BUREAU OF INDIAN STANDARDS

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Draft Indian Standard

SPECIFICATION FOR SPIRAL WELDED PIPES

(*Second Revision of* IS 5504)

ICS 77.140.75

Steel Tubes, Pipes and Fittings Sectional Committee, MTD 19	Last date of comments **05 April 2024**

FOREWORD

(*Formal foreword clause will be added later*)

This standard was first published in 1969 to meet the increased application of spiral welded pipes and subsequently revised in 1997.

This revision has been brought out to bring the standard in the latest style and format of the Indian Standards. In addition, the following significant modifications have been made:

a) All amendments issued to this standard have been incorporated;
b) Clause on manufacturer has been modified;
c) Clause on tensile test has been modified;
d) Requirement for hydrostatic test has been modified;
e) Requirement of the ovality has been modified;
f) Clause on types and grades has been added; and
g) Clause on marking has been modified

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

SPECIFICATION FOR SPIRAL WELDED PIPES

(Second Revision)

1 SCOPE

This standard covers the requirements of spiral seam welded steel pipe over 457 mm diameter and up to 3 250 mm diameter with wall thickness up to 25 mm inclusive.

2 REFERENCES

The following standards 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 subjected to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying to the most recent editions of the standards indicated below:

IS No.	*Title*
IS 228 (in various parts)	Methods of chemical analysis of steels
IS 1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
IS 1608 (Part 1) : 2022 / ISO 6892-1 : 2019	Metallic materials — Tensile testing: Part 1 Method of test at room temperature (*fifth revision*)

3 SUPPLY OF MATERIAL

General requirements relating to the supply of spiral welded pipes shall conform to IS 1387.

4 MANUFACTURE

4.1 Material for manufacture of pipes shall be of steel made by any process at the discretion of the manufacturer.

4.2 The pipes shall be made by rolling a strip, sheet or plate so that a helical seam is formed around the circumference of the pipe. The helical seam shall be welded by one of the following processes:

a) Electric fusion butt welding internally and submerged arc welding externally;
b) electric resistance welding; and
c) Automatic submerged-arc welding using at least two weld passes, one of which shall be on the inside of the pipe. All end welding of spiral seams of submerged-arc welding pipe if not done by automatic submerged-arc welding, shall be done by a procedure and welder qualified in accordance with Annex A.

4.3 The coil or sheet used for manufacture of the pipe shall be trimmed to the proper width and given special edge treatment required by the welding process. The material then shall be rolled so

that a helical seam is formed around the circumference of the pipe. The electric arc welding operation performed to fuse or seal the edges or surface of helical seam shall produce generally uniform weld.

5 TYPES AND GRADES

Types and grades of the welded pipes shall be based on the process of manufacture and minimum yield stress, in MPa, as given in Table 1.

Table 1 Types and Grades of Square and Rectangular Hollow Section

(*Clause* 5**)**

Type	**Grade**
(1)	(2)
Welded (WT)	WT310, WT410 and WT 450

6 CHEMICAL COMPOSITION

6.1 Ladle Analysis

The ladle analysis of the steel when analysed in accordance with the relevant parts of IS 228 shall be as given below:

Sl No.	*Constituents*	*Percent, Max*
(1)	(2)	(3)
i)	Carbon	0.25
ii)	Sulphur	0.05
iii)	Phosphorus	0.05

6.2 Product Analysis

Variation in case of product analysis from the limits specified in **6.1** shall be as follows:

Sl No.	*Constituents*	*Percent, Max*
(1)	(2)	(3)
i)	Carbon	0.02
ii)	Sulphur	0.005
iii)	Phosphorus	0.005

7 PHYSICAL TESTS

7.1 Tensile Test

7.1.1 One tensile test, either longitudinal or transverse as required, shall be made on a length of pipe from each lot of 200 lengths or less.

When tested in accordance with IS 1608, the tensile properties shall be as shown in Table 2.

Table 2 Tensile Properties

(*Clause* 7.1.1)

Sl No.	Grade Designation	Yield Strength, Min	Tensile Strength, Min	Elongation Percent, Min On GL 5.65 $\sqrt{S_0}$
(1)	(2)	(3)	(4)	(5)
i.	WT310	160	310	20
ii.	WT410	240	410	20
iii.	WT450	240	450	15
S_0 = Original cross-sectional area. GL = Gauge length in mm. 1 MPa = 0.102 0 kgf/mm^2.				

