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Earthquake risk assessment of Mississippi State University

Inoka Peiris

EARTHQUAKE RISK ASSESSMENT OF MISSISSIPPI STATE UNIVERSITY

By

Inoka Peiris

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By

Inoka Peiris

Approved:

Darrel Schmitz
Professor of Geology
Head of Department of Geosciences
Committee Chair

James May
Adjunct Professor of Geology
Department of Geosciences
Committee Member

Charles Wax
Professor of Geography
Department of Geosciences
Committee Member

Christopher Dewey
Associate Professor of Geology
Department of Geosciences
Graduate Coordinator

Gary Myers
Dean of Arts and Sciences

Name: Inoka Peiris

Date of Degree: August 7, 2010

Institution: Mississippi State University

Major Field: Geosciences

Major Professor: Dr. Darrel Schmitz

Title of Study: EARTHQUAKE RISK ASSESSMENT OF MISSISSIPPI STATE UNIVERSITY

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Candidate for Degree of Master of Science

Mississippi State University is one of the many public institutions in Mississippi located near a seismic hazard zone known as the New Madrid Seismic Zone (NMSZ). Previous studies reveal the possibility of damage to the campus during an earthquake is in the order of ten percent. Risk assessment for building structures on campus was carried out using HAZUS-MH MR3 software package, for several earthquake scenarios defined to replicate historic and hypothetical earthquake events.

The study predicts peak ground accelerations of 0.09g to 0.2g relating to 0.67% to 4.28% building loss ratios respectively, which amounts to a loss of $8.2 million to $53 million. Wood and reinforced masonry buildings show significant resistance to earthquakes compared to concrete and unreinforced masonry buildings. The results of this study suggest that there is a considerable seismic risk to Mississippi State University buildings from a seismic event originating in NMSZ.

DEDICATION

To my loving husband, family, friends.

ACKNOWLEDGEMENTS

I would like to expresses my sincere gratitude to all who helped me in the completion of this research. Especially to Dr. Darrel Schmitz, my supervisor, for his continuous support and guidance. I also would like to thank Dr. May, Dr. Wax, Dr. Dewey and all other faculty members of Department of Geosciences.

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CHAPTER I

INTRODUCTION

Catastrophic natural disasters that could impact the United States include a significant earthquake in Los Angeles, California, a category V hurricane in Miami, Florida, and a magnitude 7.7 earthquake in the New Madrid Seismic Zone (Elnashai et. al., 2008). The state of Mississippi is considered as a one of the states that has the potential to experience the impact due to earthquake activity in the New Madrid Seismic Zone (NMSZ). States Alabama, Arkansas, Illinois, Indiana, Kentucky, Missouri and Tennessee will also experience damage from an earthquake in NMSZ.

An earthquake is a sudden release of energy or strain that has accumulated over a long time period. Earthquake activity may cause noticeable surface motion or very small subsurface movement. The State of Mississippi has experienced earthquake activities in the past (United States Geological Survey). Observable surface motion in Mississippi is mostly attributed to activity generated from the New Madrid fault zone (Figure1), which lies within the central Mississippi valley; extending from northeast Arkansas through southeast Missouri, western Tennessee, western Kentucky to southern Illinois. Historically, this area has been the site for some of the largest earthquakes in North America. Between 1811 and 1812, four catastrophic earthquakes with magnitude estimates greater than 7.0 occurred during a three month period. The earthquake which occurred on December 16, 1811 at Marked Tree, Arkansas, had an intensity of about VII

Figure 1 Location of the New Madrid fault zone and the Mississippi State University (After Snodgrass, 1998).

which is equivalent to a magnitude 6.0 impact on Mississippi State University, as indicated by the modified Mercalli scale intensity map (Figure 2). Instruments were installed in 1974 to monitor seismic activities of the NMSZ. Since then more than 4000 earthquakes, most of which are too small to be felt have been recorded.

Analysis of seismological and geophysical data around NMSZ, gathered after 1974 show that there is a relationship between earthquake locations and distinct geophysical anomalies (Braile et al., 1997). Through the analysis of data, scientists suggest that the seismicity of the NMSZ is associated with a reactivated ancient, buried rift. Reactivation of the buried rift occurred due to nearly east-west compressional plate-tectonic-generated stresses (Zoback et al., 1980, Braile et al., 1997).

The probability for an earthquake of magnitude 6.0 or greater to occur in the NMSZ is significant in the near future. Prior research assumes that strong earthquakes will occur along the New Madrid seismic zone within this generation as well as within the lifetimes of presently existing structures (Olshansky, 1994). Although calculations of probabilities of earthquake recurrence of NMSZ (Table1) suggest that a major seismic event will occur in near future in New Madrid seismic zone, it has been recently estimated that the odds of another earthquake of magnitude 8.0 or greater taking place in the next fifty years is between 7-10 percent (Smalley Jr. et al., 2005). An earthquake with a magnitude equal to that of those which occurred in the 1811 – 1812 events could result in much great economic loss than was previously incurred at the beginning of the nineteenth century.

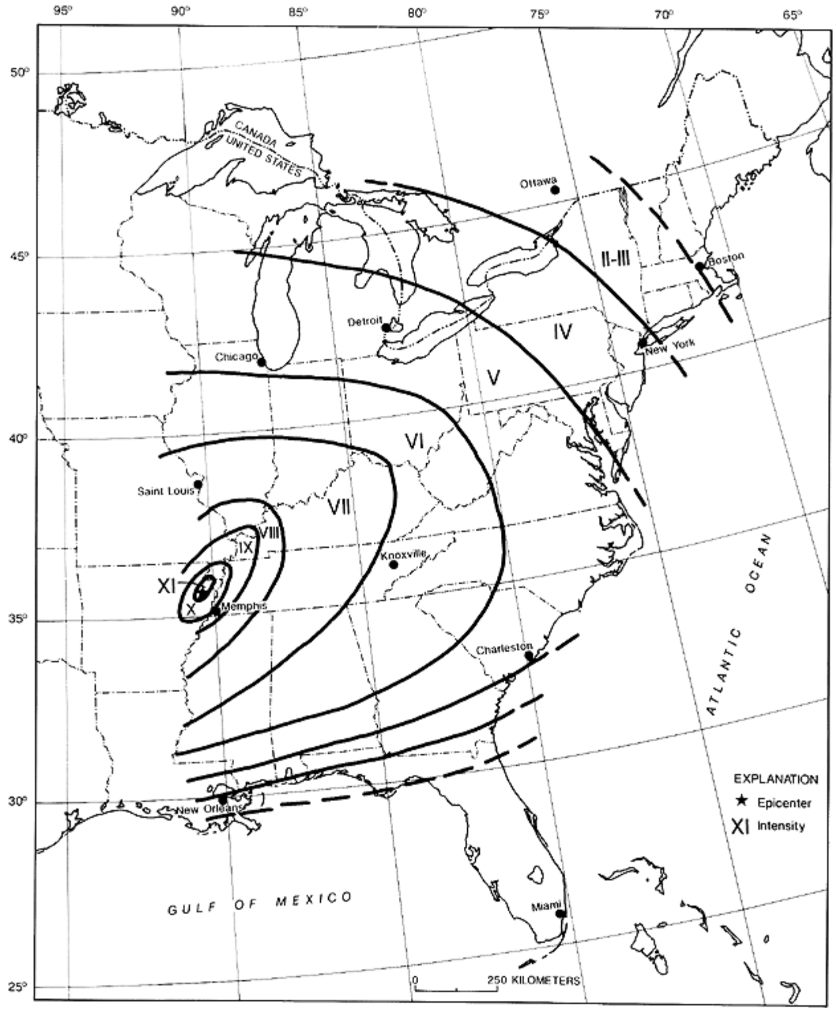

Figure 2 Isoseismal map for the Arkansas earthquake of December 16, 1811 (After Stover and Coffman, 1992).

Table 1 Probabilities for earthquake activity recurrence of New Madrid Seismic Zone (After Hopper, 1985).

Magnitude	Modified Mercalli Intensities at Mississippi State University	Approximate Probability in 15 years (%)	Approximate Probability in 50 years (%)
6.7	Vi – V	40 -60	86 -97
7.6	Vii - Vi	5.4 – 8.7	19 – 29
8.6	Viii - Vii	0.3 – 1.0	2.7 – 4.0

Mississippi State University is located approximately 250 kilometers (400 miles) southeast of the New Madrid fault zone. Although previous studies indicate possible damage in the order of 10 percent to Mississippi State University, the effects of an earthquake upon its structures have not yet been fully investigated.

The study area, is located southeast of the city of Starkville in Oktibbeha County, latitudes 33^0 27^0 30^0N and longitudes 88^0 47^0 30^0W. As of fall 2008, MSU is the largest university in the state of Mississippi. It is also the largest employer in Starkville and dominates the city economy.

Considering the location of Mississippi State University (relative to the New Madrid seismic Zone) and the probability of earthquakes in the area, it is clear that there could be a possibility of the University being damaged by an earthquake within the near future. The earthquake risk assessment process will help to understand the risk and the possible effect on building structures from an earthquake. HAZUS- MH MR3 (HAZUS) is a Geographical Information System (GIS) based loss estimation software that estimates damage from earthquakes, hurricanes, and floods. HAZUS can be used to simulate user defined, historic, or probabilistic earthquake events to calculate ground motion parameters such as spectral acceleration, spectral displacement, peak ground acceleration, peak ground velocity. It can then estimate physical damages, economic losses and social impact from the specified earthquake event.

Geology at Mississippi State University

Mississippi State University is located within the Mississippi Embayment, which is a northward extension of the Gulf of Mexico coastal plain. The Mississippi Embayment is a southwestward-plunging geosyncline that contains late Cretaceous and Cenozoic sediments (Figure 3). Mississippi State University is on the Upper Cretaceous age Prairie Bluff Chalk formation (Figure 4). The Prairie Bluff Formation is a transgressive blanket that consists of two types of chalk. The top nine meters (29 ft) of the formation consists of dense, deeply weathered, fossiliferous, gluconitic clay, and the lower part consists of highly fossiliferous, gluconitic, sandy chalk (Figure 5). The Prairie Bluff Formation rests on top of the Ripley Formation. Excavations at Mississippi State University expose marls and chalk from the Ripley and the Prairie Bluff formations respectively (Russell et al., 1983).

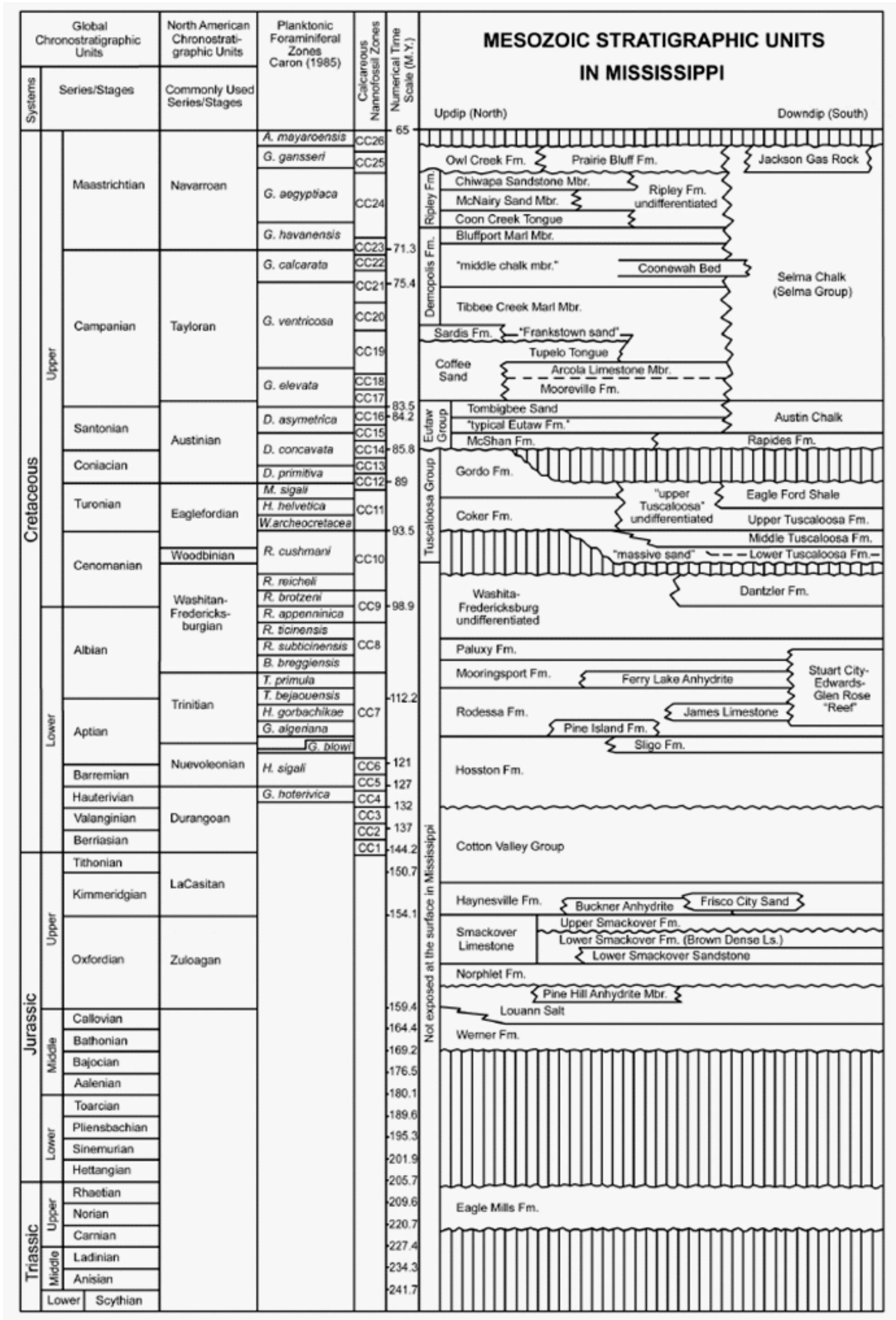

Figure 3 Mesozoic stratigraphic section of Mississippi (After Dockery, 2008).

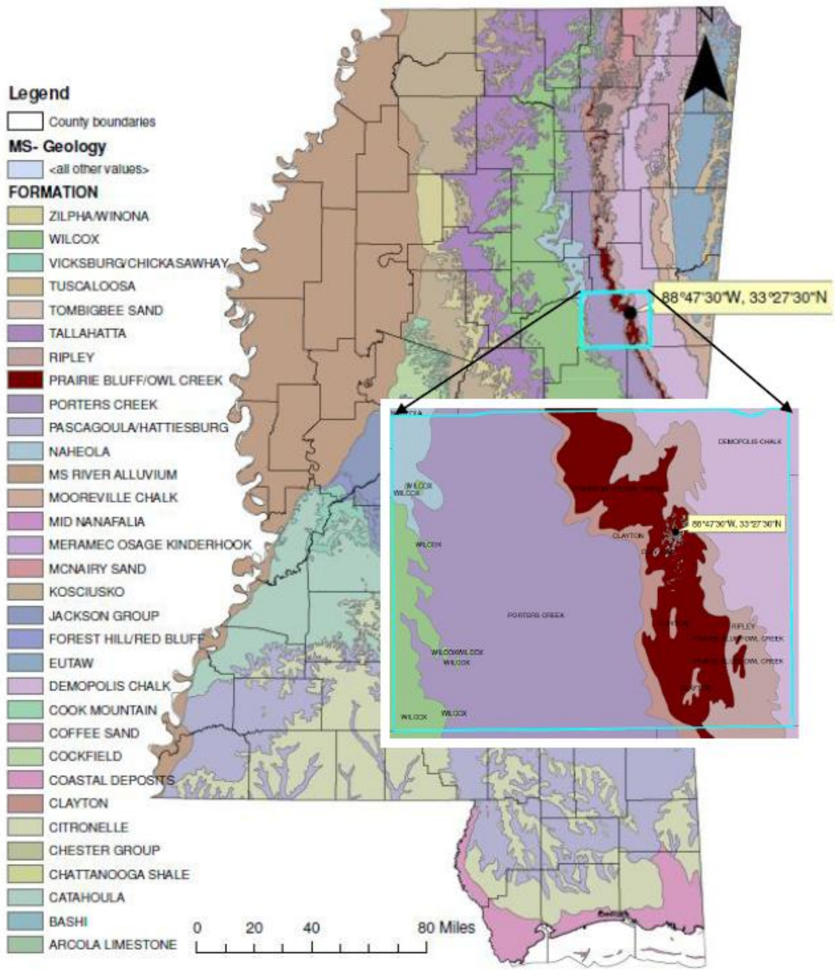

Figure 4 Geologic map of Mississippi and the location of Mississippi State University in the Oktibbeha County (Digital data for the image is from Mississippi Automated Resource Information System (MARIS)).

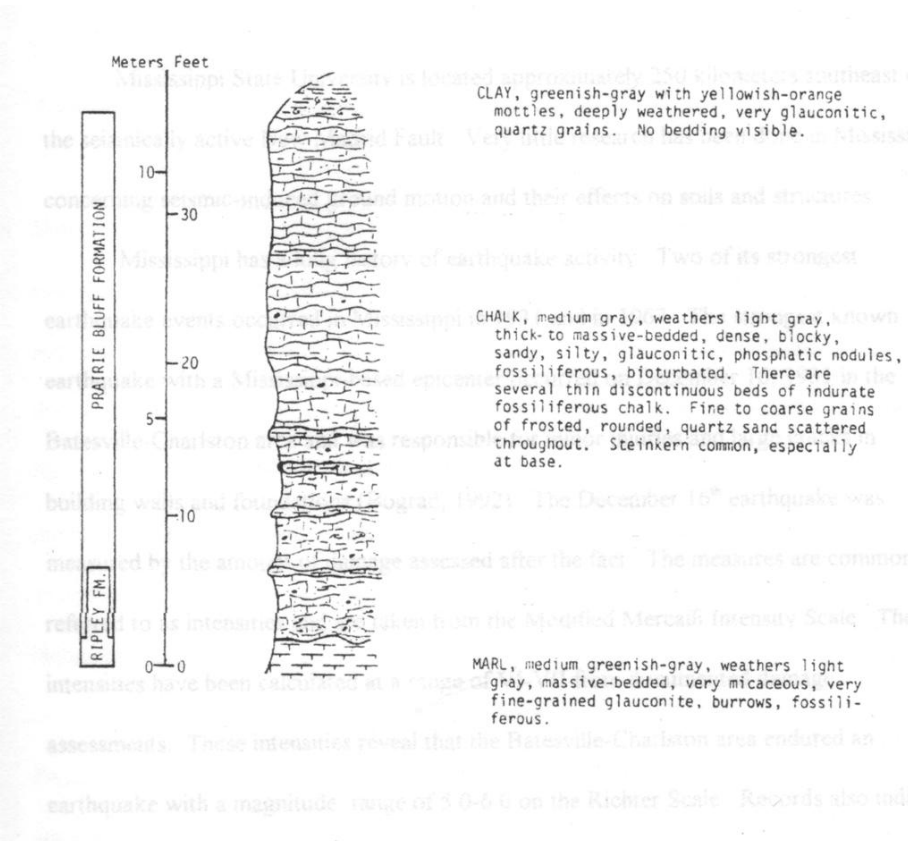

Figure 5 Geologic column in parking lot behind Mckee dormitory on the east side of Mississippi State University (After Russell et al., 1983).

Earthquake site analysis of Mississippi State University (Snodgrass, 1998) confirms the bedrock of the MSU area is Cretaceous chalk of the Prairie Bluff Formation with an average shear wave velocity of 785 meters/sec (2575ft/sec). The research also suggests a spectral peak ground acceleration range of 0.57g to a 0.65g generated from 6.2 and a 8.25 magnitude earthquake events at an epicentral distance of approximately 250 kilometers (400 miles).

CHAPTER II

LITERATURE REVIEW

Earthquakes

An earthquake is a sudden shaking of the earth. Earthquakes occur due to release of elastic strain energy that is accumulated beneath the surface of the earth due to plate movement (Murty, 2005). Energy released in an earthquake spreads out as seismic waves that travel through and along the surface of the earth causing damage to structures built on it.

Depending on the location of the earthquake on the tectonic plates, earthquakes can be broadly divided into two categories. Namely inter-plate earthquakes and intra-plate earthquakes. The inter-plate earthquakes occur along the boundaries of the tectonic plates whereas intra-plate earthquakes occur within the plate and/or away from the plate boundaries.

Measurement of earthquake magnitude and intensity

Quantitative measure of the amount of energy released during an earthquake at the source is known as the magnitude of an earthquake. Magnitudes of earthquakes are estimated based on instrumental observations and are not based on the effects of earthquake to structures. Richter scale is a commonly used magnitude scale in earthquake studies.

Qualitative measure of actual ground shaking at a location during an earthquake is known as the intensity of the earthquake. Modified Mercalli Intensity (MMI) is a commonly used intensity scale in earthquake studies. Intensity, records only observations of effects due to an earthquake and help to understand the extent of the affected area.

An earthquake with a specific magnitude will produce different intensities at different places depending on many factors like geology and distance from the epicenter. The relationship between earthquake magnitude, MMI and effects produced by different values is shown in Table 2.

Table 2 The relationship between earthquake magnitude and MMI (Source: Missouri department of natural resources)

EQ Magnitude	MMI Value	Summary Damage Description Used on Maps	Full Description
1.0-3.0	I		Not felt. Marginal and long period effects of large earthquakes.
3.0-3.9	II		Felt by persons at rest, on upper floors, or favorably placed.
	III		Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
4.0-4.9	IV		Hanging objects swing. Vibration like passing of heavy trucks;
	V	Pictures Move	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.
5.0-5.9	VI	Objects Fall	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
	VII	Non-Structural Damage	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).
6.0-6.9	VIII	Moderate Damage	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
	IX	Heavy Damage	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
7.0 and greater	X	Extreme Damage	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
	XI		Rails bent greatly. Underground pipelines completely out of service.
	XII		Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.
Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.
Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.
Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Seismic Hazard and Seismic Risk

The probability of occurrence of a potentially damaging phenomenon is known as a hazard. The term "seismic hazard" describes the potential for occurrence of an earthquake related natural phenomena such as ground shaking and liquefaction (Reiter, 1990). Results of a seismic hazard analysis include ground motion parameters such as peak ground acceleration and peak ground velocity.

Seismic risk is the probability of occurrence of seismic hazard related consequences such as damage to infrastructures and loss of life (Reiter, 1990). Results of a seismic risk assessment include probability of damage and probability of fatalities. In order to assess the seismic risk of an area the seismic hazard of the area must first be assessed.

Effects of Earthquakes on Buildings

The primary effect to a building or infrastructure during an earthquake is shaking. Generally building structures have the ability to withstand vertical forces to some extent, but building structures are not generally built to take lateral forces which occur during an earthquake (Stewart, 1994). Structural characteristics like natural period, damping, ductility, stiffness, drift, and building configuration play very important roles in how a building behaves during an earthquake.

The damage due to an earthquake differs from building to building. Some of the parameters that control the degree of damage due to an earthquake to a structure include the building structural type, age of the building, building configuration, construction materials, site condition and non structural elements of the structure. Damage to a building can be structural or nonstructural (FEMA 154). Damage to a building's structural support system (building frames and walls) causes structural damage where as damage to non-structural elements such as ceilings and windows are called non-structural damage.

Different types of buildings

Damage to a building due to an earthquake largely depends on the construction material and the technique used. Depending on the construction material, buildings can be divided in to several categories. Different types of construction material include wood, masonry, concrete, steel, brick or a combination of more than one of these materials.

Buildings constructed using wood

Buildings constructed using wood (Figure 6) usually performs well during an earthquake due to light weight, low rise and structural system used (FEMA 154). Lack of connection between the foundation and superstructures causes the most damage to this type of buildings.

Figure 6 Example for a building constructed using wood - Computer Based Testing Center at MSU

Buildings constructed using masonry

Masonry buildings (Figure 7) can be reinforced masonry or unreinforced masonry depending on the material used. Reinforced buildings can perform well in moderate earthquakes, but unreinforced buildings perform poorly during an earthquake (FEMA 154).

Figure 7 Example for a building constructed using masonry - The Lee Hall at MSU

Buildings constructed using concrete

Buildings constructed using concrete (Figure 8) can have concrete moment resisting frames, concrete shear walls, concrete frames with unreinforced masonry infill walls etc. (FEMA 154). Performance of this type of buildings during an earthquake can vary widely.

Buildings constructed using steel

Buildings constructed using steel (Figure 9) can have steel moment resisting frames, braced steel frames, steel frames with cast-in place concrete shear walls, etc.. Damages to this type of buildings include broken connections between the beams and columns, and shear cracking (FEMA 154).

Figure 8 Example for a building constructed using concrete - Allen Hall at MSU

Figure 9 Example for a building constructed using steel – New Construction near Coliseum at MSU

Terminology

Peak ground acceleration (PGA)

PGA is the maximum level of vertical or horizontal ground acceleration caused by an earthquake. The rate of change in motion of the earth's surface is expresses as a percent of the acceleration due to gravity (9.8 m/sec^2 or 32.15 ft/sec^2). The approximate relationship between MMI and PGA is illustrated in Table3.

