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DESIGN FOR ROBUSTNESS: BURDEN OR OPPORTUNITY?

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Abstract

In bridge planning, the successful translation of the many conditioning factors into a solution that meets all safety requirements while also addressing considerations such as economy and elegance is essentially a matter of conceptual design. Despite the utmost importance of that stage, which in addition to an intuitive understanding of load-bearing mechanisms calls for imagination and a sense of form and beauty, creative conceptual thinking is systematically underestimated both in engineering training and everyday practice. The resulting impoverishment of the profession stems not only from growing, need-driven and hardly reversible specialisation, but also from inexorably extensive and opaque standardisation and control.

The rules for ensuring robustness reflect the increasing complexity and opacity characterising structural design codes. While the practical importance of designing and building robust structures is universally acknowledged, the codes presently in place are often vague or confusing. Cross-referencing, in turn, may lead to loops around rules that, confounding engineers, are counterproductive. Conversely, that lack of clarity for robust structural design, an outcome of the complexity of the problem itself, may spur careful or even innovative solutions if suitable mechanisms are built into the load-bearing system early, in other words in the conceptual design phase.

Building on that premise, this contribution suggests a practical approach to robust bridge design. The general idea is that conceptual design should embrace continuous, ductile structural systems given their inherent advantages for identified design situations, such as moment redistribution capacity and energy dissipation. Preventing the propagation of key member local failure-induced collapse in unidentified accidental situations would call for building either alternative load paths or predefined collapse mechanisms into structural systems. Such measures should be combined with risk-based criteria in key member as well as remaining structure design.

Deployment of the procedure proposed afford reasonable assurance that the actual load-bearing mechanism called into play after local failure in the wake of unidentified accidental situations would be as assumed. This is evidenced by applying the proposal to a real-life design situation.

Keywords: Reliability; local failure; progressive collapse; robustness; conceptual design; integral bridge; ductility; key member; inbuilt failure mechanism; aesthetics.

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