Connected Control Method for Adjacent Base-Isolated Buildings Using a 200KN MR Damper

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Overview

Base isolated buildings are susceptible to long-period ground excitations. Connected control method (CCM) can be applied to adjacent base isolated buildings to provide reduction of the response at low frequencies while not affecting the performance of the isolation to higher frequency excitations.
Adjacent isolated buildings

- Superstructures:
  - Two identical buildings
  - Four-story reinforced concrete building
  - Experimental specimen tested at E-Defense (Japan)

- Isolation layers
  \[ T_{bA} = 2s \]
  \[ T_{bB} = 5s \]
  \[ k_b = \frac{m_s + m_b}{(2\pi T_b)^2} \]
  \[ \zeta_{bA} = 3\% \]
  \[ \zeta_{bB} = 3\% \]
  \[ c_b = \frac{\zeta_b (m_s + m_b) T_b}{\pi} \]

- EXPERIMENTAL SPECIMEN
- FEM ABAQUS
- REDUCED MODEL MATLAB
- STATE SPACE MODEL SIMULINK
Coupling device: MR damper

- Fully dynamic hyperbolic tangent model (Jiang et. al 2012)
- Dynamics of:
  - Force at constant current
  - Current after modified by amplifier
  - Inductance of magnetic coils
Numerical model in SIMULINK

- State-space format

\[ \dot{z} = [A]z + [B]u \]
\[ y = [C]z + [D]u \]

\[
[A] = \begin{bmatrix}
0_{r \times r} & [I]_{r \times r} \\
-[\bar{M}_r]^{-1}[\bar{K}_r] & -[\bar{M}_r]^{-1}[\bar{C}_r]
\end{bmatrix}
\]

\[
[B] = \begin{bmatrix}
0_{r \times 1} & 0_{r \times c} \\
-[\bar{M}_r]^{-1}[\bar{I}_g] & [\bar{M}_r]^{-1}[\bar{I}_c]
\end{bmatrix}
\]

\[
[C] = \begin{bmatrix}
[\Phi_{pr}] [I]_{r \times r} & [\Phi_{pr}] [0]_{r \times r} \\
-[\Phi_{pr}] [\bar{M}_r] [\bar{I}_b] & [\Phi_{pr}] [\bar{M}_r] [\bar{I}_c]
\end{bmatrix}
\]

\[
[D] = \begin{bmatrix}
[\Phi_{pr}] [0]_{r \times 1} & [\Phi_{pr}] [0]_{r \times c} \\
[\Phi_{pr}] [0]_{r \times 1} & [\Phi_{pr}] [\bar{M}_r] [\bar{I}_c]
\end{bmatrix}
\]
Results

Displacements Tohoku Earthquake

Accelerations filtered noise

Buildings A and B

Building B with increased damping at base
Come see my Poster!

Today Poster Session:

- **Time**: 3:30 – 5:00 pm
- **Room**: Santa Monica B (Exhibit Hall)
- **Poster location**: Number 135