EBCS-1

Ethiopian Building Code Standard

BASIS OF DESIGN AND ACTIONS ON STRUCTURES

Ministry of Works & Urban Development
Addis Ababa, Ethiopia
1995

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FOREWORD

The Proclamation to define the powers and duties of the Central and Regional Executive Organs of the Transitional Government of Ethiopia No. 41/1993 empowers the Ministry of Works and Urban Development to prepare the Country's Building Code, issue Standards for design and construction works, and follow up and supervise the implementation of same.

In exercise of these powers and in discharge of its responsibility, the Ministry is issuing a series of **Building Code Standards** of general application.

The purpose of these standards is to serve as nationally recognized documents, the application of which is deemed to ensure compliance of buildings with the minimum requirements for design, construction and quality of materials set down by the **National Building Code.**

The major benefits to be gained in applying these standards are the harmonization of professional practice and the ensuring of appropriate levels of safety, health and economy with due consideration of the objective conditions and needs of the country.

As these standards are technical documents which, by their very nature, require periodic updating, revised editions will be issued by the Ministry from time to time as appropriate.

The Ministry welcomes comments and suggestions on all aspect of the **Ethiopian Building** Code Standards. All feedback received will be carefully reviewed by professional experts in the field of building construction with a view to possible incorporation of amendments in future editions.

Haile Assegidie
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Ministry of Works and
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1995

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CHAPTER 1
BASIS OF DESIGN

1.1 INTRODUCTION

1.1.1 Scope

(1) This Chapter establishes the principles and requirements for safety and serviceability of structures, describes the basis for design and verification and gives guidelines for related aspects of structural reliability.

(2) This Chapter provides the basis and general principles for the structural design of buildings and civil engineering works including geotechnical aspects and shall be used in conjunction with the other parts of EBCS 1. This Chapter relates to all circumstances in which a structure is required to give adequate performance, including fire and seismic events.

(3) This Chapter may also be used as a basis for the design of structures not covered in EBCS 2 to 8 and where other materials or other actions outside the scope of EBCS 1 are involved.

(4) This Chapter is also applicable to structural design for the execution stage and structural design for temporary structures, provided that appropriate adjustments outside the scope of ENV 1991 are made.

(5) This Chapter also gives some simplified methods of verification which are applicable to buildings and other common construction works.

(6) Design procedures and data relevant to the design of bridges and other construction works which are not completely covered in this Chapter may be obtained from other Chapters of EBCS 1 and other relevant Eurocodes.

(7) This Chapter is not directly intended for the structural appraisal of existing construction in developing the design of repairs and alterations or assessing changes of use but may be so used where applicable.

(8) This Chapter does not completely cover the design of special construction works which require unusual reliability considerations, such as nuclear structures, for which specific design procedures should be used.

(9) This Chapter does not completely cover the design of structures where deformations modify direct actions.

1.1.2 Assumptions

The following assumptions apply:

(a) The choice of the structural system and the design of a structure is made by appropriately qualified and experienced personnel.
(b) Execution is carried out by personnel having the appropriate skill and experience.

(c) Adequate supervision and quality control is provided during execution of the work, i.e. in design offices, factories, plants and on site.
(d) The construction materials and products are used as specified in this Code or in ENVs EBCS 2 to 8 or in the relevant supporting material or product specifications.
(e) The structure will be adequately maintained.
(f) The structure will be used in accordance with the design assumptions.
(g) Design procedures are valid only when the requirements for the materials, execution and workmanship given in EBCS 2 to 8 are also complied with.

1.1.3 Definitions

(1) Unless otherwise stated in the following, the terminology used in the International Standard ISO 8930:1987 is adopted.

Note: Most definitions are reproduced from ISO 8930:1987.

(2) The following terms are used in common for EBCS 1 to 8 with the following meaning:

(a) **Construction Works:** Everything that is constructed or results from construction operations. This definition accords with ISO 6707: Part 1. The term covers both building and civil engineering works. It refers to the complete construction works comprising structural, non-structural and geotechnical elements.

(b) **Type of building or civil engineering works:** Type of construction works designating its intended purpose, e.g dwelling house, retaining wall, industrial building, road bridge.

(c) **Type of construction:** Indication of principal structural material, e.g. reinforced concrete construction, steel construction, timber construction, masonry construction, composite steel and concrete construction.