7.1.2 Tensile test specimen, shall be taken at such a portion that the centre of the specimen is located at least on quarter the distance adjacent to weld convolutions.

7.1.3 Retests

If the tensile test specimen representing a lot of pipe fails to conform to the specified requirements, the manufacturer may elect to make retests on two additional lengths from the same lot. If both retest specimens conform to the requirements all the lengths in the lot shall be accepted except the length from which the initial specimen was taken. If one or both the retest specimens fail to conform to the specified requirements, the manufacturer may elect to test individually the remaining lengths in the lot in which case determinations arc required only for the particular requirements with which the specimens failed to comply in the preceding tests.

7.1.3.1 If any tensile test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted. When the elongation of any tensile test specimen is less than that specified and if any part of the fracture is outside the middle third of the gauge length as indicated by scribe scratches marked on the specimen before testing a retest shall be allowed.

7.2 Flattening Tests

7.2.1 For electric resistance-welded pipes produced in single lengths, the crop ends cut from each end of each length shall be flattened between parallel plates until opposite walls of the pipe meet. The tests from each end shall be made alternately with the welds at 0°and 90° (point of maximum bending). No opening in the weld shall take place until the distance between the plates is less than two-thirds of the original outside diameter of the pipe, and no cracks or breaks in the metal,

elsewhere than in the weld, shall occur until the distance between the plates is less than one-third of the original outside diameter of the pipe. Also evidence of laminations or burnt metal shall not develop during the entire flattening operation. If any crop end fails to conform to these requirements additional tests shall be made on specimens cut from the same end of the same length of pipe until the requirements are met except that the finished pipe shall not be shorter than 80 percent of its length after the initial cropping. Precautions shall be taken so that the crop ends can be identified with respect to the length of pipe from which they were cut.

7.2.2 For electric-resistance-welded pipe produced in multiple lengths and subsequently cut into single lengths, the crop ends cut from each end of each multiple length shall be flattened between parallel plates until opposite walls of the pipe meet. The tests shall be made with the weld at 90° (point of maximum bending). The tests shall also be made on two intermediate rings cut from each multiple length of pipe with the weld at 0°. If any of the specimens fail to conform to the requirements specified in **7.2.1** the manufacturer may elect to make retests cut from each end of each individual length as provided in **7.2.1**. Retests shall be made with the welds alternately at 0° and 90°.

7.3 Submerged-Arc Weld Tests

7.3.1 For submerged-arc welds, the spiral weld and the skelp end weld shall be tested by either of the following tests at the option of the manufacturer. The required specimens shall be cut from a length of pipe from each lot of 100 lengths or less of each size. The specimen shall not contain any repair welding made by the manual metal-arc process.

7.3.1.1 *Guided-bend tests*

One face bend and one root bend specimen, both conforming to Fig. 1 shall be bent approximately 180° in jig substantially in accordance with Fig. 2 for any combination of diameter and wall thickness and grade. The manufacturer shall use a jig based on this dimension or a smaller dimension at his option. The maximum value for jig dimension *A* may be calculated by the formula given below:

$$A = \frac{1.15\ (D-2t)}{\frac{eD}{t}-2e-1}$$

where

1.15 = peaking factor,

D = specified OD in mm,

t = specified wall thickness in mm,

e = strain,

= 0.132 5 for Grade Fe 330

= 0.127 5 for Grade 410 and Grade Fe 450

The specimens shall not fracture completely and no cracks or other defects exceeding 3 mm in any direction shall be present in the weld metal or between the weld metal and the pipe metal. Cracks which originate at the edges of the specimen and which are less than 7 mm long shall not be the cause for rejection. At the option of the manufacturer, specimen may be flattened before testing.

