

Indian Standard

**SPECIFICATION FOR
UNCOATED STRESS RELIEVED STRAND FOR
PRESTRESSED CONCRETE**

(First Revision)

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

Indian Standard
SPECIFICATION FOR
UNCOATED STRESS RELIEVED STRAND FOR
PRESTRESSED CONCRETE
(*First Revision*)

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(*Continued on page 2*)

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Indian Standard
SPECIFICATION FOR
UNCOATED STRESS RELIEVED STRAND FOR
PRESTRESSED CONCRETE
(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 14 March 1983, after the draft finalized by the Joint Sectional Committee for Concrete Reinforcement had been approved by the Civil Engineering Division Council.

0.2 This standard was first published in 1970 to cover the requirements of strands used in prestressed concrete work. The present revision has been taken up with a view to incorporating modifications found necessary as a result of use of this standard both by manufacturers and users.

0.3 The significant modifications incorporated in this revision are in respect of provisions relating to physical requirements of nominal mass of strand and proof load and the sample size for tensile test. Further, SI units have been adopted in the revision and references to related Indian Standards appearing in the standard have been updated.

0.4 In the formulation of this standard, due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.5 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 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.

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

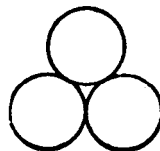
1. SCOPE

1.1 This standard covers the requirements for manufacture, supply and testing of uncoated, stress relieved, high tensile steel strands for use in prestressed concrete. The following types of strands are covered:

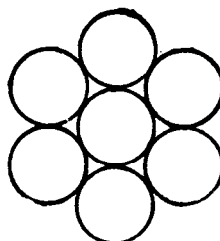
a) Two wire strand



b) Three wire strand



c) Seven wire strand
Class 1 and Class 2
(For classification, see
Tables 2 and 3)



2. TERMINOLOGY

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

2.1 **Breaking Load** — The maximum load reached in a tensile test on the strand.

2.2 **Coil or Reel** — One continuous length of strand in the form of a coil or reel.

2.3 **Elongation** — The increase in length of a tensile test piece under stress. In case of strands, the elongation is measured immediately prior to fracture of any of the component wires and is expressed as a percentage of the original gauge length of a standard test piece.

2.4 **Length of Lay** — Length of lay is the distance measured along a straight line parallel to the strand forming one completed spiral of a wire around the strand.

2.5 Parcel — Any quantity of finished strand presented for examination and test at any one time.

2.6 Production Length — The maximum length of strand which can be manufactured without welds being made after drawing in any of its component wire.

2.7 Proof Load — The load which produces a residual strain of 0.2 percent of the original gauge length (non-proportional elongation).

2.8 Seven Wire Strand — Any length of finished material which comprises six wires spun together in helical form around a central wire.

2.9 Three Wire Strand — Any length of finished material which comprises three wires spun together in helical form.

2.10 Two Wire Strand — Any length of finished material which comprises two wires spun together in helical form.

3. MANUFACTURE

3.1 Wire

3.1.1 The base metal shall be carbon steel of such quality that when drawn to suitable round wire sizes and fabricated into proper strand sizes and properly stress relieved after stranding, shall have the properties and characteristics as prescribed in this specification.

3.1.2 The element wire to be used for strand shall be cold-drawn from plain carbon steel (*see 3.1.1*) and shall contain not more than 0.050 percent of sulphur and not more than 0.050 percent of phosphorus, when tested in accordance with relevant parts of IS : 228*.

3.1.2.1 The wire used in the manufacture of the strand shall be well and cleanly drawn to the specified dimensions and shall be sound and free from splits, surface flaws, piping, and any other defects likely to impair its use in the manufacture of the strand and the performance of the strand in prestressed concrete.

3.2 Strand — The seven wire strand shall have a centre wire at least $1\frac{1}{2}$ percent greater in diameter than the surrounding wires enclosed tightly by six helically placed outer wires with a uniform length of lay of at least 12 times but not more than 16 times of the nominal diameter of the strand. The length of lay for the two and three wire strands shall be uniform throughout and shall be 24 to 36 times the diameter of element wire. The wires in the strand shall be so formed that they shall not unravel when the strand is cut and they shall not fly out of position when the strand is cut without seizing.

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

3.3 Joints

3.3.1 There shall be no strand joints or strand splices in any length of the completed strand unless specifically permitted by the purchaser.

3.3.2 During process of manufacture of individual wires for stranding, welding is permitted only prior to or at the size of the last heat treatment (patenting).

