Full-Scale Structural and Nonstructural Building System Performance during Earthquakes & Post-Earthquake Fire

Joint NSF-Private Sector Initiative

Overview

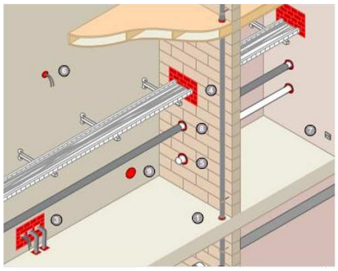
- $5.0 million, 3 year research project
  - University of California San Diego (UCSD), WPI, San Diego State University (SDSU), Howard University, and industry
- Full-scale shake table test of 5-story building
  - UCSD Large Outdoor Shake Table
  - Outfitted with nonstructural components / systems
  - Seismic performance of non-structural systems
  - Post-earthquake fire performance

Goals

- Investigate interaction of structural and nonstructural components and systems under seismic loading at full-scale with the aim to reduce economic losses by mitigating damage to nonstructural components
- Study the performance of passive and active fire-safety systems and products during strong ground shaking and post-earthquake fire

Architectural / Passive Fire Protection

- Cladding / glazing
- Floor types (e.g., raised)
- Stairs (safety, integrity)
- Partition walls / seals
- Suspended ceilings / fixtures
- Doors



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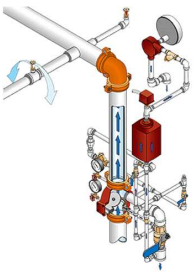
Mechanical, Electrical & Fire Systems

- Elevator
- HVAC
  - Heating / chillers
  - Fans / ducts / dampers
- Piping systems
- Fire suppression system
- Pumps / tanks
- Electrical distribution
- Fire detection / alarm
- Voice communication
- Telecommunications

SimplexGrinnell



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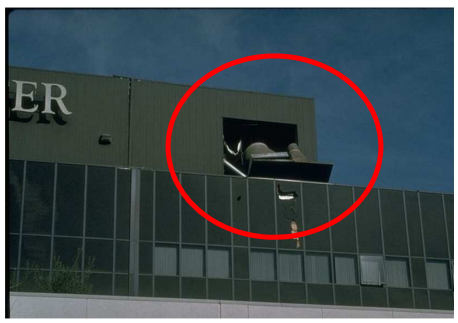
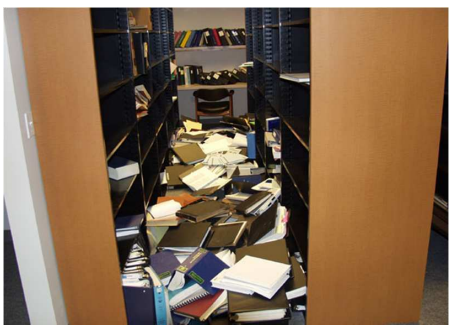
Contents

- Fully functional pressurized hospital ICU
- Servers on raised access floors
- Rooftop equipment

