

ROVER for End-to-End Seismic Risk Management

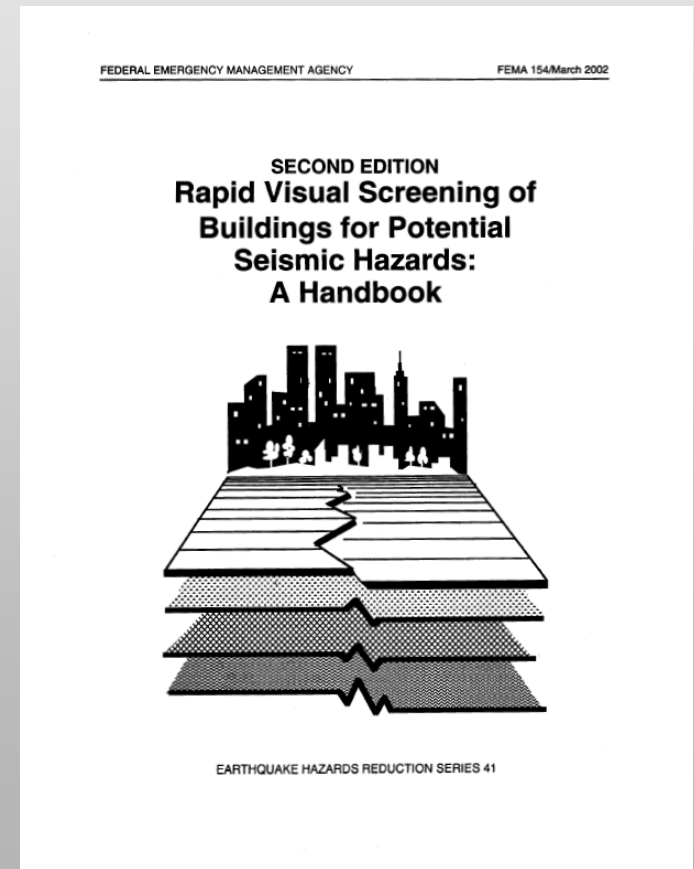
FEMA 4th Annual HAZUS Conference
Indianapolis, 23-25 August 2010
Keith Porter *SPA Risk LLC*

Problem: Efficient Earthquake Safety Inspection

- Pre-earthquake
 - ◆ Compile building inventory with seismic attributes
 - ◆ Screen buildings for potential seismic risk
 - ◆ Inform risk mitigation decisions e.g., using HAZUS
- Immediate post-earthquake response
 - ◆ Quickly estimate damage for management
 - ◆ Carry out & manage safety inspections
- Long-term post-earthquake recovery
 - ◆ Track repairs

FEMA 154 for pre-earthquake inventory

- 1-pg paper & clipboard recon tool
- 10 min/building to calculate risk score S: 0-6
- $S < 2 \rightarrow$ detailed eval. required
- Used 100,000s of times
- Free document:
<http://www.fema.gov/plan/prevent/earthquake/pdf/fema-154.pdf>
- Training materials available



Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA-154 Data Collection Form

HIGH Seismicity

Plan @ 2nd floor

Address: 3711 Roxbury St. Anyplace, Zip 91234
 Parcel 7469027034
 No. Stories: 12 Year Built 1945
 Screener: A. James/D. Taylor Date 2/28/01
 Total Floor Area (sq. ft.): 34,800
 Building Name: Commercial and Offices above

OCCUPANCY		SOIL		TYPE		FALLING HAZARDS							
<input checked="" type="checkbox"/> Commercial	<input type="checkbox"/> Other	<input type="checkbox"/> S1	<input type="checkbox"/> S2	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input checked="" type="checkbox"/> D	<input type="checkbox"/> E	<input type="checkbox"/> F	<input type="checkbox"/> Underload	<input type="checkbox"/> Pileup	<input checked="" type="checkbox"/> Overhang	<input type="checkbox"/> Other

