इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

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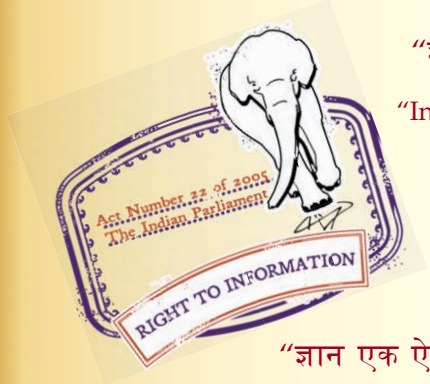
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 14399-1 and 2 (1996): Hot Press Moulded Thermosetting Glass Fibre Reinforced Polyester Resin (GRP) Sectional Water Storage Tanks, Part 1: palels, Part 2 Guidelines for assembly, installation and test [CED 3: Sanitary Appliances and Water Fittings]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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Reaffirmed 2008
IS 14399 (Parts 1 and 2) : 1996

भारतीय मानक

गर्म प्रैस संचकन तापदृदी काँच रेशा प्रबलित पोलिएस्टर रेजिन (जी आर पी) से बने जल-भंडारण के लिए सैक्शनल टैन्क

Indian Standard

HOT PRESS MOULDED THERMOSETTING GLASS FIBRE REINFORCED POLYESTER RESIN (GRP) SECTIONAL WATER STORAGE TANKS

ICS 23.020.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1996 Price Group 8

AMENDMENT NO. 1 JUNE 2003
TO
IS 14399 (PART 1) : 1996 HOT PRESS MOULDED THERMOSETTING GLASS FIBRE REINFORCED POLYESTER RESIN (GRP) SECTIONAL WATER STORAGE TANKS

PART 1 SPECIFICATION FOR PANELS

(*Page* 1, *clause* 3.3) — Insert the following at the end of clause:

'The minimum glass content in the compound shall be 30 percent by weight.'

(CED 3)

Reprography Unit, BIS, New Delhi, India

Sanitary Appliances and Water Fittings Sectional Committee, CED 3

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Sanitary Appliances and Water Fittings Sectional Committee had been approved by the Civil Engineering Division Council.

This Indian Standard has been prepared with a view to provide guidance in the manufacture of glass fibre reinforced polyester resin sectional tanks for water storage made with hot compression moulded panels.

Part 1 of the standard covers panels for the tanks made by hot compression moulding process and Part 2 covers assembly, installation and testing procedure for these tanks.

In the formulation of this standard, assistance has been sought from Singapore Standard SS 245 : 1981 'Specification for glass reinforced polyester sectional water tanks'.

The composition of technical committee responsible for the formulation of this standard is given at Annex L.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HOT PRESS MOULDED THERMOSETTING GLASS FIBRE REINFORCED POLYESTER RESIN (GRP) SECTIONAL WATER STORAGE TANKS

PART 1 SPECIFICATION FOR PANELS

1 SCOPE

1.1 This standard (Part 1) lays down the requirements for the panels of glass fibre reinforced polyester resin (GRP) sectional tanks meant for storing potable water under pressure not exceeding the static head corresponding to the depth of the tank and temperature of water not exceeding 50°C.

1.1.1 GRP panels used in manufacturing tanks as covered in this standard are hot compression moulded, using sheet moulding compound (SMC).

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard, the definitions given in 3.1 to 3.12 shall apply.

3.1 Glass Reinforced Plastic (GRP)

A product of polyester resin combined with reinforcing glass, fillers, catalysts and accelerators.

3.2 Unsaturated Polyester Resin

Resin produced by condensation of one or more acids (including unsaturated acids) with one or more polyols followed by copolymerization with one or more cross linking agents.

3.3 Sheet Moulding Compound (SMC)

A hot compression mouldable moulding compound based on polyester, fibreglass, fillers, high temperature catalysts, etc, pre-thickened chemically to a non-tacky sheet form.

3.4 Crazing

Fine hair cracks on the surface.

3.5 Blistering

Air or solvent entrapped during moulding.

3.6 Pin Holes

Pores of size less than 1 mm appearing on the surface.

3.7 Wrinkling

Wrinkling on finished surface, normally caused due to under curing.

3.8 Impurities

Foreign matter present.

3.9 Defective Impregnation

Imperfect impregnation of glass fibre with unsaturated polyester resin.

3.10 Colour Blots and Striations

Colour blots/striation occurring on account of uneven distribution of colouring material (pigment).

3.11 Traces of Mending

The trace's left over after mending is carried out to eliminate minor defects, as permissible.

3.12 Panel

A GRP composite produced by hot compression moulding of SMC into specified dimensions.

3.12.1 *Side Panel*

The panels contoured suitably to withstand the hydrostatic load corresponding to the height of water in the tank. Side panels when assembled constitute the vertical sides of the tank.

3.12.2 *Bottom Panels*

The panels contoured suitably to withstand the hydrostatic load corresponding to the depth of the tank. These panels when assembled make up the bottom side of the tank. They are also contoured to avoid stagnation of water inside the tank.

NOTE — The combination of half, quarters or full panels provide enough flat surface of even thickness for mounting fittings at the inlet and outlet openings.

3.12.3 *Half and Quarter Panels*

Inlets, outlets and drains can be combinations of smaller panels namely half and quarter panels or full panels. The assembled outer dimensions of these panels shall be as prescribed in 5 of Part 2.

3.12.4 *Drain Panel Assembly*

Combination of half, quarter or full panels contoured to allow complete draining of water and having required flat surface of even thickness to mount drain fittings.

3.12.5 *Manhole Panels*

The panels which provide access to the inside of the tank for cleaning/inspection purpose.

4 MATERIALS

4.1 The material to be used shall be composed of unsaturated thermosetting polyester resin (food grade) reinforced with glassfibre. This system will include catalysts and may include pigments (compatible with unsaturated polyester resin) and ultra violet stabilizers. These materials coming in contact or likely to come in contact with water should not constitute toxic hazard, should not support microbial growth and should not give rise to unpleasant taste or odour, cloudiness or discolouration of water. Tank manufacturer should ensure and obtain a certificate to this effect from the raw material manufacturer.

4.2 Polyester Resin

Appropriate type of unsaturated polyester resin system conforming to IS 6746 : 1994 shall be used.

4.2.1 The resin shall meet the following characteristics when tested as per IS 6746 : 1994:

a) Specific gravity = 1.13 ±.01 at 27°C,
b) Acid value = 16±4 mg koH/g,
c) Volatile content = 30 percent ± 3 percent, and
d) Gel time at 25°C = 20 to 30 minutes

4.2.2 The following characteristics of the cured resin shall also be met with, when tested in accordance with IS 6746 : 1994 :

a) Barcol hardness = 40 BHU *Min*;
b) Heat deflection temperature = 80°C to 90°C
c) Elongation at break = 1.9 percent, −0, +25 percent, and
d) Water absorption after 7 days at 25°C = 1 percent, *Max.*

4.2.2.1 *Hydrolysis test*

The cured resin samples of size 50 mm × 50 mm × 3 mm approx shall be immersed and boiled in distilled water at 100°C. After 200 h resin samples shall be weighed and boiled for further 200 h and re-weighed. There shall be no evidence of weight loss (due to break down of the polymer).

4.3 Glass Fibre Reinforcements

Glass fibre reinforcement shall be of commercial grade E type and shall conform to IS 11273 : 1992, IS 11320 : 1985 or IS 11551 : 1986 as appropriate.

4.4 Fillers

Inert inorganic fillers (with particle size below 0.05 mm) shall only be used, if required.

4.5 Additives

Additives may be incorporated for modifying the properties of the resin.

5 COLOUR

Colour of the panel shall be a shade of grey or cream. Any other colour (pastal shade) may be used, as mutually agreed between the purchaser and the manufacturer.

