Hazus: Earthquake Global Risk Report

Region Name: CalavCNCCCSCE

Earthquake Scenario: calaverascncccscesha_m7p43_se

Print Date: May 20, 2024

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.

Table of Contents

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 39 county(ies) from the following state(s):

California

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

The geographical size of the region is 68,457.81 square miles and contains 3,891 census tracts. There are over 5,831 thousand households in the region which has a total population of 16,846,162 peopleF. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 5,230 thousand buildings in the region with a total building replacement value (excluding contents) of (millions of dollars). Approximately 90.00 % of the buildings (and % of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 270,014 and 217,136 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 5,230 thousand buildings in the region which have an aggregate total replacement value of (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 86% 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 288 hospitals in the region with a total bed capacity of 43,687 beds. There are 6,267 schools, 1,670 fire stations, 570 police stations and 98 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 487,150.00 (millions of dollars). This inventory includes over 12,612.59 miles of highways, 13,345 bridges, 289,950.35 miles of pipes.

Table 1: Transportation System Lifeline Inventory

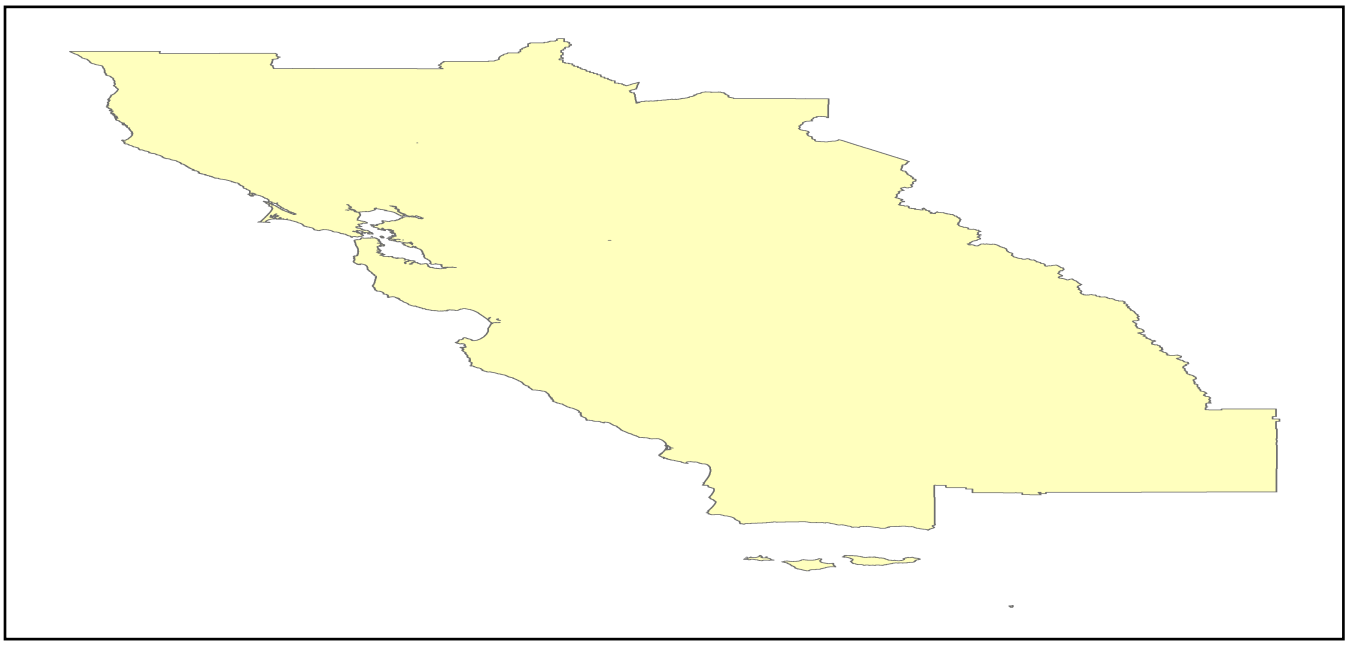
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	13,345	62853.6251
	Segments	8,126	108549.9650
	Tunnels	52	1011.6097
		Subtotal	**172415.1998**
Railways	Bridges	2,042	11618.9800
	Facilities	101	268.9630
	Segments	3,549	69510.7967
	Tunnels	3	1.8495
		Subtotal	**81400.5892**
Light Rail	Bridges	112	15.3529
	Facilities	255	4154.0000
	Segments	15	5403.2756
	Tunnels	0	0.0000
		Subtotal	**9572.6285**
Bus	Facilities	61	137.0192
		Subtotal	**137.0192**
Ferry	Facilities	28	37.2680
		Subtotal	**37.2680**
Port	Facilities	379	1444.6891
		Subtotal	**1444.6891**
Airport	Facilities	139	3077.9753
	Runways	200	1929.4731
		Subtotal	**5007.4484**
		Total	**270,014.80**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	5761.2154
	Facilities	28	1100.2320
	Pipelines	0	0.0000
		Subtotal	**6861.4474**
Waste Water	Distribution Lines	NA	3456.7293
	Facilities	204	35078.1672
	Pipelines	0	0.0000
		Subtotal	**38534.8965**
Natural Gas	Distribution Lines	NA	2304.4862
	Facilities	19	746.9647
	Pipelines	1,107	20194.4985
		Subtotal	**23245.9494**
Oil Systems	Facilities	35	4.1300
	Pipelines	0	0.0000
		Subtotal	**4.1300**
Electrical Power	Facilities	566	148421.6218
		Subtotal	**148421.6218**
Communication	Facilities	582	68.6760
		Subtotal	**68.6760**
		Total	**217,136.70**