7.3.1.2 *Retests*

If any guided bend test specimen representing a lot of pipe fails to conform to the specified requirement the manufacturer may Re-Sample from the same end of the pipe adjacent location where the failed specimen obtained. If the results obtained from the retest specimen are acceptable, normal test schedule shall be resumed. If the results obtained from retest specimen are not acceptable, the pipe shall be rejected & select two additional lengths from the same lot. If the both re-test specimen fulfill the requirements all length in the lot shall be accepted.

If one or both of the guided-bend specimens fail to conform to the specified requirements, the Manufacturer may elect to repeat the tests on specimens cut from two additional lengths of pipe from the same test unit. If such specimens conform to the specified requirements, each length in the test unit shall be accepted, except the length initially selected for test. If any of the retested specimens fail to pass the specified requirements, the manufacturer may elect to test specimens cut from individual lengths remaining in the test unit. The manufacturer may also elect to retest any length that has failed to pass the test by cropping back and cutting two additional specimens from the same end. If the requirements of the original test are met by both of these additional tests, that length shall be acceptable. No further cropping and retesting is permitted.

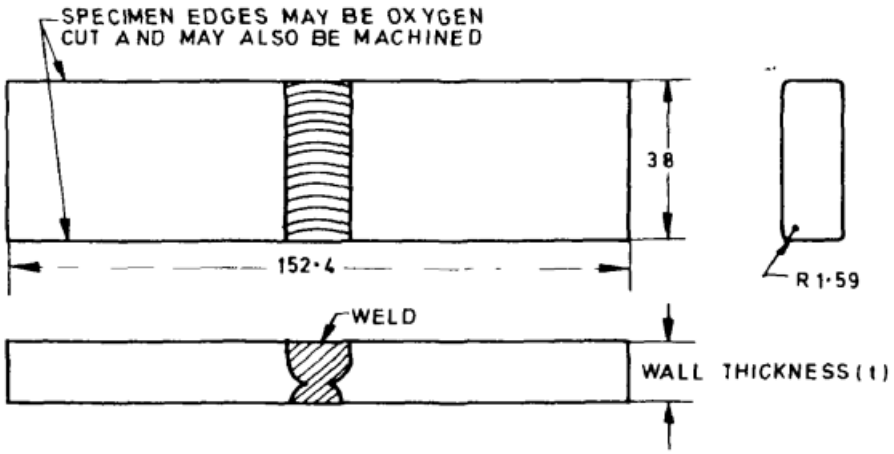
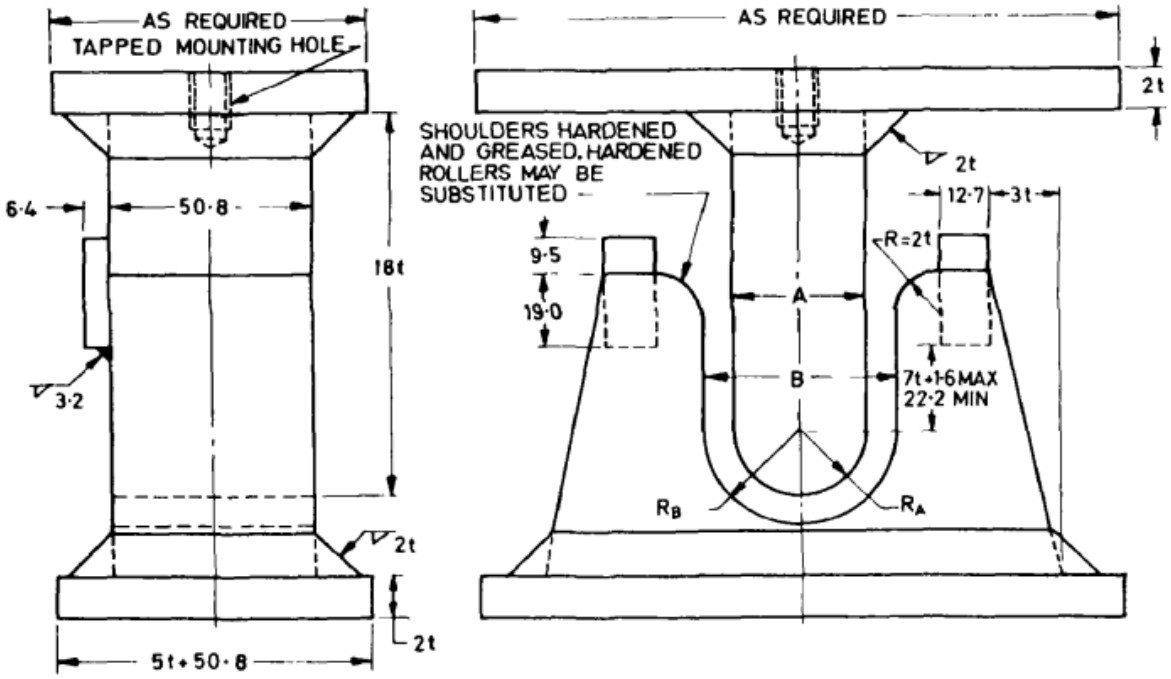