6 PANEL DIMENSIONS

6.1 Flange of Panels

The panels shall be manufactured with a combined double flange at an angle of 45° and 90° to face of the panels on all four sides or a single flange at an angle of 90° to the face of the panels on each of the 2, 3 or 4 sides. The flange shall be provided with holes to accommodate fasteners according to the position of the panels in the tank and they should be free from irregularities.

6.1.1 The joint width (land width) of the flanges shall not be less than 45 mm (*see* Fig. 1).

6.2 The nominal external size of the unit panels shall be 1 meter square or 1 m × 0.5 m or 0.5 m × 0.5 m or any other size as agreed to between the purchaser and the manufacturer.

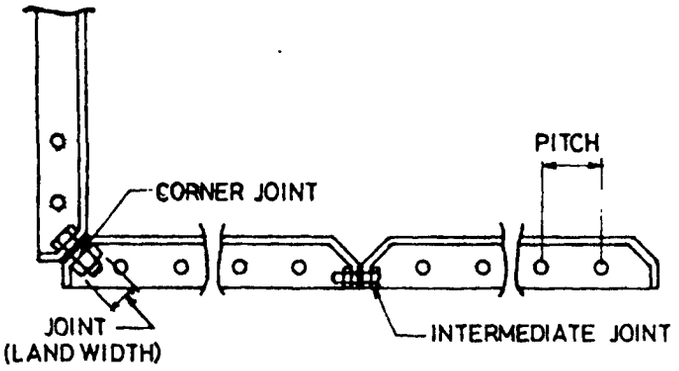
6.3 Tolerance in the external dimensions of each panel shall be within ± 0.2 percent of the external dimensions. Tolerance on the angles shall be within ± 0.3°.

6.4 Type/Thickness of Panel

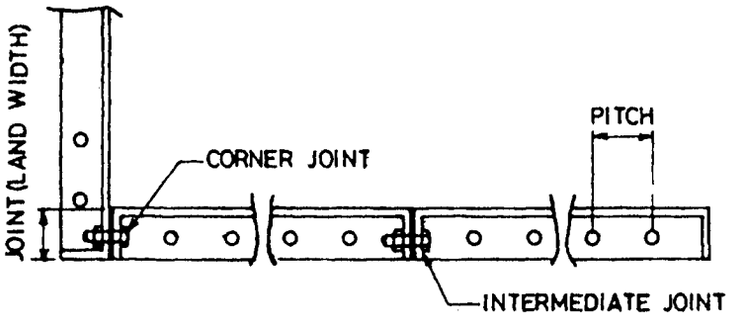
The type and corresponding minimum thickness of the panels shall be as follow:

Type of Panel	*Min Thickness*, mm
A	3
B	4
C	5

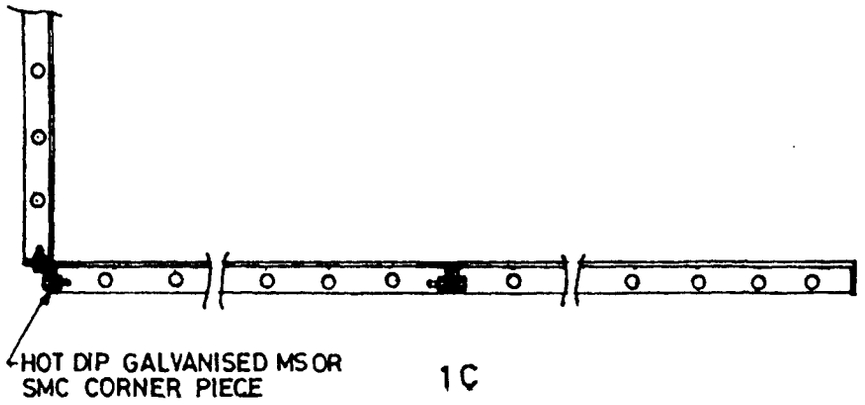
NOTE — Half and quarter panel in Type A, B or C shall have the corresponding minimum thickness as specified above and these shall meet the requirements stipulated in 6.1, 6.1.1, 6.2 and 6.3.



1 A



1 B



1 C

FIG. 1 TYPICAL FLANGE JOINTS

7 VISUAL INSPECTION OF PANELS

The internal and external surfaces of the panels when visually inspected shall be free from the following defects:

a) Small pits appearing on the surface.
b) Poor impregnation of fibreglass with resin.
c) Cuts, cracks and scratches exposing the glass reinforcement.
d) Sharp projections, exposed fibres or glass reinforcement too close to the surface.
d) Surface and non-structural repair marks.
f) Blister on the surface caused by air pockets.

8 MECHANICAL AND PHYSICAL PROPERTIES OF PANELS

8.1 The mechanical and physical properties of panels shall be determined from specimens cut

from panels or from flat laminates prepared in the same composition and by the same techniques as the panels.

8.2 The test specimen shall be prepared and tested for the tests specified in Table 1 in accordance to the methods described in relevant Annexes for the mechanical/physical properties and shall meet the specified acceptance criteria.

Table 1 Mechanical/Physical Properties, Acceptance Criteria and Test Methods

Sl No.	Physical Property	Acceptance Criteria	Test Method
i)	Tensile strength	70 MPa (*Min*)	Annex B
ii)	Bending strength (cross-breaking)	100 MPa (*Min*)	Annex C
iii)	Elastic modulus in bend	6 000 MPa (*Min*)	Annex D
iv)	Glass content	25 percent (*Min*)	Annex E
v)	Barcoal hardness	50 BHU (*Min*)	Annex F
vi)	Water absorption	0.5 percent (*Max*)	Annex G

9 HYDROSTATIC TEST

Panels of Type A, B and C when fixed to a hydrostatic tester as described in Annex H, shall withstand the following hydrostatic pressure without bursting, cracking or leakage:

Type of Panel	*Hydrostatic Pressure, MPa*
A	0.04
B	0.08
C	0.12

10 DEFLECTION TEST

10.1 This test shall be carried out simultaneously with the hydrostatic test and the maximum deflection in the panel shall not exceed 10 mm.

10.1.1 The deflections shall be measured at the centre of the panels using a dial gauge graduated to 0.01 mm having a range of at least 25 mm.

10.1.2 The gauges shall be first set to zero and then the panel pressurised.

10.1.3 The deflection reading shall be taken immediately after the working pressure is reached.

10.1.4 Working pressure shall be maintained for 4 h and the deflection at the same position shall again be taken and the greater of the two results used.

11 TEST ESTABLISHING POTABILITY OF WATER (TYPE TEST)

11.1 General

The fibreglass panels for water tanks shall not contaminate the water. Tests shall be included to determine the degree of effect on taste, odour, colour and turbidity, the change in levels of toxic metals and other toxic substances and whether or not the panel supports the growth of bacteria, algae and fungi. These effects shall be within the limits.

11.2 Effect on Taste, Odour, Colour and Turbidity

When tested by the method described in Annex J the 7th extract shall show no deterioration of colour or turbidity as compared with the original tap water.

Taste and odour should be assessed on the 7th extract or on earlier extracts if all taste and odour has gone. This extract shall not have a taste or odour described as 'chlor-phenolic', 'medicinal', or 'disinfectant'. Other tastes may be present in this extract if they are not detectable at dilutions greater than 1 + 3 with tap water (that is, a threshold odour number of 4). Tastes described as 'rubber', 'plastics', 'greasy', 'waxy' or similar descriptions may be present in this extract if they are not detectable at dilution greater than 1 + 6 with tap water (that is, a threshold odour number of 7).

11.3 Toxic Metals

Toxic metals should be assessed on the extract or on earlier extracts if these are within the recommended limits when tested by the method described in Annex J, the amounts of toxic metals in this extract shall not exceed the limits specified in IS 10500 : 1991.

11.4 Cytotoxicity

When tested by the method described in Annex J, the extract after the third extraction, if necessary, shall be free from cytotoxicity. If the control system fails to support the confluent growth of the cell line, the results of the test shall be regarded as invalid. If confluent growth of the cells does not occur in contact with the third extract of the test material, this should be interpreted as a failure in this test.