(d) **Method of construction:** Manner in which the execution will be carried out, e.g. cast in place, prefabricated, cantilevered.

(e) **Construction material:** Material used in construction work, e.g. concrete, steel, timber, masonry.

(f) **Structure:** Organized combination of connected parts designed to provide some measure of rigidity. ISO 6707: Part 1 gives the same definition but adds " or a construction works having such an arrangement".

(g) **Form of structure:** The arrangement of structural elements, such as beam, column, arch, foundation piles. Forms of structure are, for example, frames, suspension bridges.

(h) **Structural system**: The load-bearing elements of a building or civil engineering works and the way in which these elements function together.

(i) **Structural model:** The idealization of the structural system used for the purposes of analysis and design.

(j) **Execution:** The activity of creating a building or civil engineering works. The term covers work on site; it may also signify the fabrication of components off site and their subsequent erection on site.

(3) Special terms relating to design in general are:

(a) **Design criteria:** The quantitative formulations which describe for each limit state the conditions to be fulfilled.

(b) **Design situations:** Those sets of physical conditions representing a certain time interval for which the design will demonstrate that relevant limit states are not exceeded.

(c) **Transient design situation:** Design situation which is relevant during a period much shorter that the design working life of the structure and which as a high probability of occurrence. It refers to temporary conditions of the structure, of use, or exposure, e.g. during construction or repair.

(d) **Persistent design situation:** Design situation which is relevant during a period of the same order as the design working life of the structure. Generally it refers to conditions of normal use.

(e) **Accidental design situation:** Design situation involving exceptional conditions of the structure or its exposure, e.g. fire, explosion, impact or local failure.

(f) **Design working life:** The assumed period for which a structure is to be used for its intended purpose with anticipated maintenance but without substantial repair being necessary.

(g) **Hazard:** Exceptionally unusual and severe event, e.g. an abnormal action or environmental influence, insufficient strength or resistance, or excessive deviation form intended dimensions.

(h) **Load arrangement:** Identification of the position, magnitude and direction of a free action.

(i) **Load case:** Compatible load arrangements, sets of deformations and imperfections considered simultaneously with fixed variable actions and permanent actions for a particular verification.

(j) **Limit states:** States associated with collapse, or with other similar forms of structural failure. They generally correspond to the maximum load-carrying resistance of a structure or structural part.

(k) **Ultimate limit states:** States associated with collapse, or with other similar forms of structural failure. They generally correspond to the maximum load-carrying resistance of a structure or structural part.

(l) **Serviceability limit states:** States which correspond to conditions beyond which specified service requirements for a structure or structural element are no longer met.

(m) **Irreversible serviceability limit states:** Limit states which will remain permanently exceeded when the responsible actions are removed.

(n) **Reversible serviceability limit states:** Limit states which will not be exceeded when the responsible actions are removed.

(o) **Resistance:** Mechanical property of a component, a cross-section, or a member of a structure, e.g. bending resistance, buckling resistance.

(p) **Maintenance:** The total set of activities performed during the working life of the structure to preserve its function.

(q) **Strength:** Mechanical property of a material, usually given in units of stress.

(r) **Reliability:** Reliability covers safety, serviceability and durability of a structure.

(4) Terms relating to actions are

(a) **Action:**

(i) Force (load) applied to the structure (direct action)

(ii) An imposed or constrained deformation or an imposed acceleration caused for example, by temperature changes, moisture variation, uneven settlement or earthquakes (indirect action).

(b) **Action effect:** The effect of actions on structural members, e.g.. internal force, moment, stress, strain.

(c) **Permanent action *(G)*:** Action which is likely to act throughout a given design situation and for which the variation in magnitude with time is negligible in relation to the mean value, or for which the variation is always in the same direction (monotonic) until the action attains a certain limit value.

(d) **Variable action *(Q)*:** Action, which is unlikely to act throughout a given design situation or for which the variation in magnitude with time is neither negligible in relation to the mean value nor monotonic.

(e) **Accidental action *(A)*** Action, usually of short duration, which is unlikely to occur with a significant magnitude over the period of time under consideration during the design working life. An accidental action can be expected in many cases to cause severe consequences unless special measures are taken.