FIG. 1 GUIDED BEND TEST SPECIMENS



All dimensions in millimetres

FIG. 2 JIG FOR GUIDED BEND TEST

$$R_A = \frac{A}{2}\ B = A + 2t + 3.2 \text{ mm}$$

$$R_B = \frac{B}{2}$$

8 HYDRAULIC PRESSURE TEST

Each pipe shall be hydraulically tested at the manufacturer's works before the pipe is coated, wrapped and lined.

8.1 The hydraulic test pressure shall be the pressure calculated as per the following formula:

$$P = \frac{2ST}{D}$$

where

P = hydraulic test pressure MPa,

D = specified outside dia of the pipe in mm,

T = specified thickness of the tube in mm, and

S = stress 60 percent of the specified minimum yield stress in MPa. The maximum test pressure to be limited to 5 MPa wherever applicable.

8.1.1 Test pressures for each size of pipe with D ≤ 457 mm shall be held for not less than 5 seconds. Test pressures for welded pipe with D > 457 mm shall be held for not less than 10 seconds.

8.2 The hydraulic test may be substituted by a non-destructive test if agreed between manufacturer and purchaser.

8.2.1 Method of NDT and the acceptance level shall be as agreed to between the manufacturer and the purchaser.

9 PERMISSIBLE VARIATIONS IN DIMENSIONS

9.1 Lengths

Steel pipe shall be supplied in single random length between 4 m to 7 m or double random length of 7 m to 14 m. For order over 200 m it shall be permissible to supply short random length of 2 m to 4 m provided total or such lengths does not exceed 7.5 percent of supply of the order.

9.2 Thickness and Diameter

9.2.1 The tolerance on wall thickness shall be + 15 percent and – 12.5 percent unless otherwise agreed in plate/coil specification.

9.2.2 The tolerance on outside diameter of pipe shall be as follows:

Upto 1 000 mm OD = ± 0.75 percent

Over 1 000 mm OD = ± 1 percent

9.2.3 Ovality shall not exceed 1 percent of the specified outside diameter for pipes having diameter to thickness ratio not exceeding 100.Where the diameter to thickness ratio exceeds 100 the tolerance on ovality should be agreed between the manufacturer and the purchaser.

10 FINISH

The finished pipe shall be reasonably straight free from injurious defects and with ends prepared as specified in the purchase order.

10.1 The pipe shall be substantially round, outside circumference of the pipe shall not more than 10 percent from the nominal outside circumference based on diameter specified.

11 REPAIR BY WELDING

Injurious defects in pipe wall provided their depth does not exceed one third of the specified wall thickness shall be repaired by welding. Defects in the welds, such as sweats and leaks, unless otherwise specified shall be repaired or piece rejected at the option of the manufacturer. Repairs of this nature shall be made by completely removing the defect cleaning the cavity and then welding.

All repaired pipe shall be re-tested hydraulically in accordance with **8**.

12 PROTECTIVE COATING

After pipe is subjected to hydrostatic test if so specified by the purchaser outside surface may be given a protective coating of the kind specified by the purchaser.

13 MARKING

13.1 Each length of pipe shall be embossed or painted with the manufacturer's name or trademark. Each length of pipe shall be marked suitably with the following:

a) Name/trade-mark of the manufacturer;
b) Grade of material; and
c) Outside diameter and thickness.

