Indian Standard (Reaffirmed 1996)
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TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL FASTENERS

PART XIII HOT-DIP GALVANIZED COATINGS ON THREADED FASTENERS

(Second Revision)

Bolts, Nuts and Fasteners Accessories Sectional Committee, EDC 27 | Ref: Doc: EDC 27 (3646) |

1. Scope — Covers the requirements for zinc coating applied by hot-dip galvanizing on bolts, screws and nuts having ISO metric coarse threads, in the nominal size range M12 to M36.

Note — ISO metric coarse threads below M12 and all ISO metric fine pitch theads, generally cannot be hot-dip galvanized without difficulty of assembly of bolt and nut.

2. General Requirements — The quality of zinc, bath temperature and the process of galvanizing in general, shall conform to IS : 2629-1966 'Recommended practice for hot-dip galvanizing of iron and steel'.

2.1 Galvanizing shall be carried out by hot-dip process.

2.2 For bolts and screws of property class 10·9 and higher or nuts of property class 10 and higher, particular care shall be exercised in acid pickling or cathodic cleaning prior to galvanizing to avoid risk of hydrogen embrittlement.

2.3 The galvanizing process shall provide for substantial diffusion of hydrogen. Bolts of property class 10·9 or higher and nuts of property class 10 and higher shall be baked at a temperature of 200°C for a period of 30 minutes. Appendix A gives information on embrittlement phenomenon and the possibility of embrittlement occurring in fasteners due to severe cold working, over-pickling, etc.

2.4 The fasteners after galvanizing, shall meet the physical properties of the relevant standards.

3. Dimensions

3.1 *Fasteners with Internal Threads* — Prior to galvanizing and subsequent tapping the dimensions of fasteners with internal threads shall conform to the relevant standards. Internal threads shall be tapped over-size after galvanizing and they shall be oiled for corrosion protection.

3.1.1 The oversize tapping allowance shall be as given in Table 1. These allowances are applicable to major, pitch and minor diameters, the amended diameters being subject to the same manufacturing tolerances of the appropriate grade of threads stated in the relevant fastener standard.

TABLE 1 ALLOWANCES FOR INTERNAL THREADS TO ACCOMMODATE GALVANIZED EXTERNAL THREADS

Nominal Size Internal Threads	Diametral Allowance mm
Below M16	+0·40
M16 to M22	+0·50
Over M22 and up to and including M36	+0·65

3.2 *Fasteners with External Threads* — Prior to galvanizing, the dimensions of fasteners with external threads shall conform to the relevant standards including thread sizes.

3.2.1 The thickness of galvanized coating on external threads shall be so controlled in the galvanizing process that galvanized fasteners with external threads can be assembled by hand with internally threaded fasteners complying with **3.1**.

3.2.2 Galvanized external threads shall not be recut.

4. Coating Requirements

4.1 *Mass of Coating* — The mass of coating per square metre of the surface shall comply with the minimum average and minimum individual sample coating given in Table 2. The mass of coating shall

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be determined by one of the following methods:

a) The stripping test described in Appendix B; or

b) Magnetic or electronic thickness measuring devices as covered in IS : 3203-1965 ' Methods of testing local thickness of electroplated coatings '. The mass of coating in g/m² is found by multiplying the thickness in micrometers by 7·0.

4.1.1 In case of dispute, the stripping test shall be the referee test.

TABLE 2 MASS AND EQUIVALENT THICKNESS OF COATING

Minimum Average		Minimum Individual	
Mass	Thickness	Mass	Thickness
g/m²	µm	g/m²	µm
375	54	300	43

4.2 *Uniformity of Coating* — The uniformity of zinc coating shall be such that the coating shall withstand the copper sulphate test as given in IS : 2633-1972 ' Methods of testing uniformity of coating on zinc coated articles (*first revision*) ' without showing any adherent red deposit of metallic copper upon the base metal with the following exceptions:

a) A fine line of copper on the crest of the screw threads or on sharp edges of bolt/nut or at or adjacent to any cut or abrasion present in the original fastener shall not be considered a defect to cause rejection, and

b) Any deposit of metallic copper with threads of fasteners which have been re-thread rolled after galvanizing, is allowable.

4.3 *Adhesion of Coating* — The coating shall withstand the knife test as covered in IS : 2629-1966.

5. Appearance and Defects — The galvanized coating shall be continuous and free from defects, such as blisters, flux stains, dross, excessive projections or other imperfections which would impair serviceability. The causes for these defects, remedial measures and grounds for rejection are given in Appendix A to IS : 2629-1966 (for terminology *also see* IS : 2629-1966).