3.3.3 During fabrication of the 7 wire strand, butt-welded joints may be made in the individual wires, provided there is not more than one such joint in any 45 m section of the completed strand.

NOTE — When specifically ordered as weldless grade, a product free of welds shall be supplied. When this grade is specified, no welds or joints are permitted except as detailed in 3.3.2.

3.4 Stress Relieving of Strand — After stranding, all strands shall be subjected to a stress-relieving. Stress relieving shall be carried out as a continuous process on a length of strand by uncoiling and running through any suitable form of heating to produce the prescribed mechanical properties. Temper colours, which may result from the stress-relieving operation, shall be considered normal for the finished appearance of the strand.

After stress relieving, the strand shall be reformed into coils or wound on to reels, having core diameter of sufficient size and in any case not less than 600 mm to ensure that the strand will lay out straight.

3.5 Workmanship and Finish — The finished strand shall be uniform in diameter and shall be free from injurious flaws and imperfections. The strand shall not be oiled or greased. Slight rusting, provided it is not sufficient to cause pits visible to the naked eye, shall not be a cause for rejection.

4. SIZE AND DESIGNATION

4.1 Two Wire Strand — The nominal diameter, the nominal cross-sectional area and the nominal mass per unit length of the strand shall be as given in Table 1.

4.1.1 The two wire strand shall be designated by the number of element wires (plies) and the diameter of the element wire making the strand, for example, 2-ply 2 mm strand will mean a strand consisting of two element wires of diameter 2.0 mm each.

4.2 Three Wire Strand — The nominal diameter, the nominal cross-sectional area and the nominal mass per unit length of the strand shall be as given in Table 1.

4.2.1 The three wire strand shall be designated by the number of element wires (plies) and the diameter of the element wire making the strand, for example, 3-ply 3 mm strand will mean a strand consisting of three element wires of diameter 3.0 mm each.

TABLE 1 DIMENSIONS, TOLERANCES AND MASS OF TWO AND THREE WIRE STRANDS

(Clauses 4.1, 4.2 and 5.1)

DESIGNATION	NOMINAL DIAMETER OF ELEMENT WIRE	TOLERANCE ON DIAMETER OF ELEMENT WIRE	NOMINAL CROSS-SECTIONAL AREA OF STRAND	NOMINAL MASS OF STRAND
(1)	(2)	(3)	(4)	(5)
	mm	mm	mm ²	kg/m
2-ply 2 mm	2.0	± 0.03	6.28	0.0493
2-ply 3 mm	3.0	± 0.03	14.14	0.111
3-ply 3 mm	3.0	± 0.03	21.21	0.166

NOTE — The nominal cross-sectional area and the nominal mass of strand are given for information only.

4.3 Seven Wire Strand — The nominal diameter, nominal cross-sectional area and nominal mass per unit length of the strand shall be as given in Table 2.

4.3.1 The nominal diameter of strand shall be measured across the crown of the wires.

4.3.2 The seven wire strand shall be designated by the approximate overall diameter of the strand and number of element wires (plies) making the strand, for example, 6.3 mm 7-ply strand will mean a strand of approximate diameter 6.3 mm and made out of seven (six outer and one central) wires.

5. TOLERANCES

5.1 The tolerance on the nominal diameter of the element wire in case of two wire and three wire strands and the tolerance on the nominal diameter of the strand in case of seven wire strand shall be as given in Tables 1 and 2 respectively.

TABLE 2 DIMENSIONS, TOLERANCES AND MASS OF SEVEN WIRE STRANDS
(Clauses 4.3 and 5.1)

CLASS	DESIGNATION	NOMINAL DIAMETER OF STRAND	TOLERANCE ON THE NOMINAL DIAMETER OF STRAND	NOMINAL CROSS-SECTIONAL AREA OF STRAND	NOMINAL MASS OF STRAND
(1)	(2)	(3)	(4)	(5)	(6)
		mm	mm	mm ²	kg/m
1	6.3 mm 7-ply	6.3	± 0.4	25.1	0.195
	7.9 mm 7-ply	9.7	± 0.4	37.4	0.295
	9.5 mm 7-ply	9.5	± 0.4	51.6	0.408
	11.1 mm 7-ply	11.1	± 0.4	70.3	0.555
	12.7 mm 7-ply	12.7	± 0.4	92.9	0.730
	15.2 mm 7-ply	15.2	± 0.4	138.7	1.094
2	9.5 mm 7-ply	9.5	+ 0.66 - 0.15	54.8	0.435
	11.1 mm 7-ply	11.1	+ 0.66 - 0.15	74.2	0.585
	12.7 mm 7-ply	12.7	+ 0.66 - 0.15	98.7	0.775
	15.2 mm 7-ply	15.2	+ 0.66 - 0.15	140.0	1.102

NOTE — The nominal cross-sectional area and the nominal mass of the strand are given for information only.

