THE USE OF MAGNETORHEOLOGICAL DAMPERS AS SEMI ACTIVE DEVICE FOR STRUCTURES SUBJECTED TO EARTHQUAKE

Final Project

by:

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INTERNATIONAL S1 PROGRAM

DEPARTMENT OF CIVIL ENGINEERING

FACULTY OF ENGINEERING

ATMA JAYA YOGYAKARTA UNIVERSITY

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DECLARATION

I hereby declare this final project report with the title:

THE USE OF MAGNETORHEOLOGICAL DAMPERS AS SEMI ACTIVE DEVICE FOR STRUCTURES SUBJECTED TO EARTHQUAKE

is my own work and not plagiarism. Idea, results or quotations which are from other sources are stated in this final report.

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LEGISLATION

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Has been examined and approved by

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Yogyakarta, 13 June 2013

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NOTATIONS

a_k	= proportional constant that relates damping and stiffness
A, B, E	= system matrices in state space equation $\dot{\mathbf{Z}} = \mathbf{AZ} + \mathbf{Bu} + \mathbf{Ew}$
A_b	= area of the beam
A_c	= area of the column
b_i	= vector representing the location of the ith control force
b_s	= control force location matrix
c	= damping
$\mathbf{C}_{3D}$	= damping matrix of three-dimensional building
$\mathbf{C}_s$	= damping matrix
$\mathbf{C}_y$	= measurement matrix
$\mathbf{d}_C$	= displacement to be condensed
$\mathbf{d}_R$	= displacement to be retained
E	= modulus of elasticity
f	= external force
I	= matrix identity
ID	= destination vector
I_x	= second moment area of the floor with respect to X axis

I_{yb}	= second moment area of the beam with respect to y_m axis
I_{yc}	= second moment area of the column with respect to y_m axis
I_{zb}	= second moment area of the beam with respect to z_m axis
I_{zc}	= second moment area of the column with respect to z_m axis
I_y	= second moment area of the floor with respect to Y axis
J	= torsional constant
k	= stiffness
$\mathbf{K}_{3D}$	= stiffness matrix of three-dimensional building
$\mathbf{K}_{CC}$	
$\mathbf{K}_{CR}$	= partitionof the stiffness matrix
$\mathbf{K}_{RC}$	
$\mathbf{K}_{RR}$	
$\mathbf{K}_C$	= element stiffness in terms of Global Frame Coordinate Systems
$\mathbf{K}_s$	= stiffness matrix
m	= mass
M	= total mass of the floor
$\mathbf{M}_{3D}$	= mass matrix of three-dimensional building
$\mathbf{M}_s$	= mass matrix
MMI	= mass moment of inertia of the floor
n	= total degrees of freedom
N	= total number of floors

NRJ = total number of restrained joints

NTF = total number of joints at the floor

NTJ = total number of joints of the structure

$\mathbf{T_R}$ = transformation matrix

$\mathbf{u}$ = control force vector

V = Lyapunov function

$\mathbf{X}_{3D}$ = displacement vector of three-dimensional structures

$\mathbf{X_s}$ = displacement vector

$\dot{\mathbf{X}}_\mathbf{s}$ = velocity vector

$\ddot{\mathbf{X}}_\mathbf{s}$ = acceleration vector

y = storey drift

$\mathbf{y}$ = measurement vector

$\mathbf{Z}$ = state vector

Δ_F = displacement of the structure in terms of Global Frame Coordinate Systems

Δ_{FC} = displacement of the structure to be condensed out

Δ_{FR} = displacement of the structure to be retained

ABSTRACT

Awareness of engineers in designing earthquake resistant building is arising nowadays. Many strategies have been developing by the researchers to get high performance in reducing earthquake responses. Semi-active control strategy under earthquake loading is discussed in this report will be applied in three dimensionalthree-storeybuilding. In addition, the device has been added with magnetorheological fluid which will act as the liquid damper.

Firstly is to fulfill all parameters in non-linear control strategy based on the building properties. Furthermore, theforce of the device in semi-active control strategy will be analyzed with MATLAB to get displacement response by comparing passive on, passive off control and Lyapunov method

The results of the simulation comparing the uncontrolled building result with semi-active control strategies (uncontrolled-passive off; uncontrolled-passive on; uncontrolled-Lyapunov method) show satisfactory result with displacement response reduction on the first floor are31.5%, 37.5% and 48.35%, the results on the second floor are 30.7%, 30.5% and 40.2% and the results on the third floor are 26.5%, 29.8% and 40%.

Keywords : semi-active control strategy, magnetorheological fluid, passive on, passive off, Lyapunov method, MATLAB