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Hazus: Earthquake Global Risk Report

Region Name: HardinCo

Earthquake Scenario: Hardin Co 5 Mag, 5 km depth

Print Date: December 13, 2022

Disclaimer:

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-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard 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 multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Ohio

Note:

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

The geographical size of the region is 470.61 square miles and contains 8 census tracts. There are over 11 thousand households in the region which has a total population of 30,696 people. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 5,771 (millions of dollars). Approximately 92.00 % of the buildings (and 64.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,186 and 2,256 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 5,771 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 66% 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 1 hospitals in the region with a total bed capacity of 25 beds. There are 23 schools, 9 fire stations, 5 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no 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 3,442.00 (millions of dollars). This inventory includes over 84.51 miles of highways, 267 bridges, 1,660.92 miles of pipes.

Table 1: Transportation System Lifeline Inventory

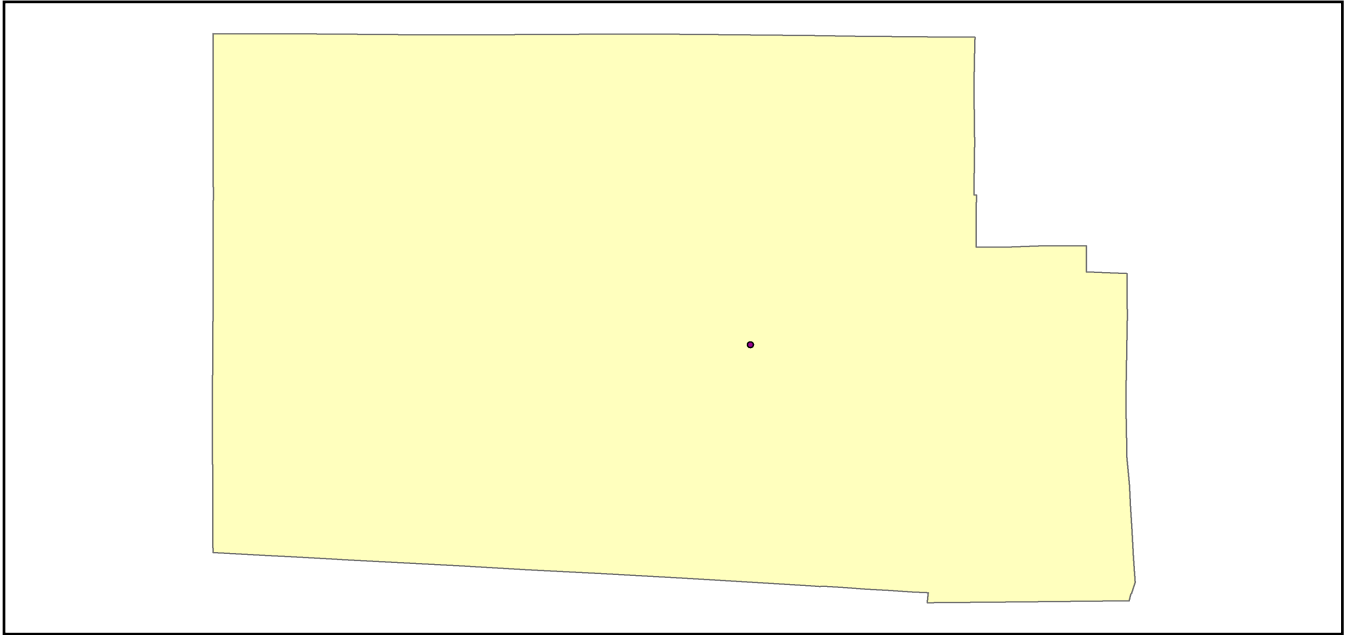
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	267	146.0281
	Segments	24	624.0247
	Tunnels	0	0.0000
	Subtotal		770.0528
Railways	Bridges	39	177.0600
	Facilities	0	0.0000
	Segments	65	227.3823
	Tunnels	0	0.0000
	Subtotal		404.4423
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		0.0000
Bus	Facilities	0	0.0000
	Subtotal		0.0000
Ferry	Facilities	0	0.0000
	Subtotal		0.0000
Port	Facilities	0	0.0000
	Subtotal		0.0000
Airport	Facilities	1	5.3000
	Runways	2	7.0974
	Subtotal		12.3974
		Total	1,186.90

