

EARTHQUAKE HAZARDS IN THE MIDWEST

INTRODUCTION

This Engineering UPDATE was published on the importance of improving the awareness of the presence of earthquake potential in the Midwest. The article was inspired by a recently conducted field inspection by MEA staff, along with the St. Louis Chapter of the Association of Environmental & Engineering Geologists. The location inspected was the New Madrid Seismic Zone in areas of Illinois, Missouri, Kentucky, and Tennessee which were affected by the 1811-1812, New Madrid earthquakes.

In this Engineering UPDATE, the New Madrid Seismic Zone and neighboring fault systems will be introduced. Also included is a brief primer on historical earthquakes in the Midwest and solutions for reducing the likelihood of infrastructure damage before and after earthquakes.

SEISMIC ZONES IN THE CENTRAL-EAST US

Seismic zones are geological systems containing subsurface faults and fractures in the earth's crust. The movement of faults in the earth's mantle is due to abrupt shifts between the earth's plates. These plates (or more solid mantle areas) lock up until they break loose due to sufficient stress building. The resulting shaking of the ground has caused frequent historical earthquakes. As shown in Figure 1, the major seismic zones include New Madrid, Wabash Valley, and South-Central Illinois seismic zones. These seismic zones affect different Midwestern states including Missouri, Kentucky, Tennessee, Illinois, Indiana, Arkansas, and Mississippi. These seismic zones are still active and the hazard of earthquake occurrence is just as high in these zones as on the West Coast.

HISTORICAL EARTHQUAKES IN THE MIDWEST

The most severe earthquakes recorded in the Midwest in the past two centuries were a series of earthquakes which took place in the 19th century called the New Madrid 1811-1812 earthquakes, which were caused by the tectonic activities in the New Madrid Seismic Zone. The magnitudes of the major incidents were up to 7.9 on the Richter Scale. Catastrophic damages and human losses occurred, especially in highly populated locations such as the City of St. Louis, Missouri. According to the U.S. Federal Emergency Management Agency, this series of earthquakes have been "the highest economic losses due to a natural disaster in the United States" (FEMA 2008). Imagine what could happen today.

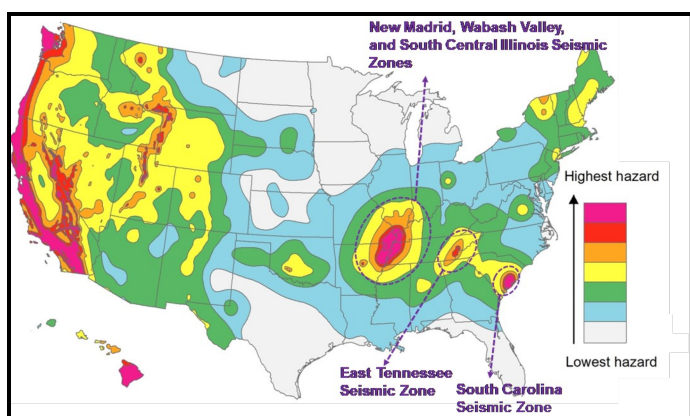


FIGURE 1 EARTHQUAKE HAZARD MAP OF THE U.S. AND MAJOR SEISMIC ZONES IN THE CENTRAL-EAST U.S. (AFTER USGS 2014)

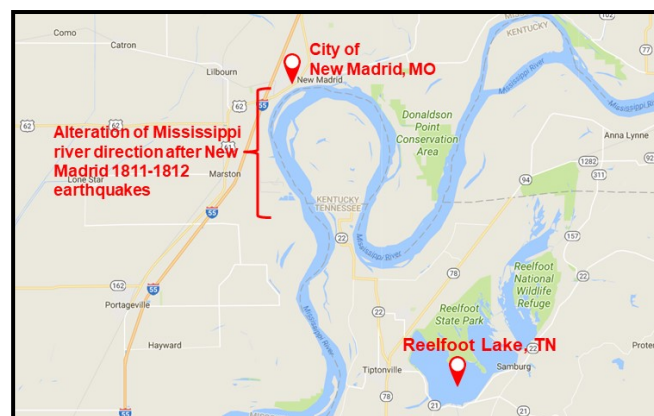


FIGURE 2 ALTERATION OF GEOLOGICAL FEATURES AFTER NEW MADRID 1811-1812 EARTHQUAKES (GOOGLE MAPS)

The New Madrid 1811-1812 earthquakes created a major geological and environmental effect in the region. One of the environmental alterations that occurred during these earthquakes was the formation of Reelfoot Lake located in the state of Tennessee and the change in the Mississippi River direction east of the city of New Madrid, Missouri. Figure 2 shows these geological phenomena (Note that due to historical nature of earthquake event, no clear map of features exists for the pre-New Madrid time period). Figure 3 shows a view of Reelfoot Lake, Tennessee which was formed after the earthquakes.

