भारतीय मानक

IS 1655 : 2023

Indian Standard

धात्विक सामग्रियाँ — जिंक मिश्रधातु — दाब डाई ढलाई के निर्माण — रीति संहिता

(तीसरा पुनरीक्षण)

Metallic Materials — Zinc Alloys — Manufacture of Pressure Die Castings — Code of Practice

(Third Revision)

ICS 77.120.60

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Ores and Feed Stock for Non-Ferrous (Excluding Aluminium and Copper) Industry, their Metals/Alloys and Products Sectional Committee, MTD 09

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Ores and Feed Stock for Non-Ferrous (Excluding Aluminium and Copper) Industry, their Metals/Alloys and Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

The standard was first published in 1960 and subsequently revised in 1968 and 1991. The first and second revision of this standard was undertaken as a result of experience gained and subsequent revisions of IS 713 ‘Specification for zinc base alloy ingots for die casting’ and IS 742 ‘Specification for zinc base alloy die castings’ in 1966 and 1981. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards. In addition, the following changes have been made:

a) Introduction of **2** on 'References' (as per the latest format);
b) Updating the details of the latest cross referred standard for electroplated coatings from IS 4828 to IS 1068, since IS 4828 has been superseded by IS 1068 in the year 1993;
c) Updating of some old terminologies and addition of few new terminologies;
d) Clause **5.2** has been added which calls for compliance with other relevant standards;
e) Corrections of editorial/typographical mistakes in the existing standards and few more editorial changes have been done to bring more clarity in the clauses;
f) Clause **29** has been modified with respect to metal temperature;
g) Annex A on mechanical properties has been included in the standard itself which were earlier covered separately in IS 742 : 1981 ‘Zinc base alloy die castings (*second revision*)’; and
h) Annex C on stabilizing treatment has been included in the standard itself which were earlier covered in IS 742 : 1981 ‘Zinc base alloy die castings (*second revision*)’.

This standard covers the code of practice to be adopted in the manufacture of zinc alloy pressure die castings.

Pressure die casting in zinc alloy provides means for a very rapid production of engineering and allied components and permits intricacy of design. It has obvious advantages when a component is required in large quantities. In case of engineering components, however, mechanical properties and durability are important considerations. For this reason, the best feature of design should be employed and optimum casting technique should be adopted.

Zinc alloy die casting will give satisfactory performance in service, only when they are free from contamination by certain elements harmful to their mechanical properties and corrosion resistance. It is, therefore, essential that these elements and, in particular, lead, tin, cadmium, thallium and indium should not be present in die castings in proportions higher than those indicated in IS 742 : 1981 ‘Zinc base alloy die castings (*second revision*)’ .

The composition of the Committee responsible for formulation of this standard is given in Annex F.

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 in this standard.

Indian Standard

METALLIC MATERIALS — ZINC ALLOYS — MANUFACTURE OF PRESSURE DIE CASTINGS — CODE OF PRACTICE

(Third Revision)

1 SCOPE

This standard covers the code of practice to be adopted in the manufacture of zinc alloy pressure die castings. Whatever the application may be, it is essential to use the zinc die casting alloys conforming to IS 713.

2 REFERENCES

The standards given below 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 these standards:

IS No.	*Title*
IS 713 : 1981	Specifications for zinc base alloy ingots for die castings (*second revision*)
IS 742 : 1981	Specifications for zinc base alloy die castings (*second revision*)
IS 1340 : 1977	Code of practice for chromate conversion coatings on zinc and cadmium coated articles and zinc base alloys (*first revision*)
IS 1068 : 1993	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium — Specification (*third revision*)

SECTION 1 GENERAL

3 TERMINOLOGY

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

3.1 Pressure Die Casting — A method of casting components by forcing molten metal under pressure into a split metal die on a die-casting machine; also defined as a casting produced on a pressure die casting machine.

3.2 Hot Chamber Pressure Die Casting — A type of pressure die casting in which metal is melted in a container and an injection plunger injects the liquid metal under high pressure into die. This method is generally limited to low melting point alloy metals like zinc alloys, magnesium alloys etc (*see* Fig. 1).

3.3 Cold Chamber Pressure Die Casting — In this type of pressure die casting process, molten metal which is externally heated poured into unheated chamber and a plunger injects metal under high pressure into die cavity larger than hot chamber die casting. This method is generally limited to high melting point alloy metals like aluminium alloys, some magnesium alloys, brass etc (*see* Fig. 2).

3.4 Castability — How well molten metal flows through a casting die.

3.5 Injection Cylinder — The chamber that, in conjunction with the plunger, enables molten metal to be forced into the die.

3.6 Plunger — The piston that, operating in a cylinder, forces molten metal into the die.

3.7 Die Cavity — The recess/space within the die casting die that is of the shape of the part to be casted. The molten metal flows into this space and is held until it has solidified.

3.8 Parting Line — The line where the two dies that is the cover and ejector portions meet is called the parting line, and this line is often visible after casting in the form of flash; also a line-like mark around a die casting where the two halves of the die came together.

3.9 Parting Plane — The plane where the die blocks meet that results in the parting line.

3.10 Flash — A thin extrusion of excess material that has escaped the cavity at the parting line due to insufficient clamping force.

3.11 Ejector Pins — Rods which force the casting out of the die cavity.

3.12 Draft Angle/Taper — The taper given to walls, cores and other parts of the die cavity to permit easy ejection of the casting.

3.13 Runner — A channel in the die through which molten metal passes into the gate and subsequently fills the die cavity. This term is also applied to the surplus metal which solidifies in this channel.

3.14 Gate — That part of the die through which the metal enters the die cavity from the runner.

3.15 Sprue — The metal attached to the runners which solidifies in the sprue bush (*see* Fig. 1) on a hot chamber machine.

3.16 Slug —The surplus metal from the injection cylinder of a cold-chamber machine which is attached to the runner. Sometimes called as 'biscuit'.

