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BUREAU OF INDIAN STANDARDS

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भारतीय मानक मसौदा

ट्रैक्टर संचालित लेसर लेवलर — परीक्षण कोड एवं चुनिंदा कार्यकारिताएं एवं मापदण्ड के लिए अनुशंसाएं

Draft ***Indian Standard***

TRACTOR DRAWN LASER LAND LEVELLER — TEST CODE, AND RECOMMENDATIONS ON SELECTED PERFORMANCE CHARACTERISTICS

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ICS 65.060.20

Agricultural Machinery and Equipment Sectional Committee, FAD 11

Last date for Comments: **30 September 2024**

FOREWORD

(*Formal clause will be added later*)

The unevenness of soil surface can significantly affect crop growth, as it leads to uneven distribution of water and soil moisture, resulting in poor germination, weak crop stand, and low yield. Hence, land levelling is a crucial step towards achieving effective soil and crop management practices. In intensively cultivated irrigated areas, flood basin and check basin irrigation systems are commonly used, but they can cause water logging in low-lying areas and water scarcity in higher areas, especially if the land is not levelled.

Laser land levelling is one such important technology which uses laser-guided equipment to level the farm fields accurately, thus ensuring uniform distribution of water across the field, reducing water loss due to uneven terrain and resulting in improved crop yield. Moreover, laser land leveling provides a smoother surface for farm machinery to operate on, reducing fuel consumption and wear and tear on equipment. This, in turn, leads to cost savings and improved efficiency in the use of non-water inputs. It has also been observed that with laser land levelling, 2-3% increase of effective cropped area in case of flat fields and even more in ridge sown fields become available for cultivation of crops, as the number of bunds and irrigation channels get reduced considerably.

There is substantial demand for laser land levellers among farmers which has led to increased production of these machines in the country. Nowadays, a number of manufacturers are producing laser land levellers and many manufacturers are importing as well . To ensure the quality of these levellers, the standard is being brought out. This standard would serve as a tool to test and establish the performance of tractor-drawn laser land levellers.

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***

TRACTOR DRAWN LASER LAND LEVELLER — TEST CODE, AND RECOMMENDATIONS ON SELECTED PERFORMANCE CHARACTERISTICS

1 SCOPE

1.1 This standard covers

a) terminologies, requirements and method of testing for tractor drawn laser leveller in respect of performance of operation and soundness of construction;
b) assessment of the evaluative requirements applicable for qualifying minimum performance criteria of the laser land leveller.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions 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 listed below. In case the standards are to be referred in this clause, they are to be listed as follows:

IS No.	*Title*
IS 14624 (Part 2) : 2012/ IEC 60825-2:2005	Safety of laser products — Part 2: Safety of optical fibre communication systems (OFCS) (*first revision*)
IS 14963 :2001/ ISO 11554 : 1998	Optics and optical instruments — Lasers and laser related equipment — Test method for laser beam power, energy and temporal characteristics
IS/ISO 11145 : 1994	Optics and optical instruments — Lasers and laser related equipment — Vocabulary and symbols
IS 4905 :2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
IS 1586 : 2018/ISO 6508-1 : 2016	Metallic materials — Rockwell hardness test: Part 1 Test method (*fifth revision*)
IS 2609 : 1972	Specification for coach bolts (*first revision*)
IS 2062 : 2011	Hot rolled medium and high tensile structural steel — Specification (*seventh revision*)
IS 2004 : 1991	Carbon steel forgings for general engineering purposes — Specification (*third revision*)

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 (*first revision*)

3 TERMINOLOGY

3.1 Laser Land Levelling

Laser levelling is a process of smoothening the land surface (± 2 cm) by using laser equipped drag buckets to achieve precision in land levelling (Fig. 1). Precision land levelling involves converting the fields in such a way as to create a regular slope. In this technique, large horsepower tractors are utilized that are equipped with global positioning systems (GPS) and/or laser-guided instrumentation so that the soil can be moved either by cutting or filling to create the desired slope/level.

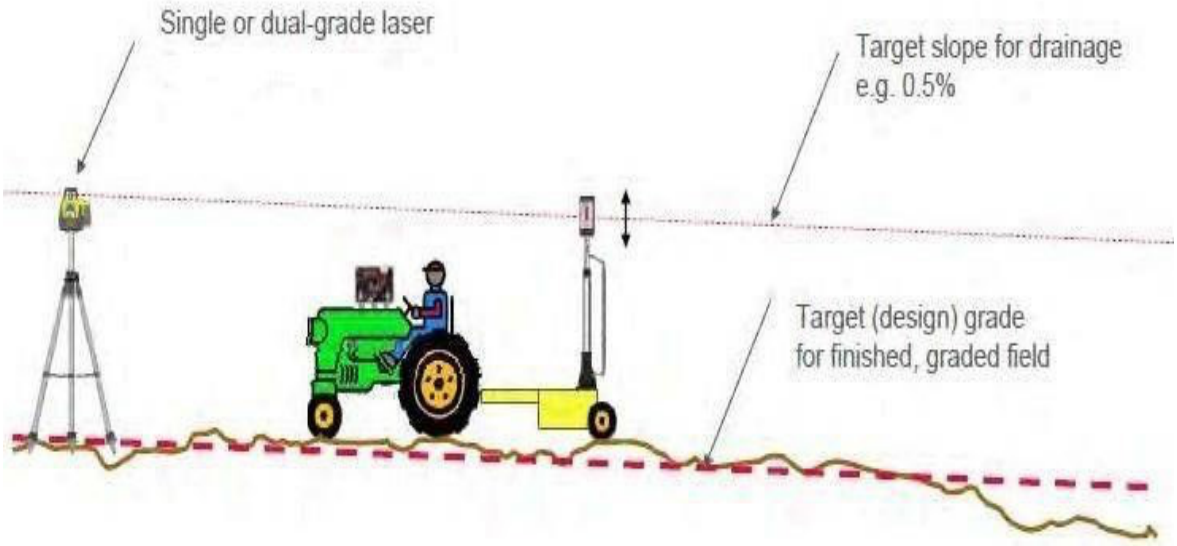


FIG. 1 LASER LAND LEVELLING

A laser-controlled land levelling system consists of the following five major components (see Fig. 2):

a) Drag Scrapper/bucket (*see* Fig. 3)

The drag scrapper/bucket is generally pulled by a tractor. This system is preferred as it is easier to connect the tractor's hydraulic system to an external hydraulic system. The hydraulic line of laser leveller is connected as: Supply line of leveller is connected to supply line of tractor pump and return line of leveller is directly connected to the oil sump of the tractor. Typical bucket/scraper dimensions should match with the requirements of tractors as given in Table 1.

