NEW NUMERICAL TECHNIQUE FOR COLLAPSE ANALYSIS AND MITIGATION OF REINFORCED CONCRETE AND COMPOSITE FRAMED STRUCTURES

By

MOHAMED SAYED GOMAA MAHMOUD

A Thesis Submitted to the

Faculty of Engineering at Cairo University

in Partial Fulfillment of the Degree of

DOCTOR OF PHILOSOPHY

In

Structural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

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Under the Supervision of

Prof. Dr. Adel Yehia Akl	**Dr. Said Abdel Fattah Said El-Kholy**
Prof. of Structural Analysis and Mechanics,	Assist. Prof. of Structural Engineering,
Cairo University	Fayoum University

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Approved by the

Examining Committee:

Name and Affiliation	Signature
Prof. Dr. Adel Yehia Akl Professor of Structural Analysis and Mechanics Cairo University	**Thesis Main Advisor**
Prof. Dr. Sherif A. Mourad Professor of Steel Structures Vice Dean for Post Graduate Studies and Research, Cairo University	**Member**
Prof. Dr. Hany A. El-Ghazaly Professor Emeritus of Structural Analysis and Mechanics Fayoum University	**Member**

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TITLE OF THESIS: "NEW NUMERICAL TECHNIQUE FOR
COLLAPSE ANALYSIS AND MITIGATION OF REINFORCED
CONCRETE AND COMPOSITE FRAMED STRUCTURES"

Key Words: Progressive Collapse, Numerical Technique, Applied Element Method, Improved Applied Element Method, Multi-Layered Element, Numerical Simulation

Summary:

To obtain full knowledge of the performance of structures under extreme loading conditions, it is essential to accurately simulate the collapsing process and the trace of yielding, damage and deformation at each structural member. Recently, the Improved Applied Element Method (IAEM) has been introduced to simulate the total behavior of large-scale steel towers; however, its application was limited to structures with homogeneous material. In this thesis, a new improvement for IAEM is introduced to develop a novel numerical simulation analysis of collapse of RC and composite structures under hazardous loads. With the new method, structures with homogenous and non-homogenous materials can be simulated with high accuracy. The code reliability is investigated by comparing its results with existing experimental and numerical results which show good agreement. Finally, the method is used to study the vulnerability of four school building types in Egypt to progressive collapse and the suitable retrofitting technique.