IS : 1786 - 1985
Superseding IS : 1139-1966
(Reaffirmed 1990)

Indian Standard

SPECIFICATION FOR HIGH STRENGTH DEFORMED STEEL BARS AND WIRES FOR CONCRETE REINFORCEMENT

(Third Revision)

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(Third Revision)

0. FOREWORD

0.1 This Indian Standard (Third Revision) was adopted by the Indian Standards Institution on 1 May 1985, after the draft finalized by the Joint Sectional Committee for Concrete Reinforcement had been approved by the Civil Engineering Division Council.

0.2 Deformed bars for concrete reinforcement are being produced in the country for many years, the main processes being hot rolling or hot rolling followed by cold twisting. In the past decade there has been an increasing demand for higher strength deformed bars (415 N/mm^2, *Min*, yield strength/0·2 percent proof stress being the most common). This high yield strength was being first achieved by raising carbon and manganese and to a great extent by cold twisting. In addition to this, there has been considerable demand for larger diameter bars with similar strength, elongation, weldability and bendability as that of small size bars. Along with this, there is also a need for these steel bars to be welded and fabricated on the site easily. For this, strength and ductility have to be achieved at the lowest possible carbon content.

0.2.1 Technological advances during the last few years in the field of deformed bar production have helped in meeting all the above requirements together. Microalloying with Nb, V, Ti and B, in combination or individually, and thermomechanical treatment process are worth mentioning in this field. With these two processes higher strength values could be achieved at low carbon levels even in large diameter bars.

0.3 Two Indian Standard specifications, namely, IS : 1139-1966 'Specification for hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement (*revised*)' and IS : 1786-1979 'Specification for cold-worked steel high strength deformed bars for concrete reinforcement (*second revision*)' covered deformed bars

for concrete reinforcement. To take advantage of the technological changes, it is thought necessary to merge these two specifications giving the option of the manufacturing process to the producers so as to meet all the requirements of the specification. Hence the revision of IS : 1139-1966 and IS : 1786-1979 has been prepared combining them into a single specification with modified designation and title. In this revision the requirements of chemical composition have been modified, a new strength grade Fe 550 has been introduced, Fe 250 and Fe 350 strength grades have been deleted, requirements of modified bar geometry have been made applicable to hot-rolled bars in addition to cold-worked bars; further 4, 5 and 7 mm nominal sizes have been introduced; and a few other changes found necessary as a result of experience gained have been incorporated.

0.4 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*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements of deformed steel bars and wires for use as reinforcement in concrete, in the following three strength grades:

a) Fe 415,

b) Fe 500, and

c) Fe 550.

NOTE — The figures following the symbol Fe indicates the specified minimum 0·2 percent proof stress or yield stress in N/mm².

2. TERMINOLOGY

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

2.1 Batch — Any quantity of bars/wires of same size and grade whether in coils or bundles presented for examination and test at one time.

2.2 Bundle — Two or more coils or a number of lengths properly bound together.

*Rules for rounding off numerical values (*revised*).

2.3 Elongation — The increase in length of a tensile test piece under stress. The elongation at fracture is conventionally expressed as a percentage of the original gauge length of a standard test piece.

2.4 Longitudinal Rib — A rib of uniform cross-section, parallel to the axis of the bar/wire (before cold-working, if any).

2.5 Nominal Diameter or Size — The diameter of a plain round bar/wire having the same mass per metre length as the deformed bar/wire.

2.6 Nominal Perimeter of a Deformed Bar/Wire — 3·14 times the nominal diameter.

2.7 Nominal Mass — The mass of the bar/wire of nominal diameter and of density 0·007 85 kg/mm^2 per metre run.

2.8 0·2 Percent Proof Stress — The stress at which a non-proportional elongation equal to 0·2 percent of the orginal gauge length takes place.

2.9 Tensile Strength — The maximum load reached in a tensile test divided by the effective cross-sectional area of the gauge length portion of the test piece. Also termed as ultimate tensile stress.

2.10 Transverse Rib — Any rib on the surface of a bar/wire other than a longitudinal rib.

2.11 Yield Stress — Stress (that is, load per unit cross-sectional area) at which elongation first occurs in the test piece without increasing the load during tensile test. In the case of steels with no such definite yield point, proof stress shall be applicable.

