IRC : 71-1977

# RECOMMENDED PRACTICE
## FOR
# PREPARATION OF NOTATIONS


THE INDIAN ROADS CONGRESS

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# PREPARATION OF NOTATIONS

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# RECOMMENDED PRACTICE FOR PREPARATION OF NOTATIONS

## INTRODUCTION

The Bridges Committee of Indian Roads Congress in its meeting held in September, 1975 took note of the developments in international acceptance of a common logical system of notations and set up a Panel to recommend a system of notations in conformity with the same.

The following members served on the Panel :

P.C. Bhasin — *Convenor*
D.T. Grover
D. Ajitha Simha
Dr. V.K. Raina

The draft standard framed by the Panel was approved by the Bridges Committee in their meeting held on the 9th to 11th May 1977 and then by the Executive Committee. Later it was approved by the Council in their 90th meeting held on the 29th July 1977.

The object of issuing this Standard is to establish the usage of a logical and uniform system of notations in all IRC Standards as well as in all technical literature, design calculations and drawings. Certain changes necessary may cause inconvenience in initial use. But, an immediate and rigid adherence is recommended to achieve the desired results in shortest possible time. Suggestions for improvement of the Standard, arising out of practical use, are most welcome and may be sent to the *Secretary*, Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi-110011.

## 1. SCOPE

This standard recommends the practice to be followed in preparing symbols to be used in notation defining any aspect of bridge construction.

## 2. DEFINITION

Notation is defined as a system of symbols formed in a logical manner to represent definitions of engineering concept, for the purpose of this standard.

## 3. CONSTRUCTION OF SYMBOLS

A symbol shall consist of :

(i) *a leading letter*,
to be chosen according to 4.

(ii) *a descriptive subscript, added where necessary*,
to be chosen according to 5.

(iii) indices and signs, where *necessary* according to 6. (*see Appendix I typical notations for a concrete beam, Appendix II Symbols for unit, Appendix III Common mathematical signs or symbols*).

## 4. LEADING LETTER

4.1. A leading letter shall be selected from :

(i) Roman upper case letters

(ii) Roman lower case letters

(iii) Greek lower case letters

Greek upper case letters are reserved for mathematics and not recommended for use in notations, within the scope of this standard.

4.2. The selection of the leading letter of symbol shall be based on the consideration of the dimensions of the physical quantity involved, as given hereafter. Concepts not included shall comply with the nearest appropriate category listed.

Some exceptions have been adopted in deference to traditional practice. These are indicated at appropriate places and should be carefully noted.

Some letters are generally prohibited from use to avoid confusion. These are indicated as VOID in Tables 1, 2 and 3.

4.2.1. **Roman uppear case letters**

shall denote quantities with the following dimensions :

(i) Force

(ii) Force times length

(iii) Area to a power

(iv) Temperature

4.2.1.1. An *exception* shall be made in case of the modulus of elasticity, the modulus of shear, which shall be denoted by Roman upper case letters i.e. E,G. respectively (for exception regarding optional use of L in place of l, see Table 2).

4.2.1.2. The following quantities shall be denoted generally by Roman upper case letters (see Table 1 for a more detailed description) :

(i) Concentrated load, total load, normal force, shear,

(ii) Moment,

(iii) Area, first or second moment of area, volume,

(iv) Temperature,

(v) Modulus of elasticity, modulus of shear. (exception to dimensions 4.2.1.)

4.2.1.3. Table 1 gives a detailed description of the recommended usage of Roman upper case letters :

TABLE 1. ROMAN UPPER CASE LETTERS—FOR USE AS LEADING LETTER

| Letter | Denotes | Remarks |
|---|---|---|
| A | area | |
| B | — | |
| C | torsional moment of inertia | |
| D | — | |
| E | modulus of elasticity | |
| F | load, force | shall include all actions including imposed deformations |
| G | modulus of shear, dead load | |
| H | — | |
| I | moment of inertia | |
| J | — | |
| K | any coefficient with proper dimensions | |
| L | — | can be used in lieu of lower case l to denote 'span, length of member' (see Table 2), when confusion with 1 (numeral) is likely in typescript. |
| M | bending moment | |
| N | normal force | |
| O | VOID | |
| P | prestressing force | |

*Table 1 (contd.)*

| Letter | Denotes | Remarks |
|---|---|---|
| Q | live load | |
| R | — | |
| S | first moment of area | |
| T | torsional moment, temperature | |
| U | — | |
| V | shear force, volume | |
| W | wind load, section modulus ($W=I/y$) | |
| X | reactions or forces in general parallel to axis $x$ | |
| Y | reactions or forces in general parallel to axis $y$ | |
| Z | reactions or forces in general parallel to axis $z$. | |

*Note :* 1. A blank space against a letter means that the same is unassigned and not prohibited.

