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IS 276 (2000): Austenitic-Manganese Steel Castings [MTD 14: Foundry]



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“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

ऑस्टेनाइटी-मैंगनीज इस्पात ढलाइयाँ — विशिष्टि

(पाँचवाँ पुनरीक्षण)

Indian Standard

AUSTENITIC-MANGANESE STEEL CASTINGS —

SPECIFICATION

(*Fifth Revision*)

ICS 77.140.80

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

FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Steel Castings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1953 and was revised in 1963, 1969, 1978 and 1992. While reviewing the standard in light of the experience gained during these years the committee has decided that the standard may be further revised. In this revision various clauses have been aligned with the recent standards on steel castings. In view of the increasing quality consciousness and in order to align the standard with the International Standards, the limits of silicon, sulphur and phosphorus have been revised to update the chemical composition of Austenitic Manganese Steel Castings.

In preparation of this standard, assistance has been derived from:

- a) ASTM Designation : A 128/A 128 M-86 Steel castings 'Austenitic manganese' issued by the American Society for Testing and Materials.
- b) JIS: G5131 : High Manganese Steel Castings.

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

AUSTENITIC-MANGANESE STEEL CASTINGS — SPECIFICATION (Fifth Revision)

1 SCOPE

This standard covers the requirements for austenitic manganese steel castings.

2 REFERENCES

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

3 TERMINOLOGY

3.1 For the purpose of this standard, the following definitions shall apply.

3.1.1 Cast (Melt) — The product of any of the following:

- a) One furnace heat,
- b) One crucible heat, or
- c) A number of furnace or crucible heats of similar composition mixed in a ladle before pouring.

3.1.2 Batch — A group of castings of one grade of material, cast from the same melt and heat-treated together under identical conditions.

4 GRADES

4.1 This standard covers a total of seven grades of austenitic manganese steel castings.

5 SUPPLY OF MATERIAL

General requirements relating to supply of steel castings shall be as laid down in IS 8800.

6 MANUFACTURE

The steel for the castings shall be made by electric arc or electric induction or such other processes as may be agreed to between the purchaser and the manufacturer.

7 PARTICULARS TO BE SPECIFIED WHILE ORDERING

For the benefit of the purchaser, particulars to be specified while ordering for steel castings to this specification are given in Annex B.

8 CHEMICAL COMPOSITION

8.1 The ladle analysis of steel when carried out either by the method specified in IS 228 and its relevant parts or any other established instrumental/chemical methods shall be as given in Table 1. In case of dispute the procedure given in IS 228 shall be the referee method. However, where the method is not given in IS 228, the referee method shall be as agreed to between the purchaser and the manufacturer.

Table 1 Chemical Composition of Austenitic Manganese Steel Castings
(Clauses 8.1 and 8.3)

Grade	Constituent, Percent ¹⁾							
	C	Si	Mn	P ²⁾	S	Cr	Mo	Ni
1	1.05-1.35	1.0	11.0-14.0	0.08	0.025	—	—	—
2	0.90-1.05	1.0	11.5-14.0	0.08	0.025	—	—	—
3	1.05-1.35	1.0	11.5-14.0	0.08	0.025	1.5-2.5	—	—
4	0.70-1.30	1.0	11.5-14.0	0.08	0.025	—	—	3.0-5.0
5	1.05-1.45	1.0	11.5-14.0	0.08	0.025	—	1.8-2.1	—
6	1.05-1.35	0.30-0.90	16.0-19.0	0.08	0.025	—	—	—
7	1.05-1.35	0.30-0.90	16.0-19.0	0.08	0.025	1.5-2.5	—	—

NOTES

1 In case of Grades 1 and 3 it is desirable to have a minimum ratio of manganese to carbon 10:1.

2 Section size precludes the use of all grades and the producer should be consulted as to the grade practically obtainable for a particular design required. Final selection shall be by mutual agreement between the purchaser and the manufacturer.

¹⁾ Maximum, unless a range is specified.

²⁾ Whenever a particular application warrants it, a purchaser may stipulate, at the time of enquiry and order, a lower 'P' level.

8.2 The manufacturer shall carry out analysis from a sample of each melt and, if so specified by the purchaser at the time of enquiry and order, shall supply a test certificate of chemical analysis of the sample of steel for each melt.

8.3 Product Analysis

If specified at the time of enquiry and order, product analysis may be carried out from a test piece or from a casting representing each melt. Drillings for analysis shall be taken from not less than 6 mm beneath the cast surface, and in such a manner as to not impair the usefulness of any casting selected. The permissible variation in product analysis from the limits specified in Table 1 shall be as given in IS 6601.