BUILDING TYPE	BASIC SCORE MODIFIERS: ANTERIOR SCORE S														
	W1	W2	S1	S2	S3	S4	S5	C1	C2	C3	PC1	PC2	RM1	RM2	URM
	(RRF)	(RRF)	(UM)	(R2UM)	(R2UM)	(RRF)	(RRF)	(RRF)	(RRF)	(RRF)	(RRF)	(RRF)	(RRF)	(RRF)	(RRF)
Basic Score	4.4	3.8	2.8	3.0	3.2	2.8	2.0	2.5	2.8	1.8	2.6	2.4	2.8	2.8	1.8
Mid Rise (4 to 7 stories)	N/A	N/A	-0.5	-0.4	N/A	-0.4	-0.4	-0.4	-0.4	-0.2	N/A	-0.2	-0.4	-0.4	0.0
High Rise (7+ stories)	N/A	N/A	-0.5	-0.5	N/A	-0.5	-0.5	-0.5	-0.5	-0.3	N/A	-0.4	N/A	-0.5	N/A
Vertical irregularity	-0.5	-0.5	-0.5	-0.5	N/A	-0.5	-0.5	-0.5	-0.5	-0.5	N/A	-0.5	-0.5	-0.5	-0.5
Plan irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Pre-Code	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Post-Code	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Soil Type C	0.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Soil Type D	0.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Soil Type E	0.0	-0.8	-1.2	-0.5	-1.0	-1.2	-0.8	-1.2	-0.8	-0.8	-1.2	-0.4	-0.4	-0.8	-0.8

FINAL SCORE S: 2.5

COMMENTS

Detailed Evaluation Required

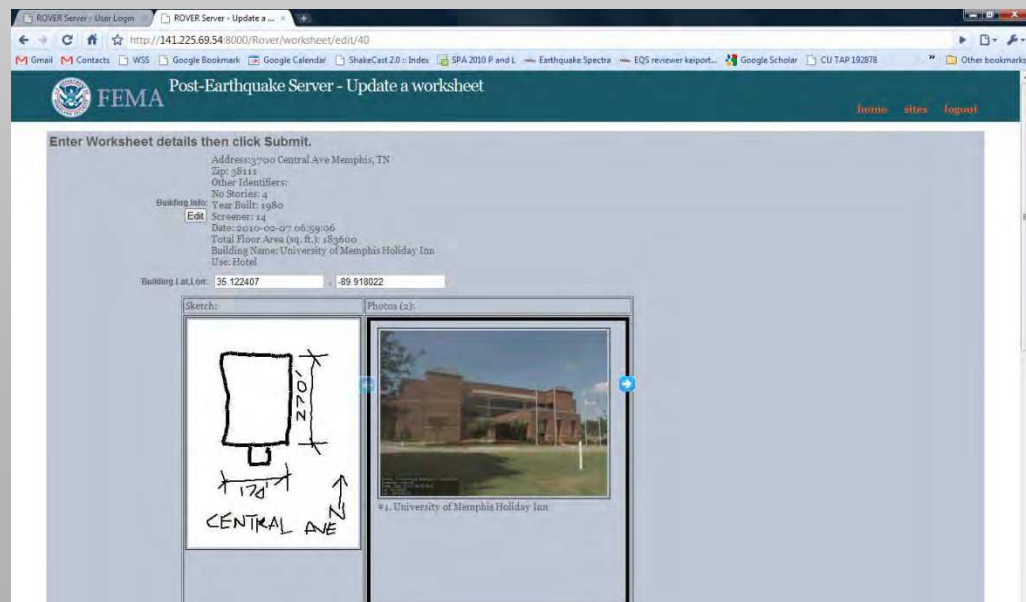
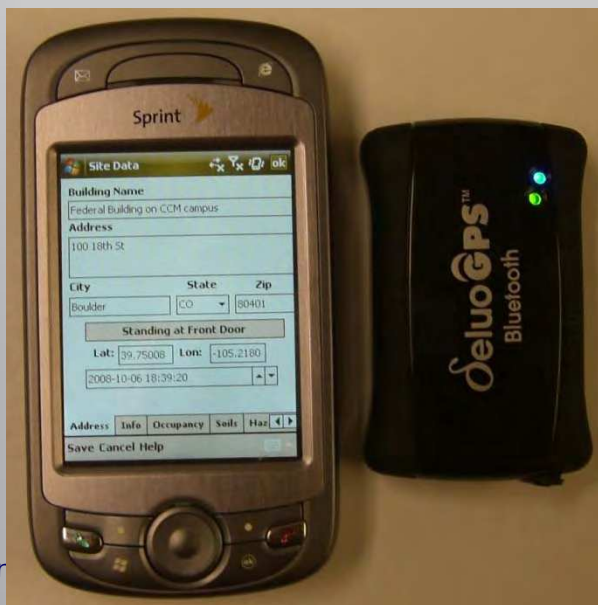
YES NO

