# འབྲུག་མོག་བཟོའི་ཞ་རྩི་གནས་པོ་གི་པི་སིའི་གནས་ཚད།

# BHUTAN STANDARD

**Black lead paper-cased pencil**

**ICS 97.180**



**_____, 2020** **Price group C**

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## FOREWORD

This Bhutan Standard for Black lead paper-cased pencil was adopted by Bhutan Standards Bureau after the draft finalized by the Sustainability and Environment Technical Committee TC 10 and approved by the Bhutan Standards Bureau Board (BSB Board) on Day Month 2020.

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 : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard

This standard is subject to systematic review after five years to keep pace with the market trends, industrial and technological developments. Any suggestions and further information may be directed to the concerned Technical Committee.

# འབྲུག་མོག་བཟོའི་ཞ་རྩི་གནས་པོ་གི་པི་སེའི་གནས་ཚད།

## BHUTAN STANDARD FOR BLACK LEAD PAPER-CASED PENCIL

## 1 Scope

This Bhutan Standard prescribes the requirement for black lead and paper cased pencils, herein referred to as 'pencil'.

This Bhutan Standard applies to paper roll type of circular cross-section and any other type of pencils is not within this scope of the standard.

## 2 Normative references

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

ISO 8124-3:2010 *Migration of certain elements*

EN 717-3:1996 *Wood based panels - Determination of formaldehyde release - Part 3: Formaldehyde release by the flask method.*

## 3 Terms and definition

For the purposes of this standard, the following terms and definitions shall apply;

### 3.1 Black lead

Solid writing material which consists of carbon (e.g. graphite) and a binding agent. The lead generates black lines which are erasable. Herein referred to as 'lead'.

### 3.2 Black lead paper-cased pencil

A pencil in which the black lead is bonded to a paper casing.

### 3.3 Defects

Defects involve anything that hinders the strength of the pencil. E.g. cracking, extraneous matter.

### 3.4 Hardness degree

Classification indicating increasing hardness from 6B to 6H and increasing line density from 6H to 6B.

*Note - A scientific definition of hardness degree is not yet available.*

## 4 Classification

**4.1** Lead shall be classified according to their hardness degree into the following 13 types;

6H, 5H, 4H, 3H, 2H, H, HB, B, 2B, 3B, 4B, 5B and 6B

*Note – B denotes softness and blackness of pencil and H denotes hardness of pencil.*

## 5 General requirements

### 5.1 Lead

**5.1.1** The lead shall be in one piece, of uniform grading, free from grittiness so as to produce smooth, even and uniform writing.

**5.1.2** It shall be sufficiently strong to withstand sharpening by a standard pencil sharpener and shall not break on mending or writing.

**5.1.3** The lead shall be firmly bonded to paper without gaps.

## 5.2 Paper casing

**5.2.1** The casing shall be made of paper and coated by non-toxic material.

**5.2.2** When sharpened with a standard pencil sharpener, the paper shall take a smooth and even finish.

**5.2.3** The casing shall enclose the lead in a neat, secure manner, in such a way that the lead is centered and enclosed at one end.

**5.2.4** The surface of the paper casing shall be smooth and even, without defects.

# 6 Lead diameters

**6.1** Lead diameters shall be as specified in *table 1*.

**Table 1 – Lead diameters**

| Sl. No. | Hardness degree | Diameter (mm) |
|---|---|---|
| 1 | 6H,5H,4H,3H,2H, H | ≥ 1.8 |
| 2 | HB,B,2B,3B,4B,5B,6B | > 2 |

# 7 Shape and dimension.

## 7.1 Shape

The pencils shall be circular in cross-section.

## 7.2 Dimension

**7.2.1** The length of pencils shall be 175.0 ± 5.0 mm

**7.2.2** The diameter of pencils shall be 7.2 to 9.0 mm

# 8 Sampling

**8.1** A sample(s) for testing may be taken by the purchaser or his representative, or by any person appointed to superintend the work for the purpose of which the pencil is required or by latter's representative. The required number of sample pencils shall be taken from every lot /consignment of 1000 pencils or part thereof from the same grade, colour of casing, size and same batch of manufacture.

**8.2** The required number of pencils shall be taken at regular intervals during the loading of the vehicle or the unloading of the vehicle depending on whether sample is to be taken before delivery or after delivery. When this is not practicable, the sample shall be taken from the stack in which case the required number of pencils shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top.

## 8.3 Tests

**8.3.1** The sample(s) of pencils for test shall be taken as described in *clause 8* and shall be tested in manner described in relevant clauses.

## 9 Criteria for conformity

**9.1** The lot shall be considered as not conforming to the requirements of the specification if it does not conform to any of the requirements of this specification.

## 10 Tests

### 10.1 Uniformity of lead

**10.1.1** This test is intended to check the continuity of lead and their uniformity of manufacture. The electrical resistance of the lead shall be measured with any suitable instrument. The coefficient of variation of the resistance, when calculated by taking a class range of 5 Ohms, shall not exceed 20 percent. The method of calculation is given in *Annex A.*

### 10.2 Transverse strength of lead

**10.2.1** When tested by the method described in *Annex B*, the transverse strength of the lead, other than pencil of hardness degree 4H, 5H and 6H, shall not be less than 2.05 kg.