3. MANUFACTURE AND CHEMICAL COMPOSITION

3.1 Steel shall be manufactured by the open-hearth, electric, duplex, basic-oxygen, or a combination of these processes. In case any other process is employed by the manufacturer, prior approval of the purchaser should be obtained.

3.1.1 Steel shall be supplied semi-killed or killed.

3.1.2 The bars/wires shall be manufactured from properly identified heats of mould cast, continuously cast steel or rolled semis.

3.1.3 The steel bars/wires for concrete reinforcement shall be manufactured by the process of hot-rolling. It may be followed by a suitable method of cooling and/or cold working.

3.2 Chemical Composition — The ladle analysis of steel when made as per relevant parts of IS : 228* shall be as follows:

Constituent	*Percent, Maximum*		
	Fe 415	Fe 500	Fe 550
Carbon	0·30	0·30	0.30
Sulphur	0·060	0·055	0.055
Phosphorus	0·060	0·055	0.050
Sulphur and phosphorus	0·11	0·105	0.10

NOTE 1 — For guaranteed weldability, the percentage of carbon shall be restricted to 0·25 percent, maximum.

NOTE 2 — Addition of microalloying elements is not mandatory for any of the above grades. When strengthening elements like Nb, V, B and Ti are used individually or in combination, the total contents shall not exceed 0·30 percent; in such case manufacturer shall supply the purchaser or his authorized representative a certificate stating that the total contents of the strengthening elements in the steel do not exceed the specified limit.

3.2.1 In case of product analysis, the permissible variation from the limits specified under **3.2** shall be as follows:

Constituent	*Variation, Over Specified Maximum Limit, Percent, Max*
Carbon	0·02
Sulphur	0·005
Phosphorus	0·005
Sulphur and phosphorus	0·010

3.2.2 For welding of cold-worked deformed bars, the recommendations of IS : 9417-1979† shall be followed.

3.2.3 In case of deviations from the specified maximum, two additional test samples shall be taken from the same batch and subjected to the test or tests in which the original sample failed. Should both additional test samples pass the test, the batch from which they were taken shall be deemed to comply with this standard. Should either of them fail, the batch shall be deemed not to comply with this standard.

*Methods for chemical analysis of steels (*second revision*) (issued in parts).

†Recommendations for welding cold-worked steel bars for reinforced concrete construction.

3.3 Rolling and Cold-Working of Bars/Wires

3.3.1 All bars/wires shall be well and cleanly rolled and shall be sound and free from surface defects and pipe, or other defects detrimental to its subsequent processing and to its end use. Rust, seams, surface irregularities or mill scale shall not be the cause for rejection provided a hard wire brushed test specimen fulfils all the requirements of this specification.

3.3.2 Stretching may or may not be combined with cold-working. The unworked length at each end of the bar/wire shall not exceed 100 mm or 4 times the nominal diameter, whichever is greater.

4. REQUIREMENTS FOR BOND

4.1 High strength deformed bars/wires shall satisfy the requirements given in either **4.2** or **4.7**.

4.2 Deformations and Surface Characteristics — For high strength deformed bars/wires, the mean area of ribs (in mm^2) per unit length (in mm) above the core of the bar/wire, projected on a plane normal to the axis of the bar/wire calculated in accordance with **4.4** shall not be less than the following values:

$0{\cdot}12\ \phi$ for $\phi \leqslant 10$ mm

$0{\cdot}15\ \phi$ for $10\ mm < \phi \leqslant 16$ mm

$0{\cdot}17\ \phi$ for $\phi > 16$ mm

where ϕ is the nominal diameter of bar/wire in mm.

The mean projected area of transverse ribs alone shall be not less than one-third of the values given above.

4.3 The ribs contributing to the projected area considered in **4.2** shall consist of:

a) Longitudinal ribs in the form of continuous or discontinuous helix; and

b) Transverse ribs which after hot-rolling or cold-working are uniform in size and shape along the length of the bar/wire, and are spaced along the bar/wire at substantially uniform distances.

