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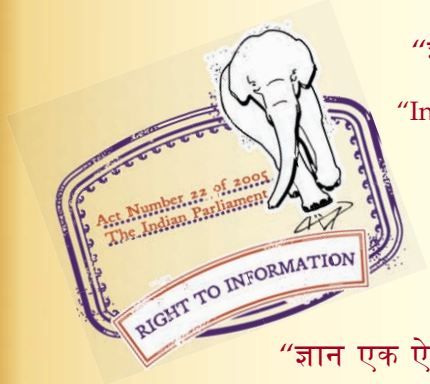

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METHOD OF TEST FOR PREFORMED BLOCK-TYPE AND PIPE-COVERING TYPE THERMAL INSULATION

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METHODS OF TEST FOR PREFORMED BLOCK-TYPE AND PIPE-COVERING TYPE THERMAL INSULATION

(First Revision)

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METHODS OF TEST FOR PREFORMED BLOCK-TYPE AND PIPE-COVERING TYPE THERMAL INSULATION

(First Revision)

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 July 1982, after the draft finalized by the Thermal Insulation Materials Sectional Committee had been approved by the Chemical Division Council.

0.2 This standard was first published in 1970 with the purpose of providing details of standard methods of test for preformed block-type and pipe-covering type thermal insulation for the assessment of a range of properties which are likely to be of value to users as well as manufacturers.

0.3 In this revision, definition of resistance to breakage has been added along with a method for its determination and the formulae for various characteristics have been modified for measurement in SI Units.

0.4 In the preperation of this standard, assistance has been derived from the following publications of American Society for Testing and Materials:

ASTM C 165-77	Measuring compressive properties of thermal insulations.
ASTM C 203-58	Breaking load and calculated flexural strength of preformed block-type thermal insulation.
ASTM C 302-77	Density of preformed pipe-covering type thermal insulation.
ASTM C 303-77	Density of preformed block-type thermal insulation.
ASTM C 446-64	Breaking load and calculated modulus of rupture of preformed insulation for pipes.

0.5 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard prescribes the methods of test for preformed block-type and pipe-covering type thermal insulation.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 3069-1965† and the following shall apply.

2.2 Resistance to Breakage — It is a characteristic that affects the breakage of block-type insulation during transportation and installation (*see* **8.1**).

3. SAMPLING

3.1 Representative samples of the material shall be drawn as prescribed in the relevant material specifications.

4. DETERMINATION OF DENSITY

4.0 General — Density measurements of preformed block-type and pipe-covering type insulation are useful in determining compliance of a product with specification limits, and in providing a relative measure of the mass of the products. For any one kind of insulation, some important physical and mechanical properties, such as thermal conductivity, heat capacity and strength, also bear a specific relationship with its density. However, on a density basis, these properties are not directly comparable with those for other kinds of materials.

4.1 Apparatus

4.1.1 *Flexible Steel Rule* — graduated at 1-mm intervals.

4.1.2 *Scales* — to measure to the nearest 5 g.

4.1.3 *Drying Oven or Desiccator*

4.2 Test Specimen

4.2.1 *For Preformed Blocks*

4.2.1.1 The test specimen shall be of commercial size, whenever practicable, but shall not be less than 150 × 75 mm.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms, symbols and units relating to thermal insulation materials.

4.2.1.2 When the specimen has to be cut from larger blocks or from irregular shapes, it shall be cut in such a manner as to preserve as many of the original surfaces as possible.

4.2.2 *For Preformed Pipe-Covering*

4.2.2.1 The test specimen shall be of commercial size, whenever practicable, but shall be not less than a full section and shall be at least 300 mm long.

4.3 Procedure

4.3.1 *For Preformed Blocks*

4.3.1.1 Dry the specimen to constant mass in an oven or a desiccator at a temperature of 110 ± 5°C. When drying at these temperatures is destructive to the insulation, dry to constant mass at a suitable temperature.

4.3.1.2 After drying, measure the width, length and thickness of the specimen to the nearest millimetre, taking a minimum of three measurements of each dimension at different locations of the specimen. Measure the specimens that are in segmental form, or those having bevelled edges, on each face separately. Use edge supports, as required, to facilitate accurate measurements. Average the individual measurements of each dimension.

4.3.2 *For Preformed Pipe-Covering*

4.3.2.1 Remove any jacket on the specimen, unless it is of a type that would cause disintegration of the specimen upon removal.