6. PHYSICAL REQUIREMENTS

6.1 Breaking Strength — The breaking load of finished stress relieved strand determined in accordance with 7.1, shall not be less than the values given in Table 3.

6.1.1 Tests in which fracture of any of the wires occur within a distance of 3 mm from the jaws of the machine shall be discarded, if the results do not comply with the requirements of this specification.

6.2 Proof Load — The 0.2 percent proof load of the strand tested in accordance with 7.2, shall be not less than the values specified in Table 3.

6.3 Elongation — Elongation of the strand measured on a gauge length of not less than 600 mm by means of a suitable extensometer.

TABLE 3 MINIMUM BREAKING LOAD

(Clauses 6.1, 6.2 and 7.2.1)

CLASS	DESIGNATION	BREAKING LOAD Min	0.2 PERCENT PROOF LOAD
(1)	(2)	(3)	(4)
		N	N
—	2-ply 2 mm	12 750	10 840
	2-ply 3 mm	25 500	21 670
	3-ply 3 mm	38 250	32 460
1	6.3 mm 7-ply	44 480	37 810
	7.9 mm 7-ply	68 950	58 600
	9.5 mm 7-ply	93 410	79 400
	11.1 mm 7-ply	124 540	105 860
	12.7 mm 7-ply	164 580	139 900
	15.2 mm 7-ply	226 860	192 830
2	9.5 mm 7-ply	102 310	86 960
	11.1 mm 7-ply	137 890	117 210
	12.5 mm 7-ply	183 710	156 150
	15.2 mm 7-ply	261 440	222 230

attached to the test piece shall be not less than 3.5 percent immediately prior to fracture of any of the component wire (see 7.3).

6.4 Relaxation — The relaxation stress in the wire, when tested in accordance with 7.4 shall not exceed 5 percent of the initial stress as specified in 7.4 at the end of 1 000 h. Alternatively the manufacturer shall provide proof that the quality of wire supplied is such as to comply with this requirement.

6.4.1 When it is not possible to conduct 1 000 h relaxation test, the wire may be accepted on the basis of 100 h relaxation test provided the manufacturer furnishes proof establishing a relation between relaxation stress values at 1 000 h and 100 h and provided that the relaxation stress at 100 h is not more than 3.50 percent of the initial stress as specified in 7.4.

7. TESTS

7.1 Tensile Test — The breaking load shall be determined in accordance with IS : 1521-1972*.

7.2 Test for Proof Load — Proof load shall be determined in accordance with IS : 1521-1972*.

*Method for tensile testing of steel wire (first revision).

7.2.1 The 'load at 1.0 percent extension' method may be used by agreement between the manufacturer and the purchaser. In this test, an initial load equivalent to 10 percent of required minimum breaking strength as prescribed in Table 3 shall be applied to the test piece and a sensitive extensometer then attached. The dial of the latter shall be adjusted to read 0.001 mm/mm of the gauge length to represent the extension due to the initial load.

The load shall be increased until the extensometer shows an extension corresponding to 1.0 percent. The load at this extension shall not be less than the minimum 0.2 percent proof load specified in Table 3.

7.3 Elongation Test — The elongation shall be determined in accordance with IS : 1521-1972*.

7.4 Test for Relaxation — If required by the purchaser, the manufacturer shall provide evidence from records of tests of similar strand that the relaxation of load from an initial stress of 70 percent of the specified minimum tensile strength (calculated from the minimum specified breaking load and the nominal cross-sectional area of strand) conforms to that specified in 6.4. During the whole period of test the temperature shall be maintained within the range $20 \pm 2^\circ\text{C}$. The initial load shall be applied in a period of 5 minutes and shall then be held constant for a further period of one minute. Thereafter no adjustment of load shall be made, and load relaxation readings shall commence from the end of the sixth minute. On no account shall the test specimen be overstressed.

8. SAMPLING AND CRITERIA FOR CONFORMITY

8.1 Selection of Test Samples — Test samples of sufficient length to permit the tests for breaking load and elongation shall be cut from one end of every fifth coil, but sample size shall not be less than 2 from each lot. A further length shall be cut from each fifth coil or part of 5 coils for the determination of proof load.