**10.2.2** In the case of pencil hardness degree 4H, 5H and 6H, the strength of the lead shall not be less than 2.95 kg.

### 10.3 Dimension

#### 10.3.1 Diameter of lead

The diameter shall be measured with an instrument capable of measuring to an accuracy of 0.01 mm. Measure 3 points with equal distance on lead and take the average value as the final result.

#### 10.3.2 Diameter of pencil

The diameter of pencil shall be measured with a vernier caliper capable of measuring to an accuracy of 0.02mm. Measure 3 points with equal distance on pencil and take the average value as the final result.

#### 10.3.3 Length of pencil

The length of the pencil shall be measured with a ruler of accuracy not less than 0.5mm or with a vernier caliper of accuracy not less than 0.02mm.

### 10.4 Wear of lead

**10.4.1** When tested by the method prescribed in *Annex C*, the wear of the lead shall be as specified in *table 2.*

**Table 2 – Wear of lead**

| Sl. No. | Grade of pencil | **Wear of lead,** *Max.* (mm/line) |
|---|---|---|
| 1 | 6H, 5H and 4H | 0.4 |
| 2 | 3H, 2H, H and HB | 0.5 |
| 3 | B, 2B, 3B, 4B, 5B and 6B | 0.6 |

## 10.5 Friction of lead

**10.5.1** When determined by the method specified in *Annex D*, the friction of the lead shall not be more than 0.20.

## 10.6 Blackness of pencil marking

**10.6.1** When tested by method described in *Annex E,* the blackness as measured from the reflectance values of the markings for the different hardness degree shall be as specified in *table 3.*

**Table 3 – Blackness of pencil marking**

| Sl. No. | Hardness degree | Blackness Index (Percent reflectance) |
|---|---|---|
| 1 | 6H | 77±1 |
| 2 | 5H | 75±1 |
| 3 | 4H | 74±1 |
| 4 | 3H | 73±1 |
| 5 | 2H | 71±1 |
| 6 | H | 69±1 |
| 7 | HB | 68±1 |
| 8 | B | 66±1 |
| 9 | 2B | 65±1 |
| 10 | 3B | 63±1 |
| 11 | 4B | 62±1 |
| 12 | 5B | 60±1 |
| 13 | 6B | 59±1 |

## 10.7 Chemical inertness of pencil marking

When a paper marked with pencil lines is dipped in hydrogen peroxide, it shall not be affected by the latter.

## 10.8 Slide of the lead

The pencil shall be so mended that about 3 mm of the lead protrudes out of the casing. The other end of the pencil shall show the lead end clearly and no lacquer or paint shall be present on the end. A load of 50 Newton shall be applied vertically on the casing while the protruding end of the lead rests on a glass sheet with the pencil in vertical position. The lead shall not slide in the pencil casing.

## 10.9 Rod core broken

**10.9.1** When tested by method described in *Annex F*, the rod core broken shall be as given in *table 4.*

**Table 4 – Rod core broken**

| Sl. No. | Hardness Degree | Rod core broken (Point or Number) |
|---|---|---|
| 1 | 6B ~ 5B | ≤ 3 |
| 2 | 4B | ≤ 2 |
| 3 | 3B | ≤ 2 |
| 4 | 2B | ≤ 1 |
| 5 | B | ≤ 1 |
| 6 | HB | 0 |
| 7 | H ~ 6H | 0 |

## 10.10 Off centre

The deviation of the lead from the centre shall not be more than 0.3mm.The method of calculation is given in *Annex G*.

## 10.11 Pencil casing strength

When tested by the method described in *Annex H*, the strength of the pencil casing shall not be less than 50 Newton.

## 10.12 Pencil coating

There shall be no peeling or cracking of the coating when tested by the method given in *Annex I.*

## 10.13 Binding strength of pencil

Immerse the test pencil in the water at 30°C ± 2°C for 1 h; then, take it out; use both hands to twist the two ends of the pencil in reverse; observe that the pencil shall not be unglued and delamination shall not occur.

## 10.14 Formaldehyde release

Formaldehyde release shall not be more than 80mg/kg when tested by the test given in EN 717－3.

## 10.15 Migratable element

The requirements are based on the bioavailability of certain elements resulting from the use of toys and should not, as an objective, exceed the following levels per day as described in ISO 8124-3: 2010 *Migration of certain elements.*

## 11 Packaging and labelling

**11.1** Each pencil shall be labelled with:

a) The name or trade-mark of the manufacturer or the supplier,

b) Hardness degree, and

c) Other indications which may be specified by the purchaser.

**11.2** Ten pencils of the same grade and type shall be packed in a 'fit for purpose' with adequate barrier and strength to withstand handling and storage. Each such box shall be marked to indicate the name or trade-mark of the manufacturer, type, grade of pencils and quantity contained therein, and shall be clear and free of incompleteness.