11.5 Microbiological Growth

When tested by the method described in Annex J, the counts of coliform organisms and Pseudomonas aeruginosa made 4 weeks, 5 weeks and 6 weeks after the initial inoculation shall be less than 1 per 100 ml. All the counts of bacteria capable of growth at 37°C and 22°C and fungi made 4 weeks, 5 weeks and 6 weeks after the initial inoculation shall be less than 10 times the corresponding count in the control flask.

Irrespective of the above requirements however counts shall be deemed to be acceptable if they are less than the maximum limits given in Table 2.

Table 2 Maximum Limits Below Which Count is Acceptable
(*Clause* 11.5)

Coliform organisms	0 per 100 ml
Pseudomonas aeruginosa	0 per 100 ml
37°C Colony count	100 per ml
22°C Colony count	10 000 per ml
Fungi	100 per ml

There shall be no visible film on the sample or turbidity in the water which is confirmed or microbiological examination as growth.

12 SAMPLING AND ACCEPTANCE CRITERIA FOR CONFORMITY

12.1 Acceptance Test

12.1.1 Sampling and criteria for conformity for dimensional (**6**) and visual (**7**) shall be based on the general inspection level II and acceptance quality level 2.5 in accordance with IS 2500 (Part 1) : 1992 assuming single normal sampling plan.

12.1.2 Sampling and criteria for conformity for mechanical and physical properties (**8**), hydrostatic (**9**) and deflection test (**10**) shall be based on the special inspection level S-3 and acceptance quality level 2.5 in accordance with IS 2500 (Part 1) : 1992, assuming single normal sampling plan.

12.2 Type Test

Tests establishing the potability of water (**11**) shall be carried out as type test. This test shall be repeated whenever a significant change is made in the composition or process in order to establish the suitability and performance capacity of the panels. Even if no change is made in the composition or process, this test shall be repeated once in three years.

13 MARKING

13.1 GRP Panels conforming to this standard shall be permanently and legibly marked with the following information:

a) Identification of the source of manufacture,
b) Type/thickness of panel, and
c) Lot number or serial number of panel.

13.2 BIS Certification Marking

The panels may also be marked with the Standard Mark.

13.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
2500 (Part 1) : 1992	Sampling inspection procedures: Part 1 Attribute sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection (*second revision*)	10500 : 1991	Drinking water (*first revision*)
		11273 : 1992	Woven roving fabrics of 'E' glass fibre (*first revision*)
6746 : 1994	Unsaturated polyester resin system for low pressure fibre reinforced plastics (*first revision*)	11320 : 1985	Glassfibre roving for reinforcement of polyester and of epoxide resin systems
		11551 : 1986	Glassfibre chopped strand mat for the reinforcement of polyester resin systems

ANNEX B

(*Clause* 8.2)

TENSILE STRENGTH

B-1 APPARATUS

A testing machine that can be operated at constant rates of crosshead motion.

B-2 TEST SPECIMEN

Five specimens shall be used for this test.

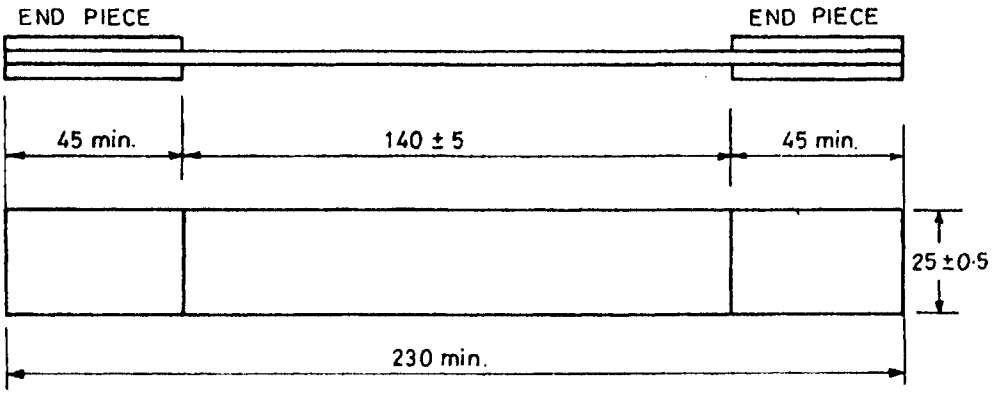
The test specimen shall be a rectangular strip not less than 230 mm long and 25 ± 0.5 mm wide with four rectangular end pieces, as shown in Fig. 2, bonded to it with a cold-hardening epoxide resin. The thickness of the rectangular strip shall be that of the sheet under test. The faces shall be parallel to within 0.15 mm.

The four end pieces of any one test specimen shall be of the same thickness, which shall be not less than 3 mm. They shall be prepared from material similar to that under test.

NOTES

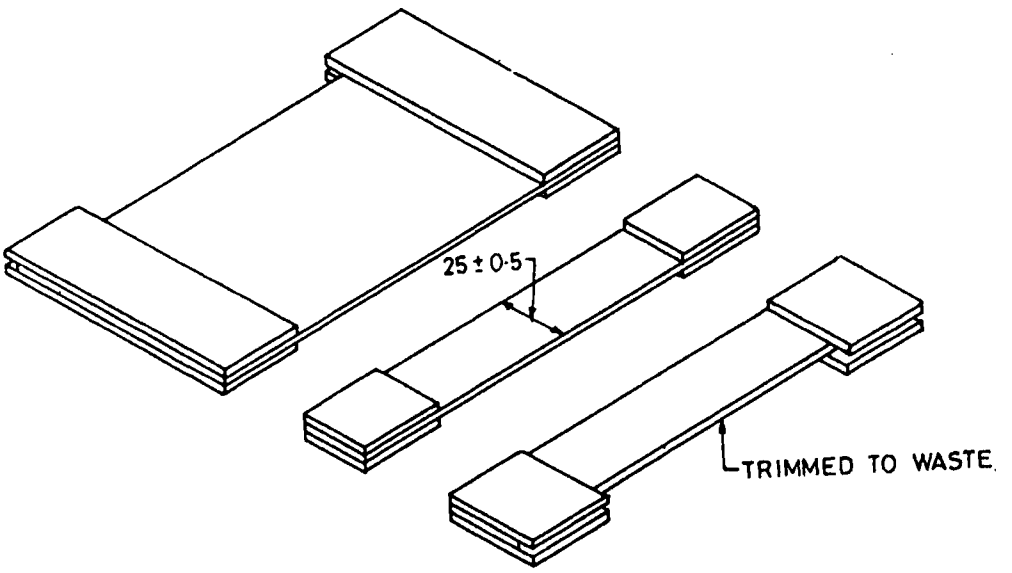
1 Before the adhesive is applied the surfaces to be bonded should be slightly roughened with a fine grade of abrasive paper and thoroughly cleaned with solvent. It is recommended that the assembly should be allowed to stand overnight while under pressure.

2 Test specimens can be sawn from the blank (*see* Fig. 3) by means of a carbide-tipped fine toothed circular saw or a nylon-bonded carborundum wheel. The sawing operation must not overheat the specimen and the sawn edges must be free from imperfections. It is essential that the edges of the specimen are not finished by hand.



All dimensions in millimetres.

FIG. 2 TEST SPECIMEN



All dimensions in millimetres.

FIG. 3 METHOD OF PREPARING SPECIMENS WITH ATTACHED END PIECE FROM TEST BLANK

B-3 PROCEDURE

The test shall be carried out at 27°C ± 2°C, after conditioning the test specimen at this temperature for two hours.

The mean width and mean thickness of the specimen between the end pieces shall be measured to the nearest 0.05 mm.

The specimen shall be clamped in the serrated jaws of a tensile machine. The jaws shall grip the entire faces of the end pieces and the specimen shall be in axial alignment with the direction of pull. The specimen shall be loaded by separating the grips at a substantially constant rate such that fracture occurs in 30 to 90 seconds. The maximum load shall be noted and shall not differ from the true load by more than 2 percent.