NOTE — Return Line should be free flow without any interruption.

Table 1 Bucket Dimensions

[*Clause* 3.1.1 (a)]

Tractor Size Range (hp)	Scraper Width Range (m)
30-50	1.5 - 2.0
50-100	2.0 - 3.0
100-125	3.0 - 3.5
125-150	3.5 - 4.0
> 150	4.0 - 5.5

b) Laser transmitter

The laser transmitter is mounted on a tripod, which allows the laser beam to sweep above the field. (*see* Fig. 4)

c) Laser receiver

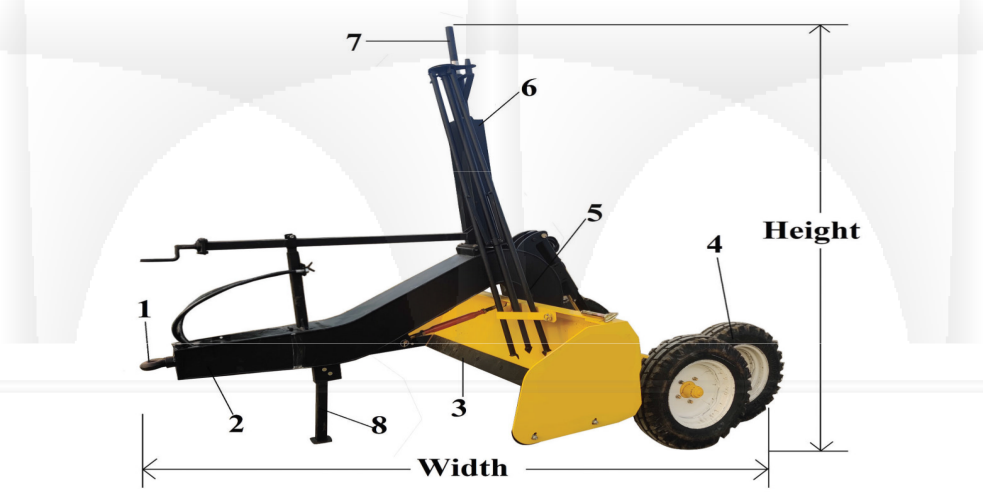
A multi-directional receiver that detects the position of the laser reference plane and transmits this signal to the control box. The operator should adjust the settings on the receiver, and should override the receiver when he/she wants to pick up a bucket full of soil and transport it to another section of the field. (*see* Fig. 4)

d) Control box

The control box accepts and processes signals sent by receiver. It displays these signals to indicate the drag buckets position relative to the finished grade. When the control box is set to automatic, it provides electrical output for driving the hydraulic valve. (*see* Fig. 4)

e) Hydraulic system

The hydraulic system of the tractor is used to supply oil to raise and lower the levelling bucket.



1 Toe hook	2 Beam	3 Blade
4 Tyre axle system	5 Tripod	6 Mast
7 Receiver column	8 Parking stand	

FIG. 2 LASER LEVELLER COMPONENTS

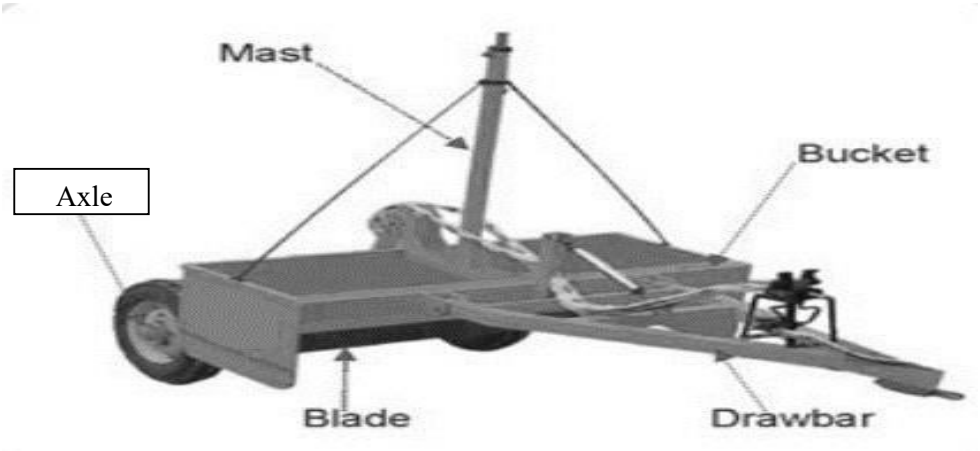


FIG. 3 LASER LEVELLER ATTACHMENT

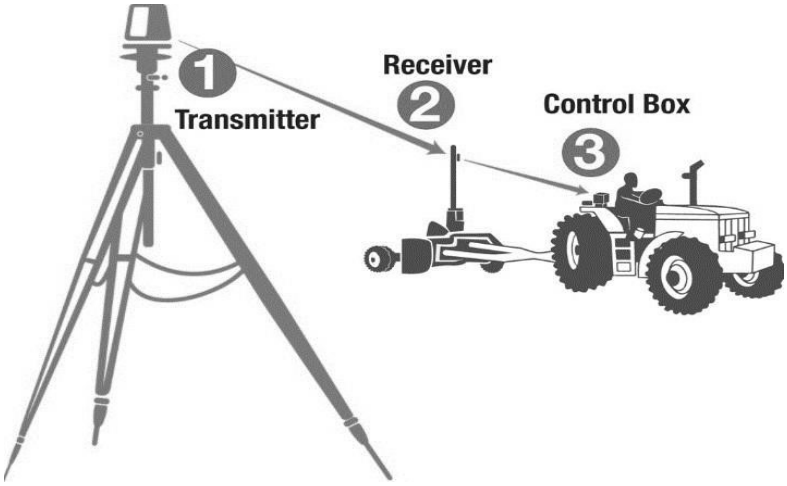


FIG. 4 LASER LEVELLER WORKING

3.2 Laser Power Sensor (*see* Fig 5)

Laser power sensor is a detector that absorbs a laser beam and outputs a signal proportional to the beam's power, usually calibrated with a defined accuracy to a specified standard and used as the input of a laser power meter. The type of sensor to be used depends on various details of the laser beam being measured, including power level, spectral region, beam size, and others.