4.3.2.2 Dry the specimen to constant mass (**4.3.1.1**). When possible, obtain dimensions by using two half-sections of pipe insulation, joined together concentrically as applied to a pipe. After drying in accordance with **4.3.1.1**, measure the outer circumference, wall thickness, and length of the specimen to the nearest millimetre, taking a minimum of six measurements of each dimension at different locations on the specimen. Average the individual measurements of each dimension.

4.4 Calculation

4.4.1 *For Preformed Blocks*

4.4.1.1 Calculate the volume of the specimen from the average width, length and thickness.

4.4.1.2 Calculate the density of the specimen from the dry mass and calculated volume, and express the result in kg/m^3.

4.4.2 *For Preformed Pipe-Covering*

4.4.2.1 Calculate the average outside diamater of the specimen from the average outer circumference.

NOTE — If the jacket was not removed before measuring the outer circumference, deduct twice the jacket thickness from the calculated outside diameter.

4.4.2.2 Calculate the average inside diameter by deducting twice the average wall thickness from the calculated outside diameter.

4.4.2.3 Calculate the volume of the specimen from the calculated outside diameter, calculated inside diameter and length using the formula given below, for a full cylindrical section:

$$V = \frac{\pi (d_o^2 - d_i^2) L}{4}$$

where

V = volume of the cylindrical specimen, m^3;

d_o = average outside diameter of the specimen, m;

d_i = average inside diameter of the specimen, m; and

L = average length of the specimen, m.

4.4.2.4 Calculate the density of the specimen from the dry mass and the calculated volume, and express the result in kg/m^3.

5. DETERMINATION OF FLEXURAL STRENGTH

5.1 Breaking Load and Calculated Flexural Strength of Preformed Block-Type Thermal Insulation

5.1.0 *General* — This test procedure may be used to determine the resistance of some types of preformed block insulation when transverse loads are applied normal to the surface. Values are measured at the maximum load of breaking point under specified conditions of specimen size, span between supports and rate of load application. The formulae used are based on isotropic materials and presume that the stress-strain characteristics above and below the elastic limit are nearly alike. This method is not applicable to thermal insulation of certain types in which crushing is observable before failure is obtained in transverse bending. Numerical values should be compared only when determined on materials of similar compositions and physical properties. This property is considered helpful, in combination with other appropriately selected properties, to indicate the acceptability of the product for certain uses.

5.1.1 *Apparatus*

5.1.1.1 *Testing machine* — a suitable hydraulic or mechanical testing machine capable of applying and measuring the required load to the nearest $\pm$ 2 percent.

5.1.1.2 *Bearing edges* — cylindrical bearing edges 30 ± 5 mm in diameter. The bearing cylinders shall be straight and shall be self-aligning so as to maintain full contact with the specimen throughout the test. They shall have a length at least equal to the width of the specimen.

5.1.2 *Test Specimens*

5.1.2.1 The test specimens shall be preferably 150 mm, but in no case less than 75 mm in width and shall be approximately 300 mm in length. The width and thickness of test specimens shall be recorded to the nearest 0·25 mm.

NOTE — If the test specimen is cut to obtain a narrower width than as received, the cut shall be made along the length of the block. When comparative tests are to made on preformed materials, all specimens shall be of the same thickness, preferably 40 mm.

5.1.2.2 The specimens shall be cut from larger blocks or irregular shapes in such a manner as to preserve as many of the original surfaces as possible. Only one specimen shall be cut from a single block or shape. The bearing faces of the test specimens shall be approximately parallel planes. In preparing specimens from pieces of irregular shape, any means such as a band saw, or any other method involving the use of abrasives, such as a high speed abrasion wheel or a rubbing bed, that will produce a specimen with approximately plane and parallel faces without weakening the structure of the specimen, may be used.

5.1.2.3 The test specimens shall be dried in a vented oven for not less than 16 hours at 110 ± 5°C.

5.1.3 *Number of Test* — At least four test specimens shall be tested.

5.1.4 *Procedure*

5.1.4.1 The bearing edges shall be so placed as to provide a span of 250 mm. A test specimen shall be placed flat on the bearing edges and the load applied at midspan, across the width and perpendicular to the top face of the specimen.

