

# Earthquake

As the name suggests, Earthquake is a sudden shaking of the ground. This natural phenomenon can occur anytime due to many factors, including ground lurching, land and mudslides, structural collapse, ground displacement, Tsunamis, and more.

Seismographs are devices that record seismic waves, which are vibrations produced by earthquakes and propagate through the Earth. The epicenter is the point on the earth's surface that is directly above the hypocenter, which is where the earthquake begins under the surface.

## Causes of Earthquakes

The tectonic motions of the earth are what generate earthquakes. The focus, usually 60 kilometers, is where energy is unleashed. Waves that propagate in all directions are created when energy is released. The focus or hypocentre of an earthquake is the location where the energy is released. The epicenter is the location on Earth's surface directly above the focus. It is the first location where waves are felt.



- The rocks can sometimes overcome this friction as they tend to move apart. Eventually, the blocks suddenly bend out of the shape and slide over.
- It causes the release of energy waves traveling in all directions and induces Earthquakes.
- Ground lurching is an important phenomenon that is a consequence of Earthquakes. It demonstrates the horizontal movement of deposits, soil, or fills on vertical embankments as seismic activity affects uneven surface ruptures.

## Types of Earthquakes

Depending upon the exact cause, there are three types of Earthquakes. The releasing of energy during an Earthquake takes place from a fault. This area is a sharp rupture in the rocks. Rocks alongside the fault tend to move in opposing directions. As the overlying rock layer press them, they get locked together due to frictional force.

## Tectonic Earthquake

The most frequent type of earthquake that occurs is a tectonic earthquake. The Earth's surface comprises four elemental layers: a crust, a hot solid mantle, an outer core (liquid), and an inner core (solid).

- Tectonic, also known as Lithospheric plates, constantly move as they slide over the gently flowing mantle layer that is present just downward.
- The non-stop activity generates pressure on Earth's crust, and when the stresses get extensive, it leads to cracks. The movement of tectonic plates causes motion at the faults.
- Thus, land slipping along the faultline along convergent, divergent, and transform boundaries causes Earthquakes.
- The epicenter is the first point to experience the waves as it is directly above the focus.

## Volcanic Earthquake

One class of tectonic Earthquakes is recognized as volcanic Earthquakes. However, these are confined to areas that are prone to volcanic eruptions.

- Earthquakes produced by solid rock tension due to molten rock (magma) escape are called volcanic Earthquakes.
- These can cause the land to diminish and result in large cracks in the ground.
- This type of Earthquake occurs as rock pushes itself to fill spaces where molten rock is no longer present.
- Volcanic-tectonic Earthquakes don't need to result in erupting volcanoes, but there is a possibility of occurring at anytime.

## Human-Induced Earthquakes

There are majorly two types of human-induced Earthquakes. They include collapse Earthquakes, explosion Earthquakes, and reservoir-induced Earthquakes. To know about the types of Earthquakes and more details on the UPSC Earthquakes, read the full information until the end.

- Often, the roof area of an underground mine collapses, resulting in minor quakes. The situation occurs mainly in a location where extreme mining occurs and is called collapse Earthquakes.

- Explosion Earthquakes are a consequence of outbursts of chemical or nuclear devices. It is also one of the types of human interference Earthquakes that cause the ground to shake.
- The last type of Earthquake is a reservoir-induced Earthquake that occurs in the regions of large reservoirs.

## Types of Earthquakes: Based on the Depth of Focus

The Earthquakes are categorized into shallow, intermediate, and deep zones based on their depth ranging between 0 – 700 km. Deep Earthquakes (300-700 km) are generally produced in the Wadati–Benioff zone, where the interaction of a downgoing oceanic crustal plate against a continental plate occurs. The most powerful Earthquakes are known to appear under this zone.

| Types Of Earthquakes     | Depth Of Focus |
|--------------------------|----------------|
| Shallow Earthquakes      | 0 – 70 km      |
| Intermediate Earthquakes | 70 – 300 km    |
| Deep Earthquakes         | 300 – 700 km   |

## Seismic Waves

The energy waves caused by Earthquakes are called seismic waves. These waves can travel all over the Earth and are studied on seismographs. Earthquake waves are predominantly of two kinds: body and surface waves.

Body waves are generated due to the release of energy at the focus and are of 2 categories, i.e., P and S-waves. Thus, the attributes of the seismic waves are quite important. All these parameters aid scientists in understanding the Earth's interior structure. For more information, check out the table below.

| Types Of Seismic Waves   |  |  |
|--|--|--|
| Body waves   |  | Surface waves  |
| <p><b>P waves</b><br/>P-waves are also called 'primary waves'. They move faster and are the first to arrive at the surface. They are identical to sound waves and travel through gaseous, liquid, and solid materials.</p> | <p><b>S-waves</b><br/>The full form is secondary waves. They arrive at the surface with some time lag and only travel through solid materials.</p> | <p>The interaction of the body waves with the surface rocks generates surface waves. The last waves to be reported on seismographs. More destructive and causes displacement of rocks and also the collapse.</p> |

## Shadow Zone of an Earthquake

An area of the Earth's surface known as a seismic shadow zone is one where seismographs cannot pick up direct P and/or S waves from an earthquake. This is because the Earth's surface has liquid layers or structures.

