



# Earth



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# Earthquake Risk In India

India is prone to various natural disasters such as Cyclone, Drought, Earthquake, Floods – riverine as well as surface water, and Tsunami etc. Among these, earthquake is considered the most severe, though not most frequent natural hazard. Earthquakes, occurring in India as well as neighboring countries viz. Afghanistan, Bangladesh, Bhutan, Nepal, and Pakistan can create loss of life and property in India.

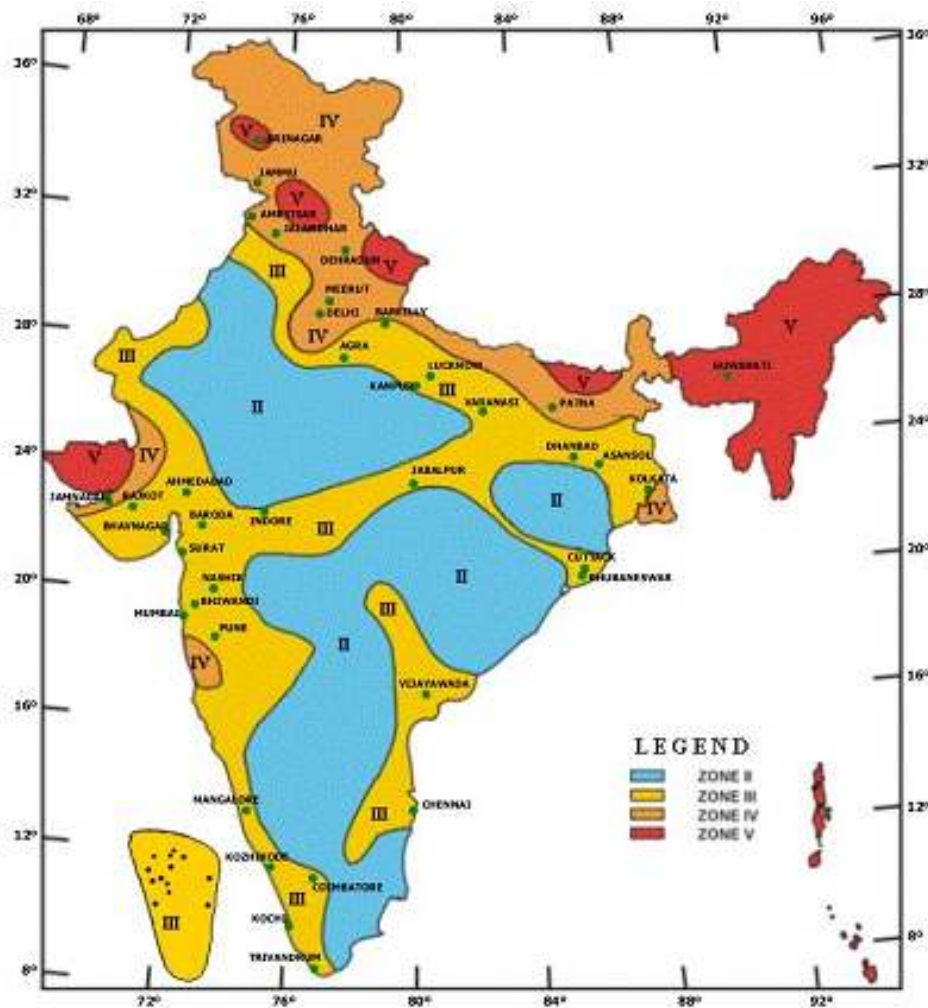


Figure 1: Seismic Zoning Map of India| Source: Bureau of Indian Standards

Around 59 % of land area of India is susceptible to seismic hazards. Risk is high in states located alongside of the Himalayas which is seismically active - though its seismicity varies from West to East. Some of the most disastrous earthquakes have occurred in the Himalayas viz. Great Shillong Earthquake of 1897, Kangra Earthquake of 1905, Bihar - Nepal earthquakes of 1934, 1988, and 2015 (The Gorkha Earthquake) to name a few.

In addition to the Himalayas, in the Kutch region some high intensity earthquakes have occurred in the past such as 1819 Great Kutch earthquake, 1956 Anjar earthquake, and 2001 Gujrat earthquake. Southern part of India is relatively less seismically active. Table 1 shows major historic earthquakes occurred in India.

Out of 675 districts in India, 222 fall in zone III – moderate risk zone, 30.79 % of total area; 131 fall in zone IV – high risk zone, 17.49 % of total area; and 108 fall in zone v – very high risk zone, 10.79 % of total area. Remaining 214 districts are in zone II – low risk zone, 40.93% of total area of India.