B-4 CALCULATION

$$\text{Tensile strength } (TS) = \frac{L_B}{A}$$

where

TS = tensile strength, MPa;
L_B = load at break, N; and
A = original cross-sectional area, mm^2.

Results obtained on specimens that break within the area of the end pieces shall be disregarded and additional specimens tested in their place. The tensile strength of the material under test shall be reported as the arithmetic mean of the tensile strengths of the test specimens.

ANNEX C

(Clause 8.2)

BENDING STRENGTH

C-1 APPARATUS

A testing machine that can be operated at constant rates of crosshead motion and in which the error in the load measuring system shall not exceed ± 1 percent of the maximum load expected to be measured. The radius of the loading blocks and supports shall be at least 3.0 mm.

C-2 TEST SPECIMEN

Five test specimens shall be used for this test. Each specimen shall be a rectangular bar 12.70 ± 0.50 mm wide and of length 24 to 30 times its thickness. The thickness of the specimen shall be the thickness of the panel under test.

C-3 PROCEDURE

The test shall be carried out at a temperature of 27°C ± 2°C.

The breadth (b) and thickness (d) of the specimen shall be measured to the nearest 0.03 mm.

The specimen shall be placed symmetrically across two parallel V-shaped supports, the distance (L) between the supporting edges being 16 times the measured thickness of the specimen, to the nearest 1 mm.

A load shall be applied squarely across the breadth of the specimen by means of a third V-shaped block parallel to and midway between the supporting blocks. The contact edges of the supporting blocks and the block applying the load shall have a radius of at least 3.0 mm. The cross-head speed shall be set to 5.0 mm/minute. The load of fracture (P) shall be noted.

C-4 CALCULATION

The bending strength of the test specimen shall be computed as follows:

$$S = \frac{3PL}{2bd^2}$$

where

S = bending strength, MPa;
P = load at fracture, N;
L = support span, m;
b = breadth of specimen, m; and
d = thickness of specimen, mm.

The bending strength of the material under test shall be reported as the arithmetic average of the bending strength of the test specimens.

NOTE — The above calculation is not valid if the specimen is slipping excessively between the supports. Care should be taken to ensure that there is no slippage.

ANNEX D

(*Clause* 8.2)

ELASTIC MODULUS IN BEND

D-1 APPARATUS

A testing machine that can be operated at constant rates of cross-head motion.

D-2 TEST SPECIMEN

Two specimens shall be used for this test. Each specimen shall be of a rectangular bar. The length of the specimen shall be not less than 24 times its thickness and breadth shall be 10 to 25 mm. The thickness of the specimen shall be equal to the thickness of the corresponding panel.

D-3 PROCEDURE

The test shall be carried out at 27 ± 2°C.

The breadth and thickness of the specimen shall be measured to the nearest 0.01 mm.

The specimen shall be placed symmetrically across two parallel supports. The edges making contact across the specimen shall have radii of 1.5 to 3.5 mm. The distance (L) between the lines of contact of the supports with the specimen shall be 16 times the thickness of the specimen, accurate to the nearest 1 mm.

A load shall be applied squarely across the breadth of the specimen by means of a loading nose of radius 5 mm and parallel with and midway between the two supports. The rate at which the specimen shall be deflected that is, the rate of travel of the loading nose relative to the supports on which the specimen rests shall be 5 mm/min. For a series of values of force the corresponding deflections shall be noted and from there a load-deflection curve shall be drawn.

D-4 CALCULATION

The elastic modulus in bending of the specimen shall be calculated from the initial straight part of the load deflection curve as follows:

$$\text{Elastic modulus in bend } (E_{MOD}) = \frac{PL^3}{4\,bd^3D}$$

where

E_{MOD} = elastic modulus in bending, MPa;
P = load selected from the straight part of the curve, N;
L = distance between supports, mm;
b = breadth of specimen, mm;
d = thickness of specimen, mm: and
D = deflection corresponding to the load, mm.

The elastic modulus of the material under test shall be reported as the arithmetic average of the elastic modulus of the test specimens.

ANNEX E

(*Clause* 8.2)

GLASS CONTENT OF GLASS-REINFORCED LAMINATES

E-1 APPARATUS

a) A weighing balance with an accuracy of ± 10 mg,
b) A muffle furnace,
c) A crucible of appropriate dimensions, and
d) A desiccator.

E-2 TEST SPECIMEN

Two specimens shall be tested for sample containing no filler and colouring agent according to E-3(a). Three specimens shall be tested for sample containing filler and/or colouring agent according to E- 3(b).

The specimen may be of any convenient shape provided that it is representative of the material under test and that its mass is not less than 5 g. A rectangular specimen, with a face of area not less than 400 mm^2 and whose shorter edges are not less than 12 mm long, is usually suitable.

E-3 PROCEDURE

A crucible of appropriate dimensions shall be heated in a muffle furnace at 575°C±25°C for 15 minutes, cooled in a dessicator and weighed (W_1). The test specimens shall be placed in the crucible and the crucible and contents heated in an oven at 105°C to 110°C for 2 h. The crucible and contents shall then be cooled in a dessicator, weighed and returned to the oven for a further 30 min, cooled and reweighed. This procedure shall be repeated until the mass (W_2) of crucible and specimen becomes constant to within 0.01 g:

a) Sample containing no filler and colouring agent:

The crucible and contents shall then be heated in a ventilated muffle furnace at a temperature of 575°C±25°C for 30 minutes or more, until the residue of glassfibre is white in colour . The crucible and contents shall then be removed from the furnace, allowed to cool in a dessicator and weighed. This process of heating, cooling and weighing shall then be repeated until the mass (W_3) becomes constant to within 0.01 g.

b) Sample containing filler and/or colouring agent:

The crucible and contents shall be heated in a ventilated muffle furnace at a temperature of 575°C± 25°C to burn out the resin completely (by repeating the process of heating and weighing as above), leaving behind the glass, filler and colouring agent. Water shall then be added to the residue and the mixture shall be filtered through a tared standard sieve of 200 mesh size. Wash the residue with water till the filtrate is clear. The glass residue shall then be heated at 105°C to 110°C for 3 h or more until the mass of the glass residue (W_4) becomes constant to within 0.01 g.

E-4 CALCULATION

E-4.1 For samples determined according to E-3(a):

$$\text{Percentage glass content} = \frac{100\,(W_3 - W_1)}{(W_2 - W_1)}$$

where

W_1 = mass of crucible,
W_2 = mass of sample + crucible, and
W_3 = mass of glass residue + crucible.

E-4.2 For samples determined according to E-3(b):

$$\text{Percentage glass content} = \frac{100\,W_4}{W_2 - W_1}$$

where

W_1 = mass of crucible,
W_2 = mass of sample + crucible, and
W_4 = mass of glass residue.

The glass content of the material under test shall be reported as the arithmetic mean of the results obtained on the test specimens.

ANNEX F

(*Clause* 8.2)

BARCOL HARDNESS

F-1 APPARATUS

F-1.1 Indentor

The indentor shall consist of a hardened steel truncated cone having an angle of 26° with a flat tip of 0.157 mm in diameter. It shall fit into a hollow spindle and be held down by a spring loaded plunger (*see* Fig. 4).