# Annex A

(Normative)

## Uniformity of lead

## A.1 Procedure

**A.1.1** For this test, 100 pencils selected at random from a given lot shall be taken. The ends of the pencils shall be cleaned with sand paper and the electrical resistance of each lead shall be measured with a multi-range ohmmeter. The values of the resistance obtained shall be recorded. From the values obtained, the arithmetical mean value of the resistance and the coefficient of variation could be calculated. The method described here for the calculation of the arithmetical mean and the coefficient of variation would result in considerable saving in labour, as compared to their computation from individual measurements.

**A.1.2** In this method, the pencils shall be grouped in different classes according to the values of the resistance obtained. The width of the class (*W*) shall be taken as 5 ohms. The mid-value of each class is called the class mark. In Table A.1, the class range, and the class marks are given in col 1 and 2, respectively. Col 3 gives frequency (*f*) or the number of pencils falling in each class.

**Table A.1 - Calculation of Standard Deviation and Coefficient of Variation**

| Class Range ohms | Class Marks *W* | No. of Pencils *f* | Class Distance *d* | Moment *f* x *d* | 2nd Moment *f* x $d^2$ |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| Below 5.0 | 2.5 | 0 | -3 | 0 | 0 |
| 5.1-10.0 | 7.5 | 2 | -2 | -4 | 8 |
| 10.1-15.0 | 12.5 | 10 | -1 | -10 | 10 |
| 15.1-20.0 | 17.5 | 70 | 0 | -14 | 0 |
| 20.1-25.0 | 22.5 | 13 | 1 | +13 | 13 |
| 25.1-30.0 | 27.5 | 5 | 2 | +10 | 20 |
| 30.1-35.0 | 32.5 | 0 | 3 | 0 | 0 |
| | | | | +23 | |
| | | | | +9 | 51 |

**A.1.3** The method of computation involves the assumption that the members grouped in each class actually were at the mid-point of their class. This assumption may not be strictly correct, but the individual discrepancies usually balance out, so that the net error is unimportant in practice.

**A.1.4** Provisional mean (*r*) of the resistance values could be judged by inspection of the distribution of pencils falling in different class ranges. It is seen from Table 1 that 70 percent of the pencils fall in

the class range having the class marks of 17.5 ohms and hence the provisional mean value may be taken as 17.5 ohms.

**A.1.5** Take the class range giving the provisional mean as the origin. Classes having higher resistances may be marked + (positive) and those having lower resistance may be marked - (negative). The distances (*d*) of each class from the origin are indicated in col 4. The moments *(f* x *d)* about the origin are given in col 5. Col 6 gives the second moments *(f* x $d^2$). The average resistance (*R*) is given by:

$$R = \text{Provisional Resistance}(\ r\ ) + \left\{\frac{\sum(f \times d)}{f} \times W\right\} \text{ ohms}$$

$$= 17.5 + \frac{9}{100} \times 5 = 17.95 \text{ ohms}$$

The standard deviation ( σ ) is given by:

$$\sigma = W\left\{\frac{\sum f.d^2}{\sum f} - \left(\frac{\sum f.d}{\sum f}\right)^2\right\}^{\frac{1}{2}}$$

$$= 5\left\{\frac{51}{100} - \left(\frac{9}{100}\right)^2\right\}^{\frac{1}{2}} = 5 \times \frac{70.8}{100} = 3.540$$

$$\text{Coefficient of Variation, Percent} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100 = \frac{3.54}{17.95} \times 100 = 19.7$$

# Annex B

(Normative)

## Determination of transverse strength of pencil lead

### B.1 Apparatus

**B.1.1** The apparatus for this test consists of an arrangement *(see* Fig B. 1) to load the pencil lead gradually. The lead is supported on two smooth knife edges, 12.7 mm apart, and loaded in the centre.

### B.2 Procedure

**B.2.1** The balancing load *L* shall be so positioned that it balances the container *C*. The lead under test shall then be placed on the knife edges perpendicular to them. Lead shots shall be added gradually to the container *C*, till the lead breaks. Four times the weight of the lead shots which the lead under test was able to bear gives the value of the strength of the lead.

*Note- As the diameters of the pencils vary from one grade to another and from one manufacturer to another, the fibre stress ( f ) which gives the strength of the lead independent of the diameter may be calculated with the formula given below*:

$$f = \frac{M}{I} \times h$$

Where

$I$ = moment of inertia of the area of cross-section about the neutral axis,

$M$= bending moment, and

$h$= distance of the farthest fibre from the neutral axis

And

$$M = \frac{Wt \times l}{4} = \frac{Wt \times 1.27}{4}$$

Where

$Wt$ = load in g at which the lead break,

$l$ = distance between the knife edges.

