

Hazus-MH: Earthquake Event Report

Region Name: Cheraw_55M

Earthquake Scenario: Cheraw_5.5M_Plan

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 9 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 5,267.63 square miles and contains 116 census tracts. There are over 193 thousand households in the region which has a total population of 503,926 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 219 thousand buildings in the region with a total building replacement value (excluding contents) of 43,522 (millions of dollars). Approximately 93.00 % of the buildings (and 76.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 10,792 and 4,386 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 219 thousand buildings in the region which have an aggregate total replacement value of 43,522 (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 62% 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 16 hospitals in the region with a total bed capacity of 1,723 beds. There are 202 schools, 86 fire stations, 36 police stations and 9 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 2,304 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 15,178.00 (millions of dollars). This inventory includes over 1,967 kilometers of highways, 1,541 bridges, 7,338 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	1,541	1,118.60
	Segments	422	8,279.60
	Tunnels	0	0.00
	Subtotal		9,398.10
Railways	Bridges	3	20.10
	Facilities	5	13.30
	Segments	250	568.40
	Tunnels	0	0.00
	Subtotal		601.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	10	8.90
	Subtotal		8.90
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	13	138.50
	Runways	17	645.40
	Subtotal		783.90
		Total	10,792.80

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	398.00
	Facilities	416	1,226.80
	Pipelines	9,186	1,160.00
		Subtotal	2,784.80
Waste Water	Distribution Lines	NA	238.80
	Facilities	318	31.20
	Pipelines	9,267	926.90
		Subtotal	1,196.90
Natural Gas	Distribution Lines	NA	159.20
	Facilities	0	0.00
	Pipelines	105	307.30
		Subtotal	466.50
Oil Systems	Facilities	1	1.80
	Pipelines	0	0.00
		Subtotal	1.80
Electrical Power	Facilities	43	711.20
		Subtotal	711.20
Communication	Facilities	39	20.70
		Subtotal	20.70
		Total	5,182.00

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	Cheraw_5.5M_Plan
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-79.83
Latitude of Epicenter	34.60
Earthquake Magnitude	5.50
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 7,461 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 272 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	706	0.35	44	0.35	21	0.36	6	0.45	1	0.46
Commercial	8,638	4.33	599	4.72	376	6.32	128	10.32	39	14.17
Education	378	0.19	23	0.18	14	0.23	4	0.32	1	0.40
Government	295	0.15	22	0.17	17	0.28	7	0.58	2	0.90
Industrial	2,330	1.17	144	1.14	96	1.61	34	2.71	10	3.68
Other Residential	53,504	26.83	5,449	42.93	3,432	57.72	715	57.51	149	54.89
Religion	1,361	0.68	92	0.73	54	0.90	19	1.49	6	2.09
Single Family	132,194	66.29	6,319	49.79	1,937	32.57	331	26.61	64	23.41
Total	199,405		12,693		5,945		1,244		272	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	128,460	64.42	5763	45.40	1,510	25.40	178	14.33	13	4.70
Steel	6,116	3.07	362	2.85	260	4.38	96	7.75	31	11.23
Concrete	1,046	0.52	63	0.50	49	0.83	19	1.50	6	2.03
Precast	404	0.20	29	0.23	28	0.47	13	1.03	3	1.07
RM	1,550	0.78	76	0.60	68	1.15	30	2.43	5	1.66
URM	13,297	6.67	1290	10.17	772	12.98	246	19.74	81	29.68
MH	48,531	24.34	5109	40.25	3,258	54.80	662	53.22	135	49.64
Total	199,405		12,693		5,945		1,244		272	

*Note:

RM Reinforced Masonry
 URM Unreinforced Masonry
 MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,723 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,213 hospital beds (70.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 83.00% of the beds will be back in service. By 30 days, 94.00% 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	16	3	0	13
Schools	202	10	0	186
EOCs	9	1	0	8
PoliceStations	36	2	0	32
FireStations	86	4	0	79

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	422	0	0	422	422
	Bridges	1,541	55	0	1,487	1,511
	Tunnels	0	0	0	0	0
Railways	Segments	250	0	0	250	250
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	5	0	0	5	5
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	10	0	0	10	10
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	13	1	0	12	13
	Runways	17	0	0	17	17