8.1.1 All test pieces shall be selected by the purchaser or his authorized representative. The test piece shall not be detached from the coil or length of strand, except in the presence of the purchaser or his authorized representative.

8.1.2 Before test pieces are selected, the manufacturer or supplier shall furnish the purchaser or his authorized representative with copies of the mill records giving number of coils in each cast with sizes as well as the identification marks, whereby each coil can be identified.

*Method for tensile testing of steel wire (*first revision*).

8.2 Retest — Should any sample fail any of the tests, by agreement between manufacturer and purchaser, two additional test samples from the same end of the same coil shall be taken and subjected to the test or tests in which the original sample failed. Should both additional test samples pass the test or tests, the coil from which they were taken shall be deemed to comply with the requirements of this standard. Should either of them fail, the coil shall be deemed not to comply.

8.3 If ten percent or more of the selected coils fail to fulfil the requirements of the standard, the parcel from which they were taken shall be deemed not to comply with this standard.

9. DELIVERY, INSPECTION AND TESTING FACILITIES

9.1 Unless otherwise specified, general requirements relating to the supply of material, inspection and testing shall conform to IS : 1387-1967*.

9.2 No material shall be despatched from the manufacturer's or suppliers' 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 coil or reel containing the strand is marked with the ISI Certification Mark.

9.3 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 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.

9.4 Manufacturer's Certificate — In the case of strands which have not been inspected at the manufacturer's work 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, 0.2 percent proof load and the chemical composition, if required. Each test sheet shall indicate the number or identification mark of the cast to which it applies, corresponding to the number or identification mark to be found on the material.

10. PACKING, IDENTIFICATION MARKING

10.1 Unless otherwise agreed to between the purchaser and the supplier, the strands shall be supplied as indicated in 10.1.1 or 10.1.2.

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

10.1.1 Strands shall be wound into traversed layered coils having an internal diameter of a size as specified in 3.4. These coils shall be securely strapped to prevent distortion of the coil in transit and unless otherwise specified the coils shall be protected against damage in transit by wrapping with hessian.

10.1.2 Strands shall be coiled on to suitable reels having a core diameter of not less than 600 mm.

10.2 The manufacturer or supplier shall have coils of strands marked in such a way that all finished strand 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 strands to the cast from which they were made. Each coil shall carry a label giving the following details:

- a) Size of strand;
- b) The coil number; and
- c) Class, where applicable.

10.2.1 Each coil containing the strands may also be suitably marked with the ISI Certification Mark in which case the concerned test certificates shall also bear the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The Standard 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 BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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AMENDMENT NO. 1 NOVEMBER 1984

TO

IS:6006-1983 SPECIFICATION FOR UNCOATED STRESS
RELIEVED STRAND FOR PRESTRESSED CONCRETE

(First Revision)

Corrigenda

*(Page 8, Table 2, col 3, 2nd entry) - Substitute
'7.9' for '9.7'.*

*(Page 9, Table 3, col 2, 12th entry) - Substitute
'12.7 mm 7-ply' for '12.5 mm 7-ply'.*

(BSMDC 8)

Printed at Simco Printing Press, Delhi, India

AMENDMENT NO. 2 JANUARY 1988

TO

IS : 6006 - 1983 SPECIFICATION FOR UNCOATED STRESS RELIEVED STRAND FOR PRESTRESSED CONCRETE

(First Revision)

(Page 5, clause 2.6) — Substitute the following for the existing clause:

'2.6 Production Length — The maximum length of strand that can be manufactured without or with welds (see 3.3) being made after drawing in any of its component wire.'

(Page 8, Table 2) — Substitute the following for the existing table:

**TABLE 2 DIMENSIONS, TOLERANCES AND MASS OF SEVEN
WIRE STRANDS**

(Clauses 4.3 and 5.1)

CLASS	DESIGNATION	NOMINAL DIAMETER OF STRAND	TOLERANCES ON THE NOMINAL DIAMETER OF STRAND	NOMINAL CROSS- SECTIONAL AREA OF STRAND	NOMINAL MASS OF STRAND
(1)	(2)	(3)	(4)	(5)	(6)
		mm	mm	mm ²	kg/m
1	6.3 mm 7-ply	6.3	± 0.4	23.2	0.182
	7.9 mm 7-ply	7.9	± 0.4	37.4	0.294
	9.5 mm 7-ply	9.5	± 0.4	51.6	0.405
	11.1 mm 7-ply	11.1	± 0.4	69.7	0.548
	12.7 mm 7-ply	12.7	± 0.4	92.9	0.730
	15.2 mm 7-ply	15.2	± 0.4	139.4	1.094
2	9.5 mm 7-ply	9.5	+ 0.66 - 0.15	54.8	0.432
	11.1 mm 7-ply	11.1	+ 0.66 - 0.15	74.2	0.582
	12.7 mm 7-ply	12.7	+ 0.66 - 0.15	98.7	0.775
	15.2 mm 7-ply	15.2	+ 0.66 - 0.15	140.0	1.102

NOTE — The nominal cross-sectional area and the nominal mass of the strand are given for information only.