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	32.6085
	Facilities	0	0.0000
	Pipelines	0	0.0000
	Subtotal		32.6085
Waste Water	Distribution Lines	NA	19.5651
	Facilities	13	1783.5844
	Pipelines	0	0.0000
	Subtotal		1803.1495
Natural Gas	Distribution Lines	NA	13.0434
	Facilities	0	0.0000
	Pipelines	8	290.6538
	Subtotal		303.6972
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
	Subtotal		0.0000
Electrical Power	Facilities	3	116.5897
	Subtotal		116.5897
Communication	Facilities	2	0.2100
	Subtotal		0.2100
		Total	2,256.30

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	Hardin Co 5 Mag, 5 km depth
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-83.61
Latitude of Epicenter	40.65
Earthquake Magnitude	5.00
Depth (km)	5.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Direct Earthquake Damage

Building Damage

Hazus estimates that about 2,794 buildings will be at least moderately damaged. This is over 19.00 % of the buildings in the region. There are an estimated 181 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.

Damage Categories by General Occupancy Type

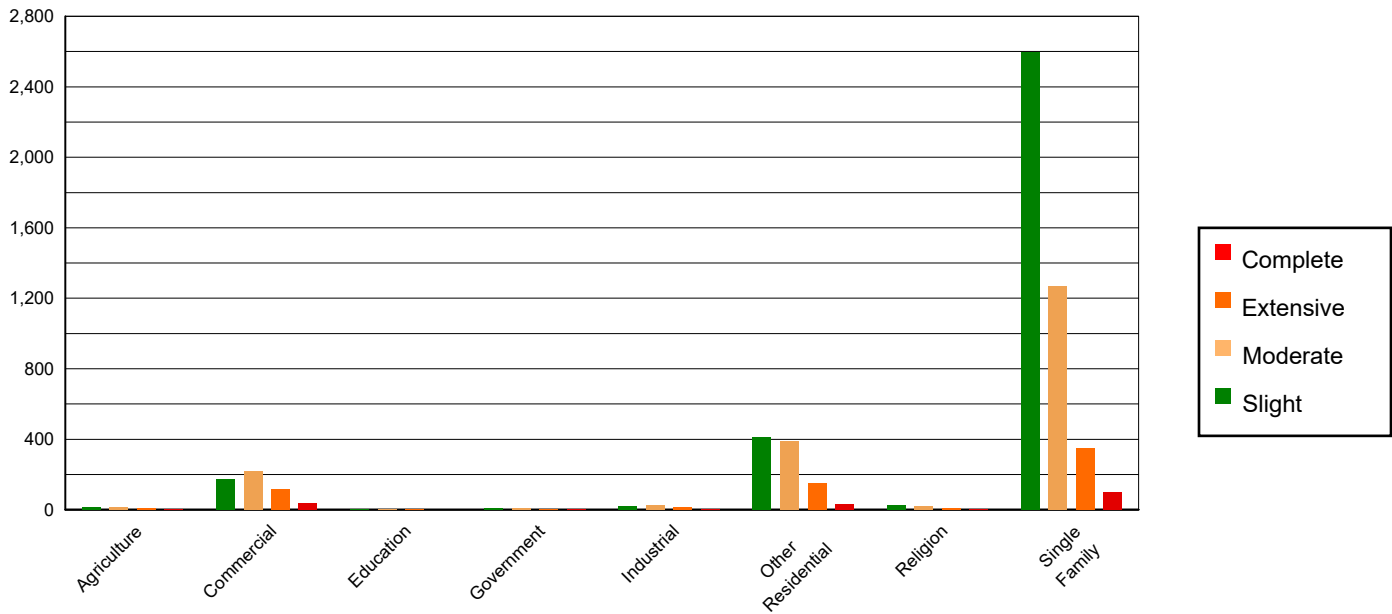


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	28.57	0.33	13.60	0.42	17.03	0.87	9.33	1.42	2.48	1.36
Commercial	305.94	3.54	171.62	5.28	216.99	11.09	115.02	17.52	36.43	20.08
Education	8.53	0.10	3.43	0.11	3.80	0.19	1.70	0.26	0.54	0.30
Government	10.86	0.13	6.77	0.21	9.47	0.48	4.43	0.67	1.48	0.81
Industrial	36.37	0.42	19.66	0.61	27.85	1.42	16.97	2.59	5.15	2.84
Other Residential	1088.83	12.59	412.25	12.69	387.27	19.79	150.32	22.90	32.33	17.82
Religion	60.97	0.70	25.17	0.77	22.91	1.17	11.45	1.74	3.49	1.93
Single Family	7109.26	82.19	2596.40	79.92	1271.63	64.98	347.17	52.89	99.55	54.86
Total	8,649		3,249		1,957		656		181	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6589.95	76.19	2219.94	68.33	810.68	41.43	101.53	15.47	7.27	4.01
Steel	105.96	1.23	49.33	1.52	98.15	5.02	71.37	10.87	22.98	12.66
Concrete	38.38	0.44	17.11	0.53	23.49	1.20	12.90	1.97	2.86	1.58
Precast	36.06	0.42	13.42	0.41	24.19	1.24	18.91	2.88	4.27	2.35
RM	22.71	0.26	5.71	0.18	9.97	0.51	7.19	1.10	1.10	0.60
URM	1459.34	16.87	725.00	22.32	698.72	35.70	321.35	48.96	118.18	65.13
MH	396.93	4.59	218.40	6.72	291.74	14.91	123.12	18.76	24.80	13.67
Total	8,649		3,249		1,957		656		181	

*Note:

- RM Reinforced Masonry
- URM Unreinforced Masonry
- MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 25 hospital beds available for use. On the day of the earthquake, the model estimates that only 5 hospital beds (23.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 45.00% of the beds will be back in service. By 30 days, 74.00% 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	1	1	0	0
Schools	23	5	0	10
EOCs	1	1	0	0
PoliceStations	5	1	0	4
FireStations	9	0	0	8

