

IS 10790 ( Part 1 ) - 1984

*Indian Standard*

METHODS OF SAMPLING OF STEEL FOR  
PRESTRESSED AND REINFORCED CONCRETE

PART 1 PRESTRESSING STEEL

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

*Indian Standard***METHODS OF SAMPLING OF STEEL FOR  
PRESTRESSED AND REINFORCED CONCRETE****PART 1 PRESTRESSING STEEL**

Building Materials and Components Sampling Sectional  
Committee, BDC 31

*Chairman*

DR MOHAN RAI

*Representing*Central Building Research Institute ( CSIR ),  
Roorkee*Members*SHRI S. K. GOSWAMI ( *Alternate* to  
Dr Mohan Rai )

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National Test House, Calcutta

SHRI BIMLESH KUMAR

Export Inspection Council of India, New Delhi

SHRI J. P. MAIKHURI ( *Alternate* )

SHRI Y. C. GOKHALE

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Delhi

SHRI P. S. GOPINATH

Central Public Works Department, New Delhi

SURVEYOR OF WORKS ( NZ ) ( *Alternate* )

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Small Industries Service Institute, Trichur

SHRI K. V. K. RAJU ( *Alternate* )

SHRI M. V. LAKSHMANASWAMY

Indian Statistical Institute, Bombay

DR A. G. MADHAVIA RAO

Structural Engineering Research Centre ( CSIR ),  
MadrasSHRI D. S. RAMACHANDRA MURTHY  
( *Alternate* )

SHRI S. M. MITTAL

Railway Board ( Ministry of Railways ), New  
Delhi

DEPUTY DIRECTOR RESEARCH

( B & S )-I ( *Alternate* )

SHRI S. S. RAJPUT

Forest Research Institute and Colleges, Dehra  
Dun

SHRI K. S. SRINIVASAN

SHRI T. R. BHATIA ( *Alternate* )

National Buildings Organization, New Delhi

DR V. V. SUBBA RAO

SHRI K. H. BABU ( *Alternate* )

Cement Research Institute of India, New Delhi

SHRI G. VENKATESULU

SHRI PRAFULLA KUMAR ( *Alternate* )

Ministry of Shipping and Transport, New Delhi

SHRI D. S. AHLUWALIA,

Director ( Statistics )

Director General, ISI ( *Ex-officio Member* )*Secretary*

SHRI A. K. TALWAR

Deputy Director ( Statistics ), ISI

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**Building Steels and Steel Products Sampling Subcommittee,  
BDC 31 : 1**

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*Representing*

The Tata Iron and Steel Co Ltd, Jamshedpur  
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Hindustan Prefab Ltd, New Delhi  
Structural Engineering Research Centre ( CSIR ),  
Madras  
Cement Research Institute of India, New Delhi  
Hindustan Steel Works Construction Ltd,  
Calcutta

# Indian Standard

## METHODS OF SAMPLING OF STEEL FOR PRESTRESSED AND REINFORCED CONCRETE

### PART 1 PRESTRESSING STEEL

#### 0. FOREWORD

**0.1** This Indian Standard ( Part 1 ) was adopted by the Indian Standards Institution on 19 March 1984, after the draft finalized by the Building Materials and Components Sampling Sectional Committee had been approved by the Civil Engineering Division Council.

**0.2** This Indian Standard has been prepared with a view to unifying the quality control and sampling provisions applicable to all types of prestressing steel used in prestressed concrete. Some broad guidelines regarding the provisions for process control have also been indicated besides giving an objective sampling procedure helpful in large scale transactions.

**0.3** Such process control and sampling procedures will help in the development of adequate quality assurance system in the manufacture and also in assuring adequate protection to the users against poor quality. Further, proper quality control during the process of manufacture would substantially reduce quality fluctuations of the various characteristics and thus, ensure supply of uniform quality of prestressing steels. For effective process control, the use of statistical quality control techniques is imperative, for which helpful guidance may be obtained from IS : 397 ( Part 1 )-1972\*, IS : 397 ( Part 2 )-1975\* and IS : 397 ( Part 3 )-1980\*. The purchasing organizations need guidance in economic and effective sampling inspection of the lots of materials being received by them to evaluate their quality before their actual use. The sampling procedures recommended in this standard, therefore, include provisions both for process control and lot inspection.

**0.4** The reinforcing steel used in reinforced concrete is separately covered in Part 2 of this standard.

**0.5** In reporting the results of test or analysis, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960†.

\*Method for statistical quality control during production:

Part 1 Control charts for variables ( first revision ).

Part 2 Control charts for attributes and count of defects ( first revision ).

Part 3 Special control charts.

†Rules for rounding off numerical values ( revised ).

## 1. SCOPE

**1.1** This standard ( Part 1 ) prescribes the methods for sampling, sample sizes and the criteria for conformity for prestressing steel used in prestressed concrete. Broad outlines with regard to the controls to be exercised during the manufacturing process have also been indicated.