Table 3 Approximate relationship between MMI and PGA

MMI	Acceleration (%g) (PGA)	Perceived shaking	Potential Damage
I	<.17	Not Felt	None
II,III	.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 - 18	Strong	Light
VII	18 - 34	Very Strong	Moderate
VIII	34 - 65	Severe	Moderate to Heavy
IX	65 - 124	Violent	Heavy
X, XI, XII	>124	Extreme	Very Heavy

Spectral acceleration

The spectral acceleration is what is experienced by a building during an earthquake as modeled by a particle on a massless vertical rod having the same natural period of vibration as the building. Spectral acceleration can be used as a better indicator of damage to specific buildings types and heights.

Damage state probabilities

The probability of occurrence of specific damage to a target is expressed as a percentage or as a decimal.

Capacity curve

A capacity curve (Figure 10) is a plot of a building's lateral load resistance as a function of a characteristic lateral displacement which is used to model the strength of the building.

Yield capacity represents the true lateral strength of the building. Ultimate capacity implicitly accounts for loss of strength due to shear failure of brittle elements.

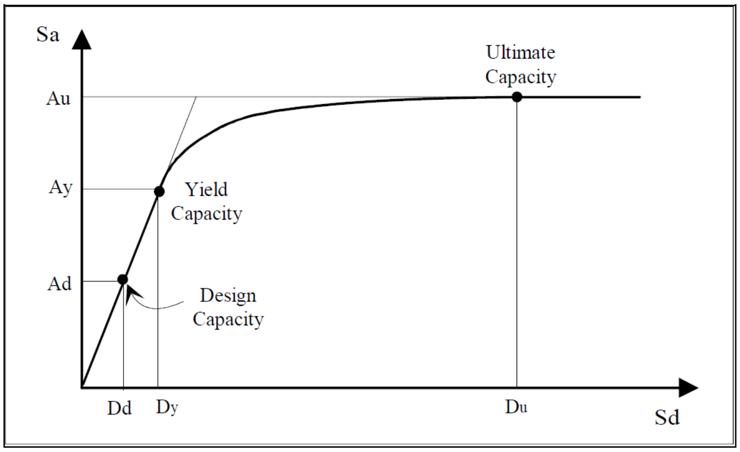

Figure 10 Example for a building capacity curve where Sd represents the spectral displacement and Sa represents the spectral acceleration (From HAZUS Technical Manual)

Fragility curve

Fragility curve (Figure 11) describes the probability of being in a specific damage state as a function of the size of earthquake. Structural fragility curves model the structural behavior of the building when subject to ground shaking and express damage as a function of building displacement.

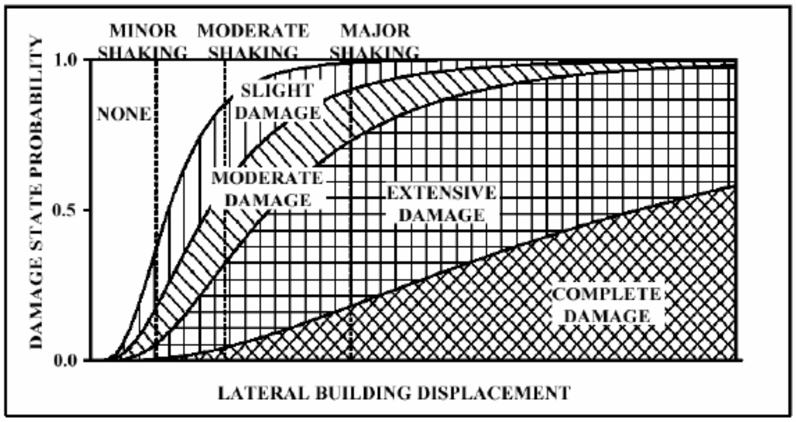

Figure 11 Example for a building fragility curve (From HAZUS Technical Manual)

Seismic Standards for Buildings

Recent earthquakes in the United States and throughout the world show that seismically designed buildings can reduce the damage from an earthquake. The earliest seismic design code in the United States is the Uniform Building Code (Building Seismic Safety Council, 1990) which was introduced in 1927 (Olshansky, 1993). The National Bureau of standards, the Applied Technology Council, the National Earthquake Hazard Reduction Program, the Building Seismic Safety council, and the National Institute of Standards and technology are some of the organizations that played important role in seismic designs of buildings beginning in mid 1970s. By 1990 the law required all new structures owned, leased regulated, or receiving assistance from the federal government to meet accepted seismic design standards.

As of 1993 the state of Mississippi does not have a state building code requirement (Olshansky, 1993), but some of the counties have adopted the standard building code (SBC). In 2006 the Mississippi building codes council adopted the 2003 International Building Code and 2003 International Residential Code for the state, but local jurisdictions have the power to enforce it and to decide on seismic provisions.

New Madrid Seismic Zone

The New Madrid seismic zone (NMSZ) is the most seismically active area in North America east of the Rocky Mountains (Tuttle and Schweig, 1995). The seismic zone is known as the source area of three to five great earthquakes that took place during 1811 and 1812 which are among the largest known intraplate earthquakes (Johnston and Kanter, 1990). The NMSZ is in the northern part of the Mississippi embayment, and spreads to southeastern Missouri, northeastern Arkansas, northwestern Tennessee, southeastern Kentucky, and southern Illinois (Figure 12). The Structure of the NMSZ is related to the Reelfoot rift (Johnston and Schweig, 1996). The Reelfoot rift was formed in the time period that spans from late Precambrian to early Cambrian (Braile et al., 1986). It is a result of a continental breakup and has been reactivated by compressional or tensional stresses related to plate tectonic interactions (Braile et al., 1986). Previous studies on the fault of NMSZ conclude that the fault of NMSZ is segmented (Hough and Martin, 2002) (Figure 13). The New Madrid fault system contains two types of faults, a strike slip segment oriented to the northeast, running from Marked Tree, Arkansas to Caruthersville, Missouri, and a northwest trending reverse fault that rests below the New Madrid region

The geologic record of the NMSZ reveals that it has produced major earthquakes over the past 4,500 years (Frankel et al., 2009). Sand blow deposits that are found buried within the Mississippi River valley are believed to be the by-products of large earthquakes that occurred in the past. These sand blows provide evidence for earthquakes occurring as far as A.D. 1450 and A.D. 900 (Frankel et al., 2009).

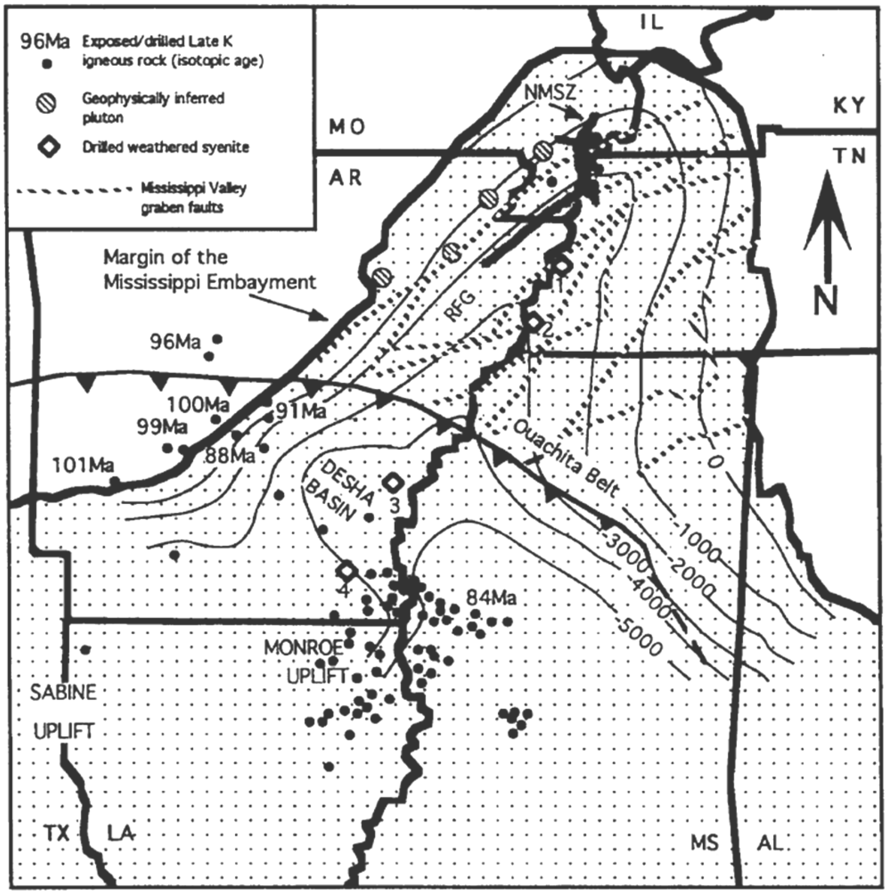

Figure 12 Location of NMSZ within Mississippi embayment (After Cox and Arsdale, 1997).

Contours are top of the Paleozoic section (in feet subsea) (after Cushing et al.,1964), faults related to the Mississippi Valley graben systems after Johnson et al.(1994), geophysically inferred late Mesozoic plutons after Hildenbrand et al.(1982), and exposed or drilled Late Cretaceous igneous rocks after Kidwell (1951) and Morris (1987); RFG, Reelfoot Graben

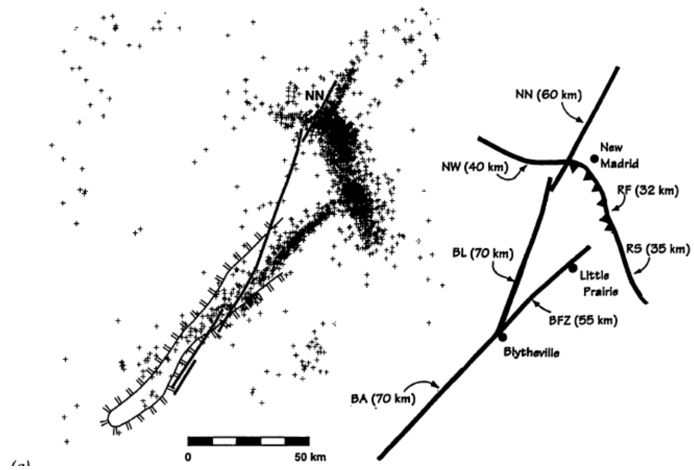

Figure 13 Fault segmentation of the NMSZ (After Johnston and Schweig (1996))

The seismic activities in the NMSZ include the New Madrid- Missouri earthquake sequence that occurred from 1811 to 1812 with a maximum magnitude of 8. The earthquakes of 1811-1812 began in the December of 1811 and continued into the spring of 1812, producing three principal shocks (Nutti, 1973, Hough et al., 2000). The three principal mainshocks occurred at approximately 02:15 local time on 16 December 1811; around 08:00 on 23 January 1812, and approximately 03:45 on 7 February 1812 (Hough and Martin, 2002). Two smaller earthquakes occurred in 1843 in Marked Tree, Arkansas (M=6.3), and in 1895 Charleston, Missouri (M=6.6) (Figure 14).

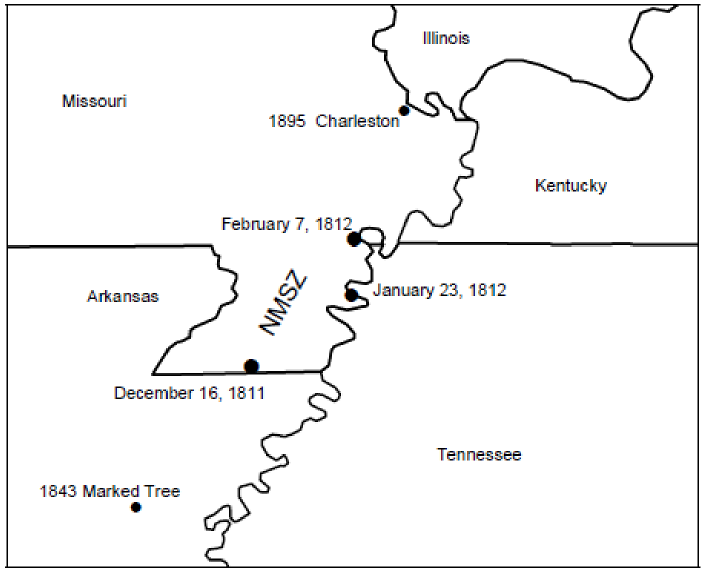

Figure 14 Approximate Locations of NMSZ Earthquakes with M≥6.0 since 1700 (After Kochkin and Crandell, 2003)

Although earthquake mainshocks are important for hazard assessment, the largest aftershocks are also very important. Some of the large aftershocks that occurred in the NMSZ were among the largest earthquakes that occurred in the central United States (Hough and Martin, 2002). Two of the largest aftershocks of 1811-1812 New Madrid earthquakes include the aftershock that occurred in the early hours of 16 December 1811and one in 17 December 1811(Hough and Martin, 2002). Approximately 7.0 and 6.1 magnitude values were assigned for these two aftershocks respectively.

Hough and Martin (2002) suggest an epicenter in the north central part of the Mississippi, well away from the southern end of the NMSZ for the second aftershock. According to Hough and Martin (2002) "Considering the aftershock and remotely triggered earthquake sequences generated by other large earthquakes" (e.g., Bodin and Gomberg, 1994; Hough, 2001; Meltzner and Wald, 2001), a large aftershock with a considerable magnitude can occur at this distance from its mainshock. "The hazards associated with future large New Madrid mainshocks therefore include, a significant additional hazard associated with large aftershocks that occur outside the New Madrid Seismic Zone" (Hough and Martin, 2002).

One school of thought regarding the NMSZ is that the zone is shutting down as shown by the Global Positioning System (GPS) readings. According to Newman (1999) Global Positioning System measurements across the New Madrid Seismic Zone show little or no motion within uncertainties, which is consistent with plate wide GPS data away from the NMSZ. Newman (1999) also suggests that "the hazard posed by great earthquake in the NMSZ appears to be overestimated".

The U.S. Geological Survey conducted a workshop in 2006, which brought together experts to evaluate the latest findings in earthquake hazards in the Eastern United States. Considering the geologic records, continuing seismic activity and the intraplate settings experts did not find the GPS data to be a convincing reason to lower the risk of earthquake in the NMSZ. According to the USGS "Earthquake Hazard in the New Madrid Seismic Zone Remains a Concern" and these short term observations made using GPS, though important, needs to consider in the context of tectonic processes developed over thousands to millions of years. The USGS also pointed out that the New Madrid region is located in the middle of the North American tectonic plate and in contrast to plate boundary settings where continuous deformation can be measured at the surface; the NMZS will experience little deformation, during the period between large earthquakes.

More than 3,000 earthquakes have occurred in the NMSZ since 1974 to 1996 (Johnston and Schweig, 1996). Different scientific communities use different techniques to calculate the return period of NMSZ earthquakes. The USGS and scientists at the

Center for Earthquake Research and Information (CERI) of the University of Memphis estimate the chance of having an earthquake similar to one of the 1811–1812 sequence in the next 50 years, is about 7 to 10 percent, and the chance of having a magnitude 6 or larger earthquake in the next 50 years is 25 to 40 percent. However, according to Hildenbrand et al. (1996), the chance of a magnitude 6 or 7 earthquake occurring within the next 50 years is roughly 90 percent.

Earthquake History of Mississippi

The state of Mississippi has experienced many shocks from earthquakes including those which occurred in neighboring states. Although the greatest risk to the state of Mississippi from earthquakes is from the NMSZ, number of small earthquakes have centered within the state of Mississippi (Table 4 and Figure 15).

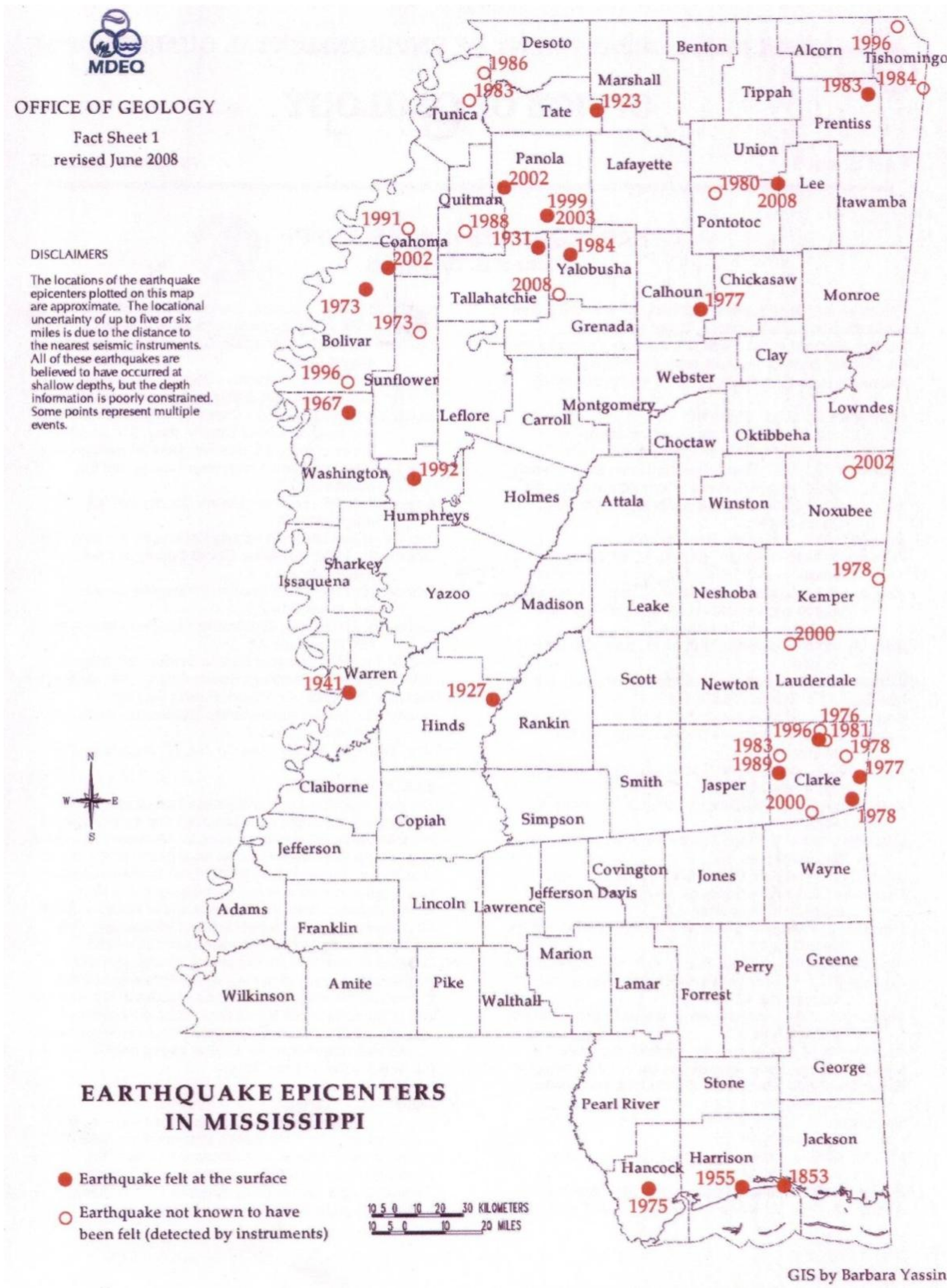

Figure 15 Earthquake epicenters in Mississippi (From Bograd, 2008).

Table 4 Earthquakes in Mississippi (After Bograd, 2008).

Date	Magnitude	Intensity	Location
09/11/1853			Biloxi
03/27/1923		IV	Wyatte, Tate County
11/13/1927		IV	Jackson
12/16/1931	4.7	VI-VII	Batesville-Charleston
06/04/1967	3.8	VI	Greenville
06/29/1967	3.4	V	Greenville
01/08/1973	3.5		Sunflower County
05/25/1973			Boliver County
09/09/1975	2.9	IV	Hancock County
10/23/1976	3.0		Northeren Clarke County
05/03/1977	3.6	V	Southeren Clarke County
11/04/1977	3.4	V	Vardaman,Calhoun County
01/08/1978	3.0		Kemper County
06/09/1978	3.3		Eastern Clarke County
11/10/1978	3.5	V	Southeastern Clarke County
10/12/1980	2.1		Northwestern Pontotoc Conty
02/15/1981	2.4		Clarke County
01/29/1983	2.4		Northeastern Prentiss County
02/05/1983	2.9	V	Northeastern Prentiss County
04/25/1983	1.6		Tunica County
05/30/1983	2.4		Western Clarke County
03/23/1984	2.0		Tishomingo County
09/24/1984	2.5		Northwestern Yalobusha County
05/11/1986	1.6		Northeastern Tunica County
08/01/1988	2.1		Quitman County
08/23/1989			Pachuta, Clarke County
08/25/1989			Pachuta Clarke County
11/26/1989			Pachuta Clarke County
02/11/1991	2.7		Clarksdale, Coahoma County
12/11/1992	2.4		Belzoni, Humphreys County
03/25/1996	3.5		Clarke County
05/13/1996	2.7		Northern Tishomingo County
08/11/1996	3.1		Southern Bolivar County
02/24/1999	2.8	IV	Southern Panola County
01/28/2000	2.7		Shubuta, Clarke County
10/10/2000	2.3		Northwestern Lauderdale County
01/06/2002	2.2		Near Brooksville, Noxubee County
08/11/2002	2.8		Western Panola County
10/26/2002	3.1		Northern Bolivar County
02/26/2003			Courtland, Panola County
01/20/2008	1.7		Southwestern Yalobusha County
05/10/2008	3.1		Belden , Lee County

According to the United States Geological Survey earthquake records the earliest and strongest earthquake reported within the state of Mississippi occurred on December

16, 1931, at about 9:36 p.m. at Charleston (intensity VI - VII). The shock was felt over a 168,349 square kilometers (65,000 square miles) area including the northern two-thirds of Mississippi and adjacent states (Hake, 1974).

Many people along an 18.75 kilometer (30 mile) strip of the Mississippi Gulf Coast strongly felt an earthquake on February 1, 1955 (Hake, 1974). In Gulfport, houses shook, windows and dishes rattled and deep rumbling sounds were heard by many (intensity V). The tremor was reported at Bay of St. Louis, where buildings creaked and loose objects and windows rattled.

In June 1967, two earthquakes occurred about 11.25 kilometers (18 miles) northeast of Greenville, Mississippi. The first, on June 4, measured magnitude 3.8 on the Richter scale and was felt over approximately 64,750 square kilometers (25,000 square miles). On June 29, a second earthquake occurred in the same region with a magnitude of 3.4. The felt region of this shock was limited to parts of Bolivar, Sunflower, and Washington Counties (Hake, 1974).

One of the aftershocks of 1811- 1812 New Madrid earthquakes occurred on 17 December 1811 and is believed to have occurred in Mississippi, over 200 kilometers (320 miles) southeast of the NMSZ. Magnitude of this aftershock is approximately 6.1± 0.2 (Hough and Martin, 2002). Hough and Martin (2002) suggest an optimal location for the event, in north central Mississippi, at 34.6N, 89.2W (Figure 16). However, considering the overall distribution of shaking effects the location was concluded to be at least as far south as the Chickasaw Bluffs (35.1N, 90.0W) (Hough and Martin, 2002). According to available records the Mississippi River Valley was sparsely populated (Figure 17) to the south of New Madrid at the time (Anderson, 1937) and no damages were recorded during this event. Details about the aftershock (Table 5) are from those who were on the boats on the Mississippi River at the time of the event. John Bradbury describes the aftershock (Bradbury, 1819, p. 205) “We did not experience any more shock(s) until the morning of the 17th, when two occurred; one about five and the other about seven o’clock. We continued our voyage, and about twelve that day, we had a severe shock, of long duration.” William Pierce (Street, 1984) wrote of a “long and dreadful shock that appeared threatening at 5 after 12 meridian.

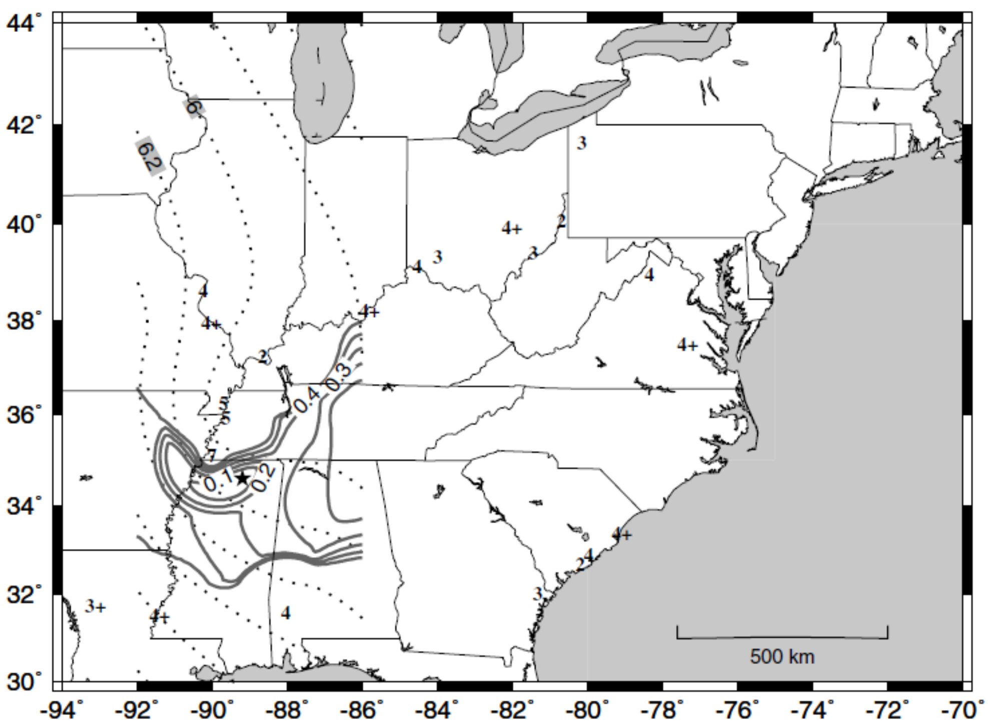

Figure 16 Location and estimated Modified Mercalli Intensity values for 17th December 1811 aftershock (Hough and Martin, 2002).

