بسم الله الرحمن الرحيم

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Faculty of Engineering
Structural Engineering Department

Evaluation of Seismic Response of Hybrid Buckling-Restrained Braced Frames

A Thesis Presented by

Mohab Anan Abdelhay Elghamry

B.Sc. of Structural Engineering.
Civil Engineering Department - Ain Shams University,2016

Supervised by:

Prof. Dr. Mohamed Nour El-den
Professor of structural Engineering
Structural Department
Faculty of Engineering
Ain Shams University

Prof. Dr. Hisham A.El-Arabaty
Professor of structural Engineering
Structural Department
Faculty of Engineering
Ain Shams University

Dr. Mohamed Abd ElWahhab
Assistant Professor of structural Engineering
Structural Department
Faculty of Engineering
Ain Shams University

2022

Ain Shams University
Faculty of Engineering
Structural Engineering Department

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A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Structural Engineering

A Thesis Presented by
Mohab Anan Abdelhay Elghamry

Examiners Committee Signature

Prof. Dr. Hala Mohamed Gamal Eldin Elkady …….
Professor of Civil Engineering Department
National Research Center

Prof. Dr. Ahmed AbdElmanaem Korashy …….
Professor of Structural Engineering
Structural Engineering Department, Ain Shams University

Prof. Dr. Mohamed Nour El-Den Saad Fayed …….
Professor of Structural Engineering
Structural Engineering Department, Ain Shams University

Prof. Dr. Hisham Ahmed El-Arabaty …….
Professor of Structural Engineering
Structural Engineering Department, Ain Shams University

Date: 18/4/2022

Ain Shams University
Faculty of Engineering
Structural Engineering Department

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Supervisors Committee Signature

Prof. Dr. Mohamed Nour El-Den Saad Fayed …….
Professor of Structural Engineering
Structural Engineering Department, Ain Shams University

Prof. Dr. Hisham Ahmed El-Arabaty …….
Professor of Structural Engineering
Structural Engineering Department, Ain Shams University

Dr. Mohamed Ahmed Abd ElWahhab …….
Assistant Professor of Structural Engineering
Structural Engineering Department, Ain Shams University

Postgraduate Studies
Authorization stamp: The thesis is authorized at / / 2022

College Board Approval
/ / 2022

University Board Approval
/ / 2022

Date: 18/4/2022

1 CURRICULUM VITAE

Name	Mohab Anan Abdelhay Elghamry
Date of Birth	17, April 1993
Place of Birth	Egypt
Scientific degree	B.Sc. of Structural Engineering, Faculty of Engineering, Ain Shams University, 2016
Current Job	Demonstrator of Structural Analysis, Structural Engineering Department, Faculty of Engineering, Ain Shams University

2 STATEMENT

This thesis is submitted to Ain Shams University for the degree of M.Sc. in Civil Engineering.

The work included in this thesis was carried out by the author at the Department of Structural Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

Name: Mohab Anan Abdelhay Elghamry

Signature:

Date: 18 / 4 / 2022

Thesis Summary

This research investigates the seismic response of buckling restrained braces (BRB) in comparison with hybrid buckling restrained braces (HBRB) under near fault earthquakes known with its extensive structural damages because of the velocity pulses and high frequency contents. Both systems use a bracing that consists of a steel core with a buckling restraining component such as a mortar filled steel tube which leads to a good energy dissipation behavior. The problem of the BRB is the residual displacement after earthquakes because of the yielding of the braces. The HBRB uses a combination of low yield point steel with high strain hardening and high-performance steel which counteracts the low post yield stiffness of BRB. A complex non-linear finite element model (FEM) was used to simulate the real behavior of structures under the combination of both vertical and lateral loads

A parametric study was performed on 3 buildings with different heights -5-, 7-, and 9-story- and different bracing compositions using standard and 2 hybrid combinations. Each building was designed and subjected to pushover analysis and incremental dynamic time history analysis. Time history analysis was performed under 7 near fault ground motions with velocity pulses after scaling and rotating them in fault normal and fault parallel directions.

Seismic code factors such as response modification factor and over strength factor were computed based on the analysis results and compared with design codes. Another comparison was made between the standard bracing and the two hybrid bracing compositions in regard of the max roof drift, residual displacement and inter story drift ratio. Finally, the difference between the effect of fault normal and fault parallel on the structure was illustrated. Based on these comparisons number of considerations were recommended to be taken in dealing with BRB and HBRB and generally for building near active faults.

KEYWORDS: Hybrid buckling restrained brace, Near fault, Nonlinear analysis, Residual displacement.

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