**Table 1 Historic earthquakes with magnitude more than 5.0 in last 200 years** | Source: IMD, USGF

<b>Date</b>	<b>Epicenter Location</b>	<b>Magnitude</b>	<b>Max. Intensity</b>
2/6/2017	Rudraprayag, Uttarakhand	5.6	VIII
5/12/2015	Nepal	6.6	VIII
4/25/2015	Nepal	7.8	XII
10/26/2014	Hindukush Region, Afghanistan	7.5	
1/18/2011	Pakistan	7.2	VIII
10/29/2009	Hindukush Region, Afghanistan	6.2	XII
9/21/2009	Bhutan	6.1	
8/10/2009	Andaman Islands	7.5	VII
10/28/2008	Pakistan	6.4	X
2/14/2006	Sikkim	5.7	VII
12/12/2005	Hindukush Region, Afghanistan	6.5	
10/8/2005	Pakistan/Kashmir	7.4	VII
7/24/2005	Nicobar Islands	7.3	
12/26/2004	Great Sumatra	9.3	IX
4/5/2004	Hindukush Region, Afghanistan	6.6	VIII
9/14/2002	Diglipur, A & N Islands	6.0	VII
3/25/2002	Hindukush Region, Afghanistan	6.1	X
3/3/2002	Hindukush Region, Afghanistan	7.4	VIII
1/26/2001	Bhuj	7.7	IX
3/29/1999	Chamoli	6.6	IX
5/30/1998	Afghanistan-Tajikistan Border Region	6.6	IX
2/4/1998	Afghanistan-Tajikistan Border Region	5.9	
5/22/1997	Jabalpur	5.8	VIII
9/30/1993	Latur	6.2	VIII
10/20/1991	Uttarkashi	6.4	VIII
8/21/1988	Bihar-Nepal	6.6	VIII
4/26/1986	Dharamshala	5.5	
12/30/1984	Silchar	5.6	
7/29/1980	Pithoragarh	6.8	
1/19/1975	Kinnaur	6.5	VIII
12/28/1974	Northern Pakistan	6.2	VII
3/23/1970	Bharuch	5.2	VII
12/11/1967	Koyna	6.3	VIII
3/14/1965	Hindukush Region, Afghanistan	7.4	
9/2/1963	Badgam	5.5	VII
12/28/1958	Kapkote, Uttarakhand	6.3	
10/10/1956	Bulandshahar	6.7	
7/21/1956	Anjar	6.1	IX
8/15/1950	Great Assam	8.6	XII
11/27/1945	Makran Coast, Pakistan	8.0	X
6/26/1941	Great Andaman	8.1	X
5/30/1935	Quetta, Pakistan	7.5	VIII
1/15/1934	Great Bihar-Nepal	8.1	X
4/4/1905	Great Kangra	7.5	VIII
2/8/1900	Coimbatore	6.0	VII
6/12/1897	Great Shillong	8.3	X
6/16/1819	Great Kutch	8.3	VII

## Insured Exposure and Potential Losses

We think about 25 % of total market exposure falls in zone IV and V. Insurance companies can easily identify whether their exposure is in districts falling in those zones and can make suitable business decisions. #

Earthquake intensity is measured by Medvedev- Sponhener- Karnik (MSK) scale. Table below shows earthquake intensity, damage associated with each intensity and corresponding seismic zones (II - V) as shown in figure 1.

# J.B.Boda can share the list of districts falling in zone IV and V.

**Table 2 Medvedev-Sponhener-Karnik (MSK) Intensity Scale (1964)**

Intensity Scale	Seismic Zone	Feature	Damage Description
I	II	Not noticeable	Not felt, registered only by seismographs.No effect on objects. No damage to buildings.
II	II	Hardly perceptible	Felt only by individuals at rest. No effect on objects. No damage to buildings.
III	II	Weak	Felt indoors by a few. Hanging objects swing slightly. No damage to buildings
IV	II	Largely observed	Felt indoors by many and felt outdoors only by very few. A few people awake. Moderate vibration. Observers feel a slight trembling or swaying of the building, room, bed, chair etc. China, glasses, windows, and doors rattle. Hanging objects swing. Light furniture shakes visibly in a few cases. No damage to buildings.
V	II	Fairly strong	Felt indoors by most, outdoors by few. A few people are frightened and run outdoors. Many sleeping people awake. Observers feel a strong shaking or rocking of the whole building, room, or furniture. Hanging objects swing considerably. China and glasses clatter together. Doors and windows swing open or shut. In a few cases, windowpanes break. Liquids oscillate and may spill from fully filled containers. Animals indoors may become uneasy. Slight damage to a few poorly constructed buildings.
VI	II	Strong	<ul style="list-style-type: none"> <li>● Felt by most indoors and outdoors. Many people in buildings are frightened and run outdoors. A few persons lose their balance. Domestic animals run out of their stalls. In many instances dishes and glassware may break, books fall down, pictures move, and unstable objects over turn.</li> <li>● Heavy furniture may possibly move and small steeple bells may ring.</li> <li>● Damage of grade 1 is sustained in single buildings of type B and in many of type A. Damage in some buildings of type A is of grade 2</li> <li>● Cracks up to widths of 1 cm possible in wet ground; in mountains occasional land slips;change in flow of springs and in level of well-water</li> </ul>
VII	III	Very strong	<ul style="list-style-type: none"> <li>● Most people are frightened and run outdoors Objects fall from shelves. Water splashes from containers.</li> <li>● In many buildings of type C, damage of grade 1 is caused; in buildings of type B, damage is of grade 2. Most buildings of type A suffers damage of grade 3, some of grade 4. In single instances landslips of roadway on steep slopes; cracks in roads; seams of pipelines damages; cracks in stonewalls.</li> </ul>
VIII	IV	Damaging	<ul style="list-style-type: none"> <li>● Many people find it difficult to stand, even outdoors. Waves may be seen on very soft ground. Rockfalls.</li> <li>● Most buildings of Type C suffer damage of Grade 2, and few of Grade 3. Most buildings of Type B suffer damage of Grade 3. Most buildings of Type A suffer damage of Grade 4. Many buildings of Type C suffer damage of Grade 4. Occasional breaking of pipe seams. Memorial and monuments move and twist. Tombstones overturn. Stone walls collapse</li> </ul>