Transportation Lifeline Damage

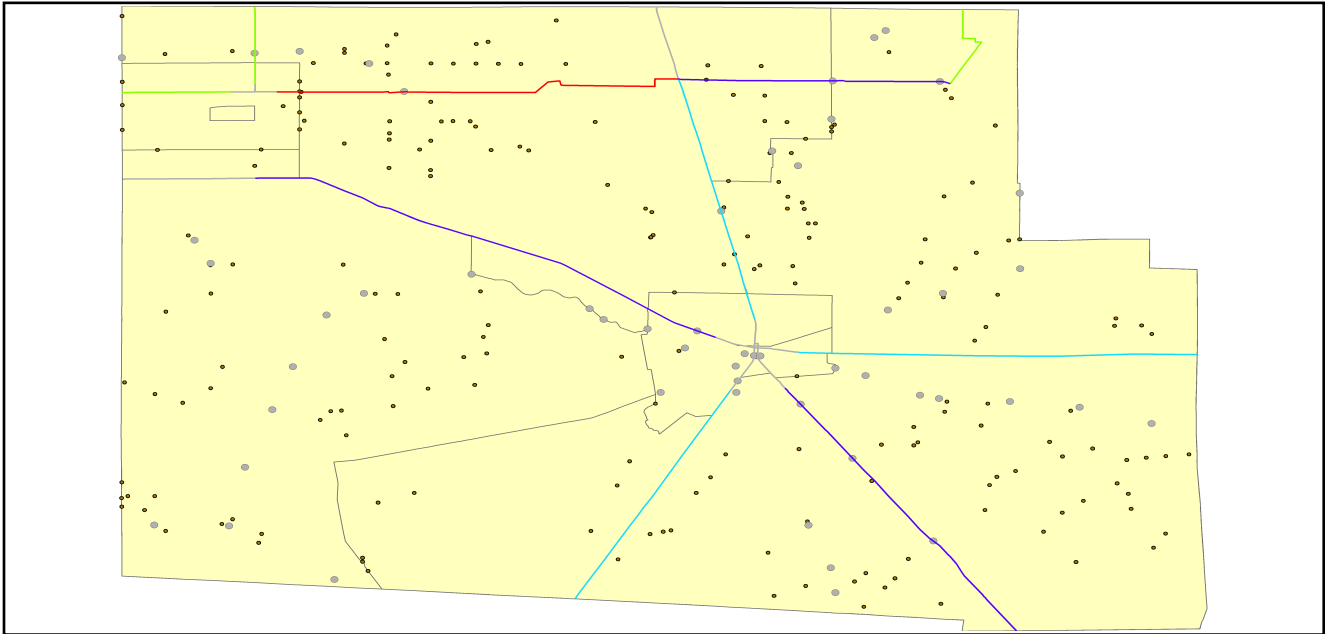


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	24	0	0	24	24
	Bridges	267	0	0	267	267
	Tunnels	0	0	0	0	0
Railways	Segments	65	0	0	65	65
	Bridges	39	0	0	39	39
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	1	0	1	1
	Runways	2	0	0	2	2

Table 6 provides damage estimates for the transportation system.

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	0	0	0	0	0
Waste Water	13	5	0	5	13
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	3	2	0	2	3
