Effective Strategies for Improving the Disaster Resilience of Critical Nonstructural Components and Systems

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Nonstructural Components and Systems

- Architectural components includes cladding, ceilings, glazing, partitions, etc.
- Mechanical and electrical components and systems (utilities)
- Contents including medical equipment, communications equipment, computers, shelves and bookcases, valuable contents on shelves, etc.
Performance Goals For Critical Facilities in Disasters

• First step in process is to establish goals.

• Typical goal is to have facility perform its critical function following disaster occurrence.

• To meet goal all critical components and systems must function – not just structural system (which is different from highways)

• This means critical nonstructural systems and components are of equal importance to structural systems from a facility performance perspective (i.e. both most perform)
Identification of Critical Nonstructural Systems

- Second Step in process after establishing performance goals

- Need to identify critical functions – This is a facility management decision

- Need to do a systematic review of all systems, components and utilities and identify those which are critical to maintain function.

- Identify those requiring redundancy or backup where they are out management control.
Establish Vulnerability Capacity of Critical Nonstructural Systems

• Typically components and systems are either acceleration sensitive or relative displacement sensitive.

• In past capacity have been based on capacity of anchorage and bracing

• For critical systems, just understanding anchorage and bracing capacity is not good enough. Must also understand and establish demands at which systems no longer function (fragility).
Determination of Demands on Nonstructural Systems

- In some cases demands are directly based on external hazards such as wind or blast pressure on exterior cladding or glazing.

- In other cases, the demands on nonstructural components are a bit indirect and are based on the response of the structure such as inter-story drift or floor accelerations rather than the hazard itself.

- Sometimes nonstructural components significantly affect the response of the structure and therefore there are interaction effects that need to be accounted for.
Strategies for Improving Nonstructural Performance

- Sitting – away from faults, good soil conditions, high ground, stand-back distances
- Selection of structural system to reduce NS demand including enhanced systems
- Positioning within structure to reduce demand
- Increase the capacity of the critical nonstructural system greater than demand
- Provide back-up systems especially for utilities (emergency generator, UPS, etc.)
Strategies for Further Improvements in Nonstructural Performance

- Requirement for detailed dimensional design of critical nonstructural systems in design phase
- Qualification Testing (i.e. AC-156)
- Peer Review of critical nonstructural systems
- Special Inspection of installation of critical nonstructural systems
Performance Metrics (Facility Based versus Community Based)

• Event Occurs – Did facility meet functional performance goals (including non structural)?

• Deterministic Based Evaluation – Do analytical simulation of disaster scenario using objective criteria/testing. Does facility satisfy? (yes or no?) NRC/ DOE approach.

• Probability Based Evaluation – Probable downtime for a given probable event (ATC-58 approach). Acceptable downtime TBD.
Future Work

- Develop a better understanding of which nonstructural components and system are critical to function.
- Develop better determinations of the vulnerabilities (fragilities) of critical nonstructural components and systems.
- For probabilistically based approaches, establish consensus on acceptable downtime from a probabilistic perspective.
- Implement much improved post disaster reconnaissance of critical facilities with emphasis on the observed functional performance including a detailed evaluation of nonstructural performance.