6. Sampling

6.1 *Selection of Specimens for Testing* — For testing the requirements at **4** and **5**, the number of specimens to be tested shall be selected at random in accordance with Table 3.

TABLE 3 NUMBER OF TEST SAMPLES

Total Number of Fasteners in Batch	Number of Test Samples
Upto and including 500	3
501 up to and including 35 000	5
Over 35 000	8

6.2 *Retests* — Should any one of the samples selected fail to meet the requirements at **4** and **5**, twice the number of samples first taken shall be so tested, and if any one of these fails the batch represented by the samples shall be rejected or the batch may be re-galvanized and re-submitted for testing.

APPENDIX A

(*Clause* 2.3)

EMBRITTLEMENT

A-0. General — For steel fasteners to be in the embrittled condition after hot-dip galvanizing is rare, and its occurrence depends on a combination of factors. Under certain conditions, some steels may lose their ductile properties and become embrittled. The following information is given as a guidance in critical applications.

A-1. Strain-Age Embrittlement — Strain-age embrittlement occurs when steels of certain compositions are aged following cold working. Steels made by the Bessemer process are generally more susceptible to strain age embrittlement than those made by the open hearth, electric or oxygen process; aluminium killed steels are the least susceptible. Embrittlement can occur very slowly even at ambient temperatures; the galvanizing process, involving immersion in a bath of molten zinc for up to 5 minutes at a temperature of about 450°C can greatly accelerate the process.

Manufacture of fasteners commonly involve cold working in the form of upsetting, thread rolling, etc. Where it is known that a steel susceptible to strain-age embrittlement has been used, the fasteners should be stress relieved before galvanizing.

A-2. Hydrogen Embrittlement — Hydrogen embrittlement can occur in steels of high tensile strength (greater than 1 000 MPa) or high surface hardness due to case hardening or cold working. It results from the absorption of atomic hydrogen generated at the steel surface by processes, such as acid pickling or cathodic cleaning.

The galvanizing process should itself serve to provide substantial diffusion of hydrogen. Where additional safeguard is sought (as for bolts of Grade 10.9 or higher, cleaned by acid pickling), fasteners should be baked at a temperature of 200 ± 10°C, for a time found on the basis of experience to be adequate. (For guidance, a time of 30 minutes before galvanizing, or 4 hours immediately after galvanizing, might prove satisfactory.)

APPENDIX B

(Clause 4.1)

STRIPPING TEST FOR MASS OF COATING

B-1. Solution Required — The following reagents are required:

Antimony chloride solution-20 g of antimony trioxide (Sb_2O_3) or 32g of antimony trichloride ($SbCl_3$) dissolved in 1 000 ml of concentrated hydrochloric acid.

Hydrochloric acid-concentrated (sp gr 1·14 to 1 19).

B-2. Preparation of Samples for Test — The test samples shall preferably be full size or for larger fasteners may be a section cut from the shank unless otherwise agreed between the manufacturer and the purchaser.

The test sample in case of nuts shall be one complete nut and the calculation of the surface area of the nut shall exclude threaded hole.

The samples shall be cleaned by dipping them in benzene (C_6H_6) or other suitable organic solvent which will not attack the zinc coating, wiping dry with a clean soft cloth, and then dipping into a two percent solution of sulphuric acid at 15·6-21·1°C for 15 seconds and thoroughly rinsing in clear water. The samples shall be finally dried by wiping with a clean soft cloth.

B-3. Procedure — The samples shall be weighed to the nearest 0 01 g. The zinc coating shall then be stripped from each sample by completely immersing the sample in any convenient volume of solution, made by adding 5 ml of antimony chloride solution to each 100 ml of concentrated hydrochloric acid. The temperature of the stripping solution shall not exceed 38°C.

The same solution may be repeatedly used without further addition of antimony chloride solution until the time for stripping become inconveniently long.

When the evolution of hydrogen has ceased or when only a few bubbles are being evolved, the sample shall be removed from the solution, scrubed under running water, and then dried by wiping with a clean soft cloth and heating to about 100°C and cooling.

The stripped sample shall then be weighed, the surface area measured and the average mass of the zinc coating per unit area of the surface calculated.

EXPLANATORY NOTE

The requirements for hot-dip galvanized coatings on threaded fasteners were earlier covered in IS : 5358-1969 'Hot-dip galvanized coatings on fasteners'. Consequent to the decision to revise IS : 1367-1967 'Technical supply conditions for threaded steel fastener (*first revision*)' splitting it into many parts, it was felt appropriate to publish 'hot-dip galvanized coatings on threaded fasteners' as one of its parts.

In the preparation of this standard considerable assistance has been derived from AS : 1214-1973 'Hot-dip galvanized coatings on threaded fasteners' issued by Standards Association of Australia.