भारतीय मानक मसौदा

कांच एनेमल माण्ड के परीक्षण की पद्तियाँ

भाग 2 परीक्षण पद्तियाँ

अनुभाग 12 ऐठन के प्रति प्रतिरोदिता

(*दूसरा पुनरीक्षण*)

Draft Indian Standard

METHODS OF TEST FOR VITREOUS ENAMELWARE

PART 2 TEST METHODS

SECTION 12 RESISTANCE TO TORSION

(*Second Revision*)

(ICS 97.040.60, 25.220.50)

Ceramicware Sectional Committee CHD 09	Last Date for Comments: 30 April 2024

FOREWORD

(*formal clause to be added later*)

This standard was first published in 1968. The committee while reviewing IS 3972 : 1968 decided to publish this standard in two parts. Part 1 deals with production of specimens for testing in two sections, namely, Section 1 Enamelled sheet steel, and Section 2 Enamelled cast iron. Part 2 deals with various test methods applicable to vitreous enamelled sheet steel and vitreous enamelled cast iron. The committee also decided that Part 2 shall have various sections and each section will deal with a particular test method.

The first revision of this standard was brought out in 1999. In this revision the committee felt a need to revise the standard with a view to update the standard based on the experience of last two decades and on the currently available data.

This standard (Part 2/Sec 12) prescribes the method for determination of resistance of vitreous enamelware to torsion. The other sections of Part 2 are as follows:

Section 1	Resistance to citric acid at room temperature and boiling temperature
Section 2	Resistance to citric acid at room temperature and boiling temperature
Section 3	Resistance to boiling water and water vapour
Section 4	Resistance to thermal shock
Section 5	Resistance to hot alkali (sodium hydroxide)
Section 6	Reflectance and specular gloss
Section 7	Resistance to boiling hydrochloric acid
Section 8	Resistance to heat
Section 9	Resistance to dilute sulphuric acid at room temperature
Section 10	Resistance to hot detergent solution used for washing textiles
Section 11	Resistance to abrasion
Section 13	Resistance to warpage

This method of test covers a procedure for evaluating the relative resistance to failure under torsion, of vitreous enamelled test specimens prepared either from different enamels or from the same enamel processed under different conditions.

The laboratory torsion test data correlate well with tensional stress on vitreous enamelled ware subjected to distortion through bending or twisting, or a combination of both.

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.

1 SCOPE

This standard (Part 2/Sec 12) prescribes the method for resistance to torsion for vitreous enamelware.

2 REFERENCES

The standards given 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 revisions, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

IS No.	Title
2717:1979	Glossary of terms relating to vitreous enamelware (*first revision*)

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 2717 shall apply.

4 APPARATUS

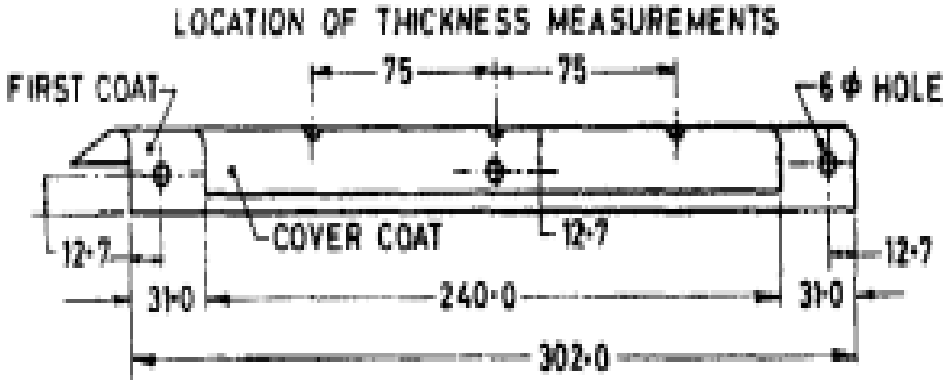
The apparatus essentially consists of a grip assembly which keeps one end of the specimen stationary while the other end is rotated about a predetermined axis at the rate of 100° per minute by means of a motor-driven grip assembly. The non-rotary grip assembly rests in ball bushings which permit free linear motion as the specimen shortens during twisting.

