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

Final Project

by:

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May 2013
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.

Yogyakarta, April 2013

[Signature]

Aldorin Prastyawan Satriajaya
LEGISLATION

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NOTATIONS

\( a_k \) = proportional constant that relates damping and stiffness

\( A \) = system matrices in state space equation \( \dot{Z} = AZ + Bu + Ew \)

\( B \)

\( E \)

\( A_b \) = 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

\( C_{3D} \) = damping matrix of three-dimensional building

\( C_s \) = damping matrix

\( C_y \) = measurement matrix

\( d_C \) = displacement to be condensed

\( d_R \) = displacement to be retained

\( E \) = modulus of elasticity

\( f \) = external force

\( I \) = matrix identity

\( \text{ID} \) = 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

\( K_{3D} \) = stiffness matrix of three-dimensional building

\( K_{cc} \)

\( K_{cr} \)

\( K_{rc} \)

\( K_{RR} \)

\( K_{c} \) = element stiffness in terms of Global Frame Coordinate Systems

\( K_s \) = stiffness matrix

\( m \) = mass

\( M \) = total mass of the floor

\( M_{3D} \) = mass matrix of three-dimensional building

\( M_s \) = 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

\( T_R \) = transformation matrix

\( u \) = control force vector

\( V \) = Lyapunov function

\( X_{3D} \) = displacement vector of three-dimensional structures

\( X_s \) = displacement vector

\( \dot{X}_s \) = velocity vector

\( \ddot{X}_s \) = acceleration vector

\( y \) = storey drift

\( y \) = measurement vector

\( Z \) = state vector

\( \Delta F \) = displacement of the structure in terms of Global Frame Coordinate Systems

\( \Delta_{FC} \) = displacement of the structure to be condensed out

\( \Delta_{FR} \) = 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 dimensional three-storey building. 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, the force 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 are 31.5%, 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