For leads of circular cross-section

$$I = \frac{\pi d^4}{64}$$

Where

d= diameter of the leads in cm, and

$$h = \frac{d}{2}$$

For leads of rectangular cross-section

$$I = \frac{br^3}{12}$$

Where

b= breadth

t= thickness of the lead, and

$$h = \frac{t}{2}$$

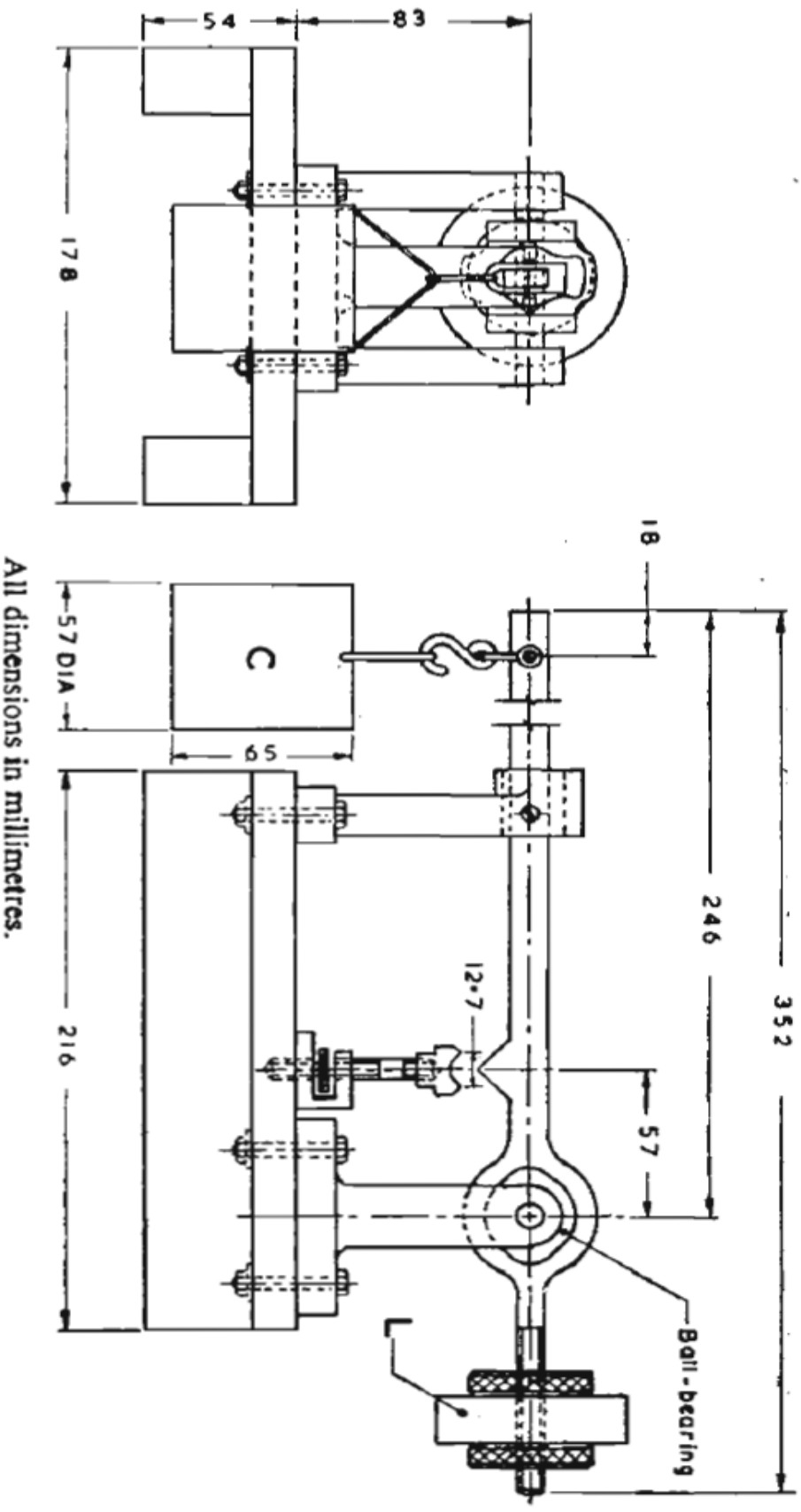



Fig B. 1 - Transverse Test Machine

# Annex C

(Normative)

## Determination of wear of lead

### C.1 Apparatus

**C.1.1** The apparatus for this test consists of a travelling microscope body or any other convenient arrangement, where the microscope is replaced by a pencil holder (see Fig C. 1). A 3/0 Grade sand paper shall be fixed on the flat top surface of a wooden or any other suitable platform with the help of clips. The platform shall be fixed either to the table or to the travelling microscope body with a suitable arrangement. The load on the pencil, including the weight of the holder, shall be 575± 3 g.

**C.1.2** The pencil lead holder (see Fig C. 2) shall have markings from 0 to 80 mm. The socket in which the holder moves shall have 40 markings, each at a distance of 39/40 mm. A groove shall be made in the holder and a screw fixed in the socket, so that the holder does not rotate in the socket but moves only in vertical direction.

### C.2 Procedure

**C.2.1** The lead under test shall be cut square to its length and a piece of suitable length shall be fixed in the holder. In the case of carpenter's pencil lead, it shall be so fixed that the lines are drawn in the direction of the maximum cross-section of the lead. The holder shall then be slid into its socket and the weight placed on it. A few lines shall be marked on a separate sand paper placed on the platform to make the writing end of the lead flat. The holder shall then be taken to the extreme position and the reading noted down. A line, 12 cm long, shall then be drawn slowly. By shifting the holder by 1.5 mm, another line shall be drawn in the opposite direction. In this way, after drawing four lines, the holder shall be taken to the starting position and the reading of the holder shall be noted down. The difference in the two readings shall give the wear of the pencil for four lines, each 12 cm long. Four more lines shall be drawn and the mean of the two values shall give the wear of the pencil lead.