NOTE — Contamination of the drillings by drill chips must be avoided. Flat drills of the best high speed steels, or drills of some of the newer tool materials, will generally be satisfactory for drilling manganese steel. Manganese steel may be drilled best after it has been annealed for several hours at 500 to 600°C.

8.4 Residual Elements

8.4.1 Elements not specified in Table 1 shall not ordinarily be added to the steel and all reasonable precautions shall be taken to prevent contamination from scrap, etc, to keep them as low as practicable.

8.4.2 Analysis and reporting of the analysis in test certificate for the residual elements shall be done only when so specified by the purchaser in enquiry and order. However, the manufacturer shall ensure that the residual elements are within the limits, when such limits are specified by the purchaser in enquiry and order.

9 WORKMANSHIP AND FINISH

9.1 The castings shall be accurately moulded in accordance with the pattern or the working drawings supplied by the purchaser or mutually agreed to with the addition of such letters, figures and marks as may be specified.

9.2 The purchaser shall specify the tolerances on all important dimensions. On other dimensions, tolerances specified in IS 4897 shall apply.

NOTE — For the sake of information it is stated that to ensure proper fitting it is often necessary to keep the tolerances on external dimensions on negative side and on the internal dimensions on positive side in case of austenitic manganese steel castings.

10 FREEDOM FROM DEFECTS

10.1 All castings shall be free from defects that will adversely affect machining or utility of castings.

10.2 When necessary to remove risers or gates by flame or arc or a combination thereof, or by any

other process involving intense heat, care shall be taken to make the cut at a sufficient distance from the body of the casting so as to prevent any defect being introduced into the casting due to local heating. Any such operation is to be done before final heat treatment.

10.3 In the event of any casting proving defective from foundry causes in the course of preparation, machining or erection, such a casting may be rejected notwithstanding any previous certification of satisfactory testing and/or inspection.

NOTES

1 The relatively high austenitising temperature in combination with high carbon content causes marked surface decarburization by furnace atmosphere and some loss of manganese. The skin may hence be partially martensitic which can lead to formation of fine and shallow surface cracks. These cracks for most of the ordinary applications are not functionally harmful unless severe impact or tensile stresses are involved. This is for information only.

2 The changes that occur in composition of the surface of the castings during heat treatment may produce a magnetic skin. This surface magnetism thus developed is usually not harmful. It can be substantially diminished by grinding, if required. This is for information only.

3 (a) After heat treatment, the microstructure of the material is ordinarily fully austenitic. However, in case of heavy section thickness, due to the relatively slow rate of solidification and cooling, a substantial quantity of carbides separate out during the original casting process. Such carbides are rather slow to dissolve back into the austenite during heat treatment. Attempting to totally eliminate carbides from microstructure, especially in the interior regions of thick walled castings, may call for very prolonged soaking periods at the austenitization temperature. Such a prolonged soaking, in turn, could result in some degree of degradation of the surface, in the nature of scaling, decarburisation, etc, as also grain growth which can be harmful. Hence, the presence of a small percentage of carbides in heavy section thickness castings, especially in the inner region, is tolerated as a practical compromise and is usually not harmful. It is open to the parties to agree on the extent of presence of carbides for a given section thickness. However, unless specially agreed upon between the parties, or so stipulated in the enquiry and order, microstructural examination 51 is not a criterion for acceptance of castings to this standard.

3 (b) To overcome, or to minimise, the problem of presence of carbides in the heat treated condition and the consequent loss of toughness to a certain degree, for applications involving heavy section thicknesses and high impact Grades 4 and 5 are recommended.

11 FETTLING AND DRESSING

All castings shall be properly fettled and dressed, and all surfaces shall be thoroughly cleaned.

12 HEAT TREATMENT

12.1 The castings shall be heat treated in a properly constructed furnace, having adequate means of temperature control, which shall permit the whole of the castings to be uniformly heated to the necessary

temperature. All castings shall be suitably heat treated so as to attain the specified mechanical properties.

12.2 Unless otherwise specified in enquiry and order or agreed to between the purchaser and the manufacturer, all castings shall be suitably heat treated to render them tough and ductile. This treatment shall consist of uniformly heating the castings to a suitable temperature, holding them till they are uniformly heated throughout, and quenching them with a minimum time lag in water from a minimum temperature of 1 040°C. Water shall be adequately agitated to prevent formation of a vapour blanket around castings during quenching. In case of Grade 4 castings, alternatively they may be air cooled from above 1 040°C if the maximum section thickness does not exceed 60 mm and if so agreed to between the parties.

12.2.1 A record of heat treatment of the castings shall be maintained by the manufacturer, a copy of which shall be supplied to the purchaser, if so specified at the time of enquiry and order.