Note:Values immediately along the Atlantic coast line are shifted west by 0.2 degrees for clarity

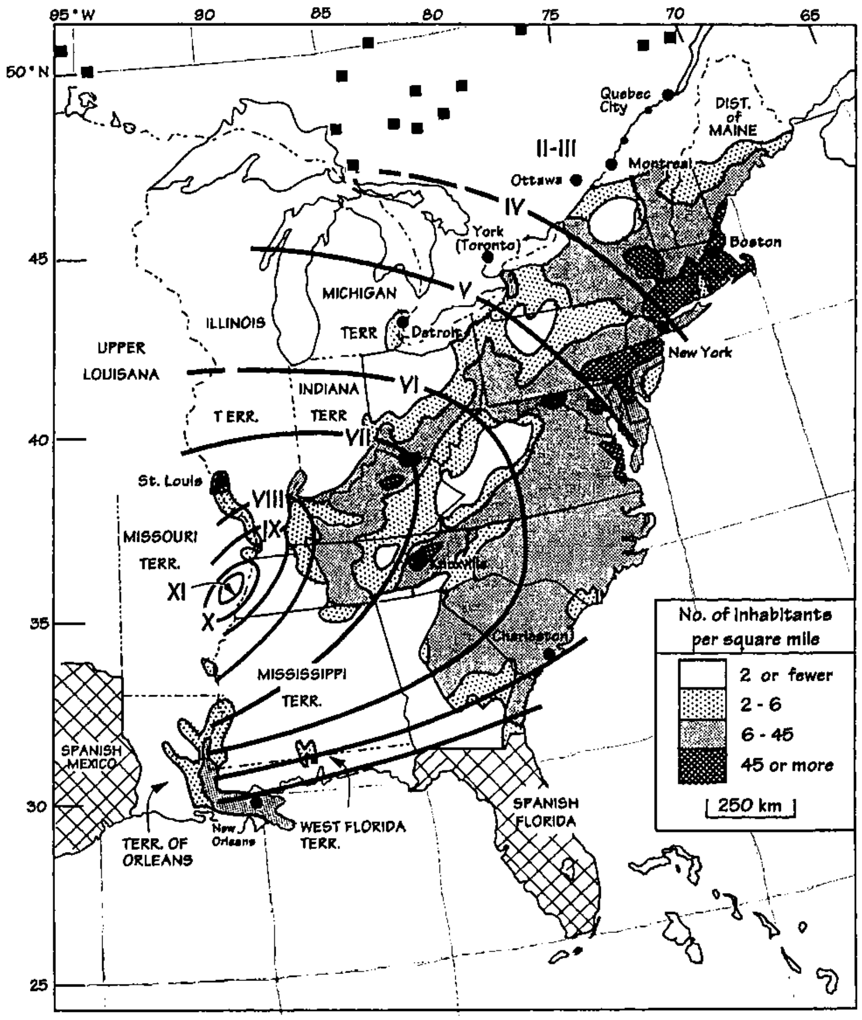

Figure 17 Historical setting in 1811-1812 (After Johnston and Schweig (1996))

Note: States of the Union have continuous borders, territory and district borders have dash-dot borders, and Spanish possessions are cross- hatched. Population density for the US is for 1810 (Garrett, 1988)

Table 5 Accounts of 17 December 1811 aftershock (After Hough and Martin (2002))

Location	Longitude	Latitude	MMI	Report
Charleston, South Carolina	−79.97	32.90	3	“sensibly felt” by those at rest
Chickasaw Bluffs, Tennessee	−90.00	35.10	7.0	one of 3 strongest shocks felt
Chillicothe, Ohio	−83.00	39.35	3	slight
Cincinnati, Ohio	−84.52	39.16	4	“strong,” “fourth class”
Columbia, South Carolina	−79.97	32.90	4	“smart shock”
Fort Massac, Illinois	−88.65	36.25	2	lightly felt
Fort St. Stephens, AL	−87.98	31.60	4	house shaken
Georgetown, South Carolina	−78.78	33.38	4.5	“severe,” no damage
Louisville, Kentucky	−85.73	38.18	4.5	“strong to intense”
Marietta, Ohio	−81.45	39.42	3	lighter than mainshock
Meadville, Pennsylvania	−80.12	41.63	3	lighter than mainshock
Mississippi (Pierce)	−89.70	36.25	5	“long and dreadful”
Mississippi	−89.68	36.00	4.5	“heavy,” trees shaken
Mississippi (Bradbury)	−89.63	35.93	5	“severe,” long duration
Natchez, Mississippi	−91.38	31.55	4.5	some clocks stopped
Natchitoches, Louisianna	−93.10	31.75	3.5	felt, less severe than mainshock
New Bourbon, Missouri	−90.05	37.98	4.5	“severe,” no damage described
Richmond, Virginia	−77.33	37.50	4.5	“violent,” no damage described
Saint Louis, Missouri	−90.38	38.75	4	“smart shock”
Savannah, Georgia	−81.13	32.03	3	felt
Strasburgh, Virginia	−81.13	32.03	4	“severe,” no damage
Wheeling, West Virginia	−80.70	40.08	2	“faint”
Zanesville, Ohio	−82.01	39.95	4.5	church steeple agitated

Prior Research

According to Federal Emergency Management Agency (FEMA), the Oktibbeha county of the state of Mississippi is located within a region that has a moderate seismic activity (Figure 18). FEMA claims that if earthquakes occur in the New Madrid Seismic Zone (NMSZ), they would cause "the highest economic losses due to a natural disaster in the United States” (Elnashai et. al, 2008). In such an event, economic loss due to business interruption and loss of market share, would incur approximately a $9.5 billion loss in Mississippi. Due to the possibility of an earthquake risk from the New Madrid Seismic zone, emergency management agencies of Mississippi, Tennessee, Kentucky, Indiana, Illinois, Missouri, and Arkansas formed the Central United States Earthquake Consortium (CUSEC) and developed a map illustrating areas of greater vs. lesser risk

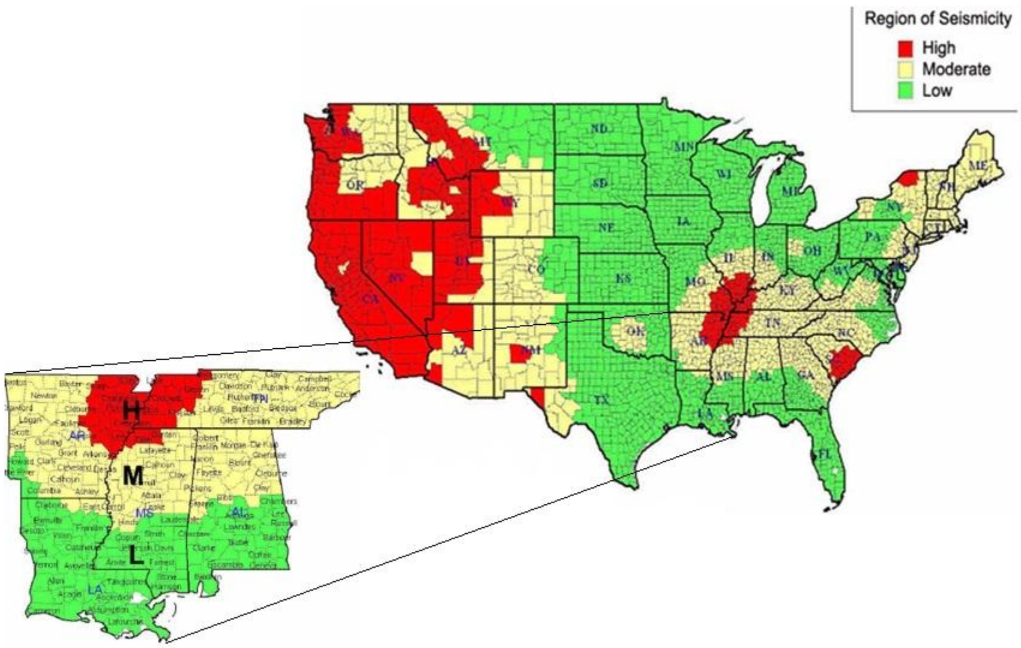

Figure 18 Seismicity of Oktibbeha County according to FEMA studies.

from seismic induced ground motions (Bograd, 1997). According to this map Mississippi State University is built upon an area with higher potential for enhanced ground shaking.

Risk Management Solutions Inc. and Michael Baker Corporation jointly conducted a study on the application of the HAZUS earthquake model to the New Madrid Earthquake zone for CUSEC. The study was focused on greater Memphis area and the results of the study provide quantitative losses upon an earthquake. The study emphasizes the importance of HAZUS as a modeling method in earthquake risk assessments.

Hwang, (Hwang et al., 1995) studied seismic vulnerability on the University of Memphis Campus. Information for each building including facility code, year of construction, type of construction, and replacement value were used to study seismic vulnerability. Results of Hwang, (1995) indicated how an earthquake will affect each building.

In 1997, Mississippi Emergency Management Agency, Central United States Earthquake Consortium, University of Mississippi Schools of Engineering, the Minerals Resource Institute and the Mississippi Department of Geology has conducted a structural evaluation of the buildings and a geological study of University of Mississippi.

Snodgrass, (1998) conducted an earthquake site analysis of Mississippi State University. The objective of the study was to evaluate primary ground surface responses of three sites on the University using WESHAKES response analysis software. Results suggested spectral peak ground accelerations range of 0.57g to a 0.65g generated from a 6.2 and a 8.25 magnitude earthquake events at an epicentral distance of approximately 250 kilometers (400 miles). The study also demonstrated that possible damage to the campus could be in the order of ten percent.

In a related study, from a completely different geographic region, Gulati, (2006) conducted a study on "Earthquake Risk Assessment of Buildings: Applicability of HAZUS in Dehradun, India". According to his findings the HAZUS methodology can be adopted and implemented in India, but requires attention to the nature of potential ground motion and the non-linear behavior of the structural components.

Schweig, (2007) used an earthquake scenario to estimate total county building losses in the southwest portion of the New Madrid zone. Although the study region did not include Oktibbeha county, neighboring counties have direct economic loss about 25 – 50 million dollars.

Considering the possibility of an earthquake and the fact that Mississippi State University was not included in any of the previous risk assessment studies, indicate that there is a need for a risk assessment of the University.

Hypothesis

There is a risk to buildings at Mississippi State University being damaged by an earthquake of magnitude seven or greater occurring in the New Madrid Seismic Zone in near future. The analysis of such a risk can be performed using the HAZUS software package.

Objective

The main objective of the earthquake risk assessment is to understand the seismic risk from New Madrid Seismic zone to the Mississippi State University and to evaluate the response of buildings from an earthquake.

CHAPTER III

METHODS

The process of earthquake risk assessment of the Mississippi State University (MSU) can be divided in to four phases.

1. Identifying the probability of a hazard
2. Profiling a hazard event
3. Making an inventory of the assets
4. Estimation of losses

Data gathered in each of these phases can be combined to assess the risk of an earthquake upon structures at MSU.

The first phase of the earthquake risk assessment of MSU was the identification of the probability of the hazard. The process begins with gathering information about past seismic events in and around MSU and finding the probabilities and the magnitudes of the next major seismic events that could possibly occur in near future. Details regarding the magnitude and frequency of seismic events that occurred in New Madrid Seismic Zone and the State of Mississippi in the past were obtained from United States Geological Survey (USGS) and from available literature. Probability of occurrence of a major seismic event in the near future that can impact MSU was obtained from available literature.

The next phase of the risk assessment process was profiling a hazard event. This step includes creation of a digital map of the MSU and the determination of the peak ground acceleration of the ground on which the MSU is located. A digital map of the MSU buildings was obtained from the department of Geosciences at MSU (Personal communication with Dr. Wax). Geographical information obtained from the Mississippi Automated Resource Information System (MARIS) technical center, was also incorporated into the digital map of the MSU. The response of geologic deposits in a seismic event at Mississippi State University was evaluated in an earlier study using a computer based program called WESHAKE5 (Snodgrass, 1998). Snodgrass studied three locations within the campus and determined each site's natural low strain dynamic period, peak ground acceleration and peak amplifications from ground motion.

The third step of the earthquake risk assessment is making an inventory of assets. Information regarding building structural type (wood, brick, concrete etc…), height of the building, number of stories, building code design level, date of construction, and replacement value was obtained from the Department of Facilities Management.

The information gathered in the first three steps are input in the HAZUS software program which then analyzes the data and calculates potential loss for MSU due to an earthquake originating in the New Madrid Seismic Zone.

HAZUS (HAZards United States)

HAZUS is risk assessment software developed by Federal Emergency Management Agency (FEMA). It is freely available from FEMA's publication warehouse. HAZUS uses geographic information systems technology together with scientific and engineering knowledge to perform risk assessments due to natural disasters, namely earthquakes, floods and wind.

HAZUS software uses census tracts to aggregate population information. Census tracts are divisions of land that has about 2500-8000 inhabitants with relatively homogeneous population characteristics, economic status and living conditions. The census data are used to estimate direct social loss due to displaced households and casualties due to earthquakes (HAZUS Technical Manual). There are three levels of analysis available in the HAZUS. For the purpose of this project the first and second levels of analysis were conducted.

1. Default Data Analysis:

The data needed to input, and run the program at this level can be obtained from government agencies and published information. The census data are based on the 2000 census and 2006 Dun and Bradstreet data (HAZUS Technical Manual). Results obtained from an analysis at this level will not be extremely accurate.

2. User-Supplied Data Analysis:

This is the most commonly used analysis type. Loss estimates are based on inventories that are provided by the user. This is a more accurate calculation compared to the former analysis.

3. Advanced Data and Models Analysis:

This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology. There are no standardized Advanced Data and Models Analysis studies (HAZUS Technical Manual).

Earthquakes produce ground motion and ground failures. For computation of ground shaking parameters, the following inputs are required by HAZUS.

Scenario basis

A basis for ground shaking must be selected by the user from one of three options:

1. Deterministic ground motion analysis: In this method deterministic seismic ground motion parameters are calculated for user-specified scenario earthquakes. Magnitude of the event and selected attenuation relationships are used to calculate ground shaking parameters.
2. USGS probabilistic ground motion maps (maps supplied with HAZUS-MH): In probabilistic analysis procedure, the ground shaking is characterized by spectral contour maps developed by the USGS
3. Other probabilistic or deterministic ground motion maps: In this method user-supplied peak ground acceleration (PGA) and spectral acceleration contour maps are used with the maps available in HAZUS.

Attenuation relationship

The attenuation of ground shaking with increasing distance from the source is modeled using attenuation functions in HAZUS. Therefore the selection of a suitable attenuation function is crucial for the analysis. Depending on the choice of attenuation functions, the ground shaking can be different for a specific location for the earthquake with same magnitude (Figure 19).

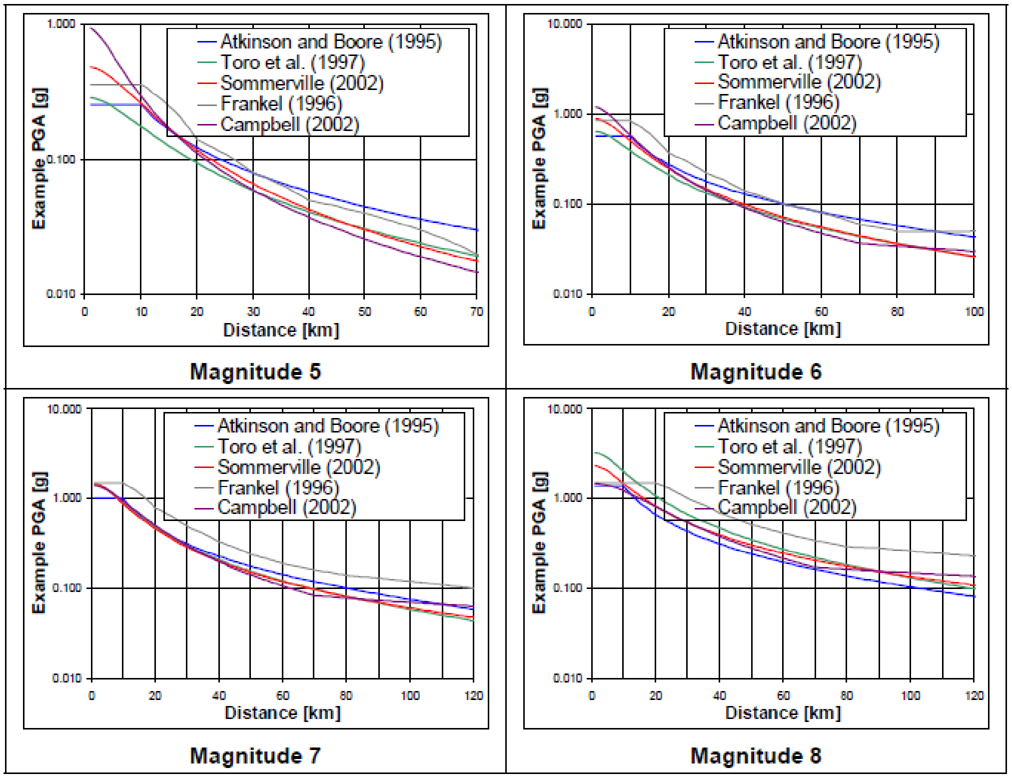

Figure 19 Relationship between Attenuation functions, Moment of magnitude of an earthquake, Distance and Peak Ground Acceleration (HAZUS Technical Manual).

Soil map

Soil type is important in determination of impact due to an earthquake. Stiffness of the soil affects the velocity of earthquake wave. Generally in a stiff or hard soil waves will travel at a higher velocity. If the soil is soft (low in stiffness) waves generally have low velocities. Slower velocities of waves will results in modification of seismic energy and greater damages due to earthquakes than higher velocities.

The HAZUS user can supply a detailed soil map that suits the specific site or specify the type of soil for an area. In the absence of details, HAZUS-MH will amplify the ground motion parameters assuming class D soil at the sites (Table 6).

Table 6 Soil Classes (HAZUS- MH MR3 Technical Manual)

Site Class	Site Class Description	Shear Wave Velocity (m/sec)	
		Minimum	Maximum
A	Hard Rock	1500	
B	Rock	760	1500
C	Very Dense Soil and Soft Rock	360	760
D	Stiff Soils	180	360
E	Soft Soils		180
F	Soils Requiring Site Specific Evaluations		

Selection of representative design level

The user has to select the seismic design level of buildings considered appropriate for the study region and to define a mix of seismic design levels for each model building type (Table 7 and Figure 20). Design level is related to the important changes in building designs that controls the behavior of building in a seismic event.

Table 7 HAZUS MH Guidelines for selection of damage functions for buildings based on seismic zone and building age (HAZUS MH-MR3 Technical Manual)

UBC Seismic Zone	Post 1975	1941-1975	Pre 1941
Zone 4	High Code	Moderate Code	Pre Code
Zone 3	Moderate Code	Moderate Code	Pre Code
Zone 2B	Moderate Code	Low Code	Pre Code
Zone 2A	Low Code	Low Code	Pre Code
Zone 1	Low Code	Pre Code	Pre Code
Zone 0	Pre Code	Pre Code	Pre Code

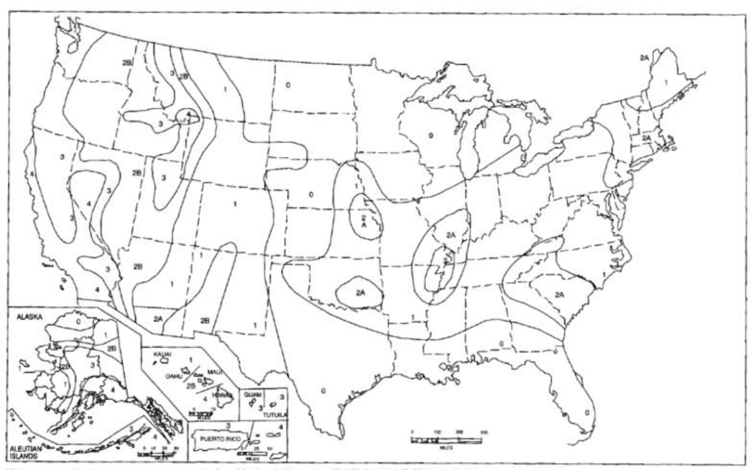

Figure 20 Map showing UBC seismic zones of United States

Selection of building type

The HAZUS user can select the building structure or model building type for a user defined building. There are 36 model building types listed in HAZUS as shown in Table 8.

Table 8 Building structure (Model Building Types) listed in the HAZUS MH-MR3 (From HAZUS User Manual)

No.	Label	Description	Height			
			Range		Typical	
			Name	Stories	Stories	Feet
1	W1	Wood, Light Frame (≤ 5,000 sq. ft.)		1 - 2	1	14
2	W2	Wood, Commercial and Industrial (> 5,000 sq. ft.)		All	2	24
3	S1L	Steel Moment Frame	Low-Rise	1 - 3	2	24
4	S1M		Mid-Rise	4 - 7	5	60
5	S1H		High-Rise	8+	13	156
6	S2L	Steel Braced Frame	Low-Rise	1 - 3	2	24
7	S2M		Mid-Rise	4 - 7	5	60
8	S2H		High-Rise	8+	13	156
9	S3	Steel Light Frame		All	1	15
10	S4L	Steel Frame with Cast-in-Place Concrete Shear Walls	Low-Rise	1 - 3	2	24
11	S4M		Mid-Rise	4 - 7	5	60
12	S4H		High-Rise	8+	13	156
13	S5L	Steel Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	24
14	S5M		Mid-Rise	4 - 7	5	60
15	S5H		High-Rise	8+	13	156
16	C1L	Concrete Moment Frame	Low-Rise	1 - 3	2	20
17	C1M		Mid-Rise	4 - 7	5	50
18	C1H		High-Rise	8+	12	120
19	C2L	Concrete Shear Walls	Low-Rise	1 - 3	2	20
20	C2M		Mid-Rise	4 - 7	5	50
21	C2H		High-Rise	8+	12	120
22	C3L	Concrete Frame with Unreinforced Masonry Infill Walls	Low-Rise	1 - 3	2	20
23	C3M		Mid-Rise	4 - 7	5	50
24	C3H		High-Rise	8+	12	120
25	PC1	Precast Concrete Tilt-Up Walls		All	1	15
26	PC2L	Precast Concrete Frames with Concrete Shear Walls	Low-Rise	1 - 3	2	20
27	PC2M		Mid-Rise	4 - 7	5	50
28	PC2H		High-Rise	8+	12	120
29	RM1L	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms	Low-Rise	1-3	2	20
30	RM2M		Mid-Rise	4+	5	50
31	RM2L	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms	Low-Rise	1 - 3	2	20
32	RM2M		Mid-Rise	4 - 7	5	50
33	RM2H		High-Rise	8+	12	120
34	URML	Unreinforced Masonry Bearing Walls	Low-Rise	1 - 2	1	15
35	URM M		Mid-Rise	3+	3	35
36	MH	Mobile Homes		All	1	10

Capacity curves and fragility curves for different seismic zones and different building types are supplied with the HAZUS model. Terminology used in HAZUS to describe the damages to building structures include 'none', 'slight', 'moderate', 'extensive' and 'complete'. Descriptions for each of these damage states for different building types can be found in HAZUS Technical Manual.

CHAPTER IV

RESULTS AND DISCUSSION

Earthquake Risk Assessment with Default Data

Earthquake risk assessment of Mississippi State University was performed using default data supplied with HAZUS software and user supplied data. Although analysis of default data supplied with HAZUS does not include any specific details about damage to MSU, analysis results can be used to understand earthquake risk to the area and to the specific facilities included.

Earthquake scenarios were defined within New Madrid Seismic Zone and within the state of Mississippi.

Earthquake scenario at 35.53N, 90.42W; Marked Tree, Arkansas

An earthquake scenario (deterministic arbitrary event) of magnitude 8.00 was defined at latitude and longitudes 35.53N, 90.42W; Marked Tree, Arkansas. For this analysis CEUS (Central and Eastern United States) was used as the attenuation function with soil type D. Results indicate that there will be no significant ground motion (Figure 21) and hence no significant damage to the Mississippi State University from such an event. According to Nutti (1993) the earthquake on January 4, 1843 in Arkansas had a Modified Mercalli Intensity value VI or higher and caused structural damage in Memphis, Southwest Tennessee, Northeast Arkansas and the extreme Northwest corner of Mississippi. After comparing the results from above analysis and Nutti (1993) it is fair to say that the results from this study shows a little bit lower damage to the state of

Mississippi, due to an earthquake that occurs approximately the same location, but with a higher magnitude.

