

Leaflet

Earthquake

What to do if you experience a strong Earthquake

Prepared by Prof. Peter Bormann

This leaflet provides basic information for those citizens who may have temporary or long-term stays in earthquake-endangered regions of the world:

1. strength and duration of tremors
2. where to find more detailed information on earthquake threat
3. local and architectural factors leading to increased risk
4. catering for **preventive measures** during and after tremors,
5. how to behave **in the case** of an earthquake
6. essential factors to be considered **after a destructive earthquake**.

1. Strength and Duration of tremors

Earthquake and earthquake destruction are classified according to an **intensity** scale. The most modern and internationally-applied scale is a 12-grade European Macroseismic Scale (EMS 1998). See attachment for a short summary, which can also be viewed on the Internet:

<https://www.gfz-potsdam.de/en/section/seismic-hazard-and-risk-dynamics/data-products-services/ems-98-european-macroseismic-scale/>

Actually earthquakes are also classified in most of the non-European countries using this 12-grade scale. One exception, however, is Japan where a 7-grade scale (JMA) is used. A JMA=4 represents intensities of VI to VII and a JMA=7 equals tremors with an intensity of over X on the EMS scale. Earthquake engineers prefer specification with respect to the tremor intensity in values of ground acceleration (in m/s² or % of ground acceleration).

Earthquake risk is normally defined as the probability (e.g. 10 %) with which a tremor reaches or exceeds a given intensity or acceleration within a fixed time frame (e.g. 50 years). For example, in Germany in the Schwabian Alps as well as around Aachen and Basel the probability of an earthquake reaching or exceeding an intensity of VII during 50 years time-span is 10 %. On average, tremors of this intensity in the named regions occur every 475 years. For earthquake engineers the risk is indicated as the probability with which a given ground acceleration value is exceeded. For

an intensity of VII the ground acceleration is on average 1 m/s^2 which corresponds to approx. 10 % ground acceleration. In the case of a strongest possible quake the ground acceleration can reach more than 10 m/s^2 in the epicenter.

Specifications on tremor intensities must not be mistaken for figures on the Richter scale (magnitudes). The latter are a gauge for the released energy in the earthquake epicenter and do not refer to the tremor intensity at different locations on the Earth's surface. Magnitude values are determined from instrument measurements of ground vibration. The strongest registered earthquake had a magnitude of $M=9.5$. Quakes with a magnitude of $M=7$ and larger occur on average approx. 17 time a year worldwide. They can lead to tremors of an intensity X to XII at the epicenter if the earthquake is shallow (i.e. less than 30 km).

In the case of a severe quake, the tremor duration can vary from just a few seconds (at a magnitude of 6) to even more than 5 minutes (at a magnitude of 9) depending on the type and extent of the rupture event.

2. Where to find more detailed information

The global Seismic Risk Map provides a worldwide overview of earthquake-endangered regions. It can be viewed and downloaded in large format on Internet:

<https://media.gfz-potsdam.de/gfz/wv/pic/globalseismichazardmap.png>

On the spot information can also be obtained from the National Geological and Meteorological Surveys, Seismological and Geophysical Institutes or Observatories as well as the Offices for Disaster Management of the respective countries.

3. Local and architectural factors

Records in seismic risk maps are based on the mean stable underground condition. In regions covered with loose and damp sediments, the intensity of the earthquake can be 1 - 1 1/2 degrees higher. In sediment areas with a low groundwater level there is often danger of ground liquefaction. In this case streets can collapse, sink or slip, houses or bridges can be ruptured from their foundations and tip over. In earthquake risk areas it is advisable not to build on or live in buildings built on instable ground. Buildings constructed with natural quarry stone with heavy roofs without sufficient cement should be avoided. Wooden frame constructions with light roofs are least in danger. Stable earthquake-reinforced frame-construction is often also available in steel or steel cement. If necessary please obtain advice on the stability of the underground, the fundament and the norms of earthquake-safe construction for the planned new building or the building you will be living in from the local Building Permission Authorities.

4. Preventive Measures during and after a tremor

Earthquakes occur all of a sudden and they are usually intense. To the present day, there is no option for earthquake prediction. The application of preventive measure is the only means to risk reduction. Should a professional evaluation on the stability of your building and building foundation point to increased risk in the case of an earthquake; reinforcement measures must be carried out by a specialist. Furthermore, following individual factors can be considered:

- Before buying or renting an apartment/house the earthquake safety of the building and the constitution of the underground should be considered. The buildings should not be situated on sandy ground, on ground with underground hollows, or on active tectonic faults lines. Hillside locations should also be avoided.
- Do not rent apartments in skyscrapers without certified earthquake-proof, or in houses in narrow streets; avoid as well objects on which badly constructed neighboring houses can fall.

