun shall be provided.

9 WORKMANSHIP AND FINISH

9.1 Plough

9.1.1 The components should be free from pits, burrs and other visual defects. The castings shall be free from blow holes. Welded joints shall not be porous and brittle.

9.1.2 The surface of parts of the plough shall be evenly dressed and shall have a protective coating which will prevent surface deterioration in transit and storage.

9.2 Share

9.2.1 The shares shall be free from flaws, scratches, cracks and other defects. All fins, burrs, flashes and sharp edges other than the cutting edge shall be removed.

9.2.2 In case of steel shares, the welding of gunnel shall be satisfactory in all respects. The welding shall not be porous or brittle.

9.2.3 A coating of protective paint or grease on soil facing surface of the share shall be provided. The bottom surface not in direct contact with soil shall have an anti-rust paint coating.

10 MARKING AND PACKING

10.1 The following particulars shall be marked legibly and indelibly on the Mouldboard Ploughs:

- a) Manufacturer's name or recognized trademark, if any;
- b) Batch or code number;
- c) Type and size; and
- d) Any other markings required under the *Standards of Weights and Measures (Packaged Commodities) Rules, 2011*.

10.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

10.3 Packing

The mould board plough shall be packed as agreed to between the purchaser and the supplier. The packing shall ensure safety of the parts in transit.

11 PERFORMANCE TESTS

The tests recommended below shall be carried out at the testing station both in the laboratory and the field.

11.1 Laboratory Tests

The plough shall be tested in the laboratory:

- a) to check the product with the specification sheet submitted by the applicant; and
- b) to determine hardness of material and examine constructional details.

11.2 Field Tests

The plough shall be tested in the field to measure and assess the following:

- a) Shape and Size (Width and Depth) of Furrow
- b) Power Requirement (Draft, Speed and Power)
- c) Field Efficiency (Effective Field Capacity or Output, Theoretical Field Capacity and Field Efficiency)
- d) Soil Inversion
- e) Soil Pulverization
- f) Performance Index
- g) Ease of Adjustment and Maintenance
- h) Soundness of Construction
- i) Wear in Share

11.3 Selection of Sample for Test

11.3.1 Selection of Sample

The mouldboard plough shall be taken from the series production by the testing authority with the agreement of the applicant. The plough shall be a production model in all respects. The applicant may submit prototype for confidential tests.

11.3.2 *Specification Sheet*

The applicant shall furnish the specification in accordance with Annex A.

11.3.3 *Assembling and Preliminary Adjustments*

It would be the responsibility of the applicant to ascertain that plough selected for testing is complete in all respects and necessary adjustments have been carried out in the presence of the representative of the testing station.

11.4 Laboratory Tests

11.4.1 The specification given by the applicant shall be checked and recorded in Annex A.

11.4.2 The plough should be dismantled and the material of construction, and hardness shall be tested. The data shall be recorded as in Annex B. The hardness of steel parts should be tested in accordance with IS 1501 (Part 1).

11.5 Preparation of Sample for Field Tests and Selection of Land

11.5.1 *Preparation of Sample*

11.5.1.1 Testing authority shall ensure that the plough has been properly assembled after laboratory test.

11.5.1.2 All the attachments and accessories should be fitted in proper place and the adjustments made therein shall be in accordance with the applicant's setting and adjustments.

11.5.1.3 The plough should be properly hitched with source of power. As far as possible the same model, make and hp range of tractor should be employed for testing as specified by the applicant.

11.5.2 *Selection of Land*

11.5.2.1 The minimum area of the plot for testing animal drawn plough should be 0.25 hectare and for tractor operated plough one hectare. The ratio of width and length of the plot should be as far as possible 1 : 2.

11.5.2.2 The following field conditions of the plot shall be checked and reported:

- a) Site of the plot
- b) Type of soil
- c) Last crop grown
- d) Date of last crop harvested
- e) Date and details of preceding tillage treatments, if any, after the date of harvesting of last crop
- f) Topography of the field
- g) Soil moisture percentage and
- h) Bulk density.

11.6 Field Tests

At least three series of field tests shall be carried out under different soil conditions. Under each set of conditions, take at least five samples of soil along with the diagonal lines about 3 m inside the boundary lines. Determine the bulk density and moisture content of the samples and report their average. Depending upon the facilities available, additional series of field tests may be conducted.

11.6.1 *Shape and Size of Furrow*

11.6.1.1 Shape – Operate the plough and cover one row length. Clean the furrow carefully and observe the shape of furrow. The shape may be rectangular, triangular or trapezoidal.

