

1. HUMAN ERROR ANALYSIS

Nowak, A.S., Collins K.R. *Reliability of structures*.
McGraw-Hill Higher Education 2000

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Human errors add considerable uncertainty to design and construction activities, being dominant causes of structural failures.

There are two approaches of error control: error frequency reduction and minimization of error consequences.

Calculation check and job inspection control the quantity of errors, while sensitivity analyses identify the severity of their consequences.

Uncertainties of the building process depend on their sources.

Two major uncertainty sources are natural and man-made hazards.

Natural hazards are caused by

- wind, earthquake, temperature, snow load, ice accretion,
- natural variation of structural material properties (strength, modulus of elasticity, dimensions),
- load variation (weight of people, furniture, trucks on bridges).

Man-made hazards may be shown their major causes:

- the building process: uncertainties due to acceptable practice (innovations, unique and new structures, new materials) and caused by **departure from acceptable practice**,
- outside the building process: fires, gas explosions, collisions.

Comment:

- **Practice is acceptable** if not negated by a significant number of expert engineers.
- **Common practice is not necessarily acceptable.**
- Acceptable practice is not necessarily common.
- **Departures from acceptable practice are human errors.**

Errors are considered with regard to

- person involved (i.e., designer, architect, draftsman, contractor, construction worker, manufacturer, user, owner),
- phase of the building process (planning, design, fabrication, transportation, construction, operation, use, demolition),
- location (office, job site, factory),
- reason (ignorance, negligence, carelessness),
- frequency or mechanism of occurrence.

The discrepancy between the theoretical and actual failure rates is due to an incomplete theoretical model.

Most failures are caused by human errors while are not analyzed.

Structural failure surveys indicate human error as a major cause.

The impact of human error - two research directions: fundamental studies and frameworks for application.

Fundamental studies improve the understanding of error statistics, phenomenological models and heuristic models.

Their range: experimental studies of error commission, simplified mathematical models, stochastic process models.

Frameworks for application to structural engineering – the field of engineering science, operational research, management science.

Pragmatic approach -efficient control, the error-prone structures introduced and identified by a framework:

- the use of fuzzy-set concepts,
- optimal time allocation for design, modelling, material testing and inspection to reach a given target reliability,
- relation of human errors and their effects on structural reliability via sensitivity coefficients.