FIG. 5 LASER POWER SENSOR

3.3 Effective Width of Cut — Length of cutting blade in lateral plane which cuts the soil during levelling operation.

3.4 Maximum Depth of Cut — Vertical distance between the level surface (ground reference plane) and lowest position of blade below ground reference plane.

3.5 Working Length of Laser Leveller — Longitudinal distance between two extreme points measured in horizontal plane of the machine while it is in field operation mode.

3.6 Working Width of Laser Leveller — Lateral distance between two extreme points measured in horizontal plane of the machine while it is in field operation mode.

3.7 Working Height of Laser Leveller — Vertical distance between the ground to the topmost point of the machine while it is in field operation mode.

3.8 Evaluative Requirements — Requirements under this category are the ones which are mandatory for acceptance of the Laser Leveller for the purpose of subsidies and financing.

3.9 Non-Evaluative Requirements — Requirements under this category are the ones which are not mandatory for acceptance of the Laser Leveller for the purpose of subsidies and financing. However, the authorized testing agency shall observe the performance for these requirements and record in the test report.

4 MATERIAL REQUIREMENTS

4.1 Soil Cutting Blades

The blade shall be made of high carbon steel [*see* IS 1570 (Part 2/Sec 1)] or boron steel or any other steel of superior quality.

4.1.1 The chemical composition of the high carbon steel and boron steel shall be as follows:

Sl. No.	**Material**	**Requirement (Carbon Steel) (Percent)**	**Requirement (Boron Steel) (Percent)**
(1)	(2)	(3)	(4)
1	Carbon (C)	0.6 to 0.9	0.6 to 0.9
2	Silicon (Si)	0.1 to 0.3	0.1 to 0.3
3	Manganese (Mn)	0.5 to 0.85	0.5 to 0.85
4	Sulphur (S)	0.05, *Max*	0.05, *Max*
5	Phosphorous (P)	0.04	0.04
6.	Boron (B)	-	0.003 to 0.008

4.1.2 Some typical examples of grades of high carbon steel that may be used are 45C8 [see IS 1570 (Part 2/Sec 1)] or EN8.

4.1.3 Some typical examples of grades of boron steels that may be used are 27/28MnCrB_5.

4.2 The materials of construction of various others components of laser leveller shall be as given in Table 2.

Table 2 Material for Different Components of Laser Leveller Blade

(*Clause* 4.2)

Sl. No.	Components	Material (Requirements)	Referred IS
(1)	(2)	(3)	(4)
1	Frame	Mild steel	IS 2062
2	Strut hitch	Mild Steel	IS 2062
3	Hitch pin	Carbon steel	IS 2004
4	Pin adjusting screw	Carbon steel	IS 2004
5	Mould board frame	Mild steel	IS 2062
6	Side plate	Mild Steel	IS 2062
7	Mould board	Mild steel	IS 2004

5 HARDNESS

The soil cutting blade shall be heat treated to have a hardness in the range of 45 to 60 HRC when tested as per IS 1586 (Part 1).

6 SIZE OF BLADE

The size of laser leveller blade shall be determined by length of blade plus the length of extension blade if any, in meters. The nominal size of blade should be between 1.5 to 2.5 m.

7 CONSTRUCTIONAL REQUIREMENTS

7.1 Frame

The frame shall be capable of sustaining a pull of 9.8 N per mm of blade width without permanent deflection or change in shape. The point of application of pull shall be at mid-point of cutting blade.

7.2 Soil Cutting Blade

The blade of the laser leveller shall conform to the following requirements:

7.2.1 The blade shall be bevelled. The length of bevelling should be 10 mm (*min*). The thickness of the edge shall be as far as possible uniform and should be between 1.5 to 3 mm.

7.2.2 The bevelling shall be done on lower side of the blade. Both the rear and front sides of the blade may be bevelled to make it reversible.

7.2.3 The corners of the square holes shall be slightly rounded.

7.2.4 The holes of the blade shall be provided with counter-sunk bolt of 10 mm size. As far as possible, the bolts should conform to grade M10 of IS 2609. The bolt head should flush with the blade surface.

7.2.5 The blade shall be free from cracks and should be reasonably free from flaws, such as seams, scales and pits.

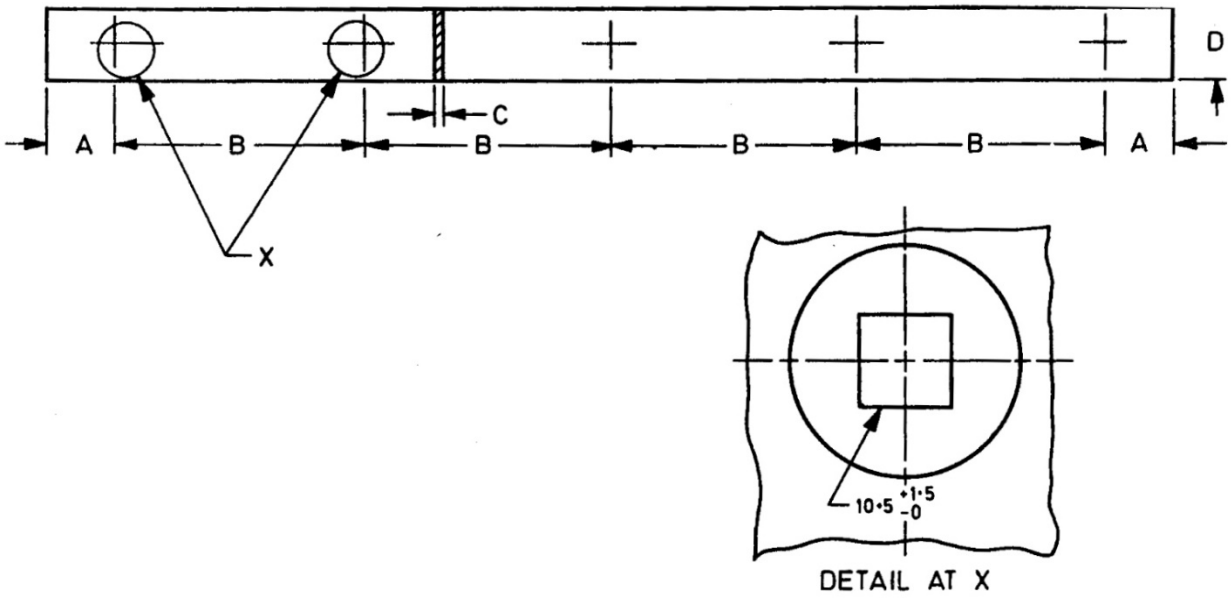
7.2.6 The blade shall be free from rust and shall have protective coating which will prevent surface deterioration in transit and storage.