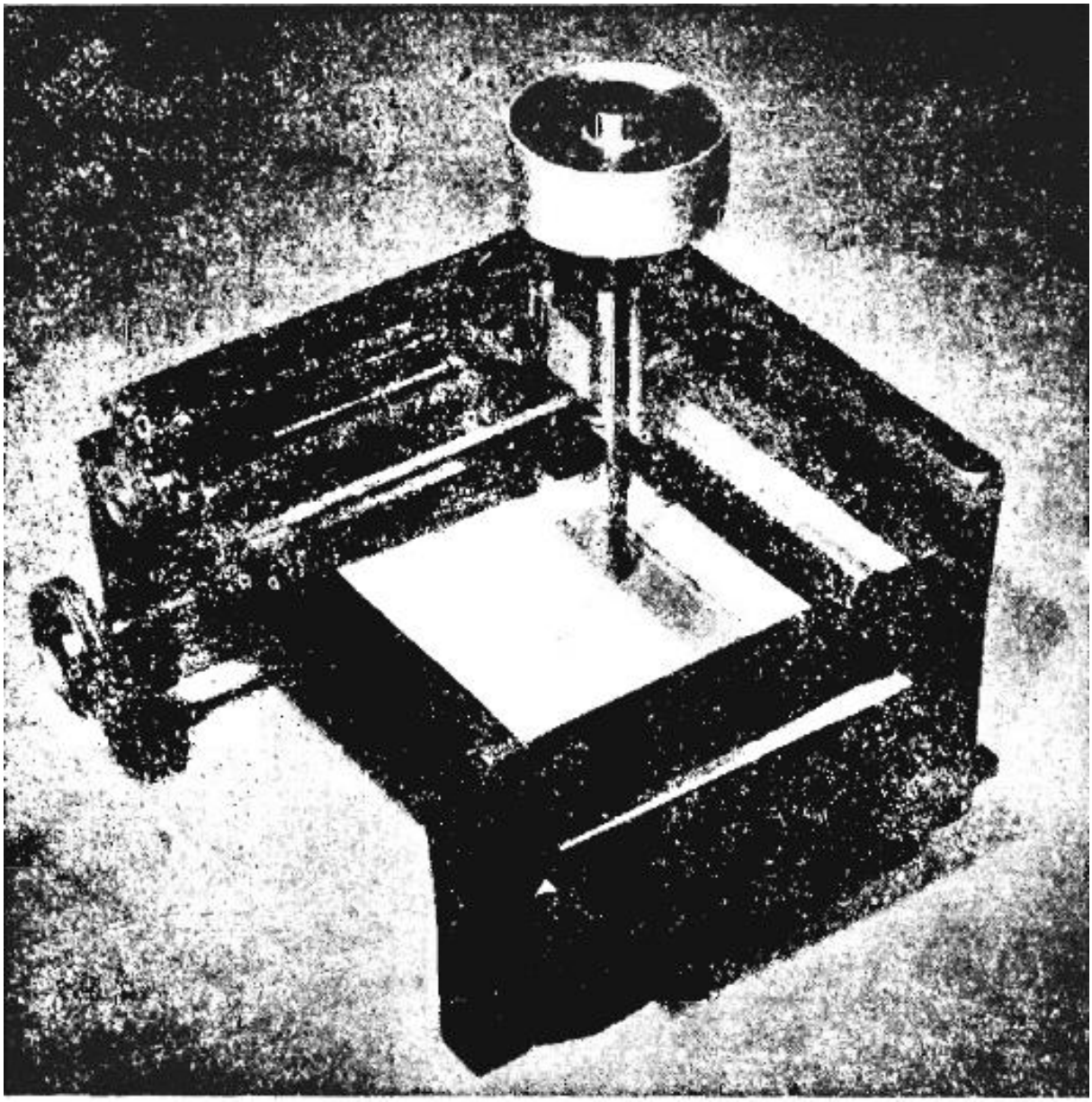
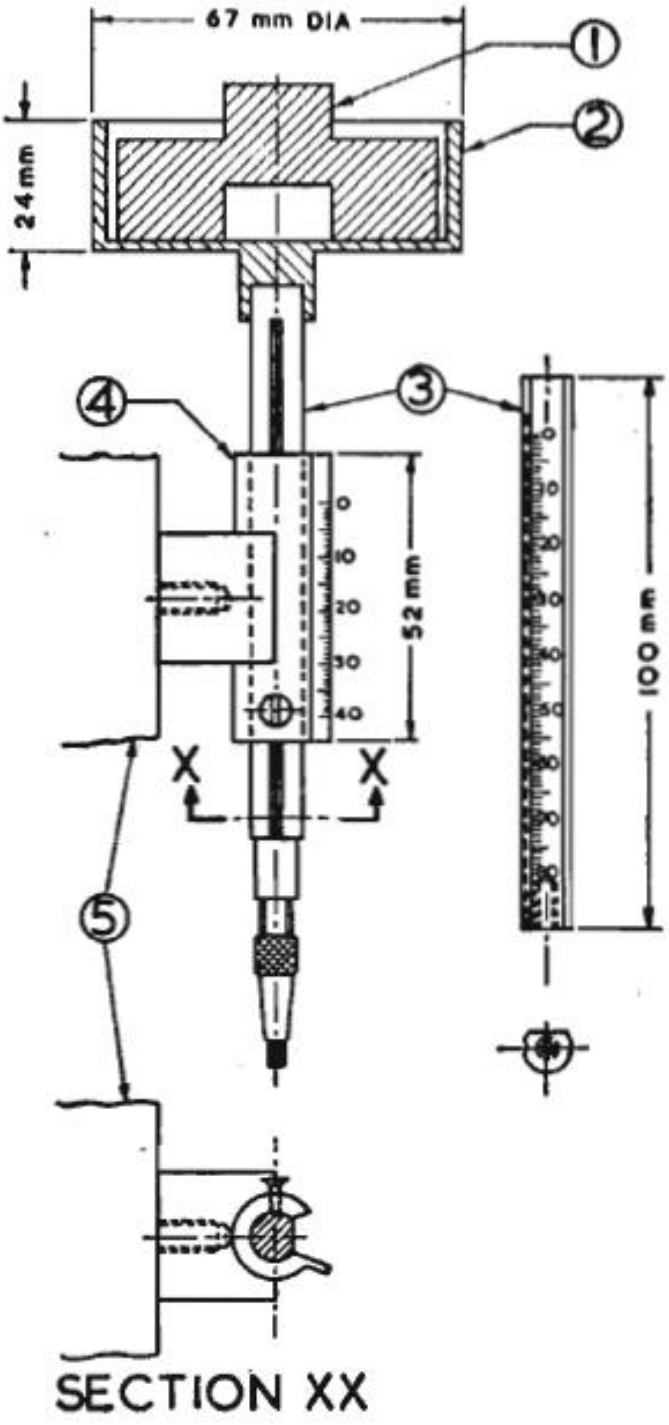