(f) **Seismic action *(A_E)*:** Action which arises due to earthquake ground motions.

(g) **Fixed action:** Action which may has a fixed distribution over the structure such that the magnitude and direction of the action are determined unambiguously for the whole structure if this magnitude and direction are determined at one point on the structure.

(h) **Free action:** Action which may have any spatial distribution over the structure within given limits.

(i) **Single action:** Action that can be assumed to be statistically independent in time and space of any other action acting on the structure.

(j) **Static action:** Action which does not cause significant acceleration of the structure or structural members.

(k) **Dynamic action:** Action which causes significant acceleration of the structure or structural members.

(l) **Quasi-static action:** Dynamic action that can be described by static models in which the dynamic effects are included.

(m) **Representative value of an action:** Value used for the verification of a limit state.

(n) **Characteristic value of an action:** The principal representative value of an action. In so far as this characteristic value can be fixed on statistical bases, it is chosen so as to correspond to a prescribed probability of not being exceeded on the unfavourable side during a "reference period" taking into account the design working life of the structure and the duration of the design situation.

(o) **Reference period:** See (n) above.

(p) **Combination values:** Values associated with the use of combinations of actions (see (t) below to take account of a reduced probability of simultaneous occurrence of the most unfavourable values of several independent actions.

(q) **Frequent value of a variable action:** The value determined such that:

(i) the total time, within a chosen period of time, during which it is exceeded for a specified part, or
(ii) the frequency with which it is exceeded,

is limited to a given value.

(r) **Quasi-permanent value of a variable action:** The value determined such that the total time, within a chosen period of time, during which it is exceeded is a considerable part of the chosen period of time.

(s) **Design value of an action F_d:** The value obtained by multiplying the representative value by the partial safety factor γ_F.

(t) **Combination of actions:** Set of design values used for the verification of the structural reliability for a limit state under the simultaneous influence of different actions.

(5) Terms relating to material properties

(a) **Characteristic value X_K:** The value of a material property having a prescribed probability of not being attained in a hypothetical unlimited test series. This value generally corresponds to a specified fractile of the assumed statistical distribution of the particular property of the material. A nominal value is used as the characteristic value in some circumstances.

(b) **Design value of a material property X_d:** Value obtained by dividing the characteristic value by a partial factor γ_M or, in special circumstances, by direct determination.

(6) Terms relating to geometrical data are:

(a) **Characteristic value of a geometrical property a_k:** The value usually corresponding to the dimensions specified in the design. Where relevant, values of geometrical quantities may correspond to some prescribed fractile of the statistical distribution.

(b) **Design value of a geometrical property a_d:** Generally a nominal value. Where relevant, values of geometrical quantities may correspond to some prescribed fractile of the statistical distribution.

1.1.4 Symbols

(1) For the purposes of this Code, the following symbols are used. The notation used is based on ISO 3898:1987.

A	accidental action
A	area
A	loaded area
A_d	design value of an accidental action
A_{Ed}	design value of seismic action
A_{EK}	characteristic seismic action
A_{fr}	area swept by the wind
A_K	characteristic value of an accidental action
A_{ref}	reference area
C_d	nominal value, or a function of certain design properties of materials
E	effect of an action
E_d	design value of effects of actions
$E_{d,dst}$	design effect of destabilizing action
$E_{d,stb}$	design effect of stabilizing actions
F	action
F_d	design value of an action
F_{fr}	resultant friction force
F_k	characteristic value of an action
F_{rep}	representative value of an action
F_w	resultant wind force
G	permanent action
G_d	design value of a permanent action
$G_{d,inf}$	lower design value of a permanent action
$G_{d,sup}$	upper design value of a permanent action
G_{ind}	indirect permanent action
G_{kj}	characteristic value of permanent action j
$G_{k,inf}$	lower characteristic value of a permanent action
G_k	characteristic value of a permanent action
$G_{k,sup}$	upper characteristic value of a permanent action
H	height of a topographic feature
I	importance factor
I_v	turbulence intensity
K_l	shape parameter
L_e	effective length of an upwind slope
L_u	actual length of an upwind slope
P	prestressing action
P_d	design value of a prestressing action
P_k	characteristic value of a prestressing action
Q	variable, action
Q_d	design value of a variable action
Q_{ind}	indirect variable action