- The FEMA 154 form
- Location, name, use
- Sketch
- Photo
- Occupancy
- Soil
- Falling hazard
- Scoring section
- Comments
- Detailed eval required?

Figure 5-11 Completed Data Collection Form for Example 2, 3711 Roxbury Street.

Automating FEMA 154

- ROVER: *Rapid Observation of Vulnerability and Estimation of Risk*
- Client-server software:
 - ◆ Smartphone client for field data (thick client—no data plan required)
 - ◆ Windows, Mac or Linux PC server to compile & manage database
 - ◆ Free and open-source software
- High fidelity to FEMA 154—integrates well with existing training



Client Address tab

Site Data

Building Name
University of Memphis Holiday Inn

Address
3700 Central Ave

City	State	Zip
Memphis	TN	38111

Standing at Front Door

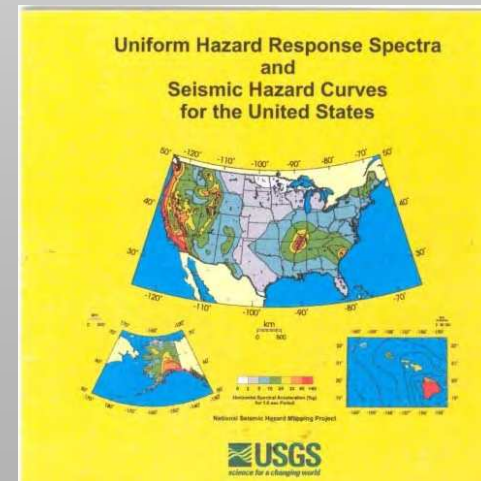
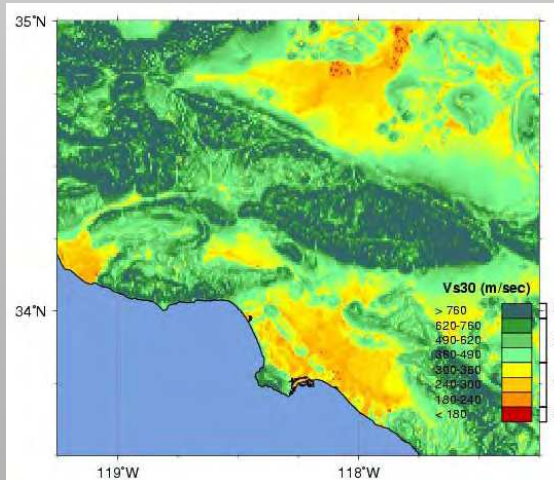
Lat: 35.12240 **Lon:** -89.91802

2010-02-06 23:59:06

Address **Info** **Occupancy** **Soils** **Haz**

Save Cancel Help

- Building name, address
- Remembers last city/state/zip
- Lat/Lon from Bluetooth GPS
 - ◆ Better than geocoding address
 - ◆ Server can look up soil & site hazard from internal databases



