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System Identification of a Mid-rise CFS Building Subject to Earthquake and Fire Tests
Test Building & Test Protocol

**Test Building**

- Plan layout: 10.4 m × 7.3 m; Story height: 3.1 m
- Site Location: **Downtown LA** \( (S_{DS} = 1.5 \text{ g}, \ S_{D1} = 0.8 \text{ g}) \)
- Lateral load resisting system: **CFS shear walls**
  - Corridor walls: primary lateral resisting elements
  - Exterior walls: resist transverse & torsional loads

**Test Protocol**

- **Fire Test Phase**
  - Test Day 1
  - Test Day 2
  - Test Day 3
  - Test Day 4

- **Pre-Fire EQ Test Phase**
  - MCE
  - SLE

- **Post-Fire EQ Test Phase**
  - MCE
  - SLE

![Diagram](image-url)
White Noise (WN) Base Excitation Tests

- Amplitude: 1.5% g & 3.0% g RMS
- Duration: 3 minutes
- Before & after each EQ test
  - a total of 20 WN tests
- Analysis Method: Deterministic-stochastic Subspace Identification (DSI) method
  - 1 input & 24 output channels

Roof Accelerations during WN test
Identified Modes – Reference State

**Six Vibration Modes (1.5% g RMS)**

- **Mode 1-T:** $f = 2.2$ Hz; $\xi = 5.8\%$
- **Mode 1-L:** $f = 3.9$ Hz; $\xi = 5.2\%$
- **Mode 1-To:** $f = 4.3$ Hz; $\xi = 4.2\%$
- **Mode 2-T:** $f = 7.6$ Hz; $\xi = 5.6\%$
- **Mode 2-L:** $f = 12.5$ Hz; $\xi = 3.3\%$
- **Mode 2-To:** $f = 13.5$ Hz; $\xi = 2.2\%$
Identified Frequencies & Damping – WN Tests

**Amplitude Dependency**
As excitation amplitude increases
- frequency drops
- damping rises

**Damage Dependency**
As damage progresses
- frequency drops
- damping rises

- **Frequency (Hz)**
  - **Mode 1–L**
  - **Mode 2–L**

- **Damping (%)**
  - **Mode 1–L**
  - **Mode 2–L**

- **Samples**: S0, S3, S4, S5, S6, S7, S8, S9

- **Excitation Amplitude**: 1.5% g RMS, 3.0% g RMS
**Frequency Loss Evolution vs Damage Progression**

\[ \text{Freq. Loss} = \left( \frac{f_{ref} - f}{f_{ref}} \right) \times 100\% \]

- Remained small (< 10%) during service level (SLE) events (S0–S4)
- Increased substantially (~50%) following design (DE) event (S6)
- Continued to increase (~60%) following MCE test (S7)
- Remained stable following fire tests & post-fire SLE test (S8–S9)

**Frequency Loss Evolution** correlates well with **Damage Progression**

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**Mode 1-L**

- 1.5% g RMS
- 3.0% g RMS

**Mode 2-L**

- 1.5% g RMS
- 3.0% g RMS

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**Post-MCE**

- Minor (Cosmetic)
- Moderate (Repairable)

**Post-SLE**

- Moderate (Repairable)
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