7.2.7 *Dimensions*

Fixing position, A and B, thickness C and width D shall be as given in Fig. 6.

7.2.8 Hardware fitted on the blade and on the face of the mould board (portion coming in direct contact with soil) should not protrude above the surface and should be 8.8 grade quality.

7.2.9 The blade and mould board should have a contour such that it allows the free rolling of earth. The curvature of mould board with blade shall be 300 or 375 mm with a tolerance of ± 20 mm (*see* Fig. 7)



$A = 75.00 \pm 0.25;\ B = 275.00 \pm 0.25;\ C = 8, min;\ D = 90, min$

All dimensions in millimetres.

FIG. 6 BLADE FOR LASER LAND LEVELLER

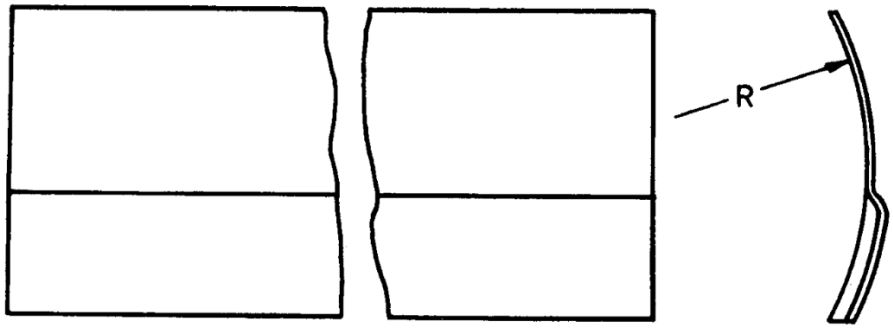


FIG. 7 MOULD BOARD AND BLADE

8 ACCEPTANCE CRITERIA FOR PERFORMANCE CHARACTERISTICS

The product may be accepted for performance after confirming compliance to all evaluative requirements. Performance characteristics of laser leveller, along with the tolerances for the declared values, and in certain cases minimum / maximum values are given in Table 3.

8.1 Maximum Laser Range

Manufacturer should declare the maximum range of laser transmitter, which will then be tested as per the declaration. If found less (even after allowing tolerance of ± 5 percent), then non-conformity should be reported.

8.2 Dead Band

Manufacturer should declare the dead band of laser at 100 meters. (i.e. accuracy of laser at 100 meter).

Table 3 Parameters Applicable for Qualifying Minimum Performance Criteria
(*Clause* 8)

Sl No.	Parameters	Nature of test (Evaluative/Non-Evaluative)	Requirements	Whether Meets the Requirement (Yes/No.)
(1)	(2)	(3)	(4)	(5)
1	Power Source	Non-Evaluative	Tractor 35 hp and above	Yes/No
Laser Transmitter				
2	Laser Source Wattage, mW, Max	Evaluative	5.0	Yes/No
3	Laser Source Range, nm	Evaluative	630 to 680	Yes/No
4	Laser Class	Evaluative	3A/3R	Yes/No
5	Operating Temperature, ^{o}C	Evaluative	– 20 to + 70	Yes/No
6	Compensation Method	Evaluative	Electronic Self Levelling through Steeper Motor	Yes/No
7	Rotation Speed, rpm, Min	Evaluative	600	Yes/No
8	Level Accuracy, mm/30m, Min	Evaluative	1.5	Yes/No
9	Operating Diameter, m	Evaluative	600 - 800	Yes/No

10	Level Indicator	Evaluative	LED Flash	Yes/No
11	Power Supply	Evaluative	Internal and External DC Battery with Charger	Yes/No
12	Enclosure	Evaluative	Rugged with minimum one-meter drop height on concrete	Yes/No
Laser Receiver				
13	Laser Beam Reception	Evaluative	360°	Yes/No
14	Vertical Reception Window, mm	Evaluative	Four Laser Reception windows of 210 to 230 each	Yes/No
15	Dead Band, mm	Evaluative	10 to 15	Yes/No
16	LED Display	Evaluative	Red = Hi/Low, On Grade = Green/ Yelow/Red	Yes/No
17	Operating Temperature º C	Evaluative	-20 to + 70	Yes/No
18	Operating Range, m	Evaluative	300 to 400 (Radius)	Yes/No
19	Laser RPM	Evaluative	600/1200	Yes/No
20	Enclosure	Evaluative	Rugged, Rust Proof, Casted Aluminum alloy or any other alloy	Yes/No
Control Box				
21	On Grade LED's	Evaluative	Green	Yes/No
22	High/Low LED's	Evaluative	Red	Yes/No
23	Operating Voltage	Evaluative	10 to 30 VDC, Polarity protected	Yes/No
24	Operating Temperature, º C	Evaluative	- 20 to + 70	Yes/No
25	Electrical Connections	Evaluative	All Standard Military Type	Yes/No

26	Valve Compatibility	Evaluative	Proportional Type (on/off) only	Yes/No
27	Current Usage, Amp(A)	Evaluative	5 to 10	Yes/No
28	Switch Options	Evaluative	Raise / Lower, Auto Manual	Yes/No
29	Enclosure Type	Evaluative	Rugged, Rust Proof, Casted Aluminum alloy or any other alloy	Yes/No
30	Cables	Evaluative	Set of Cables with Military Connectors	Yes/No
31	Accessories	Evaluative	Survey scale, Survey Receiver	Yes/No
Bucket Scrapper				
32	Working Width, mm	Evaluative	1500 to 2500	Yes/No
33	Bucket Depth, mm, Min	Evaluative	600	Yes/No
34	Material	Evaluative	MS Sheet, B2062 /EN10130	Yes/No
35	Sheet Thickness, mm	Evaluative	10	Yes/No
36	Blade Height, mm	Evaluative	125 ± 5	Yes/No
37	Blade Thickness, mm	Evaluative	12 ± 0.5	Yes/No
38	Blade Material	Evaluative	High carbon steel, Boron steel or above	Yes/No
39	No of Tyres	Evaluative	2/4 (6×16)	Yes/No
40	Mast	Evaluative	Rigid Mast/ Gear Mast/ Electric Mast	Yes/No
41	Hydraulic Cylinder	Evaluative	Automatic Double Acting Hydraulic Cylinder	Yes/No
42	Hydraulic Valve	Evaluative	Automatic Double Acting Hydraulic Valve assemble with pressure relive valve	Yes/No

43	Accessories	Evaluative	Set of High-Pressure Hoses, Firm Stand /Tripod, Top Link	
44	Marking/labeling of machine	Evaluative	The labeling plate should be riveted on the body of machine having name & address of manufacturer, country of origin, make, model, year of manufacture, serial number, wt in kg, tractor kW/hp.	Yes/No
45	Literature	Evaluative	Operator manual, service manual & parts catalogue should be provided	Yes/No

9 SAMPLING AND GENERAL REQUIREMENTS

9.1 Specification Sheet

The applicant/manufacturer shall supply the specification sheet of the laser leveller consisting of the items listed in the specimen report given in Annex A as well as additional data (if any) required to carry out the tests. The manufacturer shall also supply literature consisting of operational and maintenance manual, service manual and parts catalogue with the laser leveller. The literature can be in Hind or English.