4.4 The mean projected rib area per unit length A_r (in mm^2 per mm) may be calculated from the following formula:

$$A_r = \frac{n_{tr} A_{tr} \sin \theta}{s_{tr}} + \frac{n_{lr}\, d_{lr}\, \pi\, \phi}{s_p}$$

where

n_{tr} = number of rows of transverse ribs;

A_{tr} = area of longitudinal section of a transverse rib on its own axis (*see* Fig. 1) in mm^2;

θ = inclination of the transverse rib to the bar axis (after twisting for cold-worked twisted bars) in degrees. Average value of two ribs from each row of transverse ribs shall be taken;

s_{tr} = spacing of transverse ribs in mm;

n_{lr} = number of longitudinal ribs;

d_{lr} = height of longitudinal ribs in mm;

ϕ = nominal diameter of the bar/wire in mm; and

s_p = pitch of the twist in mm.

NOTE 1 — In the case of hot rolled bars/wires which are not subjected to cold twisting, the value of s_p in the second term of the expression for A_r shall be taken as infinity rendering the value of the second term to zero.

NOTE 2 — A_{tr} may be calculated as 2/3 l_{tr} d_{tr} where l_{tr} and d_{tr} are shown in Fig. 1.

NOTE 3 — In the case of cold-worked bars/wires with some discontinuous longitudinal ribs, the number of longitudinal ribs, n_{lr} shall be calculated as an equivalent number using the following formula and accounted for in the expression for A_r:

$$n_{lr} = \frac{n_{lr}'\, l'\, d_{lr}'}{s_{lr}'\, d_{lr}} + \text{Number of continuous longitudinal ribs}$$

where

n_{lr}' = number of discontinuous longitudinal ribs,

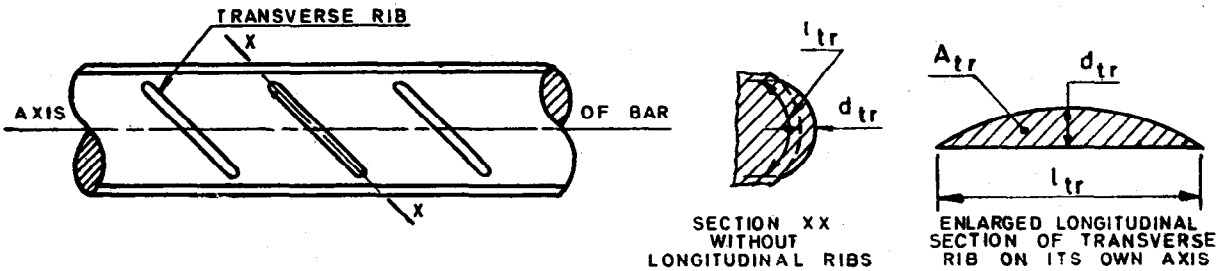
l' = average length of discontinuous longitudinal ribs,

d_{lr}' = height of discontinuous longitudinal ribs,

s_{lr}' = average spacing of discontinuous longitudinal ribs, and

d_{lr} = height of continuous longitudinal ribs.

NOTE 4 — The average length of discontinuous longitudinal ribs shall be determined by dividing a measured length of the bar equal to at least 10 ϕ by the number of discontinuous longitudinal ribs in the measured length, ϕ being the nominal diameter of the bar. The measured length of the bar shall be the distance from the centre of one rib to the centre of another rib.



NOTE — A_{tr}, d_{tr} and l_{tr} represent longitudinal sectional area, height and length respectively of transeverse rib.

FIG. 1 DETERMINATION OF LONGITUDINAL SECTIONAL AREA A_{tr} OF A TRANSVERSE RIB

4.5 The heights of longitudinal and transverse ribs shall be obtained in the following manner:

a) The average height of longitudinal ribs shall be obtained from measurements made at not less than 4 points, equally spaced, over a length of 10 ϕ or pitch of rib, whichever is greater.

b) The height of transverse ribs shall be measured at the centre of 10 successive transverse ribs.

4.6 The average spacing of transverse ribs shall be determined by dividing a measured length of the bar/wire equal to at least 10 ϕ by the number of spaces between ribs in the measured length, ϕ being the nominal diameter of the bar/wire. The measured length of the bar/wire shall be the distance from the centre of one rib to the centre of another rib.

