Post-Earthquake Building Assessment

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Tutorial Overview

Assessment Stages:

- **Search & Rescue**: focus on safety of buildings for extraction of entombed victims and safety of rescuers

- **Safety**: focus on the safety of a building for continued occupancy, without regard to the extent of non-structural damage
  - ATC-20
  - BORP

- **Damage**: focus on the determination of the nature, extent, and appropriate repair of earthquake damage
Tutorial Schedule

2:00  Introduction
2:05  Urban Search & Rescue
2:30  ATC-20 Post-Earthquake Safety Assessment of Buildings
3:00  Break
3:15  Mobile Post-Earthquake Building Safety Evaluation Data Acquisition System ATC-20i
3:45  City of San Francisco Building Occupancy Resumption Program BORP
4:15  Break
4:30  Post-Earthquake Building Damage Assessment
4:55  Summary & Closing
5:00  Q&A
5:30  Adjourn
Urban Search & Rescue & Rescue Engineering

John Osteraas, PhD, PE
Exponent Failure Analysis Associates
US&R Agenda

- US&R Background
- US&R Capabilities
- Rescue Engineering
- US&R Marking Systems
Urban Search & Rescue:
Location, Rescue (Extrication), & Initial Medical Stabilization of Victims Trapped / Entombed in Confined Spaces of Collapsed Urban Structures due to Earthquakes, Hurricanes, Tornadoes, Explosions, Terrorist Acts, and other Life Threatening Disasters
Impetus for US&R System

- Many heavily populated areas of the U.S. are at high risk for a major earthquake or hurricane.

- Earthquakes in Mexico City (1985), El Salvador (1986), and Armenia (1988) indicated that a catastrophic event in the U.S. would overwhelm state and local resources and that Urban Search and Rescue capabilities would be inadequate.

- 1989 Loma Prieta Earthquake and Hurricane Hugo highlighted the Earthquake and Hurricane threats in the U.S. and underscored the need for a National Urban Search and Rescue capability.
US&R Background

Phases of Large Urban Earthquake

CONDITION of VICTIMS

- Injured and Not Trapped
- Non-Structure Entrapment
- Lightly Trapped
- Trapped

5 to 10%

15%

30%

50%

EMERGENCY RESPONSE

- Spontaneous Civilians Nearby
- Community Response Teams
- Lt. Rescue Teams
- TF US&R

Civilians Nearby

Community Response Teams

Lt. Rescue Teams

TF US&R

Injured and Not Trapped

Non-Structure Entrapment

Lightly Trapped

Trapped

5 to 10%
Survival Rates of Trapped Earthquake Victims

- 30 minutes: 90% survive
- 1 day: 80% survive
- 2 days: 37% survive
- 3 days: 30% survive
- 4 days: 20% survive
- 5 days: 10% survive
US&R Capabilities

28 FEMA Task Forces Nationwide
8 FEMA Task Forces in California
Various other non-FEMA US&R Teams
US&R Capabilities

- Task Force = 70 positions, 24-hour ops, 3 deep
  - Physical, K9, and electronic searches
  - Advanced life support medicine: crush syndrome / confined space medicine
  - Structural integrity assessment & mitigation
  - Heavy rigging, shoring, bracing, debris mining
  - HAZMAT, safety, communications, logistics
  - Planning, documentation, public information

- $2+ million gear & equipment:
  - Search, rigging, breeching, cutting, shoring
  - Self-sufficient for 72 hours

- Operate under Incident Command System (ICS)
  - IC is designated by Local Authority
It’s always good to know where you are in the system
70 Person – Type 1 Task Force

Task Force Leader (2)

Safety (2)

Search Tm Mgr (2)
- K9 Search (2)
- K9 Search (2)
- Tech Search (2)

Rescue Tm Mgr (2)
- Rescue Sqd 1 1 Off + 5 Spec
- Rescue Sqd 1 1 Off + 5 Spec
- Rescue Sqd 1 1 Off + 5 Spec
- HERS (2)

Hazmat Tm Mgr (2)
- Hazmat Spec (4)
- Hazmat Spec (4)
- Hazmat Spec (4)

Medical Mgr (2)
- Med Spec (2)
- Med Spec (2)

Logistics Mgr (2)
- Log Spec (4)
- Comm Spec (2)
- Support Spec (10)

Planning Tm Mgr (2)
- Struct S (2)
- Tech Info (2)

70 Positions
24 hour Operations
(Each TF has Dbl Cache)
Incident Support Team - A

IST Commander
(2)

IST Safety Off
(1)

Operations Sect Ch
(2)

Planning Sect Ch
(2)

Logistics Sect Ch
(2)

ESF-9 Leader
(2)

IST Struct S
(1)

IST US&R S
(2)

IST Situation
Unit Ldr (1)

IST Comm
Unit Ldr (2)

IST Medical
Unit Ldr (1)

IST Transport
Unit Ldr (1)

IST POA/MOB
Center S (1)