9.2 Selection of Sample

The laser leveller shall either be selected at random (*see* IS 4905) from the production lot by the testing institute for commercial tests or shall be submitted by the applicant/manufacturer to the testing authority for confidential tests or as the case may be. The laser leveller selected or submitted for test shall be complete with its usual accessories and in a condition generally offered for sale. The laser leveller shall be new and shall not be given any special treatment or preparation for test.

9.3 Assembling and Preliminary Adjustments

It shall be the responsibility of the applicant/manufacturer to ascertain that Laser Leveller selected for testing is complete in all respects and necessary adjustments have been carried out in the presence of the representative of the testing institute.

9.4 Conditions for Checking of Dimensions

9.4.1 The laser leveller shall be standing on a firm, level and horizontal surface.

9.4.2 The laser leveller shall be stationary with its wheels and components in positions they would be, as if the Laser Leveller was travelling in a straight line.

9.4.3 The pressure in pneumatic tyres shall be adjusted to the value recommended by the applicant/ manufacturer for field work. The tyres shall be new. The measurement of height of lugs shall be made at the centre line of tyres.

9.4.4 Measurement conditions for various dimensions and characteristics as stipulated above shall be followed.

10 TESTS

The following laboratory and field tests shall be conducted on the laser leveller.

10.1 Laboratory Tests

10.1.1 *Laser Land Leveller Specification and Requirement Check*

10.1.1.1 The specification of the Laser leveller supplied by the manufacturer/applicant as given in Annex A shall be checked and reported.

10.1.1.2 The hardness of the soil cutting blade is determined as per **5** and shall be reported as in Annex B.

10.1.1.3 The material of soil cutting blades is analysed as per **4.1** and shall be reported as in Annex B.

10.1.1.4 The material for different components of laser leveller is analysed as per **4.2** and shall be reported as in Annex B.

10.1.1.5 The other constructional requirements for of the laser leveller shall be analysed as per **5** and shall be reported as in Annex B.

10.1.2 *Laser Calibration Check*

10.1.2.1 *Calibration for laser transmitter (Laser Power)*

In order to match up the stated laser power to the actual power, the laser transmitter must be calibrated. Calibration of the laser Leveller shall be checked against the specified power limits with the help of calibration devices (Laser Thermal Power sensor). It shall be within the tolerance limits specified by the applicant/manufacturer.

Laser Thermal Power Sensor having suitable configuration (e.g. power range, beam width etc.) shall be used for testing the laser transmitter. Laser beam shall be passed through the aperture and average reading (watts) of three measurements shall be reported. As an e*xample*, if a laser beam is supposed to deliver an

output of 100W power with 0.1% tolerance, then measurements may be taken at various power levels and draw a two-column chart: one for the laser setting and one for the actual output power. Laser power shall be reported and should be the same as declared by the applicant.

10.1.2.2 *Laser focus calibration*

10.1.2.2.1 Set the tripod up so that it is approximately 50 m from a fixed object such as a wall or utility pole. Take the Carpenter's level, and, using the tripod legs, level the head of the tripod as carefully as possible. If the tripod head has been properly levelled, it will be possible to rotate the laser 360° on the tripod with minimal re-levelling.

10.1.2.2.2 Attach the laser to the tripod and power the instrument on. Self-levelling lasers will automatically level upon being turned on. Manual levelling lasers can be levelled with the screws on the laser base. Grade lasers should be set to 0.00%.

10.1.2.2.3 Rotate the laser so that the front is pointed at the target. Turn the laser on, then go to the target with the detector and remove the clamp. When the detector gives the on grade signal, make a mark on the target using the detector's marking notch. Label this mark +Y.

10.1.2.2.4 Rotate the laser 180° so that the back side of the laser is pointed at the target. Make sure that the laser is at still level. Make a level mark with the detector and label this mark -Y. The midpoint between the -Y and +Y marks is true level. If the specified accuracy of the laser is less than the width between the two lines, this axis is out of adjustment and needs corrective action.

10.1.2.2.5 Rotate the laser 90º so the third side of the instrument is pointed at the target. Make sure that the laser is at still level. Make a level mark with the detector and label this mark +X. Rotate the laser 180° so that the opposite side of the laser is pointed at the target. Make sure that the laser is still level. Make a level mark with the detector and label this mark -X. The mid-point between the -X and +X marks is true level. If the specified accuracy of the laser is less than the width between the two lines, this axis is out of adjustment and needs corrective action.

10.1.3 *Lab Test For Laser Emitter and Receiver*

a) Measurement of strength of laser beam
b) Vibration test for laser emitter and receiver
c) Temperature gradient test (55 ± 5) °C
d) Endurance test for laser emitter and receiver
e) Leakage test for seal and joints in hydraulic circuit (60 ± 5) °C
f) Water resistance test for laser emitter and receiver unit.

10.1.3.1 *Measurement of strength of laser beam*

Strength of the laser beam shall be measured as per IS 14963 [Strength shall be expressed in mW and it should be within the safe limit described in IS 14624 (Part 2)].

Laser thermal power sensor having suitable configuration (e.g. power range, beam width etc.) shall be used to measure strength of laser. Laser beam shall be passed through the aperture and average reading (watts) of three measurements shall be reported. Measurements can be made using standard beam profile measurement and diagnosis systems. The laser beam can be scanned with a probe containing a rotating pinhole, which is used to couple-out a small part of the radiation in the focus region and direct it to a detector. The positions of the scanning traces are movable in 'Y' and 'Z' directions, so it is possible to measure one plane of the beam within a few minutes. This can be repeated at different positions from the focusing head to establish the full profile of the beam showing the waist and depth of focus, etc.