2. The letters indicated as VOID are generally prohibited from use.

### 4.2.2. Roman lower case letters

shall denote quantities with the following dimensions :

(i) length
(ii) length per time to a power
(iii) force per unit length or area.

4.2.2.1. (i) An *exception* shall be made in case of symbols to be used for stress. Greek lower case letters shall be used for denoting stress (strength) e.g. normal stress, shear stress etc., to be indicated by $\sigma$, $\tau$ respectively.

(ii) The diameter of a reinforcing bar or tendon shall be indicated by the Greek lower case letter $\phi$, as an *exception.*

4.2.2.2. The following quantities shall be denoted generally by Roman lower case letters (see Table 2 for more detailed description) :

(i) Linear dimensions (for exception see 4.2.2.1. ii)
(ii) Velocity, acceleration,
(iii) Unit moment/shear/normal force/load, force per unit area (exception for stress, see 4.2.2.1. i).

4.2.2.3. Table 2 gives a detailed description of the recommended usage of Roman lower case letters :

TABLE 2. ROMAN LOWER CASE LETTERS—FOR USE AS LEADING LETTER

| Letter | Denotes | Remarks |
|---|---|---|
| a | deflection; distance | |
| b | width | |
| c | concrete cover | |
| d | effective depth, diameter | diameter of reinforcing bar indicated by $\phi$, see 4.2.2.1. and table 3. |
| e | eccentricity | also used in mathematics to denote base of Naperian logarithm. |
| f | strength | |
| g | distributed dead load; acceleration due to gravity | |
| h | total depth or diameter of a cross-section; thickness | |
| i | radius of gyration | |
| j | number of days | |
| k | any coefficient with proper dimensions | |
| l | span; length of member | can be replaced by L when ambiguity with 1 (numeral may) arise. |
| m | bending moment per unit length or width | |
| n | normal force per unit length or width | also used in mathematics to denote number |
| o | VOID | |
| p | VOID | |
| q | distributed live load | |
| r | radius | |

*Table 2 (contd.)*

| Letter | Denotes | Remarks |
|---|---|---|
| s | standard deviation, spacing | |
| t | time, torsional moment per unit length or width | |
| u | perimeter | |
| v | shear force per unit length or width, velocity | shall not be used for shear stress, see 4.2.2.1. and Table 3 |
| w | distributed wind load, crack width | |
| x | co-ordinate, depth of neutral axis | |
| y | co-ordinate, depth of rectangular stress block | |
| z | co-ordinate lever arm | |

*Note :* 1. The meanings given here are not necessarily valid for subscripts for which Table 4 may be referred.

2. A blank space against a letter means that the same is unassigned and not prohibited.

3. The letters indicated as VOID are generally prohibited from use.

4.2.3. **Greek lower case letters**

shall denote dimensionless terms

4.2.3.1. (i) As an exception, stress (strength) shall be denoted by Greek lower case letters, see 4.2.2.1.

(ii) The diameter of a reinforcing bar or tendon shall be denoted by $\phi$, as an exception.

4.2.3.2. The following quantities shall be denoted generally by Greek lower case letters

(i) Coefficient and dimensionless ratio
(ii) Strain
(iii) Angle
(iv) Stress (strength) (exception to dimensions 4.2.3.)
(v) Diameter of a reinforcing bar or tendon (exception to dimensions 4.2.3.)

4.2.3.3. Table 3 gives a detailed description of the recommended usage of Greek lower case letters:

## Table 3. Lower Case Greek Letters—for Use as Leading Letter

| Letter | | Denotes | Remarks |
|---|---|---|---|
| Alpha | $\alpha$ | angle, ratio, coefficient | |
| Beta | $\beta$ | angle, ratio, coefficient | |
| Gamma | $\gamma$ | specific gravity, safety factor, shear strain (angular deformation) | |
| Delta | $\delta$ | coefficient of variation, coefficient | |
| Epsilon | $\epsilon$ | strain | |
| Zeta | $\zeta$ | coefficient | |
| Eta | $\eta$ | VOID | |
| Theta | $\theta$ | rotation | |
| Iota | $\iota$ | VOID | |
| Kappa | $\kappa$ | VOID | |
| Lambda | $\lambda$ | slenderness ratio, coefficient | |
| Mu | $\mu$ | coefficient of friction | |
| Nu | $\nu$ | Poisson's ratio | |
| Xi | $\xi$ | coefficient | |
| Omicron | o | VOID | |
| Pi | $\pi$ | (mathematical usage only) | $\pi$=3,14159 |
| Rho | $\rho$ | geometrical ratio of reinforcement | |
| Sigma | $\sigma$ | normal stress | exception to dimensions 4.2. |
| Tau | $\tau$ | shear stress | exception to dimensions 4.2. |
| Upsilon | $\upsilon$ | VOID | |
| Phi | $\phi$ | diameter of reinforcing bar or tendon, coefficient | exception to dimensions 4.2. |
| Chi | $\chi$ | VOID | |
| Psi | $\psi$ | coefficient | |
| Omega | $\omega$ | VOID | |

*Note :* 1. A blank space against a letter means that the same is unassigned and not prohibited.