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	calaverascncccscesha_m7p43_se
Type of Earthquake	User-defined
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	7.43
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about 120,768 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 1,972 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

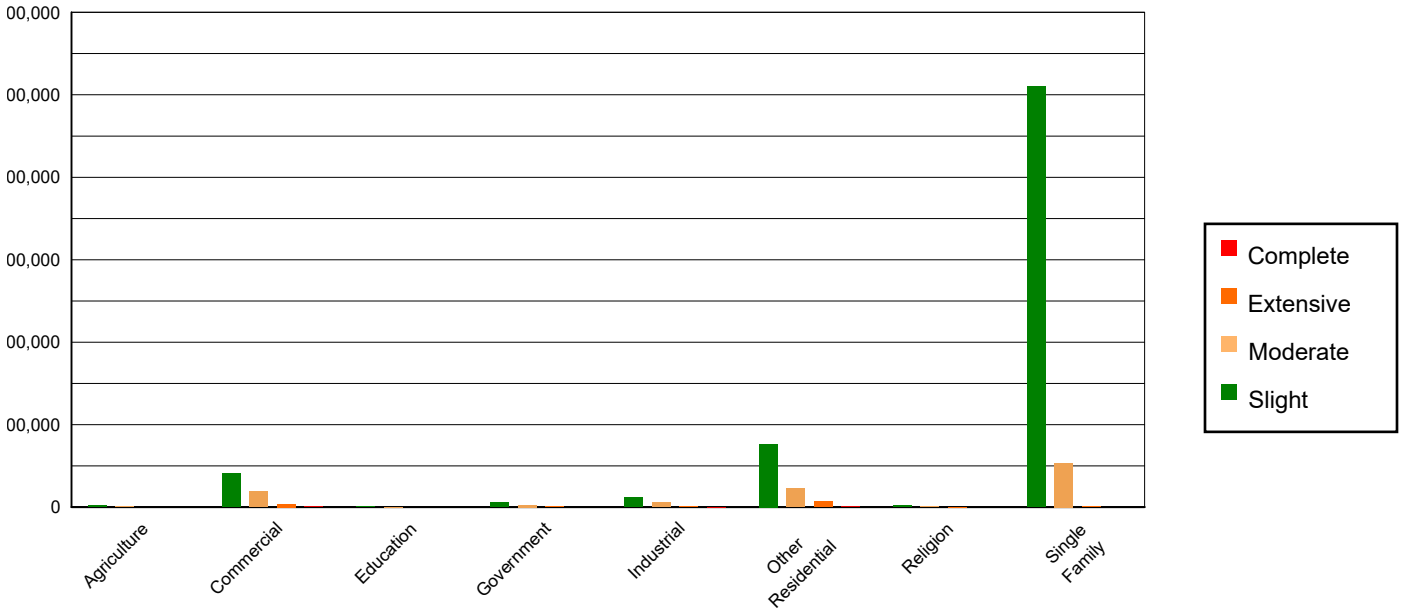


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	35281.40	0.79	1992.30	0.31	794.79	0.75	153.85	1.17	25.66	1.30
Commercial	271779.24	6.09	41120.03	6.33	18812.38	17.81	3913.05	29.75	748.30	37.94
Education	9295.50	0.21	856.68	0.13	282.59	0.27	57.31	0.44	11.92	0.60
Government	14810.50	0.33	5405.21	0.83	2621.96	2.48	448.91	3.41	56.42	2.86
Industrial	75192.46	1.69	11556.74	1.78	5517.01	5.22	1170.19	8.90	207.59	10.53
Other Residential	584173.83	13.10	76659.77	11.80	22959.99	21.73	6584.51	50.06	839.90	42.59
Religion	16916.67	0.38	2197.11	0.34	1081.79	1.02	250.23	1.90	47.20	2.39
Single Family	3452483.13	77.41	510035.52	78.49	53573.04	50.71	575.23	4.37	35.08	1.78
Total	**4,459,933**		**649,823**		**105,644**		**13,153**		**1,972**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	3892566.98	87.28	570281.37	87.76	57936.22	54.84	526.78	4.00	21.10	1.07
Steel	90213.52	2.02	15669.90	2.41	11751.85	11.12	3040.77	23.12	541.07	27.44
Concrete	102295.37	2.29	19096.16	2.94	9228.01	8.74	2721.02	20.69	486.21	24.66
Precast	57749.29	1.29	9003.39	1.39	4885.44	4.62	488.17	3.71	38.31	1.94
RM	170576.25	3.82	17357.53	2.67	6860.65	6.49	492.94	3.75	8.01	0.41
URM	26350.26	0.59	11560.74	1.78	7058.45	6.68	1711.47	13.01	417.35	21.16
MH	120181.06	2.69	6854.26	1.05	7922.96	7.50	4172.13	31.72	460.01	23.33
Total	**4,459,933**		**649,823**		**105,644**		**13,153**		**1,972**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 43,687 hospital beds available for use. On the day of the earthquake, the model estimates that only 36,870 hospital beds (84.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 93.00% of the beds will be back in service. By 30 days, 99.00% 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	288	13	0	250
Schools	6,267	425	0	5,327
EOCs	98	5	0	88
PoliceStations	570	19	0	508
FireStations	1,670	50	0	1,537