The following beam parameters can be measured accurately by measuring the laser power density distribution in the focus region:

a) Focus radius
b) Position of the focal plane in space
c) Spatial power density distribution
d) Beam propagation ratio M_2 (laser beam quality)

With different detectors and special measuring tips it is possible to detect a highly divergent beam as generated by high power diode lasers.

The approximate beam focus position can be determined by running a series of beam print tests on a flat, anodized aluminium sheet (or photographic paper) at various focus positions, or by conducting beam swiping on a tilted anodized aluminium sheet.

10.1.3.2 *Vibration test for laser emitter and receiver*

Mount the emitter unit on a vibrator test bench, capable of generating various vibration frequencies. Conduct the test for 60 minutes at a vibration frequency of 18-20 per min observed during the transport of laser unit under field transport condition.

The accuracy and repeatability across 'X' and 'Y' axis of rotating emitter shall be observed by calibration of unit before and after the vibration test.

Result shall be recorded as given in Annex C (**C-1** and **C-2)**.

10.1.3.3 *Temperature gradient test*

The laser emitter unit shall be kept in a controlled environment chamber. Laser emitter unit shall be operated in field work configuration as recommended (e.g. Laser emitter unit rotational RPM which is maintained at field condition) by the manufacturer. Temperature and relative humidity shall be maintained 55 ± 5 °C and 15% respectively. Test shall be conducted continuously for 2 hours to assess the performance of laser emitter by measuring the deviation of laser beam in 'X' and 'Y' axis per 100 feet of length which should not exceed the value declared by the manufacturer in 'X' and 'Y' direction.
The details of the calibration before and after the test shall be reported as given in Annex C (**C-3)** and performance parameter under temperature gradient shall be recorded as given in Annex C (**C-4** and **C-5)**.

10.1.3.4 *Endurance test for Receiver, Emitter and Control box*

Park the machine on a level ground. If the control box has the options of Auto and Manual mode, the test shall be conducted in two steps each of 500 cycles in auto and manual mode. If the control box has only one mode, the test shall be conducted for 1000 cycles in the same mode. PTO speed (RPM) / Engine speed shall be maintained corresponding to the field operation. Temperature of the hydraulic fluid shall be maintained 60±5 °C. Observation shall be reported as given in Annex C **(C-6)**.

10.1.3.5 *Leakage test for seal and joints in hydraulic circuit*

The hydraulic system of Leveller shall be locked for 180 seconds to its Maximum Achievable working pressure declared by applicant. Temperature of the hydraulic fluid shall be maintained at 60±5 °C. There should not be any pressure drop (due to any internal or external leakage) during the locking period.

10.1.3.6 *Water resistance test*

The water resistance test shall be conducted under water shower sprayed through a spray nozzle (solid cone type nozzle) connected with a water pump capable of producing working pressure of 2 kg/cm^2 to 4 kg/cm^2. The discharge of the water shall be maintained at (1 ± 0.25) l/min. Wind velocity shall not be more than 3 m/s and atmosphere temperature should be 27 ± 7 °C while conducting the test. The Laser emitter shall be kept in working position for 30 minutes, as well as in inverted position for 30 minutes. Visual observation shall be taken after test and shall be reported. There shall not be any sign of mist or water droplet/vapour on prism glass of emitter or other electronic components which may affect the functionality of emitter.

10.2 Field Test

Field test shall be conducted for at least for 25 hours. Machine shall be adjusted as recommended by applicant/manufacturer. Data may be recorded as per Annex D.

10.2.1 *Test Field Condition*

Field/test plot shall be prepared for conducting test by some suitable means (e.g. After harvesting the crop use straw reaper to cut the left over residues followed up by ploughing, tandem-harrowing, running cultivator and planking). Field shall be free from crop residue like stubbles, plant roots and thick stems. There shall not be stones, soil clods or any pits in the field.

There should not be any object (e.g. tree, electrical pole etc.) which creates obstacle for laser communication between emitter and receiver.

Average moisture content of the field shall not be more than 10% or shall be maintained in the field/test plot so that the levelling operation shall perform smoothly.

10.2.2 *Output of the Machine*

Levelling operation shall be conducted at the speed recommended by applicant. Wheel slippage during the operation shall not be more than 7 percent and should be minimized during testing.

Average slope of land shall be measured before levelling operation and after operation. Following parameters shall be recorded:

a) Average depth of cut,
b) Effective working width or width of cut,
c) Area covered and field efficiency – The Leveller should be operated for continuous 5 hours and the area covered during the period shall be measured in hectare. Calculate the average output per hour.
d) Fuel consumption (l/h)
e) Coefficient of variation of levelling after levelling can be calculated with data recorded as Annex D.

On the basis of the width of cut and speed, theoretical field capacity (*TFC*) should be calculated by following formula:

$$TFC\ (hectare/h) = \frac{width\ of\ cut\ in\ m \times Speed\ in\ m/sec}{10\,000} \times 3600$$

And field efficiency should be calculated as follows:

$$Field\ Efficiency\ (percent) = \frac{Effective\ field\ capacity}{Theoritical\ field\ capacity} \times 100$$

11 WORKMANSHIP AND FINISH

11.1 All components of laser leveller blade shall be free from pits, burrs and other visual defects.

11.2 The welding of various parts shall be free from blow holes, exposed porosity, exposed inclusion unfilled crate and unfused weld.

11.3 The exposed metallic parts shall be free from rust and shall have a protective coating.

12 MARKING AND PACKING

12.1 Marking

Each laser leveller shall be marked with following particulars:

a) Manufacture's name and trade-mark, if any;
b) Size; and
c) Batch or code number.

These particulars shall be stamped, embossed or engraved on metallic plate and rigidly fitted on a non-wearing part of blade.

