

# 8

## Earthquakes

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## Introduction



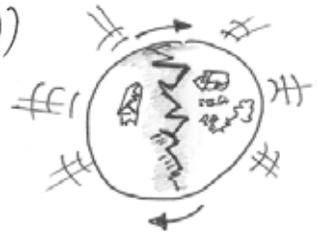
An earthquake is a sudden shaking of a section of the Earth's outer rocky surface. Over the years, huge plates that form this surface move slowly over, under and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to move to release the accumulating pressure. When the pressure grows strong enough, the plates break free, causing the ground to shake sideways or up and down. Most earthquakes occur at the boundaries where the plates meet. When the quake has finished, the land may be higher or lower than before, there may be cracks in the ground, and sea level may appear to be higher or lower than before.



1. Movement of the Earth's plates towards each other.



2. The plates collide and cause an earthquake.



3. Following an earthquake there are sometimes aftershocks.

## Earthquake impact and aftershocks

In a desert or remote mountain area, an earthquake may be relatively harmless. However, when it occurs in a populated area, it may cause deaths and injuries and extensive property damage. Infrastructure, such as roads, bridges and railways, will be badly damaged. Sometimes essential emergency services, such as hospitals, will themselves be destroyed. There are likely to be secondary impacts also: an earthquake may trigger landslides, avalanches, flash floods, fires and tsunamis, which can have a much wider impact many miles from the epicentre of the quake.

Ground movement during an earthquake is rarely the direct cause of death or injury. Ninety-eight per cent of all earthquake deaths occur as a result of buildings and structures collapsing. Buildings with foundations on unstable ground, or with walls not tied securely to the foundations and the roof, are at high risk of structural failure and collapse. Sadly, building regulations in urban areas are often not followed, and the systems to enforce the laws are weak. There is a well known saying: 'It's the buildings that kill the people, not the earthquakes.'

Aftershocks are smaller earthquakes that follow the main shock and can cause further damage to weakened buildings. Aftershocks may continue for several months after the quake. Sometimes, an earthquake may actually be a foreshock, heralding a larger earthquake coming soon.

In addition to structural damage, gas, electricity, water and phone services may all be disrupted. Minor injuries are caused by flying glass and falling objects. Much of the damage and injury in earthquakes is predictable and can be prevented, either by improving the design of buildings or by acting on the simple guidelines below.



# Preparing for earthquakes

## Personal safety

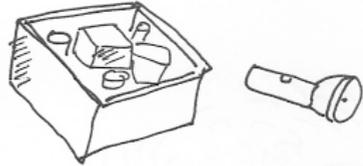
You should take the following steps to protect yourself and others:

- Make sure you know about the fire evacuation procedures and any earthquake plans for all of the buildings you occupy regularly, including the church building.
- Identify safe places in each room of your home, workplace or school. A safe place could be under a piece of heavy furniture or against an interior wall – away from windows, bookcases or tall furniture that could fall on you.
- Practise the earthquake procedure of **'drop, cover and hold on'** in each safe place. **'Drop'** means sit down to the floor. **'Cover'** means protect your head using a school-bag or cushion. **'Hold'** means grab hold of some solid furniture. If you do not have sturdy furniture, sit on the floor next to an interior wall and cover your head and neck with your arms.
- Make sure everyone in your family knows the correct action to take, especially children.
- Keep a flashlight (or candles and matches) and shoes by each person's bed at night, plus a bottle of drinking water (changed regularly).
- Place all furniture at the sides of your room and store any heavy objects such as sewing machines on the floor, not on high shelves. Consider ways of attaching heavy cupboards and bookshelves to the wall with hooks and brackets.
- Make sure that all high-up cupboards or cabinets are shut, and locked if possible, at night.