Transportation Lifeline Damage

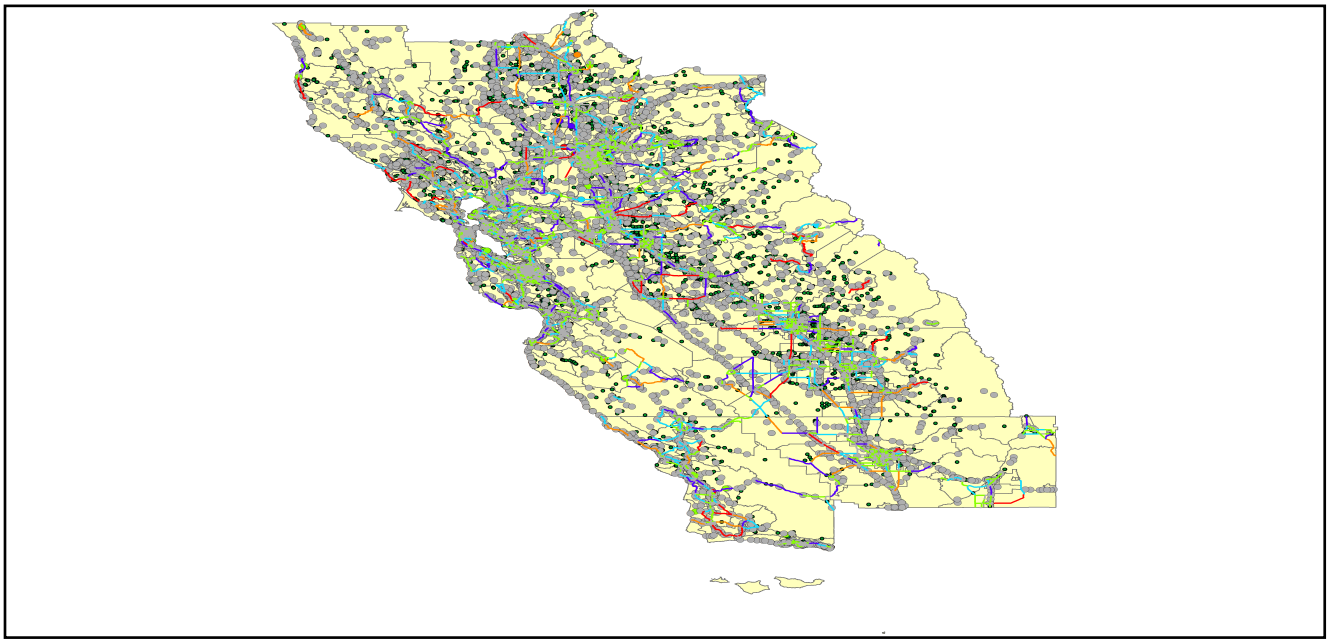


Table 6: Expected Damage to the Transportation Systems

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	8,126	0	0	8,126	8,126
	Bridges	13,345	28	0	13,316	13,336
	Tunnels	52	0	0	52	52
Railways	Segments	3,549	0	0	3,549	3,549
	Bridges	2,042	0	0	2,042	2,042
	Tunnels	3	0	0	3	3
	Facilities	101	0	0	101	101
Light Rail	Segments	15	0	0	15	15
	Bridges	112	0	0	112	112
	Tunnels	0	0	0	0	0
	Facilities	255	0	0	255	255
Bus	Facilities	61	0	0	61	61
Ferry	Facilities	28	0	0	28	28
Port	Facilities	379	0	0	379	379
Airport	Facilities	139	2	0	139	139
	Runways	200	0	0	200	200

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	28	4	0	21	28
Waste Water	204	8	0	178	204
Natural Gas	19	0	0	19	19
Oil Systems	35	0	0	35	35
Electrical Power	566	44	0	541	565