12.2 Marking of Laser Product

Laser product shall have labelling and marking as per section **4.6** of IS 14624 (Part 2)

ANNEX A
SPECIFICATIONS OF LASER LEVELLER
(*Clause* 9.1 *and* 10.1.1.1)

Sl No.	Specification		Observation
(1)	(2)		(3)
A-1	**GENERAL**	**:**	
	Type of machine	**:**	
	Name of Implement	**:**	
	Make	**:**	
	Model	**:**	
	Manufactured by (Name and address)	**:**	
	Test requested by (Name and address)	**:**	
	Year of manufacture	**:**	
	Serial number	**:**	
	Tractor horsepower recommended, hp	**:**	
	Type of blade	**:**	
	Working width of implement, mm	**:**	
	Country of origin - For Scraper blade - For laser equipment	**:**	
	Max. deflection/accuracy for laser unit per 30 m of length of laser beam, mm	**:**	
A-2	**PRIME MOVER INFORMATION**	**:**	
	Tractor	**:**	
	Engine No.	**:**	
	Chassis No.	**:**	
	Max. PTO power, kW	**:**	
	Engine/ PTO speed recommended for field	**:**	
A-3	**CHASSIS OF LEVELLER**	**:**	
	Type	**:**	
	Size of M.S. beam at front, mm - Length	**:**	

	- Cross section Size of M.S. beam at rear, mm - Length - Cross section		
	Type of mounting of beam section	:	
A-4	**SIDE SUPPORT PLATES**	:	
	Type	:	
	Thickness of plate, mm	:	
	Method of fixing	:	
A-5	**BLADE**	:	
	Type of material	:	
	Method of fixing	:	
	Dimensions, mm (*see* Fig. 6) - A - B - C - D	:	
	Provision of bevel	:	
	Provision for adjusting tilt angle	:	
	Provision for raising mould board and transport mechanism	:	
A-6	**SOIL CARRYING MOULD BOARD**	:	
	Type	:	
	Thickness of plate, mm	:	
	Size of plate, mm	:	
	Method of mounting	:	
A-7	**TOEING MECHANISM**	:	
	Type and material	:	
A-7.1	**Toe Beam**	:	
	Type	:	
	Size, mm	:	
	Size of arm beam, mm	:	

	Method of fixing	:	
A-7.2	**Specification of Toe Hook** - Type - Diameter of hole, mm - Thickness of plate, mm - Length of plate, mm - Distance of centre of hole from front, mm	:	
A-8	**RECEIVER MOUNTING UNIT**	:	
A-9	**RECEIVER COLUMN**	:	
	Type and Material	:	
	Size, mm - Length - Diameter	:	
	Adjustable length of the shaft, mm	:	
	Method of height adjustment and depth control	:	
	Details of DC Motor - Type - Make - Model - Serial Number	:	
A-10	**Mast**		
	Type	:	
	Size of duct, mm	:	
A-11	**TRANSPORT MECHANISM**		
	Type	:	
	Size of square beam, mm	:	
	Size of cross support beam, mm	:	
	Method of fixing of channel axle	:	
A-11.1	**Wheel Axle Shaft**		
	Size of solid shaft, mm - Length - Inner side diameter - Outer side diameter	:	
	Size of threaded portion, mm - Length	:	

	- Diameter		
	Size of shaft flange, mm - Thickness - Diameter	:	
	Method of fixing		
A-11.2	**Transport Wheel**		
	Type	:	
	Make and size	:	
	Numbers	:	
	Method of arrangement	:	
A-12	**ELECTRONIC EQUIPMENT**		
A-12.1	**Control Panel (Box)**		
	Make	:	
	Model	:	
	Serial number /identification number	:	
A-12.2	**Transmitter**		
	Make		
	Model		
	Serial number /identification number		
A-12.3	**Receiver**		
	Make	:	
	Model	:	
	Serial number /identification number	:	
A-12.4	**Hydraulic Directional Valve Unit**		
	Make	:	
	Model	:	
	Max operating pressure, kg/cm^2	:	
	Max operating pressure recommended for field test, kg/cm^2	:	
	Operating pressure during field test, kg/cm^2	:	

	Operating pressure during idle running, kg/cm^2	:	
	Serial number/ Identification number		
A-12.5	**Battery**		
	Make	:	
	Type	:	
	Capacity	:	
A-13	**OVERALL DIMENSIONS, mm** (*see* Fig. 1)	:	Sole unit during operation
	Length	:	
	Width	:	
	Height	:	
A-14	**MASS, kg**	:	
A-15	**ACCESSORIES**	:	
A-15.1	**Tripod**	:	
A-15.2	**Connective Wires**	:	
A-15.3	**Laser Leveler Stand**	:	
A-15.4	**Labelling Plate Information**	:	

ANNEX B

DATASHEET FOR MATERIAL AND CONSTRUCTIONAL REQUIRMENTS

(*Clause* 10.1.1.2, 10.1.1.3, 10.1.1.4 and 10.1.1.5)

B-1 CHEMICAL COMPOSITION OF SOIL CUTTING BLADE

Material used_____

Sl No.	Material	Requirement (Carbon Steel) (*see* Clause 4.1)	Requirement (Boron Steel) (*see* Clause 4.1)	Composition as observed (Percent of weight)	Remark
(1)	(2)	(3)	(4)	(5)	(6)
1	Carbon (C)				
2	Silicon (Si)				
3	Manganese (Mn)				
4	Sulphur (S)				
5	Phosphorous (P)				
6.	Boron (B)				

B-2 HARDNESS OF SOIL CUTTING BLADE

Component	Hardness Requirement (*see* Clause 5)	Hardness as observed (HB/HRC)	Remark
(1)	(2)	(3)	(4)
Soil Cutting Blade			

B-3 MATERIAL REQUIREMENT FOR VARIOUS OTHER COMPONENTS OF LASER LEVELLER

Sl No.	Components	Material (Requirements)	Observation (Yes/No)
(1)	(2)	(3)	(4)
1	Frame	Mild steel	
2	Strut hitch	Mild Steel	
3	Hitch pin	Carbon steel	
4	Pin adjusting screw	Carbon steel	
5	Mould board frame	Mild steel	

6	Side plate	Mild Steel
7	Mould board	Mild steel

B-4 CONSTRUCTIONAL REQUIREMENTS FOR OF THE LASER LEVELLER

Sl No.	Requirements	Observation	Conformity (Yes/No)
(1)	(2)	(3)	(4)
i)	The size of laser leveller blade shall be determined by length of blade plus the length of extension blade if any, in meters. The nominal size of blade may be between 1.5 to 2.5 meter.		
ii)	The blade shall be bevelled. The length of bevelling should be 10 mm. The thickness of the edge shall be as far as possible uniform and may be between 1.5 to 3 mm.		
iii)	The bevelling shall be done on lower side of the blade. Both the rear and front sides of the blade may be bevelled to make it reversible.		
iv)	The corners of the square holes shall be slightly rounded.		
v)	The holes of the blade shall be provided with counter-sunk bolt of 10 mm size. As far as possible, the bolts should conform to grade M10 of IS 2609. The bolt head should flush with the blade surface.		
vi)	The blade shall be free from cracks and should be reasonably free from flaws, such as seams, scales and pits.		
vii)	The blade shall be free from rust and shall have protective coating which will prevent surface deterioration in transit and storage.		
viii)	Fixing position A and B, thickness C and width D shall be as given in Fig. 6.		
ix)	Hardware fitted on the blade and on the face of the mould board (portion coming in direct contact with soil) should not protrude above the surface and should be 8.8 grade quality.		