3.17 Biscuit — *see* **3.17**.

3.18 Vent — Provision in the die to permit the escape of air from the die cavity or overflow well.

3.19 Overflow Well — A recess in a die, connected to die cavity by a gate, remote from the entrance gate.

3.20 Spray — A casting or castings, complete with sprue or slug resulting from a single casting operation of 'shot'.

3.21 Inserts — Shaped pieces, commonly of metal, which are inserted in the die and thus become integral part of the casted component.

3.22 Core — An element of the die forming a recess in the die casting.

3.23 Quenching — The term used for rapid cooling of a casting by immersion in water.

3.24 Porosity — Voids or pores resulting from trapped air gas or shrinkage in casting.

3.25 Intergranular Corrosion — A type of localized corrosion at and adjacent to grain boundaries, with relatively little corrosion at the grains. As a consequence, the metal alloy disintegrates and loses its strength. This form of corrosion can be caused by impurities at the grain boundaries and depletion or enrichment of one of the alloying elements in the grain boundary area.

3.26 Dimensional Stablity — Ability of an alloy to remain unchanged in size or shape or in other words the ability of a material to retain its shape and size over a period of time which may otherwise change for example due to ageing of the material.

4 CONSULTATION ON DESIGN

It is considered most desirable to have an early and continuous co-operation between the die caster and the purchaser to ensure that design of the component and its production is satisfactory.

SECTION 2 MATERIALS AND COMPONENTS

5 GENERAL REQUIREMENTS

5.1 The basic requirements for components for engineering and allied uses are strength, structural soundness, durability and dimensional accuracy. In addition, pressure tightness is sometimes a necessity.

When considering strength, it is necessary to take account of those stresses which may be involved during assembly and which may well exceed those met in service. Allowance may have to be made for the removal of certain components or parts thereof for periodic inspection. These details may concern not only the general strength of the components, but particularly the strength of screw threads, small bosses, etc.

5.2 The compliance with the Indian Standards IS 713 and IS 742 is also implied when the recommendations given in this code of practice are employed.

6 ADVANTAGES AND LIMITATION OF ZINC ALLOY DIE CASTINGS

6.1 Pressure die casting in zinc alloy is a rapid method of production, especially when large quantities are required. The fluidity of zinc alloys permits complex shapes to be cast in thin sections and with great accuracy of dimensions. Further, the employment of precisely machined and highly finished steel dies permit complex shapes greatly enhances the dimensional accuracy as well as ability to cast zinc alloys with wall thicknesses as low as 0.5 mm over relatively large areas. The zinc alloy die castings have excellent physical and mechanical properties and require a minimum of machining. The castings also take on organic and metallic coatings to provide added protection from corrosion as also better appearance owing to their smooth as cast surface finish.

6.1.1 Zinc alloy die castings are unsuitable as components to be subjected to temperatures above 150 °C in service and if the components are to be stressed, a temperature of 100 °C should not be exceeded.

6.1.2 There are instances in which temperatures below normal are encountered, for example, in refrigerators. Zinc alloys undergo a fall in impact strength, though not in tensile strength at sub-normal temperatures. It is, therefore, considered necessary that components cast in zinc alloy, when required for use at low temperatures and which may suffer shock loading in service, should be strengthened by suitable ribbing or increase of sections or in extreme cases by reinforcement with other materials, such as steel. Experience has shown that zinc allow die castings may be used at low temperature with this safeguard.

7 CHOICE OF ALLOY

7.1 ZnAl4 conforming to IS 742 is almost invariably selected for engineering applications. It has the advantage over alloy ZnAl4Cu1 of greater dimensional stability and better response to a stabilizing anneal treatment where extremely close tolerances are specified. It is also more resistant to corrosion than ZnAl4Cu1 and is more ductile and retains its high impact strength during prolonged service at 100 °C.

7.1.1 Alloy ZnA14Cul is preferred, for example in zip fastener sliders and gear wheels on account of its slightly greater strength and hardness, improved creep performance and also slightly greater castability for thin sections. However, these improvements are accompanied by a reduction in ductility that can affect formability during secondary bending, riveting, swaging or crimping operations. An addition of 1 percent copper accounts for these property changes. When an extra measure of tensile performance is required, alloys ZnAl4Cu1 are recommended.

8 FREEDOM FROM DEFECTS

Zinc alloy die castings should be free from all defects mentioned under **6.1**, **6.2** and **6.3** of IS 742.

9 FINISHING

9.1 Resistance of zinc alloys to atmospheric corrosion is good and only abnormal conditions demand protective measures. Excessively damp locations call for a chromate treatment and installations exposed to very severe conditions, such as damp interior walls, require the added protection of bituminous or a suitable paint after chromating. Normally, where paint or enamel coating is desired, it is necessary to employ a preparatory phosphate treatment or, alternatively, a chromate treatment complying with IS 1340.

9.2 When zinc alloy die castings are required for applications demanding special resistance to contact with chemicals or for electrical insulation, plastic coatings may be applied either by dipping heated dies castings into a fluidized bed of plastic particles or by electrostatically coating die casting with plastic particles that coalesce on stoving.

9.3 To impart better surface protection and mainly for the pleasing appearance or aesthetic purposes, zinc alloy die castings are electroplated. The most usual practice is to electroplate with copper, followed by nickel and chromium. The plating should be carried out in accordance with IS 1068. Bright zinc plating is used to improve appearance of some dies castings. Alternative coatings, for example of noble metals, stainless steel etc have been developed.

9.4 When increased resistance to wear is desired, a hard chromium plating may be used. The corrosion and abrasion properties may also be improved by the anodizing of zinc that coats the zinc alloy surface with a mixture of zinc ammonium phosphate and zinc chromate. This coating has also excellent resistance to neutral salt solution and hot detergent solution.

10 MECHANICAL PROPERTIES

10.1 When a component previously made in another material is being redesigned as zinc alloy die casting, due consideration should be given for any probable differences in mechanical properties, in order to realize the full economies of the process. Annex A of gives details of the mechanical and physical properties of ZnAl4 and ZnAl4Cu1 zinc alloy die castings.

