IS 10343 (1999): Carbon and Low Alloy Steel Investment Castings for General Applications [MTD 14: Foundry]

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भारतीय मानक

सामान्य अनुप्रयोगों के लिए कार्बन और अल्प मिश्र इस्पात निवेश ढलाइयाँ — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

CARBON AND LOW ALLOY STEEL INVESTMENT CASTINGS FOR GENERAL APPLICATIONS — SPECIFICATION

(Second Revision)

ICS 77.140.80

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

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Price Group 3

FOREWORD

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

This standard was first published in 1982 and was revised in 1989. While reviewing this standard in the light of the experience gained during these years, it was decided by the sectional committee to revise the standard further with the following main modifications:

a) The definition of investment casting has been modified,

b) The number of grades have been increased from 16 to 26 to meet the requirements of the users,

c) The requirements of dimensions of the machined test piece, as well as the size and shape of cast test piece, have been deleted to avoid duplication because these are already specified in the referred standard IS 1608 : 1995, and

d) Requirement of method of manufacture of steel 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 : 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

CARBON AND LOW ALLOY STEEL INVESTMENT CASTINGS FOR GENERAL APPLICATIONS — SPECIFICATION

(Second Revision)

1 SCOPE

This standard covers the requirements for carbon and low alloy steel investment castings for general applications.

2 REFERENCES

The Indian Standards listed in Annex A contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

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.

3.2 Investment Casting

An investment casting is one that is produced in a mould shell obtained by investing (surrounding) an expendable pattern with a bonded refractory. The expendable pattern may be made of wax, urea, plastic or other material and is removed by heating or any other process prior to filling the mould with liquid metal.

3.3 Master Heat

Metal supplied is in cast or wrought form, the chemical composition of which has been established by analysis and which is remelted into small batches for pouring into shells.

4 GRADES

This standard covers a total of 26 grades of carbon and low alloy steels for investment castings.

5 SUPPLY OF MATERIAL

General requirements relating to supply of steel castings shall be as laid down in IS 11709.

6 MANUFACTURE

The steel for the castings shall be made by electric arc or electric induction or such other process 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 by 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.

8.2 The manufacturer shall carry out analysis from a sample of each melt of steel 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, the 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 2 mm beneath the cast surface and in such a manner as not to 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.

Table 1 Chemical Composition

(*Clauses* 8.1, 8.3, 8.4.1 *and* 8.4.2)

Sl No.	Grade	Constituents, Percent[1)]									Remarks
		C	Mn	P	S	Si	Ni	Cr	Mo	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	Carbon steels for general engineering										
	1A	0.15-0.25	0.2-0.6	0.040	0.045	0.2-1.0	—	—	—	—	
	2A & 2Q	0.25-0.35	0.7-1.0	0.04	0.045	0.2-1.0	—	—	—	—	
	3A & 3Q	0.35-0.45	0.70-1.0	0.040	0.045	0.2-1.00	—	—	—	—	
ii)	Carbon steel for surface hardening										
	4A & 4Q	0.45-0.55	0.70-1.00	0.040	0.045	0.20-1.00	—	—	—	—	
	5N	0.50-0.60	0.70-1.00	0.040	0.045	0.20-1.00	—	—	—	—	
iii)	Case hardening steels										
	6N	0.10-0.20	0.60-1.00	0.040	0.045	0.20-1.00	—	—	—	—	
	7N	0.10-0.20	0.30-0.60	0.04	0.045	0.20-0.60	2.75-3.50	—	—	—	
	8Q	0.15-0.25	0.65-0.95	0.04	0.045	0.20-0.80	0.40-0.70	0.40-0.70	0.150.25	—	
	9Q	0.20-0.30	0.30-0.60	0.040	0.045	0.30-0.80	0.40	2.90-3.50	0.40-0.70	—	
	10N	0.30	0.70-1.0	0.040	0.045	0.20-0.80	—	—	0.05-0.15	—	
	11N	0.35	1.35-1.75	0.040	0.045	0.20-0.80	—	—	0.25-0.55	—	
	12Q	0.15-0.25	0.40-0.70	0.040	0.045	0.20-0.80	1.65-2.00	—	0.20-0.30	—	
	13Q	0.25-0.35	0.65-0.95	0.040	0.045	0.20-0.80	0.400.70	0.40-0.70	0.15-0.25	—	
iv)	High tensile steels										
	14Q	—	—	0.035	0.035	0.60	—	—	—	—	
	15Q	—	—	0.035	0.035	0.60	—	—	—	—	
	16Q	—	—	0.035	0.035	0.60	—	—	—	—	
	17Q	—	—	0.035	0.035	0.60	—	—	—	—	
	18Q	0.35-0.45	0.70-1.00	0.040	0.045	0.20-0.80	1.65-2.00	0.70-0.90	0.20-0.30		
	19Q	0.45-0.55	0.65-0.95	0.040	0.045	0.20-0.80	—	0.80-1.10	—	0.15 *Min*	
	20Q	0.25-0.35	0.40-0.70	0.040	0.045	0.20-0.80	—	0.80-1.10	0.15-0.25	—	
	21Q	0.35-0.45	0.70-1.00	0.040	0.045	0.20-0.80	—	0.80-1.10	0.15-0.25	—	
	22Q	0.25-0.35	0.40-0.70	0.040	0.045	0.20-0.80	1.65-2.00	0.70-0.90	0.20-0.30	—	
	23A	0.95-1.10	0.25-0.55	0.040	0.045	0.20-0.80	—	1.30-1.60	—	—	