Communication	2	1	0	1	2

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	1,013	147	37
Waste Water	608	74	18
Natural Gas	40	2	0
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	11,638	13	0	0	0	0
Electric Power		5,595	4,619	2,764	406	6

Induced Earthquake Damage

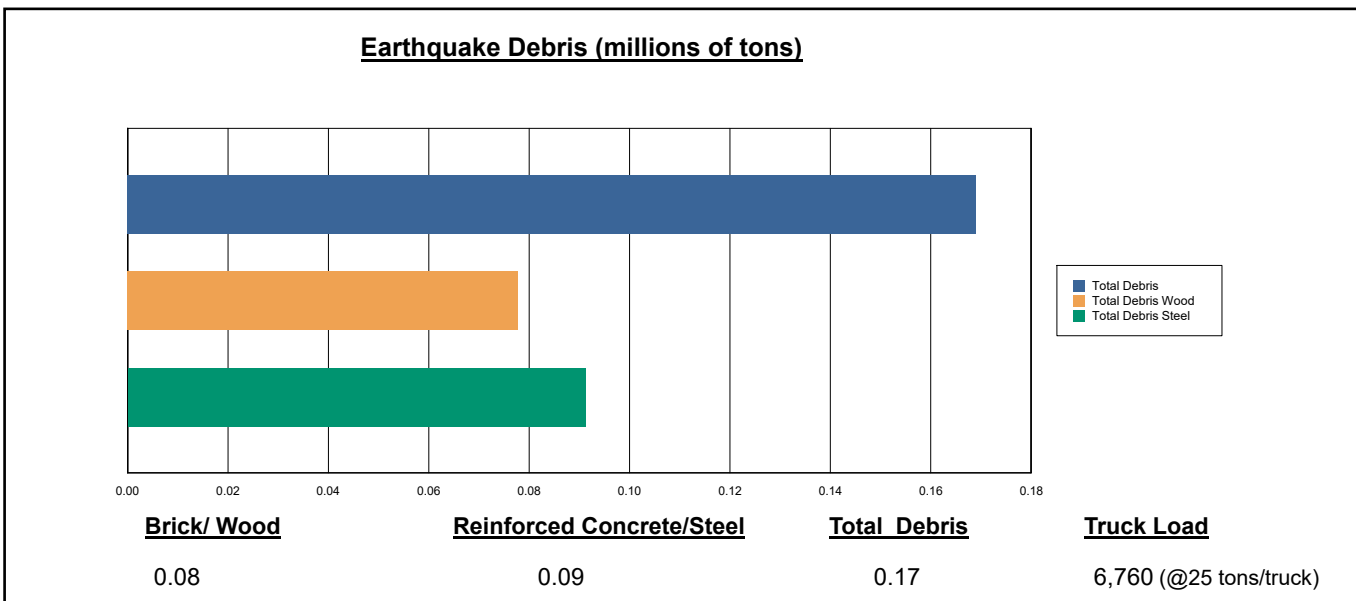
Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi (0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

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.