- Shelves should be firmly attached to the walls of the individual rooms (with long screws in the walls or wooden beams).
- Heavy objects should be stored on lower shelves.
- The same is valid for delicate objects such as bottles, glass, and china. These should be stored in cupboards with tightly closed doors.
- Household chemicals and flammable liquids should be stored on the bottom shelves of locked cupboards.
- Heavy objects such as pictures, mirrors and chandeliers should not be fixed over beds, sofas or other furniture groups.
- Lights and the supply cables should be secured with appropriate straps and clamps.
- Heavy furniture and shelves should not be placed near exits.
- Television, computer screens, machines and mobile electrical objects should be safely secured.
- Faulty and aged electrical and gas pipelines should be repaired without delay (danger of fire); use flexible gas and electricity connecting pipelines to service devices.
- Hot water boilers should be firmly anchored in the ground and fixed to the wall with straps.
- Select suitable shelters in your apartment/house (e.g. under a strong table, bed, reinforced door frames, at a carrying inner wall away from outer walls, windows, mirrors, pictures, heavy furniture, book shelves, chandeliers, etc.).
- Inquire about the nearest safest open-air area, sufficiently far away from buildings, trees, telephone and electric overhead wires, road and rail flyovers.
- Assure that all family members know how to behave during and after an earthquake (see below). Most important is to know where gas, electricity, and water can be turned off, to have contact phone numbers for police and fire brigade at hand, to know how to use the fire extinguisher, and to be informed of which radio stations report on accidents and damages.
- Organize a catastrophe emergency package to cover three days. It should include, pocket torches and a pocket radio with an extra set of batteries, a mobile phone, first-aid set with instructions, other required medicine, A-B-C fire extinguisher, long-life food products, (do not forget tin-opener and pen-knife) and drinking water (approx 4 liters per day per person), strong shoes and warm clothing, sleeping bags or light warm blankets and thermal mats, tent, cash and credit cards, identity cards and passports, city map, pen and note book. Place the information sheet with the most important addresses and telephone numbers along with the emergency supplies. Store this in a safe and easily accessible place. Replace foodstuffs and water on a regular basis.
- Do a first-aid test with your family and make sure that all family members know how to use the contents of the emergency package.
- Decide on a disaster-communication action plan in case family members are separated. Agree on a suitable meeting place for the family, if possible outside the disaster area.
- Arrange for one of your neighbors or colleagues to keep an eye on your apartment/house should you be away during a tremor.

5. How to behave during an earthquake

In a building:

- Remain calm. Do not panic. Do not jump out of the window or from the balcony.
- Seek shelter under a heavy sturdy piece of furniture (e.g. a table or bed) and hold on to it for the duration of the quake. If this is not possible shelter under a fixed door frame or lie on the floor close to a carrying inside wall and away from windows. Protect your head and face with folded arms.
- Remain in the building for the duration of the tremor. It is most dangerous to try to flee from the building during a quake due to danger from falling objects or glass splinters. Exception: only if you are on the ground floor close to an exit leading directly to an open space (garden or open space – not narrow streets) when the tremor begins. Do not use stairways. Do not use lifts.

In the open-air:

- Seek shelter immediately in an open space, away from buildings, street lamps and supply lines - remain there until the tremor is over.
- Should you be driving a vehicle, pull in immediately to the side of the street but away from buildings, trees, flyovers and supply pipes. Remain in the car for the duration of the quake. Listen to the radio. Do not cross bridges, crossings or underground tunnels. After the tremor resume your journey with extreme caution (avoid bridges, ramps flyovers etc which may have been damaged during the quake) or if you prefer abandon your car for the time being (See 6).
- Leave hillside areas immediately - danger through landslides or falling stones.
- Should you notice tremors while in flat coastal areas – run quickly land inwards, and if possible to a higher level. Earthquakes may lead to high waves (up to 30 m high – Tsunamis). These sometimes appear a considerable time after the tremors have ceased. Also a second wave may follow. Therefore, leave your save place on higher ground only when the Tsunami alert officially is cancelled.

