भारतीय मानक
Indian Standard

IS 16585 : 2016

चुंबकीय सामग्रियाँ — वैयक्तिक सामग्रियाँ की विशिष्टि अर्ध प्रक्रमित अवस्था में दिए गये लौहा आधारित अमोर्फोस स्ट्रिप

Magnetic Materials — Specification for Individual Materials — Fe-Based Amorphous Strip Delivered in the Semi-Processed State

ICS 77.140.40

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee and has been approved by Metallurgical Division Council.

Fe-based amorphous strip is produced by a rapidly-solidifying, direct-casting process. The strip is intended primarily for the construction of wound cores of oil-filled and dry-type energy efficient transformer for commercial power frequency (50 Hz and 60 Hz) applications.

The strip is usually supplied with as cast edges and without any insulating coating.

Fe-based amorphous strip is delivered in the semi-processed state and its desirable specific total loss and permeability characteristics are developed by further heat treatment in a magnetic field , namely magnetic annealing, by the purchaser. An optimum condition of the treatment to obtain the best magnetic properties of the strip is usually maintained for 2 h at a set temperature in a d.c. magnetic field according to the instruction of the manufacturer.

Magnetic properties of the strip strongly depend on the condition of magnetic annealing and it is the responsibility of the purchaser and attention is drawn to the importance of this treatment to obtain magnetic properties in Tables 1 and 2 are given for a reference condition (*see* **7.1.1**).

The strip is very thin and its sectional shape is determined in the casting process without additional rolling process. Thus, stacking factors of the strip are much lower than cold-rolled electrical steels. Therefore, grades of the strip are specified by not only values of the specific total loss and the nominal thickness but also by the value of stacking factor.

The strip is very sensitive to mechanical stress. Care must be exercized in minimizing any stresses on the strip in final application; otherwise, its magnetic properties will deteriorate significantly.

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

MAGNETIC MATERIALS — SPECIFICATION FOR INDIVIDUAL MATERIALS — Fe-BASED AMORPHOUS STRIP DELIVERED IN THE SEMI-PROCESSED STATE

1 SCOPE

This standard defines the grades of Fe-based amorphous strip supplied in the semi-processed state, that is without final heat treatment, of nominal thickness 0.025 mm. Other nominal thickness may be specified by agreement between the supplier and the purchaser when ordering.

In particular, it gives general requirements, magnetic properties, geometric characteristics, tolerances and technological characteristics, as well as inspection procedures.

This standard applies to the rapidly-solidified Fe-based amorphous strip supplied in coils with as-cast edges and intended for the construction of magnetic circuits of a transformer.

The grades are grouped into two classses as follows:

a) Conventional grades; and
b) High permeability grades.

These materials correspond to Class 1.1 of IEC 60404-1.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are 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 indicated below:

IS No./International Standards	*Title*
1885 (various parts)	Electrotechnical Vocabulary
8910/ISO 404: 2013	Steel and steel products — General technical delivery requirements (*second revision*)
13795 (Part 1) : 1993	Glossary of terms relating to special alloys: Part 1 Soft magnetic materials
16586 : 2016	Magnetic materials — Methods of measurement of magnetic properties of Fe-based amorphous strip by means of a single sheet tester
IS/ISO 10474 : 2013	Steel and steel products — Inspection documents
IEC 60050-121 : 1998	International Electrotechnical Vocabulary — Part 121: Electromagnetism
IEC 60050-221 : 1990	International Electrotechnical Vocabulary — Part 221: Magnetic materials and components
IEC 60404-1 : 2004	Magnetic materials — Part 1: Classification
IEC 60404-9 : 1987	Magnetic materials — Part 9: Methods of determination of the geometrical characteristics of magnetic steel sheet and strip

3 TERMS AND DEFINITIONS

For the purpose of this standard, the terms and definitions given in IS 1885 (Various parts), IEC 60050-121, IEC 60050-221, IEC 60404-9, IS 13795 (Part 1) and the followings shall apply.

3.1 Strip Tear Ductility — Ductility which is characterized by a ductility code that is classified by number of brittle spots when a strip of a length in twice of wheel circumference is torn in a direction parallel to the direction of casting.