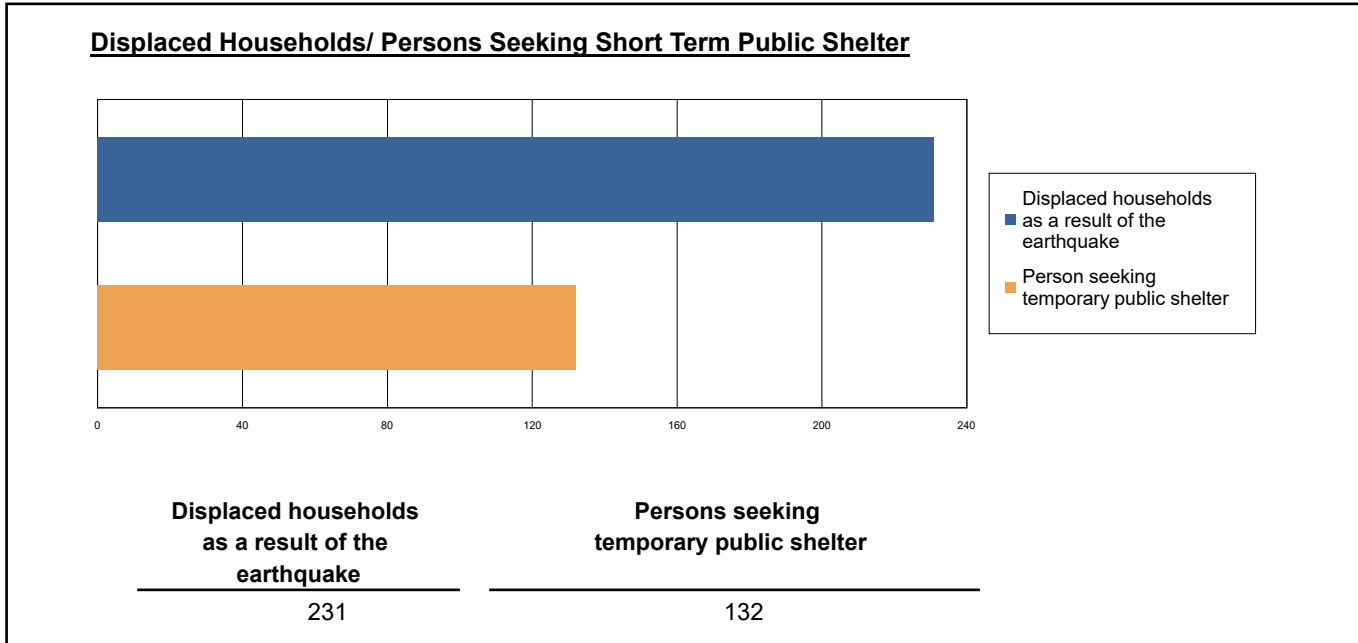
The model estimates that a total of 169,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 46.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 6,760 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.



Social Impact

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 231 households to be displaced due to the earthquake. Of these, 132 people (out of a total population of 30,696) 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	1.21	0.29	0.04	0.08
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.96	0.23	0.03	0.06
	Other-Residential	15.36	3.10	0.33	0.62
	Single Family	55.56	12.44	1.67	3.28
	Total	73	16	2	4
2 PM	Commercial	79.57	18.99	2.54	4.93
	Commuting	0.01	0.01	0.02	0.00
	Educational	22.09	5.35	0.77	1.49
	Hotels	0.00	0.00	0.00	0.00
	Industrial	7.08	1.68	0.21	0.41
	Other-Residential	5.14	1.06	0.12	0.22
	Single Family	18.82	4.35	0.61	1.14
	Total	133	31	4	8
5 PM	Commercial	52.89	12.60	1.70	3.25
	Commuting	0.13	0.24	0.33	0.07
	Educational	0.85	0.15	0.02	0.03
	Hotels	0.00	0.00	0.00	0.00
	Industrial	4.43	1.05	0.13	0.26
	Other-Residential	5.87	1.22	0.14	0.25
	Single Family	22.30	5.15	0.72	1.35
	Total	86	20	3	5