10.2 Other mechanical and physical properties of zinc alloy die castings are given in Annex B.

11 DIMENSIONAL CHANGES

11.1 Zinc alloy die castings undergo very small dimensional changes on ageing, which for most practical purposes, are insignificant. The magnitude of dimensional changes depend upon whether the castings are quenched or air cooled. ZnA14 and ZnAl4Cu1 exhibit a small shrinkage which starts immediately after casting and proceeds at a diminishing rate over a period of year. The stabilizing treatment given in Annex C, accelerates these changes, particularly in respect of die castings of alloy ZnAl4 and when put in use subsequent to the treatment ensures minimal or no dimensional changes occurring over the subsequent period of service.

11.2 The magnitude of dimensional changes and the effects and details of stabilizing anneal treatment is given in Annex A.

SECTION 3 COMPONENT DESIGN

12 GENERAL AIMS

12.1 To ensure complete satisfaction with the performance of any zinc alloy die castings, careful consideration should be given in the first instance to its design, which should be established by close cooperation between the purchaser and the die caster. This is particularly necessary when zinc alloy die castings are being substituted for other materials. In such instances, redesigning may often lead to economy of metal and yet result in a component which is stronger than that which is being replaced.

12.2 Zinc alloy pressure die casting should be so designed that it not only meets the service requirements, but also embodies these features which permit ease of production. For example, avoidance of sudden changes in section and sharp corners should be avoided; it is preferable to use appropriate section thickness (*see* **13**). The greatest advantage of the die casting process is that, if the component designed in a better, machining operations can be minimized or eliminated.

12.3 It is necessary that the design should allow the effective location of the gates and vents in the die cavity. The arrangement of these features may affect the quality of the castings produced.

13 SECTION THICKNESS

Thickness of section should be the minimum consistent with adequate strength. Reduction of cross-section, apart from economy in material, gives greater strength per unit thickness. Larger sections promote the occurrence of porosity and should be avoided by suitable alteration in design. Thinner sections accelerate cooling and thus increase the rate of production. Too thin a section may, however, interfere with metal flow in the die and lead to distortion or breakage on ejection. The wall thickness of small castings may be as small as 0.4 mm and 1 mm for large castings. It is essential that reductions in thickness, particularly in the lower ranges, are decided upon after consultation with die caster.

14 RIBS

The use of strengthening ribs helps in the reduction of wall thickness. The thickness of the rib should not exceed 80 percent of thickness of the section if shadow marks are to be avoided on the reverse face of section less than 2.5 mm in thickness.

15 UNIFORMITY OF SECTIONS

In order to facilitate production and to minimize turbulence of the metal flow in the die which may result in unsound zones in a casting, sudden changes of wall sections should be avoided. These changes also cause stress concentration and weakening of the casting.

16 UNDERCUT SECTIONS

Undercut sections are permissible, but should preferably be avoided, because they add to the cost of the die and decrease the rate of casting. It is often possible to eliminate them by modifying the design.

17 FILLETS

Fillets should be used to eliminate sharp corners. They facilitate metal flow through the die and strengthen the component by avoiding concentration of stresses. A minimum radius of 0.5 mm should be observed, but larger radii are recommended and in fact a radius of 0.75 mm is not excessive. Inside corners should preferably have a radius of at least 1.5 mm.

18 EXTERIOR CORNERS

Sharp exterior corners, except at the parting line of the die add to the cost of die construction and may result in finishing difficulties. They should be rounded slightly, where possible.

19 BOSSES

Integral bosses are frequently provided for studs, pins, bolts, screws, etc required for purposes of assembly. They should be given a fillet at their base and if slender, may need to be provided with buttress.

20 STUDS

Integral studs may also be used but they should be of sufficient diameter in relation to the size and weight of the casting to withstand damage in handling and service; they also should have a fillet at their base. The length of small studs should not be greater than twice their diameter. Studs of 12 mm diameter or over may have greater proportional length. These studs may be produced with cast threads.

21 THREADS

21.1 Threads over 1 mm pitch (external or internal) may be cast. In practice, however, cast internal threads seldom prove more economical than formed or tapped ones, especially in holes of small diameter. External threads located across a parting line in the die can be cast, particularly if they are coarse and of large diameter. They are later chased, if accuracy demands this operation.

21.2 The recommended minimum thread diameter is 10 mm for inner and 8 mm for outer threads.

21.3 It is not possible to cast very fine threads of square and trapezoidal with a small taper angle.

22 INSERTS

22.1 Inserts of other materials, either cast-in-place or post installed, are employed in zinc alloy die castings to provide:

a) Additional strength;
b) Locally increased hardness;
c) Bearing surfaces;
d) Improved electrical properties;
e) Passages otherwise difficult to cast;
f) Passages intended to carry corrosive media;
g) Facilities for soldered connections; and
h) Means for easier assembly.

22.2 Both metallic and non-metallic inserts of suitable materials may be used. Plated inserts may be used, but cadmium or tin coatings are best avoided because of the risk of alloy contamination. Galvanized inserts are to be preferred.

22.3 It is necessary to anchor the insert securely and knurling grooving, or some form of under cutting should be employed, depending on the required strength of anchorage. Inserts should be manufactured to close tolerances, since they become, in effect a working part of the die.

22.4 Consultation with the die caster is desirable on various parts relating to the use of inserts in die castings since production cost may be appreciably affected.

23 LETTERING

Fine detail of lettering and designs may be reproduced on the surface of zinc alloy die castings. Raised lettering on the casting is to be preferred to sunk lettering from the point of view of die cost, and where lettering flush with the surface is essential, it is preferable that it may be in the form of raised lettering on a recessed panel.

24 DIMENSIONS

24.1 The dimensions of the die castings shall be as shown on the drawing supplied by the purchaser and within tolerances to be agreed to between the purchaser and the manufacturer.

24.1.1 Tolerances should not be specified more closely than is necessary, since this generally adds to the cost of production.

24.1.2 Recommended tolerances for linear dimensions of die are illustrated in Annex D.

25 DRAFTS

On cored holes and side walls draft should always be as generous as possible to facilitate rapid and economic production of castings and good die-life. In special cases the draft may be reduced, by arrangement with the die caster, to very small values. Draft on walls is normally between 1° and 2° per side. Shallow ribs, however, require more draft (5° to 10°) although for ribs which are in line with shrinkage as, for instance, spokes of a wheel smaller draft is more acceptable.