NOTE — If the plough is making trapezoidal furrow its adjustments and hitching should be rechecked and then further tests should be conducted.

11.6.1.2 Size of furrow – Mark a strip of width (A) on unploughed land from the furrow wall of the furrow already opened for a length of about 30 m. Operate the plough in the marked distance in such a way that a straight row adjacent to furrow wall is cut.

11.6.1.2.1 Width – Measure the marked unploughed land at an interval of about 3 m in length. Take the average of readings obtained, in order to get average width of unploughed strip (B). The difference of A and B would give the width of ploughing if the plough is single bottom; otherwise divide the difference of A and B by the number of plough bottoms in order to get the width of one bottom.

11.6.1.2.2 Depth – Clean carefully the furrow already cut and measure the depth (distance between furrow sole and ground level, measured along the furrow wall) at an interval of about 3 m in length.

11.6.1.3 Repeat **11.6.1.1** and **11.6.1.2** for every test conducted and record the data as in Annex C.

11.7 Power Requirement

11.7.1 For Tractor Operated and Animal Drawn Ploughs (Trailed)

- Insert a dynamometer in the hitch to measure the draft in kgf (N). The draft is defined as the horizontal component of the pull, parallel to the line of motion. If the line of pull through the dynamometer is not horizontal, measure the angle, the line of pull makes with the horizontal and calculate the horizontal component (draft) by the following formula:

$$D = P \cos \theta$$

where

D = draft in kgf (N),

P = pull in kgf (N), and

θ = angle between line of pull and horizontal.

- Lay off a space of 30 m in the middle of a long row and mark each end of this space with an easily distinguished pole.
- Operate the plough as in per **11.6.1.1**. Start the plough well in advance of the first pole marker and ensure that it is operating uniformly when it reaches this pole. As the plough operates in 30 m space, record the dynamometer reading at about 4 to 5 minutes' intervals. Average these readings for obtaining the average draft for the 30 m run. A stop-watch or other accurate time piece should be used to record the time for the plough to traverse the 30 m. From this value the speed of travel in metre per second can be calculated.
- Calculate the power from the following formula:

$$\text{Metric hp} = \frac{\text{Draft in kgf} \times \text{Speed in km/h}}{270}$$

Or

$$\text{Power (kW)} = \frac{\text{Draft in kN} \times \text{Speed in km/h}}{3.6}$$

- e) Repeat the above a minimum of 5 times to arrive at average power requirement. Data should be recorded as in Annex C.

11.7.2 For Tractor Operated Ploughs (Mounted)

- Lay off a space of 30 m in the middle of a long row and mark each end of this space with an easily distinguished pole.
- A direct reading spring or hydraulic type dynamometer should be attached in front of the tractor. Another tractor should be used to pull the tractor on which the plough is attached.
- Repeat the operation as in 11.7.1(c).
- Detach the plough from the tractor and the draft required only to pull the tractor (with which the plough was attached) should be recorded in same manner as in 11.7.2(c). Ensure that the tractor is pulled at the same speed as in case of 11.7.1(c).
- Draft of the plough may be obtained by deducting the draft of tractor [as obtained in 11.7.2(d)] from the draft of plough and tractor [as obtained in 11.7.2(c)].
- Calculate the power in accordance with the procedures as given in 11.7.1(d).
- Repeat the above a minimum of 5 times to arrive at average power requirement. Data should be recorded as in Annex C.

11.7.3 Repeat 11.7.1 and 11.7.2 for all the tests.

11.8 Field Efficiency

11.8.1 Effective Field Capacity or Output — The plough should be operated for continuous field work for at least 4 hours and the area covered during the period shall be measured in hectare. Calculate the average of output per hour.

If facilities exist, plough may be operated for at least three days and an average of output should be obtained by dividing the area covered with the number of hours for which plough has been used.

11.8.2 Theoretical Field Capacity — On the basis of the width of furrow and speed, theoretical field capacity should be calculated by following formula:

$$\text{Theoretical field capacity in } \frac{\text{hectare}}{h} = \frac{\text{Width in cm} \times \text{Speed in m/sec} \times 36}{10\,000}$$

11.8.3 Field Efficiency — This should be calculated as follows:

$$\text{Field Efficiency, percent} = \frac{\text{Effective Field Capacity} \times 100}{\text{Theoretical Field Capacity}}$$

Record the data as in Annex C.

11.9 Soil Inversion

It should be measured by the weed count method described as follows.

11.9.1 A square ring (30 × 30 cm) should be placed at random in the field before starting the test. The number of weeds and stubbles enclosed within this ring should be counted. Take at least five observations at different places in test plot. Record the observations as in Annex C.