4.7 When subjected to pull-out test in, accordance with Appendix A, the bond strength calculated from the load at a measured slip of 0·025 mm and 0·25 mm for deformed bars/wires shall exceed that of a plain round bar of the same nominal size by 40 percent and 80 percent respectively.

5. NOMINAL SIZES

5.1 The nominal sizes of bars/wires shall be as follows:

'Nominal size, 4, 5, 6, 7, 8, 10, 12, 16, 18, 20, 22, 25, 28, 32, 36, 40, 45 and 50 mm'.

NOTE — Other sizes may also be supplied by mutual agreement.

5.2 The exact values for the cross-sectional area and nominal masses of individual bars/wires, shall be as given in Table 1.

5.3 Effective Cross-Sectional Area of Deformed Bars and Wires

5.3.1 For bars/wires whose pattern of deformation is such that by visual inspection, the cross-sectional area is substantially uniform along the length of the bar/wire, the effective cross-sectional area shall be the gross sectional area determined as follows, using a bar/wire not less than 0·5 m in length:

$$\text{Gross cross-sectional area in mm}^2 = \frac{w}{0{\cdot}007\,85\,L}$$

where

w = mass in kg weighed to a precision of $\pm 0{\cdot}5$ percent, and

L = length in m measured to a precision of $\pm 0{\cdot}5$ percent.

TABLE 1 CROSS-SECTIONAL AREA AND MASS

(*Clause* 5.2)

Nominal Size	Cross-Sectional Area	Mass per Metre Run
(1)	(2)	(3)
mm	mm^2	kg
4	12·6	0·099
5	19·6	0·154
6	28·3	0·222
7	38·5	0·302
8	50·3	0·395
10	78·6	0·617
12	113·1	0·888
16	201·2	1·58
18	254·6	2·00
20	314·3	2·47
22	380·3	2·98
25	491·1	3·85
28	616·0	4·83
32	804·6	6·31
36	1 018·3	7·99
40	1 257·2	9·85
45	1 591·1	12·50
50	1 964·3	15·42

5.3.2 For a bar/wire whose cross-sectional area varies along its length, a sample not less than 0·5 m long shall be weighed (w) and measured to a precision of ±0·5 percent in the as rolled and/or cold-worked condition, and after the transverse ribs have been removed, it shall be re-weighed (w'). The effective cross-sectional area shall then be found as follow:

a) Where the difference between the two masses ($w - w'$) is less than 3 percent of w', the effective cross-sectional area shall be obtained as in **5.3.1**.

b) Where the difference is equal to or greater than 3 percent, the effective cross-sectional area in mm^2 shall be taken as:

$$\frac{1{\cdot}03\ w'}{0{\cdot}007\ 85\ L}$$

where

w' = mass in kg of the bar with transverse ribs removed, and

L = length in m.

For routine test purposes, a nominal ratio of effective to gross cross-sectional area of bars/wires covered by (b) shall be declared and used by the manufacturer.

6. TOLERANCES ON DIMENSIONS AND NOMINAL MASS

6.1 Specified Lengths — If bars/wires are specified to be cut to certain lengths, each bar/wire shall be cut within deviations of $^{+75}_{-25}$ mm on the specified length, but if minimum lengths are specified, the deviations shall be +50 mm and −0 mm.

6.2 Nominal Mass

6.2.1 For the purpose of checking the nominal mass, the density of steel shall be taken as 0·007 85 kg/mm^2 of the cross-sectional area per metre run.

6.2.2 Unless otherwise agreed to between the manufacturer and the purchaser, the tolerances on nominal mass shall be as in Table 2. For bars/wires whose effective cross-sectional areas is determined as in **5.3.2** (b), the nominal mass per metre run shall correspond to the gross mass and the deviations in Table 2 shall apply to the nominal mass.

TABLE 2 TOLERANCES ON NOMINAL MASS

Nominal Size mm	Tolerance on the Nominal Mass, Percent		
	Batch	Individual Sample*	Individual Sample for Coils only†
(1)	(2)	(8)	(4)
Up to and including 10	±7	−8	±8
Over 10 up to and including 16	±5	−6	±6
Over 16	±3	−4	±4

*For individual sample plus tolerance is not specified.
†For coils batch tolerance is not applicable.