3.2 Brittle Spots — Areas of strip which shatter or fracture when being torn through, which divert the path and or direction of the tear by approximately 6 mm or more, or where a piece of the ribbon comes free from the strip

4 CLASSIFICATION

The grades covered by this standard are classified according to the value of maximum specific total loss, in watts per kilogram, at 1.3 T and 50 Hz, according to the value of minimum stacking factor in percentage and according to the nominal thickness of the strip.

5 DESIGNATION

The material name complies with the following in the order given:

a) Letters AM for Fe-based amorphous strip;
b) One hundred times the specified value of the maximum specific total loss at 1.3 T and 50 Hz, in watts per kilogram;
c) One thousand times the nominal thickness of the strip, in mm;
d) Characteristic letter:
   1) S for conventional grades;
   2) P for high permeability grades;
e) One-tenth of the frequency 50 Hz, that is 5; and
f) One hundred times the specified value of the minimum stacking factor,

EXAMPLE — AM10-25S5-84 for Fe-based amorphous strip of conventional grade with a maximum specific total loss at 1.3 T of 0.10 W/kg at 50 Hz, a minimum stacking factor of 0.84 and nominal thickness of 0.025 mm, supplied in the semi-processed state.

6 GENERAL REQUIREMENTS

6.1 Production Process

The production process of the strip and its chemical composition are left to the discretion of the manufacturer.

6.2 Form of Supply

The strip is supplied in coils. A coil shall be a single-ply spool which is a continuous single strip wound on a spool hub or a multi-ply spool which is a number of strips simultaneously wound on a spool hub.

The mass of the coils shall be agreed at the time of ordering.

The recommended value for the internal diameter of the spool hub is approximately 406 mm. The outside diameter of the coil shall be at least 600 mm and shall not exceed 1 120 mm.

Strip shall be of constant width and wound in such a manner that the edges are superimposed in a regular manner and the side faces of the coil are substantially flat.

Irregular flatness and/or the size and the number of void or opening in the coil shall be agreed to at the time of ordering.

Coils shall be sufficiently tightly wound in order that they do not loosen under their own weight.

In the case of a coil of multi-ply spools, strips may exhibit single-ply joints, if agreed to at the time of enquiry and order. The shape of the strip ends at the joint may be agreed at the time of ordering.

The edges of parts jointed together shall be not so much out of alignment as to affect the further processing of the strip.

6.3 Delivery Condition

Fe-based amorphous strip is usually supplied without any insulating coating. An oxide layer is formed naturally on the strip surface during processing of the strip.

6.4 Surface Condition

The surfaces shall be smooth and clean, free from grease and rust. No continuous indication of oxide shall be visible along the surfaces or edges of the strip.

The surfaces and edges shall have no wrinkles, dimples, cracks, folds, flakes, or other defects that would make the strip unsuitable for the fabrication of wound cores. Dispersed imperfections such as minor rusts, slight colouration, small pinholes, shallow dimples, etc, are permitted if they are not detrimental to the correct use of the supplied strip.

The strip shall have no needle-like hollow gaps exceeding 7.0 mm in diameter. The strip shall have no more than 8 no needle-like hollow gaps aligned in the longitudinal axis of the strip in any 25 mm segment. For the purpose of determining conformance to this requirement, holes are considered aligned when a straight edge can be aligned so as to intersect each hole.

The strip edge shall have no slivers, nicks or feathers with a maximum dimension exceeding 4.0 mm.

6.5 Suitability for Cutting

The strip shall be suitable for cutting straight at any point when appropriate cutting tools are used.

7 TECHNICAL REQUIREMENTS

7.1 Magnetic Properties

7.1.1 *Reference Condition*

The magnetic properties [magnetic polarization and specific total loss (*see* **7.1.2** *and* **7.1.3**)] shall apply only to test specimens in the reference condition which is obtained by the following magnetic annealing.

When applying any other International standards/ methods for the measurement of magnetic properties, the specified values of maximum specific total loss and the minimum magnetic polarization at 80 A/m and 50 Hz shall be agreed to between the parties, when ordering.

Test strips shall be subjected to a heat treatment in a d.c. magnetic field in a direction parallel to the direction of casting, at least 1 600 A/m in strength at the

temperature in accordance with the specification of the manufacturer. The atmosphere of the heat treatment shall be dry and inert.

The magnetic annealing shall be maintained for 2 h at the temperature and a d.c. magnetic field shall be maintained until the temperature falls to 200 °C.

A quick magnetic annealing may be performed in a higher temperature and a shorter time than the above treatments by agreement between the parties when ordering.