## 2. TERMINOLOGY

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

**2.1 Acceptance Number** — The maximum allowable number of defectives in the sample for acceptance of the lot.

**2.2 Coil** — One continuous length in the form of a coil.

**2.3 Bar** — A rolled rod or bar of steel of circular cross section.

**2.4 Item** — A coil or a bar on which inspection will be performed.

**2.5 Lot** — The quantity of material of the same grade and nominal size manufactured from steel fully tested in respect of physical, chemical and surface characteristics and processed under similar conditions shall constitute a lot.

**2.6 Lot Size** — The number of items in a lot.

**2.7 Mean ( $\bar{x}$ )** — The sum of test results divided by the number of test results.

**2.8 Range ( $R$ )** — The difference between the maximum and minimum values of test results in the sample.

**2.9 Sample** — Collection of coils or bars of prestressed steel selected for inspection and testing from a lot.

**2.10 Sample Size** — Number of items in the sample.

**2.11 Acceptable Quality Level ( AQL )** — The maximum percent defective that, for the purpose of sampling inspection, can be considered satisfactory as a process average.

## 3. PROCESS INSPECTION

**3.1** The object of inspection by the purchaser is to ensure conformity of the material offered to him to the specification requirements, whereas the inspection done by the manufacturer during the production is not only to ensure the conformity to relevant specifications, but also to maintain overall uniform quality. For process control, the manufacturer should test representative samples of the material at regular intervals during manufacture to control the quality variation at various manufacturing stages. The inspection levels given in Table.1 may serve as a guide for routine control over the manufacturing process.

TABLE 1 PROCESS INSPECTION LEVELS

( Clause 3.1 )

SL No.	STAGE	RECOMMENDED FREQUENCY OF INSPECTION AND TESTING
(1)	(2)	(3)
i)	Raw material	One coil from every heat/cast received to be tested for chemical, physical and metallurgical characteristics
ii)	After patenting	Two coils to be tested for every patenting batch/lot
iii)	Before final pass in drawing	Dimensional check every four hours
iv)	After final pass in drawing	Dimensional check and UTS for each coil
v)	After stress relieving	Every fifth coil for dimensions, proof stress, UTS, elongation ductility and indentation. One coil every month for relaxation and susceptibility to stress corrosion

3.2 The manufacturer should maintain control of various characteristics of the prestressing steel on the basis of the following considerations.

3.2.1 Following an unsatisfactory test result, the manufacturer should take all necessary steps to rectify the deficiencies and shortcomings in the process. Products which do not satisfy the requirements are to be segregated.

3.2.2 Results of the inspection and testing should be recorded and evaluated statistically. The records may be preserved for adequate period of time say 2 to 3 years so that they can be referred to in case of difficulties and complaints.

3.2.2.1 The scrutiny of the test results may be carried out with the aid of statistical methods adopting the variables or attributes approach as appropriate. The variables approach shall normally be applied for proof stress, tensile strength, elongation, weight, dimensions, rolling and cutting tolerances and chemical requirements. The attributes approach might be applied in respect of bending test and visual characteristics. For this purpose, reference may be made to IS : 7200 ( Part 1 )-1974\*, IS : 7200 ( Part 2 )-1975†, IS : 6200 ( Part 1 )-1977‡, IS : 6200 ( Part 2 )-1977§, IS : 7300-1974|| and IS : 7600-1975¶.

3.3 On the basis of the process inspection data, the manufacturer may issue relevant test certificate to prove the conformity of a lot to the requirements of any specification.

\*Presentation of statistical data: Part 1 Tabulation and summarization.

†Presentation of statistical data: Part 2 Diagrammatic representation of data.

‡Statistical tests of significance: Part 1  $t$ -, Normal and  $F$ -tests ( first revision ).

§Statistical tests of significance: Part 2  $\chi^2$ -test ( first revision ).

||Methods of regression and correlation.

¶Analysis of variance.

3.3.1 When such test certificate cannot be made available to the purchaser or when the purchaser so desires, the procedure laid down in 4 shall be followed for judging the conformity or otherwise of a lot to the requirements of relevant specifications.

#### 4. LOT INSPECTION

4.1 Lot — The quantity of material of the same grade and nominal size manufactured from steel fully tested in respect of physical, chemical and surface characteristics and processed under similar conditions shall constitute a lot.

4.2 The samples shall be selected and examined for each lot separately for ascertaining their conformity to the requirements of the relevant specifications.

#### 4.3 Scale of Sampling and Criteria for Conformity

##### 4.3.1 Visual, Dimensional and Weight Characteristics

4.3.1.1 The number of items to be selected for visual, dimensional and weight characteristics as mentioned in the respective Indian standard specification depend upon the size of the lot and shall be in accordance with Table 2. These items shall be selected from the lot at random. In order to ensure the randomness of selection, procedures given in IS : 4905-1968\* may be followed.