26 CORED HOLES

The diameter of cored holes should not be less than 0.6 mm. The maximum depth of ‘through’ holes should not exceed 8 times the diameter and in the case of blind holes, four times the diameter. Also the minimum permissible diameter depends upon the length of core. Acceptable diameter/depth ratios are given in Annex E.

SECTION 4 WORKING PRACTICE

27 DIE CASTING MACHINE

27.1 Only those die casting machines in which pressure is applied by motive power through the medium of a plunger may be considered suitable for the production of zinc alloy die castings for critical applications demanding maximum strength and soundness. A pressure on the metal of at least 10 N/mm^2 is generally necessary but density improves further at higher pressures. Direct air or hand operated machines are not recommended for these reasons.

27.2 The die casting machine should be selected to provide ample capacity for production of the component. Apart from the question of pressure on the metal, the volume of metal displaced by the plunger per shot and the maximum permitted projected area of casting should be taken into account when selecting a machine for production of a given component.

27.3 The machine should be in good mechanical condition. Special attention should be devoted to the plunger system to be certain that it is operating efficiently without loss of pressure or delay in the application of pressure, after the die cavity has been completely filled.

27.4 The following two types of die casting machines are principally used in the production of zinc alloy die castings:

a) Hot-chamber machine (*see* Fig. 1) — In this die casting machine, the pressure is applied to the molten metal directly through plunger travelling in a cylinder below the level of the molten metal in the pot, the plunger is operated either by air pressure or more usually by the application of pressure from a hydraulic fluid. Metal injection pressures in this type of machines are of the order 10 N/mm^2; and

b) Cold-chamber machine (*see* Fig. 2) — This type of machine is more widely used for die casting aluminium, magnesium and copper base alloys, which, if in continuous contact with the cylinders and plungers used in the hot-chamber machine, would attack them, the molten metal is ladled into the horizontal cylinder through a suitably placed side port which is covered by the piston when the shot is made. There is no sprue as in the case of hot chamber machines; instead the die is mounted close to the end of the cylinder, and only a relatively small slug remains attached to the casting when it is removed from the die. High metal injection pressures are possible by this method; pressures in the region of 40 N/mm^2 to 140 N/mm^2 are being used. This machine may also be used for zinc alloys, but for faster and simple operations hot-chamber machine is preferred.

28 CLEANLINESS OF WORKING

Clean conditions of working are an absolute necessity. It is of utmost importance that where ZnAl4 and ZnAl4Cu1 are being worked, the two alloys should be carefully segregated from each other. All metals and alloys, other than the particular zinc die casting alloy should be scrupulously kept away from the vicinity of the die casting machine and precautions should be taken to ensure that no scrap metal of any description is carelessly thrown into the melting pot. Alloys (containing lead, tin, cadmium etc), such as tin foil, lead foil and solders, are to be kept away especially.

29 METAL TEMPERATURE

The metal temperature should be lowest consistent with the production of castings of good surface appearance and internal soundness. Such conditions should prevail within the range of temperature 400 °C to 415 °C for alloy Al Zn4 and 400 °C to 425 °C for alloy AlZn4Cu1 on hot chamber machine, and the pot temperature should normally be in the range of 430 °C to 450 °C for cold chamber machines. Automatic temperature controlling equipment should be installed and its accuracy checked at regular intervals.

30 DIE TEMPERATURE

30.1 The correct die face temperature (as measured by surface pyrometer) is the lowest at which castings of good quality can be produced and depends to some extent on the section thickness.

30.2 The accepted die temperature range is 180 °C to 260 °C for both ZnA14 and ZnAl4Cul. If die temperatures in excess of this range are found necessary to attain a satisfactory surface condition when using molten metal within the recommended temperature range, cavity fill time and the gating and venting of the die should be examined and modified.

31 RECLAIMED METAL

31.1 The use of scrap in the manufacture of die casting should be avoided as far as possible. If scrap is to be used, the following conditions shall be observed.

a) No scrap shall be used other than sprues, gates, rejected die castings, overflow wells, etc, of the particular alloy that are produced in the manufacturer's own plant conforming to IS 713. The rejected die castings shall be free from finishes, solder or inserts which may contaminate the alloys;

b) Castings with inserts may be used, provided the scrap is remelted into ingots and analyzed for purity, which shall conform to IS 713; and

c) Where the purchaser so requires, the proportion of scrap to virgin alloy ingots shall be agreed to between the purchaser and the manufacturer.

31.2 It is recommended that the normal maximum of reclaimed metal should be 25 percent, but it should never exceed 50 percent of the total melt.

31.3 The accumulation of large quantities of scrap is undesirable because of the risk of contamination, but where accumulation is unavoidable, it is recommended that the metal be remelted into ingots and their composition determined for compliance with IS 713.

31.4 Dross, skimmings, swarf or sweepings should never be introduced directly or indirectly, into the melting pot.

32 STABILIZING TREATMENT

The dimensional stability of zinc alloy die castings may be improved by 'stabilizing'. The phase change and the shrinkage are accelerated by a controlled annealing known as 'stabilizing' treatment (*see* Annex C). The treatment has a little effect on the mechanical properties of the casting. Stabilizing is only necessary when extremely close tolerance is required.

33 RADIOGRAPHIC EXAMINATION

Where internal soundness of a casting is vital, it is essential that the die caster shall use radiographic examination in the development of casting technique.