NOTES

1 As a general guideline, the temperature for the heat treatment is 140 °C – 170 °C below the onset of crystallization temperature determined by differential scanning calorimetry (DSC) at heating rate of 20 °C/min.

2 In case of the quick magnetic annealing, magnetic properties of the test specimen can be worse than the case of the reference condition.

7.1.2 *Magnetic Polarization*

The specified minimum values of peak polarization for the peak magnetic field strength of 80 A/m at 50 Hz shall be given in Tables 1 and 2.

7.1.3 *Specific Total Loss*

The specified values of maximum specific total loss at 1.3 T and 1.4 T at 50 Hz shall be as given in Tables 1 and 2.

NOTE — Annex A gives non-specified values of maximum specific total loss at 1.5 T.

7.2 Geometric Characteristics and Tolerances

7.2.1 *Thickness*

The nominal thickness of the strip is 0.025 mm. Other nominal thickness may be specified by agreement between parties when ordering.

For thickness tolerance, a distinction is made between

a) the allowable tolerance on the nominal thickness within the same acceptance unit;
b) the difference in thickness in a length of strip

Table 1 Technological Properties and Magnetic Properties of the Conventional Grades of Fe-based Amorphous Strip

(*Clauses* 7.1.2 *and* 7.1.3)

Sl No.	Steel Name	Nominal Thickness	Maximum Specific Total Loss at 1.3 T [1]		Maximum Specific Total Loss at 1.4 T [1]		Minimum Magnetic Polarization [1, 2]		Minimum Stacking Factor	Typical Density [3]
			W/kg		W/kg		T			
		mm	50 Hz	60 Hz [4]	50 Hz	60 Hz [4]	80 A/m	800 A/m [4]		kg/dm^3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	AM08-25S5-88	0.025	0.08	0.11	0.11	0.14	1.35	1.50	0.88	7.20
ii)	AM08-25S5-86								0.86	
iii)	AM08-25S5-84								0.84	
iv)	AM10-25S5-88	0.025	0.10	0.13	0.13	0.17	1.35	1.50	0.88	7.20
v)	AM10-25S5-86								0.86	
vi)	AM10-25S5-84								0.84	
vii)	AM12-25S5-88	0.025	0.12	0.15	0.16	0.20	1.35	1.50	0.88	7.20
viii)	AM12-25S5-86								0.86	
ix)	AM12-25S5-84								0.84	
x)	AM16-25S5-88	0.025	0.16	0.20	0.21	0.26	1.35	1.50	0.88	7.20
xi)	AM16-25S5-86								0.86	
xii)	AM16-25S5-84								0.84	

1) These values are valid only for test specimens in the reference condition (*see* **7.1.1**).

2) Magnetic polarization (intrinsic flux density) is defined as follows in accordance with IEC 60050-121:

$$J = B - \mu_0 H$$

where

J = magnetic polarization;
B = magnetic flux density;
μ_0 = magnetic constant: $4\pi \times 10^{-7}$ H m^{-1};
H = magnetic field strength;

NOTE — The difference between B and J at 800 A/m is equal to 0.001 T.

3) Other values may be as agreed to between the manufacturer and the purchaser.

4) Only for information.

Table 2 Technological Properties and Magnetic Properties of the High Permeability Grades of Fe-Based Amorphous Strip

(*Clauses* 7.1.2 *and* 7.1.3)

Sl No.	Steel Name	Nominal Thickness	Maximum Specific Total Loss at 1.3 T [1]		Maximum Specific Total Loss at 1.4 T [1]		Minimum Magnetic Polarization [1), 2)]		Minimum Stacking Factor	Typical Density [3]
			W/kg		W/kg		T			
		mm	50 Hz	60 Hz [4]	50 Hz	60 Hz [4]	80 A/m	800 A/m [4]		kg/dm^3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	AM08-25P5-88	0.025	0.08	0.11	0.11	0.14	1.50	1.60	0.88	7.35
ii)	AM08-25P5-86								0.86	
iii)	AM08-25P5-84								0.84	
iv)	AM10-25P5-88	0.025	0.10	0.13	0.13	0.17	1.50	1.60	0.88	7.35
v)	AM10-25P5-86								0.86	
vi)	AM10-25P5-84								0.84	
vii)	AM12-25P5-88	0.025	0.12	0.15	0.16	0.20	1.50	1.60	0.88	7.35
viii)	AM12-25P5-86								0.86	
ix)	AM12-25P5-84								0.84	
x)	AM16-25P5-88	0.025	0.16	0.20	0.21	0.26	1.50	1.60	0.88	7.35
xi)	AM16-25P5-86								0.86	
xii)	AM16-25P5-84								0.84	

[1] These values are valid only for test specimens in the reference condition (*see* **7.1.1**).