20 Positions
24 Hour Ops

(may add 6 for full 24 hr ops)
Federal, State Local Partnership

- All FEMA TFs are Local Assets First
- CA has Robust Mutual Aid System
  - 8 FEMA Type 1 TFs
  - ? State TFs
  - ? State Strike Teams
  - All CA Teams are categorized by Type
    - All Types are Uniform Configuration thru-out State
- Local Team responded to 2003 Paso Robles Earthquake
- The Most Effective Response is Local Response
- FEMA US&R teams serve only at request of and under command of local authority
FEMA US&R Responses

- Hurricane Andrew, 1992
- Hurricane Iniki, 1992
- Typhoon Brian, 1992
- Hurricane Emily, 1993
- Northridge Earthquake, 1994
- Oklahoma City Bombing, 1995
- Hurricanes Luis, Marilyn, & Opal, 1995
- Hurricane Fran, 1996
- Kansas Grain Elevator Explosion, 1998
- Puerto Rico Gas Explosion, 1998
- World Trade Ctr, 2001
- Pentagon, 2001
- SLC Olympics 2002
- Nat. Sec. Events 2004
- Hurricanes Charley, Francis, Ivan & Jeanne, 2004
- Hurricanes Katrina & Rita, 2005
Basic Approach to US&R

• Identify the Problem
  – Prioritize

• Find Victims
  – Re-prioritize

• Mitigate Hazards
  – Risk vs Reward

• Remove Victims
  – Medically stabilize

• CREATE NO NEW VICTIMS
Rescue Engineering

• Rapid assessment of severely damaged hazardous structures for US&R
  – Hazard assessment
  – Hazard mitigation
  – Collapse patterns & void locations
  – Risk/reward analysis

• Difficult engineering judgments - under pressure
  - at disorderly disaster site – with incomplete information

• Getting dirty to get the job done

• Very different from “Normal” Engineering
  – NOW Engineering
Structures Specialist’s Role

To Promote Safe Rescue Practices

Not to Impede Rescue Operations
US&R Focus

• FEMA US&R Objectives
  – Locate, Rescue & Medically Stabilize Victims
  – FOCUS on VICTIMS

• Structures Spec. Responsibilities
  – Support the Above US&R Objectives
  – FOCUS on RESCUERS
Structures Specialist

- Works with all Aspects of US&R Operations
  - Initial Triage of Buildings
  - Support of Search Operations
  - Support of Rescue Operations
  - Longer Term Building Monitoring
  - Shoring and Hazard Mitigation
  - Breaching, Breaking & Rigging

- Risk/Reward Analysis
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HEAVY WALL - URM BUILDING - HAZARDS

EXPECTED PERFORMANCE – for the following:
- Progressive Collapse – URM walls likely to disintegrate, and interior structure may stand independently.
- E. Quake – Poor performance – out of plane ext wall failures, loss of connection to floors leading to partial or total collapse. Many lethal Aftershock falling and collapse hazards.
- Explosion – Walls become disconnected from floors (horizontal diaphragms), leading to part or total collapse.
- Fire – Loss of roof/floors will leave walls unbraced. Collapsing roof/floors can thrust walls in or out.
- Wind – Roof vulnerable to uplift, leading to partial or total collapse or roof & walls. Massive masonry is more resistant.
- Struct Overload/Defect – Roof failures due to ponding and snow. Wood decay, brick disintegration or remodeling in older buildings.

CHECK POINTS
- Loose, broken parapets and ornamentation.
- Connections between exterior walls and roof/floors.
- Cracked wall corners and openings, plus peeled walls.
- Unsupported and partly collapsed roof/floors.

HAZARD REDUCTION
- Shut off gas and reduce other fire hazards.
- Diagonally shore, tie-back, avoid, remove hazardous walls.
- Shore hazardous roof/floor beams, etc.
- Monitor changes in raked/leaning structures.

VICTIM ACCESS
- Vertical access through floor/roof from above collapsed area.
- Horizontal entry through existing cavities and openings.
- Remove bricks by hand, excavator, or crane with clamshell.
- Remove or shore hazards near victims, if required.
Structure relatively safe for S&R ops. There is little chance of further Collapse.

Structure is significantly damaged. may need shoring, bracing, removal, and/or monitoring of hazards.

Structure is NOT SAFE for Rescue Ops and may be subject to Sudden Collapse.
US&R Structure / Hazard Marking

15JUN92
HM  NATURAL GAS
OR-1
US&R Search Marking

2’ x 2’ X near each entry

First slash is made when entering

Date & time of exit

Crossing slash is made as TF exits and then other info is added

TF indicator date & time of entry

OR-1
2-10-04
1100

2-10-04
1400

RATS
1-L
3-D
**Incomplete Search**

If TF exits w/o completing search, crossing slash is not made, but filled circle is added.

Indicates Floors or Quadrants Completed
F = Floors  Q = Quads

If Only an Exterior Search is done as in Hurricanes

US&R Search Marking

OR-1
2-10-04
1100

RATS
3-D

2-10-04
1400

F 1 - 4
or
No Entry

OR-1
2-10-04
1100
US&R Hazard & Search Markings

Photo Credits FEMA
More Information

US&R Structures Specialist Field Operations
Guide:

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Questions?