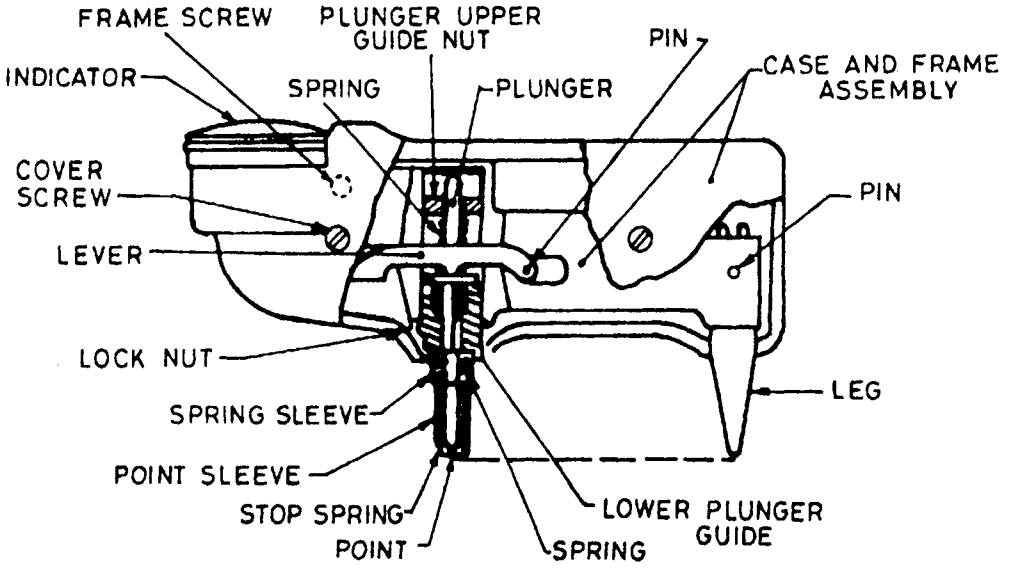


FIG. 4 DIAGRAM OF BARCOL IMPRESSOR

F-1.2 Indicating Device

The indicating dial shall have 100 divisions, each representing a depth of 0.007 6 mm penetration.

F-2 TEST SPECIMENS

Number of test specimen shall be taken as five.

The testing area shall be smooth and free from mechanical damage.

Test specimens shall be at least 1.5 mm thick and large enough to ensure a minimum distance of 3 mm in any direction from the indentor point to the edge of the specimen.

F-3 PROCEDURE

The test shall be carried out at a temperature of 27°C ± 2°C and 65 ± 5 percent relative humidity.

Place the impressor and the material to be tested (for the calibration disc) on a solidly supported, flat, hard, firm surface such as stone, metal or ceramic. If softer supporting surfaces are used, a falsely low instrument reading may occur.

Set the point sleeve on the surface to be tested. Set the legs on the same surface or on solid material of the same thickness, so that the indentor is perpendicular to the surface being tested. Grasp the instrument firmly between the legs and point sleeve. Apply quickly, by hand, uniformly increasing force on the case until the dial indication reaches a maximum. Record the maximum reading obtained.

F-4 CONDITIONING

Test specimens shall be conditioned at 27°C ± 2°C and 65 ± 5 percent relative humidity for at least 40 h prior to test.

F-5 NUMBER OF READINGS

Minimum number of readings per sample shall be eight, taking care that impressions are not made within 3 mm of the edge of specimen or earlier impressions.

F-6 REPORT

Report the average of the hardness value.

ANNEX G

(*Clause* 8.2)

WATER ABSORPTION

G-1 APPARATUS

A weighing balance with an accuracy of ± 10 mg.

G-2 TEST SPECIMEN

Two specimens shall be used for this test.

The specimen shall be 38±0.5 mm^2 and shall have smooth edges.

The thickness of the specimen shall be the thickness of the sheet under test.

The surfaces of all specimens shall be free from dust, oil or other matter that might interfere with the absorption of water.

G-3 PROCEDURE

The thickness of the test specimen shall be measured to the nearest 0.025 mm. The specimen shall then be weighed (W_1) and immersed for 24 ± 1 h in distilled water at 27°C ± 2°C. Precautions shall be taken to prevent specimens from making contact over any substantial area with one another or with the container. The specimen shall be dried with a clean cloth or filter paper and, not more than 2 min after removal from the water, shall be reweighed (W_2).

G-4 CALCULATION

The absorption coefficient shall be determined from the following:

$$A = \frac{W_2 - W_1}{W_1} \times 100$$

where

A = absorption coefficient (percent);
W_2 = mass of specimen after immersion in water, mg; and
W_1 = mass of specimen before immersion in water, mg.

The water absorption of the material under test shall be reported as the average of the water absorption of the test specimens.

ANNEX H

(*Clause* 9)

HYDROSTATIC TEST

H-1 EQUIPMENT

H-1.1 A hydrostatic tester with a minimum pressure of 200 kPa for the panel (*see* Fig. 5).

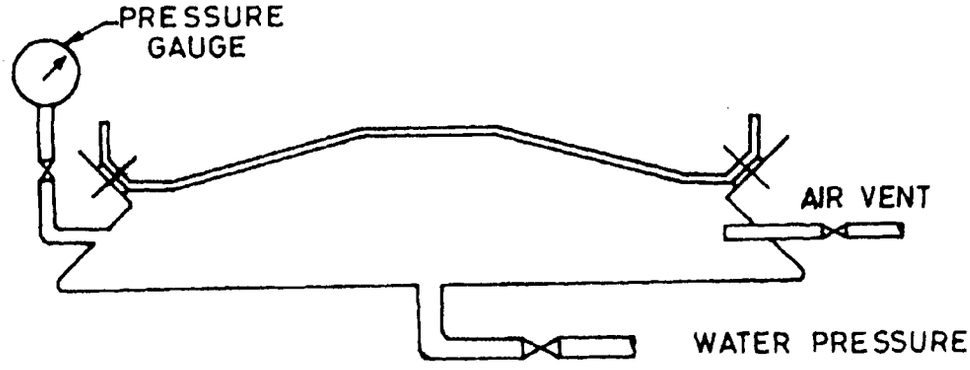


FIG. 5 THE HYDROSTATIC TESTER

H-1.2 A pressure gauge with a graduation of 10 kPa with an accuracy of ± 1 percent full range.

H-2 TEST SPECIMEN

One GRP panel.

H-3 TEMPERATURE OF TEST

Test can be carried out indoors or outdoors provided that the temperature does not exceed 40°C.

H-4 CALCULATION

Pressure for test shall be calculated as shown below:

$$P = gh\rho \times S, \text{ N/m}^2$$

where

h = denotes height of sectional GRP water tank, in m;

ρ = denotes density of fluid in tank, in kg/m^3, (For water, $\rho = 10^3$ kg/m^3);

S = denotes safety factor (to be taken as 4); and

g = denotes gravitational constant, taken as 9.81 m/s^2.

H-5 PROCEDURES

The panel shall be fixed to the hydrostatic tester as shown in Fig. 5. The hydrostatic tester shall be filled with water and the chamber shall be completely evacuated of air. Pressure shall be increased at regular intervals of 5 kPa per minute until the pressure P is achieved. If no bursting, crack or leakage is observed, the panel shall be deemed to have passed this test.

ANNEX J

(*Clauses* 11.2, 11.3, 11.4 *and* 11.5)

ESTABLISHING POTABILITY OF WATER

J-1 GENERAL

The effects of the material of GRP water tank on the quality of potable water shall be determined by the following tests:

a) Effect on Taste, Odour, Colour and Turbidity;
b) Toxic Metals;
c) Cytotoxicity; and
d) Microbiological Growth.

J-2 TEST SPECIMEN

J-2.1 Number of Specimen

Eight specimens shall be tested. Each test shall be carried out in duplicate using 2 separate test specimens. Alternatively, 4 containers internally coated with the specimen coatings, may be used, 2 for the microbiological growth test and the other 2

to be used in succession for each of the remaining 3 tests.

J-2.2 Size of Specimens

The surface area of each specimen shall be 150 cm^2 ± 10 percent. The specimen should not exceed 15 cm in length and 6 cm in width or depth. For sample containers the capacity should be between 1 to 5 litres.

J-2.3 Sample Preparation

Specimens of coatings shall be applied to water tank or containers of an appropriate material of the size described above, including all appropriate primings and under coats, and completely covering all sides and edges. Specimens specially prepared for testing shall be subject to the same conditions of maturing or curing as would normally be achieved either in manufacture or on site. Specimens shall not be subject to any specialized cleaning procedures, except where this would normally occur.

J-3 METHOD OF TEST FOR TASTE, ODOUR, COLOUR AND TURBIDITY

J-3.1 Extraction

Immerse the test specimens in 750 ml of odour-free tap water contained in glass vessels for a period of 24 h, 48 h and 7 days at room temperature. In the case of containers, place at least one litre of water in the sample. Store an additional quantity of odour-free tap water for the same periods of time and under the same conditions as control.