11.9.2 Repeat the above process after ploughing the field and record the data as in Annex C.

11.9.3 Calculate the soil inversion as follows:

$$\text{Soil inversion, percent} = \frac{100 (\text{No. of weeds before test} - \text{No. of weeds after test})}{\text{No. of weeds before test}}$$

11.10 Soil Pulverization

Measure the depth of penetration by a penetrometer [see 4.1 of IS 2720 (Part 5)] as follows.

11.10.1 The penetrometer should be held vertically at a place selected at random in the field after ploughing and a hammer should be dropped on it from the height of one metre. The depth of penetrometer should be recorded after every two drops. The time gap between these two strokes should be as short as possible. The angle of the metallic cone and weight of the hammer should be stated in the test report.

11.10.2 Repeat the above at least at five places in the field and record the data as in Annex C.

$$PI = \frac{d \times A \times I \times P}{D}$$

where

PI = performance index,

d = depth in cm,

A = effective field capacity in hectare per day of 8 h,

I = soil inversion expressed as percent,

P = pulverization in terms of penetrometer reading in cm, and

D = draft in kgf per cm²

The above formula should be applied in judging the overall performance of a plough and a comparative study may be made if there are number of ploughs to be tested in same soil condition. Record the data as in Annex C.

11.11 Ease of Operation

Assess the following:

- a) Whether the plough is balanced during the operation?
- b) Whether the plough scours properly?
- c) Is there any Marked clogging of soil in the throat?

Record the observations as in Annex C.

11.12 Soundness of Construction

The deformation and breakage of parts should be checked during the test for its soundness and observations should be recorded as in Annex C.

11.13 Wear in Share

The loss in weight of the share after completing each test and after entire test shall be recorded as in Annex C.

12 SUMMARY REPORT

For reducing the data to a readily usable form and for preparing a meaningful report, compile a 'Summary Report' as given in Annex D.

ANNEX A
(Clauses 11.3.2 and 11.4.1)
SPECIFICATION SHEET FOR APPLICANT/FOR TESTING STATION

A-1 NAME AND ADDRESS OF APPLICANT

A-2 TRADE NAME AND MODEL OF PLOUGH

A-3 SAMPLE NUMBER

A-4 TYPE OF SAMPLE

- a) Prototype
- b) Production model

A-5 TYPE OF PLOUGH

- a) One way
- b) Two way (reversible)

A-6 NUMBER OF PLOUGH BOTTOM

A-7 SOURCE OF POWER

- a) Animal, and
- b) Tractor
 - a) Make and model
 - b) hp range

A-8 TYPE OF SHARE

- a) Slip
- b) Slipnose
- c) Shin
- d) Bar
- e) Special

A-9 TYPE OF MOULDBOARD

- a) Sod
- b) Stubble
- c) General purpose
- d) Special

A-10 HANDLE

- a) Number:
 - 1) Single
 - 2) Double
- b) Material:
 - 1) Wooden
 - 2) Steel
- c) Grip height from ground

A-11 LANDSIDE

- a) It is a part of frog or separate
- b) Heel is part of landside or detachable

- c) Size

A-12 STANDARD

- a) Type
- b) Location

A-13 BEAM

- a) Wooden
 - 1) Long
 - 2) Short
 - 3) Size (cross section and length)
- b) Steel
 - 1) Straight
 - 2) Curved
 - 3) Size (cross section and length)

A-14 CLEVIS

- a) Vertical
- b) Horizontal

A-15 TYPE OF HITCHING

- a) Mounted
- b) Trailed
- c) Semi-mounted

A-16 HITCHING PIN

- a) Pin diameter:
 - 1) Top link
 - 2) Lower link
- b) Pin length

A-17 CROSS SHAFT

- a) Diameter
- b) Range of variation

A-18 ATTACHMENTS PROVIDED

- a) Gauge wheel
- b) Coulter
- c) Joints
- d) Braces
- e) Weed hook
- f) Rear furrow wheel
- g) Front furrow wheel

