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ACI Standard Preparation of Notation for Concrete (ACI 104-71) (Revised 1982) Reapproved 1997

Reported by ACI Committee 104 *

M. D A N E L V A N D E R B I L T

Chairman

HIROYUKI AOYAMA

STEPHANE BERNAERT

ALVARO GARCIA MESEGUER

HUBERT K. HILSDORF

GERALD B. NEVILLE

FRANCISCO ROBLES

HEDLEY E. H. ROY

SVEN SAHLIN

METE A. SOZEN

Indicates how symbols shall be selected to represent quantities or terms. Principal symbols are upper and lower case Roman letters and Greek lower case letters. Roman lower case letters are used as subscripts and Greek upper case letters are reserved for mathematics.

Keywords: coding; concretes; definitions; nomenclature; notation; prestressed concrete; reinforced concrete; structural analysis; structural design; symbols; terminology.

PREPARATION OF NOTATION

Scope

All symbols used in defining any aspect of concrete construction shall be prepared using the guide outlined in Table 1.

Construction of symbols

The preparation of a symbol to represent a given quantity shall be conducted in the following manner.

- (a) The leading or main letter of the symbol shall be selected from Table 1 based on

TABLE I-GUIDE FOR CONSTRUCTION OF SYMBOLS

- (a) Roman capital letters (dimensions: force, force times length, area, area to a power, temperature)
1. Moments, shears, normal forces, concentrated loads, total loads
 2. Area, first and second moments of area
 3. Strain moduli (exception to dimensions)
 4. Temperature
- (b) Roman lower case letters (dimensions: length, length per time to a power, force per unit length, area, or volume, except where used as subscripts)
1. Unit moments, shears, normal forces, loads
 2. Linear dimensions (length, width, thickness, etc.)
 3. Unit strengths, stresses'
 4. Velocity, acceleration, frequency
 5. Descriptive letters (subscripts)
- (c) Greek upper case letters
Reserved for mathematics
- (d) Greek lower case letters (dimensionless)
1. Coefficients and dimensionless ratios
 2. Strains
 3. Angles
 4. Specific gravity (ratio of densities)
 5. Variable stresses (exception, CEB usage only)¹

- (e) Indices
' = compression

- (f) Subscripts
Roman lower case letters may be used following the main symbol as required. Definitions assigned to subscripts include but are not limited to those listed below:

- a* = additional
b = bond
c = concrete
e = effective, elastic
i = initial
k = characteristic
l = longitudinal
m = average
p = prestress
r = tensile rupture
s = steel
t = transversal; total
u = ultimate
v = shear
x, y, z = axial directions

¹Compatibility between ACI and CEB symbology for stresses to be achieved in the future.

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*ACI 104 has been maintained by Committee 116 since 1981.

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consideration of the dimensions of the quantity under consideration.

- (b) An index representing compression shall be added to symbols representing geometrical quantities if required.
- (c) Descriptive subscripts may be selected as desired. When subscripts other than those

appearing in Table 1 are used, a clear written definition of their meaning shall be given.

- (d) The sign of a computed stress is given by + (plus) for tension and - (minus) for compression.

COMMENTARY AND APPENDICES

The following commentary and appendices, while not a part of ACI 104-71, will assist the user in applying the standard and selecting notation which conforms to selections made by ACI committees, based on the standard.

Commentary on Application of Standard Notation

Need for standard notation

A “symbol” is here defined as a short grouping of letters and numerals to represent a written definition of some engineering concept. Thus, A_s is commonly used to define the cross-sectional area of reinforcing steel. The body of symbols used by an engineering discipline is further defined as the “notation” for that discipline. The sole function of a notation is to serve as a form of “shorthand” to aid in the communication of ideas among members of the discipline. A good notation then is one which best serves its masters. Hallmarks of a good notation are lack of ambiguity in determining the meaning of any given symbol, consistency of construction of symbols, and a common use of the notation by all members of the discipline.

Prior to the adoption of ACI Standard 104 in 1971, the notation for concrete in use in United States practice was the product of random evolution and not systematic planning. As a result, a single symbol was often used to represent a multiplicity of disparate concepts in a number of cases. For example, the symbol D was used to represent dead loads, bar diameter, column diameter, and wall length. Also a number of slightly different definitions of the same basic concept were represented by a single symbol, such as t to represent many kinds of thickness. With the rapid development of new knowledge and the corresponding continual need for new symbols, the need for a consistent method for the construction and definition of symbols was apparent.

In the 1977 Code, the subscript u has been reserved for load effects (shear force, bending moment) computed from factored loads. The subscript n is used for nominal strength which is the strength calculated using the nominal values of f'_c , f_y , etc., and the standard calculation procedures.

Development of standard notation

Recognizing the need for a standard, the Technical Activities Committee of ACI organized Committee 104, Notation, in 1964. Initially, the committee examined the notation* prepared by Commission VII, Notation and Terminology, of the Comité Européen du Béton (European Concrete Committee) to see if it could be adopted in toto since one of the goals was the attainment of a universal standard. However, the first version of the notation prepared by CEB VII was felt to be unacceptable since it involved the use of a large number of sub- and superscripts and Greek letters. Hence, it was necessary for ACI 104 to develop an independent notation which was, however, modeled as closely as possible on that of the CEB. The first version of the ACI 104 notation was published in the May 1968 ACI JOURNAL.²

Close liaison between ACI 104 and CEB VII was maintained by having several persons serve simultaneously as members of each committee. The possibility of arriving at a

common ACI-CEB notation was continuously explored but appeared unlikely until about 1969, since the CEB notation had already been adopted by several countries for use in their national building codes. However, at the 13th biennial meeting of the CEB, held at Scheveningen, Netherlands, in September 1969, discussions of a common ACI-CEB Standard for notation were held. Extensive discussions were conducted jointly by ACI 104 and CEB VII and also the general assembly discussed notation during two meetings. The point was repeatedly made that several major codes, including the ACI, the CEB, the British, the Scandinavian, and others, were soon to appear in new editions and that the Scheveningen meeting represented the last chance to arrive at a common standard for perhaps decades. During the discussions numerous compromises were made and a proposed standard was developed. The standard was adopted by the CEB general assembly contingent upon its acceptance by the ACI. The standard was then presented to ACI membership vote and adopted as an ACI standard in 1971. The new standard for preparation of notation for concrete thus became the first universal standard in any profession.

The logic of the system described in Table 1 of the standard lies in the selection of the leading letter of a symbol based on a consideration of the units of the physical quantity involved. One exception occurs in the case of strain moduli. The symbols E and G are retained for Young's modulus and the shear modulus since these are now universally in use. One divergence between CEB and ACI usage is the retention by CEB of sigma and tau for normal and shear stresses.

A detailed description of the usage of each Roman and Greek letter based upon the standard is given in Appendix A. Definitions which are not italicized were jointly adopted. Italicized definitions have been adopted by ACI.

Appendix B is a listing of the notation used in ACI Standard 318.

References

1. *International Recommendations for the Design and Construction of Concrete Structures*, Comité Européen du Béton/Fédération Internationale de la Précontrainte, Paris, 1970. (English translation, Cement and Concrete Association, London, 1970, 80 pp.)
2. Vanderbilt, M. D., “Notation-The Case for a New System,” ACI JOURNAL, *Proceedings V. 65, No. 5*, May 1968, pp. 357-361.
3. “Bases for Design of Structures: Notations, General Symbols,” (ISO 3898-1976), International Standards Organization/American National Standards Institute, New York, 1976, 4 pp.