6. factors for consideration after a quake

- Keep tuned to the radio for information and instruction from the Disaster Service.
- Help injured and buried persons with utmost caution. Give first aid help where possible. Do not move critically injured persons unless they are in immediate danger. Phone for professional help.
- Help neighbors, especially children, senior citizens and injured persons.
- Keep in mind that after-shocks are possible. Although after-shocks are less intensive than the main tremor, they may cause further damage to already damaged buildings leading even to collapse. After-shocks can continue over days, weeks and even months after the main tremor.
- Do not enter damaged buildings and if necessary only together with rescue service and with helmets. Return home only when the authorities have officially given green light.
- Telephone in urgent cases only – no long telephone conversations. Rescue and help activities can be hindered due to overloaded telephone lines.
- Immediately remove poisonous or inflammable liquids.
- Be careful when opening cupboards doors.
- Turn off the heating; Check if the chimney has been damaged (danger of fire). If so, inform the fire brigade.

- Check if the gas pipeline have been damaged (smell, noise). Close the main gas tap and inform the gas company.
- Check if electric lines have been damaged (broken cables, sparks, hot insulation). If so turn off the main switch and inform an electrician.
- Check if water pipes have leaks. If suspected - do not use the toilet, boilers, baths. Not being able to flush the toilet will lead to serious problems especially during hot weather periods – it is advisable to have a shovel on hand for the safe disposal of toilet waste.
- Should the water supply be cut off please use the emergency supply or water from boilers, canned foods or the lavatory flush. As it will then be no longer possible to flush the toilet it is advisable to keep a shovel at hand to dispose of faecal matter.
- Use the car in very urgent situations only. In this way streets and entrances are free for rescue and supply vehicles.
- Keep emergency packages close to hand should evacuation be necessary.
- In the case of temporary emergency accommodation utmost hygiene is a top priority (danger of epidemics).
- Do not remain in flat beach and coastal areas – danger of Tsunami waves.
- Should you be driving when the ground begins to shake – pull into the side immediately. After about 15 minutes the street will be traffic congested or closed by the police. You will probably not be able to leave the area by car or reach another area. It is advisable to leave your car unlocked with the key in the ignition.
- In the earthquake area smaller or larger fires may kindle. The fire service will probably have difficulty in reaching and controlling the flames due to blocked roads and broken water pipes. Large fires often pose an even greater threat than the earthquake itself. Make sure to observe your surroundings as well as the wind direction. Should your whereabouts be threatened or rendered uninhabitable by fire please take your emergency belongings and go to the assembly area – if possible to the downwind side. Assembly areas are usually larger open spaces which also function as fire breaks.
- Should you be a non-European country try to form a group with other European citizens at the designated assembly area. Compile a list of the persons present including the following information: Family name, first name, date of birth, health status as well as the names and contact numbers for relatives in the respective homeland. Then pass this list on to the German Embassy or any other European Embassy which will make every effort to be available around the clock depending on the prevailing circumstances. Representatives from the Embassies of EU member states will do their utmost to get to all assembly points to inform you of the prescribed measures and to collect the prepared lists as outlined above.

Please note that these recommendations have been developed based on state-of-the-art scientific knowledge. At the same time, however, the GFZ German Research Centre for Geosciences is not responsible and cannot be held liable for injury or damages resulting from the recommended line of action.

Short form of the EMS-98

The short form of the European Macroseismic Scale, abstracted from the Core Part, is intended to give a very simplified and generalized view of the EM Scale. It can, e.g., be used for educational purposes.

This short form is not suitable for intensity assignments.

EMS intensity	Definition	Description of typical observed effects (abstracted)
I	Not felt	Not felt.
II	Scarcely felt	Felt only by very few individual people at rest in houses.
III	Weak	Felt indoors by a few people. People at rest feel a swaying or light trembling.
IV	Largely observed	Felt indoors by many people, outdoors by very few. A few people are awakened. Windows, doors and dishes rattle.
V	Strong	Felt indoors by most, outdoors by few. Many sleeping people awake. A few are frightened. Buildings tremble throughout. Hanging objects swing considerably. Small objects are shifted. Doors and windows swing open or shut.
VI	Slightly damaging	Many people are frightened and run outdoors. Some objects fall. Many houses suffer slight non-structural damage like hair-line cracks and fall of small pieces of plaster.
VII	Damaging	Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many well built ordinary buildings suffer moderate damage: small cracks in walls, fall of plaster, parts of chimneys fall down; older buildings may show large cracks in walls and failure of fill-in walls.
VIII	Heavily damaging	Many people find it difficult to stand. Many houses have large cracks in walls. A few well built ordinary buildings show serious failure of walls, while weak older structures may collapse.
IX	Destructive	General panic. Many weak constructions collapse. Even well built ordinary buildings show very heavy damage: serious failure of walls and partial structural failure.
X	Very destructive	Many ordinary well built buildings collapse.
XI	Devastating	Most ordinary well built buildings collapse, even some with good earthquake resistant design are destroyed.
XII	Completely devastating	Almost all buildings are destroyed.