

Hazus-MH: Earthquake Event Report

Region Name: Spartanburg_55M

Earthquake Scenario: Spartanburg 5.5M

Print Date: May 24, 2016

Disclaimer:

This version of Hazus utilizes 2010 Census Data.

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 8 county(ies) from the following state(s):

South Carolina

Note:

Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 5,043.82 square miles and contains 304 census tracts. There are over 488 thousand households in the region which has a total population of 1,264,809 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 517 thousand buildings in the region with a total building replacement value (excluding contents) of 131,741 (millions of dollars). Approximately 92.00 % of the buildings (and 77.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 16,476 and 9,728 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 517 thousand buildings in the region which have an aggregate total replacement value of 131,741 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 70% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 26 hospitals in the region with a total bed capacity of 3,280 beds. There are 402 schools, 118 fire stations, 56 police stations and 8 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 5,647 hazardous material sites, 0 military installations and 1 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 26,204.00 (millions of dollars). This inventory includes over 2,664 kilometers of highways, 2,806 bridges, 10,764 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	2,806	1,822.00
	Segments	761	13,160.70
	Tunnels	0	0.00
	Subtotal		14,982.70
Railways	Bridges	7	17.20
	Facilities	15	39.90
	Segments	410	916.50
	Tunnels	0	0.00
	Subtotal		973.70
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	8	7.20
	Subtotal		7.20
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	9	95.90
	Runways	11	417.60
	Subtotal		513.50
		Total	16,477.00

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	1,016.30
	Facilities	262	2,015.50
	Pipelines	15,626	2,255.00
		Subtotal	5,286.80
Waste Water	Distribution Lines	NA	609.80
	Facilities	445	109.50
	Pipelines	13,106	1,818.20
		Subtotal	2,537.40
Natural Gas	Distribution Lines	NA	406.50
	Facilities	1	893.80
	Pipelines	44	286.70
		Subtotal	1,587.10
Oil Systems	Facilities	15	26.80
	Pipelines	9	83.30
		Subtotal	110.10
Electrical Power	Facilities	131	2,165.40
		Subtotal	2,165.40
Communication	Facilities	46	74.00
		Subtotal	74.00
		Total	11,760.80

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Spartanburg 5.5M
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-81.78
Latitude of Epicenter	34.92
Earthquake Magnitude	5.50
Depth (Km)	5.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 20,173 buildings will be at least moderately damaged. This is over 4.00 % of the buildings in the region. There are an estimated 742 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1,147	0.25	102	0.29	59	0.37	18	0.50	4	0.60
Commercial	20,879	4.52	1,955	5.64	1,411	8.90	485	13.51	124	16.73
Education	788	0.17	66	0.19	50	0.31	17	0.46	4	0.58
Government	614	0.13	66	0.19	59	0.37	22	0.62	6	0.75
Industrial	7,073	1.53	603	1.74	453	2.86	158	4.41	41	5.51
Other Residential	82,071	17.75	9,711	28.02	6,798	42.91	1,675	46.68	334	44.91
Religion	2,742	0.59	245	0.71	150	0.94	49	1.36	12	1.62
Single Family	347,075	75.06	21,904	63.21	6,864	43.33	1,165	32.46	218	29.30
Total	462,390		34,651		15,843		3,588		743	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	337,352	72.96	20,245	58.42	5,482	34.60	629	17.54	42	5.66
Steel	15,347	3.32	1,240	3.58	1,049	6.62	380	10.60	100	13.50
Concrete	2,664	0.58	209	0.60	195	1.23	69	1.92	17	2.25
Precast	1,029	0.22	90	0.26	97	0.61	48	1.33	9	1.16
RM	3,903	0.84	240	0.69	240	1.52	110	3.05	13	1.71
URM	33,900	7.33	4,010	11.57	2,566	16.20	854	23.80	272	36.55
MH	68,195	14.75	8,618	24.87	6,214	39.22	1,498	41.75	291	39.16
Total	462,390		34,651		15,843		3,588		743	

*Note:

RM Reinforced Masonry
 URM Unreinforced Masonry
 MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 3,280 hospital beds available for use. On the day of the earthquake, the model estimates that only 2,350 hospital beds (72.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 85.00% of the beds will be back in service. By 30 days, 95.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	26	2	0	22
Schools	402	32	0	337
EOCs	8	1	0	7
PoliceStations	56	1	0	50
FireStations	118	8	0	98

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Locations/ Segments	Number of Locations_			
			With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	761	0	0	761	761
	Bridges	2,806	110	0	2,698	2,753
	Tunnels	0	0	0	0	0
Railways	Segments	410	0	0	410	410
	Bridges	7	0	0	7	7
	Tunnels	0	0	0	0	0
	Facilities	15	0	0	15	15
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	8	0	0	8	8
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	9	0	0	9	9
	Runways	11	0	0	11	11