(Page 9, Table 3) — Substitute the following for the existing table:

TABLE 3 MINIMUM BREAKING LOAD

(Clauses 6.1, 6.2 and 7.2.1)

CLASS	DESIGNATION	BREAKING LOAD Min	0.2 PERCENT PROOF LOAD Min
(1)	(2)	(3)	(4)
		N	N
—	2-ply 2 mm	12 750	10 840
	2-ply 3 mm	25 500	21 670
	3-ply 3 mm	38 250	32 460
1	6.3 mm 7-ply	40 000	34 000
	7.9 mm 7-ply	64 500	54 700
	9.5 mm 7-ply	89 000	75 600
	11.1 mm 7-ply	120 100	102 300
	12.7 mm 7-ply	160 100	136 200
	15.2 mm 7-ply	240 200	204 200
2	9.5 mm 7-ply	102 300	87 000
	11.1 mm 7-ply	137 900	117 200
	12.7 mm 7-ply	183 700	156 100
	15.2 mm 7-ply	260 700	221 500

(Page 10, clause 7.2.1, first sentence) — Substitute the following for the existing sentence:

‘Alternatively, the load at 1.0 percent extension method may also be determined.’

(BSMDC 8)

AMENDMENT NO. 3 JUNE 1993
TO
IS 6006 : 1983 SPECIFICATION FOR UNCOATED
STRESS RELIEVED STRAND FOR PRESTRESSED
CONCRETE

(First Revision)

(Pages 8 and 9, clause 6.3) — Substitute the following for the existing matter:

'6.3 Elongation — Elongation of the strand shall not be less than 3.5 percent and shall be measured on a gauge length of not less than 200 mm for 2-ply and 3-ply strands and not less than 600 mm for 7-ply strands.

The elongation shall be measured by a suitable extensometer which is attached to the test piece, after an initial load equivalent to 10 percent of the required minimum breaking load as specified in Table 3 has been applied.

Following an extension of 1 percent, the extensometer may be removed and loading continued to ultimate failure. The elongation value is then determined by the movement between the jaw gripping the test piece on the new base length of jaw-to-jaw distance to which will be added the value of 1 percent determined by the extensometer.'

[Page 9, Table 3 (see also Amendment No. 2)] — Insert the following Note below the Table:

'NOTE — The modulus of elasticity is to be taken as $195 \pm 10 \text{ KN/mm}^2$, unless otherwise indicated by the manufacturer'

(CED 54)

AMENDMENT NO. 4 JUNE 1997
TO
IS 6006 : 1983 SPECIFICATION FOR UNCOATED
STRESS RELIEVED STRAND FOR PRESTRESSED
CONCRETE

(First Revision)

(Page 4, clause 2.4) — Substitute the following for the existing clause:

'2.4 Length of Lay — The distance (measured along a straight line parallel to the strand) in which a wire forms one complete helix.'

(Page 5, clause 3.1.2, lines 2 and 3) — Substitute '0.040 percent' for '0.050 percent'.

(Page 6, clause 3.3.2) — Delete the last word '(patenting)'.

(Page 10, clause 8.1) — Substitute the following for the existing clause:

'8.1 For 7-ply strand coils, test samples of sufficient length to permit the tests for breaking load, proof load, and elongation shall be selected, at random, from a group of 5 coils; but sample size shall not be less than 2 from each lot.

For 2-ply and 3-ply strand coils, test samples shall be selected at random from each lot in accordance with following table:

<i>No. of coils in the lot</i>	<i>No. of coils to be selected</i>
Up to 25	3
26 to 65	4
66 " 180	5
181 " 300	7
301 and above	10'

(Page 12, clause 10.1.2) — Insert the following new clause after **10.1.2**:

'10.1.3 By mutual agreement between the purchaser and the manufacturer, water soluble oil may be applied on strands.'

(CED 54)