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# Modelling Damage and Progressive Collapse of Frames using a Gaussian Springs based Applied Element Method

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Nonlinear dynamic analysis has been widely modelled using finite element methods for analysis of collapse of structures; however, difficulties in the analysis were found at the presence of excessively deformed elements with cracking or separation, having high computational costs, and difficulties in choosing the appropriate material models. Current available methods cannot deal with structural collapse accurately; however, the Applied Element Method (AEM) was developed to aid in the analysis of the collapse of structures. It can simulate the behaviour of a structure from an initial state of no loading until total collapse, and is particularly attractive since it can model cracking and element separation.

The elements in AEM are rigid, and the material properties are introduced through the spring stiffness. The elements are connected with sets of normal and shear springs along the edges of the elements, that represent the stresses and strains of the element in that region. The present paper utilises a modified AEM to model the collapse of structures based on the Gaussian Quadrature for spring distribution. The scheme works for linear elastic, and nonlinear cases, including elasto-plastic and large deformation.

In this paper, the scheme is validated for damage and fragmentation modelling in order to simulate progressive collapse of buildings subjected to dynamic loading. This is achieved by introducing a separation strain criteria that describes the complete failure of the material. If the strain at a spring exceeds the separation strain, that spring is removed from the element. Once all springs of the element fail, the element will be separated from its adjacent element. This leads to a load redistribution, and the progressive collapse analysis of the structure proceeds.

Structural members and frames with dynamic loadings are analysed to induce collapse of the structure using the modified AEM. The results showed that modelling the collapse of the structure was straight forward, with a low computational cost and high accuracy. The framework developed allows to perform AEM analysis on a Finite Element model.

## REFERENCES

[1] Kimiro Meguro and Hatem Tagel-Din *Applied Element Method for Structural Analysis.* pp. 31 – 45, 2000.

[2] Mai Abdul-Latif and Y.T. Feng *A modified applied element method using adapative Gaussian springs for Elasto-plastic analysis of structures.* In:UKACM, pp 300–303, 2017.