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	262	12	0	233	260
Waste Water	445	48	0	379	440
Natural Gas	1	0	0	1	1
Oil Systems	15	15	0	0	0
Electrical Power	131	1	0	103	106
Communication	46	6	0	46	46

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,575	197	49
Waste Water	3,633	172	43
Natural Gas	440	6	2
Oil	117	6	1

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	488,763	0	0	0	0	0
Electric Power		22,773	10,154	3,447	1,010	490

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.63 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 51.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 25,160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1,343 households to be displaced due to the earthquake. Of these, 936 people (out of a total population of 1,264,809) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	5	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	11	2	0	1
	Other-Residential	173	32	3	6
	Single Family	178	31	4	7
	Total	368	66	7	13
2 PM	Commercial	298	65	8	16
	Commuting	2	2	3	1
	Educational	136	30	4	8
	Hotels	0	0	0	0
	Industrial	84	18	2	5
	Other-Residential	41	8	1	1
	Single Family	43	8	1	2
	Total	604	131	20	33
5 PM	Commercial	217	47	6	12
	Commuting	28	33	60	11
	Educational	14	3	0	1
	Hotels	0	0	0	0
	Industrial	52	11	1	3
	Other-Residential	65	12	1	2
	Single Family	70	13	2	3
	Total	446	119	71	32

Economic Loss

The total economic loss estimated for the earthquake is 2,346.53 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 2,178.38 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 52 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	7.65	75.99	4.83	7.49	95.96
	Capital-Related	0.00	3.20	62.11	3.02	1.44	69.77
	Rental	12.33	18.18	37.69	2.06	3.16	73.41
	Relocation	45.33	23.87	62.64	9.19	22.66	163.68
	Subtotal	57.65	52.91	238.42	19.09	34.75	402.82
Capital Stock Losses							
	Structural	97.81	44.15	82.75	28.88	20.48	274.08
	Non_Structural	469.64	168.41	222.44	95.15	62.87	1,018.52
	Content	191.84	43.25	123.83	69.10	36.41	464.43
	Inventory	0.00	0.00	3.40	14.86	0.27	18.54
	Subtotal	759.30	255.81	432.43	207.99	120.04	1,775.56
	Total	816.95	308.72	670.85	227.09	154.78	2,178.38

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	13,160.66	\$0.00	0.00
	Bridges	1,822.04	\$36.91	2.03
	Tunnels	0.00	\$0.00	0.00
	Subtotal	14982.70	36.90	
Railways	Segments	916.50	\$0.00	0.00
	Bridges	17.23	\$0.03	0.18
	Tunnels	0.00	\$0.00	0.00
	Facilities	39.95	\$3.48	8.72
	Subtotal	973.70	3.50	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	7.15	\$1.20	16.85
	Subtotal	7.20	1.20	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	95.86	\$5.82	6.07
	Runways	417.60	\$0.00	0.00
	Subtotal	513.50	5.80	
	Total	16477.00	47.50	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	2,255.00	\$0.51	0.02
	Facilities	2,015.50	\$49.73	2.47
	Distribution Lines	1,016.30	\$3.76	0.37
	Subtotal	5,286.79	\$54.00	
Waste Water	Pipelines	1,818.20	\$0.52	0.03
	Facilities	109.50	\$3.57	3.26
	Distribution Lines	609.80	\$2.70	0.44
	Subtotal	2,537.42	\$6.79	
Natural Gas	Pipelines	286.70	\$0.05	0.02
	Facilities	893.80	\$31.19	3.49
	Distribution Lines	406.50	\$0.77	0.19
	Subtotal	1,587.06	\$32.02	
Oil Systems	Pipelines	83.30	\$0.04	0.05
	Facilities	26.80	\$10.06	37.52
	Subtotal	110.09	\$10.10	
Electrical Power	Facilities	2,165.40	\$14.38	0.66
	Subtotal	2,165.45	\$14.38	
Communication	Facilities	74.00	\$3.41	4.61
	Subtotal	73.96	\$3.41	
Total		11,760.78	\$120.69	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of \$)

LOSS	Total	%

Appendix A: County Listing for the Region

Cherokee,SC

Chester,SC

Greenville,SC

Laurens,SC

Pickens,SC

Spartanburg,SC

Union,SC

York,SC

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina	Cherokee	55,342	3,275	1,147	4,422
	Chester	33,140	2,054	657	2,712
	Greenville	451,225	38,889	11,726	50,615
	Laurens	66,537	4,441	1,299	5,740
	Pickens	119,224	9,101	2,388	11,489
	Spartanburg	284,307	22,494	8,026	30,520
	Union	28,961	1,969	591	2,560
	York	226,073	19,563	4,115	23,679
Total State		1,264,809	101,786	29,949	131,737
Total Region		1,264,809	101,786	29,949	131,737