5 TEST SPECIMEN

5.1 Test Specimens

For each sample, prepare ten flat test blanks of enameling iron 302 mm × 50 ± 0.4 mm × 0.9 ± 0.025 mm (can be selected from 20 gauge). Variation of thickness between any two blanks shall not exceed 0.05 mm where the metal thickness is not a desired variable of the investigation.

5.1.1 Holes which are required in the test specimens shall be placed as in Fig. 1 with the exercise of proper caution to ensure that the specimens are not deformed during the process.



All dimensions in millimetres.

FIG. 1 DIAGRAM SHOWING STANDARD TORSION SPECIMEN

5.1.2 All burrs developing from shearing, drilling or punching shall be removed before the specimens are formed.

5.2 Form flat test blanks into 90 ± 1° angular specimens as measured within 15 mm of either end with an adjustable protractor.

5.2.1 The inside radius of bend shall be 3.0 mm as measured with commercial V-dies or bending bar, and the apex of the radius shall be located at the centre of the width so that when measured as shown in Fig. 2, the width of sides does not differ by more than 0.8 mm.

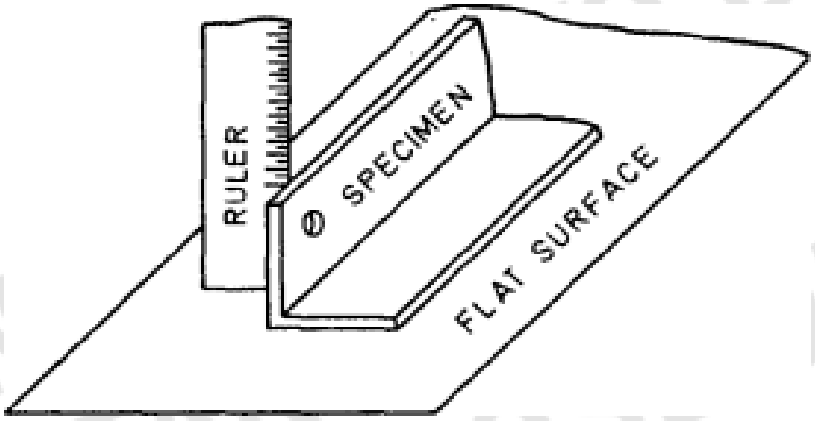


FIG. 2 SKETCH SHOWING METHOD OF MEASURING WIDTH OF FORMED SPECIMEN

5.3 Preparation of Test Specimens

5.3.1 The enamel thickness of the 'sides' shall be less by about 20 percent and never to exceed than that on the apex. To avoid the difficulty of applying an even thickness over a convex surface and the adjacent flat areas, it may be necessary to spray an extra amount to enamel on the apex of the specimen to bring the thickness within the requirements.

5.3.2 The ground coating of enamel should be on all sides of the specimen. Any bead apparent in the first coat after drying should be removed before firing. There shall be no bead on the ends of the specimen where it will interfere with clamping.

5.3.3 Where a second or cover coat is to be evaluated, it is to be applied to the outside of the specimen only. After drying and before firing, the cover coating shall be brushed back 31 mm from each end and 6 mm from each side of the specimen as shown in Fig. 1.

5.3.4 The tolerance limit of the total enamel thickness shall be ± 20 percent of the desired standard thickness with at least three of the specimens having a thickness less than the standard and at least three of the specimens having a thickness greater than standard, unless at least five specimens have exactly the standard thickness.

