

Application of Topology Optimization in the Development of Lightweight and High-Strength Structural Components

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Abstract: *Topology optimization has emerged as an advanced computational design methodology for developing structural components that are lightweight while maintaining adequate stiffness, strength, and functional performance. Unlike conventional size and shape optimization, topology optimization determines the optimal distribution of material within a prescribed design domain by removing inefficient material and retaining material along structurally important load paths. This approach is particularly valuable in aerospace, automotive, biomedical, robotics, and mechanical engineering applications, where reduction in component mass directly influences energy consumption, payload capacity, dynamic performance, and material efficiency. The integration of topology optimization with finite element analysis, advanced numerical algorithms, and additive manufacturing has further expanded the design space toward complex organic geometries that are difficult or impossible to manufacture using conventional processes.*

Keywords: Topology Optimization, Lightweight Structures, High-Strength Components, Structural Optimization, Compliance Minimization.