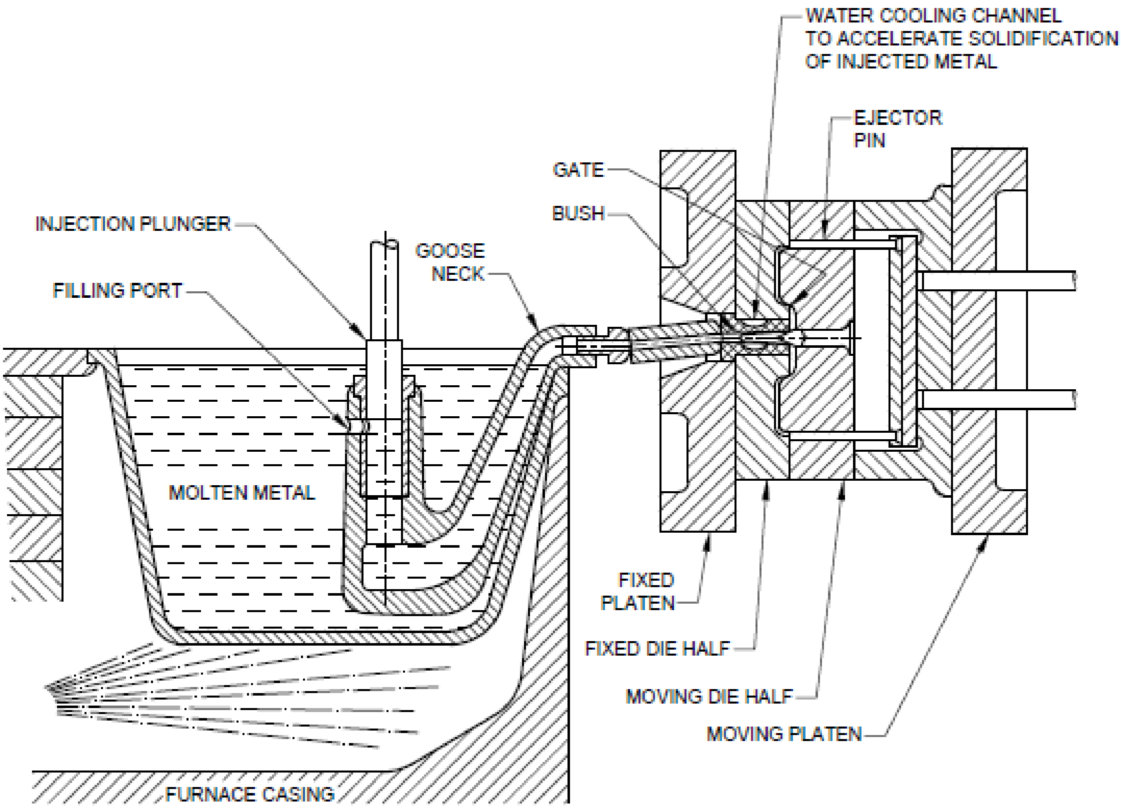
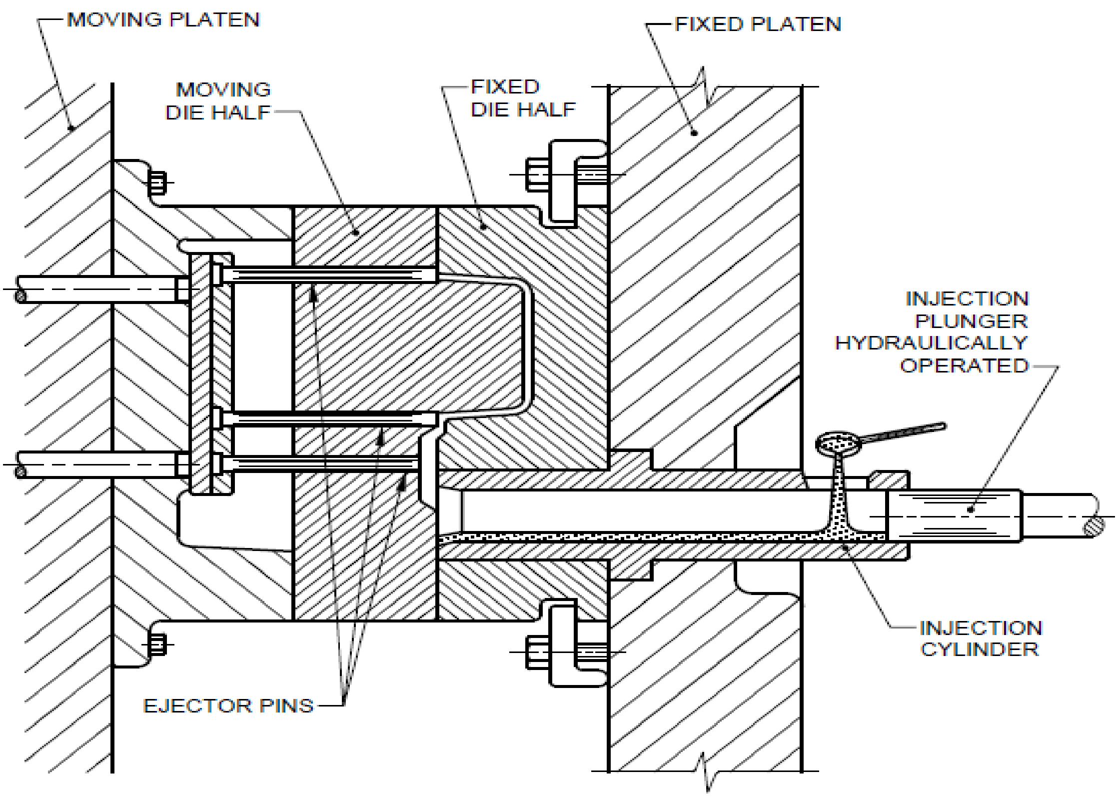
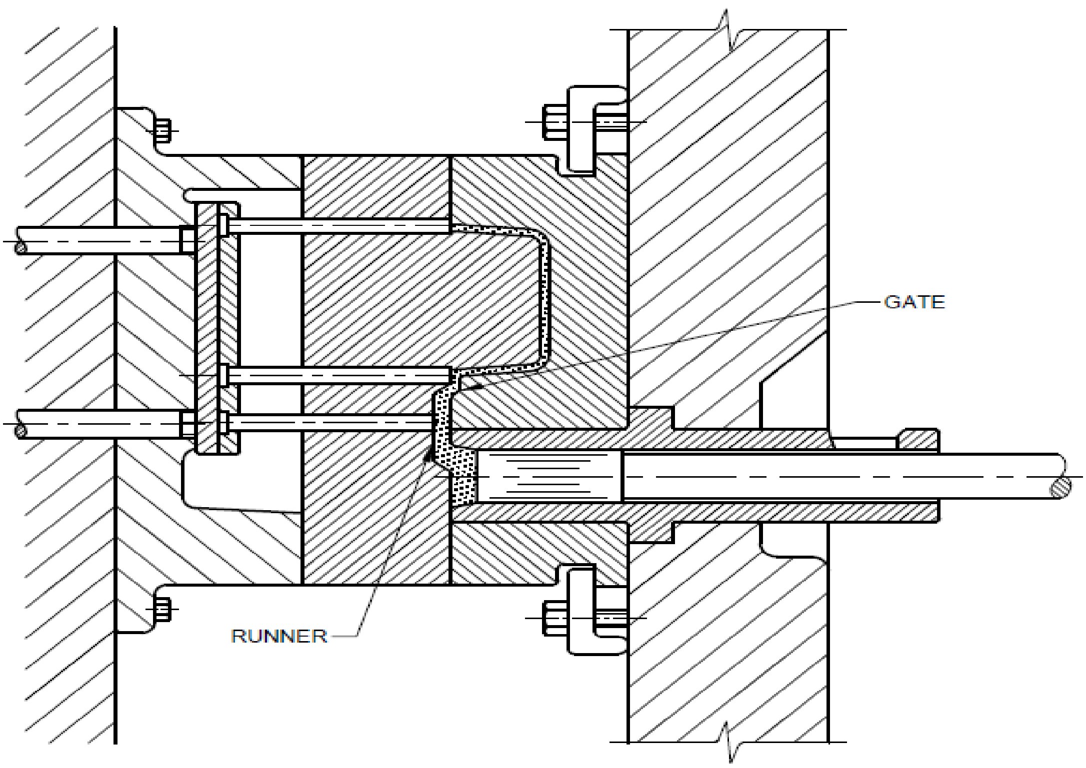


