Research Proposal

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Title:

Numerical Simulation and Analytical Assessment of Progressive Collapse Mechanisms in Reinforced Concrete and Steel Framed Structures

1. Background

Progressive collapse refers to a phenomenon where the failure of one or more structural components initiates a chain reaction that can lead to partial or complete structural failure. Conventional design codes typically address individual load cases but provide limited guidance on structural robustness under accidental or extreme events such as blast, impact, fire, or sudden column removal. With the growing complexity of modern high-rise and special structures, advanced numerical simulation tools like ABAQUS have made it possible to accurately predict load redistribution, dynamic interactions, and the progression of failure throughout a structure.

This study aims to build **numerical and analytical models** to understand, simulate, and quantify the mechanisms governing progressive collapse in RC and steel frames.

2. Problem Statement

Existing analytical approaches to progressive collapse are often simplified and fail to capture the complex nonlinear dynamic behavior and alternate load redistribution that occur following a local member failure. Therefore, there is a need to:

- Develop a comprehensive and validated numerical framework capable of simulating progressive collapse under various initiating events such as column loss, blast, or fire.
- Formulate analytical models and robustness indices that effectively correlate with detailed numerical simulation results.

- Propose design recommendations and guidelines to enhance structural resilience and support code-based provisions against disproportionate collapse.

3. Objectives

1. To develop nonlinear finite element models of RC and steel framed structures for column removal and abnormal loading conditions.
2. To simulate progressive collapse propagation using time-history and static analyses.
3. To conduct parametric studies on the influence of member strength, redundancy, connection stiffness, and load redistribution.
4. To derive simplified analytical expressions for robustness quantification and propose design recommendations.

4. Methodology

The study will employ advanced finite element software such as ABAQUS to perform nonlinear static and dynamic simulations. Models will be validated using benchmark studies. Parametric analyses will be conducted by varying material properties, connection stiffness, and loading scenarios. Analytical correlations will be developed using regression-based techniques in MATLAB or Python. The final phase will focus on formulating design-oriented recommendations and publishing outcomes in peer-reviewed journals.

5. Significance of Research

This research will contribute to the development of resilience-based design methodologies for civil structures. The results will aid in enhancing the safety and robustness of buildings and infrastructure, particularly in the context of abnormal or unforeseen loading conditions.