Basic variables

3. BASIC VARIABLES

3.1 General

The calculation model expressing each limit state considered should contain a specified set of basic variables. In general the basic variables should correspond to measurable physical quantities. Normally basic variables are parameters characterising:

- actions
- properties of materials
- structural and environmental geometry
- uncertainties of calculation models (see 5.1).

Basic variables are considered as being random variables.

3.2 Actions

3.2.1 Definitions

An action is

an assembly of concentrated or distributed forces acting on the structure (direct actions)

or

the cause of imposed or constrained deformations in the structure (indirect actions).

Actions and their random variations should be established on the basis of reliable observations, tests, decisions, or from data supplied by producers of material, equipment, etc.

An action should be considered to be <u>one</u> single action if it can be assumed stochastically independent, in time and space, of any other action acting on the structure.

> However, actions often occur simultaneously and they may be stochastically dependent to some extent. For the purposes of calculation it is more convenient to treat them as single actions. The problem of stochastic dependence may be treated as a special case.

To facilitate the calculation of the action effects, it may be convenient to regroup several elementary analogous actions into one composite action or to resolve certain actions into a sum or difference of several components.

3.2.2 Classification of actions according to their occurrence in time and to the variation of their magnitude with time.

In order to define the type of treatment in reliability checking and to determine their rules of combination, actions should be classified according to their variations in time taking into account the reference period chosen for the given type of structure and for the particular design situation.

One can distinguish:

- permanent actions, which are likely to act throughout a given design situation and for which variations in magnitude with time are negligible in relation to the mean value; or those for which the variation is in one sense and the action attains some limiting value.
- variable actions, which are unlikely to act throughout a given design situation or for which variations in magnitude with time are not negligible in relation to the mean value.
- accidental actions, the occurrence of which, in any given structure and with a significant value, is unlikely during the reference period, but the magnitude of which could be important.

  Temporary actions may be used as a concept to include variable actions and accidental actions.

3.2.3 Classification of actions according to their variation in space.

According to their variation in space, actions should generally be divided into two groups:

- fixed actions, which have a fixed spatial distribution over the structure, so that the magnitude of the action is unambiguously determined for the whole structure if it is given for one point.
- free actions, which may have arbitrary spatial distribution over the structure within given limits.

Actions which cannot be defined as belonging to either of these two groups may be considered to consist of a fixed part and a free part.

The treatment of free actions needs the consideration of different load cases. A load case is determined by fixing the configuration of each of the free actions.

3.2.4 Classification of actions according to structural response.

According to the way in which the structure responds to an action, one can distinguish:

- static actions, which are applied to the structure without causing any significant acceleration of the structure or structural member;
- dynamic actions, which may cause significant acceleration of the structure.

Whether or not an action is to be considered as a dynamic one is thus dependent on the structure.

Often dynamic actions may be treated as static actions by taking into account the dynamic effects by an appropriate increase in the magnitude of the static actions.

3.3 Properties of materials and soils

The properties of materials including soil are described by quantities, time-dependent functions, etc.

The properties of materials and their random variations should be determined by tests on appropriate standard test specimens. These properties relating to standard test specimens should be converted to the relevant properties of the actual material in the structure by the use of conversion factors or functions. The uncertainty of the properties of the material in the structure should be derived from the uncertainties of the standard test results and of the conversion factor or function. Thereby allowance should also be made for different standards of workmanship and control.

3.4 Geometrical parameters

Geometrical parameters describe the shape, size and overall arrangement of structures, elements and cross sections. When the deviation of any of the geometrical parameters from their sprescibed values may have a significant effect on the structural behaviour and the resistance of the structure, these parameters should be considered as basic variables. The parameters describing their variability should be determined by taking into account prescribed tolerance limits (see 5.4).

In most cases, however, the random variability of the geometrical parameters may be considered to be small in comparison with the variability of the actions and of material properties, or dealt with as included in these variabilities. Hence, in general, the geometrical parameters may be assumed to be non-random and as specified in the design.

4. ANALYSIS

Calculation models and basic assumptions for the calculation should express the structural response according to the limit state under consideration.

For the ultimate limit states,linear, non-linear and plastic theories may be applied depending on the response of the material and the structure to the actions.

For the serviceability limit states linear methods of analysis will usually be appropriate because the material normally remains within the linear elastic range.

For the purpose of analysis, a structure can generally be idealized by reducing it to one dimensional elements (beams and columns), two dimensional elements (slabs and shells) and three dimensional elements.

The influence of the working and environmental conditions on the behaviour of materials, elements and structures should be taken into account by the specific codes for each special material and each special type of structure. If this influence is of a systematic nature it should be expressed directly in the analysis. Sometimes it is possible to express this influence by some working condition factor (see 5.3.2).