[1)] *Max*, except where range or otherwise limit is specified.

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 The following limits shall apply for the elements not specified in Table 1:

Constituent	*Percent, Max*
Chromium	0.30
Nickel	0.40
Molybdenum	0.10
Copper	0.30
Total content of the unspecified elements	0.80

8.4.3 Analysis and reporting of the analysis in the test certificate for the above residual elements need 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 specified.

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 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 11166 shall apply.

10 FREEDOM FROM DEFECTS

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

10.2 In the event of any casting proving defective during subsequent manufacturing operations, such castings

shall be deemed not to comply with the requirements of this standard, notwithstanding any previous certification of satisfactory testing, provided the castings have not been improperly treated after delivery. Surface or superficial imperfections may be removed provided that such rectifications do not materially affect the strength, the appearance or use for which casting is intended. Any casting which has been subjected to rectification shall conform to such tolerances as specified in **9.2**. Unless otherwise agreed to between the manufacturer and the purchaser, a casting may have a gate evidence of 0.8 mm, *Max* on surfaces subjected to subsequent machining and 0.3 mm, *Max* on surfaces which are not subjected to machining.

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

12.2 The test pieces shall be heat treated along with the castings they represent.

12.3 Unless otherwise specified at the time of enquiry and order or agreed to between the purchaser and the manufacturer, all castings shall be supplied in finally heat treated condition to give mechanical properties specified in Table 2.

NOTE — If it is mutually agreed in some cases that the castings may be supplied in other than finally heat treated condition, then the representative test bars may be separately heat treated to evidence of obtainability of the mechanical properties specified in Table 2. The heat treatment cycle to be followed in such cases shall be as may be specified in the product standard or in enquiry and order or as may be agreed to between the manufacturer and the purchaser.

12.4 Care shall be taken to prevent excessive oxidation or decarburization. If the depth of surface decarburization is specified in the enquiry and order as a relevant factor, then, unless otherwise stated in enquiry and order, the depth of decarburized layer shall be restricted to 2 percent of the relevant section thickness or 0.5 mm whichever is higher.

13 METALLOGRAPHY TEST

For ensuring proper heat treatment and structure of castings, microstructure examination may be carried out, if so specified at the time of enquiry and order.

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.

14.1.1 *Test Sample*

The thickness or diameter of as cast bar will ordinarily be 18 ± 3 mm however, size other than this may be agreed to between the manufacturer and the purchaser.

14.2 The tensile test shall be carried out in accordance with IS 1608. The relevant mechanical properties shall be as given in Table 2.

14.3 If specified in enquiry and order, the impact test shall be carried out in accordance with IS 1598 and the values obtained shall conform to the requirements given in Table 2.