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	416	41	0	372	416
Waste Water	318	19	0	299	318
Natural Gas	0	0	0	0	0
Oil Systems	1	1	0	0	1
Electrical Power	43	0	0	22	22
Communication	39	2	0	38	39

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	4,482	68	17
Waste Water	2,207	72	18
Natural Gas	649	9	2
Oil	0	0	0

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	193,143	0	0	0	0	0
Electric Power		6,296	3,009	1,082	333	187

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 0.18 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 52.00% 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 7,240 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 340 households to be displaced due to the earthquake. Of these, 289 people (out of a total population of 503,926) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	70	12	1	2
	Single Family	51	9	1	2
	Total	125	22	2	4
2 PM	Commercial	82	18	2	5
	Commuting	1	1	1	0
	Educational	44	10	1	3
	Hotels	0	0	0	0
	Industrial	29	7	1	2
	Other-Residential	18	3	0	1
	Single Family	13	2	0	1
	Total	187	41	6	10
5 PM	Commercial	61	13	2	3
	Commuting	7	9	16	3
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	18	4	1	1
	Other-Residential	26	5	0	1
	Single Family	20	4	0	1
	Total	133	35	19	9

Economic Loss

The total economic loss estimated for the earthquake is 644.90 (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 537.42 (millions of dollars); 19 % 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 53 % 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	2.94	16.09	1.66	1.88	22.57
	Capital-Related	0.00	1.23	12.67	1.01	0.42	15.33
	Rental	3.26	5.18	8.31	0.57	0.89	18.21
	Relocation	11.95	9.26	13.52	2.25	6.50	43.48
	Subtotal	15.21	18.61	50.58	5.48	9.69	99.59
Capital Stock Losses							
	Structural	22.79	15.42	18.34	8.48	6.19	71.24
	Non_Structural	106.92	49.09	45.95	28.78	18.41	249.15
	Content	42.90	11.28	25.31	20.92	10.43	110.83
	Inventory	0.00	0.00	1.03	5.49	0.09	6.61
	Subtotal	172.62	75.79	90.63	63.67	35.12	437.83
	Total	187.83	94.41	141.21	69.16	44.82	537.42

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	8,279.56	\$0.00	0.00
	Bridges	1,118.58	\$12.34	1.10
	Tunnels	0.00	\$0.00	0.00
	Subtotal	9398.10	12.30	
Railways	Segments	568.41	\$0.00	0.00
	Bridges	20.12	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	13.32	\$0.46	3.45
	Subtotal	601.80	0.50	
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	8.94	\$0.52	5.78
	Subtotal	8.90	0.50	
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	138.46	\$13.71	9.90
	Runways	645.39	\$0.00	0.00
	Subtotal	783.90	13.70	
	Total	10792.80	27.00	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	1,160.00	\$0.14	0.01
	Facilities	1,226.80	\$74.52	6.07
	Distribution Lines	398.00	\$1.02	0.26
	Subtotal	2,784.83	\$75.67	
Waste Water	Pipelines	926.90	\$0.19	0.02
	Facilities	31.20	\$1.52	4.87
	Distribution Lines	238.80	\$0.73	0.31
	Subtotal	1,196.93	\$2.45	
Natural Gas	Pipelines	307.30	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	159.20	\$0.21	0.13
	Subtotal	466.53	\$0.21	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.80	\$0.32	17.87
	Subtotal	1.79	\$0.32	
Electrical Power	Facilities	711.20	\$1.53	0.21
	Subtotal	711.17	\$1.53	
Communication	Facilities	20.70	\$0.28	1.35
	Subtotal	20.75	\$0.28	
Total		5,181.99	\$80.46	

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

Chesterfield,SC

Darlington,SC

Dillon,SC

Florence,SC

Kershaw,SC

Lancaster,SC

Lee,SC

Marion,SC

Marlboro,SC

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina	Chesterfield	46,734	2,764	842	3,607
	Darlington	68,681	4,450	1,428	5,878
	Dillon	32,062	1,612	551	2,163
	Florence	136,885	9,672	3,713	13,385
	Kershaw	61,697	4,571	1,039	5,611
	Lancaster	76,652	5,646	1,251	6,898
	Lee	19,220	930	300	1,230
	Marion	33,062	1,966	722	2,688
	Marlboro	28,933	1,575	481	2,057
Total State		503,926	33,186	10,327	43,517
Total Region		503,926	33,186	10,327	43,517