13.2 BIS Certification marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

14 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser shall state in his enquiry or order:

a) Outside diameter, nominal thickness and total length of pipe required,
b) Purpose for which pipes are intended to be used,
c) Length range in individual tube to be supplied,
d) Working pressure for the pipe envisaged in conveying fluid, if any,
e) Whether any protective coating is needed on outside surface,
f) Whether he himself or representative wishes to witness hydrostatic test of individual pipe and
g) Any special markings required.

ANNEX A
(*Clause* 4.2)

REPAIR-WELDING PROCEDURE AND WELDER PERFORMANCE TESTS

A-1 GENERAL

A-1.1 All manual and semi-automatic submerged-arc and gas-shielded-arc repair welds and manual and semi-automatic metallic-arc repair welds using coated electrodes shall be made according to a tested procedure and by a repair-welder tested in a flat position as specified in **A-2** and **A-3**. When the base metal temperature of the material to be repair welded is below 10 °C, submerged-arc, gas-shielded-arc or manual metallic-arc methods with low hydrogen electrodes shall be used for the repair-welding test. The manufacturer shall maintain a record of the procedure and performance test results. Test welds may be made either on plate stock or pipe stock at the option of the manufacturer.

A-2 REPAIR-WELDING PROCEDURE TESTS

A-2.1 Repair-welding procedure tests ore required on two specimens from each test of every grade and on material which is on the high side of the chemical specification and which is at least as thick as the pipe on which welds are to be made. The repair-welding procedure test shall be made at a temperature at or below the lowest temperature at which repair welds are made.

A-2.2 Transverse Tensile Test

The transverse tensile test specimen (*see* Fig. 3) shall be approximately 38 mm wide and shall have the transverse metallic-arc butt weld perpendicular to the longitudinal axis at the centre of the test specimen. The weld reinforcement shall be removed from both faces. The ultimate tensile strength shall be at least equal to the minimum specified for the grade.

A-2.3 Longitudinal Tensile — Elongation Test

The longitudinal tensile-elongation test specimen shall conform to Fig. 4. The weld shall be made in a groove as shown. The elongation after complete rupture of the test specimen in tension shall be at least equal to the minimum elongation specified for the grade.

A-2.4 Transverse Guided — Bend Test

The transverse guided-bend test specimen shall conform to Fig. 5. The weld shall be made in a groove as shown. The specimen shall be placed on the die with the weld at mid-span and shall be bent approximately 180° in a jig in accordance with Fig. 2 with the exposed surface of the weld in tension. The bend test shall be considered acceptable if:

a) No crack or other defect exceeding 5 mm in any direction is present in the weld metal or between the weld and the pipe metal after bending. Cracks which originate along the edges of the specimen during testing and which tire less than 6.5 mm measured in any direction shall not be considered.
b) The specimen cracks or fractures during bending and the exposed surface shows complete penetration and fusion throughout the entire thickness of the weld specimen not more than

1 gas pocket per square cm with the greatest dimension not exceeding 1.6 mm and no slag inclusions greater than 0.8 mm deep or 3 mm wide and separated by at least 13 mm of sound metal (if necessary the specimen shall be broken apart to permit examination of the fracture).

A-2.5 Nick-Break Test

The nick-break specimen shall conform to Fig. 6. The weld shall be made in a groove as shown. The specimen shall be hacksaw-notched from both edges at the centre of the weld and shall be broken by pulling or hammer blows at the centre or one end. The exposed surface of the specimen shall be considered acceptable if it shows not more than

a) One gas pocket for nominal wall thicknesses of 6.35 mm and less;
b) Two gas pockets for nominal wall thicknesses of 12.7 mm or less but greater than 6.35 mm;
c) Three gas pockets for nominal wall thicknesses greater than 12.7 mm. The greatest dimension of a gas pocket shall not exceed 1.6 mm. Slag inclusion shall be separated by at least 13 mm of sound metal and shall be not greater than 0.8 mm deep or 3 mm wide.