Intensity Scale	Seismic Zone	Feature	Damage Description
IX	V	Destructive	<ul style="list-style-type: none"> <li>● General panic. People may be forcibly thrown to the ground. Waves are seen on soft ground.</li> <li>● Many buildings of Type C suffer damage of Grade 3, and a few of Grade 4. Many buildings of Type B show a damage of Grade 2 and a few of Grade 5. Many buildings of Type A suffer damage of Grade 5. Monuments and columns fall. Considerable damage to reservoirs; underground pipes partly broken. In individual cases, railway lines are bent and roadway damaged.</li> </ul>
X	V	Devastating	<ul style="list-style-type: none"> <li>● Many buildings of Type C suffer damage of Grade 4, and a few of Grade 5. Many buildings of Type B show damage of Grade 5. Most of Type A have destruction of grade 5. Critical damage to dikes and dams. Severe damage to bridges. Railway lines are bent slightly. Underground pipes are bent or broken. Road paving and asphalt show waves.</li> <li>● Massive landslides. Water bodies may be overtopped, causing flooding of the surrounding areas and formation of new water bodies.</li> </ul>
XI	V	Catastrophic	<ul style="list-style-type: none"> <li>● Severe damage even to well-built buildings, bridges, water dams, and railway lines. Highways become useless. Underground pipes destroyed</li> <li>● Most buildings and structures collapse. Widespread ground disturbances, tsunamis.</li> </ul>
XII	V	Very catastrophic	All surface and underground structures completely destroyed. Landscape generally changed, rivers change paths, tsunamis.

Tables in Appendix show types of structures and classification of damage to buildings

In case of an event, entire exposure would not be damaged. The damage might vary among classes. Individual houses that are normally not constructed using engineering guidelines would be damaged more than compared to a structure for which construction codes and safety features are normally followed. However, losses in that structure compared to individual houses might be very high. Likewise, an earthquake occurring near a residential or commercial center would cause higher losses. Time of occurrence would be a major factor.

An earthquake might cause damage of building, contents and trigger business interruption/loss of profit and Contingent Business Interruption. Table below shows losses of recent earthquakes occurred in India.

**Table 3 Losses Due to Historic Earthquakes**

Date of Occurrence	Region Impacted	Economic Loss (USD)	Insured Loss (USD)
25 April, 2015	Areas closer to Nepal border (epicenter in Nepal)	5 Billion	160 million (Nepal)
08 October, 2005	Kashmir (epicenter in Pakistan)	5.2 Billion	5 Million
26 January, 2001	Gujarat	4.6 Billion	100 Million
30 September, 1993	Latur, Maharashtra	1.3 Billion	N/A

Source: Munich Re

## Appendix

### Types of Structures | Source: Bureau of Indian Standards

Structure A	Buildings in field stone, rural structures, abode houses, clay houses
Structure B	Ordinary brick buildings, buildings of the large block and prefabricated type, half-timbered structures, buildings in natural hewn stone
Structure C	Reinforced buildings, well-built wooden structures

### Classification of Damage to Buildings | Source: Bureau of Indian Standards

Grade 1	Sight damage	Fine cracks in plaster: fall of small pieces of plaster
Grade 2	Moderate damage	Small cracks in walls: fall of fairly large piece of plaster: pantiles slip off: cracks in chimneys: parts of chimneys fall down
Grade 3	Heavy damage	Large cracks in walls: fall of chimneys
Grade 4	Destruction	Gaps in walls: parts of buildings may collapse separate
Grade 5	Total Damage	Total collapse of buildings

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