[2] Magnetic polarization (intrinsic flux density) is defined as follows in accordance with IEC 60050-121:

$$J = B - \mu_0 H$$

where

J = magnetic polarization;

B = magnetic flux density;

μ_0 = magnetic constant: $4\pi \times 10^{-7}$ H m^{-1};

H = magnetic field strength.

NOTE — The difference between B and J at 800 A/m is equal to 0.001 T.

[3] Other values may be agreed to between the manufacturer and the purchaser.

[4] Only for information.

along the direction parallel to the longitudinal axis of the strip; and

c) the difference in thickness in the direction perpendicular to the longitudinal axis of the strip.

At any point, the allowable tolerance on the nominal thickness within the same acceptance unit shall not exceed ± 0.002 mm.

The difference in thickness in a length of strip of 2 m along the direction parallel to the longitudinal axis of the strip shall not exceed ± 0.002 5 mm.

The difference in thickness in the direction perpendicular to the longitudinal axis of the strip shall not exceed ± 0.002 5 mm.

7.2.2 *Width*

The available nominal widths are 142.2 mm, 170.2 mm and 213.4 mm. Other nominal width may be specified by agreement between the parties when ordering.

The width tolerances of Table 3 shall apply. For other nominal width, the Tolerance may be specified by agreement between the parties when ordering.

Table 3 Tolerances on Nominal Width of Fe-based Amorphous Strip

(*Clause* 7.2.2)

Sl No.	Nominal Width	Tolerance
	mm	mm
(1)	(2)	(3)
i)	142.2	± 1.0
ii)	170.2	± 1.1
iii)	213.4	± 1.4

7.2.3 *Length*

The determination of the length of strips does not apply to the strip.

7.2.4 *Edge Camber*

A requirement concerning edge camber may be specified by agreement between the parties when ordering.

7.2.5 *Flatness (Wave Factor)*

A requirement concerning flatness (wave factor) may be specified by agreement between the parties when ordering.

7.2.6 *Residual Curvature*

A requirement concerning residual curvature may be specified by agreement between the parties, when ordering.

7.2.7 *Burr Height*

The determination of burr height does not apply to the strip.

7.3 Technological Characteristics

7.3.1 *Density*

The density of the strip is not specified.

The conventional values of density are given in Tables 1 and 2. They shall be used to calculate the magnetic properties and the stacking factor, unless otherwise agreed (*see* footnote 3 under Tables 1 and 2).

7.3.2 *Stacking Factor*

The minimum values of stacking factor shall be specified in Tables 1 and 2.

7.3.3 *Strip Tear Ductility*

The strip tear ductility characterized by the ductility codes defined in the Table 4 shall not exceed the Code "4".

Table 4 Ductility Code and Number of Brittle Spots of Fe-based Amorphous Strip

(*Clauses* 7.3.3 *and* 8.4.4.2)

Sl No. (1)	Ductility Code (2)	Number of Brittle Spots (3)
i)	1	0
ii)	2	1 to 3
iii)	3	4 to 6
iv)	4	7 to 9
v)	5	10 or more

7.3.4 *Internal Stresses*

The verification of internal stress does not apply to the strip.

7.3.5 *Surface Insulation Resistance*

The determination of surface insulation resistance does not apply to the strip.

8 INSPECTION AND TESTING

8.1 General

The strip defined by this standard can be ordered with or without specific inspection in accordance with IS 8910/ISO 404. However, as a dispensation from IS 8910/ISO 404, in the case of an order without inspection, the manufacturer shall supply a certificate giving the specific total loss of the supplied strip.

In the case of an order with specific inspection, the type of inspection document in accordance with IS/ISO 10474 shall be specified when ordering. In this case, the delivery is divided into acceptance units.

Each acceptance unit shall be a coil. Different acceptance units can be adopted by special agreement between the manufacturer and the purchaser.