12.3 Test pieces shall be heat treated along with the castings they represent.

NOTE — When bend test specimens are heat-treated with the castings of comparatively heavy section, the test bars may be protected from oxidation by enclosing them in pipes or containers having a small amount of carbonaceous material or any other suitable protective medium and suitably closed to prevent the furnace gases from coming in contact with the test bars. To permit the expansion of the gases within these pipes or containers, they should not be completely sealed.

13 TEST BARS

13.1 Unless otherwise specified, test bars shall be cast separately in the same manner as the castings they represent and shall be poured at the same time and from the same ladle from which the castings are poured.

13.2 All test bars shall be suitably marked to identify them with the castings they represent.

14 MECHANICAL TESTS

14.1 The mechanical properties specified are those which are to be obtained from test bars cast either separately from or attached to the castings to which they refer and heat treated as given in 12. The test values so exhibited, therefore, represent the quality of steel from which the castings have been poured; they do not necessarily represent the properties of the castings themselves.

14.2 Brinell Hardness Test

Castings when supplied in the heat-treated condition and tested in accordance with IS 1500 shall have the Brinell hardness for the various grades as given in Table 2 subject to the condition as specified in 14.2.1.

14.2.1 In case of Grades 4, 5, 6 and 7 the upper limit for hardness values are only indicative and, unless agreed to between the purchaser and the manufacturer at the time of enquiry and order, are not applicable. It may be noted that in these grades, the hardness value is not a reliable indicator of quality.

14.2.2 The hardness test may be carried out either on a casting or on a test bar at the discretion of the purchaser.

14.3 Bend Test

The test specimen shall withstand cold bending through 150° around a mandrel of 50 mm in diameter without breaking into two pieces. Surface cracks after bending are not considered as failure if the sample remains in one piece. The bars shall be approximately 225 mm long and of 20 × 13 mm in cross section. The edges may be rounded to a radius not exceeding 1.5 mm.

Table 2 Mechanical Properties of Austenitic Manganese Steel Castings
(Clauses 14, 14.2.1, 14.3 and 14.4)

Grade	Tensile Strength	Yield Stress	Elongation Percent	Hardness HB	Angle of Bend Degrees, Min
	Min (MPa)	Min (MPa)	Min	Max	
(1)	(2)	(3)	(4)	(5)	(6)
1	600	300	24	229	150
2	—	—	—	229	150
3	600	300	24	229	150
4	—	—	—	229	150
5	—	—	—	229	150
6	—	—	—	280	150
7	—	—	—	280	150

NOTE — All the mechanical properties shown above in the table are optional except for the bend test requirement for all grades and hardness values given against grades 1, 2, and 3.

14.4 Tensile Test (Optional Test)

If specified by the purchaser at the time of enquiry and order, the tensile test shall be carried out in accordance with IS 1608.

15 NON-DESTRUCTIVE TESTS

15.1 Non-destructive testing shall be applied if so specified in enquiry and order. Under this heading the tests are grouped which aim at revealing defects which cannot be detected by a simple visual examination, such as penetrant, magnetic particle, ultrasonic, X-radiographic, or gamma-radiographic inspection; also included under this heading are tests on the surface condition by visual or visual-tactile examination. The purchaser shall specify the following in enquiry and order:

- a) The type of non-destructive testing which he intends to carry out or to have carried out;
- b) The area or areas of the casting to which these tests apply, and the types of discontinuity, where relevant;
- c) Whether all, or what proportion, of the castings are to be tested;
- d) The severity level defining the acceptability or non acceptability of defects which may be revealed; and
- e) Whether the manufacturer is or is not contractually responsible for carrying out the tests.

15.2 Unless otherwise agreed upon, when non-destructive testing is to be done, the castings shall be examined as follows:

- a) Ultrasonic examination (see IS 7666)
- b) Magnetic particle examination (see IS 3703)
- c) Liquid penetrant examination (see IS 3658)
- d) Radiographic examination (see IS 2595)

15.3 Unless otherwise agreed upon the following shall be the acceptance standards:

- a) IS 9565 for ultrasonic inspection.
- b) IS 10724 for magnetic particle inspection.
- c) IS 11732 for liquid penetrant inspection.
- d) IS 12938 for radiographic inspection.

NOTE — The castings to this standard are austenitic. Hence, it would not be ordinarily feasible to conduct ultrasonic and magnetic particle inspection on them.

16 REPAIR OF CASTINGS

16.0 Care should be taken that minimum heat is applied to the base metal during welding. For this purpose a short arc length, the lowest practicable current, welding in parts the smallest diameter of electrodes as per section to be welded and where possible submerging in water the portion of the casting being welded up to just below the weld level and other methods of rapid cooling of the weld area are to be applied.

16.1 Unless otherwise specified by the purchaser in the enquiry and order, castings may be rectified by welding. All repairs by welding shall be carried out in accordance with the procedure laid down in IS 5530. If castings have been subjected to non-destructive testing by agreement between the purchaser and the manufacturer, the castings shall be re-examined in the area of repair following any rectifying operation performed on the castings.

