Seismic Hazard and Policy in the Central U.S.

James C. Cobb,
State Geologist and Director
Kentucky Geological Survey
University of Kentucky

ACEHR Meeting
November 9, 2010
Memphis, TN
Problems caused by high seismic hazard assessment and policy

- Kentucky has lost more than $1 billion in lost industrial development (PACRO, 2010)

- Permit for a landfill for clean-up and closure of the Super-fund site at the Paducah Gaseous Diffusion Plant has been delayed for more than 10 years (KEEC, 2010)

- Professional services (geo-tech and structural engineers) will be required for construction of single-family house in western KY (SEAOK, 2002)
KGS Efforts Chronology

• Hosted a workshop on the NEHRP hazard and design maps in November 2002 in Lexington, KY

• Made a presentation to the SESAC in June 2004 in Memphis, TN

• Met and discussed with USGS staff the national hazard maps in 2004, 05, 06, 07, 08, 09 and as recently as last week in Denver

• Made a presentation at the hazard mapping workshop in May 2006 in Boston, MA

• Wrote a letter to ACEHR in October 2007
NEHRP Design Map 0.2 sec Spectral Response Acceleration for the U.S. (2% PE in 50 yrs., NEHRP)
California

Two times gravity

San Francisco

Central U.S.

Four times gravity

Memphis

0.2 sec Spectral Response Acceleration

Kentucky Geological Survey
NEHRP Design Map 1.0 sec Spectral Response Acceleration for the U.S. (2% PE in 50 yrs., NEHRP)
Two times gravity

One times gravity

California

Central U.S.

San Francisco

Memphis

Paducah

1.0 sec Spectral Response Acceleration
Rebuilding after 2008 8.0M Wenchuan earthquake near Longnam, Gansu Province, China
Mitigation (engineering design) makes a big difference

- Complete collapse
- No damage with seismic design: 0.2g PGA
- Some damage with seismic design: 0.15g PGA
- No damage
Actual record 2008 Wenchuan earthquake (M8.0, 0.2s PSA g)

NEHRP Design map with 0.2 sec PSA (%g, with 2% PE in 50 years)

Visit in June

(2009 NEHRP Provisions)

(Xie and others, 2010)
Actual record 2008 Wenchuan earthquake (M8.0, 1.0s PSA g)

NEHRP Design map with 1.0 sec PSA (%g, with 2% PE in 50 years)

(2009 NEHRP Provisions)

(Xie and others, 2010)
Development of *Design Ground Motion Policy*

**Science**
- Seismic Hazard Map (USGS)
- BSSC – engineers, seismologists, and others

**Policy**
- Seismic *Design Ground Motions* (FEMA)
- Federal agencies
- State Agencies
- Other organizations

Kentucky Geological Survey
USGS 7-Day Seismicity in the U.S.

Fri Oct 29 18:51:35 UTC 2010
875 earthquakes on these maps

http://earthquake.usgs.gov/earthquakes/recenteqsus/
Figure 9. Composite DYFI? map of the U.S. (1988–2007) showing the maximum credible intensity reported by the public for each zip code for which there is reported felt information. To date, there are more than one million DYFI? entries for the U.S.
GPS results

California

Deformation rate: > 30 mm/y

Central U.S.

Deformation rate: < 3 mm/y
Active Plate Tectonics

Deformation rate: $> 30\ mm/y$

Intra-Plate tectonics

Deformation rate: $< 3\ mm/y$
National Seismic Hazard map for Central U.S. - PGA with 2% PE in 50 years

China - Wenchuan earthquake Actual (M8.0) PGA map

Red area: 0.40 – 0.80g

(Peterson and others, 2008)
National Seismic Hazard map for Central U.S. - PGA with 2% PE in 50 years

PGA inferred from liquefaction for M7.7 NM earthquake

(Peterson and others, 2008)

(Holzer and others, 2010)
The National Seismic Hazard Maps

Inputs

Scientific data

Modeling (computer)

PSHA

Outputs

Hazard curves

HAZARD CURVES FOR SELECTED CITIES

(Frankel et al., 1996)
PSHA End Results: Seismic Hazard Curves

HAZARD CURVES FOR SELECTED CITIES

(Frankel et al., 1996)

Hazard curves

Hazard maps
PSHA produces infinite ground motions at a site from a single earthquake. NO, not possible.
One earthquake can only generate one ground motion at a site

M7.7 with recurrence time of 500 years

PSHA does not pass a simple sensitivity test
Development of Design Ground Motion Policy

Seismic Hazard Map (USGS)

BSSC – engineers, seismologists, and others

Seismic Design Ground Motions (FEMA)

Federal agencies
State Agencies
Other organizations

Science

Policy

Kentucky Geological Survey
http://www.uky.edu/KGS/geologichazards/equake3.htm
The Central U.S. Seismic Observatory
Alternative methods deterministic/scenario based

(Wang, 2010)

.2 sec response acceleration
Conclusions

• By comparisons and sensitivity test the Central U.S. seismic hazard is too high. The USGS National Seismic Hazard Maps portray the Central U.S. as a worst case.

• Comparisons to real-world-worst-cases such as Wenchuan China shows the NMSZ still twice as dangerous – this is not reasonable.

• Kentucky should not be placed in a hazard category twice as dangerous as California or China – not reasonable!

• The scientific inputs to the NEHRP Provisions for the Central U.S. are not consistent with observations.
• There must be changes to the NEHRP maps. Kentucky has been and is being harmed by the NEHRP maps.
Thank You