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Autor: Mathieu, Henry
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Quality of Designs

Qualité des projets

Qualitätseigenschaften von Projekten

Henry MATHIEU
Insp. Gén. des Ponts et Chaussées
S.E.T.R.A.
Bagneux, France

Henri Mathieu, born 1925, got his diploms in Ecole Polytechnique and Ecole Nationale des Ponts et Chaussée in Paris. For 13 years he was chief of central bridge division in France. Besides general inspection tasks for bridge activities, he chairs now several national and international Commissions, most of them devoted to problems associated with structural reliability.

SUMMARY
Desirable qualities of designs are numerous and various; they cannot be measured and they are highly subjective. In spite of these difficulties, a proposal is presented to define synthetically different degrees of quality. How to obtain the required qualities is also discussed in general terms.

RESUME
Les qualités désirables des projets sont nombreuses et variées, non mesurables et largement subjectives. Malgré ces difficultés, une proposition est présentée pour définir de façon synthétique différents degrés de qualité. Comment obtenir ces qualités est discuté en termes généraux.

ZUSAMMENFASSUNG
Die wünschbaren Qualitätseigenschaften von Projekten sind zahlreich und verschieden; sie können nicht gemessen werden und sind zudem stark abhängig von subjektiven Werten. Trotz dieser Schwierigkeiten wird hier ein Vorschlag beschrieben, um auf eine synthetische Weise verschiedene Qualitätsstufen zu definieren. Wie diese Eigenschaften erreicht werden können, wird auf einer allgemeinen Ebene diskutiert.

PRELIMINARY REMARK

This short contribution has been taken out from the draft of a paper under discussion in IABSE Commission I, devoted to the techniques of checking designs. More details will be found in the final document or can, in the between-time, be obtained from the author (in a French version).

1. SCOPE

For many activities (among them the design) the quality cannot be measured, and quality assurance is up to now limited to very general rules. To improve this situation a first step is to define quality and quality degrees (or levels) for these activities.

2. ELEMENTS OF A DESIGN PROCEDURE

2.1 A design is recorded by drawings, written specifications and calculations.

Drawings and specifications are the "final product"; calculations are only auxiliary. However all these elements are important for quality.

2.2 In a design three successive conception stages are commonly distinguished :

- primary conception, which is functional (location, some requirements, constraints, program ...)

- 2nd stage conception, which includes the choice of the structural type and of some basic dimensions; few and simple calculations are usually done at this stage

- 3rd stage conception, which includes final dimensioning and detailing; sufficiently complete and final calculations are then necessary.

3. DESIRABLE QUALITIES OF DESIGNS.

3.1 These qualities depend on the conception stage under consideration (see above).

Desirable qualities are also not the same for the client, for the staff working on site, and for a checker of the design. For people working on site the information to be provided by the design documents depends on their intellectual level and on the possible cooperation with the designer.

3.2 Desirable qualities (aspects of quality) may be related to :

a - the quality of the proposed solution, i.e. :

- functional requirements,
- aesthetics,
- mechanical requirements (ULS, SLS, robustness, durability ...)
- inspection and maintenance,
- cost,
- delays,
- etc ...

b - the quality of the description of this solution,

c - the quality of the justification of this solution (notably calculations).

Mechanical requirements are mainly considered in the 3rd stage conception.

4. QUALITY DEGREES OF DESIGNS

4.1 No common measurement unit can be found for all the aspects of quality. Some aspects cannot be assessed but in a subjective manner (e. g. aesthetics). Even the quality of calculations (editorial aspects excluded) cannot be considered as represented by the numerical precision of the results, because the necessary precision depends considerably on the structure and the structural element under consideration.

4.2 Although the aspects of quality hereover mentioned are almost mutually independant, a tentative synthetic classification of quality degrees, derived from practice, is proposed hereafter for the 3rd stage conception*.

Level Q_o

Calculations are theoretically consistent with existing Codes, but they are very incomplete and cannot be easily read (if even they can be presented); many data and symbols are not defined.

With regard to the drawings :

- they are not systematically in a right scale,
- dimensions etc ... can generally be found in one place,
- they are unclear and cannot be used without interpreting the content; instead of representing details ambiguous foot-notes refer to other more or less analogous details,
- individual dimensions of reinforcing bars are not given,
- any ducts for prestressing are only represented by a line in longitudinal section,
- no or almost no internal checking by an engineer has been done.

Level Q_1

Calculations are really consistent with existing codes.

Calculations and drawings are graphically correct.

Technical choices have been derived from the most common practice; no time has been given to investigate better solutions.

Level Q_2

Calculations are made with due regard to existing Codes, but also to physics, material properties, external and internal equilibria and synthetic view on the details. They are not highly sophisticated.

All important drawings defining reinforcement and prestressing are done before the final calculation which takes them into account. All details are represented at a big scale.

An engineer cares about all important and/or tricky details (beam ends, anchorage areas ...). All aspects which may affect the final structural quality are closely examined. The whole design is supervised by a senior engineer. The designer visits the works on site during the main phases and writes down possible improvements for future studies.

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* Such a classification has been proposed by M. TONNELLO in his introductory report to the Journées of March 1983 of the Association Française des Ponts et Charpentes (A.F.P.C).

Level Q_3

Design is done as in Q_2, but it is supplemented by a continuous cooperation of the designer with the execution. Economical as well as technical consequences of the design are considered in order to reconsider and improve it when useful. All possible incidents are submitted to the designer for interpretation.

Design is no more a supply, it has become a part of the fulfilment.

5. HOW TO ACHIEVE THE DESIRED QUALITY OF DESIGNS.

5.1 Because of the numerous aspects of quality and the variety of structures, no more than very general rules can be proposed hereafter.

5.2 The general principles for q. a. are applicable, that is : a logical and relevant organization must be established; it includes controls, but does not consist only of controls.

5.3 This organization is not necessarily completely defined in advance.

Hence it may be judicious that the checker takes some initiative in order to prevent possible defects of the design.

5.4 Many aspects of the quality of designs can be ensured mainly by organizational preventive measures and may be checked very easily before calculations (or most of the calculations) and detailing are done. Checking these aspects as soon as possible is desirable for efficiency and economical reasons.

These are the reasons why the three conception stages defined in 2.2 are usually distinguished and why "preliminary designs" (avant-projets-Vorentwürfe) having predefined contents are commonly required for acceptance.

6. CONCLUSION

Quality of design has many aspects and can be defined only when the objectives in the particular case under consideration have been identified.

Refering to Codes is unsufficient for defining this quality. Quality of design cannot be assured without requirements about intellectual means and methods to be used for the design.

The difficulties which are met for defining this quality can be overcome. For example, since 1975 the French Administration has been specifying, for the design of scaffoldings of bridges, means and methods close to the level Q_2, and since this time practically no collapse of such scaffolding happened (instead of about 2 per year - for 1000 bridges before).

On the other hand, not defining this quality may be harmful. Not having defined it might be one of the reasons why so many damages occur in buildings in France, with obvious consequences on economy and cost of insurances.

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