Prediction of Progressive Collapse for Multi-Storey Steel Moment Frames Using Machine Learning Algorithms

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Abstract. The growing importance of artificial intelligence (AI) in structural engineering has highlighted the effectiveness of machine learning (ML) techniques for data prediction. This study focuses on progressive collapse, a critical phenomenon where the failure of a single element can lead to the collapse of an entire structure, particularly in multi-storey steel frames, one of the most common structural systems. The primary factor in preventing progressive collapse is the accurate prediction of the load increase factor (LIF), a crucial parameter for assessing structural susceptibility. Traditional finite element (FE) analysis for progressive collapse is complex, time-consuming, and prone to human error. To address these limitations, this study proposes a novel approach combining ML with FE simulations to predict LIF. We generated a dataset of 3990 models using commercial FE software, and used them to evaluate various ML algorithms, including linear/polynomial regression, decision tree, and random forest. The results demonstrate the potential of ML as a powerful tool for improving the accuracy and efficiency of progressive collapse analysis in structural engineering.

Keywords: Artificial Intelligence (AI), Progressive Collapse, Load Increase Factor (LIF), Finite Element Modeling (FEM), Machine Learning (ML), Structural Steel Frames, Predictive Analysis, Damage Prediction