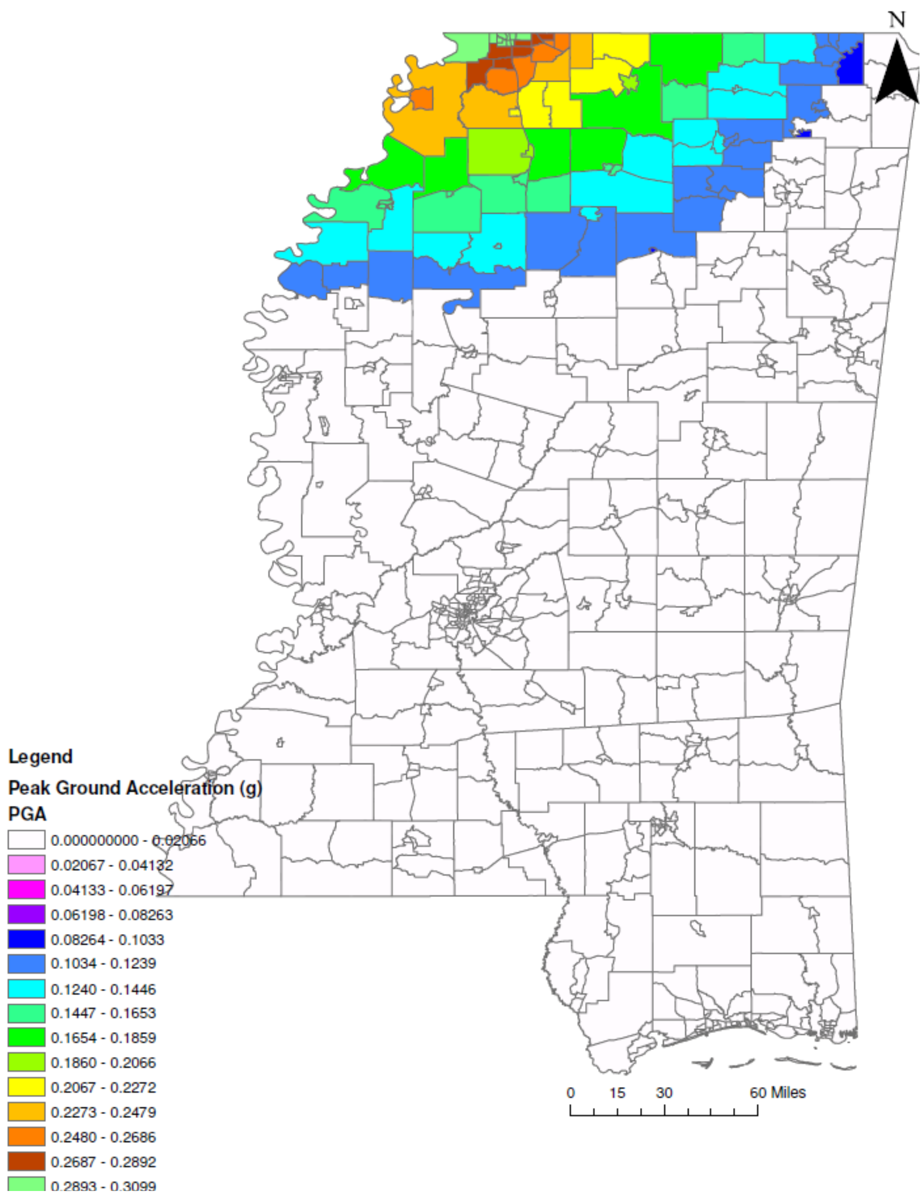

Figure 21 Peak ground acceleration for magnitude 8.0 Earthquake at 35.53N, 90.42W; at Marked Tree, Arkansas (Attenuation function - CEUS, Soil Type- D)

Earthquake scenario at 36.00N and 90.00W; Missouri

Earthquake scenario of magnitude 8.5 was defined using the historical epicenter event database of HAZUS. The epicenter of the earthquake was in Missouri and the latitude and longitude are 36.00N and 90.00W. The results indicate that there will be no significant ground motion or damage to the university from such event.

Earthquake scenario at 34.6N, 89.2W; Benton County, Mississippi

According to Hough and Martin (2002) one of the largest aftershocks of 1811-1812 earthquake series of the New Madrid Seismic Zone centered at 34.6N, 89.2W latitude and longitudes; Benton county, Mississippi. A scenario earthquake of magnitude 7.00 was defined at this location. Depth to the epicenter was considered as 10 kilometers (6.2 miles) and the attenuation function was set to CEUS with soil type D. Spectral acceleration at 0.3 sec (g) (Figure 22) and peak ground acceleration (Figure 23) due to above earthquake scenario shows that there will be an impact to MSU from such event. Spectral acceleration of the Oktibbeha County at 0.3 sec ranges between 0.162g – 0.202g. Peak ground acceleration of the Oktibbeha County generated from the above earthquake scenario ranges between 0.082g– 0.104g (Table 9).

The same earthquake scenario (magnitude 7.00 at 34.6N, 89.2W with soil type D) with a different attenuation function was defined to understand the effect of the attenuation function on the result. The attenuation function used was from Toro et al., and peak ground acceleration (Figure 24) due to such event shows different values than earlier scenario. The peak ground acceleration range of the Oktibbeha County for the earthquake scenario that used CEUS attenuation function is between 0.082g– 0.104g, whereas for the earthquake scenario using Toro et al.'s attenuation function generated a peak ground acceleration range between 0.053g -0.066g (Table 10).

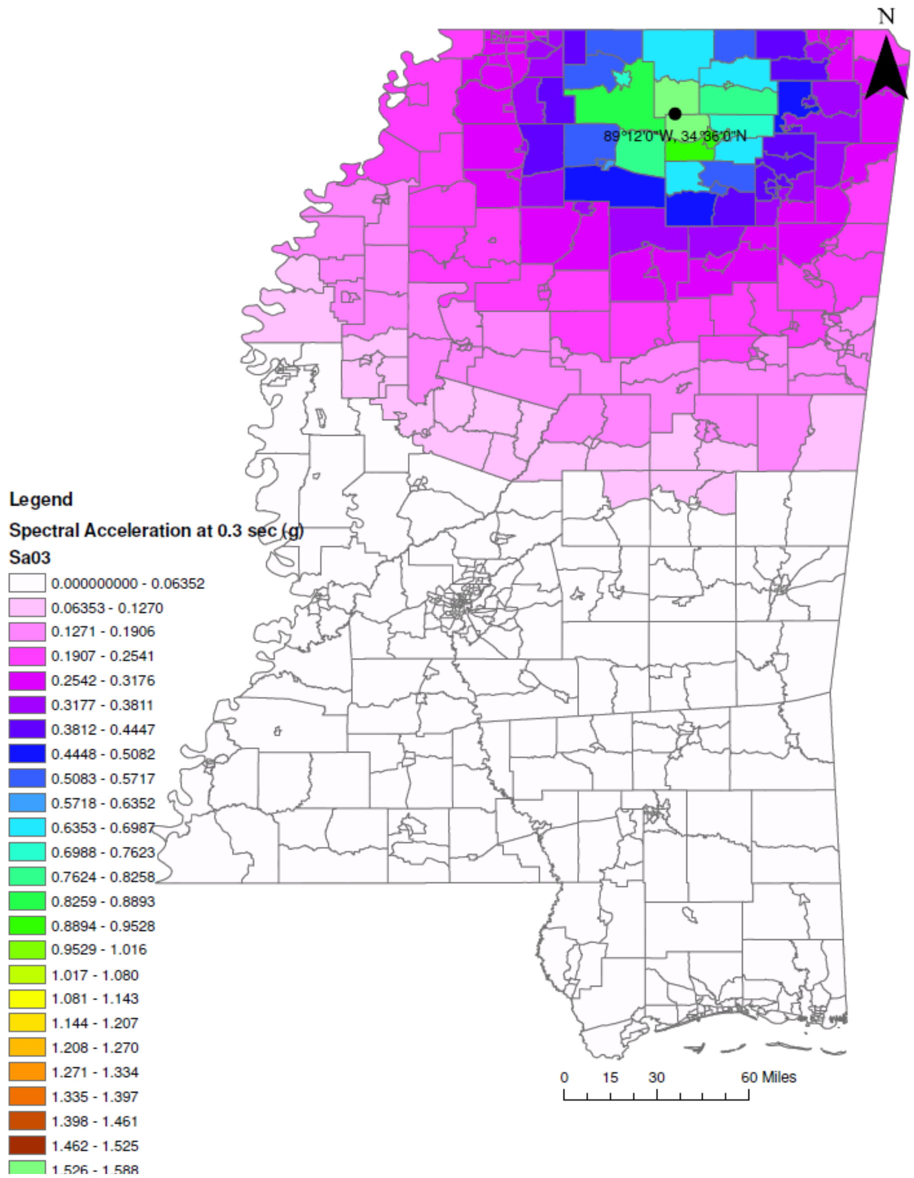

Figure 22 Spectral acceleration at 0.3 sec (g) for magnitude 7.00 earthquake at 34.6N, 89.2W (Attenuation function-CEUS, soil type D).

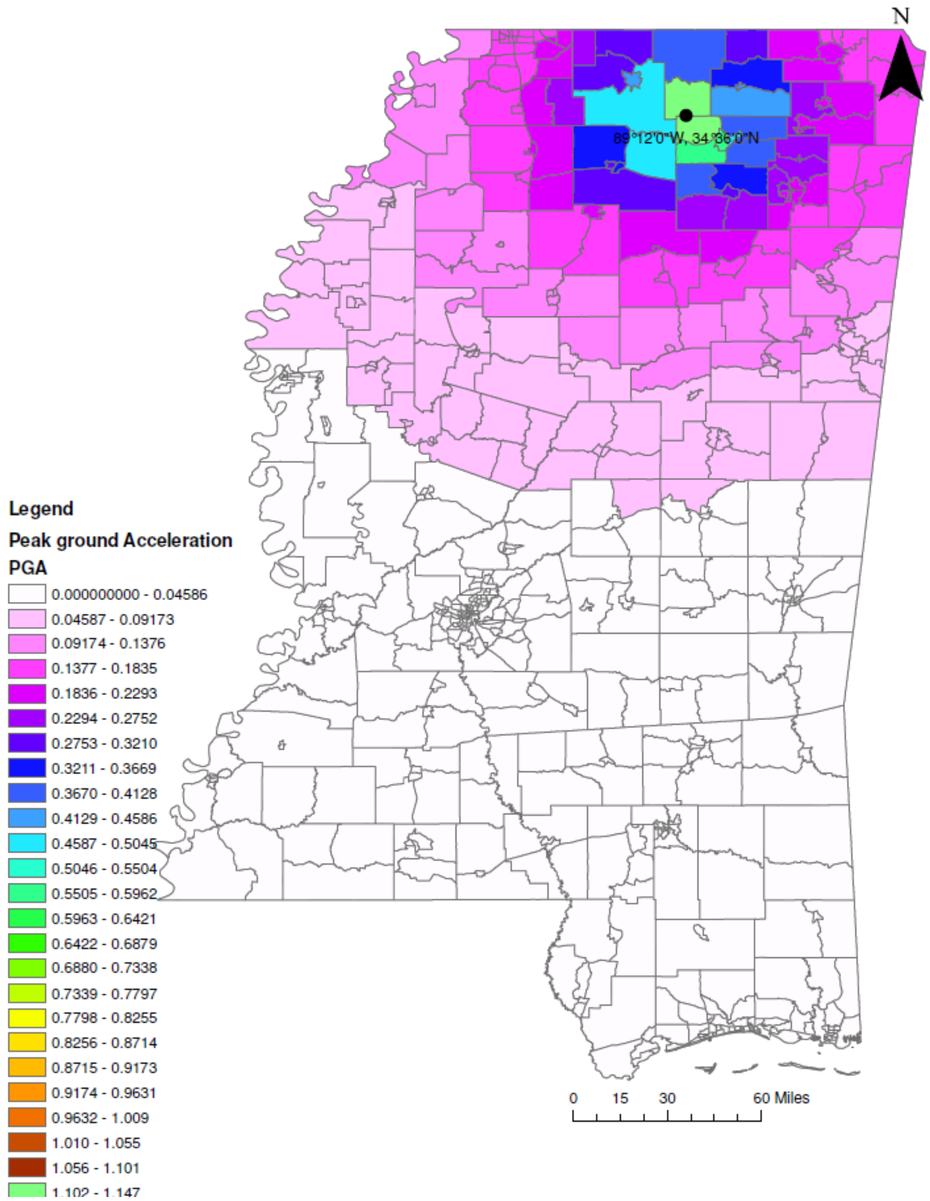

Figure 23 Peak ground acceleration for magnitude 7.00 earthquake at 34.6N, 89.2W (Attenuation Function-CEUS, Soil Type D).

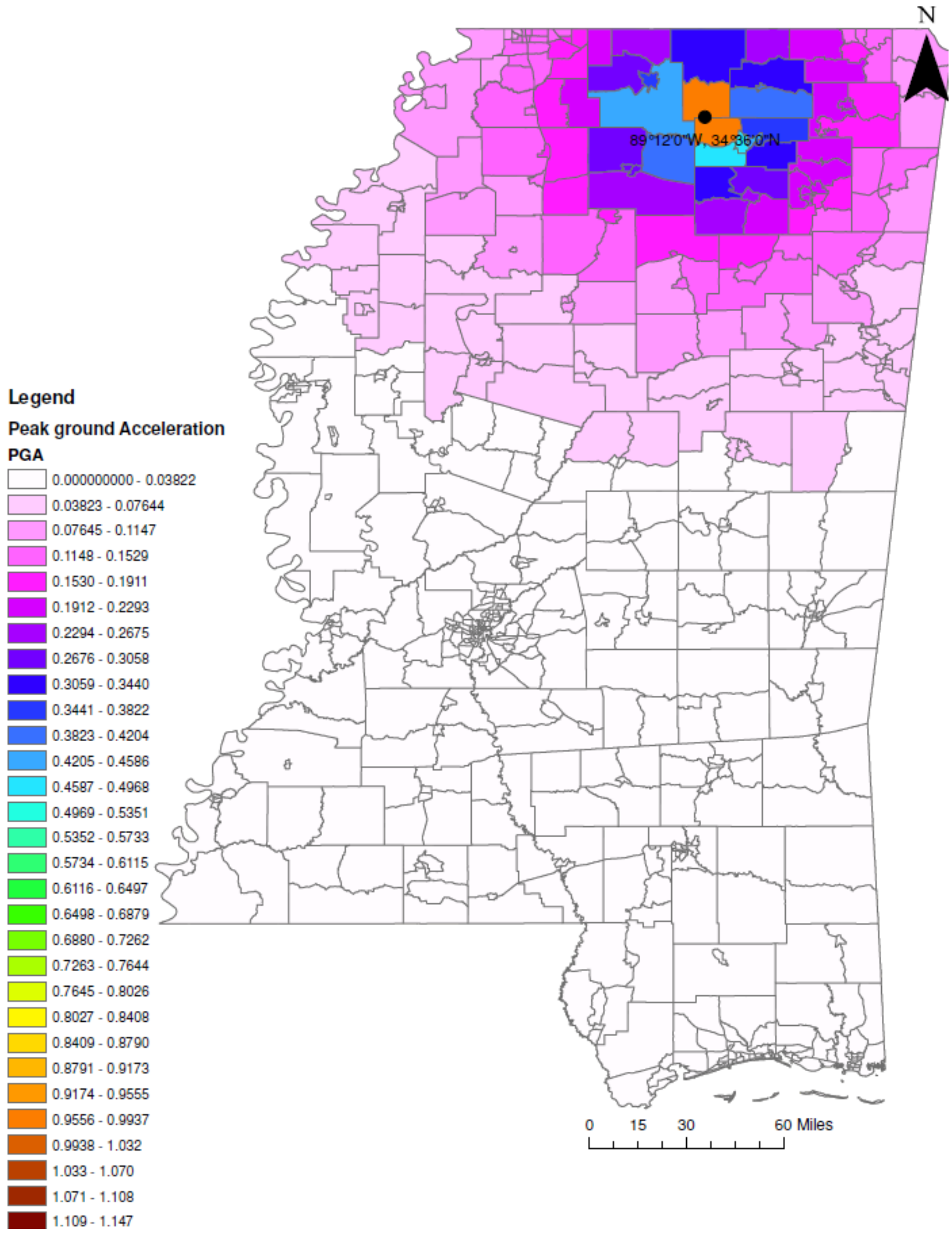

Figure 24 Peak ground acceleration for magnitude 7.00 earthquake at 34.6N, 89.2W (Attenuation Function-Toro et al. (1997), Soil Type D)

Table 9 Ground motion parameters for magnitude 7.00 earthquake scenario at 34.6n,89.2w for Oktibbeha county census tracts (Attenuation function CEUS, soil type D)

Census Tract	Spectral Acceleration		Spectral Displacement		Other Ground Motion Parameters			
	At 0.3 sec (g)	At 1.0 sec (g)	At 0.3 sec (in)	At 1.0 sec (in)	Spectral Velocity at 0.3 sec (in./sec)	Spectral velocity at1.0 sec (in./sec)	Peak Ground acceleration (g)	Peak Ground Velocity (in./sec)
28105950100	0.185	0.111	0.163	1.087	3.416	6.819	0.095	4.160
28105950200	0.202	0.121	0.178	1.181	3.717	7.410	0.104	4.520
28105950300	0.194	0.116	0.171	1.138	3.570	7.141	0.100	4.356
28105950400	0.179	0.107	0.158	1.049	3.302	6.582	0.091	4.015
28105950500	0.177	0.106	0.156	1.039	3.267	6.517	0.090	3.975
28105950600	0.171	0.103	0.151	1.006	3.154	6.309	0.087	3.848
28105950700	0.162	0.098	0.143	0.957	2.994	6.000	0.082	3.660

Table 10 Ground motion parameters for the magnitude 7.00 earthquake scenario at 34.6N,89.2W for Oktibbeha county census tracts (Attenuation function Toro et al., (1997), soil type D)

Census Tract	Spectral Acceleration		Spectral Displacement		Other Ground Motion Parameters	
	At 0.3 sec (g)	At 1.0 sec (g)	At 0.3 sec (in)	At 1.0 sec (in)	Peak Ground acceleration (g)	Peak Ground Velocity (in./sec)
28105950100	0.106	0.092	0.093	0.900	0.061	3.443
28105950200	0.114	0.099	0.101	0.969	0.066	3.707
28105950300	0.107	0.093	0.094	0.911	0.062	3.488
28105950400	0.104	0.091	0.092	0.891	0.061	3.411
28105950500	0.103	0.090	0.091	0.879	0.060	3.365
28105950600	0.098	0.086	0.086	0.841	0.057	3.217
28105950700	0.091	0.080	0.080	0.786	0.053	3.106

From CEUS and Toro et al., attenuation functions, use of CEUS will produce the maximum damage due to an earthquake.

If the soil type is not well known for an area, HAZUS uses type D as the soil type to amplify the ground motion parameters. According to Snodgrass, (1998) the average shear wave velocity of the material in which the MSU is located is 785 meters/sec (2575 ft/sec). Considering the velocity and other characteristics, the soil type of the area can be classified as type C (type C is described as very dense soil and soft rock). To understand the changes in ground motion parameters due to different soil types, earthquake scenario with soil type C was defined at the same location (34.6N, 89.2W) with same magnitude (magnitude 7) and same attenuation function (CEUS) as above. When the soil type change from type D to type C values for the peak ground acceleration show a decrease (Table 9 and Table 11). Peak ground acceleration of the Oktibbeha County for the earthquake scenario that uses soil type D is between 0.082g– 0.104g. When soil type C is used the peak ground acceleration is between 0.062g-0.078g. Although the soil type of the area in which MSU is located is known to be type C, soil type(s) of the area between the earthquake epicenter and MSU can vary and are not well known. So it is fair to use soil type D to obtain risk due to an earthquake.

Table 11 Ground motion parameters for the magnitude 7.00 earthquake scenario at 34.6N,89.2W for Oktibbeha county census tracts (attenuation function CEUS, soil type C)

Census Tract	Spectral Acceleration		Spectral Displacement		Other Ground Motion Parameters	
	At 0.3 sec (g)	At 1.0 sec (g)	At 0.3 sec (in)	At 1.0 sec (in)	Peak Ground acceleration (g)	Peak Ground Velocity (in./sec)
28105950100	0.139	0.079	0.123	0.770	0.071	2.947
28105950200	0.151	0.085	0.133	0.837	0.078	3.202
28105950300	0.145	0.082	0.128	0.806	0.075	3.086
28105950400	0.134	0.076	0.118	0.743	0.068	2.844
28105950500	0.133	0.075	0.117	0.736	0.068	2.816
28105950600	0.128	0.073	0.113	0.0.712	0.065	2.726
28105950700	0.122	0.069	0.107	0.678	0.062	2.593

There were 11,104 buildings included in the HAZUS default data inventory for Oktibbeha County (Figure 25). Buildings were classified into different categories based on construction materials, namely wood, steel, concrete, Reinforced Masonry, Unreinforced Masonry and Manufactured Home.

According to the results no building in the study was completely damaged by an earthquake scenario of magnitude 7.00 occurring at 34.6N, 89.2W (CEUS attenuation function). Out of 11,104 buildings the majority (that is 9,457 buildings) used wood as the construction material. From the buildings that use wood as the construction material only 7 will have extensive damages due to an earthquake. Most of the buildings (8658) constructed with wood will not have any damage by an earthquake. Only 687 buildings constructed with wood will undergo slight damages due to an earthquake. According to the results (Figure 26) wood and reinforced masonry buildings used in the study have a probability of 0.90 to not being damage by an earthquake.

The earthquake scenario of magnitude 7.00 occurring at 34.6N, 89.2W shows 0.80% loss ratio (Figure 27) for the Oktibbeha County. Although 0.80% is not considered as a huge loss, when it comes to dollars the total direct economic loss is 27,664 thousand dollars (Approximately 27.6 million dollars).

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
Mississippi						
Oktibbeha						
Wood	8,658	687	106	7	0	9,457
Steel	27	3	2	0	0	33
Concrete	12	1	1	0	0	14
Precast	13	1	1	0	0	15
Reinforced Masonry	0	0	0	0	0	0
Unreinforced Masonry	337	49	23	4	0	413
Manufactured Home	945	145	74	7	0	1,172
Total	**9,992**	**887**	**206**	**19**	**1**	**11,104**
Region Total	**9,992**	**887**	**206**	**19**	**1**	**11,104**

Figure 25 Summary report from HAZUS for building damage by building count for Oktibbeha County

	Average Damage State				
	None	Slight	Moderate	Extensive	Complete
Mississippi					
Oktibbeha					
Wood	0.90	0.10	0.00	0.00	0.00
Steel	0.80	0.10	0.00	0.00	0.00
Concrete	0.80	0.10	0.00	0.00	0.00
Precast	0.80	0.10	0.00	0.00	0.00
Reinforced Masonry	0.90	0.10	0.00	0.00	0.00
Unreinforced Masonry	0.80	0.10	0.00	0.00	0.00
Manufactured Home	0.80	0.10	0.10	0.00	0.00
Total	**0.80**	**0.10**	**0.00**	**0.00**	**0.00**
Region Average	**0.80**	**0.10**	**0.00**	**0.00**	**0.00**

Figure 26 Summary report from HAZUS for building damage by building type for Oktibbeha County

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Mississippi										
Oktibbeha	4,572	11,779	3,926	195	0.80	147	2,091	2,720	2,235	27,664
Total	4,572	11,779	3,926	195	0.80	147	2,091	2,720	2,235	27,664
Region Total	4,572	11,779	3,926	195	0.80	147	2,091	2,720	2,235	27,664

Figure 27 Summary report from HAZUS for direct economic losses for buildings at Oktibbeha County

Note: All values are in thousands of dollars

Earthquake Risk Assessment with User Defined Data

Oktibbeha County of the State of Mississippi comprises of seven census tracks, but the majority of the Mississippi State University buildings are within three of those census tracks (Figure 28).

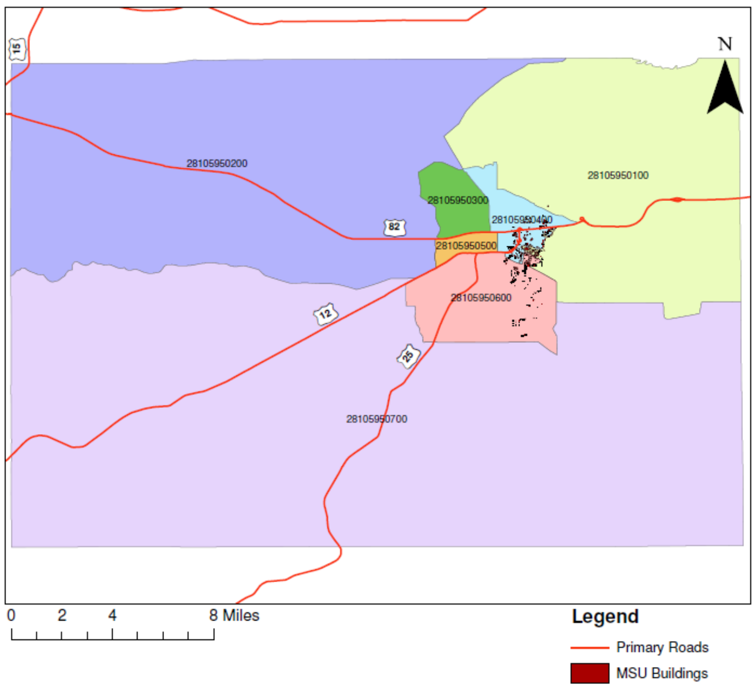

Figure 28 Mississippi State University buildings in different census tracts within Oktibbeha County

Note: Different colors in the figure 28 indicate different census tracts with their name on it. Most of the MSU buildings are within 28105950100, 28105950400 and 28105950600 census tracts.