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Economic Loss

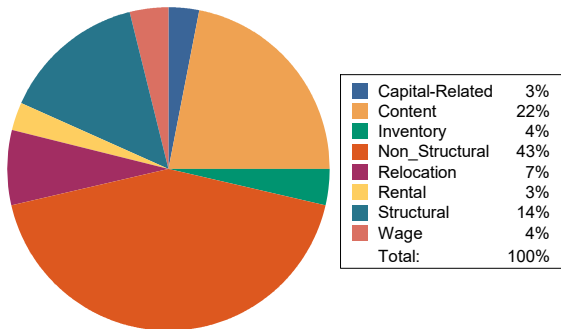
The total economic loss estimated for the earthquake is 974.10 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

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 675.70 (millions of dollars); 17 % 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 37 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type (\$ millions)



Earthquake Losses by Occupancy Type (\$ millions)

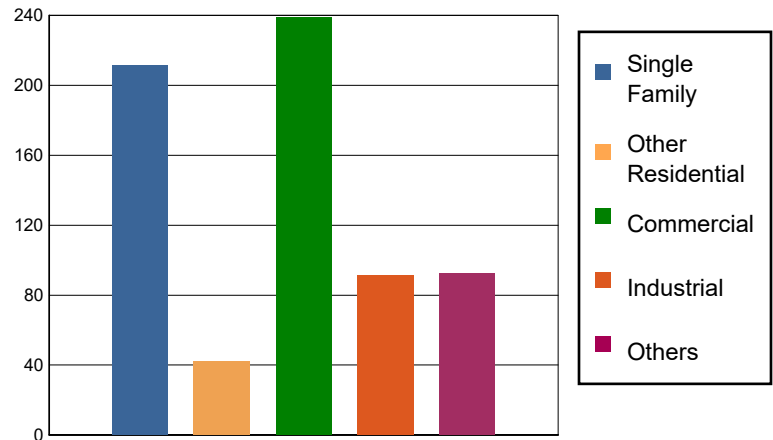


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	1.1164	21.4116	1.4660	2.3888	26.3828
	Capital-Related	0.0000	0.4749	18.6705	1.2535	0.7228	21.1217
	Rental	4.6967	2.4322	11.3376	0.5459	1.1287	20.1411
	Relocation	16.8570	2.8462	18.3352	2.8525	9.5580	50.4489
	Subtotal	21.5537	6.8697	69.7549	6.1179	13.7983	118.0945
Capital Stock Losses							
	Structural	28.9631	4.5336	32.5603	12.5765	18.0017	96.6352
	Non_Structural	114.0966	23.6685	78.7333	39.3331	33.3758	289.2073
	Content	46.5592	7.0866	44.4165	28.5914	20.6764	147.3301
	Inventory	0.0000	0.0000	13.0650	4.7479	6.6199	24.4328
	Subtotal	189.6189	35.2887	168.7751	85.2489	78.6738	557.6054
	Total	211.17	42.16	238.53	91.37	92.47	675.70

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.

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	624.0247	0.0000	0.00
	Bridges	146.0281	1.9209	1.32
	Tunnels	0.0000	0.0000	0.00
	Subtotal	770.0528	1.9209	
Railways	Segments	227.3823	0.0000	0.00
	Bridges	177.0600	0.6184	0.35
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	404.4423	0.6184	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Airport	Facilities	5.3000	2.1556	40.67
	Runways	7.0974	0.0000	0.00
	Subtotal	12.3974	2.1556	
Total		1,186.89	4.69	

Table 13: Utility System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	32.6085	0.6616	2.03
	Subtotal	32.6085	0.6616	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	1783.5844	262.1581	14.70
	Distribution Lines	19.5651	0.3324	1.70
	Subtotal	1803.1495	262.4905	
Natural Gas	Pipelines	290.6538	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	13.0434	0.1139	0.87
	Subtotal	303.6972	0.1139	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Electrical Power	Facilities	116.5897	30.3794	26.06
	Subtotal	116.5897	30.3794	
Communication	Facilities	0.2100	0.0538	25.62
	Subtotal	0.2100	0.0538	
	Total	2,256.25	293.70	



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Appendix A: County Listing for the Region

Hardin, OH

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Ohio	Hardin	30,696	3,685	2,086	5,771
Total Region		30,696	3,685	2,086	5,771