5.1.4.2 The speed of the moving head of the testing machine, during the application of the load, shall be not more than 12 mm/min or the rate of load shall be not more than 2·2 kN/min.

5.1.4.3 The load shall be applied until definite failure occurs, and the maximum load in kilogram as indicated by the testing equipment shall be recorded.

5.1.5 *Calculation* — Calculate the flexural strength as follows:

$$R = \frac{3\,W\,l}{2\,bd^2}$$

where

R = flexural strength, N/m^2;

W = load at which the specimen failed, N;

l = distance between the supports, m;

b = width of the specimen, m; and

d = thickness of the specimen, m.

5.2 Breaking Load and Calculated Modulus of Rupture of Preformed Insulation for Pipe

5.2.0 *General* — This test is used to determine the resistance to breakage of preformed pipe insulation under transverse load applied normal to the inside (concave) surface under specified test conditions. The formula assumes that the material being tested is isotropic and the stress-strain relationships above and below the elastic limit are nearly alike. This method is not applicable to thermal insulations of certain types in which failure by crushing occurs before failure in transverse bending. The values are helpful, along with other properties, as a measure of the resistance of the insulation to damage by shipping and handling.

5.2.1 *Apparatus*

5.2.1.1 *Testing machine* — a suitable hydraulic or mechanical testing machine capable of applying the required loads at the specified speed and of measuring the load to the nearest $\pm$ 2 percent.

5.2.1.2 *Bearing edges* — rounded bearing edges, at least 10 mm in diameter. If soft materials are tested, the bearing edges may indent the samples; in this case bearing edges of larger diameters shall be used. The outside bearing edges (or saddles) shall be curved to fit the outside arc of the specimens, so as to maintain full contact with the surfaces of the samples. They shall be at least as long as the respective curved surfaces with which they will be in contact. Bearing edges of different sizes are required for each inside or outside diameter to be tested.

5.2.2 *Test Specimens*

5.2.2.1 The test specimens shall be quarter-section (90-degree) pieces, approximately 300 mm in length. They shall be cut from full-size sections or half-sections in such a manner as to preserve the original faces as much as possible.

5.2.2.2 The specimens shall be dried to constant mass in a vented oven at 110° ± 5°C.

5.2.3 *Number of Tests* — Carry out the determination on at least four test specimens cut from the same test sample material.

5.2.4 *Procedure*

5.2.4.1 Place the outside bearing edges so as to provide a span of 250 mm between their centres; a jig is advisable to hold them. Place a test specimen on the two outside bearing edges and apply the load at mid-span, with the centre bearing edge in complete contact with and perpendicular to the inside, or concave, surface. The outside, or convex, surface will thus be in tension.

5.2.4.2 Do not allow the speed of the moving head of the testing machine, during the application of the load, to exceed 12 mm/min, or the rate of the load to exceed 2·2 kN/min.

5.2.4.3 Apply the load until definite failure occurs (as indicated by a fall-off in the load), and record the maximum load in kilogram as indicated by the testing machine.

5.2.4.4 Measure the outside arc of each test specimen once to the nearest millimetre and the thickness to the nearest of 0·25 mm, once on each side of the break.

5.2.5 *Calculation* — Calculate the flexural strength as follows:

$$S = \frac{0{\cdot}25\ Wl\,[R\ (R^2-r^2)-0{\cdot}6\ (R^3-r^3)]}{0{\cdot}321\ 4\ (R^4-r^4)\ (R^2-r^2)-0{\cdot}282\ 9\ (R^3-r^3)^2}$$

where

S = flexural strength, Pa;

W = load (maximum) at which the specimen failed, N;

l = distance between the supports, m;

R = outside radius of the specimen

= outside arc of specimen $\times \frac{4}{6{\cdot}28}$, m; and

r = inside radius of specimen, that is, R minus the average thickness, m.

6. COMPRESSIVE STRENGTH OF PREFORMED BLOCK-TYPE THERMAL INSULATION

6.1 Apparatus

6.1.1 *Testing Machine* — a suitable hydraulic or mechanical compression testing machine.

6.1.2 *Spherical Bearing Block* — a spherical bearing block having a plane bearing surface at least 150 mm square.

6.2 Test Specimens

6.2.1 The test specimens shall be preferably 150 mm, but in no case less than 125 mm square.

NOTE — When comparative tests are to be made on preformed materials, all test specimens shall be of the same thickness, preferably 40 mm.