Communication	582	36	0	569	582

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	178,993	12035	3009
Waste Water	107,396	6046	1511
Natural Gas	3,563	0	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	5,831,946	544,268	491,982	384,243	87	0
Electric Power		434,818	271,811	108,062	9,147	591

Induced Earthquake Damage

Fire Following Earthquake

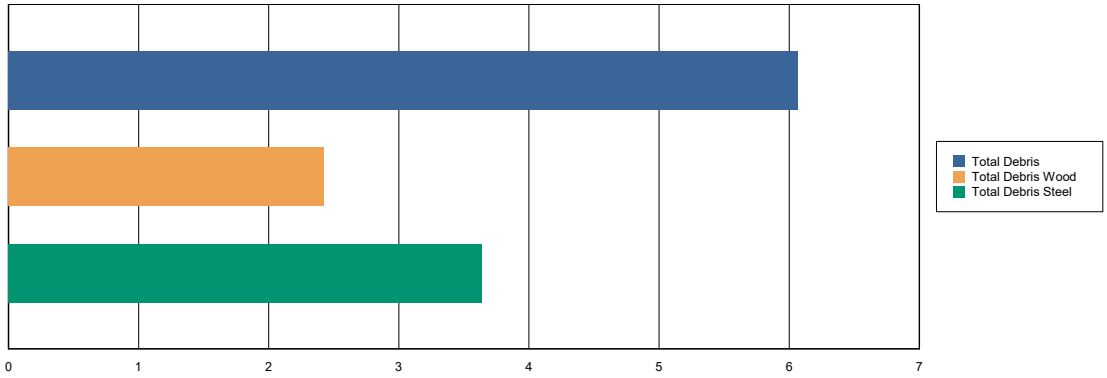
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 81 ignitions that will burn about 2.63 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 26,121 people and burn about 3,673 (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 6,065,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 40.00% 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 242,600 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