Except by special agreement, the same rules apply to the inspection of suitability for cutting and tolerances of shape and dimensions.

8.2 Selection of Samples

Samples shall be taken from both of the beginning and the end of coils at casting and undergo testing separately. Other sample frequencies may be used by agreement between the manufacturer and the purchaser.

In the case of successive casting to plural coils, samples taken from the end of preceding coil are considered the same as samples taken from the top next coil.

The last external turns of the coil shall be considered as wrapping and not as representative of the quality of the rest of the coil. The selection shall be made from the first internal or external turn, excluding the wrapping turn.

By choosing a suitable order for the execution of the tests, the same sample shall serve to check the various properties.

8.3 Preparation of Test Specimens

8.3.1 *Magnetic Properties*

The measurement of magnetic polarization and specific total loss shall be made using the single sheet method specified in IS 16586 (*see* **8.4.2**), the test specimen for the single sheet tester shall consist of four sheets having the following dimensions:

a) Length 280 mm to 300 mm; and
b) Width equal to the width of the strip.

Two test specimens shall be carefully cut without deformation from each sample taken from both of the beginning and the end of coils at casting. Cutting shall be carried out only with well sharpened tools.

When applying any other International standards/ methods, one test specimen shall be carefully cut from both of the beginning and the end of coils at casting.

The length, width of the test specimen, the number of stacks and specimens shall be determined by agreement between two parties when ordering.

Before measurements the test specimens shall be subjected to a magnetic annealing in accordance with the reference condition (*see* **7.1.1**).

In the case of measurements of specific total loss on aged test specimens, there shall be heated at 225 ± 5°C for a duration of 24 h and shall be cooled to ambient temperature. Other aging treatment conditions can also be used by agreement between the manufacturer and the purchaser.

8.3.2 *Geometrical Characteristics and Tolerances*

For the measurement of thickness, the test specimen shall be rectangular/square and have a width of at least 20 mm, a length of at least 20 mm and a surface area of at least 5 000 mm^2. The test specimen for stacking factor can be used for the measurement.

For the measurement of width, the test specimens shall consist of a strip with a length of at least 200 mm.

For the measurement of flatness and edge camber, the test specimen shall consist of a 2 m length and of width equal to the delivery width of the strip.

For the measurement of the residual curvature, the test specimen shall consist of a strip in length and of width equal to the delivery width of the strip.

8.3.3 *Technological Characteristics*

8.3.3.1 *Stacking factor*

The test specimen shall consist of at least 20 strips of the same size; in case of dispute, the test shall be made with 100 strips. They shall have a width equal to the width of the strip and the same length within the range of 75 mm to 125 mm within tolerance of ± 0.5 mm.

The strip shall be cut consecutively from the sample in the longitudinal direction of the strip by a method which will not produce excessive burrs on cut edges that cause deterioration of the stacking factor. They shall be stacked directly on top of one another in the same direction.

8.3.3.2 *Strip tear ductility*

The test specimen shall consist of a strip of a length in twice of wheel circumference.

8.4 Test Methods

8.4.1 *General*

For each specified property, one test shall be carried out per acceptance unit. Unless otherwise specified, the tests shall be made at a temperature of 27 ± 5°C.

In case of a coil of multi-ply spools, the properties shall be determined by taking the average of strips.

8.4.2 *Magnetic Properties*

The test shall be made using a single sheet tester in accordance with IS 16586.

The magnetic properties shall be determined by taking the average of four test specimens which each two taken from both of the beginning and the end of the coil.

When applying any other international standards/ methods, the magnetic properties shall be determined by taking the average of test specimens which are taken from both of the beginning and the end of the coil.

8.4.3 *Geometrical Characteristics and Tolerances*

8.4.3.1 *Thickness*

The thickness t_h of the test specimen shall be determined by the following formula:

$$t_h = \frac{m}{\rho_m \cdot b \cdot l} \qquad \ldots(1)$$

where

t_h = calculated average thickness of the test specimen, expressed, in metre (m);

m = mass of the test specimen, in kilogram (kg);

b = width of the test specimen, in metre (m);

l = length of the test specimen, in metre (m); and

ρ_m = density of the test specimen, in kilogram per cubic metre (kg/m^3).

8.4.3.2 *Width*

The width $\left(500^{+2.5}_{0}\right)$ mm shall be measured perpendicular to the longitudinal axis of the strip.