5.3.5 Measure the enamel thickness at three evenly spaced points on the apex and at one point on each side of the specimen 13 mm from the apex and midway between the ends (see Fig. 1). The enamel thickness shall be average of the three measurements made on the apex, and the thickness of the sides shall conform to the requirements as given in **5.3.1.**

5.3.6 Measurements may be made by any nondestructive means or gauge that will give readings accurate to within 10 percent on areas 19 mm square and on a curved surface with a radius as small as 3 mm.

5.3.7 Subject a group of test specimens to identical cleaning and pickling procedures and preferably pickle together. This step is especially important for finish coat applied directly to the metal.

6 METHOD OF TEST

6.1 The rotary head of the torsion test machine will cruise about 2° after the motor switch has been turned off. This 'cruise constant' is determined as follows:

With the control lever on 'reset' rotate the free head by hand until the pointer indicator comes to the 350° mark. Raise control lever to 'run' and when the pointer indicates 358°, move the control lever to 'stop' and note the position where the pointer comes to rest.

6.2 Mount the test specimen in the machine with the non-rotary grip assembly, which has a free lateral motion, at the extreme position from the rotary head. Insert the end of the specimen into the open grip on the rotary head, and laterally move the non-rotary grip over the other end of the specimen. Position the non-rotary grip by pulling a cam-lock lever against a pin stop, which assures a distance of 250 mm between grip faces. Cam-lock levers are provided for locking the specimen firmly in each grip.

6.3 Use a cellulose sponge or a soft cloth and one percent solution of trisodium phosphate to wet the specimen uniformly before starting the test and maintain the surface visibly wet by quickly stroking the specimen at every 40° of twist required to produce failure.

6.4 Begin twisting by moving the control lever to 'run' and continue until a chip occurs along the apex and within the central 229 mm of the specimen. Chips on apparent failure within 12.7 mm of the grips or on the edge of the sides should not be considered.

6.5 Immediately upon observing failure, move the control lever to 'stop' position. Compensate the degrees of twist to cause failure by subtracting the previously determined 'cruise constant' from the indicator reading after the motor has stopped.

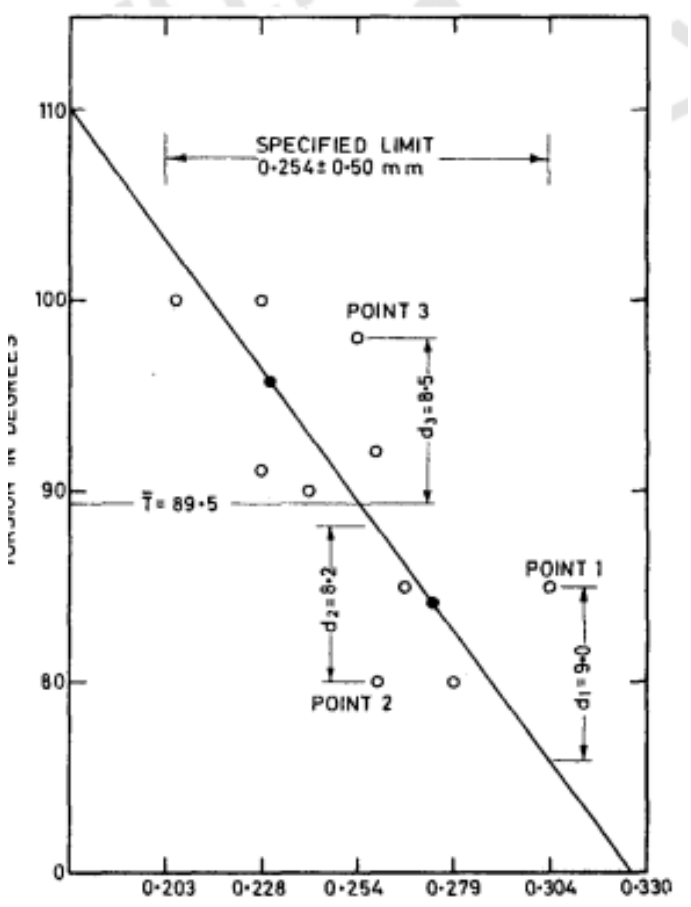
7 CALCULATION

7.1 Calculations for Single Determination

7.1.1 The sample consists of ten specimens. Plot the results for the ten specimens with degrees torsion T versus enamel thickness t on Cartesian (rectilinear) graph paper (*see* Fig. 3 and Table 1).

