EFFECTS OF LONG-DURATION SHAKING ON BUILDING COLLAPSE RISK

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MARCH 22, 2012
DEFINITION OF DURATION

5-95% Ds: 21.2s

Hollister $M_w$ 5.45

5-95% Ds: 80.1s

Chi Chi Taiwan $M_w$ 7.62
GROUND MOTIONS

Epicentral Distance (km) vs. 5-95% Ds (s) with $R^2 = 0.74396$
- Crustal
- Subduction

Moment Magnitude vs. 5-95% Ds (s) with $R^2 = 0.52302$

PGA (g) vs. 5-95% Ds (s) with $R^2 = 0.52302$
- Crustal
- Subduction
• Analyzed 20 concrete frame buildings

• Representative of modern and older buildings

• Varying ductility due to design/detailing differences

• Varying height (1 to 20 stories)
NONLINEAR SIMULATION MODELS

Diagram of a building structure with labels indicating various components such asGravity Frame Loads, Tributary Gravity Loads, Lumped Plasticity-Columns, Lumped Plasticity-Beams, P-Δ Leaning Column, and detail at A. Graphs showing the relationship between M/M and θ (rad) with markers at specific values.

Graph 1: M/M vs θ (rad) with values from -0.8 to 1.2 at various θ values.

Graph 2: M/M vs θ (rad) with values from -0.4 to 1.2 at various θ values.

Graph 3: M/M vs θ (rad) with values from -0.048 to 0.048 at various θ values.
**Goal:** To predict structural collapse response as a function of ground motion intensity and duration.

\( S_{di} \) used as ground motion intensity measure based on bilinear oscillator.
TRENDS BETWEEN COLLAPSE CAPACITY AND DURATION

a) 04MP
- Collapse $S_{di}$ Crustal
- Collapse $S_{di}$ Subduction
- Individual Building Model
- Final Model

b) 08MS
- Collapse $S_{di}$ Crustal
- Collapse $S_{di}$ Subduction
- Individual Building Model
- Final Model

c) 04OP
- Collapse $S_{di}$ Crustal
- Collapse $S_{di}$ Subduction
- Individual Building Model
- Final Model

d) 08OS
- Collapse $S_{di}$ Crustal
- Collapse $S_{di}$ Subduction
- Individual Building Model
- Final Model
TRENDS BETWEEN COLLAPSE CAPACITY AND DURATION

Collapse $S_{di}$ Crustal
Collapse $S_{di}$ Subduction
Individual Building Model
Final Model

5-95% $D_s$ (s)
HOW DOES DURATION IMPACT STRUCTURAL RESPONSE?

\[ y = -4 \times 10^{-6} x + 0.014 \]

\[ R^2 = 0.0012 \]

\[ S_{di} = 4.25 \text{ in} \]

\[ y = 8 \times 10^{-7} x + 0.005 \]

\[ R^2 = 4 \times 10^{-5} \]
HOW DOES DURATION IMPACT STRUCTURAL RESPONSE?

\[ y = 0.39x + 11.61 \]
\[ R^2 = 0.72 \]

\[ S_{di} = 2.25 \text{ in} \]

\[ y = 0.39x + 11.61 \quad R^2 = 0.72 \]

\[ S_{di} = 4.25 \text{ in} \]

\[ y = 0.52x + 17.84 \quad R^2 = 0.80 \]
HOW DOES DURATION IMPACT STRUCTURAL RESPONSE?

Before Collapse

Total Hysteretic Energy (kips-in)

5-95% $D_s$ (s)

$y = 0.49x + 90.11$

$R^2 = 0.53$

Crustal  Subduction
HOW DOES DURATION IMPACT STRUCTURAL RESPONSE?

**Decreasing ductility SDOF models**

**Decreasing energy dissipation capacity SDOF models**
EFFECTS OF LONG-DURATION SHAKING ON BUILDING COLLAPSE RISK

QUESTIONS?

Acknowledgments: Funding for this study comes from the USGS external grants program. Conclusions and findings do not necessarily represent U.S. government policies.