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Progressive Collapse Analysis of 2D RC Frames Under the Impact of Single Interior and Exterior Columns

[IIUM Engineering Journal](#) • Article • Open Access • 2026 • DOI: 10.31436/iiumej.v27i3.4607 [Md Kassim, Tahara Ramadan](#)^a ; [Mohamad nor, Muhammad Faiz](#)^a; [Majid, Taksiah A.](#)^b^a Department of Civil Engineering, Kulliyah of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia[Show all information](#)

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Abstract

Structural elements are susceptible to both local and global failures triggered by progressive collapse, making it essential in structural vulnerability assessments. This research investigates and predicts the progressive collapse behavior of two-dimensional (2D) reinforced concrete frames designed for gravity loadings, considering the removal of columns in both interior and exterior locations. Linear static and nonlinear dynamic analyses are conducted to investigate and predict the development of alternate load paths (ALPs) and dynamic structural response under column-loss scenarios using SAP2000 software. Three cases are considered: Case 1 (no column removal), Case 2 (removal of one interior column), and Case 3 (removal of one exterior column). Linear static analysis reveals that the General Services Administration (GSA) yields slightly higher, more conservative axial forces than the British Standard (BS). Regardless of where the column was removed, ALP under progressive collapse significantly altered the structural response in Case 2 and Case 3. Nonlinear

dynamic analysis revealed that Case 3 exhibited the highest displacement and interstorey drift ratio (IDR), particularly under Ground Motion (GM5). The findings also demonstrate that exterior column removal triggered the highest drift demands, indicating critical structural vulnerability to progressive collapse. Copyright (c) 2026 IIUM Press. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License. <https://creativecommons.org/licenses/by-nc/4.0/>

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Alternate Load Path; Column Removal; Nonlinear Dynamic Analysis; Progressive Collapse

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