Evolution of Structural Safety Concepts to Fail-Safe Structural Topology Optimization Postprint

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Abstract

Ensuring structural safety is a perpetual concern in the engineering application of mechanics. To this end, this paper reviews the evolutionary process of structural safety concepts, dividing it into five stages: First, from material permanent safety to material resident safety, which marks the conceptual origin; Second, from material exhaustive resident safety to component exhaustive resident safety, representing a gradual conceptual evolution; Third, from component exhaustive resident safety to structural damage-safety, which constitutes a major conceptual leap; Fourth, damage-safety-based structural cross-section and shape optimization, which represents a conceptual enhancement; Fifth, damage-safety-based structural topology optimization, which represents the conceptual sublimation. Since the fifth stage is one of the most actively researched topics among scholars currently, it is discussed in considerable detail, with representative theories and numerical examples presented. Subsequently, the discussion expands in two directions: the inspiration derived from the concept and the essence of the concept itself. First, the conceptual inspiration is discussed from the perspective of damage-safety-based structural analysis and structural optimization, where Inspiration 1 is adhering to the damage-safety design principle without abandoning the safety-economy design principle, and Inspiration 2 is elevating the empirical design experience of statically indeterminate structures to the rational generation of redundant regions. Second, the essence of the concept is discussed through a temporal and spatial analysis of in-service damage-safety of structures, and a clear list is provided.

Full Text

Preamble

The provided text consists primarily of corrupted characters, encoding artifacts, and PDF extraction errors that cannot be meaningfully translated. No coherent Chinese sentences or technical content could be recovered from this section.