A-19 SIZE OF PLOUGH

A-20 CLEARANCES

- a) Vertical
- b) Horizontal

A-21 ADJUSTMENTS PROVIDED FOR

- a) Depth
- b) Width
- c) Any other

A-22 WING BEARING

A-23 THROAT CLEARANCE

A-24 ANGLE OF PENETRATION

A-25 CLEAVAGE ANGLE

A-26 SIZE OF DIFFERENT BOLTS AND NUTS

A-27 TOTAL WEIGHT

Signature of Applicant
Engineer

Test

ANNEX B
(Clause 11.4.2)
DATA SHEET FOR LABORATORY TESTS

B-1 DATE OF TEST

B-2 MATERIAL OF CONSTRUCTION AND HARDNESS

| Sl. No. | Name of Part | Material Used | Hardness | Depth of Hardness |
|---------|-----------------|---------------|----------|-------------------|
| (1) | (2) | (3) | (4) | (5) |
| i) | Share | | | |
| ii) | Mouldboard | | | |
| iii) | Landside | | | |
| iv) | Frog | | | |
| v) | Any other parts | | | |

B-3 WEIGHT OF SHARE

B-4 HOW DIFFERENT PARTS ARE ATTACHED

B-5 INTERCHANGEABILITY OF PARTS

B-6 FACILITY FOR REPLACING WORNOUT PARTS

B-7 SIMPLICITY OF CONSTRUCTION

B-8 ALIGNMENT OF PLOUGH

- a) Distance between two consecutive share points
- b) Distance between two consecutive heels of landside
- c) All share points are in same horizontal plane and lie in one straight line
- d) Beam of all plough bottoms are in same horizontal plane
- e) All bearing points of each plough bottom are in one horizontal plane
- f) Landside of one plough bottom and wing of share of next bottom are lying in one straight line parallel to direction of motion.

Test Engineer

ANNEX C
(Clauses 11.6, 11.7, 11.8, 11.9, 11.10,11.11, 11.12 and 11.13)
DATA SHEET FOR FIELD TEST

C-1 DATE OF TEST

C-2 SITE OF TEST

C-3 FIELD CONDITIONS

- a) Type of soil
- b) Last crop grown
- c) Date of last crop harvested
- d) Dates and details of preceding tillage treatments
- e) Soil moisture percentage
- f) Bulk density
- g) Topography of field

C-4 SIZE OF TEST PLOT

- a) Length
- b) Width

C-5 CONE ANGLE OF PENETROMETER

C-6 WEIGHT OF HAMMER

C-7 TOTAL TIME OF TEST

C-8 TEST OBSERVATIONS

| Sl. No. | Observations | Measurement No. |
|---------|---|------------------------|
| i) | Depth of furrow (cm) | 1 2 4 5.....10 Average |
| ii) | Width of furrow (cm) | |
| iii) | Time taken to traverse 30 m length in seconds | |
| iv) | Draft in (kgf) | |
| v) | Output per day of 8 hours (hectare) | |
| vi) | Weed count before ploughing | |
| vii) | Weed count after ploughing | |
| viii) | Penetrometer readings (cm) | |
| ix) | Weight of share before test (g) | |
| x) | Weight of share after test (g) | |

C-9 SPEED OF PLOUGHING

C-10 UNIT DRAFT (KGF/CM²)

C-11 HORSE POWER REQUIREMENT

C-12 THEORETICAL FIELD CAPACITY

C-13 FIELD EFFICIENCY

C-14 SOIL INVERSION, PERCENT

C-15 PULVERIZATION

C-16 PERFORMANCE INDEX

C-17 WEARING OF SHARE (G) AFTER COMPLETING THE TEST

C-18 SCOURING

- C-19 BALANCE OF PLOUGH**
- C-20 CLOGGING OF THROAT**
- C-21 UNIFORMITY OF FURROW**
- C-22 DETAILS OF DEFORMATIONS AND BREAK-DOWN**
- C-23 ANY OTHER REMARKS**

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ANNEX D
(Clause 12)
SUMMARY REPORT

- D-1 TRADE NAME AND MODEL OF PLOUGH**
- D-2 TYPE OF SAMPLE - PROTOTYPE/PRODUCTION MODEL**
- D-3 NAME AND ADDRESS OF APPLICANT**
- D-4 DATES AND DURATION OF TEST**
- D-5 TYPE OF SOIL**
- D-6 WIDTH OF FURROW**
- D-7 DEPTH OF FURROW**
- D-8 OUTPUT PER DAY OF 8 HOURS**
- D-9 DRAFT**
- D-10 HORSE POWER REQUIREMENT**
- D-11 EASE OF OPERATION**
- D-12 ALIGNMENTS**
- D-13 WORKMANSHIP AND RIGIDITY**
- D-14 INTERCHANGEABILITY OF FAST WEARING COMPONENTS**
- D-15 TOOLS AND ACCESSORIES, IF ANY, SUPPLIED BY THE APPLICANTS**
- D-16 GENERAL REMARKS**

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