J-3.2 Assessment

The extracts shall be examined at the end of 24 and 48 h and 7 days for taste, odour, colour and turbidity and it shall satisfy the requirements of 11.2.

J-4 METHOD OF TEST FOR TOXIC METALS

J-4.1 Extraction

Immerse the test specimen in 750 ml of distilled water contained in a glass container for a period of 24 h. In the case of containers, use at least one litre of water. Store an additional quantity of distilled water for the same period and under the same conditions as control.

J-4.2 Assessment

Determine the quantities of toxic metals in the extract. The analysis should normally include arsenic, cadmium, chromium, copper, lead and selenium. Other metals such as barium, beryllium, managanese, mercury, molybdenum, silver, tin, vanadium and zinc should be included if known to be incorporated in the sample. The assessment should preferably be made by atomic absorption spectrophotometry, or by any other standard methods as agreed by the purchaer or inspection agency.

J-4.3 Repeat Tests

If the results obtained are greater than the limits specified in IS 10500 : 1991 for drinking water, make further 24 h extractions until results lower than these limits are obtained up to a maximum of 7 daily extractions.

J-5 METHOD OF TEST FOR CYTOTOXICITY

J-5.1 Extraction

Immerse the test specimen in 750 ml of tap water contained in a borosilicate glass container for a period of 24 h at room temperature. In the case of containers, use at least one litre of water. Store an additional quantity of tap water for the same period and under the same conditions as control. Cover the containers during period of extraction.

J-5.2 Materials and Media

J-5.2.1 *Cell Line*

African green monkey kidney cells (VERO established cell line ATCC Number CCL 81) or equivalent shall be used.

J-5.2.2 *Media*

Commercially available media may be used wherever practical provided that they are known to be suitable for use with the cell line. Only glass distilled water, known to be free from any cytotoxic effects shall be used.

J-5.2.2.1 *Growth medium*

Distilled Water *	90 ml
199 concentrate (X10) with Earle's salts but without sodium bicarbonate buffer	10 ml
Newborn calf serum	7 ml
Gentamicin solution (4 000 i.u.ml^{-1})	1 ml
4.4 percent sodium bicarbonate buffer saturated with carbon dioxide	2 ml

J-5.2.2.2 *Maintenance medium*

Distilled Water *	90 ml
199 concentrate (X10) with Earle's salts but without sodium bicarbonate buffer	10 ml
Newborn calf serum	2 ml
Gentamicin solution (4 000 i.u.ml^{-1})	1 ml
4.4 percent sodium bicarbonate buffer saturated with carbon dioxide	3 ml

* The extract shall be used in place of distilled water for conducting the test.

J-5.2.2.3 All components of the medium shall be known to be sterile, and the medium must be prepared aseptically. Store in the dark at 4°C ± 1°C.

J-5.2.2.4 *Concentrated growth and maintenance media.*

These shall be prepared to the formulae given in J-5.2.2.1 but excluding any distilled water. Store at 4°C ± 1°C.

J-5.2.2.5 *Trypsin solution*

Trypsin	0.25 gm
Phosphate buffered saline	100 ml

Warm to 37°C to dissolve. Check *p*H 7.2 sterilize by filtration through 0.22 μm membrane filters. Store at −20°C.

J-5.3 Preparation of Cell Suspension

Obtain a 24 h or 48 h confluent monolayer culture of the cells in 4 oz or other suitably sized sterile medical flat bottles with airtight closures using the growth and maintenance media specified in J-5.2.2.1 Pour the growth or maintenance medium off the cells, irrigate the cells well with 10 ml phosphate buffered saline, discard this and add 5 ml of the trypsin solution, place the bottle on its side with the cell layer covered completely, leave for 30 seconds at room temperature and then pour off the excess trypsin solution. Incubate the bottle at 37°C ± 1°C for 4 to 5 min. Examine the bottle to ensure that the cells have become detached from the bottle surface and if satisfactory add about 2.5 ml growth medium and shake the bottle gently to suspend the cells. The number of viable cells per ml of the cell suspension may be determined by the use of a haemacytometer counting chamber together with the use of a suitable stain, such as Trypan Blue.

J-5.4 Procedure

After 24 h, remove aliquots of the extract from each test container and the control. Both growth and maintenance media shall be prepared for each specimen and control. Prepare culture media by placing 0.5 ml of either concentrated growth or maintenance media together with 4.5 ml of either the test extract or control into a sterile bottle, and mix thoroughly. Store the maintenance media at 4°C ± 1°C for later use.

To each bottle containing the diluted growth medium, add at least 5×10^5 monkey kidney cells, gently mix the contents and then transfer immediately 1 ml aliquots of this cell suspension into five sterile tubes (12 mm × 100 mm) with airtight closures. Cap each tube tightly and then incubate the tubes at 37°C ± 1°C for 24 h and inclined at an angle of 7.5° ± 2.5° from the horizontal. After incubation for 24 h remove the tubes and examine the state of the tissue culture microscopically.

J-5.5 Assessment

If there is confluent growth in the tubes from the control and the test extracts, examine the cells closely for any signs of toxicity, for example irregular shaping of cells, signs of 'rounding off' of the cells in any appreciable number, or granular inclusions.

a) Where no initial signs of any adverse reactions are seen in the confluent cell monolayer, there is no need to continue the test and the sample may be considered free from cytotoxicity.

b) If there is any appreciable irregular shaping or 'rounding off' of the cells or granular inclusions in the cells in the test system, pour off the growth medium from each tube and replace it with the appropriate maintenance medium prepared previously and store at 4°C ± 1°C and reincubate the tubes at 37°C ±1°C. Re-examine the cells at daily intervals for three to four days, recording the state of the culture on each occasion. If the cells remain viable without increasing signs of cytotoxic reactions, the sample shall be considered to be free from cytotoxicity.

J-5.6 Repeat Test

If any of the five tubes show any signs of continuing cytotoxicity at any time (except where this cytotoxicity is caused by a failure to obtain an airtight seal on the tube-indicated by a magenta colouration of the medium in the tube) the test shall be repeated for a second, and if needed a third 24 hours extraction.

J-6 METHOD OF TEST FOR MICRO-BIOLOGICAL GROWTH

J-6.1 Preparation

Place specimens in specially-cleaned 2 l wide necked flasks. Use empty flasks as controls. In the case of containers, these containers shall serve as the recipient for the inoculum and water amounting to not less than one litre of water, and it should be possible to cover the top with aluminium foil or other suitable material.

J-6.2 Inoculation

To each container place 100 ml of inoculum. The inoculum shall be a suitable source of micro-organisms, for example river or well water, or dechlorinated tap water with added organisms. The inoculum shall be standardized to contain about 100-10 000 coliform organisms and between 1 and

500 pseudomonas aeruginosa, some fungi and yeasts. Each container shall then be filled to one litre with dechlorinated tap water.

J-6.3 Incubation and Assessment

Cover each container and incubate at room temperature in the dark. After 3 days remove all the water, except 10 ml from the container and refill to one litre with fresh dechlorinated tap water. This procedure should be repeated twice weekly as long as is necessary to complete the test.

At weekly intervals, beginning four weeks from the initial inoculation, withdraw samples of water from each flask after shaking, just prior to the water being changed. Examine these samples quantitatively for the organisms given below. Also examine for visible growth.

Treat the control containers similarly.

J-6.4 Enumeration Techniques

J-6.4.1 *Coliform Organisms*

Count coliform organisms by the standard membrane filtration technique or the standard multiple tube method.

J-6.4.2 *Colony Counts at 37°C and 22°C*

Carry out the aerobic plate count procedure as given in the standard references (J-6.4.1). Incubate plates at 37°C for 48 h and 22°C for 72 h.