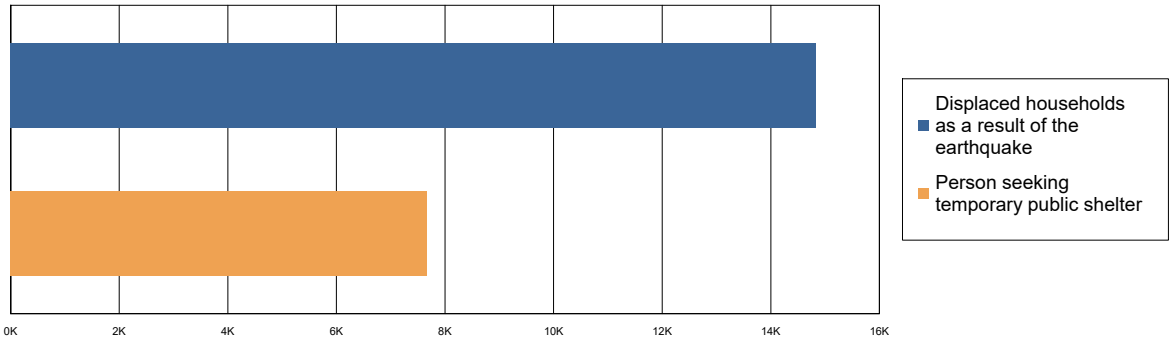
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
2.43	3.64	6.07	242,600 (@25 tons/truck)

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 14,833 households to be displaced due to the earthquake. Of these, 7,669 people (out of a total population of 16,846,162) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
14,833	7,669

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	55.78	9.54	1.06	2.07
	Commuting	0.64	0.87	1.45	0.28
	Educational	0.00	0.00	0.00	0.00
	Hotels	2.53	0.27	0.01	0.02
	Industrial	60.48	9.94	1.06	2.07
	Other-Residential	1693.86	253.32	25.15	48.65
	Single Family	1234.09	57.30	0.87	1.64
	Total	**3,047**	**331**	**30**	**55**
2 PM	Commercial	3719.87	638.72	71.36	138.33
	Commuting	5.79	7.84	13.09	2.54
	Educational	814.39	131.83	14.64	28.38
	Hotels	0.49	0.05	0.00	0.00
	Industrial	443.75	73.24	7.87	15.21
	Other-Residential	535.72	83.09	8.75	16.28
	Single Family	341.74	16.72	0.32	0.57
	Total	**5,862**	**951**	**116**	**201**
5 PM	Commercial	2606.84	449.60	50.77	96.95
	Commuting	114.09	153.46	257.49	49.94
	Educational	114.75	16.26	1.61	3.10
	Hotels	0.76	0.08	0.00	0.01
	Industrial	277.34	45.77	4.92	9.50
	Other-Residential	646.05	99.18	10.31	19.17
	Single Family	451.86	22.03	0.40	0.70
	Total	**4,212**	**786**	**325**	**179**

Economic Loss

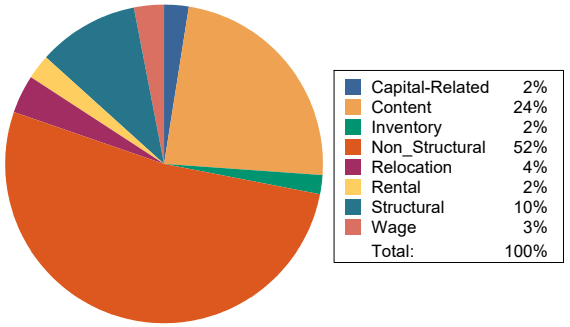
The total economic loss estimated for the earthquake is 62,970.31 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