2. The letters indicated as VOID are generally prohibited from use.

## 5. SUBSCRIPT

5.1. The subscript shall be formed by Roman lower case letters or numerals or a combination of them. Roman upper case letters or Greek letters are not recommended to be used in subscript.

5.2. Multiple subscript should be avoided as long as there is little likelihood of confusion. Multiple subscript, when required to be used, may be formed by a group of Roman lower case letters or numerals or by standard abbreviation of words.

When confusion is possible, a bar may be placed over a multiple subscript or a comma (,) may be used to distinguish between two categories of subscripts used together. Tables 4, 5 and 6 give a detailed description of the recommended usage of subscript of different types.

Subscripts other than those given in Tables 4, 5 and 6 shall be used only with a clear written definition of their meanings indicated.

TABLE 4. GENERAL SUBSCRIPTS

| Letter | Denotes | Remarks |
|---|---|---|
| a | support settlement, additional | |
| b | bond, bar, beam | |
| c | concrete, compression, column | |
| d | design value | |
| e | elastic, effective | |
| f | forces and other actions, flange, flexure, friction | |
| g | dead load | |
| h | horizontal | |
| i | initial | |
| j | number of days | |
| k | characteristic | |
| l | longitudinal | |
| m | average values, materials | |
| n | number | |
| o | VOID | only the meaning of numeral O is accepted |
| p | prestress | |

*Table 4 (contd.)*

| Letter | Denotes | Remarks |
|---|---|---|
| q | live load | |
| r | cracking | |
| s | steel, slab | |
| t | torsion, tension, transversal | |
| u | ultimate (limit state) | |
| v | shear, vertical | |
| w | web, wind | |
| x | linear co-ordinate | |
| y | linear co-ordinate, yield | |
| z | linear co-ordinate | |
| **Numerals** | | |
| 0, 1, 2.... | particular value of quantities | |

TABLE 5. SUBSCRIPTS FOR LOADS AND OTHER ACTIONS

| Letter | Denotes |
|---|---|
| g | dead load |
| q | live load |
| w | wind |
| ep | earth pressure |
| eq | earthquake |
| im | impact |
| a | support settlement |
| p | prestress |
| cc | concrete creep |
| cs | concrete shrinkage |
| te | temperature |

TABLE 6. SUBSCRIPTS FORMED FROM ABBREVIATIONS

| Abbreviation | Denotes |
|---|---|
| adm | admissible, permissible |
| cal | calculated |
| crit | critical |
| exc | exceptional |
| ext | external |
| inf | inferior, lower |
| int | internal |
| lat | lateral |
| lim | limit |
| max | maximum |
| min | minimum |
| obs | observed |
| sup | superior, upper |
| tot | total |
| var | variable |

## 6. INDICES AND SIGNS

A prime (′) may be added to a symbol representing geometrical quantity to indicate compression, if required. Use of any other superscript is not recommended. Sign of computed stress may be given by + (plus) for tension and — (minus) for compression.

