Research Objectives

- To apply topology optimization to the field of structural engineering through high-rise building design
- Use a combined approach with both continuum and discrete elements to create practical designs
- Address the importance of achieving a balance between engineering and architecture for efficient, sustainable design

Introduction: Engineering and Architecture

- Historical examples of structures by architects with strong and innovative engineering concepts

Basic Topology Optimization Framework

- Minimum compliance criteria
  \[
  \min_{\rho, \mathbf{u}} \ c(\rho, \mathbf{u}) \\
  s.t. \quad K(\rho)\mathbf{u} = f \\
  \int_{\Omega} \rho \, dV \leq V_s \\
  \rho(x) \in [0, 1] \forall x \in \Omega
  \]

- Other criteria
  - Deflection (P-Δ)
  - Buckling load
  - Natural frequency

Motivation for Combined Approach

- Incomplete bracing systems form with continuum only models
- Optimal designs give thick “columns” with unrealistic bending stiffness
- Material concentrations along edges are very dense (web-flange behavior)
- Difficult to identify the working points in such designs

Conclusions

Topology optimization using a combined approach can be a valuable tool to bridge the gap between engineering and architecture in the design industry. Moreover, resulting designs will be more efficient and sustainable, by optimizing the material consumption.

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References