Subject	Definition of tabulated data, simplified calculation method, advanced calculation method
Clause N°/ Subclause N° / Annex	N/A

Reason for change

In actual Eurocodes, it is mentioned that any numerical calculation method is considered as advanced calculation model.

However, the numerical thermal analysis is already introduced in several fire parts as simple calculation model, in particular for EN1992-1-2 and EN1994-1-2. Moreover, in some national annexes, it is stated that 2D heat transfer analysis is taken as simple calculation method.

A clear definition of what is a tabulated data, a simplified calculation model or an advanced calculation model is missing in the Eurocodes.

Original content

In EN 1992-1-2

4.2 Simplified calculation method

4.2.2 Temperature profiles (1) Temperatures in a concrete structure exposed to a fire may be determined from tests or by calculation.

Change

6.1 (1) Tabulated design data provide recognised design solutions generally in relation to section typology (dimensions) without recourse to any form of equilibrium equation.

Note: Tabulated data may be derived from tests, calculation models or some combination of the two and may be presented either in the form of a table or an equation.

7.1 (1) Simplified design methods are based on a global equilibrium equation.

Note: Solving the global equilibrium equation of a simplified design method results in the determination of a single quantity: e.g. a temperature in a section or part of it, a load bearing capacity for a section or a member.

8.1 (1) Advanced design methods are based on fundamental physical behaviour, employing local equilibrium equations which are satisfied at every point in the structure.

Note: Calculations are undertaken using numerical models based on finite element analyses or other appropriate advanced procedures. Solving the equations of an advanced design method results in the determination of a quantity in a large number of points or nodes: e.g. the temperatures in a section, the displacements along a member.

Background information

1) The fact, mentioned in the specifications of our contract (see above “Reason for change”), that “*any numerical calculation method is considered as advanced calculation model”* is not mentioned in any Part 1-2 (the “fire” Parts) of the Eurocodes.

2) The fact, mentioned in the specifications of our contract (see above “Reason for change”), that “*the numerical thermal analysis is already introduced in several fire parts as simple calculation model, in particular for EN1992-1-2 and EN1994-1-2.*” is not stated very clearly in these Eurocodes. In fact:

In EN 1992-1-2:

A) We read in 4.2.2 that "*Temperatures in a concrete structure exposed to a fire may be determined … by calculation.*" in a clause that is in the Section 4.2, entitled "Simplified calculation methods". And we know that the temperatures in a concrete section can only be calculated by numerical analysis.

   Yet, the same clause 4.2.2 also states that "*Temperatures in a concrete structure exposed to a fire may be determined from tests …* ". It does not imply that tests are a simplified calculation method. As a consequence, similarly, this clause 4.2.2 does not imply that numerical calculations are a simplified calculation method.

B) In ANNEX B "Simplified calculation methods, B.1 500°C isotherm method", we read in (1) (a) "*Determine the isotherm of 500° C*…". But it is not said how the isotherm should be determined. It could be determined by (numerical) calculation, but it could also be taken from Annex A.

In EN 1994-1-2:

We read in the section 4.3 "*Simple calculation models*", under clause 4.3.4.1.1 (3) "*The temperature distribution … may be determined from test, advanced calculation models or … , from the simple calculation model …* ". Also here, we cannot conclude that advanced calculation models for determining the temperature distribution are considered as simple calculation models from the fact that they are mentioned in this section, because tests are also mentioned in this clause.

3) In 7.1 (1), the meaning of "*a global equilibrium equation*" and "*a single temperature in a section or part of it*" is exemplified by:
   - Eq (4.25) in EN 1993-1-2 which yields "*the … temperature … in an unprotected steel member*" from the equilibrium between the energy that penetrates the section, on one hand, and the increase of enthalpy on the other hand.
   - Eq (B.1) in EN 1993-1-2 which yields "*the average temperature of the steel member*" from an energy balance between incoming and outgoing heat fluxes.
   - Eq. (4.6) in EN 1994-1-2 which yields "*The … temperature … of the various parts of an unprotected steel beam*" where "various parts" means "the flanges and the web".

   In 7.1 (1), the meaning of "*a global equilibrium equation*" and "*a load bearing capacity for a section or a member*" is exemplified by:
   - Eq. (4.1) in EN 1993-1-2 which expresses "*The load-bearing function of a steel member*" as the equilibrium between effects of actions, on one hand, and resistance of the member on the other hand. All subsequent equations in clause (4.2) that give the particular expressions of the resistance are given for "*a tension member*" (Eq. 4.3), "*a compression member*" (Eq. 4.5), "*a cross-section*" (Eq. 4.8), etc.
   - Eq. (4.3) in EN 1994-1-2 which gives the moment resistance of section.

   These examples show that the definition is valid for the mechanical analysis as well as for the thermal analysis.

4) It has not been considered as appropriate to state that the determination of 2D temperature distributions by numerical analysis is a simple calculation method because:
   - This would make impossible to have a generally valid definition. Each method should, one by one, be labelled as tabulated data, simple method or advanced method. This argument is yet more operational than fundamental.
   - Transient non-linear numerical thermal analysis remains a technique that requires specific education and some experience to be applied correctly. Non educated users can, and do all too often, make errors such as, e.g., incorrect boundary conditions in concave sections, incorrect boundary conditions with oblique boundaries (especially in finite difference software developed for vertical or horizontal boundaries), incorrect boundary conditions when symmetries are being used, representation of internal cavities filled with air as a conductive media, inappropriate consideration of delamination or falling off of protective

layers, extrapolation of thermal properties of protective products outside the range of application, meshing errors at the transition between two different materials, utilisation of reversible thermal properties in the cooling phase, unit errors in the introduction of input data…

5) It is recognised that hybrid calculation methods based on one kind of thermal analysis (test, tabulated, simple or advanced method) and another kind of mechanical calculation do exist. They are normally presented, in the Eurocodes, in the section (tabulated, simple or advanced) related to the mechanical analysis of the method.
6) It is recognised that the question of the level of qualification that is required to perform each kind of analysis is important and may have strong implications in different Member States. This question can nevertheless not be treated in the Eurocodes. It has to be treated in each Member State by its own regulations and laws which, when they refer to the different methods of the Eurocodes, have the authority to,
   - ✓ either refer to the general definition of the different kinds of methods, in which case the level of qualification is bound to these definitions,
   - ✓ or list, one by one or as a table of exceptions to the general definition, which level of qualification is required for which calculation method.

Ease of use justification

N/A