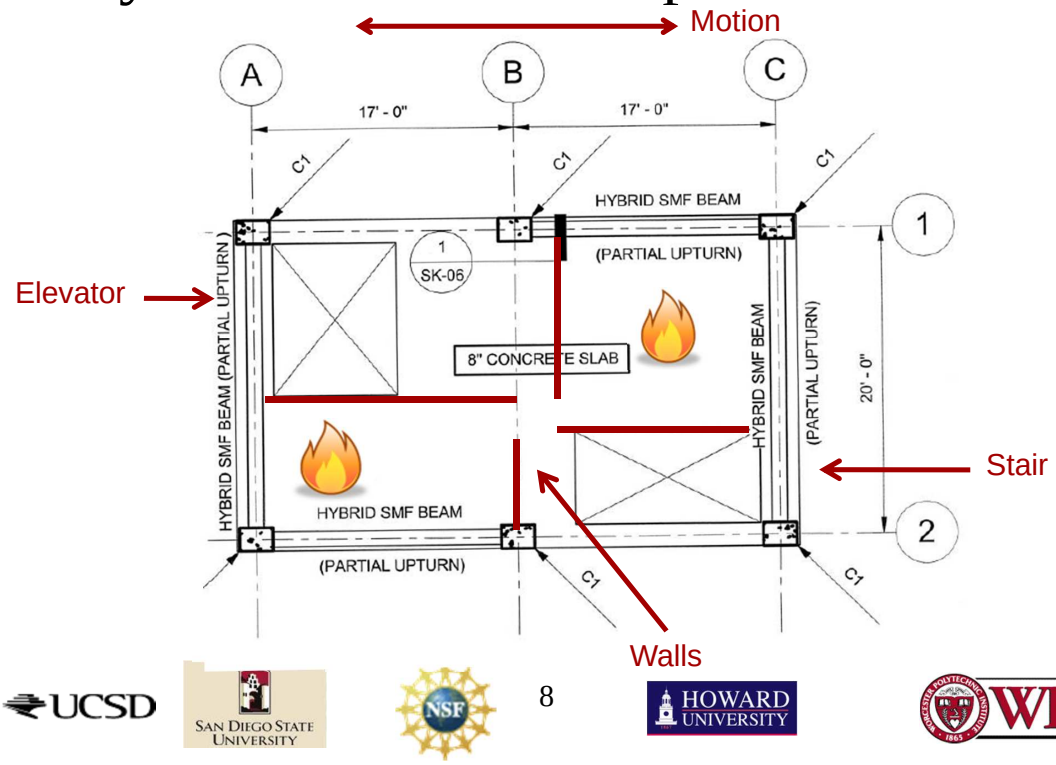




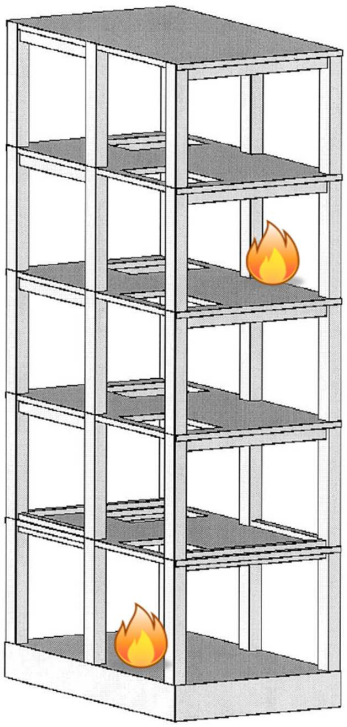
Approach

- Data collected relative to forces on the fire protection systems during ground movement.
- This will then be followed by visual, pressure, and other non-destructive testing.
- The building will then be subjected to controlled fires, which will be used to assess thermal and non-thermal response.
- Some small-scale component testing as well.

Layout / Possible Compartmentation



- Testing
  - Seismic performance
    - Drift and acceleration (movement, damage, operability)
    - Equipment / connections / anchors
    - Floor-to-floor / within a floor
  - Fire performance
    - Post-EQ damage / operability
      - Visual, pressure, and other non-destructive testing
    - Limited fire / smoke tests
      - Controlled fires – test response, effectiveness of systems
      - Fire and smoke spread
  - Pre- and post- modeling



Simulation

- Pre- and post-fire simulations using FDS
  - Model planned scenarios using available data, expectations regarding the post-EQ condition of the building and fire protection systems, and predict the post-EQ fire impacts and conditions.
  - Following the ground motion tests, the pertinent input parameters will be used and the simulations rerun to assess potential variability in predicted outcomes. Fire tests will then be conducted and compared to simulation runs.

Funding Situation

- Seismic Performance of Nonstructural Systems
  - NSF – NEESR – $1.2M (**funded**)
    - UCSD lead. No 'fire' support in NSF grant.
- Post-Earthquake Fire Performance
  - Proposals at NIST, DHS, elsewhere (not yet funded)
    - WPI lead. Targeting $250k - $375k (2-3 yrs)
- Industry Support
  - In-kind equipment & services and cash
    - Some $1.5M committed (cash and in-kind) – more sought

Broad Stakeholder Participation

- Current Industry Support
  - Arup – Fire, MEP & structural engineering
  - Hilti – Anchorage & firestop products
  - Mason Industries – Piping restraint / isolation
  - Schindler – Elevator
  - Ruskin – HVAC & fire dampers
  - NFSA – Sprinkler system
  - SimplexGrinnell – FAS
  - FMGlobal, others…