A-3 REPAIR-WELDERS PERFORMANCE TEST

A-3.1 Repair-welders performance tests are required on two specimens from each test of every grade, except that a welder qualified on one grade is also qualified for any lower grade. If either of the two specimens fails to conform to the requirements specified, four retests shall be required if made immediately, or two retests shall be required if the welder takes further instructions in the practice before making a retest. All retests shall conform to the requirements specified. Further performance tests are required at a minimum of one-year intervals and also if the repair-welder is not engaged in the tested repair-welding procedure for a period of three months or more or if there is some specific reason to question his ability. Both of the following tests shall be made:

a) Transverse guided-bend test as stipulated under welding procedure test (*see* **A-2.4**) and
b) Nick-break test as stipulated under welding-procedure test (*see* **A-2.5**)

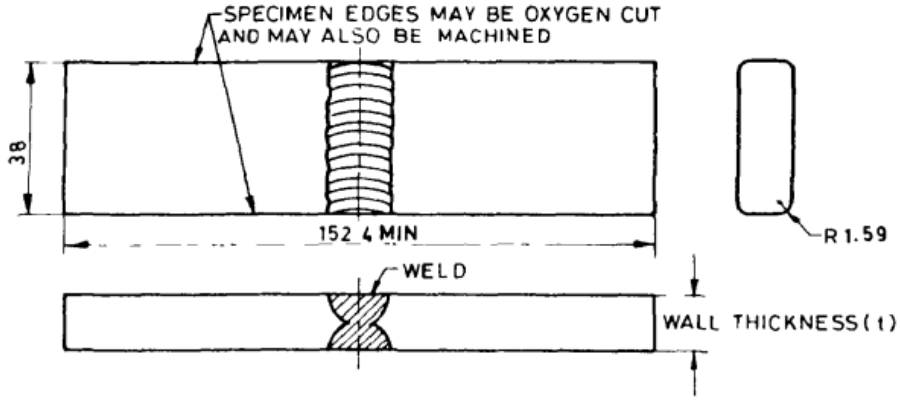
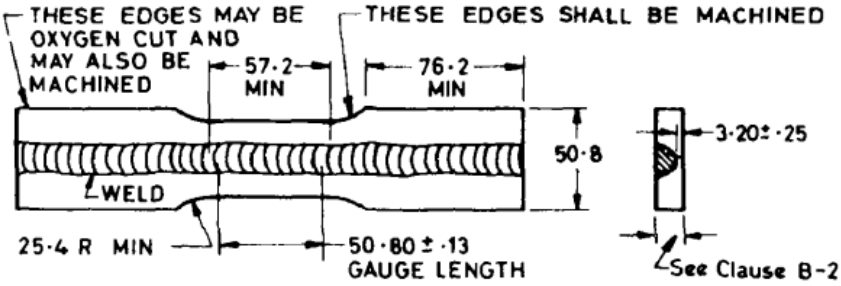
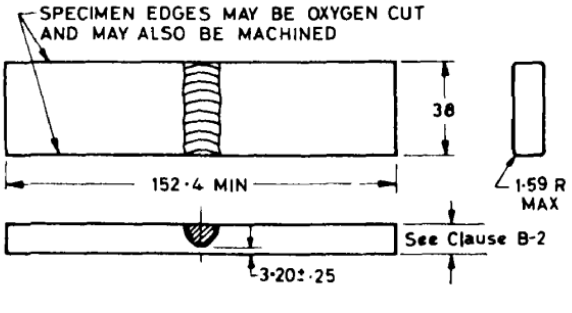


FIG. 3 TRANSVERSE TENSILE TEST SPECIMEN



All dimensions in millimetres

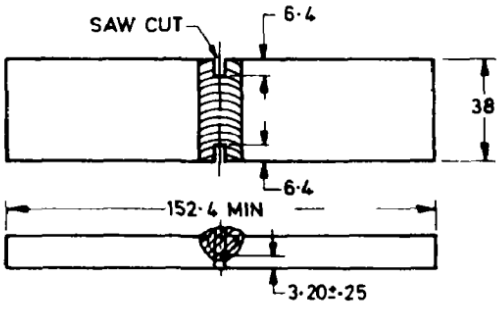
FIG. 4 TENSILE ELONGATION TEST SPECIMEN



NOTE — Weld reinforcement shall be removed

All dimensions in millimetres

FIG. 5 GUIDED BED TEST SPECIMEN



All dimensions in millimetres

FIG. 6 NICK BREAK TEST SPECIMEN