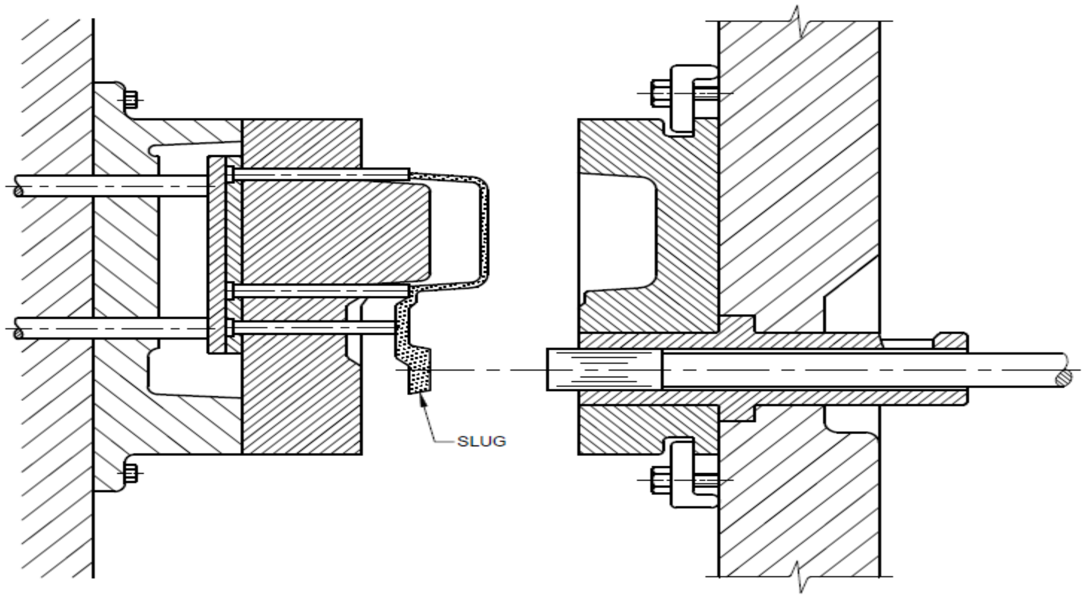
FIG. 1 DIAGRAMMATIC PART-SECTION OF A HOT CHAMBER DIE CASTING SYSTEM



(a) Die in clamped position between machine platens with metal to be injected being poured from ladle into injection chamber



(b) Die cavity completely filled



(c) Die opened and casting ejected

FIG. 2 DIAGRAMMATIC DESCRIPTION OF A HORIZONTAL COLD CHAMBER PRESSURE DIE CASTING SYSTEM

SECTION 5 IDENTIFICATION

34 IDENTIFICATION OF CASTINGS

Each die casting should bear a mark to identify the manufacturer of the casting. In addition, when multiple-cavity dies are used, each impression should bear the distinguishing mark to identify its location in the spray. The location and size of these identifying marks should be as agreed to between the die caster and the purchaser, and interference with the function or assembly of the component in question should be taken into consideration in this connection. Identifying marks should not, of course, be placed where they will be removed in any subsequent machining operation.

ANNEX A

(*Clauses* 10.1, 11.2, *Annex B and Foreword*)

PROPERTIES OF ZINC ALLOY DIE CASTINGS

A-l DIMENSIONAL CHANGES

A-l.1 Die casting of alloys ZnAl4 and ZnAl4Cu1 undergo 3 very small shrinkage at a progressively diminishing rate during ageing at normal temperature. The shrinkage is given in Table 1.

Table 1 Dimensional Changes of Die Castings

(*Clauses* A-1.1 *and* A-1.2)

Sl No.	**Shrinkage Measured After**	**Alloy ZnAl4** mm/mm	**Alloy ZnAl4Cu1** mm/mm
(1)	(2)	(3)	(4)
i)	5 weeks	0.000 32	0.000 69
ii)	6 months	0.000 56	0.000 03
iii)	5 years	0.000 73	0.001 36
iv)	8 years	0.000 79	0.001 41

A-1.2 The changes shown in Table 1 are insignificant for most practical purposes, but if greater dimensional stability is desired, this shrinkage may be accelerated, with little change in mechanical properties, by carrying out stabilizing treatment given in Annex C (*see* also Table 2).