15 NON-DESTRUCTIVE TESTS

15.1 Non-destructive testing shall be applied if specified in the enquiry and the order. Under this heading are grouped the tests, which aim at revealing defects which cannot be revealed 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 in the 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 in accordance with:

a) ultrasonic examination (*see* IS 7666),
b) magnetic particle examination (*see* IS 3703),

Table 2 Mechanical Properties

(*Clauses* 12.3, 14.2 *and* 14.3)

Grade	Tensile Strength	Yield Stress	Elongation Percent	Izod Impact	Condition[1]
		Min, MPa	*Min, MPa*	*Min*	*Min, J*
(1)	(2)	(3)	(4)	(5)	(6)
1A	414	276	22	—	A
2A	448	310	23	—	A
2Q	586	414	9	—	QT
3A	517	331	23	—	A
3Q	689	621	9	—	QT
4A	621	345	18	—	A
4Q	862	689	5	—	QT
5N	600	290	9	—	NT
6N	495	215	14	27	N
7N	700	350	13	40	N
8Q	724	586	9	—	QT
9Q	850	600	7	20	QT
10N	586	379	20	—	NT
11N	621	414	18	—	NT
12Q	827	689	9	—	QT
13Q	1 030	793	6	—	QT
14Q	640	390	14	30	QT
15Q	700	560	13	30	QT
16Q	840	700	11	28	QT
17Q	1 030	850	7	20	QT
18Q	1 241	1 000	5	—	QT
19Q	1 310	1 172	4	—	QT
20Q	1 030	793	6	—	QT
21Q	1 241	1 000	5	—	QT
22Q	1 030	793	6	—	QT
23A	—	—	—	—	A

[1] A=Annealed, N=Normalized, Q=Quenched, and T=Tempered.

c) liquid penetrant examination (*see* IS 3658), and

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; and

d) IS 12938 for radiographic inspection.

16 REPAIR OF CASTINGS

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 or hydraulic 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 as a minor repair.

b) Any weld repair exceeding the limits specified in 'a' above shall be termed as a major repair. Further any single repair having an area exceeding 250 mm^2 for every millimetre of wall thickness shall also be deemed be a major repair, regardless of the considerations mentioned in (a) above.

16.3 Carbon Equivalent

Unless otherwise specified in enquiry and order, or otherwise agreed to, the Carbon Equivalent C.E. for the purpose of guidance in determination of the pre- and post-weld treatment applicable to carbon and low alloy steels shall be computed as follows:

$$\text{Carbon Equivalent (C.E.)} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

17 SAMPLING

The method of sampling the 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 a minimum of 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 conditions under which the licence for use of Standard Mark may be granted to manufacture or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
228	Methods for chemical analysis of steels (*second revision*)
1500 : 1983	Methods for Brinell hardness test for metallic materials (*second revision*)
1598 : 1977	Method of izod impact test of metals (*second revision*)
1608 : 1995	Mechanical testing of metals for tensile testing of steel products (*second revision*)
2595 : 1978	Code of practice for radiographic testing (*first revision*)
3658 : 1981	Code of practice for liquid penetrant flaw detection (*first revision*)
3703 : 1980	Code of practice for magnetic particle flaw detection (*first revision*)
5530 : 1987	Code of procedure for repair and rectification of steel castings by metal arc welding process (*first revision*)
6601 : 1987	Permissible deviations in chemical composition for product analysis of steel castings (*first revision*)
6907 : 1992	Methods of sampling steel castings (*second revision*)
7666 : 1988	Recommended procedure for ultrasonic examination of ferritic castings of carbon and low alloy steel
9565 : 1995	Acceptance standards for ultrasonic inspection of steel castings (*first revision*)
10724 : 1990	Acceptance standards for magnetic particle inspection of steel castings (*first revision*)
11166 : 1993	Permissible deviations on dimensions, surface roughness and mass of steel castings made with investment castings (*first revision*)
11709 : 1995	Technical delivery conditions for investment steel castings
11732 : 1995	Acceptance standards for dye penetrant inspection of steel castings
12938 : 1990	Acceptance standards for radiographic 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 the purchase of steel castings covered by this standard, the purchaser should specify the following:

a) Material specification;
b) Drawing or reference number of the pattern (if supplied by the purchaser), along with a copy of the drawing;
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.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

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Amendments Issued Since Publication

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices: Telephone

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002 — 323 76 17, 323 38 41

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054 — 337 84 99, 337 85 61, 337 86 26, 337 91 20

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022 — 60 38 43, 60 20 25

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113 — 235 02 16, 235 04 42, 235 15 19, 235 23 15

Western : Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093 — 832 92 95, 832 78 58, 832 78 91, 832 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PATNA. PUNE. THIRUVANANTHAPURAM.

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