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 54,097.22 (millions of dollars); 12 % 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 49 % 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)

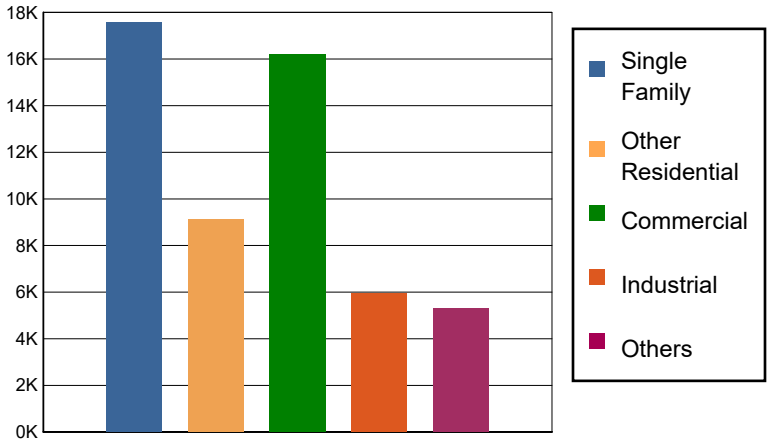


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	134.1230	1289.0453	59.6029	166.7294	1,649.5006
	Capital-Related	0.0000	57.0147	1196.6356	36.0525	27.8190	1,317.5218
	Rental	128.3094	468.3521	627.6965	34.4450	90.5903	1,349.3933
	Relocation	390.6852	300.1181	877.7996	161.5094	437.8342	2,167.9465
	Subtotal	**518.9946**	**959.6079**	**3991.1770**	**291.6098**	**722.9729**	**6484.3622**
Capital Stock Losses							
	Structural	1723.3847	961.7625	1708.7862	576.7438	590.3831	5,561.0603
	Non_Structural	11034.2774	5623.2472	6281.6044	2776.1540	2489.3322	28,204.6152
	Content	4284.7057	1551.7527	3622.0453	1995.4307	1402.4730	12,856.4074
	Inventory	0.0000	0.0000	613.2186	292.5550	85.0053	990.7789
	Subtotal	**17042.3678**	**8136.7624**	**12225.6545**	**5640.8835**	**4567.1936**	**47612.8618**
	Total	**17561.36**	**9096.37**	**16216.83**	**5932.49**	**5290.17**	**54097.22**

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	108549.9650	0.0000	0.00
	Bridges	62853.6251	654.3149	1.04
	Tunnels	1011.6097	5.6110	0.55
	Subtotal	**172415.1998**	**659.9259**	
Railways	Segments	69510.7967	0.0000	0.00
	Bridges	11618.9800	62.5188	0.54
	Tunnels	1.8495	0.0922	4.99
	Facilities	268.9630	19.1518	7.12
	Subtotal	**81400.5892**	**81.7628**	
Light Rail	Segments	5403.2756	0.0000	0.00
	Bridges	15.3529	0.3306	2.15
	Tunnels	0.0000	0.0000	0.00
	Facilities	4154.0000	459.0260	11.05
	Subtotal	**9572.6285**	**459.3566**	
Bus	Facilities	137.0192	6.9141	5.05
	Subtotal	**137.0192**	**6.9141**	
Ferry	Facilities	37.2680	3.2760	8.79
	Subtotal	**37.2680**	**3.2760**	
Port	Facilities	1444.6891	145.1569	10.05
	Subtotal	**1444.6891**	**145.1569**	
Airport	Facilities	3077.9753	296.5208	9.63
	Runways	1929.4731	0.0000	0.00
	Subtotal	**5007.4484**	**296.5208**	
	Total	**270,014.84**	**1,652.91**	