6.2.3 The nominal mass per metre of individual sample, batch and coil shall be determined as given in **6.2.3.1** to **6.2.3.3**.

6.2.3.1 *Individual sample* — The nominal mass of an individual sample shall be calculated by determining the mass of any individual sample taken at random as specified in **10.1** and dividing the same by the actual length of the sample. The sample shall be of length not less than 0·5 metre.

6.2.3.2 *Batch* — The nominal mass of a batch shall be calculated from the mass of the test specimens taken as specified in **10.1** and dividing the same by the actual total length of the specimens. Each specimen shall be of length not less than 0·5 metre.

6.2.3.3 *Coils* — The nominal mass of a coil shall be calculated by determining the mass of two samples of minimum one metre length taken from each end of the coil and dividing the same by the actual total length of the samples.

7. PHYSICAL PROPERTIES

7.1 Proof stress, percentage elongation and tensile strength for all sizes of deformed bars/wires determined on effective cross-sectional area (*see* **5.3**) and in accordance with **8.2** shall be as specified in Table 3.

TABLE 3 MECHANICAL PROPERTIES OF HIGH STRENGTH DEFORMED BARS AND WIRES

Sl No.	Property	Grade		
		Fe 415	Fe 500	Fe 550
(1)	(2)	(3)	(4)	(5)
i)	0·2 percent proof stress/ yield stress, *Min*, N/mm²	415·0	500·0	550·0
ii)	Elongation, percent, *Min*, on gauge length $5{\cdot}65\sqrt{A}$, where A is the cross-sectional area of the test piece	14·5	12·0	8·0
iii)	Tensile strength, *Min*	10 percent more than the actual 0·2 percent proof stress but not less than 485·0 N/mm²	8 percent more than the actual 0·2 percent proof stress but not less than 545·0 N/mm²	6 percent more than the actual 0·2 percent proof stress but not less than 585·0 N/mm²

7.2 The bars/wires shall withstand the bend test specified in **8.3** and the rebend test specified in **8.4**.

7.3 Bond — Bars/wires satisfying the requirements given in **4** shall be deemed to have satisfied the bond requirements of a deformed bar/wire.

8. TESTS

8.1 Selection and Preparation of Test Sample — Unless otherwise specified in this standard, the requirements of IS : 226-1975* shall apply.

*Specification for structural steel (standard quality) (*fifth revision*).

8.1.1 All test pieces shall be selected by the purchaser or his authorized representative, either:

a) from the cuttings of bars/wires; or

b) if, he so desires, from any bar/wire after it has been cut to the required or specified size and the test piece taken from any part of it.

In neither case, the test piece shall be detached from the bar/wire except in the presence of the purchaser or his authorized representative.

8.1.2 The test pieces obtained in accordance with **8.1.1** shall be full sections of the bars/wires and shall be subjected to physical tests without any further modifications. No reduction in size by machining or otherwise shall be permissible, except in case of bars of size 28 mm and above (*see* **8.1.2.1**). No test piece shall be annealed or otherwise subjected to heat treatment except as provided in **8.1.3**. Any straightening which a test piece may require shall be done cold.

8.1.2.1 For the purpose of carrying out tests for tensile strength, proof stress and percentage elongation for bars 28 mm in diameter and above, deformations of the bars only may be machined. For such bars, the physical properties shall be calculated using the actual area obtained after machining.

8.1.3 Notwithstanding the provisions in **8.1.2**, test pieces may be subjected to artificial ageing at a temperature not exceeding 100°C and for a period not exceeding 2 hours.

8.1.4 Before the test pieces are selected, the manufacturer or supplier shall furnish the purchaser or his authorized representative with copies of the mill records giving the mass of bars/wires in each bundle/cast with sizes as well as the identification marks, whereby the bars/wires from that cast can be identified.

8.2 Tensile Test — The tensile strength, 0·2 percent proof stress and percentage elongation of bars/wires shall be determined in accordance with requirements of IS : 1608-1972* read in conjunction with IS : 226-1975†.

