Design according to reliability theory

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Design according to Reliability Theory

Projet selon la théorie de fiabilité

Entwurf nach der Zuverlässigkeitstheorie

JANUSZ MURZEWSKI
Professor of Civil Engineering
Politechnika Krakowska
Kraków, Poland

New solutions of structural analysis are not so important as the technological concepts for the development of the mass-produced steel structures design, as Prof. Jungbluth pointed out in his Introductory Report. It does not mean that there is no need for new theoretical considerations. It seems that the reliability analysis will take place of the structural analysis in the design. Two questions are basic for the reliability analysis. One of them is the anticipated sevice time of the structure. It happens more and more often now that the requirements and opinions about usefullness of some kinds of structures change sooner than their real durability expires. This problem must be taken under consideration in conditions of the mass-production of steel building. and it can be done in terms of probability theory. The structure shall be designed for a given risk of failure r. When the structure is protected against the corrosion and it does not suffer the fatigue, we have

$$r = \frac{1}{T} \ln \frac{1}{1-\omega} \approx \frac{\omega}{T} , \qquad (1)$$

where T - service life ,
ω - probability of excessive overloading, which depends on the safety class.

The second basic question is the efficiency of the quality control. We expect that no defective building structure will be given to users, although some defectiveness is alowable in the case of other industrial products. A period of initial aging, when the risk of failure decreases thanks to eliminations of defective objects, must not take place for buildings, because a spontaneous elimination would mean the structural collapse and it is too dangerous for the personal life. So the risk of

failure r concerns only the failures due to exceptional overloadings and it is constant in such circumstances. Each system of mass-produced structures shall be designed simultaneously with a system of quality control. The solutions of statistical quality control shall be elaborated for this purpose.

Applications of optimization in the design of mass-produced steel structures have found a special interest on this Symposium. Prof. Goble presented effective techniques of optimal design, where the objective or cost function is minimized. Other contributors have extended the cost critrion for the whole design, fabrication and erection process. The most general point of view adopted in reliability theory defines the total costs as follows

$$C = C_r + C_a + C_e + C_l \quad , \tag{2}$$

where C_r - cost of realisation,
C_a - cost of insurance,
C_e - cost of maintenance,
C_l - cost of demolition.

The cost of insurance for many buildings shall defray the costs of failures C_f with a probability ω

$$C_a = \omega\, C_f \quad , \tag{3}$$

and all kinds of costs shall be discounted for a definite moment of time.