Only 288 buildings within MSU were used for detailed study. Building construction type (wood, concrete, steel, masonry), year of construction, area in square feet, building construction cost and number of stories for buildings in the study were obtained from 2009, Annual Capital Facilities Study of MSU Physical Plant. Buildings in the study represent different building structural types commonly found in the study area. User defined data used for the study is listed in appendix A.

Earthquake scenario at 34.6N, 89.2W

An earthquake scenario of magnitude 7.00 was defined at 34.6N, 89.2W (Attenuation function CEUS, soil type D). Analysis of peak ground acceleration of the Oktibbeha County (Figure 29) shows that most of the MSU buildings fall within 0.08597g – 0.09654g. HAZUS uses five different levels for calculation of damage probabilities, namely None, Slight, Moderate, Extensive and Complete.

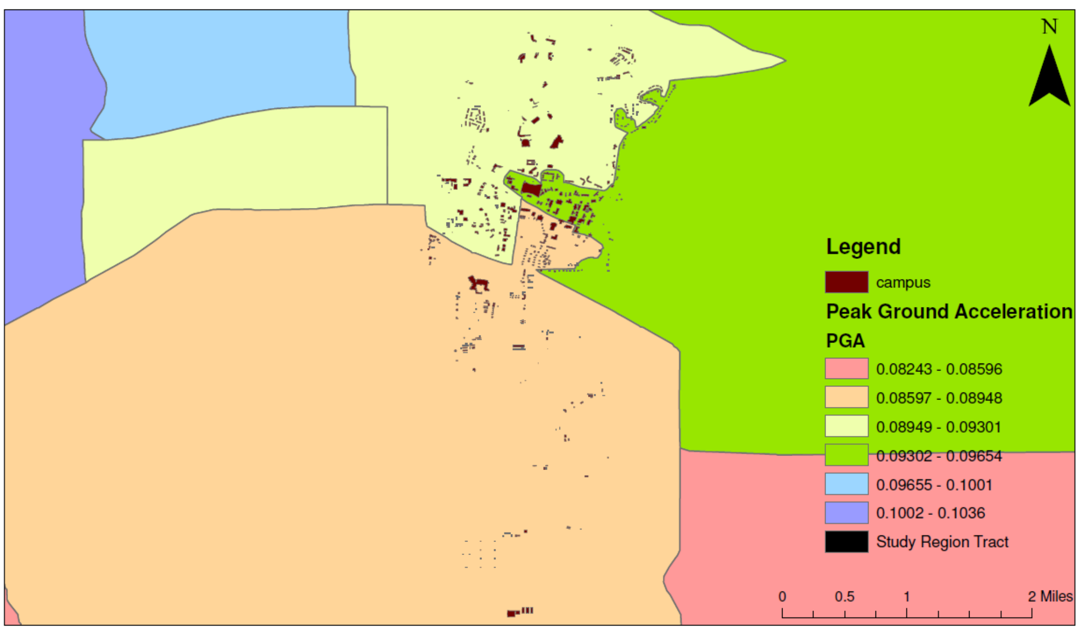

Figure 29 Peak ground acceleration for census tracts at Oktibbeha county and MSU buildings.

Note: Most of the MSU buildings are in the census tracts colored in green, beige and light yellow with peak ground accelerations ranges 0.09302g – 0.09654g, 0.08597g -0.08948g and 0.08949g-0.09301g respectively.

Out of 288 buildings used in the study 95 buildings (Figure 30) are constructed using wood, 74 buildings using steel, 57 buildings using concrete, 55 using reinforced Masonry, 6 buildings using precast concrete and only one building is constructed using unreinforced masonry. Most of the wood buildings (87 out of 95) and reinforced masonry buildings (49 out of 55) have “none” damage probability. That is most of the wood and reinforced buildings at MSU will not experience damages due to an earthquake. Analysis of percentages of different damage probabilities for different building types (Figure 31) indicate that about 85.96% of the buildings will have a “none” damage probability and 0.02% will have a “complete” damage probability.

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
Mississippi						
Oktibbeha						
Wood	87	7	1	0	0	95
Steel	59	9	6	1	0	74
Concrete	47	7	3	0	0	57
Precast	5	0	0	0	0	6
Reinforced Masonry	49	4	2	0	0	55
Unreinforced Masonry	1	0	0	0	0	1
Manufactured Home	0	0	0	0	0	0
Total	**248**	**27**	**12**	**2**	**0**	**288**
Region Total	**248**	**27**	**12**	**2**	**0**	**288**

Figure 30 Summary report from HAZUS; building damage count at MSU for different building types in different damage states

	% Distribution by Damage State				
	None	Slight	Moderate	Extensive	Complete
Mississippi					
Oktibbeha					
Wood	91.73	7.14	1.06	0.07	0.00
Steel	79.47	11.48	7.63	1.38	0.03
Concrete	82.21	12.49	4.74	0.52	0.04
Precast	86.70	8.30	4.61	0.37	0.02
Reinforced Masonry	88.64	6.70	4.15	0.49	0.01
Unreinforced Masonry	80.64	12.30	5.87	1.08	0.11
Manufactured Home	0.00	0.00	0.00	0.00	0.00
County	**85.96**	**9.27**	**4.16**	**0.59**	**0.02**

Figure 31 Summary report from HAZUS; building damage % distribution by building type at MSU

Damage probabilities for buildings are shown from Figure 32 through Figure 36. The probability of a building not being damage by the scenario earthquake is shown in Figure 32. The buildings which has the highest probability being in ‘None’ damage category to buildings which has the lowest probability being in ‘None” damage category (the safest to least safe) are shown by red, pink, purple, blue and black in the order of decreasing probability. A building that has a red or a pink dot has a high probability of not being damaged by an earthquake than a building which has a green or a blue dot. Bulldog circle buildings which are constructed with wood and Aiken village buildings which are constructed with concrete are examples for buildings that have high probabilities for not being damage by an earthquake. Most of the buildings which have high probabilities of not being damage by an earthquake are constructed with wood and reinforced masonry. Steel and concrete buildings show lower probabilities of not being damaged by an earthquake. List of different damage probabilities for different buildings is attached as appendix B.

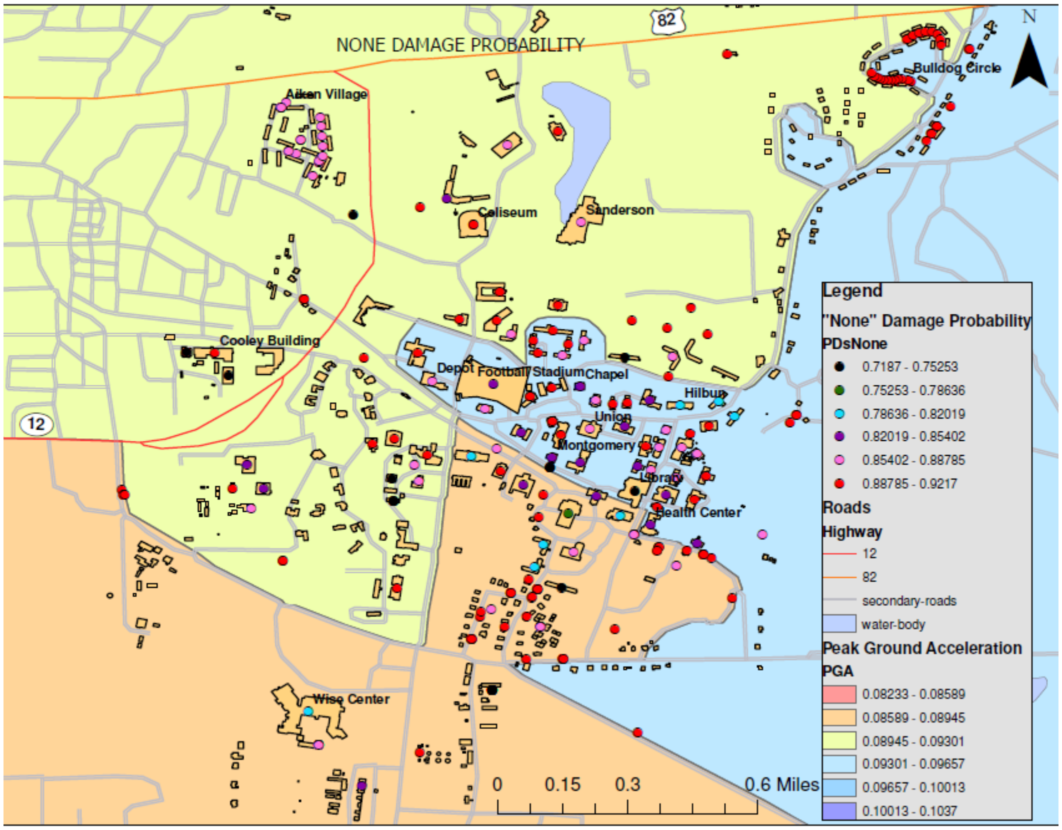

Figure 32 "None" damage probability for selected buildings at MSU

Note: Bulldog circle buildings constructed using wood and Aiken village buildings constructed using concrete has high probability of not being damage by an earthquake

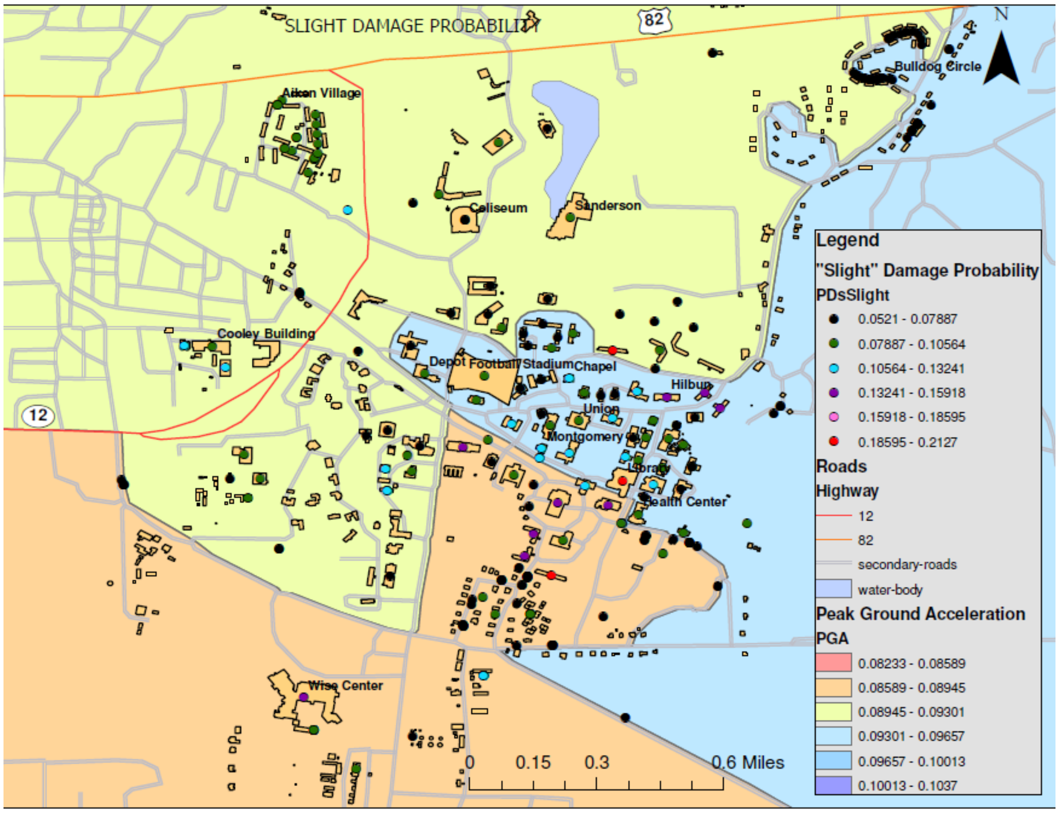

Figure 33 “Slight” damage state probability for selected buildings at MSU

Note: Most of the buildings in the figure have a green or a black dot, indicating most of the MSU buildings have a low probability of being slightly damaged by an earthquake.

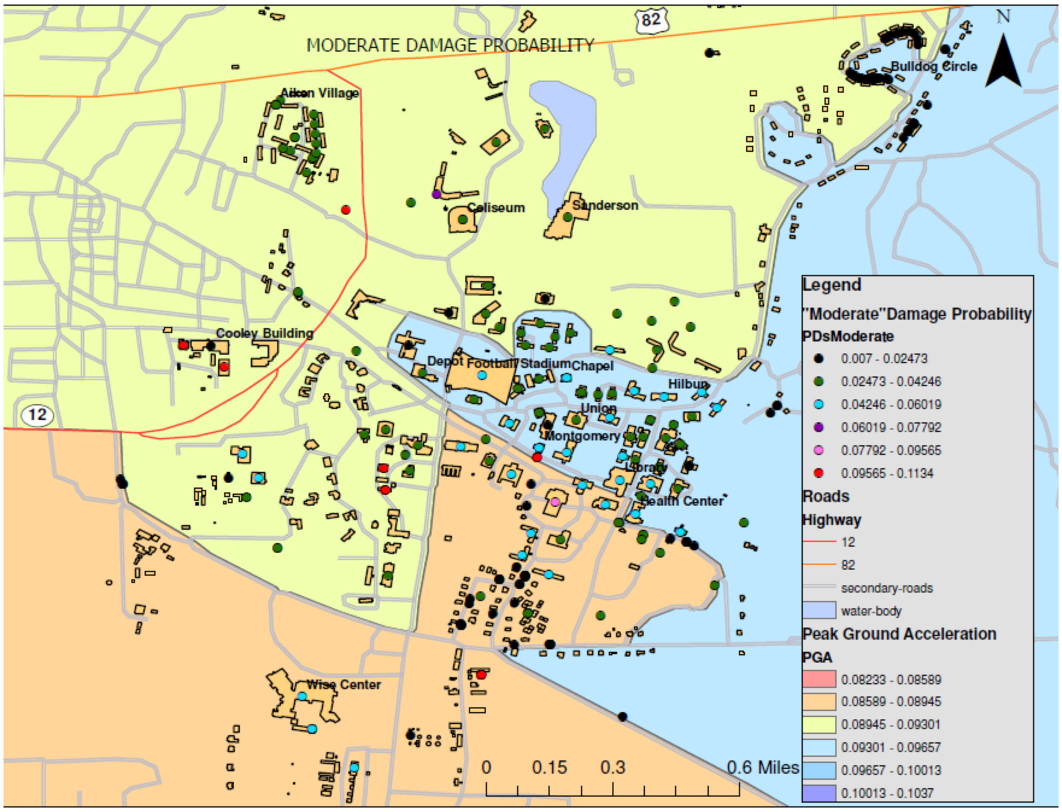

Figure 34 “Moderate” damage state probability for selected buildings at MSU

Note: Most of the MSU buildings have a low probability of experiencing a moderate damage due to an earthquake,

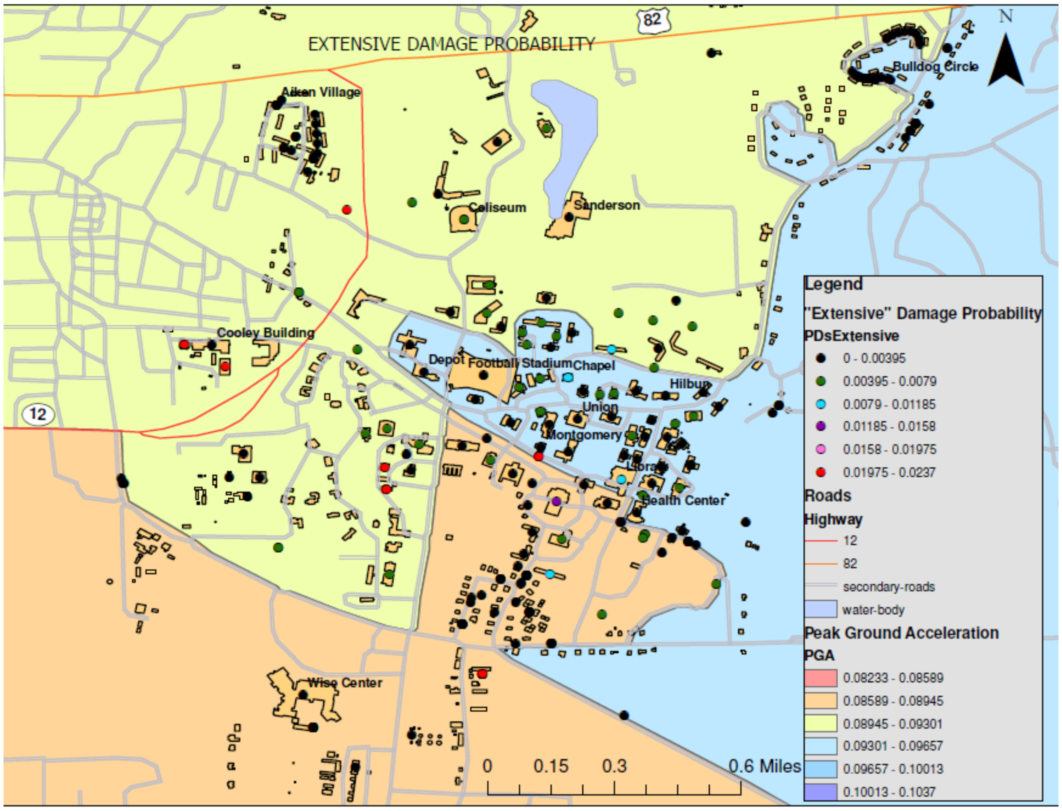

Figure 35 “Extensive” damage state probability for selected buildings at MSU

Note: Most buildings have a 0-0.00395 probability of having an extensive damage. The highest probability of building having an extensive damage is 0.0237. Only very few buildings have probabilities between 0.01975 -0.0237 to have an extensive damage.

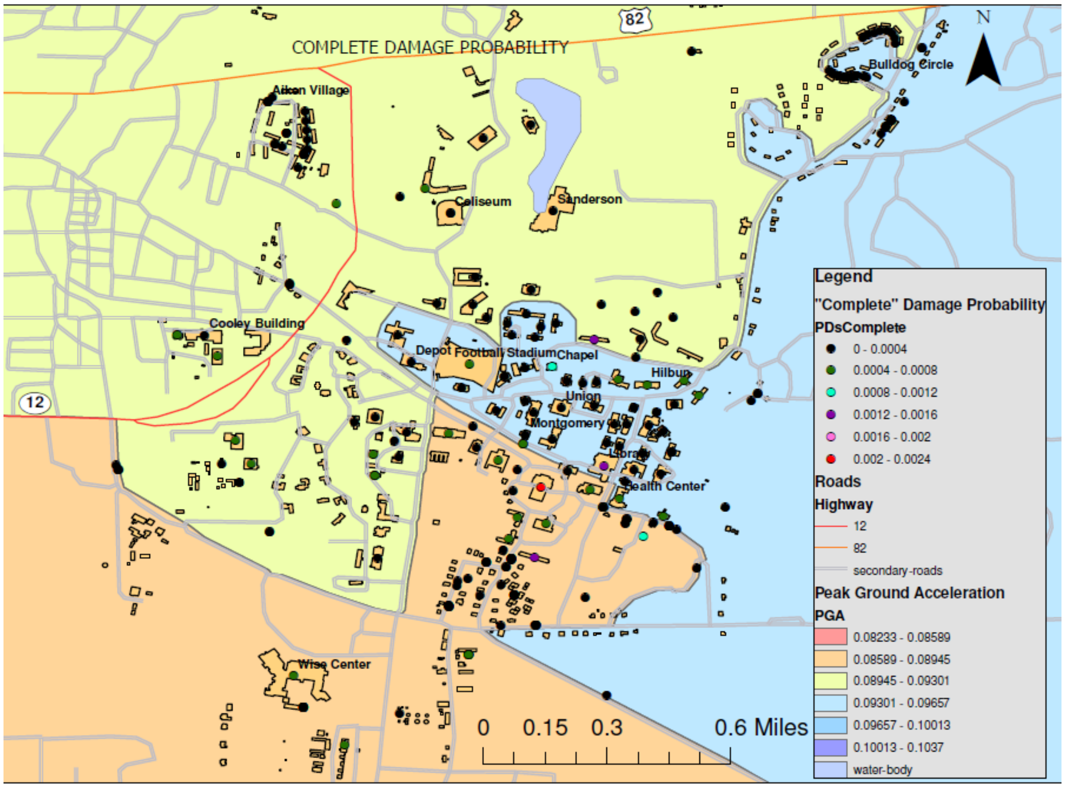

Figure 36 “Complete” damage state probability for selected buildings at MSU

Note: The highest probability of building having a complete damage is 0.0024 and most of the buildings have a very low probability (0.0004-0.0008) of being completely damage

The summary report for direct economic loss (Figure 37) indicates 0.67% loss ratio for the study. According to the summary reports the dollar amount relating to 0.67% is 8,185,898.

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Mississippi										
Oktibbeha	475,219	2,729,578	1,256,970	0	0.67	2,627,482	242,162	565,044	289,444	8,185,898
Total	475,219	2,729,578	1,256,970	0	0.67	2,627,482	242,162	565,044	289,444	8,185,898
Region Total	475,219	2,729,578	1,256,970	0	0.67	2,627,482	242,162	565,044	289,444	8,185,898

Figure 37 Summary report for the direct economic losses – User supplied data

Earthquake scenario at 34.0N, 88.76W; Hypothetical epicenter to produce ~0.2g peak ground acceleration at MSU

The peak ground acceleration in the area where Mississippi State University is located falls in the range of 0.20g for an intra-plate New Madrid seismic event (Snodgrass, 1998). Therefore a hypothetical earthquake was defined at 34.0N, 88.76W with soil type D and CEUS attenuation function to generate approximately 0.2g peak ground acceleration at MSU. Peak ground acceleration of census tracts in which MSU buildings are located at ranges between 0.198 – 0.235g (Figure 38). According to the results of this study if an earthquake produce ~0.2g peak ground acceleration at the University, probability of occurrence of damage to the buildings increase (Appendix C). From such an event MSU will have 4.28% direct economic losses from buildings. The dollar amount relating to 4.28% is $53,069,902.

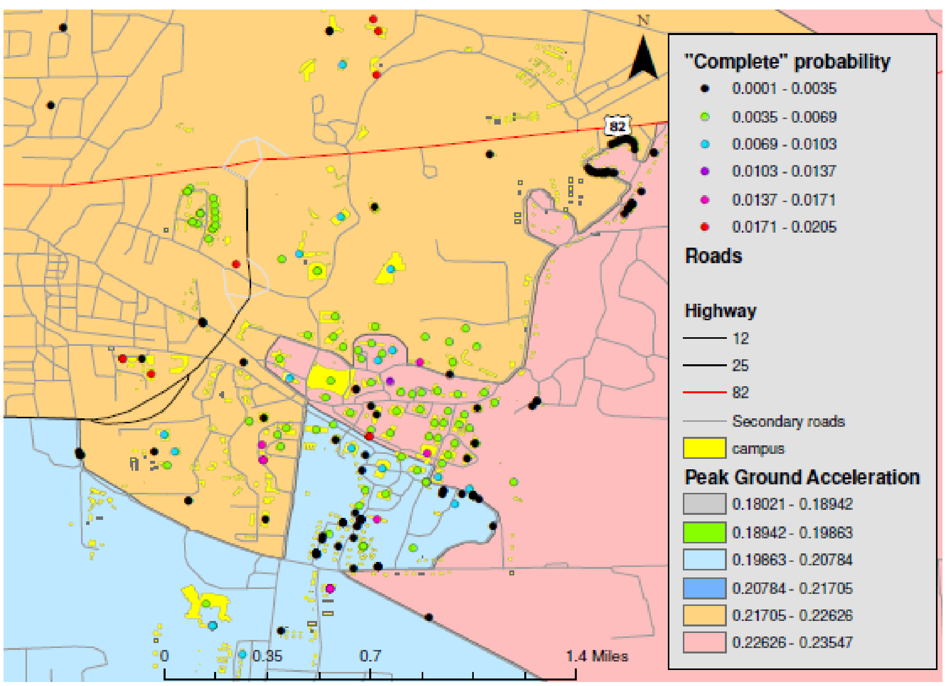

Figure 38 Peak ground acceleration values and complete damage probabilities for buildings at 0.2g

Applications of Risk Assessment

Some of the earlier earthquake risk assessment and loss estimation processes were conducted in early 1970's to improve the disaster relief and recovery process. But recent studies have been conducted with a wide range of purposes. Different professions have different advantages in conducting a risk assessment. For example fire fighters may be interested in areas where large fires can be expected where as municipalities can use the study for planning and construction purposes.

Earthquake Risk Assessment of Mississippi State University helps to understand the seismic hazard, and risk to MSU buildings.

Uncertainties of Risk Assessments

Uncertainties are common in risk assessment and loss estimation processes. They can occur due to incomplete knowledge about earthquakes and their effects upon different building structures, and by approximations and simplifications made by analysts. Uncertainties are also results from incomplete and inaccurate inventories.

CHAPTER V

CONCLUSION

Considering the facts about New Madrid Seismic Zone there is a possibility of an earthquake with considerable magnitude occurring in the life time of existing Mississippi State University buildings. Scenario earthquakes defined at well known locations (Marked Tree, Arkansas) within the seismic zone using HAZUS model does not indicate any ground motion at the Oktibbeha County, however earlier studies (Snodgrss,1998) indicate ten percent damage to the Mississippi State University.

