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Actions on structures

Actions sur les structures

Technical Report 6116 was drawn up by Technical Committee ISO/TC 98, *Bases for design of structures*, and approved by the majority of its members. The reason which led to the decision to publish this document in the form of a Technical Report rather than an International Standard is the impact of the revision of ISO 2394, *General principles for the verification of structures*, undertaken by TC 98. The future International Standard will be based partly on this Technical Report which will probably form an integral part of the revised text of ISO 2394.

0 Introduction

This document which has been prepared as a contribution towards the revision of ISO 2394-1973, *General principles for the verification of the safety of structures*, is based on principles worked out by the Joint Committee on Structural Safety (JCSS), taking into account other relevant documents such as the CEB Model Code, CMEA Standards, etc. This document is published as a Technical Report because it covers only some of the problems which enter into the content of ISO 2394, and because the rules for establishing design values and combination values of actions given in this document are closely related to the principles of verification of structural safety currently under review. The document points out the existence of divergences in approach between regional organizations on standardization.

It is hoped to review and possibly transform this document into a standard after the agreement on the new version of ISO 2394 has been reached.

During the preparation of this document care was taken to weigh off the physical and theoretical soundness versus clarity and simplicity. The flexibility of the document which ensures its acceptability to all member bodies, is achieved by the introduction of a large number of decision parameters. These are :

- the reference period T and the probability of non-exceedance p for the characteristic values;
- the partial safety coefficient γ_{fu} for the ultimate limit states;
- the coefficients ψ_o and γ_{fu} for combination values;
- the number r_1 of variable actions for fundamental combinations;
- the fraction c_1 and the coefficient γ_{fs} for frequent values;
- the fraction c_2 and the coefficients γ_{fu} and γ_{fs} for quasi-permanent values;
- the number r_2 of variable actions for long-term combinations.

The adoption of these parameters and their numerical values are left to the discretion of national code committees. A proper calibration of decision parameters should be carried out for those rare situations which — for the sake of simplicity — do not appear explicity in this document (service value and some rare combinations of actions for the serviceability limit states).

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1 Scope and field of application

The aim of this document is to create a common basis for the determination of actions for the verification of safety and serviceability of structures.

The document concerns building and civil engineering structures whatever the nature of the material used.

2 Terminology

An action F is :

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

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

An action is considered to be *one* single action if it can be assumed as being stochastically independent, in time and space of any other action acting on the structure.

NOTE — Actions, however, often occur simultaneously and they may be stochastically dependent to some extent. For the sake 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 analogous elementary actions into one composite action or to resolve certain actions into a sum or difference of several components.

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

Other sources of information, for example, judgement on the type of use, legal or physical constraints, may also be taken into account.[1].

3 Qualitative classification of actions

3.1 General considerations

Actions may be classified according to the variation of their magnitude with time and/or space, or according to the effects of the actions on the structure (static or dynamic).

NOTE — Actions may be further classified according to other criteria.

3.2 Classification of actions according to the variation of their magnitude with time

Actions are divided — according to their variation in time — into :

3.2.1 Permanent actions, G, which are likely to act throughout a given design situation[2] and for which variation in magnitude with time are negligible in relation to the mean value; or those for which the variation is in one sense and the actions attain some limiting values.

The permanent actions include :

a) the weight of structures themselves (except possibly certain parts of this weight during certain phases of construction);

b) the weight of superstructures when appropriate;

c) the forces applied by earth pressure, resulting from the weight of soil;

d) the deformations imposed by the mode of construction of the structure;

1) In existing documents, values obtained within this group of information are described as "nominal values".

2) For any structure it is generally necessary to consider several distinct design situations, for example consecutive stages of construction, normal use, changes in use, accidents etc

e) the actions resulting from shrinkage of concrete, and distortions due to welding;

f) the forces resulting from water pressure when appropriate;

g) the actions resulting from support settlements and mining subsidence;

h) prestressing forces.

3.2.2 Variable actions, Q, 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.

The variable actions include :

a) loads due to use and occupancy;

b) certain parts of the weight of structures themselves during certain phases of construction;

c) erection loads;

d) all moving loads and their effects;

e) wind loads;

f) snow loads;

g) ice formation;

h) earthquakes[1];

j) the effects of variable level of water surface, when appropriate;

k) temperature changes;

m) wave loads.

For some materials it is useful to distinguish between variable actions of long and short duration, depending upon the behaviour of the structure on which they are acting.

3.2.3 Accidental actions, F_a, the occurence of which, in any given structure and with a significant value, is unlikely for a period of time under consideration.

In the total population of structures only a limited number of structures will be exposed to an accidental action.

The accidental actions include :

a) collisions;

b) explosions;

c) subsidence of subsoil;

d) tornados in regions not normally exposed to them;

e) earthquakes[1];

f) fire;

g) extreme erosion.

1) Earthquakes may be considered either as a variable action or as an accidental action.