J-6.4.3 *Pseudomonas Aeruginosa*

Use the standard membrane filtration technique and place the membranes on pads saturated with King's A Broth (Drake's modification), the composition of which is as follows :

Bacto-peptone 20 g, ethanol 20 g (or 25 ml), K_2SO_4 10 g, $MgCl_2$ 1.4g (or $MgCl_2 6H_2O$ 2.9 g) cetrimide 0.5 g, distilled water to 1 l. Sterilise at 121°C for 15 min.

Incubate at 37°C for 48 h, count colonies which are green and/or fluorescent under an ultra-violet lamp of 250 mm wave length to obtain a presumptive count of pseudomonas aeruginosa. Confirm the colonies by subculture from the membrane on to milk agar, or other suitable medium, incubated at 41.5°C ± 0.5°C for 24 h. Growth at this temperature, coupled with production of a green and/or fluorescent pigment and case in hydrolysis, is confirmation of the organism.

J-6.4.4 *Fungi and Yeasts*

Carry out the standard membrane filtration technique and place the membrane on plates containing previously poured Rose Bengal Agar incoporated with a suitable antibiotic such as Kanamycin (100 μg/ml) or aureomycin (50 μg/ml), Incubate at room temperature for up to 7 days.

J-6.4.5 *Further Tests*

If all the counts of each group of micro-organisms are within the prescribed requirement the test shall cease and the sample shall be deemed not to have supported a significant microbial activity. If all the counts of each group of micro-organisms fall outside the prescribed requirement the test shall cease and the sample be deemed to have supported a significant microbial activity.

If any of the counts are not within the prescribed limits by six weeks, carry on weekly assessment for another 2 weeks. Any sample not giving three satisfactory consecutive counts on each group of micro-organisms within eight weeks from the beginning of the test shall be deemed to have supported a significant microbial activity.

NOTE — If counts in the test flask are less than 10 percent of those in the control flask after the 4th, 5th and 6th week of testing, this indicates the presence of leachable biocidal material and makes the test procedure unsuitable for the assessment of the material under test.

Indian Standard

HOT PRESS MOULDED THERMOSETTING GLASS FIBRE REINFORCED POLYESTER RESIN (GRP) SECTIONAL WATER STORAGE TANKS

PART 2 GUIDELINES FOR ASSEMBLY, INSTALLATION AND TESTING

1 SCOPE

1.1 This standard (Part 2) lays down the requirements for assembly, installation and testing of glass fibre reinforced polyester (GRP) resin sectional water storage tanks of capacities 1 000 l to 5 lac litres, meant for storing potable water under pressure not exceeding the static head corresponding to the depth of the tank and temperature of water not exceeding 50°C.

1.2 GRP panels used in manufacturing of tanks are covered in Part 1 of the standard.

2 REFERENCES

The Indian Standards listed in Annex K are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard, the definitions given in Part 1 of this standard shall apply.

4 MATERIALS AND CONSTRUCTION

4.1 Panels

GRP Panels to be used in the fabrication of tanks shall conform to Part 1 of this standard.

4.2 Sealants

The material used for sealing shall be non-toxic and chemically resistant to the quality of water stored. It shall also be able to withstand the temperature variation during service. It is recommended to use butyle rubber/neoprene rubber/silicon rubber sealants. Any other sealing material, if used shall be duly approved by the purchasing authority.

4.3 Bolts and Nuts

4.3.1 The bolts and nuts used as fasteners shall be conforming to IS 1364 (Part 1) : 1992 and IS 1364 (Part 3) : 1992 respectively. The diameter of bolt shall not be less than 10 mm.

4.3.2 The bolts and nuts used shall be hot dip galvanised meeting the requirements specified in IS 1367 (Part 13) : 1983.

4.3.3 If internal bolting is resorted, the bolts shall be made of stainless steel conforming to IS 1364 (Part 1) : 1992.

4.4 Support System

4.4.1 The interior supports system shall be either of stainless steel conforming to IS 6911 : 1992 or GRP or UPVC. The exterior supports shall be made of mild steel thoroughly coated with a suitable non-corrosive and non-toxic material or hot dip galvanised to IS 1367 (Part 13) : 1983.

4.4.2 A typical layout of the support system of the tank is given in Fig. 1 and Fig. 2.

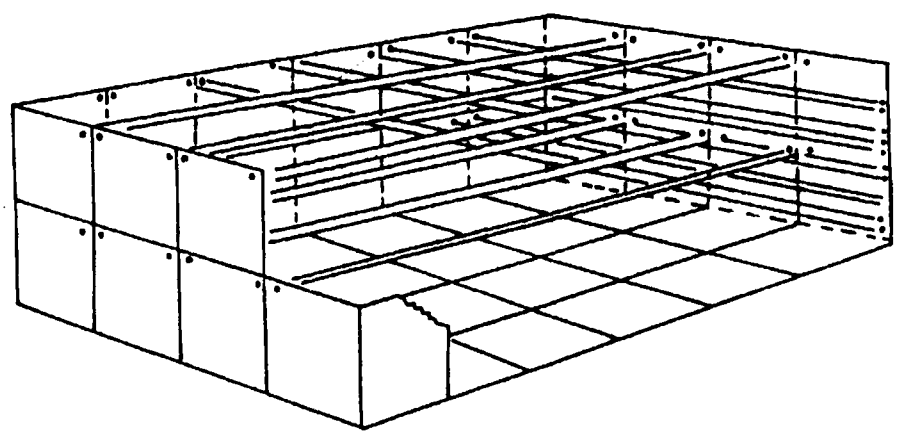


FIG. 1 TYPICAL LAYOUT OF INTERNAL STAY BAR SYSTEM FOR SUPPORTING PANELS

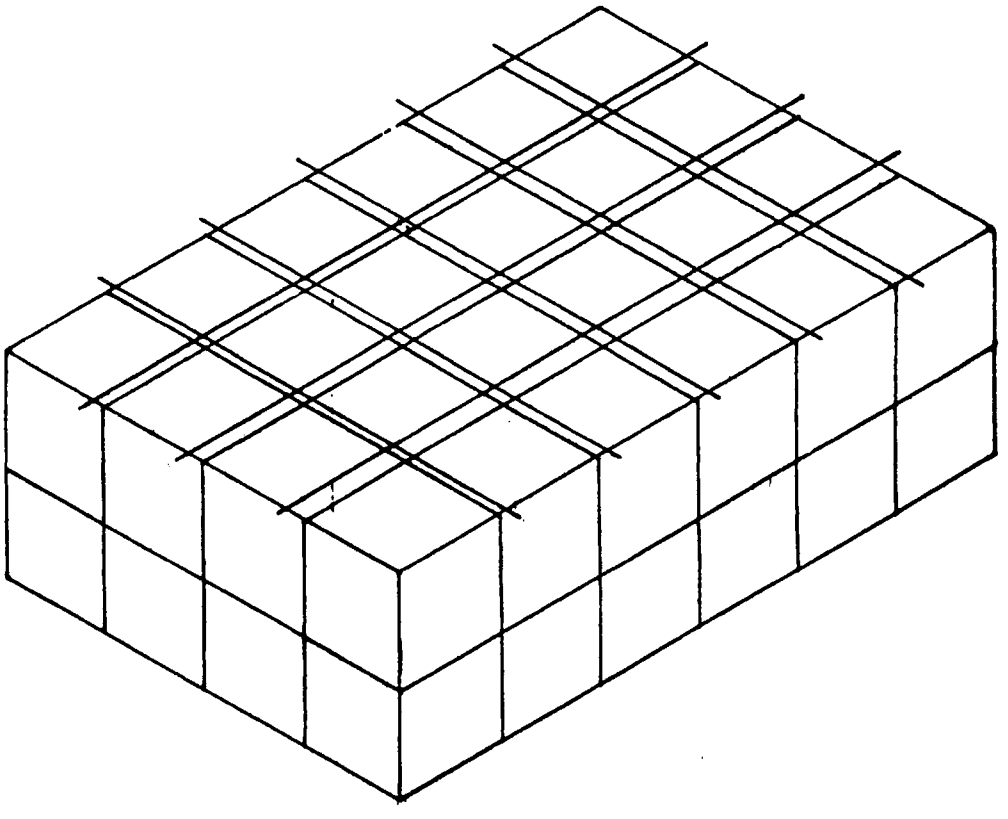


FIG. 2 TYPICAL LAYOUT OF EXTERNAL STAY BAR SYSTEM FOR SUPPORTING PANELS

4.5 The roof of the tank shall be made of non-corrosive material with sufficient strength to allow man traffic.

4.6 The tank shall be provided with inlet, outlet, overflow, drain, airvent, external and internal ladders. The sizes, materials and positions of these shall be as agreed between purchaser and supplier of the tanks.