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	1100.2320	63.7164	5.79
	Distribution Lines	5761.2154	54.1581	0.94
	Subtotal	**6861.4474**	**117.8745**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	35078.1672	1030.1856	2.94
	Distribution Lines	3456.7293	27.2050	0.79
	Subtotal	**38534.8965**	**1057.3906**	
Natural Gas	Pipelines	20194.4985	0.0000	0.00
	Facilities	746.9647	0.3019	0.04
	Distribution Lines	2304.4862	9.3202	0.40
	Subtotal	**23245.9494**	**9.6221**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	4.1300	0.1161	2.81
	Subtotal	**4.1300**	**0.1161**	
Electrical Power	Facilities	148421.6218	6031.3723	4.06
	Subtotal	**148421.6218**	**6031.3723**	
Communication	Facilities	68.6760	3.7898	5.52
	Subtotal	**68.6760**	**3.7898**	
	Total	**217,136.72**	**7,220.17**	

Appendix A: County Listing for the Region

Alameda,CA

Alpine,CA

Amador,CA

Butte,CA

Calaveras,CA

Colusa,CA

Contra Costa,CA

El Dorado,CA

Fresno,CA

Glenn,CA

Kern,CA

Kings,CA

Lake,CA

Madera,CA

Marin,CA

Mariposa,CA

Mendocino,CA

Merced,CA

Monterey,CA

Napa,CA

Nevada,CA

Placer,CA

Sacramento,CA

San Benito,CA

San Francisco,CA

San Joaquin,CA

San Luis Obispo,CA

San Mateo,CA

Santa Barbara,CA

Santa Clara,CA

Santa Cruz,CA

Solano,CA

Sonoma,CA

Stanislaus,CA

Sutter,CA

Tulare,CA

Tuolumne,CA

Yolo,CA

Yuba,CA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
California					
	Alameda	1,682,353	209,951	122,639	332,590
	Alpine	1,204	721	139	861
	Amador	40,474	5,608	2,517	8,125
	Butte	211,632	25,875	16,639	42,514
	Calaveras	45,292	8,305	4,893	13,199
	Colusa	21,839	2,244	2,024	4,268
	Contra Costa	1,165,927	158,118	60,339	218,458
	El Dorado	191,185	34,907	9,704	44,611
	Fresno	1,008,654	98,532	61,772	160,304
	Glenn	28,917	2,791	3,717	6,508
	Kern	909,235	87,567	59,168	146,736
	Kings	152,486	13,719	7,861	21,581
	Lake	68,163	9,699	4,530	14,229
	Madera	156,255	18,025	9,641	27,667
	Marin	262,321	47,738	15,030	62,769
	Mariposa	17,131	3,299	1,141	4,441
	Mendocino	91,601	14,237	8,510	22,748
	Merced	281,202	25,194	26,098	51,292
	Monterey	439,035	47,655	28,750	76,405
	Napa	138,019	20,517	13,045	33,563
	Nevada	102,241	17,908	6,108	24,016
	Placer	404,739	69,985	24,193	94,179
	Sacramento	1,585,055	179,811	83,911	263,723
	San Benito	64,209	9,440	3,799	13,239
	San Francisco	873,965	108,848	46,020	154,869
	San Joaquin	779,233	82,706	56,882	139,589
	San Luis Obispo	282,424	41,720	20,896	62,616
	San Mateo	764,442	110,372	44,995	155,368
	Santa Barbara	448,229	49,971	28,481	78,452
	Santa Clara	1,936,259	261,111	120,471	381,582
	Santa Cruz	270,861	36,147	18,805	54,952
	Solano	453,491	55,802	26,393	82,195
	Sonoma	488,863	68,827	35,781	104,609
	Stanislaus	552,878	62,937	37,511	100,449
	Sutter	99,633	10,618	6,448	17,066
	Tulare	473,117	43,262	31,210	74,472
	Tuolumne	55,620	8,964	3,507	12,471
	Yolo	216,403	24,130	18,343	42,473
	Yuba	81,575	8,161	4,677	12,839

Total Region		16,846,162	2,085,422	1,076,588	3,162,028