8.2.1 Alternatively and by agreement between the purchaser and the supplier, for routine testing, the proof stress may be determined in conjunction with the tensile strength test and may be taken as the stress measured on the specimen whilst under load corresponding to an increase measured by an extensometer of 0·4 percent for Fe 415 bars/wires, 0·45 percent for grade Fe 500 bars/wires and 0·47 percent for grade Fe 550 bars/wires the total strain on any convenient gauge length.

*Method for tensile testing of steel products (*first revision*).
†Specification for structural steel (standard quality) (*fifth revision*).

8.2.2 The stresses shall be calculated using the effective cross-sectional area of the bar/wire.

8.3 Bend Test — The bend test shall be performed in accordance with the requirements of IS: 1599-1974* and the mandrel diameter shall be as specified in Table 4. The specimen shall be considered to have passed the test if there is no transverse crack in the bent portion.

TABLE 4 MANDREL DIAMETER FOR BEND TEST

Nominal Size mm	Mandrel Diameter for Different Grades		
	Fe 415	Fe 500	Fe 550
(1)	(2)	(3)	(4)
Up to and including 22	3ϕ	4ϕ	5ϕ
Over 22	4ϕ	5ϕ	6ϕ

where ϕ is the nominal size in mm of the test piece.

8.4 Rebend Test — The test piece shall be bent to an included angle of 135° (*see* Fig. 2) using a mandrel of appropriate diameter (*see* **8.4.1**). The bent piece shall be aged by keeping in boiling water (100°C) for 30 minutes and then allowed to cool. The piece shall then be bent back to have an included angle of 157½°. The specimen shall be considered to have passed the test if there is no fracture in the bent portion.

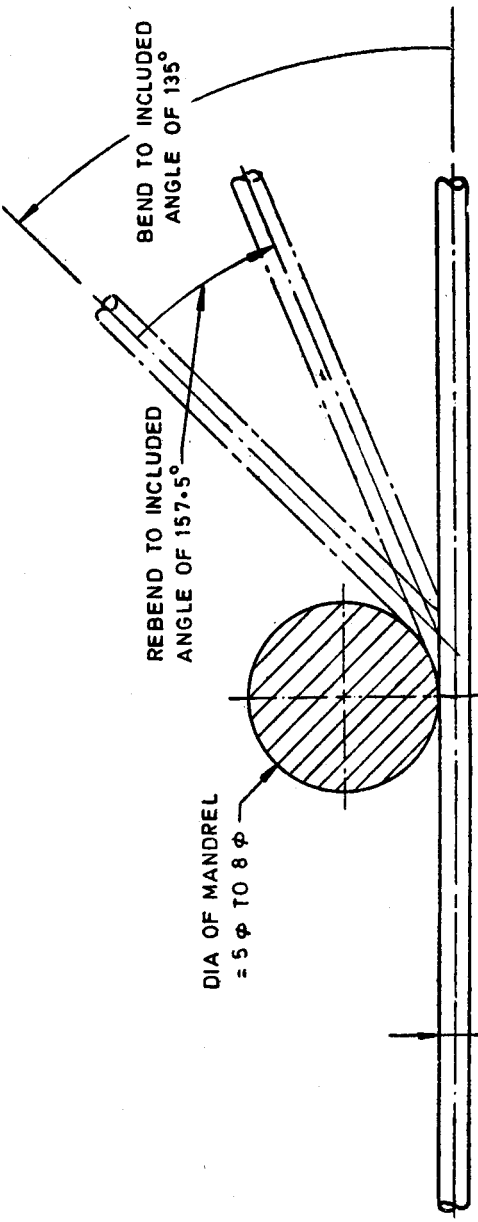
8.4.1 The diameter of the mandrel shall be as given below:

Nominal Size of Specimen	*Dia of Mandrel for Fe 415 and Fe 500*	*Dia of Mandrel for Fe 550*
Up to and including 10 mm	5ϕ	7ϕ
Over 10 mm	7ϕ	8ϕ

where ϕ is the nominal size in mm of the test piece.