Table 2 Diensional Changes of Stabilized Die Castings

(*Clause* A-1.2)

Sl No.	**Shrinkage Measured After**	**Alloy ZnAl(s)** mm/mm	**Alloy ZnAl4Cu1(s)** mm/mm
(1)	(2)	(3)	(4)
i)	5 weeks	0.000 20	0.000 22
ii)	3 months	0.000 30	0.000 26
iii)	2 years	0.000 30	0.000 37

A-2 MECHANICAL PROPERTIES

A-2.1 The mechanical properties obtainable from sound pressure cast specimens of Alloy ZnAl4 and Alloy ZnAl4Cu1, in as cast and stabilized conditions, before and after different ageing treatments, are given in Table 3 for information.

Table 3 Mechanical Properties of Pressure Die Cast Specimens

(*Clause* A-2.1)

Sl No.	**Mechanical Property**	**Alloy**	**Original Value 5 Weeks After Casting**
(1)	(2)	(3)	(4)
i)	Tensile strength* in MPa (strain rates 6.3 mm/minute crosshead speed)	ZnAl4	286
		ZnAl4 (s)	273
		ZnA14Cul	335
		ZnAl 4Cu1 (s)	312
ii)	Elongation percent on 50.8 mm × 6.35 mm diameter	ZnAl4	15
		ZnAl4 (s)	17
		ZnA14Cul	9
		ZnAl 4Cu1 (s)	10
iii)	Impact strength in joules on un-notched charpy test piece of 6.35 mm × 6.35 mm section	ZnAl4	57
		ZnAl4 (s)	61
		ZnA14Cul	58
		ZnAl 4Cu1 (s)	60
iv)	Brinell hardness number HB 10/500/30	ZnAl4	83
		ZnAl4 (s)	69
		ZnA14Cul	92
		ZnAl 4Cu1 (s)	83

NOTE — These figures indicate to designer the properties that may be expected from tensile and impact specimen cast in a test bar die. These figures shall not represent values obtained on specimens cut from commercial die castings.

*For the effects of prolonged high stresses, creep curves shall be consulted.

ANNEX B

(*Clause* 10.2)

MECHANICAL AND PHYSICAL PROPERTIES OF ZINC ALLOY DIE CASTINGS OTHER THAN THOSE COVERED IN ANNEX A

Sl No.	*Properties*	*ZnAl4*	*ZnAl4Cu1*
(1)	(2)	(3)	(4)
i)	Compression strength (N/mm^2 or MPa)	415	600
ii)	Modulus of rupture (N/mm^2)	650	720
iii)	Shearing strength (N/mm^2)	215	250
iv)	Melting point (°C)	387	388
v)	Solidification point (°C)	382	379
vi)	Casting contraction accepted mean value (mm/mm)	0.006	0.006
vii)	Specific heat capacity (J/kg °C)	420	420
ix)	Thermal conductivity (W/m °C) at 18 °C	113	109
x)	Electricity conductivity (MS/m °C) at 20 °C	15.7	15.3
xi)	Thermal expansion (μ m/m/°C) (20 °C to 100 °C)	27	27
xii)	Specific gravity	6.7	6.7

ANNEX C

(*Clauses* 11.1, 32, A-1.2 *and Foreword*)

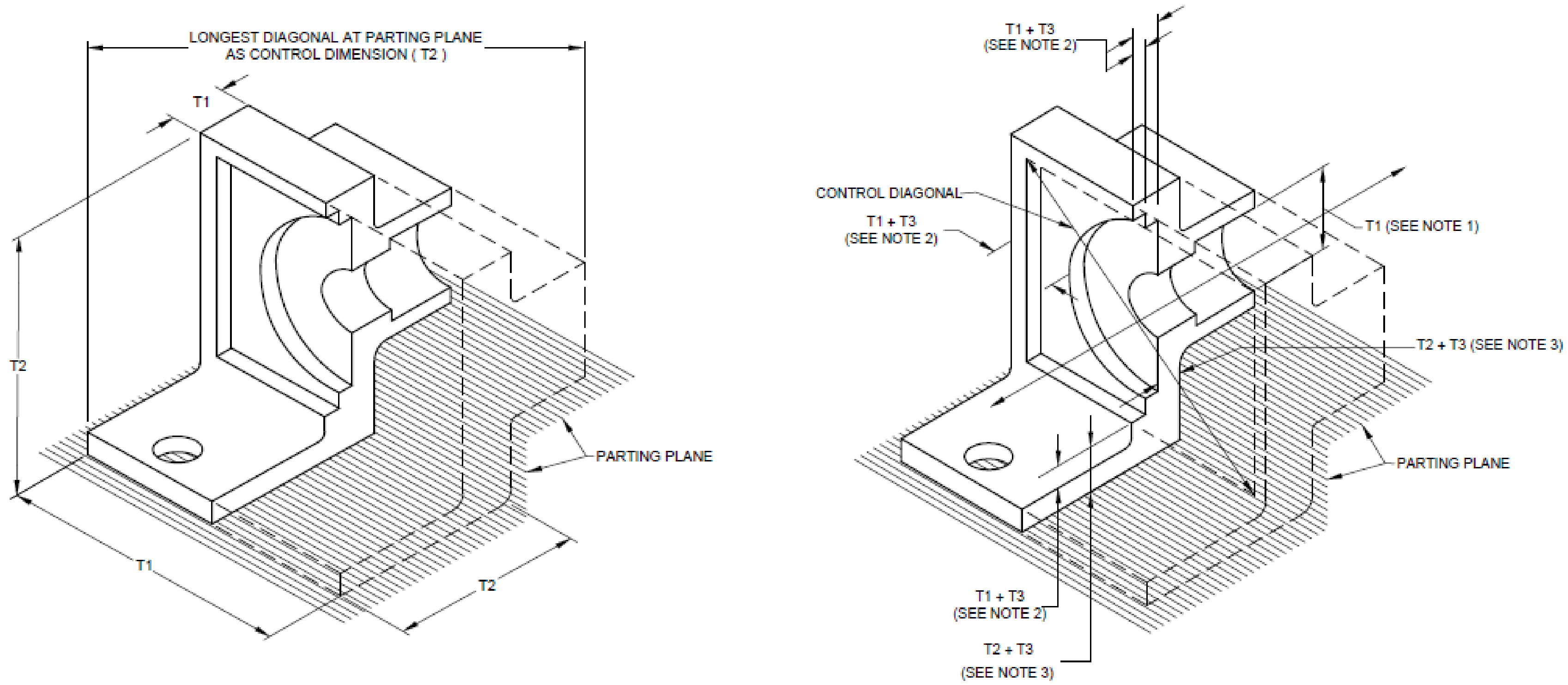
STABILIZING TREATMENT

C-1 The castings shall be heated in air to a temperature of 100 °C ± 5 °C and maintained at this temperature for six hours. They shall then be allowed to cool freely in air at room temperature**.**