According to Hough and Martin (2002) the epicenter for one of the largest aftershocks of 1811-1812 was located within the State of Mississippi possibly around 34.6N, 89.2W. Therefore not only major earthquakes but also aftershocks from major events in the New Madrid Seismic Zone should be considered in the seismic risk assessment of Mississippi State University. Scenario earthquakes defined at 34.6N, 89.2W indicated that the loss ratio will be 0.67% for a magnitude 7.00 earthquake. According to the summary reports from HAZUS the dollar amount relating to 0.67% is 8,185,898. Analysis of percentages of different damage probabilities for different buildings indicate that about 85.96% of the buildings will have a "none" damage state probability and 0.02% of the buildings will have a "complete" damage state probability. Most of the buildings constructed with wood and reinforced masonry show a significant high probability to be not damaged by an earthquake. Concrete and unreinforced masonry buildings show a significant high probability for being damaged by an earthquake.

A hypothetical earthquake defined to generate 0.2g peak ground acceleration at MSU results in loss ratio of 4.28% for buildings and relating to total economic loss of $53,069,902.

From these results it can concluded that Mississippi State University has the probability of significant damage by an earthquake.

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APPENDIX A

MISSISSIPPI STATE UNIVERSITY BUILDING DATA USED FOR USER SUPPLED DATA ANALYSIS

Table 12 Mississippi State University building data used for the study (Source: 2009 Annual Capital facility study)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002000	Industrial Education	1900	1044400.00	2	41300	Masonry, Wood
MS002001	George Hall	1902	478476.00	3	11556	Masonry, Wood
MS002002	Montgomery Hall	1903	6128656.68	5	37270	Masonry, Wood, Concrete
MS002003	McCain Engineering	1905	8128591.39	3	71545	Masonry,Concrete
MS002004	Middleton Hall	1905	84483.00	3	12418	Masonry,Wood
MS002005	Materials Testing Lab	1906	9069.00	2	3720	Masonry
MS002006	Lee Hall	1909	7028355.29	5	74830	Masonry,Wood
MS002007	Carpenter Engineering	1910	863260.16	4	43538	Masonry
MS002008	YMCA & Post Office	1914	353547.00	4	31435	Masonry
MS002009	Perry Cafeteria	1921	5214869.46	2	58696	Wood, Masonry
MS002010	Harned Hall	1921	2627593.22	5	54502	Masonry,Concrete
MS002011	Steam Plant	1921	443367.00	2	21026	Concrete, Masonry
MS002012	Herbert Hall	1928	1130905.00	3	36480	Concrete, Masonry
MS002013	Stennis Institute	1928	149184.00	1	3805	Masonry,Wood
MS002014	Giles Hall	1929	4273311.92	1	82113	Masonry, Concrete
MS002015	Bowen Hall	1929	4314253.26	3	33775	Concrete, Masonry
MS002016	Lloyd-Ricks Building	1929	914258.18	4	67323	Masonry, Concrete
MS002017	Flower Shop & Student Media Ctr	1937	713631.60	1	12271	Masonry,Concrete
MS002018	Hull Hall	1938	1314690.00	3	65682	Masonry, concrete
MS002019	Magruder Hall	1938	530611.47	3	23600	Masonry,concrete
MS002020	Band Hall	1939	58905.00	1	4437	Masonry, Concrete

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002021	Bedenbaugh Animal Laboratory	1939	183756.00	2	6120	Concrete, Masonry
MS002022	Faculty Housing	1939	51747.77	2	3536	Wood
MS002023	Box Building (formerly 35 Morrill Rd)	1939	150562.00	2	3536	Wood, Masonry
MS002024	Student Housing	1939	59500.00	2	5115	Masonry, Wood
MS002025	Art Gallery	1939	59500.00	2	5115	Masonry, Wood
MS002026	Art Gallery	1939	59500.00	2	5115	Masonry, Wood
MS002027	Roberts Building	1946	936869.52	1	21528	Masonry
MS002028	Briscoe Hall	1947	336104.00	2	13008	Masonry, Steel
MS002029	Freeman Hall	1947	204528.00	2	13008	Masonry, Steel
MS002030	Moore Hall	1947	272472.00	2	13008	Masonry
MS002031	Hill Poultry Science	1947	417827.00	2	22618	Masonry, Concrete
MS002032	Stafford Hall	1947	357154.49	2	13008	Steel, Masonry
MS002033	Plant Pathology Greenhouse	1948	86500.00	1	2112	Wood, Glass
MS002034	Davis-Wade Football Stadium	1938	35308310.28	7	186099	Concrete, Masonry
MS002035	Howell Agricultural Engineering	1950	433366.00	2	43847	Brick
MS002036	McCarthy Gym	1950	1152967.11	2	55697	Concrete
MS002037	Mitchell Memorial Library	1950	17491161.18	7	235657	Concrete, Brick,concrete
MS002038	Patterson Engineering	1950	1158456.84	2	52839	Concrete, Brick
MS002039	Newell-Grissom Building	1953	1894245.42	1	45580	Masonry
MS002040	Sewage Treatment Plant	1954	37865.00	1	594	Masonry

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002041	Butler-Williams Building	1954	358342.00	2	17763	Steel
MS002042	Petroleum Products Lab	1955	97500.00	2	9533	Concrete
MS002043	Etheredge Chemical Engineering	1957	559803.32	3	40548	Concrete, Masonry
MS002044	Critz Hall	1958	3401314.39	3	42714	Concrete
MS002045	Garner Hall	1950	2686777.33	2	41433	Masonry, concrete
MS002046	Music Building "A"	1965	25900.00	1	2474	Steel
MS002047	Music Building "B"	1958	55690.00	1	3088	Masonry
MS002048	Butler Hall	1959	2602194.80	3	36971	Concrete
MS002049	McKee Hall	1959	3505362.73	4	47434	Concrete
MS002050	Memorial Hall	1959	881558.01	3	25298	Concrete
MS002051	Sessums Hall	1959	3937059.27	4	47434	Concrete
MS002052	Turman Field House	1959	295674.80	2	10971	Concrete
MS002053	Hilbun Hall	1960	7209831.91	4	76534	Concrete
MS002054	Walker Engineering	1963	900665.53	3	45948	Concrete
MS002055	Cresswell Hall	1964	5043724.65	5	58324	Concrete
MS002056	Raspet Flight Research Lab	1964	557167.25	2	38417	Steel
MS002057	Ballew	1965	475749.00	2	21984	Concrete
MS002058	Hand Chemical Lab	1964	18619590.69	5	92801	Concrete
MS002059	Colvard Student Union	1965	2996127.31	3	93640	Concrete
MS002060	Aiken Village 20	1965	97382.00	2	4420	Concrete
MS002061	Aiken Village 21	1965	167095.00	2	12884	Concrete
MS002062	Aiken Village 22	1965	167255.00	2	13404	Concrete
MS002063	Aiken Village 23	1965	177989.00	2	13404	Concrete

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002064	Aiken Village 24	1965	167255.00	2	13404	Concrete
MS002065	Aiken Village 25	1965	167255.00	2	13404	Concrete
MS002066	Aiken Village 26	1965	167255.00	2	13404	Concrete
MS002067	Aiken Village 27	1965	167255.00	2	13404	Concrete
MS002068	Aiken Village 28	1965	167255.00	2	13404	Concrete
MS002069	Aiken Village 30	1965	167255.00	2	13404	Concrete
MS002070	Aiken Village 31	1965	167095.00	2	12884	Concrete
MS002071	Aiken Village 32	1965	177989.00	2	13404	Concrete
MS002072	Aiken Village 33	1965	177989.00	2	13404	Concrete
MS002073	Aiken Village 34	1965	167095.00	2	12884	Concrete
MS002074	Aiken Village 35	1965	177989.00	2	13404	Concrete
MS002075	Aiken Village 36	1965	167255.00	2	13404	Concrete
MS002076	Aiken Village 37	1965	167255.00	2	13404	Concrete
MS002077	Longest Student Health Center	1965	5507724.03	2	50952	Concrete,steel,brick, masonry
MS002078	Chapel of Memories	1967	644987.43	1	5310	Masonry
MS002079	Evans Hall	1965	1200980.50	4	52712	Concrete
MS002080	Dorman Hall	1966	2504935.10	4	141584	Concrete
MS002081	Polk-Dement Baseball Stadium	1987	6673748.45	2	30002	Concrete,steel)
MS002082	Edwards Reactor Lab	1967	56978.00	1	3128	Steel
MS002083	Hathorn Hall	1967	6722299.97	5	72974	Concrete
MS002084	Music Building	1968	48725.00	1	3387	Masonry
MS002085	President`s Home	1969	187344.97	3	8683	Masonry,wood

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002086	Receiving Station	1966	45173.20	1	5438	Masonry
MS002087	Rice Hall	1968	1907921.00	8	110488	Concrete
MS002088	Cooley Building	1966	467016.00	2	107558	Wood,Masonry
MS002089	Suttle Hall	1969	1951887.00	9	142598	Concrete
MS002090	McArthur Hall	1971	4301122.18	6	64516	Concrete
MS002091	GeoScience Storage Bldg	1969	34569.00	1	6078	Steel
MS002092	Physical Plant Buckner Storage	1969	34569.00	1	5109	Steel
MS002093	Scales Veterinary Science	1970	581992.00	1	15723	Concrete
MS002094	Clay Lyle Entomology Center	1971	1173383.16	2	44411	Concrete
MS002095	Clay Lyle Greenhouse Lab	1972	19839.00	1	3948	Wood
MS002096	Herzer Dairy Science	1937	1809015.39	2	62489	Masonry, Concrete, Steel
MS002097	Gast Rearing Lab	1971	602656.00	2	23474	Concrete
MS002098	Allen Hall	1972	4025606.03	7	151083	Concrete, steel
MS002099	Cobb Institute Of Archaeology	1975	799983.00	2	21754	Concrete
MS002100	Humphrey Coliseum	1975	8780819.37	5	173797	Masonry
MS002101	McCool Hall	1974	19178009.19	4	144587	Masonry, Concrete
MS002102	Noble Pace Seed Technology	1974	495186.00	1	26443	Masonry
MS002103	Simrall Electrical Engineering	1976	3817261.00	4	94477	Masonry
MS002104	Bost	1977	4435494.00	5	109957	Concrete
MS002105	Sewage Lab	1975	13024.00	1	592	Wood, Brick
MS002106	Shira Field House	1978	8203951.69	2	65288	Steel
MS002107	CVM Large Animal Clinic	1979	1517183.00	1	6700	Steel

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002108	Solvent Storage	1978	24988.00	1	1239	Steel
MS002109	Wise Center	1981	32091202.94	4	376000	Concrete
MS002110	Arbour Acres 1	1982	497733.09	2	7600	Steel
MS002111	Arbour Acres 2	1982	497733.09	2	7600	Steel, Masonry
MS002112	Arbour Acres 3	1982	497733.09	2	7600	Steel, Masonry
MS002113	Arbour Acres 4	1982	363022.09	2	4776	Steel, Masonry
MS002114	Arbour Acres 5	1982	497733.10	2	7600	Steel, Masonry
MS002115	Arbour Acres 6	1982	497733.10	2	7600	Steel, Masonry
MS002116	Arbour Acres 7	1982	363022.10	2	4776	Steel, Masonry
MS002117	Transportation Shop	1982	12350.00	1	1800	Steel, Masonry
MS002118	Facilities Use /Support Services	1928	52648.08	1	1841	Wood
MS002119	Campus Landscape Office	1983	69471.00	1	1500	Metal
MS002120	Campus Landscape Shop	1983	138942.23	1	3000	Metal
MS002121	Academic Advising Center	1890	8312.00	2	3876	Wood
MS002122	McComas Hall	1986	5570495.07	4	63941	Steel, Concrete
MS002123	Physical Plant Shop/Storage Building	1988	232640.00	2	18270	Steel
MS002124	Cobb Institute Curation Facility	1987	285128.00	1	7000	Steel
MS002125	Butler Guest House	1988	730419.00	2	6668	Brick
MS002126	Comparative Biomedical Res Facility	1988	558012.00	1	8645	Steel
MS002127	PGM Academic Facility	1991	146189.55	1	4602	Steel
MS002128	Seal "M" Club Building	1990	1428962.00	2	12537	Steel
MS002129	Raspet Flight Research Lab Annex	1991	3881256.78	2	62031	Steel

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002130	High Performance Computing Center	1990	4412172.94	3	40776	Concrete
MS002131	Meridian Admin & Classroom Bldg	1993	5755823.34		63840	Concrete, Masonry
MS002132	Ammerman-Hearnsburger Food Processing	1995	914006.73	1	7700	Metal
MS002133	Bryan Athletic Administration Bldg	1995	5415543.00	2	31044	Masonry
MS002134	RCU Building	1996	819316.67	1	8261	Steel, Masonry
MS002135	Center For Writing & Thinking	1997	94000.00	1	4674	Steel
MS002136	Plant & Soil Sciences Greenhouses	1998	2000282.09	1	17894	Masonry
MS002137	Child Development & Family Studies Ctr	1997	935363.00	1	10089	Steel, Masonry
MS002138	ICET	1998	8627606.01	2	59757	Steel, Masonry
MS002139	Sanderson Recreation Center	1998	19175574.52	2	156827	Steel, Masonry
MS002140	Mississippi Horse Park/AgriCenter	1999	5344929.45	1	69182	Steel, Masonry
MS002141	509 East Capitol Street	1998	3010925.71	4	25971	Masonry
MS002142	Swalm Chemical Engineering Bldg	2000	16179400.33	6	100638	Masonry
MS002143	Landscape Architecture Seminar/Studio	2003	2378418.41	2	13333	Steel
MS002144	Landscape Architecture Freehand Studio	2003	379069.91	1	2125	Steel
MS002145	Landscape Architecture Administration	2003	955256.17	1	5355	Steel
MS002146	Grand Opera House	1890	250000.00	3	40000	Wood
MS002147	Marks-Rothenberg Building	1889	250000.00	3	63640	Wood
MS002148	CAVS - Thad Cochran Research Park	2003	8295420.00	2	56055	Masonry
MS002149	CAVS - Canton Facility	2004	4335904.00	2	24048	Masonry
MS002150	Power Generation Plant	2005	14846204.97	2	7668	Steel
MS002151	Newberry Building	1890	135000.00	4	10466	Masonry

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002152	Poultry Diagnostic Lab	2003	476848.17		2160	Steel
MS002153	Ruby Hall	2005	20179342.91	3	157261	Masonry
MS002154	Cullis Wade Depot	2006	8820671.34	2	46084	Steel
MS002155	Palmeiro Center	2006	6397171.89	1	82005	Masonry
MS002156	Griffis Hall	2006	16377183.72	4	114509	Masonry
MS002157	Hurst Hall	2006	11713514.81	3	81864	Masonry
MS002158	Baseball Coaches Offices	2006	957782.00	1	4500	Masonry
MS002159	Building #3 - Northeast Village	2007	11713514.81	3	81864	Masonry
MS002160	Band and Choral Rehearsal Hall	2007	3739920.08	2	17980	Masonry
MS002161	Soccer Press Box	2008	673650.00	2	2948	Masonry
MS002162	Aerospace Engineering Motor Test	1950	3000.00	1	456	Brick
MS002163	Ag Engineering Processing Lab	1972	45000.00	1	4820	Metal
MS002164	Int'l Security & Strategic Studies	1939	39237.65	2	3536	Wood
MS002165	CVM Poultry House	1977	20000.00	1	1537	Steel
MS002166	Campus Landscape Storage	1964	6000.00	1	8000	Wood
MS002167	Bulldog 11-12	1960	27088.00	1	3074	Wood
MS002168	Bulldog 13-14	1960	27088.00	1	3074	Wood
MS002169	Bulldog 15-16	1960	27088.00	1	3074	Wood
MS002170	Bulldog 17-18	1960	27088.00	1	3074	Wood
MS002171	Bulldog 19-20	1960	27088.00	1	3074	Wood
MS002172	Bulldog 21-22	1960	27088.00	1	3074	Wood
MS002173	Bulldog 23-24	1960	27088.00	1	3074	Wood

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002174	Bulldog 25-26	1960	27088.00	1	3074	Wood
MS002175	Bulldog 27-28	1960	27088.00	1	3074	Wood
MS002176	Bulldog 29-30	1960	27088.00	1	3074	Wood
MS002177	Bulldog 31-32	1960	27088.00	1	3074	Wood
MS002178	Bulldog 33-34	1960	27088.00	1	3074	Wood
MS002179	Bulldog 35-36	1960	27088.00	1	3074	Wood
MS002180	Bulldog 37-38	1960	27088.00	1	3074	Wood
MS002181	Bulldog 39-40	1960	27088.00	1	3074	Wood
MS002182	Bulldog 41-42	1960	27088.00	1	3074	Wood
MS002183	Bulldog 43-44	1960	27088.00	1	3074	Wood
MS002184	Bulldog 45-46	1960	27088.00	1	3074	Wood
MS002185	Bulldog 47-48	1960	27088.00	1	3074	Wood
MS002186	Bulldog 49-50	1960	27088.00	1	3074	Wood
MS002187	Bulldog 51-52	1960	27088.00	1	3074	Wood
MS002188	Morgan 45	1935	8700.00	1	1904	Wood
MS002189	Center For America's Veterans	1898	46528.47	1	3272	Wood
MS002190	Transportation	1937	8835.00	1	2018	Wood
MS002191	Stennis Institute	1935	13178.00	2	3060	Wood
MS002192	History	1916	7344.00	1	2065	Wood
MS002193	Comprehensive Testing Center	1937	7300.00	1	1715	Wood
MS002194	Arbour Acres Laundry	1905	25960.00	1	1602	Wood
MS002195	Magruder 58	1919	8128.00	1	2408	Wood

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002196	Magruder 59	1916	7344.00	1	2124	Wood
MS002197	Magruder 60	1917	6320.00	1	2054	Wood
MS002198	Magruder 61	1920	7560.00	1	2164	Wood
MS002199	Morgan 48	1934	7625.00	1	1873	Wood
MS002200	Center For Science & Mathematics	1901	5124.00	1	2161	Wood
MS002201	Morgan 6-8	1903	18271.00	2	3558	Wood
MS002202	Morgan 10	1890	7200.00	1	1453	Wood
MS002203	Philosphy & Religion	1890	66435.00	2	3696	Wood
MS002204	Faculty Housing	1897	23441.00	1	2530	Wood
MS002205	Morgan 46	1904	4989.00	1	2891	Wood
MS002206	Morgan 47	1921	9000.00	2	2855	Wood
MS002207	Morgan 49	1922	7256.00	2	2283	Wood
MS002208	Morgan 51	1911	10490.00	1	2304	Wood
MS002209	Morgan 52	1910	7762.00	1	2096	Wood
MS002210	Morgan 53	1921	4968.00	1	1419	Wood
MS002211	Morgan 54-56	1902	6000.00	2	4095	Wood
MS002212	Blackjack 16	1929	3168.00	1	1375	Wood
MS002213	Morgan 55	1917	3000.00	1	1213	Wood
MS002214	Morrill 880	1948	25000.00	1	2214	Wood
MS002215	Morrill 880 Carport & Storage	1978	2250.00	1	800	Wood
MS002216	Blackjack 42	1882	7377.00	2	2313	Wood
MS002217	Blackjack 44	1902	5282.00	2	2346	Wood
MS002218	Early Childhood Institute	1910	6984.00	1	3006	Wood

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002219	Blackjack 48	1929	7095.00	1	1838	Wood
MS002220	White 1	1960	15584.00	1	1482	Wood
MS002221	White 3	1960	15584.00	1	1482	Wood
MS002222	White 2	1960	15584.00	1	1482	Wood
MS002223	White 4	1960	15584.00	1	1482	Wood
MS002224	Maroon 5	1960	15584.00	1	1482	Wood
MS002225	Maroon 6	1960	15584.00	1	1482	Wood
MS002226	Maroon 7	1960	15584.00	1	1482	Wood
MS002227	Maroon 8	1960	15584.00	1	1482	Wood
MS002228	Maroon 9	1960	15584.00	1	1482	Wood
MS002229	Maroon 10	1960	15584.00	1	1482	Wood
MS002230	Electrical Engineering Storage	1984	4080.00	1	1580	Metal
MS002231	Maroon 11-12	1950	17400.00	1	2417	Wood
MS002232	Golf Course Shop & Storage	1971	22166.00	1	4500	Metal
MS002233	Morrill 882	1948	1200.00	1	319	Wood
MS002234	Observatory	1975	6956.00	1	800	Metal
MS002235	Radioactive Storage Bldg	1975	2500.00	1	180	Concrete
MS002236	Airport Storage-Large	1970	3500.00	1	1200	Metal
MS002237	Water Well 1	1936	1350.00	1	225	Concrete
MS002238	Water Well 2	1939	1350.00	1	225	Concrete
MS002239	Water Well 3	1970	14600.00	1	333	Wood
MS002240	Hazardous/Radiological Waste/Stor	1985	9096.00	1	400	Wood
MS002241	Aiken Village Pavilion	1984	22597.37	1	2592	Wood

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002242	Aircraft Office- Hangers 1 & 2	1980	366602.00	1	10556	Metal
MS002243	Aiken Village Shop & Storage	1971	8824.00	1	684	Brick
MS002244	Campus Landscape Equipment Building	1983	69840.00	1	7760	Metal
MS002245	White 5	1986	47174.00	1	1496	Wood
MS002246	Maroon 4	1986	53619.00	1	1496	Wood
MS002247	Sheely House	1988	78500.20	1	2526	Wood
MS002248	East Road 893	1990	28987.43	1	1354	Wood
MS002249	Hazardous Waste Storage Building	1991	38176.00	1	1543	Concrete
MS002250	Campus Landscape Storage & Office	1991	10900.00	1	864	Metal
MS002251	Support Services Storage & Office	1991	8300.00	1	864	Metal
MS002252	Small Ruminant Research Facility	1994	150942.92	1	1956	Metal
MS002253	Golf Course Storage Building	1987	50000.00	1	2667	Wood
MS002254	PGA Model Golf Facility	1994	465000.00	1	6200	Brick
MS002255	18 East Drive	1993	55000.00	1	1436	Wood
MS002256	Radio Transmission Tower Building	1994	27719.00	1	390	Concrete
MS002257	Companion Animal Research Facility	1995	133367.72	1	3000	Metal
MS002258	CVM Hay Barn	1991	38453.00	1	3750	Metal
MS002259	Support Services Storage Bldg A	1995	96167.00	1	6000	Metal
MS002260	Support Services Storage Bldg B	1995	100485.00	1	7200	Metal
MS002261	CVM Cattle Working Facility	1991	40141.75	1	1548	Steel
MS002262	Morrill 898	1997	67950.00	1	2418	Wood
MS002263	ITS Computing Center Bldg-North	1997	22000.00	1	1202	Steel, Wood

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002264	ITS Computing Center Bldg-East	1997	22000.00	1	1192	Steel, Wood
MS002265	ITS Computing Center Bldg-West	1997	32000.00	1	2005	Steel, Wood
MS002266	Intramural Sports Office & Maintenance	1998	119000.00	1	2838	Steel, Masonry
MS002267	Intramural Softball Control Center	1998	125450.00	1	1936	Steel, Masonry
MS002268	Soccer Field Men/Women Restrooms	1998	49000.00	1	668	Steel, Masonry
MS002269	Crosby Arboretum Pavilion	1986	85000.00	1	3753	Wood
MS002270	Crosby Arboretum Gift Shop	1992	19000.00	1	1820	Metal
MS002271	Crosby Arboretum Maintenance Shop	1987	13000.00	1	840	Metal
MS002272	Crosby Arboretum Admissions	1996	3200.00	1	62	Wood
MS002273	Crosby Arboretum Greenhouse	1990	2500.00	1	1960	Metal, Wood
MS002274	Crosby Arboretum Restroom	1990	2000.00	1	45	Wood
MS002275	Blackjack 827	1998	51798.00	1	1471	Wood, Brick
MS002276	Blackjack 905	1998	112274.00	1	2422	Wood, Brick
MS002277	Campus Landscape Chemical Storage Bldg	1998	27965.00	1	178	Metal
MS002278	MSU AgriCenter Fire Pump Building	1999	20000.00	1	192	Concrete
MS002279	MSU AgriCenter Barn 1	1999	221964.00	1	21120	Metal
MS002280	MSU AgriCenter Barn 2	1999	221964.00	1	21120	Metal
MS002281	MSU AgriCenter Barn 3	1999	221964.00	1	21120	Metal
MS002282	Student Life Center (Morrill 910)	2000	668796.24	1	3312	Wood, Brick
MS002283	Campus Landscape Equipment Storage Bldg	1999	51945.06	1	4000	Metal
MS002284	CVM Modular Research Building	2000	356754.37	1	1736	Metal
MS002285	Blackjack 909	2000	98840.00	1	1765	Wood, Brick

Table 12 (Continued)