8.5 Retest — Should any one of the test pieces first selected fail to pass any of the tests specified in this standard, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirements of that particular test. Should the test piece from either of these additional samples fail, the material presented by the samples shall be considered as not having complied with this standard.

*Method for bend test for steel products other than sheet, strip, wire and tube (*first revision*).



NOTE — ϕ Represents the nominal size in mm of the test piece.

FIG. 2 REBEND TEST

9. ROUTINE INSPECTION AND TESTING

9.1 All material shall be subject to routine inspection and testing by the manufacturer or supplier in accordance with this standard, and a record of the test results of material conforming to this standard shall be kept by the manufacturer or the supplier. The records shall be available for inspection by the purchaser or his representative.

In the case of material delivered to a supplier, the manufacturer shall supply a certificate containing the results of all the required tests on samples taken from the delivered material.

10. SELECTION OF TEST SPECIMENS

10.1 For checking nominal mass, tensile strength, bend test and rebend test, test specimen of sufficient length shall be cut from each size of the finished bar/wire at random at a frequency not less than that specified in Table 5.

TABLE 5 FREQUENCY FOR NOMINAL MASS, TENSILE, BEND AND REBEND TESTS

NOMINAL SIZE	QUANTITY	
	For casts/heats below 100 tonnes	For casts/heats over 100 tonnes
(1)	(2)	(3)
Under 10 mm	1 sample from each 25 tonnes or part thereof	1 sample from each 40 tonnes or part thereof
10 mm to 16 mm inclusive	1 sample from each 35 tonnes or part thereof	1 sample from each 45 tonnes or part thereof
Over 16 mm	1 sample from each 45 tonnes or part thereof	1 sample from each 50 tonnes or part thereof

10.2 Bond Test — The frequency of bond test as required in **4.7** shall be as agreed to between the manufacturer and the purchaser/testing authority.

11. DELIVERY, INSPECTION AND TESTING FACILITIES

11.1 Unless otherwise specified, general requirements relating to the supply of material, inspection and testing shall conform to IS : 1387-1968*.

*General requirements for the supply of metallurgical materials (*first revision*).

11.2 No material shall be despatched from the manufacturer's or supplier's premises prior to its being certified by the purchaser or his authorized representative as having fulfilled the tests and requirements laid down in this standard except where the bundle containing the bars/wires is marked with the ISI Certification Mark.

11.3 The purchaser or his authorized representative shall be at liberty to inspect and verify the steel maker's certificate of cast analysis at the premises of the manufacturer or the supplier. When the purchaser requires an actual analysis of finished material, this shall be made at a place agreed to between the purchaser and the manufacturer or the supplier.

11.4 Manufacturer's Certificate — In the case of bars/wires which have not been inspected at the manufacturer's works, the manufacturer or supplier, as the case may be, shall supply the purchaser or his authorized representative with the certificate stating the process of manufacture and also the test sheet signed by the manufacturer giving the result of each mechanical test applicable to the material purchased, and the chemical composition, if required. Each test sheet shall indicate the number of the cast to which it applies, corresponding to the number or identification mark to be found on the material.

12. IDENTIFICATION AND MARKING

12.1 The manufacturer or supplier shall have ingots, billets and bars or bundles of bars/wires marked in such a way that all finished bars/wires can be traced to the cast from which they were made. Every facility shall be given to the purchaser or his authorized representative for tracing the bars/wires to the cast from which they were made.

12.2 For each bundle/coil of bars/wires a tag shall be attached indicating cast No./lot No., grade and size.

12.3 Distinguishing mark shall be given to identify the different grades of bar/wire.

12.3.1 Identification marks like brand name, trade-mark, etc, that are introduced during rolling shall be designed and located in such a manner that the performance in use of the bar is not affected.

12.3.2 Each bundle containing the bars/wires may also be suitably marked with the ISI Certification Mark in which case the concerned test certificate shall also bear the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

APPENDIX A

(*Clause* 4.7)

PULL-OUT TEST

A-1. PROCEDURE

A-1.1 The pull-out test shall be conducted in accordance with IS : 2770 (Part 1)-1967*, unless otherwise modified as in **A-1.1.1.**

A-1.1.1 Bonded length of the bar embedded in the concrete shall be 5 times the diameter of the bar; the rest of the embedded length shall be made unbonded by providing plastic sleeve for that portion.