8.4.3.3 *Edge camber*

The edge camber shall be determined in accordance with IEC 60404-9.

8.4.3.4 *Flatness (wave factor)*

The wave factor shall be determined in accordance with IEC 60404-9.

8.4.3.5 *Residual curvature*

The residual curvature in the longitudinal direction of the strip shall be determined in accordance with IEC 60404-9.

8.4.4 *Technological Characteristics*

8.4.4.1 *Stacking factor*

The stacking factor shall be measured in accordance with Annex B.

8.4.4.2 *Strip tear ductility*

The test consists of tearing the test specimen along strip's length in 5 locations across the width; within approximately 12.7 mm and 25.4 mm from both of the edges and the centre of the strip. The number of brittle spots shall be counted.

The ductility code shall be determined on the total number of the brittle spots for two test specimen by Table 4.

8.5 Re-tests

When a test does not give the specified result, this test shall be repeated on double the number of test specimens on outer strips from the coil. The delivery shall be considered to conform to the order, if all results of additional tests are in accordance with the requirements of this standard.

9 MARKING, LABELLING AND PACKAGING

Coils shall be packed to prevent physical damage during shipment. The packaging techniques used shall permit weather-protected storage at the purchaser's site for a period of six months without degradation of the strip.

The coil should be placed on a pallet which the coil axis perpendicular to the pallet, allowing handling by fork truck. Unpacking should involve only strap cutting and no nail withdrawal.

Marking and labelling of the products may be agreed at the time of ordering.

10 COMPLAINTS

Internal or external defects shall justify a complaint only, if they are clearly prejudicial to the method of working or the judicious use of the strip.

The purchaser shall give to the manufacturer the opportunity of convincing himself of the fairness of the claim by presenting the strip in dispute and evidence for the complaint.

In all cases, the terms and conditions of complaints shall be in accordance with IS 8910/ISO 404.

11 INFORMATION TO BE SUPPLIED BY THE PURCHASER

For materials to comply adequately with the requirements of this standard, the purchaser shall include the following information in his enquiry and order:

a) Quantity;
b) Number of this standard;
c) Steel name (*see* **5**);
d) Number of composed strips in case of multi-ply spools (*see* **6.2**)
e) Dimensions of strips required (including any limitations on the external diameter of a coil) (*see* **6.2**);
f) Any limitations on the mass of a coil (*see* **6.2**);
g) Any special requirement about edge camber, flatness (wave factor) and residual curvature (*see* **7.2.4**, **7.2.5** and **7.2.6**);
h) Inspection procedure required including the nature of the related documents (*see* **8.1**); and
j) Any special requirement about marking and labelling of the products (*see* **9**).

12 TEST REPORTS

To assure compliance with the requirements of this standard, the manufacturer shall furnish the following certificated test reports assuring compliance with the requirements of this standard:

a) Number of this standard ;
b) Steel name (*see* **5**);
c) Thickness and the width of strip, in millimetre (mm);
d) Mass of coil in kilograms (kg);
e) Condition of the magnetic annealing prior to the measurement of magnetic properties;
f) Values of specific total loss at 1.3 T and 1.4T, at 50 Hz, in watts per kilogram (W/kg);
g) Value of magnetic polarization for a magnetic field strength of 80 A/m at 50 Hz or 60 Hz, in tesla (T);
h) Value of stacking factor, rounded to the nearest 0.01; and
j) Ductility code (*see* **7.3.3**).

13 MARKING

13.1 Marking and labelling of the products may be agreed at the time of ordering.

13.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

13.2.1 The use of the 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 license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* 7.1.3)

NON-SPECIFIED MAGNETIC PROPERTIES

A-1 Table 5 gives the non-specified magnetic properties of Fe-based amorphous strip.