Server's built-in soil and hazard maps from USGS

Scoring

Site Data						
Building Type:	4 (C (U))	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC (T)
Basic Score	1.8	2.0	2.5	2.8	1.6	2.0
Mid Rise(4-7)	0.4	0.4	0.4	0.4	0.2	Na
High Rise(>7)	0.8	0.8	0.6	0.8	0.3	Na
Vert. Irreg.	0.0	-1.0	-1.5	-1.0	-1.0	Na
Plan Irreg.	0.5	-0.5	-0.5	-0.5	-0.5	-0
Pre-Code	0.8	-0.2	-1.2	-1.0	-0.2	-0
Post Benchmark	0.6	NaN	1.4	2.4	NaN	2.0
Soil Type C	0.4	-0.4	-0.4	-0.4	-0.4	-0
Soil Type D	0.6	-0.4	-0.6	-0.6	-0.4	-0
Soil Type E	0.2	-0.8	-1.2	-0.8	-0.8	-0
Final Score, S				2.3		

Occupancy Soils Hazards **Scoring** E

Save Cancel Help

- Tap building type(s)
- Onboard help for types
- Tap modifiers (height, etc.)
- Calculates score
- Site-specific hazard allows for site-specific score
 - Basic score is adjusted based on $S_a(0.2 \text{ sec})$

Multiple Captioned Photos



- Use phone's onboard camera
- Photo appears in database
 - ◆ A challenge for paper form
- Unlimited captioned photos
 - ◆ 8GB = 200,000 VGA jpgs
- Photo is later watermarked
- There is also a sketch

Server Sync

Login [Refresh] [Close] [Volume] [OK]

Screener ID:

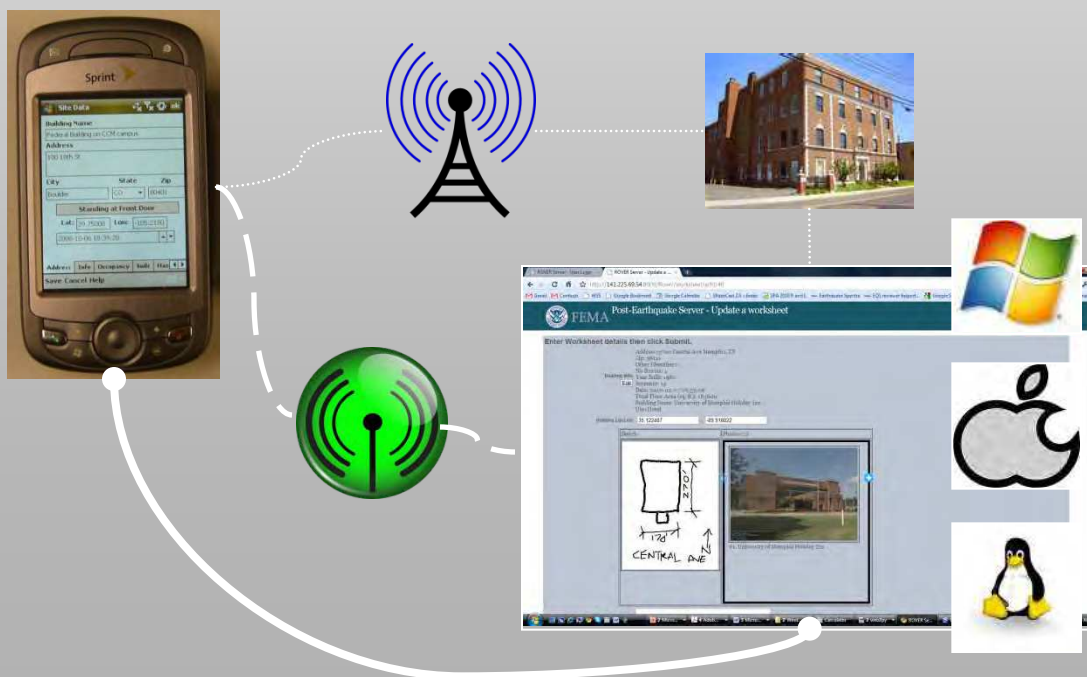
Password:

Show Password

Please enter your Screener ID and Password.