*Method of testing bond in reinforced concrete: Part 1 Pull-out test.

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Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 1 FEBRUARY 1993
TO
IS 1786 : 1985 SPECIFICATION FOR HIGH STRENGTH DEFORMED STEEL BARS AND WIRES FOR CONCRETE REINFORCEMENT

(Third Revision)

(*Page* 12, *Table* 2) — Insert the following to the foot-note marked with '*' mark:

'A single sample taken from a batch as defined in 2.1 shall not be considered as individual sample.'

(*Page* 15, *clause* 8.3)— Insert the following after first sentence:

'The test piece, when cold, shall be doubled over the mandrel by continuous pressure until the sides are parallel.'

(CED 54)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 2 MAY 2002
TO
IS 1786 : 1985 SPECIFICATION FOR HIGH STRENGTH DEFORMED STEEL BARS AND WIRES FOR CONCRETE REINFORCEMENT

(Third Revision)

(*Page* 6, *clause* **3.2**, *Note* 1) — Substitute the following for the existing Note:

'NOTE 1 – For guaranteed weldability, the Carbon Equivalent using the formula,

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

shall be not more than 0.53 percent, when micro alloys/low alloys are used. When micro alloys are not used, Carbon Equivalent using the formula,

$$CE = C + \frac{Mn}{6}$$

shall be not more than 0.42 percent. Reinforcement bars/wires with higher Carbon Equivalent above 0.42 percent should, however, be welded with precaution. Use of low hydrogen basic coated electrodes with matching strength bars/wires are recommended.'

(*Page* 6, *clause* **3.2**, *Note* 2) — Insert the following new Note after Note 2 :

"NOTE 3 – Low-alloy steel may also be produced by adding alloying elements like Cr, Cu, Ni and P, either individually or in combination, to improve allied product properties. However, the total content of these elements shall not be less than 0.50 percent. In such case, manufacturers shall supply the purchaser or his authorized representative a test certificate stating the individual contents of all the alloying elements. In such low alloy steel when phosphorus is used, it shall not exceed 0.12 percent and when used beyond the limit prescribed in 3.2, the carbon shall be restricted to a maximum of 0.15 percent; and in such case the restriction to maximum content of sulphur and phosphorus as given in 3.2 shall not apply.

User may note that there is a danger of pitting and crevice corrosion when weathering steels (that is, those with chemical composition conforming to IS 11587 : 1986 'Specification for structural weather resistant steel' are embedded in chloride contaminated concrete."

(*Page* 7 *clause* **4.1**) — Substitute the following for the existing clause:

'**4.1** High strength deformed bars/wires shall satisfy the requirements given in either **4.2** or **4.7** for routine testing. Pull out test in accordance with **4.7** shall be done in addition to **4.2** for approval of new or amended geometry for first time.'

(*Page* 7, *clause* **4.3**) — Substitute the following for the existing clause:

'**4.3** The ribs contributing the projected area considered in **4.2** shall consist of:

a) Two longitudinal ribs in the form of continuous helix in case of twisted bars/wires, and optional longitudinal ribs in case of untwisted bars/wires which may be continuous or discontinuous; and

b) Transverse ribs which after hot-rolling or cold-working are uniform in size and shape in each row along the length of the bar/wire, and are spaced along the bar/wire at substantially uniform distances.'

(*Page* 8, *clause* **4.4**) — Substitute the following for the existing formula:

$$'Ar = \sum_{i=1}^{n_{tr}} \frac{Atr \sin\theta}{S_{tr}} + \frac{n_{lr}\, d_{lr}\, \pi\, \phi}{S_p}$$

and add 'i = variable' after 'Sp = pitch of the twist in mm.'

(*Page* 14, *clause* **8.2.1**) — Insert the following at the end :

'when this alternative is availed, the total strain shall be measured only by extensometer and not by any other means. In case of dispute the proof stress determined in accordance with IS 1608 : 1995 Mechanical testing of metals — Tensile testing (*second revision*)' shall be the deciding criteria.

(CED 54)

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