7.1.2 Determine the average degrees torsion T_1 and T_2 and the average enamel thicknesses t_1 and t_2 for (a) the specimens having the five lowest values of T, and (b) the specimens having the five highest values of t. If more than one point occurs on the chart, at the value of t that divides the high and low groups, then assign them to the respective groups in such distribution that each group contains five specimens. For simplicity, this distribution is to be made according to values to T, the specimens with high value T of being placed with the group of low t, and vice versa.

7.1.3 Plot these two average points on the chart and draw a straight line through them. This is the line referred to in **7.1.4, 7.2** and **7.2.1.**



Enamel thickness in mm.

FIG. 3 PLOT OF TORSION DATA SHOWN IN TABLE 1

Table 1 Degrees Torsion for Enamels

(*Clauses* 7.1.1 and 7.2.3)

Specimen No.	Enamel Thickness t, mm	Sub-group Average	Degrees Torsion	Sub-group Average
(1)	(2)	(3)	(4)	(5)
1	0.206		100	
2	0.228		100	
3	0.228	0.231	91	95.8
4	0.241		90	
5	0.254		98	
6	0.259	0.273	92	
7	0.259		80	
8	0.266		85	84.4
9	0.279		80	
10	0.304		85	

7.1.4 Locate the value *T* on the ordinate that corresponds to the line to the appropriate standard enamel thickness (0.152, 0.254 and 0.381 mm). This value of *T* is the torsion rating of the sample and will hereafter be known as '*T* bar' or $\bar{T}$.

NOTE — In the example, shown in Fig. 3, *T* is 89.5.

7.2 Determine the effective range *R* of the torsion value *T* as follows:

Locate the point farthest from the line (point 1) and graphically determine the vertical distance, d_1, of this point from the line. Locate point 2, which is the one farthest from the line on the opposite side of the line from point 1. Graphically determine the vertical distance d_2, of this point from the line, and determine *R* from the formula given below:

$$R = d_1 + d_2$$

7.2.1 Calculate the statistical error *e* (95 percent confidence) of T from the following formula, using the appropriate value of the coefficient α from Table 2:

$$e = \alpha R$$

Since for ten specimens α = 0.23, the expression becomes $e = 0.23 R$, in which $\bar{T} \pm e$ gives the 95 percent confidence limits, and *R* is the effective range of ten torsion values.

Table 2 Values of a for 95 Percent Confidence Limits
(*Clause* 7.2.1)

Number of Specimens	Coefficient
(1)	(2)
3	1.30
4	1.72
5	1.51
6	1.40
7	1.33
8	1.29
9	1.25
10	1.23

7.2.2 In reporting the results, the gauge of the metal and the test thickness of the enamel shall be stated as well as the torsion rating of each sample and the statistical error *e* (95 percent confidence). The latter two values shall be reported to the nearest 0.1°.

7.2.3 The following example of the torsion calculations for an enamel of 0.254 mm thickness is defined by the data in Table 1. The data in Table 1 have been arranged in increasing order of enamel thickness to facilitate determination of the sub-group average. The data and averages have been plotted in Fig. 3 from which the torsion rating is found to be 89.5°. Since $d_1 = 9.0$ and $d_2 = 8.2$, the effective range $R = 9.0 + 8.2 = 17.2$; the 95 percent confidence error $e = 0.23 \times 17.2 = 3.96$. The torsion rating is thus reported as follows:

$$\bar{T} = 89.5 \pm 4.0$$