ANNEX D

(*Clause* 24.1.2)

RECOMMENDED TOLERANCE FOR LINEAR DIMENSIONS OF DIE



NOTES

1 When the dimension is influence by the moving die half only, the tolerance is in accordance with T1.

2 When the dimension is influenced by the moving die half and the die half in which it is mounted. The tolerance on dimension is the sum of the value from T1 plus the value from T3 for the moving die part diagonal.

3 When the dimension is influenced by the moving die element and the opposite die half, the tolerance on dimension is the sum of the value from T2 for the parting longest diagonal plus the value from T3 for the moving die half diagonal

FIG. 3 TOLERENCES FOR LINEAR DIMENSIONS

D-1 TOLERANCES ON DIMENSIONS FOR ONE DIE HALF (T1)

Smaller tolerances may be achieved when necessary with agreement of the die caster.

Sl No.		*Length of Dimension* (mm)																			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
i)		0 to 25	26 to 32	33 to 40	41 to 50	51 to 63	64 to 80	81 to 100	101 to 120	121 to 160	161 to 200	201 to 250	251 to 320	321 to 400	401 to 500	501 to 630	631 to 800	801 to 1 000	1 001 to 1 200	1 201 to 1 600	1 601 to 2 000
ii)	Tolerance, mm	0.10	0.12	0.14	0.16	0.18	0.20	0.24	0.28	0.36	0.44	0.54	0.68	0.84	1.04	1.30	1.64	2.04	2.44	3.24	4.04

D-2 TOLERANCES ON DIMENSIONS ACROSS DIE PARTING PLANE (RELATED TO THE LONGEST DIAGONAL) AND ON A SINGLE CAVITY DIE (T2)

Smaller tolerances may be achieved when necessary with agreement of the die caster.

Sl No.	Longest Diagonal (mm)	*Length of Dimension* (mm)																			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
i)		0 to 25	26 to 32	33 to 40	41 to 50	51 to 63	64 to 80	81 to 100	101 to 120	121 to 160	161 to 200	201 to 250	251 to 320	321 to 400	401 to 500	501 to 630	631 to 800	801 to 1 000	1 001 to 1 200	1 201 to 1 600	1 601 to 2 000
ii)	0 to 180	0.26	0.28	0.30	0.32	0.34	0.36	0.40	0.44	0.52	0.60	0.70	0.84	1.00	1.20	1.46	1.80	2.20	2.60	3.40	4.20
iii)	Over 180 to 260	0.30	0.32	0.34	0.36	0.38	0.40	0.44	0.48	0.56	0.64	0.74	0.88	1.04	1.24	1.50	1.84	2.24	2.64	3.44	4.24
iv)	Over 260 to 370	0.40	0.42	0.44	0.46	0.48	0.50	0.54	0.58	0.66	0.74	0.84	0.98	1.14	1.34	1.60	1.94	2.34	2.74	3.54	4.34
v)	Over 370 to 525	0.50	0.52	0.54	0.56	0.58	0.60	0.64	0.68	0.76	0.84	0.94	1.08	1.24	1.44	1.70	2.04	2.44	2.84	3.64	4.44
vi)	Over 525 to 750	0.70	0.72	0.74	0.76	0.78	0.80	0.84	0.88	0.96	1.04	1.14	1.28	1.44	1.64	1.90	2.24	2.64	3.04	3.84	4.64

D-3 ADDITIONAL TOLERANCES ON LONGEST MOVING DIE HALF DIAGONAL (T3)

D-3.1 Smaller tolerance may be achieved when necessary with agreement of the die caster.

D-3.2 When moving die half are needed to enable the casting to be removed from the die, the tolerance T3 should be added to the tolerances T1 and T2.

Sl No.	*Longest Moving Die Half-Diagonal*	*Tolerance* (mm)
(1)	(2)	(3)
i)	0 to 130	0.2
ii)	Over 130 to 180	0.3
iii)	Over 180 to 250	0.4
iv)	Over 250 to 400	0.6

ANNEX E

(*Clause* 26)

TAPER OF CORED HOLES (MIN)

Smaller taper may be cast when necessary with agreement of the die caster.

Sl No.	*Diameter* (mm)	*Depth* (mm)	*Taper Degrees*	*Minutes*	*Tangent*	*Inclusive Taper* (mm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	3	10	3°	0	0.052 4	0.52
ii)	4	14	2°	30	0.043 7	0.61
iii)	5	18	2°	12	0.038 4	0.69
iv)	6.5	25	1°	54	0.033 2	0.83
v)	8	32	1°	36	0.027 9	0.89
vi)	10	45	1°	24	0.024 4	1.10
vii)	12.5	60	1°	12	0.020 9	1.25
viii)	16	80	1°	0	0.017 5	1.40
ix)	20	110	0°	51	0.014 0	1.64
x)	25	150	0°	45	0.013 1	1.96

NOTES

1 The depths and tapers shown are not applicable under conditions where smaller diameter cores are widely spaced and subject to full shrinkage stress.

2 Holes to be tapped need less taper. In spite of slight production disadvantages arising from the smaller taper coring and tapping may still be more economical than drilling and tapping, whether or not a full thread is necessary. When the application does not demand a full thread, the hole should be cored to allow about 60 percent of a full thread at the larger end and 75 percent at the other end. If a full thread is essential, the taper should be removed by machining before tapping. Generally, the maximum threaded depth should not exceed twice the normal diameter of the screw and the depth of a blind hole should be in accordance with general engineering practice.

ANNEX F

(*Foreword*)

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