Table 5 Non-Specified Magnetic Properties of Fe-Based Amorphous Strip

Sl No.	Material Name [1]	Nominal Thickness	Maximum Specific Total Loss at 1.5 T [2] W/kg
		mm	50 Hz
(1)	(2)	(3)	(4)
i)	AM08-25S5-88 AM08-25S5-86 AM08-25S5-84	0.025	0.18
ii)	AM10-25S5-88 AM10-25S5-86 AM10-25S5-84	0.025	0.20
iii)	AM12-25S5-88 AM12-25S5-86 AM12-25S5-84	0.025	0.23
iv)	AM16-25S5-88 AM16-25S5-86 AM16-25S5-84	0.025	0.28
v)	AM08-25P5-88 AM08-25P5-86 AM08-25P5-84	0.025	0.14
vi)	AM10-25P5-88 AM10-25P5-86 AM10-25P5-84	0.025	0.16
vii)	AM12-25P5-88 AM12-25P5-86 AM12-25P5-84	0.025	0.19
viii)	AM16-25P5-88 AM16-25P5-86 AM16-25P5-84	0.025	0.24

[1] Material names are in accordance with Tables 1 and 2.
[2] These values are valid only for test specimens in the reference condition (*see* **7.1.1**).

ANNEX B

(*Clause* 8.4.4.1)

TEST METHOD OF DETERMINATION OF THE STACKING FACTOR FOR Fe-BASED AMORPHOUS STRIPS

B-1 GENERAL

Annex B defines the method of determination of the stacking factor for Fe-based amorphous strips. This test method may be applied to the strips of nominal thickness 0.020 mm to 0.030 mm.

The stacking factor indicates the deficiency of effective material volume which is due to the presence of oxides, roughness and other conditions affecting the strip surface.

This test method is used to predict the fraction of metal

that is included in the volume of the coil wound from the strip.

This test method is predicted on correctly aligned test strips and uniform compression during test. Both of these conditions are difficult to meet, whenever the test strips have one or more elevated ridges running lengthwise along the surface.

This test method also presupposes that the test specimens are free from other defects, such as camber and waviness, which may affect the stacking factor.

The test shall be made at an ambient temperature of 27 ± 5°C.

B-2 TEST SPECIMEN

The test specimen shall comprise a sufficient number of test strips of the same size to give a stack of minimum height 0.5 mm, at least 20 strips for the material. In case of dispute, the test shall be made with 100 strips.

The test strips shall have a width of the strip and the same length within the range of 75 mm to 125 mm within tolerances of ±0.5 mm.

The test strips shall be cut consecutively from the strip in the direction of casting by a method which will not produce excessive burrs on cut edges that cause deterioration of the stacking factor. They shall be stacked directly on top of one another in the same direction.

Fe-based amorphous strips are manufactured by pouring molten alloy on a rapidly spinning casting roll and periodic thickness variations, if any, will be related to the position on the roll circumference. To ensure that such variations are properly averaged, the total length of test strips should be in multiples of the roll circumference.

NOTE — If the exact casting roll circumference is not known, it can be assumed to be 1.2 m. Therefore 20 of 120 mm in length strips can be used as two roll circumferences of the material.

B-3 MEASUREMENT PROCEDURE

The test specimen shall be weighed with an accuracy of 0.1 percent or better. Their mean length and width shall be measured with an accuracy of ± 0.3 percent or better and preferably ± 0.1 percent.

The test strips are stacked and placed between the rams of a press. The surface area of the rams shall be sufficient to cover completely the stack of the test strips that is subjected to a pressure. By special agreement, the determination of stacking factor may be made using a linear measuring device consist of a fixed anvil and movable face with the surface area 160 to 215 mm^2.

With a pressure of 48 kPa to 55 kPa applied uniformly on the stack, the distance h between the rams shall be measured with an accuracy of ± 0.3 percent or better, on the symmetrical positions next to the four edges of the stack. If this is not possible, the two symmetrical positions next to the middle of the two shorter sides or next to the diagonal points of the stack should be used.

When test with the linear measuring device, the distance h shall be determined by taking the maximum value of multiple measurements across the entire width at intervals slightly smaller than the surface area of the pressure foot to ensure a small overlap in the area covered.

The stacking factor (f) is calculated according to the relationships:

$$f = \frac{m}{\rho_m \cdot h \cdot b \cdot l}$$

where

f = calculated stacking factor;

m = total mass of the test specimen, in kilogram (kg);

ρ_m = conventional density of the test specimen, in kilogram per cubic metre (kg/m^3);

h = height of the stack, in metre (m);

b = mean width of the test specimen, in metre (m); and

l = mean length of the test specimen, in metre (m).

NOTE — If there is difficulty in achieving the specified accuracy for the measurement of the distance between the rams, the height of the stack can be increased.

B-4 REPRODUCIBILITY

The reproducibility of the test method of determination of the stacking factor described in Annex B is characterized by a relative standard deviation of 2.0 percent.

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