**Fig C. 1 - Apparatus for Determining Wearing of Pencil lead**




Legend :

1. Weight 2. Container 3. Slip Holder 4. Vernier 5. Travelling microscope body.

**Fig C. 2 - lead Holder Assembly**

# Annex D

(Normative)

## Determination of friction of lead

### D.1 Apparatus

**D.1.1** The apparatus for carrying out this test shall consist of a trolley, 635 mm long and 127 mm wide (see Fig D. 1). A Whatman drawing paper of the size of the trolley shall be fixed on it. The trolley shall move on two rails, 122 cm long, at a speed of about 69 mm per second. The trolley shall be connected by means of a string to the rotating pulley of an electric motor.

**D.1.2** Three pencil holders shall be fixed to a triangular stand such that the distance between any two pencil holders as also the height of the strand shall be 50.8 mm. the total weight, including the weight of the holders and stand on the three pencil leads, shall be 640±3 g. The load shall be distributed equally on the three leads.

**D.1.3** A string shall be attached to the pencil stand and the other end connected to a pointer and weight arrangement, so that the force experienced by the stand is measured. The pointer readings shall be calibrated as follows:

The distance between the wooden stand and the torque meter should be kept constant. The thread connecting the pencil stand and the lower end of the pointer shall be disconnected and replaced by a longer thread which can pass over both the pulleys and through a hole in the wooden stand. Weights shall be attached to this end of the thread and the pointer readings shall be noted down, a graph of the pointer readings and the weight is drawn and may be used to convert the pointer readings to weight in grams.

### D.2 Procedure

**D.2.1** Three pieces from the same lead shall be cut square to their length and fixed in the holders. The upper surface of the stand shall be horizontal and 50.8 mm from the ends of the leads.

**D.2.2** The Whatman paper shall be fixed to the top of the trolley and the trolley shall be kept on the extreme position on the rails towards the pointer scale. The pencil stand shall be kept on the other end of the paper. The trolley shall then be pulled. The pencil stand will be dragged along with the trolley due to friction. This frictional force shall be balanced by the pointer and weight arrangement.

The coefficient of friction shall be calculated as:

$$\mu = \frac{A}{B}$$

where

$\mu$ = Coefficient of friction

$A$ = friction force, and

$B$ = total load on the pencil lead

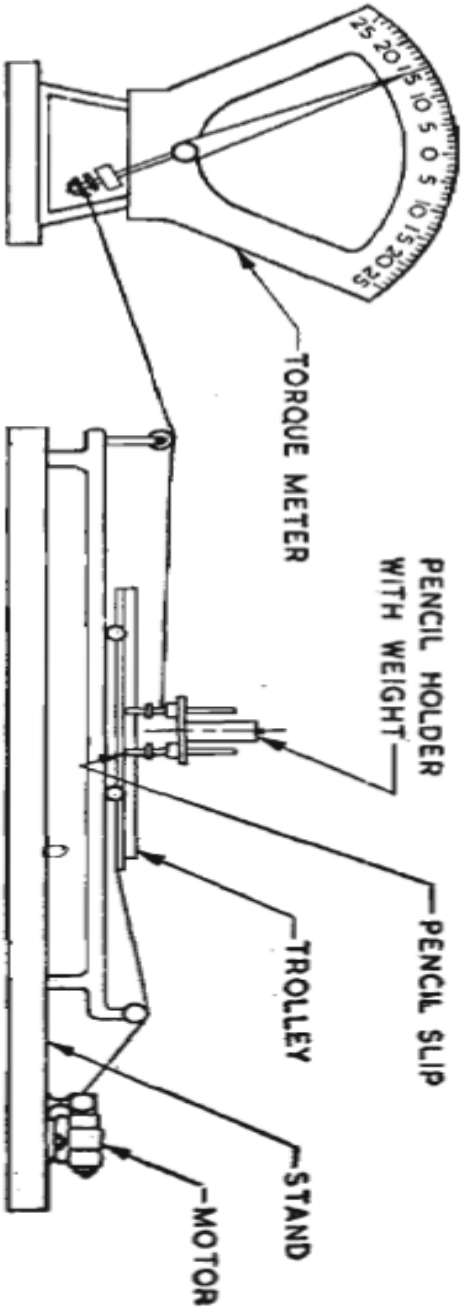



Fig D. 1 - Apparatus for Measurement of Pencil Friction

# Annex E

(Normative)

## Determination of blackness of pencil marking

### E.1 Apparatus

**E.1.1 Marking of Pencil Lines**- The apparatus shall be similar to the one used in Annex C. Instead of the sand paper, a Whatman drawing paper shall be used. The reflectance value of this paper shall be 79±2.

**E.1.2 Measurement of Blackness of Pencil Markings**- The apparatus shall consist of a box where light shall be incident on the pencil marking at an angle of 45° and the reflected light in a direction perpendicular to the markings shall be received by a photocell which shall be connected to a sensitive galvanometer *(*see Fig E. 1). The box shall be painted from inside with a white paint giving a matt surface. To the output of the photocell and in series with the circuit, a suitable opposing electromotive force shall be applied by using a dry cell and variable resistance, so that the difference in the reflectance values shall be magnified by appropriately controlling the sensitivity of the galvanometer ( by using a shunt). The reflectance values shall be in the scale of zero reflectance for a perfectly black flat surface and 100 percent reflectance for a perfectly white flat surface ($MgCO_3$ block).

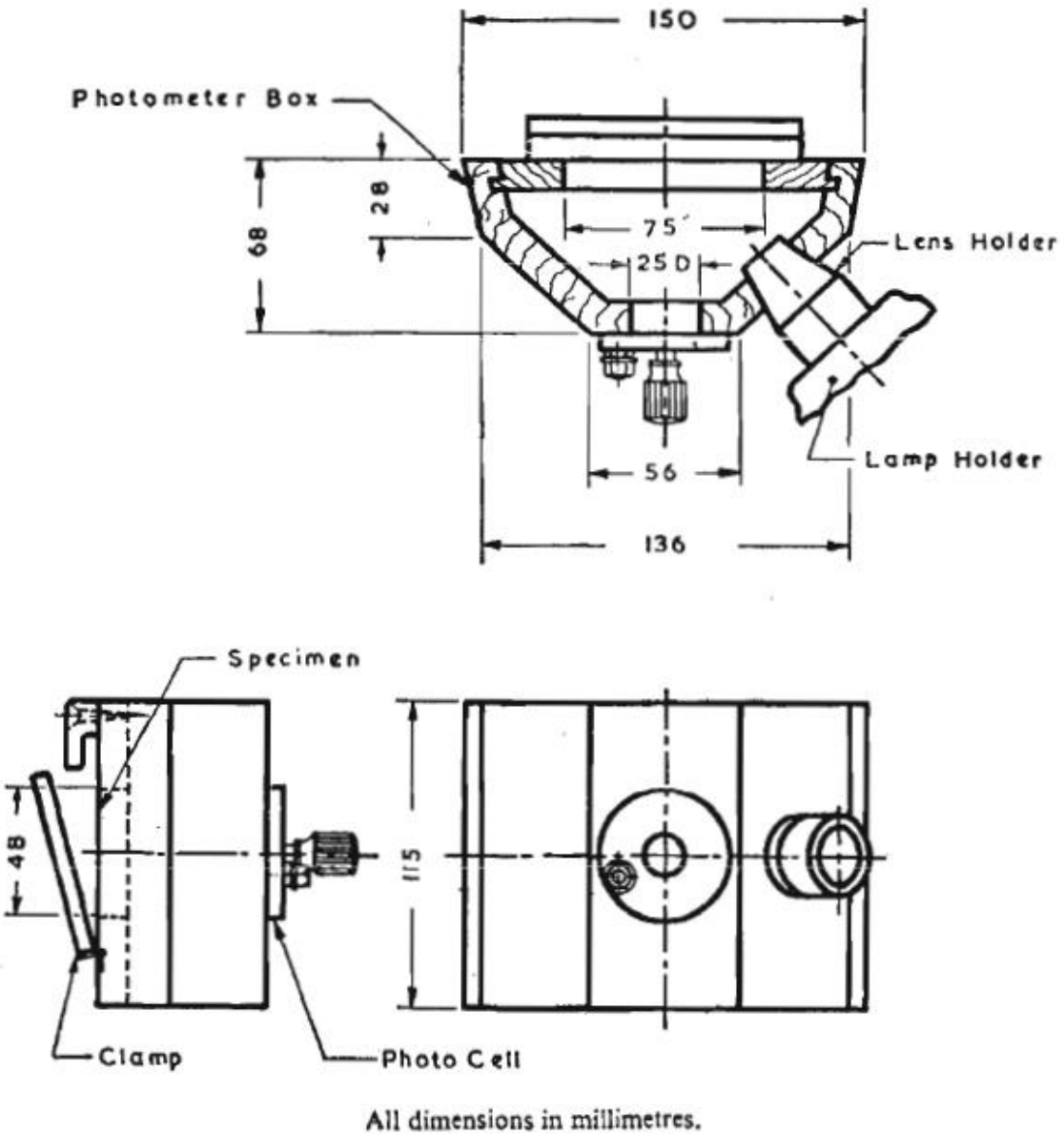
Thin metal or plastic plates of known reflectance values may also be taken. If three such plates are taken with reflectance values approximately in the range 58 to 72 and placed in the box, the galvanometer readings may be plotted against the known reflectance values. This graph, which is a straight line, may be used to convert the galvanometer readings to reflectance values.