4.7 The manhole hatches shall also be made of GRP and hinges shall be of aluminium alloy or stainless steel. The minimum internal diameter of the manhole shall not be less than 450 mm.

4.8 Airvents shall be made from GRP or PVC. They should be designed and constructed adequately to prevent the entry of insects and other foreign materials.

4.9 The internal ladders shall be made of aluminium alloy or GRP. The external ladders may be of mild steel completely coated for corrosion protection.

5 DIMENSIONS OF TANKS

5.1 Length 'L' and breadth 'B', of water tanks shall be specified as mutliples of 0.5 m or 1 m.

5.2 Depth 'D' of water tanks shall be in multiples of 0.5 m subject to maximum of 3 m.

6 ASSEMBLY

6.1 General details for assembling the tank are in accordance with Table 1 with various types of flange joints are illustrated in Fig. 3.

Table 1 Details for Assembly of Tanks

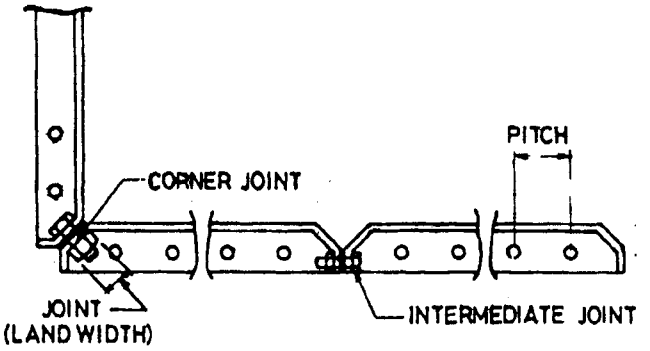
Depth of Tank (m)	Description of Panels with Regard to Location	Type of Panel
1	Top, bottom and sides	A
2	Bottom and lower tier of sides	B
	Top and top tier of sides	A
3	Bottom and lowest tier of sides	C
	Middle tier of sides	B
	Top and top tier of sides	A

6.2 Foundation/support system for the water tank shall be designed keeping in view the worst loading combination. Crossed girder system in structural steel ensuring peripherial support to each of the bottom panels as shown in Fig. 4 is recommended.

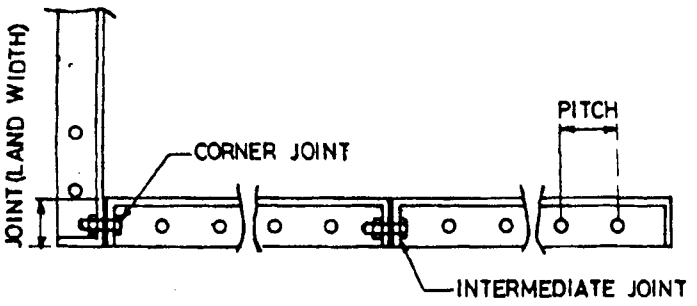
7 LEAKAGE TEST

7.1 After assembling, the tank shall be filled with water up to the overflow level and after 48 h there shall be no visible sign of leakage.

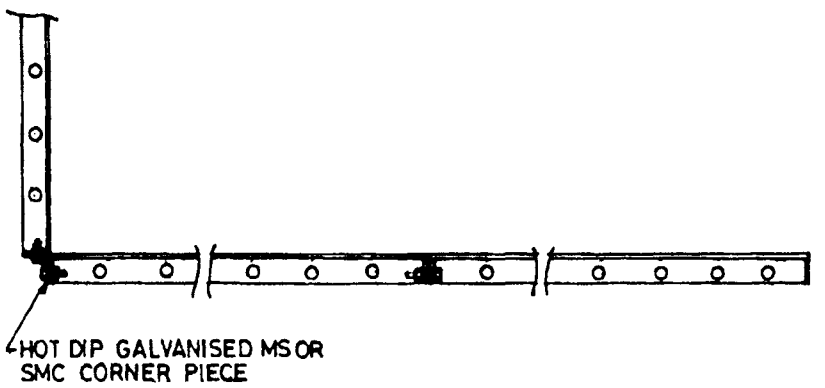
7.2 If the initial test fails, the leaks shall be stopped in accordance with the tank manufacturers recommendations and a further test carried out.



3 A

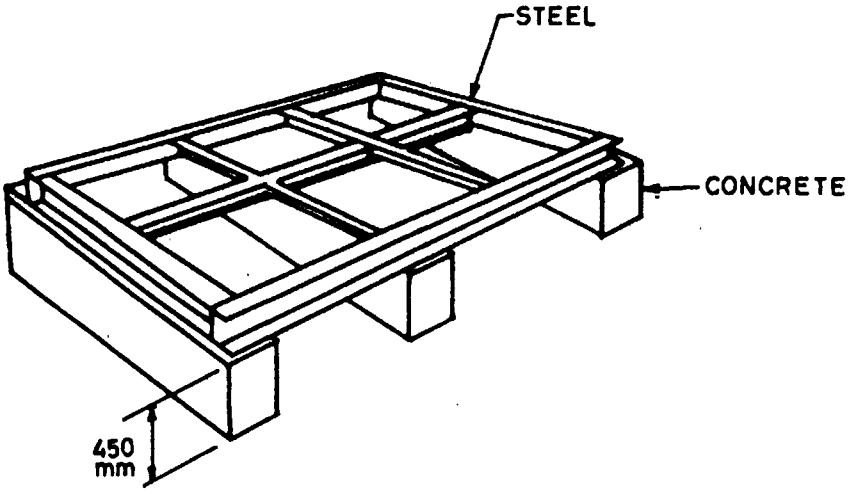


3 B



3 C

FIG. 3 TYPICAL FLANGE JOINTS



Note — The Edge of Every Panel Must be Resting on the Steel Structure

FIG. 4 STEEL FOUNDATION

ANNEX K

(Clause 2, Part 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
1364 (Part 1) : 1992	Hexagon head bolts, screws and nuts of product grades A and B: Hexagon head bolts (size range M1.6 to M64) (*third revision*)	1367 (Part 13) : 1983	Technical supply conditions for threaded steel fasteners: Part 13 Hot-dip galvanized coatings on threaded fasteners (*second revision*)
(Part 3) : 1992	Hexagon nuts (size range M1.6 to M64) (*third revision*)	6911 : 1992	Stainless steel plate, sheet and strip (*first revision*)

ANNEX L

(*Foreword*)

COMMITTEE COMPOSITION

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SHRI SANJAY AGGARWAL (*Alternate*)	
SHRI VIDHUR BHASKAR	Bhaskar Stoneware Pipes Pvt Ltd, Faridabad
SHRI ARUN KANTI BISWAS	National Environmental Engineering Research Institute (CSIR), Nagpur
CHIEF ENGINEER (RURAL)	Maharashtra Water Supply & Sewage Board, New Mumbai
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DY HYDRAULIC ENGINEER (*Alternate*)	
SHRI D. K. KANUNGO	National Test House, Calcutta
SHRI R. KAPOOR (*Alternate*)	
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EXECUTIVE ENGINEER (TAC) (*Alternate*)	
SUPRINTENDING SURVEYOR OF WORKS (NDZI)	Central Public Works Department, New Delhi
SURVEYOR OF WORKS (NDZI) (*Alternate*)	
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Member Secretary

SHRI R. S. JUNEJA
Joint Director (Civ Eng), BIS

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(*Continued on page* 20)

(*Continued from page* 19)

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