Login Cancel Help [Keyboard] [Up Arrow]

- Bi-direction server sync:
 - ◆ Server is user's own PC
- Web interface to server
 - ◆ If server is online, 24/7 access



Edit & Report Site Data from Server

- Assign buildings to inspectors from server

Post-Earthquake Server - Update a worksheet

Enter Worksheet details then click Submit.

Address: 3700 Central Ave Memphis, TN
 Zip: 38111
 Other Identifiers:
 No Stories: 4
 Building Info: Year Built: 1980
 Screener: 14
 Date: 2010-02-07 06:59:06
 Total Floor Area (sq. ft.): 183600
 Building Name: University of Memphis Holiday Inn
 Use: Hotel

Building Lat, Lon: 35.122407 -89.918022

Sketch:

Photos (2):

Occupancy: **Commercial** (Assembly, Government, Office, Emer. Services, Historic, Industrial, Residential, School)

Number of Persons: 0-10, 11-100, 101-1000, 1000+

Soil Type: A: Hard Rock, B: Avg. Rock, **C: Dense Soil**, D: Stiff Soil, E: Soft Soil, F: Poor Soil

Seismicity (Ss %) or Region: High

Score Modifier Set: High

BuildingType	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SV)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	4.4	3.8	2.8	3.0	3.2	2.8	2.0	2.5	2.8	1.6	2.6	2.4	2.8	2.8	1.6
Mid Rise (4-7 stories)	NA	NA	0.2	0.4	NA	0.4	0.4	0.4	0.4	0.2	NA	0.2	0.4	0.4	0.0
High Rise (7+ stories)	NA	NA	0.6	0.8	NA	0.8	0.8	0.6	0.8	0.3	NA	0.4	NA	0.6	NA
Vertical Irregularity	-2.5	-2.0	-1.0	-1.5	NA	-1.0	-1.0	-1.5	-1.0	-1.0	NA	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Pre-Code	0.0	-1.0	-1.0	-0.8	-0.6	-0.8	-0.2	-1.2	-1.0	-0.2	-0.8	-0.8	-1.0	-0.8	-0.2
Post-Benchmark	2.4	2.4	1.4	1.4	NA	1.6	NA	1.4	2.4	NA	2.4	NA	2.8	2.6	NA
Soil Type C	0.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	NA	-0.4	-0.4	-0.4	-0.4	-0.4
Soil Type D	0.0	-0.8	-0.6	-0.6	-0.6	-0.6	-0.4	-0.6	-0.6	-0.4	-0.6	-0.6	-0.6	-0.6	-0.6
Soil Type E	0.0	-0.8	-1.2	-1.2	-1.0	-1.2	-0.8	-1.2	-0.8	-0.8	-0.4	-1.2	-0.4	-0.6	-0.6
Final Score									2.3						

Detailed Evaluation Required:

Reset Update Worksheet

Automatic Watermarks Added



Name: University of Memphis Holiday Inn
Screener: rover12
Date: 2010-02-07 06:59:06Z
Lat: 35.122407
Lon: -89.918022

- Server adds watermark to each photo
 - ◆ Building name
 - ◆ Screener ID
 - ◆ Date & time
 - ◆ Lat & lon
- Can add captions on client or server

RedROVER for HAZUS Import

- Most AEBM fields are in FEMA 154
- Modest interpretation to map fields (occupancy, model building type, design level, number occs...)