x)	The blade and mould board should have a contour such that it allows the free rolling of earth. The curvature of mould board with blade shall be 300 or 375 mm with a tolerance of ± 20 mm (*see* Fig. 7)		

ANNEX C
LAB TESTS FOR LASER RECEIVER AND TRANSMITTER

(*Clause* 12.1.3.2, 12.1.3.3 and 12.1.3.4)

C-1 PERFORMANCE OF LASER EMITTER AFTER VIBRATION TEST

Sl No.	Particular	Observations	Remarks
(1)	(2)	(3)	(4)
1	Date of Test		
2	Make and Model of the Test Sample		
3	Normal Ambient Temperature, °C		
4	Time of Start/Stop		
5	Vibration Frequency, µ		
6	Rotational Speed of Emitter, rpm		
7	Self-Levelling Accuracy (Deflection per 30 m of length), mm - At axis X - At axis Y - At axis X, Y Repeatability, % - At X-axis - At Y-axis		

C- 2 DATA SHEET FOR DEFLECTION OF LASER BEAM AFTER FIELD AND VIBRATION TEST (mm)

					Self-levelling accuracy/ deflection /30 m length		
Sl No	**At X-axis**	**At X1 - axis**	**At Y- axis**	**At Y1 - axis**	**At X- axis (X-X1)/2**	**At Y- axis (Y-Y1)/2**	**X-Y**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1							
2							
3							
4							
5							
6	Self-levelling accuracy (Deflection per meter length), mm At axis X At axis Y At axis X, Y Repeatability, % At axis X At axis Y						

C-3 CALIBRATION ON LASER BEAM

Data Sheet for Deflection of Laser Beam before field test (mm)							
					Self-levelling accuracy/ deflection /30 m length		
Sl No.	**At X-axis**	**At X1 - axis**	**At Y- axis**	**At Y1 - axis**	**At X- axis (X-X1)/2**	**At Y- axis (Y-Y1)/2**	**X-Y**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1							
2							
3							
4							
5							
	Self-levelling accuracy (Deflection per meter length), mm At axis X At axis Y At axis X, Y Repeatability, % At axis X At axis Y						
Data Sheet for Deflection of Laser Beam after field test (mm)							

Sl No.	At X-axis	At X1-axis	At Y- axis	At Y1 axis	At X- axis (X-X1)/2	At Y- axis (YY1)/2	X-Y
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1							
2							
3							
4							
5							
6	Self-levelling accuracy (Deflection per meter length), mm At axis X At axis Y At axis X, Y Repeatability, % At axis X At axis Y						

C- 4 PERFORMANCE OF LASER EMITTER AFTER TEMPERATURE GRADIENT TEST

Sl No.	Particular	Observations	Remarks
(1)	(2)	(3)	(4)
1	Date of Test		
2	Make and model of the test sample		
3	Normal ambient temperature, °C		
4	Time of start/ Stop		
5	Time to reach 55°C, Min.		
6	Rotational speed of emitter, rpm		
7	Self-levelling accuracy (Deflection per 30 m of length), mm - At axis X - At axis Y - At axis X, Y Repeatability, % - At X-axis - At Y-axis		

C- 5 DATA SHEET FOR DEFLECTION OF LASER BEAM AFTER TEMPERATURE GRADIENT TEST (mm)

					Self-levelling accuracy/ deflection /30 m length		
Sl No.	**At X-axis**	**At X1 - axis**	**At Y- axis**	**At Y1 - axis**	**At X- axis (X-X1)/2**	**At Y- axis (Y-Y1)/2**	**X-Y**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1							
2							
3							
4							
5							
6	Self-levelling accuracy (Deflection per meter length), mm - At axis X - At axis Y - At axis X, Y Repeatability, % - At axis X - At axis Y						

C-6 ENDURANCE TEST

Sl No.	**No. of Cycles**	**Temperature of hydraulic fluid after every 100 cycles**	**Remark**
(1)	(2)	(3)	(4)
1	100		
2	200		
3	300		
4	400		
5	500		
Manual Mode			
1	100		
2	200		
3	300		
4	400		
5	500		

Observations:		
Hydraulic oil leakage from any point		
Working of hydraulic system		
Abnormality, if any		

ANNEX D

(*Clause* 10.2 and 10.2.2)

D-1 OBSERVATION SHEET FOR FIELD PERFORMANCE

Type of soil:

Place of test:

Tractor used:

Gear used:

S.No.	**Particulars**	**Test No. 1**	**Test No. 2**	**Test No. 3**	**Test No. 4**	**Test No. 5**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Date of Test					
2	Duration of test					
3	Size of test Plot (l x b), m^2					
4	Soil moisture, %					
5	Bulk density of soil, g/cc Before operation After operation					
6	Average depth of cut, mm					
7	Average working width, m					
8	Speed of operation, kmph					
9	Wheel slippage, % (may vary with depth of cut of blade)					
10	Area covered, l/h & l/ha					
11	Draft requirement, kg					
12	Drawbar horsepower, kW					
13	Range diameter of laser beam, m					

15	Land slope before operation, %	
	Lengthwise	
	Widthwise	
16	Land slope after operation, %	
	Lengthwise	
	Widthwise	
17	Blade bucket capacity, kg (approx.)	
18	Coefficient of variation of levelling after levelling	
19	Evenness in levelling, %	

D-2 VARIATION IN LASER EMITTER AFTER FIELD OPERATION

(*Clause* 12.2.1)

Sl No.	Parameters	Observations at normal field setting	Remarks
(1)	(2)	(3)	(4)
1	Rotational speed of the emitter, rpm		
Before field operation			
2	Self-levelling accuracy (Deflection per meter length), mm		
	At axis X		
	At axis Y		
	At axis X, Y		
	Repeatability, %		
	At axis X		
	At axis Y		
After field operation			
3	Self-Levelling Accuracy (Deflection per meter length), mm		
	At axis X		
	At axis Y		
	At axis X, Y		
	Repeatability, %		
	At X-axis		
	At Y-axis		