**E.1.3** The reflectance measurement shall be made with the help of the apparatus described above or any other similar apparatus.

### E.2 Procedure

**E.2.1** The lead shall be cut square to its length and the end made flat by drawing a few lines, first on a sand paper and then on a drawing paper. Thirty parallel lines, each of 12 cm length and spaced 1.5 mm from their centres, shall be drawn on the drawing paper.

**E.2.2** The paper with the markings shall be placed in the box and reflectance readings shall be taken at three different positions of the markings. The mean value of these three readings shall be the blackness of the pencil markings.




All dimensions in millimetres.

**Fig E. 1 - Blackness Indicator**

# Annex F

(Normative)

## Determination of rod core broken

### C.1 Apparatus

Pencil cutter with rotating blade.

### C.2 Procedure

Remove the paint from the outer layer of the test pen, and remove the eraser and aluminum hoop from the eraser pencil. Fix the pen holder with a clamp, adjust the cutter blade to proper position (in order not to damage the lead core), and turn on the cutter to cut a gap through the pen holder along the length direction of the pen holder. Remove the pen holder, peel off the paper layer of the pen holder at the gap by hand until the lead core is exposed, and check the broken core.

# Annex G

(Normative)

## Determination of off centre

## G.1 Apparatus

a) A measuring microscope with a resolution of not less than 0.01 mm or a measuring instrument with the same or above resolution.
b) Special clamp.

## G.2 Procedure

**G.2.1** Fix the penholder with a special clamp, measure the length of *CD* and *EF* of cut section in Fig G. 1 with a measuring microscope, and calculate the deviation from the centre according to formula given below.

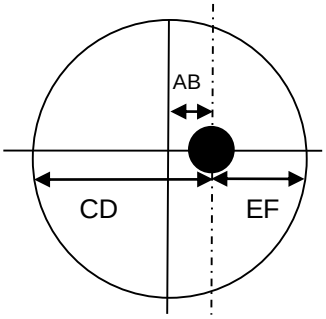



**Fig G. 1 - Schematic diagram of deviation from centre**

Calculate 'AB' from the following formula

$$AB = \frac{|CD - EF|}{2}$$

Where

AB = off centre in mm,
CD, EF = thickness of two ends on the same axis of the pencil in mm,

# Annex H

(Normative)

# Pencil casing strength

## H.1 Apparatus

**H.1.1** 50N weights or 100N tubular dynamometer.

## H.2 Procedure

**H.2.1** The clamps are fixed at 10mm from two ends of the test pen, and a 50N weight is suspended with a 2.5 mm ~ 3 mm steel wire hook at the center of the pen, or use a 100N dynamometer to apply a 50N load to the pen.

# Annex I

(Normative)

# Pencil coating

## I.1 Apparatus

a) constant-temperature oven

b) Refrigerator.

## I.2 Procedure

**I.2.1** Put the test pencil in a constant-temperature oven whose temperature is 45°C ± 2°C for 30 min; then, take it out; put it in a room whose temperature is 20°C ± 2°C and the relative humidity is 50% ~ 65% for 30 min; then, put the test pencil in a plastic bag, and tighten the mouth of the bag; put it in a refrigerator whose temperature is -10°C ± 2°C for 30 minutes; then, take it out; check that the coating of the pencil does not fall off or crack.

## Bibliography

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[2] ISO 20318-2: Mechanical pencils and leads for general use-classification, dimensions, quality and test methods. Part 2: Black Leads.

[3] EN 717-3:1996 Wood based panels - Determination of formaldehyde release - Part 3: Formaldehyde release by the flask method.

[4] IS 1375-1981 (Reaffirmed 2015): Specification for Black Lead Pencils.

[5] IS 9180: 1988: black leads for wood cased pencils-classification and diameters.

[6] QB/T 4436-2012: Paper Pencils (Draft)

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| College of Natural Resources (CNR) | Ms. Chogyel Wangmo (Alternate) |
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