6.2.2 The specimen shall be cut from larger blocks or irregular shapes in such a manner as to preserve as many of the original faces as possible. Only one specimen shall be cut from a single block or shape. The bearing faces of the test specimens shall be approximately parallel planes. Where the original surfaces of the block are substantially plane and parallel, no special preparation of the surfaces will usually be necessary. In preparing specimens from pieces of irregular shape, any means, such as a band saw, or any method involving the use of abrasives, such as a high speed abrasion wheel or a rubbing bed, that will produce a specimen with approximately plane and parallel faces without weakening the structure of the specimen, may be used.

6.2.3 The test specimens shall be dried in a vented oven for not less than 16 hours at a temperature of $110 \pm 5°C$.

6.3 Procedure

6.3.1 Test at least four specimens. In the case of blocks 75 mm in width, cut two pieces each 150 mm in length from the same block and test them side by side simultaneously; count the two pieces as one test specimen.

6.3.2 Test the specimens immediately upon removal from the drying oven. Apply the load perpendicular to the square face of the test specimen.

6.3.3 Use the bearing block on top of the test specimen in vertical testing machines when only one bearing block is provided. Place the plane bearing surface on the block assembly in contact with the entire area on the top square face of the specimen, and keep the bearing surface parallel to the weighing table of the testing machine. Keep the spherical seat of the bearing block thoroughly lubricated to ensure accurate adjustment, which should be made by hand under an initial load of 14 kPa.

6.3.4 Adjust the speed of the moving head to be not more than 1·25 mm/min. Compress the specimen to a deformation of 5 percent of its original thickness unless definite failure has occurred before this deformation is reached. Record the loads required, to produce failure or deformation of 1, 2, 3, 4 and 5 percent, or failure and these deformations.

NOTE — Certain types of insulating materials may be compressed to deformation greater than 5 percent without failure, and their compression at higher deformations may, in some cases, be desired.

6.4 Calculation — Calculate the compressive strength as follows:

$$S = \frac{W}{A}$$

where

S = compressive strength, Pa;

W = load at 5 percent deformation or at failure whichever is smaller, N; and

A = average of the gross areas of the top and bottom faces of the specimen, m^2.

7. DETERMINATION OF LINEAR SHRINKAGE

7.1 Linear shrinkage of preformed high temperature thermal insulation when subjected to soaking heat, may be determined in accordance with **9** of **IS**: 5724-1970*.

8. DETERMINATION OF RESISTANCE TO BREAKAGE

8.1 General — Resistance to breakage is determined by dropping the test specimens from the desired height under normal gravitational force and examining the extent and type of damage. This characteristic, due to the method of test, is also known as 'drop-resistance' and 'resistance to dropping'. This test is for block-type material.

8.2 Test Specimens — Five test specimens of commercial size shall be taken for the test.

8.3 Procedure — Determine the dimensions, mass and density of test specimen in accordance with **4**. Raise the specimen to the desired height from a cemented floor and allow it to fall freely on the floor with the largest face parallel to the floor. Examine visually the breakage, cracks, corner breaks, and surface chipping of the specimen. Determine the dimensions, mass and density of the largest piece.

8.4 Report — Report the initial dimensions, mass and density, the type and extent of damage, if any, and dimensions, mass and density of the largest piece after the test and whether the material has passed the test. The material shall be deemed to have passed the test if at least three of the five test specimens do not break, crack or have surface chipping.

NOTE — Corner breaks up to one percent by mass shall not be considered as 'damage'.

*Methods of test for thermal insulating cements.

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(*Page* 8, *clause* **5.1.5**, *line* 4) — Substitute 'kN/m^2' *for* 'N/m^2'.

(*Page* 8, *clause* **5.1.5**, *line* 5) — Substitute 'kN' *for* "N'.

(*Page* 9, *clause* **5.2.5**, *line* 4) — Substitute 'kN/m^2' *for* 'Pa'.

(*Page* 9, *clause* **5.2.5**, *line* 5) — Substitute 'kN' *for* 'N'.

(*Page* 11, *clause* **6.4**, *line* 4) — Substitute 'kN/m^2' *for* 'Pa'.

(*Page* 11, *clause* **6.4**, *line* 6) — Substitute 'kN' *for* 'N'.

(CHD 27)

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