ID	NAME	YEAR BUILT	CONSTRUCTION COST IN US$	NO. OF FLOORS	AREA SQ. FT	TYPE OF CONSTRUCTION
MS002286	CVM Aquatic Hatchery	2000	513182.71	1	4608	Concrete
MS002287	Raspet Generator Equipment Building	1999	12600.00	1	252	Metal
MS002288	Aircraft Hangar #3	1997	161525.00	1	4615	Metal
MS002289	Morrill 902	1938	104386.98	1	1736	Wood
MS002290	East 890	1959	70527.99	2	2814	Wood
MS002291	HPCC Modular Annex #1	2002	46711.00	1	1820	Metal
MS002292	HPCC Modular Annex #2	2002	39794.00	1	1820	Metal
MS002293	MSU AgriCenter Covered Arena	2002	255006.25	1	21000	Metal
MS002294	Oktoc 1242	2002	66500.00	1	1310	Wood
MS002295	Raspet Flight Hanger #4	2003	115000.00	1	4392	Metal
MS002296	Blackjack 906	2003	127000.00	1	2349	Wood
MS002297	Moth Building	2005	65606.74	1	720	Concrete
MS002298	Old House by MSU Golf Course	1945	500.00	1	1053	Wood
MS002299	Women's Softball Practice Facility	2005	286183.00	1	20000	Masonry
MS002300	CAVS Dynamometer Lab	2003	89003.00	1	2450	Metal
MS002301	Power Generation Electrical Rm Bldg B	2005	421533.00	1	1060	Masonry
MS002302	Power Generation Gas Compressor Bldg C	2005	1516028.00	1	3000	Masonry

APPENDIX B

DAMAGE PROBABILITIES FOR THE LIST OF BUILDINGS STUDIED AT THE MISSISSIPPI STATE UNIVERSITY

Table 13 Damage state probabilities for the list of buildings studied (These tables are presented in the output format of HAZUS-MH MR3)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002000	Industrial Education	0.907	0.055	0.033	0.005	0.000
MS002001	George Hall	0.903	0.054	0.038	0.006	0.000
MS002002	Montgomery Hall	0.838	0.107	0.052	0.002	0.000
MS002003	McCain Engineering	0.903	0.053	0.038	0.005	0.000
MS002004	Middleton Hall	0.903	0.053	0.038	0.005	0.000
MS002005	Materials Testing Lab	0.907	0.055	0.034	0.005	0.000
MS002006	Lee Hall	0.838	0.108	0.052	0.002	0.000
MS002007	Carpenter Engineering	0.838	0.107	0.052	0.002	0.000
MS002008	YMCA & Post Office	0.869	0.088	0.041	0.001	0.000
MS002009	Perry Cafeteria	0.910	0.083	0.007	0.000	0.000
MS002010	Harned Hall	0.838	0.108	0.053	0.002	0.001
MS002011	Steam Plant	0.876	0.089	0.033	0.002	0.000
MS002012	Herbert Hall	0.876	0.089	0.033	0.002	0.000
MS002013	Stennis Institute	0.904	0.053	0.038	0.005	0.000
MS002014	Giles Hall	0.902	0.054	0.039	0.006	0.000
MS002015	Bowen Hall	0.876	0.089	0.033	0.002	0.000
MS002016	Lloyd-Ricks Building	0.838	0.108	0.053	0.002	0.000
MS002017	Flower Shop & Student Media Ctr	0.906	0.055	0.034	0.005	0.000
MS002018	Hull Hall	0.902	0.054	0.038	0.006	0.000
MS002019	Magruder Hall	0.903	0.054	0.038	0.006	0.000
MS002020	Band Hall	0.905	0.053	0.037	0.005	0.000
MS002021	Bedenbaugh Animal Laboratory	0.875	0.089	0.033	0.002	0.000
MS002022	Faculty Housing	0.920	0.069	0.010	0.001	0.000
MS002023	Box Building (formerly 35 Morrill Rd)	0.920	0.069	0.010	0.001	0.000
MS002024	Student Housing	0.905	0.056	0.034	0.005	0.000
MS002025	Art Gallery	0.905	0.056	0.034	0.005	0.000
MS002026	Art Gallery	0.905	0.056	0.034	0.005	0.000
MS002027	Roberts Building	0.907	0.055	0.034	0.005	0.000
MS002028	Briscoe Hall	0.902	0.054	0.038	0.006	0.000
MS002029	Freeman Hall	0.902	0.054	0.038	0.006	0.000
MS002030	Moore Hall	0.902	0.054	0.038	0.006	0.000
MS002031	Hill Poultry Science	0.903	0.054	0.038	0.006	0.000
MS002032	Stafford Hall	0.873	0.098	0.027	0.002	0.000
MS002033	Plant Pathology Greenhouse	0.920	0.069	0.010	0.001	0.000
MS002034	Davis-Wade Football Stadium	0.847	0.103	0.046	0.004	0.001
MS002035	Howell Agricultural Engineering	0.901	0.054	0.039	0.006	0.000
MS002036	McCarthy Gym	0.836	0.102	0.059	0.003	0.001
MS002037	Mitchell Memorial Library	0.722	0.211	0.055	0.011	0.001
MS002038	Patterson Engineering	0.876	0.089	0.033	0.002	0.000
MS002039	Newell-Grissom Building	0.906	0.055	0.034	0.005	0.000
MS002040	Sewage Treatment Plant	0.906	0.055	0.034	0.005	0.000
MS002041	Butler-Williams Building	0.739	0.130	0.108	0.022	0.001
MS002042	Petroleum Products Lab	0.837	0.101	0.058	0.003	0.001
MS002043	Etheredge Chemical Engineering	0.876	0.089	0.033	0.002	0.000
MS002044	Critz Hall	0.875	0.089	0.033	0.002	0.000
MS002045	Garner Hall	0.902	0.054	0.038	0.006	0.000
MS002046	Music Building "A"	0.877	0.084	0.036	0.002	0.001
MS002047	Music Building "B"	0.908	0.054	0.033	0.005	0.000
MS002048	Butler Hall	0.873	0.098	0.027	0.002	0.000
MS002049	McKee Hall	0.805	0.148	0.044	0.002	0.001
MS002050	Memorial Hall	0.875	0.090	0.033	0.002	0.000
MS002051	Sessums Hall	0.804	0.149	0.044	0.002	0.001
MS002052	Turman Field House	0.875	0.089	0.033	0.002	0.000
MS002053	Hilbun Hall	0.804	0.149	0.044	0.002	0.001
MS002054	Walker Engineering	0.876	0.089	0.033	0.002	0.000
MS002055	Cresswell Hall	0.806	0.147	0.044	0.002	0.001
MS002056	Raspet Flight Research Lab	0.741	0.129	0.108	0.022	0.001
MS002057	Ballew	0.876	0.089	0.033	0.002	0.000
MS002058	Hand Chemical Lab	0.806	0.148	0.044	0.002	0.001
MS002059	Colvard Student Union	0.875	0.089	0.033	0.002	0.000

Table 13 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002060	Aiken Village 20	0.873	0.091	0.034	0.002	0.000
MS002061	Aiken Village 21	0.873	0.091	0.034	0.002	0.000
MS002062	Aiken Village 22	0.873	0.091	0.034	0.002	0.000
MS002063	Aiken Village 23	0.873	0.091	0.034	0.002	0.000
MS002064	Aiken Village 24	0.873	0.091	0.034	0.002	0.000
MS002065	Aiken Village 25	0.873	0.091	0.034	0.002	0.000
MS002066	Aiken Village 26	0.873	0.091	0.034	0.002	0.000
MS002067	Aiken Village 27	0.872	0.091	0.034	0.002	0.000
MS002068	Aiken Village 28	0.872	0.091	0.034	0.002	0.000
MS002069	Aiken Village 30	0.873	0.091	0.034	0.002	0.000
MS002070	Aiken Village 31	0.873	0.091	0.034	0.002	0.000
MS002071	Aiken Village 32	0.873	0.091	0.034	0.002	0.000
MS002072	Aiken Village 33	0.872	0.091	0.034	0.002	0.000
MS002073	Aiken Village 34	0.872	0.091	0.034	0.002	0.000
MS002074	Aiken Village 35	0.872	0.091	0.034	0.002	0.000
MS002075	Aiken Village 36	0.872	0.091	0.034	0.002	0.000
MS002076	Aiken Village 37	0.872	0.091	0.034	0.002	0.000
MS002077	Longest Student Health Center	0.837	0.102	0.058	0.003	0.001
MS002078	Chapel of Memories	0.821	0.115	0.053	0.009	0.001
MS002079	Evans Hall	0.917	0.070	0.013	0.000	0.000
MS002080	Dorman Hall	0.804	0.149	0.044	0.002	0.001
MS002081	Polk-Dement Baseball Stadium	0.832	0.104	0.061	0.003	0.001
MS002082	Edwards Reactor Lab	0.880	0.079	0.039	0.002	0.000
MS002083	Hathorn Hall	0.807	0.147	0.044	0.002	0.001
MS002084	Music Building	0.908	0.054	0.033	0.005	0.000
MS002085	President`s Home	0.908	0.054	0.033	0.005	0.000
MS002086	Receiving Station	0.905	0.056	0.034	0.005	0.000
MS002087	Rice Hall	0.723	0.210	0.055	0.011	0.001
MS002088	Cooley Building	0.908	0.084	0.008	0.000	0.000
MS002089	Suttle Hall	0.719	0.213	0.056	0.011	0.002
MS002090	McArthur Hall	0.916	0.070	0.013	0.000	0.000
MS002091	GeoScience Storage Bldg	0.745	0.128	0.106	0.021	0.001
MS002092	Physical Plant Buckner Storage	0.745	0.128	0.106	0.021	0.001
MS002093	Scales Veterinary Science	0.839	0.101	0.057	0.003	0.001
MS002094	Clay Lyle Entomology Center	0.835	0.102	0.059	0.003	0.001
MS002095	Clay Lyle Greenhouse Lab	0.919	0.070	0.010	0.001	0.000
MS002096	Herzer Dairy Science	0.903	0.054	0.038	0.005	0.000
MS002097	Gast Rearing Lab	0.835	0.102	0.059	0.003	0.001
MS002098	Allen Hall	0.753	0.149	0.084	0.013	0.002
MS002099	Cobb Institute Of Archaeology	0.876	0.089	0.033	0.002	0.000
MS002100	Humphrey Coliseum	0.892	0.077	0.030	0.001	0.000
MS002101	McCool Hall	0.838	0.107	0.052	0.002	0.000
MS002102	Noble Pace Seed Technology	0.907	0.055	0.033	0.005	0.000
MS002103	Simrall Electrical Engineering	0.839	0.107	0.052	0.002	0.000
MS002104	Bost	0.917	0.070	0.013	0.000	0.000
MS002105	Sewage Lab	0.922	0.068	0.010	0.001	0.000
MS002106	Shira Field House	0.875	0.082	0.041	0.002	0.000
MS002107	CVM Large Animal Clinic	0.881	0.078	0.038	0.002	0.000
MS002108	Solvent Storage	0.745	0.128	0.106	0.021	0.001
MS002109	Wise Center	0.809	0.146	0.043	0.002	0.001
MS002110	Arbour Acres 1	0.876	0.096	0.026	0.002	0.000
MS002111	Arbour Acres 2	0.876	0.096	0.026	0.002	0.000
MS002112	Arbour Acres 3	0.876	0.096	0.026	0.002	0.000
MS002113	Arbour Acres 4	0.876	0.096	0.026	0.002	0.000
MS002114	Arbour Acres 5	0.876	0.096	0.026	0.002	0.000
MS002115	Arbour Acres 6	0.876	0.096	0.026	0.002	0.000
MS002116	Arbour Acres 7	0.876	0.096	0.026	0.002	0.000
MS002117	Transportation Shop	0.876	0.096	0.026	0.002	0.000
MS002118	Facilities Use /Support Services	0.876	0.096	0.026	0.002	0.000
MS002119	Campus Landscape Office	0.745	0.128	0.106	0.021	0.001

Table 13 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002120	Campus Landscape Shop	0.745	0.128	0.106	0.021	0.001
MS002121	Academic Advising Center	0.920	0.069	0.010	0.001	0.000
MS002122	McComas Hall	0.871	0.085	0.037	0.006	0.001
MS002123	Physical Plant Shop/Storage Building	0.738	0.131	0.109	0.022	0.001
MS002124	Cobb Institute Curation Facility	0.745	0.128	0.106	0.021	0.001
MS002125	Butler Guest House	0.906	0.055	0.034	0.005	0.000
MS002126	Comparative Biomedical Res Facility	0.876	0.096	0.026	0.002	0.000
MS002127	PGM Academic Facility	0.871	0.099	0.028	0.002	0.000
MS002128	Seal "M" Club Building	0.873	0.098	0.027	0.002	0.000
MS002129	Raspet Flight Research Lab Annex	0.873	0.098	0.027	0.002	0.000
MS002130	High Performance Computing Center	0.731	0.133	0.113	0.023	0.001
MS002132	Ammerman-Hearnsburger Food Processing	0.740	0.130	0.108	0.022	0.001
MS002133	Bryan Athletic Administration Bldg	0.904	0.056	0.035	0.005	0.000
MS002134	RCU Building	0.876	0.096	0.026	0.002	0.000
MS002135	Center For Writing & Thinking	0.737	0.131	0.109	0.022	0.001
MS002136	Plant & Soil Sciences Greenhouses	0.910	0.053	0.032	0.004	0.000
MS002137	Child Development & Family Studies Ctr	0.873	0.091	0.034	0.002	0.000
MS002138	ICET	0.868	0.101	0.029	0.002	0.000
MS002139	Sanderson Recreation Center	0.872	0.099	0.028	0.002	0.000
MS002140	Mississippi Horse Park/AgriCenter	0.889	0.087	0.022	0.001	0.000
MS002142	Swalm Chemical Engineering Bldg	0.839	0.107	0.052	0.002	0.000
MS002143	Landscape Architecture Seminar/Studio	0.741	0.129	0.108	0.022	0.001
MS002144	Landscape Architecture Freehand Studio	0.741	0.129	0.108	0.022	0.001
MS002145	Landscape Architecture Administration	0.741	0.129	0.108	0.022	0.001
MS002148	CAVS - Thad Cochran Research Park	0.912	0.052	0.031	0.004	0.000
MS002150	Power Generation Plant	0.878	0.080	0.040	0.002	0.000
MS002153	Ruby Hall	0.902	0.054	0.038	0.006	0.000
MS002154	Cullis Wade Depot	0.873	0.098	0.027	0.002	0.000
MS002155	Palmeiro Center	0.895	0.057	0.041	0.006	0.000
MS002156	Griffis Hall	0.895	0.075	0.029	0.001	0.000
MS002157	Hurst Hall	0.902	0.054	0.038	0.006	0.000
MS002158	Baseball Coaches Offices	0.895	0.057	0.041	0.006	0.000
MS002159	Building #3 - Northeast Village	0.902	0.054	0.038	0.006	0.000
MS002160	Band and Choral Rehearsal Hall	0.908	0.054	0.033	0.005	0.000
MS002161	Soccer Press Box	0.906	0.055	0.034	0.005	0.000
MS002162	Aerospace Engineering Motor Test	0.907	0.055	0.033	0.005	0.000
MS002163	Ag Engineering Processing Lab	0.735	0.131	0.110	0.023	0.001
MS002164	Int'l Security & Strategic Studies	0.911	0.081	0.007	0.000	0.000
MS002165	CVM Poultry House	0.745	0.128	0.105	0.021	0.001
MS002166	Campus Landscape Storage	0.912	0.081	0.007	0.000	0.000
MS002167	Bulldog 11-12	0.918	0.071	0.011	0.001	0.000
MS002168	Bulldog 13-14	0.918	0.071	0.011	0.001	0.000
MS002169	Bulldog 15-16	0.918	0.071	0.011	0.001	0.000
MS002170	Bulldog 17-18	0.918	0.071	0.011	0.001	0.000
MS002171	Bulldog 19-20	0.918	0.071	0.011	0.001	0.000
MS002172	Bulldog 21-22	0.918	0.071	0.011	0.001	0.000
MS002173	Bulldog 23-24	0.918	0.071	0.011	0.001	0.000
MS002174	Bulldog 25-26	0.918	0.071	0.011	0.001	0.000
MS002175	Bulldog 27-28	0.918	0.071	0.011	0.001	0.000
MS002176	Bulldog 29-30	0.918	0.071	0.011	0.001	0.000
MS002177	Bulldog 31-32	0.918	0.071	0.011	0.001	0.000
MS002178	Bulldog 33-34	0.918	0.071	0.011	0.001	0.000
MS002179	Bulldog 35-36	0.918	0.071	0.011	0.001	0.000
MS002180	Bulldog 37-38	0.918	0.071	0.011	0.001	0.000
MS002181	Bulldog 39-40	0.918	0.071	0.011	0.001	0.000
MS002182	Bulldog 41-42	0.918	0.071	0.011	0.001	0.000
MS002183	Bulldog 43-44	0.918	0.071	0.011	0.001	0.000
MS002184	Bulldog 45-46	0.918	0.071	0.011	0.001	0.000
MS002185	Bulldog 47-48	0.918	0.071	0.011	0.001	0.000
MS002186	Bulldog 49-50	0.918	0.071	0.011	0.001	0.000

Table 13 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002187	Bulldog 51-52	0.918	0.071	0.011	0.001	0.000
MS002188	Morgan 45	0.920	0.069	0.010	0.001	0.000
MS002189	Center For America's Veterans	0.920	0.069	0.010	0.001	0.000
MS002190	Transportation	0.920	0.069	0.010	0.001	0.000
MS002191	Stennis Institute	0.920	0.069	0.010	0.001	0.000
MS002192	History	0.920	0.069	0.010	0.001	0.000
MS002193	Comprehensive Testing Center	0.920	0.069	0.010	0.001	0.000
MS002194	Arbour Acres Laundry	0.920	0.069	0.010	0.001	0.000
MS002195	Magruder 58	0.920	0.069	0.010	0.001	0.000
MS002196	Magruder 59	0.920	0.069	0.010	0.001	0.000
MS002197	Magruder 60	0.920	0.069	0.010	0.001	0.000
MS002198	Magruder 61	0.920	0.069	0.010	0.001	0.000
MS002199	Morgan 48	0.920	0.069	0.010	0.001	0.000
MS002200	Center For Science & Mathematics	0.920	0.069	0.010	0.001	0.000
MS002201	Morgan 6-8	0.920	0.069	0.010	0.001	0.000
MS002202	Morgan 10	0.920	0.069	0.010	0.001	0.000
MS002203	Philosphy & Religion	0.920	0.069	0.010	0.001	0.000
MS002204	Faculty Housing	0.920	0.069	0.010	0.001	0.000
MS002205	Morgan 46	0.920	0.069	0.010	0.001	0.000
MS002206	Morgan 47	0.920	0.069	0.010	0.001	0.000
MS002207	Morgan 49	0.920	0.069	0.010	0.001	0.000
MS002208	Morgan 51	0.920	0.069	0.010	0.001	0.000
MS002209	Morgan 52	0.920	0.069	0.010	0.001	0.000
MS002210	Morgan 53	0.920	0.069	0.010	0.001	0.000
MS002211	Morgan 54-56	0.920	0.069	0.010	0.001	0.000
MS002212	Blackjack 16	0.921	0.068	0.010	0.001	0.000
MS002213	Morgan 55	0.920	0.069	0.010	0.001	0.000
MS002214	Morrill 880	0.920	0.069	0.010	0.001	0.000
MS002215	Morrill 880 Carport & Storage	0.920	0.069	0.010	0.001	0.000
MS002216	Blackjack 42	0.921	0.068	0.010	0.001	0.000
MS002217	Blackjack 44	0.921	0.068	0.010	0.001	0.000
MS002218	Early Childhood Institute	0.921	0.068	0.010	0.001	0.000
MS002219	Blackjack 48	0.921	0.068	0.010	0.001	0.000
MS002220	White 1	0.921	0.068	0.010	0.001	0.000
MS002221	White 3	0.916	0.072	0.011	0.001	0.000
MS002222	White 2	0.918	0.071	0.011	0.001	0.000
MS002223	White 4	0.918	0.071	0.011	0.001	0.000
MS002224	Maroon 5	0.918	0.070	0.011	0.001	0.000
MS002225	Maroon 6	0.918	0.070	0.011	0.001	0.000
MS002226	Maroon 7	0.918	0.070	0.011	0.001	0.000
MS002227	Maroon 8	0.918	0.070	0.011	0.001	0.000
MS002228	Maroon 9	0.918	0.070	0.011	0.001	0.000
MS002229	Maroon 10	0.918	0.070	0.011	0.001	0.000
MS002230	Electrical Engineering Storage	0.743	0.129	0.107	0.021	0.001
MS002231	Maroon 11-12	0.918	0.070	0.011	0.001	0.000
MS002232	Golf Course Shop & Storage	0.736	0.131	0.110	0.023	0.001
MS002233	Morrill 882	0.920	0.069	0.010	0.001	0.000
MS002234	Observatory	0.760	0.123	0.098	0.019	0.000
MS002235	Radioactive Storage Bldg	0.870	0.079	0.047	0.004	0.000
MS002236	Airport Storage-Large	0.739	0.130	0.108	0.022	0.001
MS002237	Water Well 1	0.876	0.088	0.033	0.002	0.000
MS002238	Water Well 2	0.876	0.089	0.033	0.002	0.000
MS002239	Water Well 3	0.920	0.069	0.010	0.001	0.000
MS002240	Hazardous/Radiological Waste/Stor	0.921	0.068	0.010	0.001	0.000
MS002241	Aiken Village Pavilion	0.917	0.071	0.011	0.001	0.000
MS002242	Aircraft Office- Hangers 1 & 2	0.739	0.130	0.108	0.022	0.001
MS002243	Aiken Village Shop & Storage	0.873	0.091	0.034	0.002	0.000
MS002244	Campus Landscape Equipment Building	0.745	0.128	0.106	0.021	0.001
MS002246	Maroon 4	0.918	0.070	0.011	0.001	0.000
MS002247	Sheely House	0.918	0.071	0.011	0.001	0.000

Table 13 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002248	East Road 893	0.920	0.069	0.010	0.001	0.000
MS002249	Hazardous Waste Storage Building	0.870	0.079	0.047	0.004	0.000
MS002250	Campus Landscape Storage & Office	0.745	0.128	0.106	0.021	0.001
MS002251	Support Services Storage & Office	0.745	0.128	0.106	0.021	0.001
MS002252	Small Ruminant Research Facility	0.745	0.128	0.105	0.021	0.001
MS002253	Golf Course Storage Building	0.918	0.070	0.011	0.001	0.000
MS002254	PGA Model Golf Facility	0.874	0.090	0.034	0.002	0.000
MS002255	18 East Drive	0.920	0.069	0.010	0.001	0.000
MS002256	Radio Transmission Tower Building	0.879	0.075	0.043	0.003	0.000
MS002257	Companion Animal Research Facility	0.745	0.128	0.105	0.021	0.001
MS002258	CVM Hay Barn	0.745	0.128	0.105	0.021	0.001
MS002259	Support Services Storage Bldg A	0.745	0.128	0.106	0.021	0.001
MS002260	Support Services Storage Bldg B	0.745	0.128	0.106	0.021	0.001
MS002261	CVM Cattle Working Facility	0.745	0.128	0.105	0.021	0.001
MS002262	Morrill 898	0.920	0.069	0.010	0.001	0.000
MS002263	ITS Computing Center Bldg-North	0.741	0.129	0.107	0.022	0.001
MS002264	ITS Computing Center Bldg-East	0.741	0.129	0.107	0.022	0.001
MS002265	ITS Computing Center Bldg-West	0.741	0.129	0.107	0.022	0.001
MS002266	Intramural Sports Office & Maintenance	0.878	0.094	0.026	0.002	0.000
MS002267	Intramural Softball Control Center	0.878	0.094	0.026	0.002	0.000
MS002268	Soccer Field Men/Women Restrooms	0.878	0.094	0.026	0.002	0.000
MS002275	Blackjack 827	0.919	0.070	0.011	0.001	0.000
MS002276	Blackjack 905	0.919	0.070	0.011	0.001	0.000
MS002277	Campus Landscape Chemical Storage Bldg	0.745	0.128	0.106	0.021	0.001
MS002278	MSU AgriCenter Fire Pump Building	0.882	0.073	0.042	0.003	0.000
MS002279	MSU AgriCenter Barn 1	0.768	0.120	0.094	0.018	0.000
MS002280	MSU AgriCenter Barn 2	0.768	0.120	0.094	0.018	0.000
MS002281	MSU AgriCenter Barn 3	0.768	0.120	0.094	0.018	0.000
MS002282	Student Life Center (Morrill 910)	0.920	0.069	0.010	0.001	0.000
MS002283	Campus Landscape Equipment Storage Bldg	0.745	0.128	0.106	0.021	0.001
MS002284	CVM Modular Research Building	0.881	0.078	0.038	0.002	0.000
MS002285	Blackjack 909	0.919	0.070	0.011	0.001	0.000
MS002286	CVM Aquatic Hatchery	0.868	0.080	0.048	0.004	0.000
MS002287	Raspet Generator Equipment Building	0.739	0.130	0.108	0.022	0.001
MS002288	Aircraft Hangar #3	0.739	0.130	0.108	0.022	0.001
MS002289	Morrill 902	0.920	0.069	0.010	0.001	0.000
MS002290	East 890	0.920	0.069	0.010	0.001	0.000
MS002291	HPCC Modular Annex #1	0.729	0.133	0.113	0.024	0.001
MS002292	HPCC Modular Annex #2	0.729	0.133	0.113	0.024	0.001
MS002293	MSU AgriCenter Covered Arena	0.768	0.120	0.094	0.018	0.000
MS002294	Oktoc 1242	0.921	0.068	0.010	0.001	0.000
MS002295	Raspet Flight Hanger #4	0.739	0.130	0.108	0.022	0.001
MS002296	Blackjack 906	0.919	0.070	0.011	0.001	0.000
MS002298	Old House by MSU Golf Course	0.900	0.085	0.014	0.001	0.000
MS002299	Women's Softball Practice Facility	0.912	0.052	0.032	0.004	0.000
MS002300	CAVS Dynamometer Lab	0.912	0.052	0.031	0.004	0.000
MS002301	Power Generation Electrical Rm Bldg B	0.907	0.055	0.034	0.005	0.000
MS002302	Power Generation Gas Compressor Bldg C	0.907	0.055	0.034	0.005	0.000