Any liquid boundary or body can produce a shadow zone, but the core-mantle boundary, where P waves are refracted and S waves are blocked at the liquid outer core, creates the most well-known shadow zone. For instance, seismic shadow zones can be produced by magma reservoirs with a high enough percentage of melt.

## Effects Of Earthquake

An Earthquake is a natural disaster that results in heavy damage to the life and property of people if it is of high magnitude. Listed are the dangerous effects that an Earthquake can generate:

- **Ground Shaking** - It is a vibration of the ground observed during an Earthquake.
- **Differential ground settlement** - Only part of the floor is affected by the ground failure and causes more severe damage than uniform or tilt settlement.
- **Land and mudslides** - The shaking of the Earth's surface can disrupt land and mud.
- **Fires** - The quakes can cause fire or volcanic eruption.
- **Ground lurching** -The parallel movement of soil, sediments, or fills found on vertical embankments that create irregular ground cracks.
- **Avalanches** - Tremors can affect a large amount of snow by causing them to slide quickly down the side of a mountain.
- **Ground displacement**- It is another effect of an Earthquake that can cause the ground to change position in horizontal and vertical directions.
- **Floods from dam and levee failures** - Dams and levees are hydraulic structures that may break because of defaults or unexpected events. When an Earthquake occurs, water can be suddenly released and create a flood.
- **Structural collapse** - Excessive weight placed on a faulty structure can cause a building to collapse.
- **Tsunamis** are ocean waves activated by large Earthquakes that occur near or under the ocean.

## How are Earthquakes Measured

Seismic waves are energy from a quake that travels through Earth through vibrations. Researchers use instruments called seismometers to measure these seismic waves. The technique of calculating the intensity of an Earthquake is done in the listed manner.

### Earthquakes Measurement By Seismometer

- A seismometer is a device that identifies seismic waves and analyzes them as zig-zag series.
- This device helps scientists specify an Earthquake's time, location, and intensity.
- It also helps to gather information about the rocks through which seismic waves travel.

### Earthquakes Measurement By Richter Scale

Earthquake events are scaled according to the shock's magnitude or intensity. The magnitude scale is known as the Richter scale, and the intensity scale is named after Mercalli.

|   |  |
|---|--|
| Magnitude scale                                       | Intensity scale                                  |
| It corresponds to the energy released during a quake. | Measures the visible damage caused by the event. |
| Expressed in absolute numbers of 0-10                 | The range is from 1-12                           |

## Earthquake Disaster Management

Earthquakes are most active for a short time, just for a minute, but they can result in hazardous damage to life and property. Since Earthquakes strike without any intimation, to prevent large damage, it is crucial to recognize potential problems and indulge in systematic planning measures to reduce the impact afterward.

| Before Earthquake                             | During Earthquakes  | After Earthquakes            |
|---|---|------------------------------|
| Store delicate items in low, closed cabinets. | Try to take cover in a safe place by dropping down onto your hands and knees. | Be watchful for aftershocks. |

|   |   |   |
|---|---|---|
| Hang heavy items, like mirrors, away from beds and sofas. | Proceed into the open space or ground away from buildings or wires. | Stay updated about the news, and listen to the radio or TV.         |
| Repair cracks in walls and ceilings.                      | If you are driving your vehicle, stop it quickly, and stay inside.  | Try to support the injured or trapped people.                       |
| Restore defective water or gas connections.               |   | Follow the guidance of emergency officials.                         |
| Locate safe places outdoors, away from buildings.         |   | Review your home and clean up spilt medicines or flammable liquids. |

## Earthquake Zones in India

The Bureau of Indian Standards has divided the country into four seismic zones: Zone II till Zone V. The 5th zone is considered the most active, whereas Zone II is the least, based on the past seismic history.

- **Zone-V:** Entire northeastern states, HP, Uttarakhand, Gujarat's Rann of Kutch, few parts of Jammu and Kashmir, Ladakh, Andaman & Nicobar Islands, and North of Bihar.
- **Zone-IV:** Some parts of Jammu & Kashmir [ not included in Zone V ], small portions of the west coast of Maharashtra and Rajasthan, Bihar, Ladakh, Himachal Pradesh, north Uttar Pradesh, Union Territory of Delhi, Sikkim, West Bengal, and parts of Gujarat.
- **Zone-III:** Some parts of Uttar Pradesh [ not in Zone V and Zone IV ], West Bengal, Punjab, Madhya Pradesh, Maharashtra, Odisha, Gujarat, Tamil Nadu, Bihar, Andhra Pradesh, Karnataka, Jharkhand, Rajasthan, Kerala, Goa, Lakshadweep islands, and Chhattisgarh.
- **Zone-II:** Other parts of the country.