FINAL PROJECT

COMPARATIVE STUDY OF FIXED BASED AND BASE ISOLATOR SYSTEM IN 8-STORY STEEL STRUCTURES USING PUSHOVER ANALYTICS METHOD

By:

JONATHAN STEVEN VALENTINO
1432100027

STUDY PROGRAM CIVIL ENGINEERING
FACULTY OF ENGINEERING
UNIVERSITAS 17 AGUSTUS 1945 SURABAYA

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Submitted to Fulfill Terms of Use Get a Bachelor's Degree in Civil Engineering Study Program Faculty of Engineering

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STATEMENT OF AUTHENTICITY AND APPROVAL FOR FINAL PROJECT PUBLICATION

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Hereby declare that the "**FINAL PROJECT**" that I have completed to fulfill the graduation requirements for the Bachelor's Degree (S1) in Civil Engineering – Undergraduate Program – University of 17 August 1945 Surabaya, with the title :

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I hereby make this statement truthfully and without any coercion from any party.

Surabaya, June 24 2025

Declarant,

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FOREWORD

Praise and gratitude to God Almighty for His abundant blessings and grace, allowing the author to complete the Final Project Proposal for the Civil Engineering Study Program at Universitas 17 Agustus 1945 Surabaya. The author realizes that this Final Project Proposal could not have been completed without the assistance of many parties. Therefore, on this occasion, the author would like to express gratitude to:

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The author is also aware that this report is far from perfect and contains various errors and shortcomings. Therefore, constructive criticism and suggestions from readers are highly appreciated. Should there be any mistakes within this report, the author sincerely apologizes.Finally, may this report be beneficial. Thank you.

Surabaya, August 9, 2024

Author

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ABSTRACT

High rise buildings are vulnerable to lateral forces such as earthquakes and wind due to their mass and stiffness. This study compares the seismic performance of fixed base and base isolated systems using High Damping Rubber Bearings (HDRB) on an 8 story steel structure. Nonlinear static pushover analysis was conducted in ETABS v18, referring to SNI 1726:2019 and FEMA 356. Key parameters analyzed include lateral displacement, inter story drift, base shear, P Delta effects, plastic hinge distribution, and the initial cost of base isolation.

Lateral displacement increased in the base isolated model (54.491 mm X, 54.795 mm Y) compared to the fixed base (43.109 mm X, 43.513 mm Y). However, maximum inter story drift was reduced by 14.28% (X) and 13.39% (Y), indicating improved building flexibility. Base shear dropped significantly from 12,167.52 kN (X) and 12,335.10 kN (Y) to 2,644.93 kN (X) and 2,643.37 kN (Y). The θ coefficient also decreased, reflecting reduced P Delta sensitivity.

Despite these benefits, performance drift ratios increased under FEMA 356, shifting performance from Immediate Occupancy (IO) in the fixed base to Collapse Prevention (CP) in the isolated model. ASCE 41-13 also classifies the fixed base as IO and the isolated structure as CP. Plastic hinges in the base isolated model formed later, showing better energy dissipation. The initial cost of HDRB isolation using model HN070X4S is estimated at Rp.1,052,631,342 for a 50 years lifespan. This research confirms HDRB's effectiveness in enhancing seismic performance and provides guidance for engineers in seismic design.

Keywords : Earthquake, Pushover, Fixed Base, Base Isolator

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D	:	Influence of dead load.
L	:	Influence of live load.
L_r	:	Influence of roof live load.
R	:	Rainwater load.
W	:	Wind load.
E_v	:	Influence of vertical seismic load.
E_h	:	Influence of horizontal seismic load.
ρ	:	Redundancy factor.
Q_E	:	Effect of horizontal seismic force derived from V or Fp.
Kd	:	Wind directionality factor.
K_{zt}	:	Topographic factor.
K_e	:	Ground surface factor.
G	:	Gust effect factor.
GC_{pi}	:	Internal pressure coefficient.
K_z atau K_h	:	Velocity exposure coefficient.
q_z atau q_h	:	Velocity pressure.
C_p atau C_n	:	External pressure coefficient.
p	:	Wind pressure.
I_e	:	Seismic importance factor.
F_a	:	Short-period acceleration amplification factor.
F_v	:	One-second period acceleration amplification factor.
S_{MS}	:	Spectral response acceleration parameter for short periods.
S_{M1}	:	Spectral response acceleration parameter for a one-second period.
S_S	:	MCER spectral response acceleration parameter for short periods.
S_1	:	MCER spectral response acceleration parameter for a one-second period.
S_{DS}	:	Design spectral acceleration parameter for short periods.
S_{D1}	:	Design spectral acceleration parameter for a one-second period.
T	:	Fundamental vibration period of the structure.
T_a	:	Approximate fundamental period.
R	:	Response modification coefficient.
Ω_0	:	System overstrength factor.
Cd	:	Factor for amplifying lateral displacement.

V	:	Base shear force.
Cs	:	Seismic response coefficient.
W	:	Effective seismic weight.
Δ	:	Inter-story drift.
Δa	:	Inter-story drift Limitation
θ	:	Stability coefficient.
Ru	:	Required strength.
Rn	:	Nominal strength.
ϕ	:	Resistance factor.
ϕRn	:	Design strength.
λ	:	Width-to-thickness ratio for elements as defined in SNI 1729-2020 Article B4.1.
λp	:	Width-to-thickness limit for compact elements.
λr	:	Width-to-thickness limit for noncompact elements.
h	:	Clear web depth (mm).
b	:	Flange width (mm).
tf	:	Flange thickness (mm).
tw	:	Web thickness (mm).
K		Effective length factor.
E	:	Modulus of elasticity for steel (200,000 MPa).
G	:	Shear modulus of elasticity (77,200 MPa).
Fy	:	Minimum specified yield stress (MPa).
Fu	:	Minimum specified tensile strength (MPa).
Mn	:	Nominal flexural strength (N-mm).
Mp	:	Plastic flexural moment (N-mm).
Lb	:	Distance between braced points to prevent flange lateral movement or cross-sectional torsion (mm).
Lp	:	Limiting laterally unbraced length for yield limit state (mm).
Lr	:	Limiting laterally unbraced length for inelastic lateral-torsional buckling limit state (mm).
Cb	:	Lateral-torsional buckling modification factor for non-uniform moment diagrams with both ends braced.
Sx	:	Elastic section modulus about the x-axis (mm^3).
Fcr	:	Critical stress (MPa).
V_n	:	Nominal shear strength (N).
A_w	:	Web area, total height multiplied by web thickness (mm^2).
C_v	:	Web shear strength coefficient.
R_y	:	Ratio of expected yield stress to the minimum specified yield

		stress, Fy.
V_u	:	Required shear strength using LRFD load combinations (N).
P_n	:	Nominal axial strength (N).
P_u	:	Required axial compressive strength using DFBT load combinations (N).
A_g	:	Gross cross-sectional area of the structural component (mm²).
A_e	:	Effective area (mm²).
e	:	Eccentricity at truss connection (mm).
T_e	:	Effective vibration period.
T_i	:	Elastic vibration period.
K_e	:	Effective lateral stiffness.
K_i	:	Elastic lateral stiffness.
δ_T	:	Target displacement.
g	:	Gravitational acceleration (9.81 m/s²).
K_H	:	Structural stiffness
W	:	Weight of the column structure
T	:	Target vibration period
K_H'	:	Elastomer stiffness
G	:	Shear modulus of elastomer
A	:	Area of elastomer
tr	:	Total thickness of elastomer
B	:	Damping-related numerical coefficient