## TYPICAL NOTATIONS FOR A CONCRETE BEAM

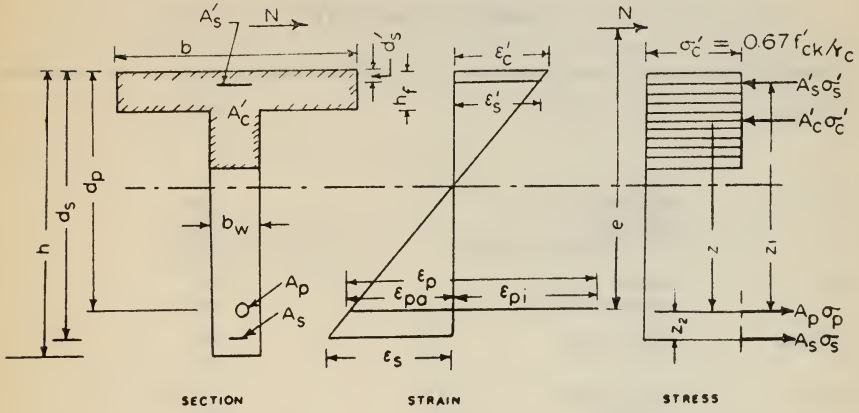


Fig. 1 Typical Notations for a Concrete Beam: Analysis of Section

| Notation | Denotes |
|---|---|
| $A'_c$ | Area of concrete in compression |
| $A_p$ | Area of prestressing steel |
| $A_s$ | Area of reinforcing steel in tensile flange |
| $A'_s$ | Area of reinforcing steel in compression flange |
| $b$ | width of flange |
| $b_w$ | width of web |
| $d'_s$ | effective depth of compressive steel reinforcement |
| $d_p$ | effective depth of prestressing steel |
| $d_s$ | effective depth of tensile steel reinforcement |
| $e$ | eccentricity of load |
| $f'_{ck}$ | characteristic compressive strength of concrete |
| $h$ | total depth of section |
| $h_f$ | depth of flange |
| $z, z_1, z_2$ | lever arm |
| $\gamma_c$ | material safety factor for concrete |
| $\varepsilon'_c$ | strain in concrete—compressive |
| $\epsilon_{po}$ | additional load strain in prestressing steel |
| $\epsilon_{pi}$ | strain in prestressing steel due to initial prestressing |
| $\epsilon_p$ | strain in prestressing steel |
| $\epsilon_s$ | strain in steel reinforcement—tensile |
| $\epsilon'_s$ | strain in steel reinforcement—compressive |
| $\sigma'_c$ | stress in concrete—compressive |
| $\sigma_p$ | stress in prestressing steel |
| $\sigma_s$ | stress in steel reinforcement—tensile |
| $\sigma'_s$ | stress in steel reinforcement—compressive |

## SYMBOLS FOR UNITS

| Quantity | Name of Unit | Symbol |
|---|---|---|
| length | metre | m |
| | millimetre | mm |
| | kilometre | km |
| | (micrometre or micron | μm) |
| area | square metre | $m^2$ |
| | squre millimetre | $mm^2$ |
| volume | cubic metre | $m^3$ |
| | litre | lit |
| mass | kilogramme | kg |
| | gramme | gm |
| | tonne | t |
| density | kilogramme per cubic metre | $kg/m^3$ |
| | tonne per cubic metre | $t/m^3$ |
| time | second | s |
| | minute | min |
| | hour | h |
| | day | j |
| | year | a |
| temperature | degree Celsius | $°C$ |
| velocity | metre per second | m/s |
| | kilometre per hour | km/h |
| force | newton | N |
| | kilonewton | kN |
| | meganewton | MN |
| moment | newton metre | N.m |
| | kilonewton metre | kN.m |
| | meganewton metre | MN.m |
| pressure/ stress | pascal (newton per square metre) | Pa ($N/m^2$) |
| | megapascal | MPa ($MN/m^2$ or $N/mm^2$) |

*Note*: 1. The symbols are given for SI units. (Technical or other metric units shall not be used. Decimal multiples or submultiples other than those mentioned herein shall also not generally be used).

2. 9.80665 N=1 kgf

For approximate conversion 1 kgf or kg≈10 N and 1 $kgf/cm^2$ or $kg/cm^2 \approx 0.1$ MPa.

3. The symbols shall remain unaltered in plural (it may be noted that s denotes second and as such should never be added to the symbol to indicate plural).

4. The symbols shall be written without a final full stop (period).

5. When symbols for units are combined in product, the process of combination shall be indicated as below:

   N.m
   N·m
   N m
   but not as Nm

   When combined in a quotient, the process of combination shall be indicated as below:

   $kg/m^3$
   $\frac{kg}{m^3}$
   $kg.m^{-3}$
   $kg \cdot m^{-3}$
   but not as $kgm^{-3}$

   Not more than one solidus (/) shall be included in such combinations; parentheses or preferably negative powers shall be used where necessary.

## COMMON MATHEMATICAL SIGNS OR SYMBOLS

| Sign or Symbol | Denotes | Remarks |
|---|---|---|
| $=$ | equal to | |
| $\neq$ | not equal to | |
| $\equiv$ | identically equal to | |
| $\approx$ | approximately equal to | |
| $\rightarrow$ | approaches | |
| $\simeq$ | asymptotically equal to | |
| $\sim$ | proportional to | $\propto$ also used |
| $\infty$ | infinity | |
| $<$ | smaller than | |
| $>$ | larger than | |
| $\leqslant \leqslant \leqq$ | smaller than or equal to | |
| $\geqslant \geqslant \geqq$ | larger than or equal to | |
| $\lll$ | much smaller than | |
| $\ggg$ | much larger than | |
| $\Sigma$ | sum | |
| $\Delta x$ | delta x=finite increment (difference) of x | |