TABLE 2 SCALE OF SAMPLING AND ACCEPTANCE NUMBER FOR VISUAL, DIMENSIONAL AND WEIGHT CHARACTERISTICS

( Clauses 4.3.1.1, 4.3.1.2 and 4.3.1.3 )

LOT SIZE	FOR VISUAL CHARACTERISTICS		FOR DIMENSIONAL AND WEIGHT CHARACTERISTICS	
	Sample Size	Acceptance Number	Sample Size	Acceptance Number
(1)	(2)	(3)	(4)	(5)
Up to 25	8	0	5	0
26 to 50	13	1	8	0
51 to 100	20	1	13	1
101 to 150	32	2	20	1
151 to 300	50	3	32	2
301 to 500	80	5	50	3
501 and above	125	7	80	5

NOTE — The above sampling plan has an associated AQL of 2.5 percent. This value of AQL will hold good generally in case of larger lots.

\*Methods for random sampling.

**4.3.1.2** Each item selected according to col 1 and 2 of Table 2 shall be inspected for visual characteristics and freedom from defects. Any item failing to meet any of the requirements shall be considered as defective. If the number of defectives found in the sample is less than or equal to the corresponding acceptance number given in col 3 of Table 2, the lot shall be considered as conforming to the requirements of visual characteristics.

NOTE — In case of those lots which have been found unsatisfactory, all the items in the lot may be inspected for visual characteristics and the defectives may be removed, if agreed to between the purchaser and the supplier.

**4.3.1.3** The lot which has been found satisfactory with respect to visual characteristics shall be further inspected for dimensional and weight requirements. The number of items required for this purpose shall be taken at random in accordance with col 1 and 4 of Table 2. These may be taken from those items which have been found conforming to visual characteristics. If the number of defectives found in the sample for weight or dimensional requirements is less than or equal to corresponding acceptance number ( see col 5 of Table 2 ), the lot shall be considered as conforming to the requirements of the relevant specifications; otherwise not.

**4.3.1.4** The lot which has been found satisfactory in visual, dimensional and weight characteristics shall be further tested for physical and chemical characteristics according to 4.3.2 and 4.3.3.

#### **4.3.2** *Physical Characteristics*

**4.3.2.1** The specimens for physical characteristics like tensile strength, proof-stress, ductility, elongation, relaxation and susceptibility to stress corrosion as given in the respective Indian Standard specification, shall be taken in such a manner that it represents the material and shall be so prepared that it conforms to the relevant specification to ensure uniformity of test procedure.

**4.3.2.2** The number of items required for tensile strength, proof-stress ductility, and elongation shall be in accordance with col 1 and 2 of Table 3. These may be taken from those items which have been found satisfactory in visual, dimensional and weight requirements. From each of the items so selected, the required number of test specimens shall be prepared for conducting the tests specified.

**4.3.2.3** When tests for relaxation and susceptibility to stress corrosion are required to be carried, six specimens obtained from the items selected in 4.3.2.2 shall be tested. In case the number of items is less than six, additional items may be selected from the lot at random.



**TABLE 3 SCALE OF SAMPLING FOR PHYSICAL AND CHEMICAL TESTS**  
( Clauses 4.3.2.2 and 4.3.3.1 )

NUMBER OF ITEMS IN A LOT (1)	NUMBER OF ITEMS TO BE SELECTED (2)
Up to 50	2
51 to 150	3
151 to 500	5
501 and above	8

**4.3.2.4** For ascertaining the conformity of the lot in respect of tensile strength, proof stress and elongation, the following procedure shall be adopted:

- a) When two items are selected from a lot and tested, the lot shall be considered as conforming to the requirements of tensile strength, proof stress and elongation if both the samples pass in each of the tests.
- b) When the number of items selected from a lot is three or more, the mean ( $\bar{X}$ ) and range ( $R$ ) are calculated from the test results for each characteristic. The lot shall be considered as conforming to the specification if the value of ( $\bar{X} - 0.4R$ ) is greater than or equal to the corresponding minimum specification limit of the characteristic in the relevant specification.

**4.3.2.5** The lot shall be considered as conforming to the requirements of ductility test, relaxation test and susceptibility to stress corrosion test if each of the test results is found to be satisfactory.

### 4.3.3 Chemical Characteristics

**4.3.3.1** The number of items required for chemical analysis shall be taken at random in accordance with col 1 and 2 of Table 3. These may be taken from those items which have been found conforming to visual, dimensional and weight requirements.

**4.3.3.2** From each of the items so selected, drilling shall be taken and a composite sample of these drillings shall be made. The lot shall be considered as complying with the requirements of various chemical constituents, if the analysis made on the composite sample conforms to the requirements of the relevant specifications.