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STABILITY AND PLASTICITY IN STRUCTURAL ANALYSIS : A NEW CONCEPTUAL FRAMEWORK

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Concepts of stability in structural analysis and design are predominantly based on the behaviour of single members, where the behaviour is often relatively simple. However, with the advances in computational power and the wide dissemination of very powerful software for structural modelling, it is important that the relationship between paradigms for hand calculation and the outcomes of fully nonlinear computer calculations is clarified. These different conceptual models for the structure require different criteria of failure, and the lack of attention to system analysis in standards for structural design has hidden the mismatches and incompatibilities between assumptions about system behaviour and member behaviour.

This paper briefly reviews the historical roots of the current paradigms for structural calculation and finds that the conceptual framework being used in modern design really dates back to very early simplifications. It argues that it is time to tidy the conceptual framework and to use a design paradigm that more explicitly acknowledges the incompatibilities and simplifications, permitting a clearer understanding of what it being done in the design process.

The paper further argues that it is the system strength that really matters in structural strength evaluations, and that this strength can be relatively easily determined by using fully nonlinear computer analyses of the structure. The strength assessment should be referred to and characterised in terms of two well defined reference strengths: the results of linear bifurcation and plastic collapse analyses. Using these, the interactions between plasticity, stability and imperfections can be characterised by a few simple parameters which can be used to characterise all structural systems. Researchers are urged to develop a database of the values of these key parameters to permit a better understanding of the roles that plasticity, stability, geometric nonlinearity, strain hardening and imperfections all play in each structural system and arrangement.