ROVER occupancy types		
Likelihood	Occupancy	Num occs
1	Residential	0-10
2	Residential	11+
3	Commercial	any
4	Office	any
5	Industrial	any
6	School	any
7	Assembly	any
8	Emer. Services	any
9	Government	any
10	Historic	any

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Possible HAZUS-MH occupancy types (could reasonably be any of these)
RES1, RES2
RES3A-F, RES4, RES5, RES6
COM1, COM2, COM3, COM5, COM10
COM3, COM4, COM7
IND1, IND2, IND3, IND4, IND5, IND6, AGR1
EDU1, EDU2
COM8, COM9, REL1
COM6, GOV2
GOV1
Any

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Default type for HAZUS-MH
RES1
RES3A
COM1
COM4
IND1
EDU1
COM9
GOV2
GOV1
COM1

ShakeCast for real-time monitoring

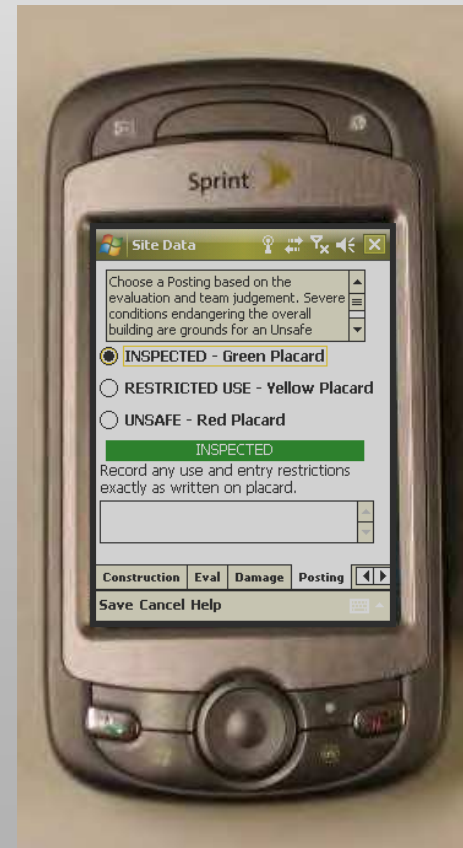
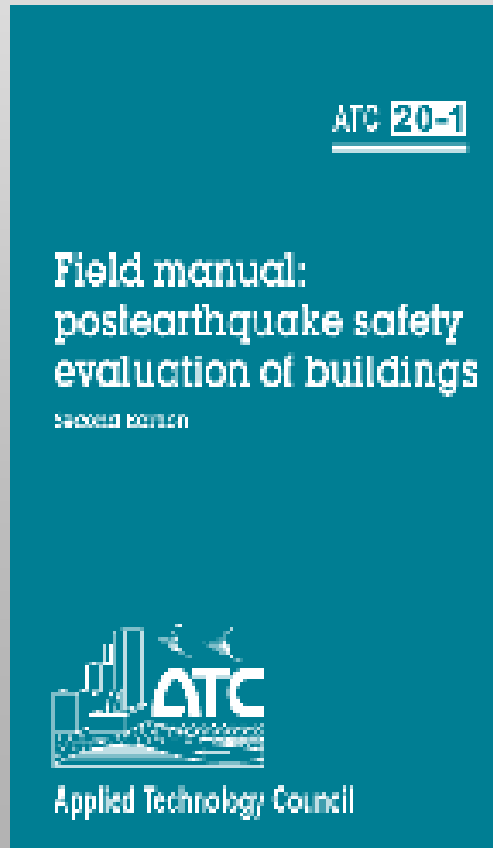
- Free USGS software polls NEIC server
- When earthquake occurs, ShakeCast estimates damage states, makes a map or likely red, yellow, and green tags
- Pushes likely damage state to user(s)

The screenshot displays the ShakeCast 2 administration interface. The left sidebar contains a navigation menu with the following items: Facility Admin, Management, Damage Level, Facility Type, **ROVER Import** (circled in red), Supplemental Attribute, Upload, Profile Admin, and Management. The main content area shows a map of California with a red star indicating the earthquake location near San Francisco. To the right of the map is a 'ShakeCast Summary' section with a progress bar showing 4 out of 9 facilities evaluated. The summary includes the following data:

- Number of facilities evaluated: 9
- Peak Ground Acceleration (%g): 3.4233 - 53.0683
- Peak Ground Velocity (cm/sec): 2.6766 - 102.2641
- Instrumental Intensity: IV - IX
- Peak Spectral Acc. at 0.3 sec (%g): 6.1762 - 136.8812
- Peak Spectral Acc. at 1.0 sec (%g): 2.8273 - 108.0266
- Peak Spectral Acc. at 3.0 sec (%g): 1.6225 - 42.2883
- Estimated Vs30 in m/s: 151 - 724

The summary also indicates a magnitude of M 7.15 - SAF_SAP, with an origin time of 2009-09-22 06:00:00 and a location of -122.21, 37.367.

ROVER after the Earthquake



ATC-20 (1989, 1991, 1996)

ATC-20 Rapid Evaluation Safety Assessment Form

Inspection
 Inspector ID: _____ Inspection date and time: _____ AM PM
 Affiliation: _____ Areas inspected: Exterior only Exterior and interior

Building Description
 Building name: _____ Address: _____ Building contact/phone: _____
 Number of stories above ground: _____ below ground: _____
 Approx. "Footprint area" (square feet): _____
 Number of residential units: _____
 Number of residential units not habitable: _____

Type of Construction
 Wood frame Concrete shear wall
 Steel frame Unreinforced masonry
 Tilt-up concrete Reinforced masonry
 Concrete frame Other: _____

Primary Occupancy
 Dwelling Commercial Government
 Other residential Offices Historic
 Public assembly Industrial School
 Emergency services Other: _____

Evaluation
 Investigate the building for the conditions below and check the appropriate column.
 Observed Conditions: Minor/None Moderate Severe Estimated Building Damage (excluding contents)
 Collapse, partial collapse, or building off foundation None
 Building or story leaning 0-1%
 Racking 1-10%
 Chimney
 Ground s
 Other (sp
 Comments: _____

Posting
 Choose a grounds for Post INSP
 INSPE
 Record an

Further
 Baric
 Detail
 Other
 Comments: _____

UNSAFE
 DO NOT ENTER OR OCCUPY
 (THIS PLACARD IS NOT A DEMOLITION ORDER)
 This structure has been inspected, found to be seriously damaged and is unsafe for occupancy as indicated below.
 Date: _____
 Time: _____
 This facility was inspected under emergency conditions for _____

 Inspector ID / Agency: _____
 Facility Name and Address: _____

 Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority

- Applied Technology Council, 1996. *ATC-20: Procedures for Postearthquake Safety Evaluation of Buildings*. Redwood City, CA, 144 pp.
- De facto international standard post-earthquake safety inspection
- Used 100,000s of times
- Red/yellow/green tag

ROVER's ATC-20 module

Site Data

Building Name
University of Memphis Holiday Inn

Address
3700 Central Ave

City Memphis **State** TN **Zip** 38111

Building Contact **Phone**

Other Identifiers

Address Building Inspection Occupancy

Save Cancel Help

Site Data

Stories Above Ground: 4

Stories Below Ground: 0

Num Residential Units: 100

Num Residential Units not habitable: 0

Footprint area (sq ft): 183600

Calculator

Address Building Inspection Occupancy

Save Cancel Help

Site Data

Standing at Building Now

Inspection Date and Time:
2010-02-08 02:16:04

Inspection Location:
Lat: 35.12374 Lon: -89.93813

Inspected Exterior Only
 Inspected Exterior and Interior

Address Building Inspection Occupancy

Save Cancel Help

Site Data

School Industrial
 Offices Public Assembly
 Commercial Emer. Services
 Dwelling Government
 Historic Other Residential

Other:

Building Inspection Occupancy Cons

Save Cancel Help

Site Data

Type of Construction:

Wood Frame
 Steel Frame
 Tilt Up Concrete
 Concrete Frame
 Concrete Shear Wall
 Unreinforced Masonry
 Reinforced Masonry

Other:

Inspection Occupancy Construction

Save Cancel Help

Site Data

Observed Conditions

Collapse, partial collapse, or building off foundation: Minor/None

Building or story leaning: Minor/None

Racking damage to walls, other structural damage: Minor/None

Chimney, parapet, or other falling hazard: Minor/None

Ground slope movement or cracking: Minor/None

Other (specify):

Occupancy Construction Eval Damage

Save Cancel Help

Site Data

Camera Browse Clear Rotate All None

UofM Holiday Inn NW facades



Posting Actions Comments Photo

Save Cancel Help

Site Data

Choose a Posting based on the evaluation and team judgement. Severe conditions endangering the overall building are grounds for an Unsafe

INSPECTED - Green Placard
 RESTRICTED USE - Yellow Placard
 UNSAFE - Red Placard

INSPECTED

Record any use and entry restrictions exactly as written on placard.

Construction Eval Damage Posting

Save Cancel Help

Kyoto
Denv
Berke
Coper
sparis

Summary: End-to-End Building Data Tool

ROVER

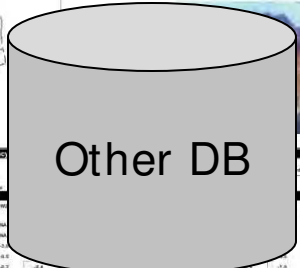
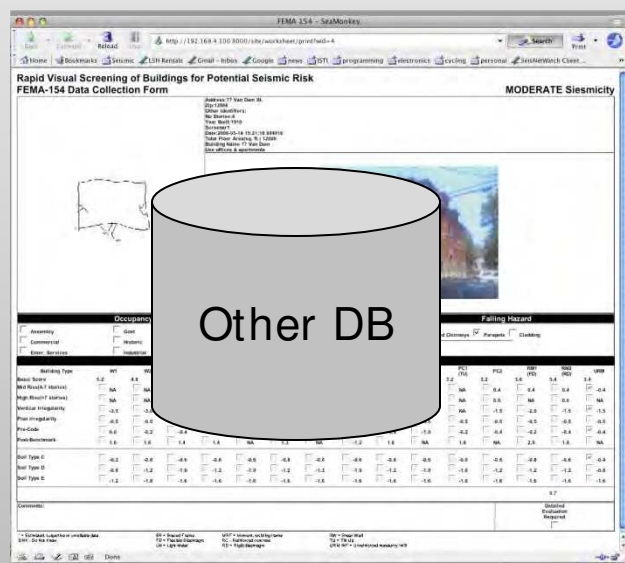
(FEMA 154)

ROVER Server

ShakeCast & HAZUS

ROVER

(ATC-20)



RedROVER



Pre-earthquake

Post-earthquake

Key Features, Key Limitations

Key features

- Free, open-source s/w for FEMA 154, ATC-20
- ShakeCast & HAZUS integration
- Use FEMA 154 data for post-earthquake ATC-20
- Web access to server allows remote assistance
- *Looking for new users*

Key limitations

- No thin client, Android, iPhone, or Blackberry client
- External GPS device
- Earthquake only
- *Looking for co-developers*

Development team:

Mike Tong & Cathleen Carlisle, [FEMA](#) Mitigation Directorate Program Officers

Tom McLane, [Applied Technology Council](#) project manager

Keith Porter, [SPA Risk LLC](#), technical lead

Sid Hellman & colleagues, [ISTI](#), software developer

David Wald & Kuo-Wan Lin, [USGS](#) ShakeCast developers

Stuart Moffatt, [George Washington University](#)

ATC-67 Project Review Panel (Bell, Holmes, Morelli, Pereira, Reavely, Scawthorn, Wang, Welliver)

Further information:

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