APPENDIX C

DAMAGE PROBABILITIES FOR THE LIST OF BUILDINGS STUDIED AT THE MISSISSIPPI STATE UNIVERSITY FOR AN EARTHQUAKE RESULTING IN APPROXIMATELY 0.2g PEAK GROUND ACCELERATION IN THE STUDY AREA

Table 14 Damage state probabilities of buildings for an earthquake producing 0.2g peak ground acceleration in the study area. (These tables are presented in the output format of HAZUS-MH MR3)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002000	Industrial Education	0.578	0.156	0.194	0.069	0.002
MS002001	George Hall	0.501	0.169	0.231	0.094	0.004
MS002002	Montgomery Hall	0.562	0.209	0.205	0.020	0.004
MS002003	McCain Engineering	0.503	0.169	0.230	0.094	0.004
MS002004	Middleton Hall	0.502	0.169	0.231	0.094	0.004
MS002005	Materials Testing Lab	0.577	0.156	0.194	0.070	0.002
MS002006	Lee Hall	0.561	0.209	0.205	0.020	0.004
MS002007	Carpenter Engineering	0.562	0.209	0.205	0.020	0.004
MS002008	YMCA & Post Office	0.592	0.196	0.190	0.019	0.004
MS002009	Perry Cafeteria	0.530	0.330	0.132	0.007	0.001
MS002010	Harned Hall	0.560	0.209	0.206	0.020	0.004
MS002011	Steam Plant	0.481	0.239	0.221	0.055	0.005
MS002012	Herbert Hall	0.482	0.239	0.221	0.054	0.005
MS002013	Stennis Institute	0.506	0.169	0.229	0.093	0.004
MS002014	Giles Hall	0.497	0.169	0.233	0.096	0.004
MS002015	Bowen Hall	0.482	0.239	0.221	0.054	0.005
MS002016	Lloyd-Ricks Building	0.561	0.209	0.205	0.020	0.004
MS002017	Flower Shop & Student Media Ctr	0.575	0.157	0.195	0.070	0.002
MS002018	Hull Hall	0.500	0.169	0.232	0.095	0.004
MS002019	Magruder Hall	0.501	0.169	0.231	0.095	0.004
MS002020	Band Hall	0.511	0.168	0.226	0.090	0.004
MS002021	Bedenbaugh Animal Laboratory	0.482	0.239	0.221	0.054	0.005
MS002022	Faculty Housing	0.686	0.235	0.072	0.007	0.000
MS002023	Box Building (formerly 35 Morrill Rd)	0.687	0.234	0.071	0.007	0.000
MS002024	Student Housing	0.570	0.157	0.198	0.072	0.003
MS002025	Art Gallery	0.570	0.157	0.198	0.072	0.003
MS002026	Art Gallery	0.570	0.157	0.198	0.072	0.003
MS002027	Roberts Building	0.575	0.157	0.195	0.070	0.002
MS002028	Briscoe Hall	0.498	0.169	0.233	0.096	0.004
MS002029	Freeman Hall	0.498	0.169	0.232	0.095	0.004
MS002030	Moore Hall	0.498	0.169	0.233	0.096	0.004
MS002031	Hill Poultry Science	0.503	0.169	0.230	0.094	0.004
MS002032	Stafford Hall	0.458	0.252	0.224	0.059	0.007
MS002033	Plant Pathology Greenhouse	0.686	0.234	0.072	0.007	0.000
MS002034	Davis-Wade Football Stadium	0.540	0.217	0.203	0.034	0.006
MS002035	Howell Agricultural Engineering	0.496	0.170	0.234	0.096	0.005
MS002036	McCarthy Gym	0.496	0.198	0.254	0.044	0.009
MS002037	Mitchell Memorial Library	0.314	0.366	0.240	0.066	0.014
MS002038	Patterson Engineering	0.481	0.239	0.221	0.055	0.005
MS002039	Newell-Grissom Building	0.576	0.157	0.195	0.070	0.002
MS002040	Sewage Treatment Plant	0.573	0.157	0.197	0.071	0.002
MS002041	Butler-Williams Building	0.318	0.185	0.316	0.164	0.017
MS002042	Petroleum Products Lab	0.497	0.197	0.253	0.043	0.009
MS002043	Etheredge Chemical Engineering	0.482	0.239	0.221	0.054	0.005
MS002044	Critz Hall	0.483	0.238	0.220	0.054	0.005
MS002045	Garner Hall	0.497	0.169	0.233	0.096	0.004
MS002046	Music Building "A"	0.569	0.210	0.179	0.032	0.010
MS002047	Music Building "B"	0.580	0.156	0.193	0.069	0.002
MS002048	Butler Hall	0.458	0.252	0.224	0.060	0.007
MS002049	McKee Hall	0.542	0.275	0.162	0.015	0.005
MS002050	Memorial Hall	0.482	0.239	0.220	0.054	0.005
MS002051	Sessums Hall	0.542	0.275	0.163	0.016	0.005
MS002052	Turman Field House	0.481	0.239	0.221	0.055	0.005
MS002053	Hilbun Hall	0.542	0.275	0.162	0.016	0.005
MS002054	Walker Engineering	0.481	0.239	0.221	0.055	0.005
MS002055	Cresswell Hall	0.548	0.273	0.159	0.015	0.004
MS002056	Raspet Flight Research Lab	0.332	0.187	0.310	0.155	0.016
MS002057	Ballew	0.482	0.239	0.220	0.054	0.005
MS002058	Hand Chemical Lab	0.547	0.274	0.160	0.015	0.004
MS002059	Colvard Student Union	0.481	0.239	0.221	0.055	0.005

Table 14 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002060	Aiken Village 20	0.478	0.239	0.223	0.055	0.005
MS002061	Aiken Village 21	0.478	0.239	0.223	0.056	0.005
MS002062	Aiken Village 22	0.478	0.239	0.223	0.056	0.005
MS002063	Aiken Village 23	0.478	0.239	0.223	0.056	0.005
MS002064	Aiken Village 24	0.477	0.239	0.223	0.056	0.005
MS002065	Aiken Village 25	0.477	0.239	0.223	0.056	0.005
MS002066	Aiken Village 26	0.477	0.239	0.223	0.056	0.005
MS002067	Aiken Village 27	0.477	0.239	0.223	0.056	0.005
MS002068	Aiken Village 28	0.476	0.239	0.224	0.056	0.005
MS002069	Aiken Village 30	0.477	0.239	0.223	0.056	0.005
MS002070	Aiken Village 31	0.477	0.239	0.223	0.056	0.005
MS002071	Aiken Village 32	0.477	0.239	0.223	0.056	0.005
MS002072	Aiken Village 33	0.476	0.239	0.224	0.056	0.005
MS002073	Aiken Village 34	0.476	0.239	0.224	0.056	0.005
MS002074	Aiken Village 35	0.476	0.239	0.224	0.056	0.005
MS002075	Aiken Village 36	0.476	0.239	0.224	0.056	0.005
MS002076	Aiken Village 37	0.476	0.239	0.224	0.056	0.005
MS002077	Longest Student Health Center	0.497	0.197	0.253	0.043	0.009
MS002078	Chapel of Memories	0.502	0.241	0.186	0.059	0.012
MS002079	Evans Hall	0.538	0.277	0.165	0.016	0.005
MS002080	Dorman Hall	0.545	0.275	0.161	0.015	0.005
MS002081	Polk-Dement Baseball Stadium	0.488	0.198	0.259	0.046	0.010
MS002082	Edwards Reactor Lab	0.523	0.184	0.240	0.046	0.007
MS002083	Hathorn Hall	0.549	0.273	0.158	0.015	0.004
MS002084	Music Building	0.580	0.156	0.193	0.069	0.002
MS002085	President`s Home	0.583	0.156	0.192	0.068	0.002
MS002086	Receiving Station	0.573	0.157	0.196	0.071	0.002
MS002087	Rice Hall	0.314	0.366	0.240	0.066	0.014
MS002088	Cooley Building	0.528	0.331	0.133	0.007	0.001
MS002089	Suttle Hall	0.310	0.366	0.243	0.067	0.014
MS002090	McArthur Hall	0.539	0.276	0.164	0.016	0.005
MS002091	GeoScience Storage Bldg	0.325	0.186	0.313	0.159	0.016
MS002092	Physical Plant Buckner Storage	0.325	0.186	0.313	0.159	0.016
MS002093	Scales Veterinary Science	0.504	0.197	0.249	0.042	0.009
MS002094	Clay Lyle Entomology Center	0.496	0.198	0.254	0.044	0.009
MS002095	Clay Lyle Greenhouse Lab	0.685	0.235	0.072	0.007	0.000
MS002096	Herzer Dairy Science	0.503	0.169	0.230	0.093	0.004
MS002097	Gast Rearing Lab	0.496	0.198	0.254	0.044	0.009
MS002098	Allen Hall	0.512	0.235	0.202	0.042	0.009
MS002099	Cobb Institute Of Archaeology	0.481	0.239	0.221	0.055	0.005
MS002100	Humphrey Coliseum	0.555	0.210	0.209	0.021	0.005
MS002101	McCool Hall	0.562	0.209	0.205	0.020	0.004
MS002102	Noble Pace Seed Technology	0.583	0.156	0.192	0.068	0.002
MS002103	Simrall Electrical Engineering	0.563	0.209	0.204	0.020	0.004
MS002104	Bost	0.540	0.276	0.163	0.016	0.005
MS002105	Sewage Lab	0.702	0.225	0.066	0.007	0.000
MS002106	Shira Field House	0.513	0.185	0.246	0.049	0.007
MS002107	CVM Large Animal Clinic	0.529	0.183	0.236	0.045	0.006
MS002108	Solvent Storage	0.325	0.186	0.313	0.159	0.016
MS002109	Wise Center	0.552	0.272	0.157	0.015	0.004
MS002110	Arbour Acres 1	0.465	0.251	0.220	0.057	0.007
MS002111	Arbour Acres 2	0.465	0.251	0.220	0.057	0.007
MS002112	Arbour Acres 3	0.465	0.251	0.220	0.057	0.007
MS002113	Arbour Acres 4	0.465	0.251	0.220	0.057	0.007
MS002114	Arbour Acres 5	0.465	0.251	0.220	0.057	0.007
MS002115	Arbour Acres 6	0.465	0.251	0.220	0.057	0.007
MS002116	Arbour Acres 7	0.465	0.251	0.220	0.057	0.007
MS002117	Transportation Shop	0.466	0.251	0.219	0.057	0.007
MS002118	Facilities Use /Support Services	0.465	0.251	0.220	0.057	0.007
MS002119	Campus Landscape Office	0.325	0.186	0.313	0.159	0.016

Table 14 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002120	Campus Landscape Shop	0.325	0.186	0.313	0.159	0.016
MS002121	Academic Advising Center	0.689	0.233	0.071	0.007	0.000
MS002122	McComas Hall	0.568	0.212	0.174	0.040	0.006
MS002123	Physical Plant Shop/Storage Building	0.318	0.185	0.316	0.164	0.017
MS002124	Cobb Institute Curation Facility	0.325	0.186	0.313	0.159	0.016
MS002125	Butler Guest House	0.574	0.157	0.196	0.071	0.002
MS002126	Comparative Biomedical Res Facility	0.468	0.251	0.218	0.056	0.007
MS002127	PGM Academic Facility	0.438	0.253	0.235	0.066	0.008
MS002128	Seal "M" Club Building	0.459	0.252	0.223	0.059	0.007
MS002129	Raspet Flight Research Lab Annex	0.470	0.251	0.217	0.056	0.006
MS002130	High Performance Computing Center	0.303	0.183	0.322	0.172	0.019
MS002132	Ammerman-Hearnsburger Food Processing	0.320	0.186	0.315	0.162	0.017
MS002133	Bryan Athletic Administration Bldg	0.563	0.158	0.202	0.075	0.003
MS002134	RCU Building	0.464	0.251	0.220	0.057	0.007
MS002135	Center For Writing & Thinking	0.317	0.185	0.316	0.164	0.017
MS002136	Plant & Soil Sciences Greenhouses	0.596	0.154	0.185	0.064	0.002
MS002137	Child Development & Family Studies Ctr	0.477	0.239	0.223	0.056	0.005
MS002138	ICET	0.445	0.253	0.231	0.064	0.008
MS002139	Sanderson Recreation Center	0.455	0.252	0.226	0.060	0.007
MS002140	Mississippi Horse Park/AgriCenter	0.498	0.248	0.201	0.048	0.005
MS002142	Swalm Chemical Engineering Bldg	0.563	0.209	0.204	0.020	0.004
MS002143	Landscape Architecture Seminar/Studio	0.321	0.186	0.315	0.162	0.017
MS002144	Landscape Architecture Freehand Studio	0.321	0.186	0.315	0.162	0.017
MS002145	Landscape Architecture Administration	0.321	0.186	0.315	0.162	0.017
MS002148	CAVS - Thad Cochran Research Park	0.550	0.160	0.208	0.079	0.003
MS002150	Power Generation Plant	0.523	0.184	0.240	0.046	0.007
MS002153	Ruby Hall	0.497	0.169	0.233	0.096	0.004
MS002154	Cullis Wade Depot	0.459	0.252	0.223	0.059	0.007
MS002155	Palmeiro Center	0.493	0.170	0.235	0.097	0.005
MS002156	Griffis Hall	0.557	0.210	0.208	0.021	0.005
MS002157	Hurst Hall	0.497	0.169	0.233	0.096	0.004
MS002158	Baseball Coaches Offices	0.494	0.170	0.235	0.097	0.005
MS002159	Building #3 - Northeast Village	0.497	0.169	0.233	0.096	0.004
MS002160	Band and Choral Rehearsal Hall	0.581	0.156	0.193	0.068	0.002
MS002161	Soccer Press Box	0.573	0.157	0.196	0.071	0.002
MS002162	Aerospace Engineering Motor Test	0.580	0.156	0.193	0.069	0.002
MS002163	Ag Engineering Processing Lab	0.313	0.185	0.318	0.166	0.018
MS002164	Int'l Security & Strategic Studies	0.535	0.328	0.129	0.007	0.001
MS002165	CVM Poultry House	0.327	0.186	0.312	0.158	0.016
MS002166	Campus Landscape Storage	0.537	0.327	0.128	0.006	0.001
MS002167	Bulldog 11-12	0.727	0.209	0.058	0.005	0.000
MS002168	Bulldog 13-14	0.727	0.209	0.058	0.005	0.000
MS002169	Bulldog 15-16	0.727	0.209	0.058	0.005	0.000
MS002170	Bulldog 17-18	0.727	0.209	0.058	0.005	0.000
MS002171	Bulldog 19-20	0.727	0.209	0.058	0.005	0.000
MS002172	Bulldog 21-22	0.727	0.209	0.058	0.005	0.000
MS002173	Bulldog 23-24	0.727	0.209	0.058	0.005	0.000
MS002174	Bulldog 25-26	0.727	0.209	0.058	0.005	0.000
MS002175	Bulldog 27-28	0.727	0.209	0.058	0.005	0.000
MS002176	Bulldog 29-30	0.727	0.209	0.058	0.005	0.000
MS002177	Bulldog 31-32	0.727	0.209	0.058	0.005	0.000
MS002178	Bulldog 33-34	0.727	0.209	0.058	0.006	0.000
MS002179	Bulldog 35-36	0.727	0.209	0.058	0.006	0.000
MS002180	Bulldog 37-38	0.725	0.210	0.059	0.006	0.000
MS002181	Bulldog 39-40	0.725	0.210	0.059	0.006	0.000
MS002182	Bulldog 41-42	0.725	0.210	0.059	0.006	0.000
MS002183	Bulldog 43-44	0.725	0.211	0.059	0.006	0.000
MS002184	Bulldog 45-46	0.725	0.211	0.059	0.006	0.000
MS002185	Bulldog 47-48	0.725	0.210	0.059	0.006	0.000
MS002186	Bulldog 49-50	0.725	0.210	0.059	0.006	0.000

Table 14 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002187	Bulldog 51-52	0.725	0.210	0.059	0.006	0.000
MS002188	Morgan 45	0.691	0.231	0.070	0.007	0.000
MS002189	Center For America's Veterans	0.689	0.233	0.071	0.007	0.000
MS002190	Transportation	0.689	0.233	0.071	0.007	0.000
MS002191	Stennis Institute	0.689	0.233	0.070	0.007	0.000
MS002192	History	0.689	0.233	0.071	0.007	0.000
MS002193	Comprehensive Testing Center	0.690	0.232	0.070	0.007	0.000
MS002194	Arbour Acres Laundry	0.689	0.233	0.071	0.007	0.000
MS002195	Magruder 58	0.689	0.233	0.071	0.007	0.000
MS002196	Magruder 59	0.689	0.233	0.071	0.007	0.000
MS002197	Magruder 60	0.689	0.233	0.071	0.007	0.000
MS002198	Magruder 61	0.689	0.233	0.071	0.007	0.000
MS002199	Morgan 48	0.691	0.231	0.070	0.007	0.000
MS002200	Center For Science & Mathematics	0.685	0.235	0.072	0.007	0.000
MS002201	Morgan 6-8	0.691	0.231	0.070	0.007	0.000
MS002202	Morgan 10	0.690	0.232	0.070	0.007	0.000
MS002203	Philosphy & Religion	0.690	0.232	0.070	0.007	0.000
MS002204	Faculty Housing	0.689	0.233	0.070	0.007	0.000
MS002205	Morgan 46	0.691	0.231	0.070	0.007	0.000
MS002206	Morgan 47	0.691	0.231	0.070	0.007	0.000
MS002207	Morgan 49	0.691	0.231	0.070	0.007	0.000
MS002208	Morgan 51	0.691	0.231	0.070	0.007	0.000
MS002209	Morgan 52	0.689	0.233	0.071	0.007	0.000
MS002210	Morgan 53	0.689	0.233	0.071	0.007	0.000
MS002211	Morgan 54-56	0.689	0.233	0.071	0.007	0.000
MS002212	Blackjack 16	0.692	0.231	0.070	0.007	0.000
MS002213	Morgan 55	0.689	0.233	0.071	0.007	0.000
MS002214	Morrill 880	0.687	0.234	0.071	0.007	0.000
MS002215	Morrill 880 Carport & Storage	0.687	0.234	0.071	0.007	0.000
MS002216	Blackjack 42	0.692	0.231	0.070	0.007	0.000
MS002217	Blackjack 44	0.692	0.231	0.070	0.007	0.000
MS002218	Early Childhood Institute	0.692	0.231	0.070	0.007	0.000
MS002219	Blackjack 48	0.692	0.231	0.070	0.007	0.000
MS002220	White 1	0.785	0.170	0.041	0.003	0.000
MS002221	White 3	0.724	0.211	0.059	0.006	0.000
MS002222	White 2	0.726	0.210	0.059	0.006	0.000
MS002223	White 4	0.726	0.210	0.059	0.006	0.000
MS002224	Maroon 5	0.730	0.207	0.057	0.005	0.000
MS002225	Maroon 6	0.730	0.207	0.057	0.005	0.000
MS002226	Maroon 7	0.730	0.207	0.057	0.005	0.000
MS002227	Maroon 8	0.730	0.207	0.057	0.005	0.000
MS002228	Maroon 9	0.730	0.207	0.057	0.005	0.000
MS002229	Maroon 10	0.730	0.207	0.057	0.005	0.000
MS002230	Electrical Engineering Storage	0.321	0.186	0.315	0.161	0.017
MS002231	Maroon 11-12	0.730	0.207	0.057	0.005	0.000
MS002232	Golf Course Shop & Storage	0.296	0.182	0.324	0.177	0.020
MS002233	Morrill 882	0.687	0.234	0.071	0.007	0.000
MS002234	Observatory	0.346	0.188	0.305	0.147	0.014
MS002235	Radioactive Storage Bldg	0.483	0.176	0.256	0.078	0.007
MS002236	Airport Storage-Large	0.329	0.187	0.311	0.157	0.016
MS002237	Water Well 1	0.483	0.238	0.220	0.054	0.005
MS002238	Water Well 2	0.482	0.239	0.221	0.054	0.005
MS002239	Water Well 3	0.751	0.193	0.051	0.005	0.000
MS002240	Hazardous/Radiological Waste/Stor	0.696	0.228	0.068	0.007	0.000
MS002241	Aiken Village Pavilion	0.732	0.206	0.057	0.005	0.000
MS002242	Aircraft Office- Hangers 1 & 2	0.329	0.187	0.311	0.157	0.016
MS002243	Aiken Village Shop & Storage	0.477	0.239	0.223	0.056	0.005
MS002244	Campus Landscape Equipment Building	0.325	0.186	0.313	0.159	0.016
MS002246	Maroon 4	0.729	0.208	0.058	0.005	0.000
MS002247	Sheely House	0.726	0.210	0.058	0.006	0.000

Table 14 (Continued)

ID Number	Name	None	Slight	Moderate	Extensive	Complete
MS002248	East Road 893	0.746	0.197	0.052	0.005	0.000
MS002249	Hazardous Waste Storage Building	0.483	0.176	0.256	0.078	0.007
MS002250	Campus Landscape Storage & Office	0.325	0.186	0.313	0.159	0.016
MS002251	Support Services Storage & Office	0.325	0.186	0.313	0.159	0.016
MS002252	Small Ruminant Research Facility	0.327	0.186	0.312	0.158	0.016
MS002253	Golf Course Storage Building	0.711	0.219	0.063	0.006	0.000
MS002254	PGA Model Golf Facility	0.461	0.241	0.232	0.060	0.005
MS002255	18 East Drive	0.745	0.197	0.052	0.005	0.000
MS002256	Radio Transmission Tower Building	0.493	0.176	0.251	0.074	0.007
MS002257	Companion Animal Research Facility	0.327	0.186	0.312	0.158	0.016
MS002258	CVM Hay Barn	0.327	0.186	0.312	0.158	0.016
MS002259	Support Services Storage Bldg A	0.325	0.186	0.313	0.159	0.016
MS002260	Support Services Storage Bldg B	0.325	0.186	0.313	0.159	0.016
MS002261	CVM Cattle Working Facility	0.327	0.186	0.312	0.158	0.016
MS002262	Morrill 898	0.687	0.234	0.071	0.007	0.000
MS002263	ITS Computing Center Bldg-North	0.320	0.186	0.315	0.162	0.017
MS002264	ITS Computing Center Bldg-East	0.320	0.186	0.315	0.162	0.017
MS002265	ITS Computing Center Bldg-West	0.320	0.186	0.315	0.162	0.017
MS002266	Intramural Sports Office & Maintenance	0.472	0.251	0.216	0.055	0.006
MS002267	Intramural Softball Control Center	0.472	0.251	0.216	0.055	0.006
MS002268	Soccer Field Men/Women Restrooms	0.472	0.251	0.216	0.055	0.006
MS002275	Blackjack 827	0.685	0.235	0.072	0.007	0.000
MS002276	Blackjack 905	0.686	0.235	0.072	0.007	0.000
MS002277	Campus Landscape Chemical Storage Bldg	0.325	0.186	0.313	0.159	0.016
MS002278	MSU AgriCenter Fire Pump Building	0.510	0.175	0.241	0.068	0.006
MS002279	MSU AgriCenter Barn 1	0.359	0.189	0.299	0.141	0.013
MS002280	MSU AgriCenter Barn 2	0.359	0.189	0.299	0.141	0.013
MS002281	MSU AgriCenter Barn 3	0.359	0.189	0.299	0.141	0.013
MS002282	Student Life Center (Morrill 910)	0.687	0.234	0.071	0.007	0.000
MS002283	Campus Landscape Equipment Storage Bldg	0.325	0.186	0.313	0.159	0.016
MS002284	CVM Modular Research Building	0.529	0.183	0.236	0.045	0.006
MS002285	Blackjack 909	0.686	0.235	0.072	0.007	0.000
MS002286	CVM Aquatic Hatchery	0.479	0.176	0.258	0.079	0.008
MS002287	Raspet Generator Equipment Building	0.329	0.187	0.311	0.157	0.016
MS002288	Aircraft Hangar #3	0.329	0.187	0.311	0.157	0.016
MS002289	Morrill 902	0.687	0.234	0.071	0.007	0.000
MS002290	East 890	0.745	0.197	0.052	0.005	0.000
MS002291	HPCC Modular Annex #1	0.300	0.183	0.323	0.174	0.020
MS002292	HPCC Modular Annex #2	0.301	0.183	0.323	0.174	0.020
MS002293	MSU AgriCenter Covered Arena	0.359	0.189	0.299	0.141	0.013
MS002294	Oktoc 1242	0.695	0.229	0.069	0.007	0.000
MS002295	Raspet Flight Hanger #4	0.329	0.187	0.311	0.157	0.016
MS002296	Blackjack 906	0.686	0.235	0.072	0.007	0.000
MS002298	Old House by MSU Golf Course	0.736	0.203	0.055	0.005	0.000
MS002299	Women's Softball Practice Facility	0.550	0.160	0.208	0.079	0.003
MS002300	CAVS Dynamometer Lab	0.550	0.160	0.208	0.079	0.003
MS002301	Power Generation Electrical Rm Bldg B	0.582	0.156	0.192	0.068	0.002
MS002302	Power Generation Gas Compressor Bldg C	0.582	0.156	0.192	0.068	0.002