16.2 To form the basis of an agreement between the purchaser and the supplier in this respect, where relevant, the following classification shall apply concerning the extent of repair:

- a) Weld repair involving a depth not exceeding 20 percent of wall thickness or 25 mm, whichever is lower, shall be termed as a minor repair.
- b) Any weld repair exceeding the above shall be termed as a major repair. Further any single repair having an area exceeding 250 mm square for every millimeter of wall thickness shall also be deemed to be a major repair, regardless of the considerations mentioned in (a) above.

16.3 In view of the practical difficulties involved in getting crack-free welding if weld metal of the same composition range as the parent material is used, the following relaxed conditions for minor welding shall apply, without formal qualification of the procedure and welder performance:

- a) Defects shall be welded using a procedure and welders capable of producing sound welds. The weld deposit shall be austenitic steel in general, but welds on wearing surfaces shall consist of austenitic manganese steel.
- b) Weld repairs shall be inspected to the same quality standards as are used in the inspection of the castings.
- c) To judge the quality of weld, attention is invited to Note No. 1 given under 10.3.

17 METHOD OF SAMPLING

The method of sampling steel castings for the purpose of chemical analysis and mechanical tests including re-test shall be in accordance with IS 6907.

18 MARKING

18.1 Each casting shall be legibly marked with the following as may be relevant. However, where linkage and traceability are required the relevant marking shall be indelible.

- a) The number or identification mark by which it is possible to trace the melt and the heat-treatment batch from which it was made;
- b) The manufacturer's initials or trade-mark; and
- c) Other identification marks in accordance with any agreement between the purchaser and the manufacturer.

NOTE — It is recommended that minimum markings be used.

18.2 By agreement between the purchaser and the manufacturer, castings complying with the requirements of this standard may, after inspection, be legibly and indelibly marked with an acceptance mark.

18.3 BIS Certification Marking

The castings may also be marked with the Standard Mark.

18.3.1 The use of Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of condition under which the 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**

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
228	Methods for chemical analysis of steels (<i>second revision</i>)	6601 : 1987	Permissible deviations in chemical composition for products analysis of steel castings (<i>first revision</i>)
1500 : 1983	Methods for Brinell Hardness test for metallic materials (<i>second revision</i>)	6907 : 1992	Methods of sampling steel castings (<i>second revision</i>)
1599 : 1985	Method for bend test (<i>second revision</i>)	7666 : 1988	Recommended procedure for ultrasonic examination of ferritic castings of carbon and low alloy steel (<i>first revision</i>)
1608 : 1995	Mechanical testing of metals-tensile testing (<i>second revision</i>)	8800 : 1997	Technical delivery conditions for steel castings (<i>third revision</i>)
1757 : 1988	Methods of Charpy impact test (V-notch) for metallic materials (<i>second revision</i>)	9565 : 1995	Acceptance standards for ultrasonic inspection of steel castings (<i>first revision</i>)
2595 : 1978	Code of practice for radiographic testing (<i>first revision</i>)	10461	Method for determination of resistance to inter-granular corrosion of austenitic stainless steel:
3658 : 1981	Code of practice for liquid penetrant flaw detection (<i>first revision</i>)	(Part 1) : 1994	Corrosion tests in nitric acid medium by measurement of loss in mass (Huoy test) (<i>first revision</i>)
3703 : 1980	Code of practice for magnetic particle flaw detection (<i>second revision</i>)	(Part 2) : 1994	Copper sulphate/sulphuric acid test (Monypenny Straus test) (<i>first revision</i>)
4897 : 1997	Deviations on untoleranced dimensions and mass of steel castings (<i>third revision</i>)	10724 : 1990	Acceptance standards for magnetic particle inspection of steel castings (<i>first revision</i>)
5530 : 1987	Code of procedure for repair and rectification of steel castings by metal arc welding process (<i>first revision</i>)	11732 : 1995	Acceptance standards for dye penetrant inspection of steel castings

ANNEX B*(Clause 7)***INFORMATION TO BE SUPPLIED BY THE PURCHASER****B-1 BASIS FOR ORDER**

While placing an order for purchase of steel castings covered by this standard, the purchaser should specify the following:

- | | |
|---|---|
| <ul style="list-style-type: none"> a) Material specification; b) Drawing or reference number of the pattern (if supplied by the purchaser), along with a copy of the drawing; | <ul style="list-style-type: none"> c) Optional/additional tests required, if any; d) Whether the castings are to be inspected and tested in the presence of the purchaser's representative; e) Condition of delivery; f) Any special requirement; and g) Test report, if required. |
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Amendments Issued Since Publication

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