FUTURE EARTHQUAKES

According to current earthquake studies, the probability of an earthquake with the magnitude of 7.5 to 8.0 in the Midwest in the next 50 years is approximately 7% to 10%. An earthquake of this magnitude would be in the range of earthquakes that occurred in 1811 to 1812. Although Midwestern earthquakes are less frequent than West Coast earthquakes, such an earthquake in the Midwest will have considerably higher catastrophic failures and losses than on the West Coast. There are mainly three reasons why earthquakes in the Midwest are more disastrous:

1. Due to the geological characteristics, the damaged area in the Central-East Seismic Zones is much larger than the damaged area in the Western Seismic Zones for the same earthquake magnitude.
2. The infrastructure in the Midwestern states is much older than those in the West Coast. Many buildings in Midwestern cities are unreinforced masonries without any earthquake design or retrofitting plan because of the lack of attention. The earthquake design of even modern structures is very primitive. Building codes require very limited earthquake obligations by states and cities.
3. From a cultural viewpoint, many people in the Midwestern states are not aware of the potential hazard of prospective earthquakes. Insufficient education has been provided to the public about earthquake preparation and safety.



FIGURE 3 VIEW OF REELFOOT LAKE, TN
(PHOTO TAKEN BY MEA)

WHAT SHOULD WE DO TO BE PREPARED FOR AN EARTHQUAKE?

- The infrastructure should be modernized and mitigate against seismic hazards.
- Masonry and old buildings should be retrofitted against earthquakes.
- Rigorous designing and construction procedures should be developed to ensure new buildings and structures will be prepared for prospective earthquakes.
- Education and cultural awareness should be increased for Midwestern civilians with regard to earthquake hazards, and their responses during and after the occurrence of an earthquake.
- More research and investigations should be conducted by Midwestern institutes and universities regarding earthquake design criteria, seismology, and earthquake engineering.
- Earthquake monitoring systems such as seismographs should be modernized and used more frequently in the Midwestern region.

ACKNOWLEDGEMENT

MEA would like to acknowledge the efforts and supports of Association of Environmental & Engineering Geologists (AEG) St. Louis Chapter especially Ms. Phyllis Steckel for directing the Earthquake Insight Field Trip.

REFERENCES

FEMA. (2008). *FEMA report*. U.S. Federal Emergency Management Agency.
USGS. (2014). *Earthquake Hazard Map of the US*. United States Geological Survey.

Other MEA Publications that may be of Interest:

[UPDATE # 5: Response of House Foundations During the Loma Prieta Earthquake](#)

[UPDATE #8: Geotechnical Investigation of Building Damage](#)

[Earthquake Damage: Inspection, Evaluation, and Repair](#)

ABOUT MEA: Marino Engineering Associates, Inc. focuses on engineering research, practice and expert evaluations and is licensed in 25 states in the U.S. Our projects primarily have an emphasis on Geotechnical Engineering, however, we also have significant experience in projects involving transportation, subsidence engineering, laboratory testing, training, and geophysical exploration. Gennaro G. Marino, Ph.D., P.E., D.GE is president and principal engineer of Marino Engineering Associates, Inc., and has been a licensed professional engineer since 1984. To obtain additional information on MEA, one can also visit our website at www.meacorporation.com.

FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact MEA at the address listed below.

All material in this Engineering UPDATE © 2018 Marino Engineering Associates, Inc. All Rights Reserved.



MARINO ENGINEERING ASSOCIATES, INC.

1370 MCCAUSLAND AVENUE, ST. LOUIS, MISSOURI 63117
PH: 314.833.3189 FAX: 314.833.3448
<http://www.meacorporation.com>