## Drop! Cover! Hold on!



- Be alert to any unusual behaviour by many birds or animals at the same time. This has happened before other earthquakes and may be a signal that tremors are coming soon.
- Learn how to shut off the gas valves in your home (if applicable) and keep a wrench handy for that purpose. It is a good idea to turn off gas at night, or if leaving the house. (Many fires result from leaking gas after a quake.)
- Keep and maintain an emergency supplies kit in an easy-to-access location. This kit should include flashlight, matches and candles, First Aid materials, basic medicines, water and some dry food supplies. A cooking pot may also be useful.



## Church and community preparedness

Churches in earthquake-prone areas can do several things to prepare for a possible earthquake:

- Raise awareness about earthquakes and train all church members, young and old, on the correct action to take if an earthquake begins (see 'Personal safety' above).
- Assess the risks in the church building and seek to minimise them (eg are there items on high shelves, or heavy furniture items which could fall and cause injury?).
- Practise an evacuation from the church, in case a quake occurs during a service.
- Develop a contingency plan, so that the church will be able to assist its members and the wider community after a quake. Link this plan with local government plans. Consider how the immediate needs for rescue, medical care, food, water, shelter and emotional support will be met, and ensure that everyone knows this plan.
- Identify safe assembly points for each group of buildings, so that a 'roll-call' can establish who might be trapped in rubble.
- Consider training a team of volunteers to lead the immediate rescue efforts (before outside help arrives) and to provide emergency First Aid (see Chapter 2, pages 41–45 and 62–66).
- Consider keeping a few basic tools – shovels, crowbars, saws, ropes etc – in a store, box or cupboard outside the church building. This can be locked, but there should be multiple keys kept by several church and community leaders. There must be quick and easy access to these tools in an emergency.

## What to do during an earthquake

If you are inside when the shaking starts, take the following action:

- Drop, cover and hold on, as practised before. Move as little as possible.
- If you are in bed, stay there, curl up and hold on. Protect your head with a pillow.
- Stay away from windows to avoid being injured by shattered glass.
- Stay indoors until the shaking stops and you are sure it is safe to go out. If you think the building has been damaged, leave it after the shaking stops, using stairs rather than a lift, in case there are aftershocks, power cuts or other damage.
- If you are outside when the shaking starts, find a clear area (away from trees, hoardings, road signs, power lines, buildings, etc) and drop to the ground. Stay there until the shaking stops.
- If you are in a vehicle, pull over to a clear location and stop. Avoid bridges, overpasses and power lines if possible. Stay inside with your seatbelt fastened until the shaking stops. Then drive carefully, avoiding dangerous cracks in the road and bridges and ramps that may have been damaged. Watch out also for landslides which may have blocked the road or removed a section of the road.
- If a power line falls on your vehicle, get out with great care, not touching cables or metal car parts.
- If you are in a mountainous area or near unstable slopes or cliffs, be alert for falling rocks and other debris. Earthquakes often trigger landslides.



## What to do after an earthquake

**When the shaking stops it does not mean that the danger is over.**



Here are some things you should do after an earthquake:

- Expect and prepare for potential aftershocks, landslides and fires.
- If you are living near the coast, expect a tsunami (a very large wave) and move to higher land quickly. Watch the behaviour of animals: some may instinctively run to high ground.
- Look quickly for damage in and around your home and get everyone out if your home is unsafe. Try to put out any small fires and turn off gas valves.
- Check yourself for injuries. Control heavy bleeding before helping other people who are injured or trapped. If you have sustained more serious injuries, you may need to seek medical help, and be unable to assist others.
- Make sure that all members of your family are safe. Mark the location of any relative or neighbour who you know is trapped under a building, and seek help. Try to pass water and wound dressings through gaps to trapped or injured people.
- Each time you feel an aftershock, follow the earthquake rule: drop, cover and hold on.
- Check the telephones in your home or workplace to see if they are working. Make brief calls to report life-threatening situations to the local authorities.
- Listen to a portable, battery-operated or hand-crank radio for updated emergency information and instructions.
- Open cupboard and cabinet doors carefully, as the contents may have shifted.
- Help people who require special assistance, such as infants, children and elderly or disabled people.
- Watch out for fallen power lines or broken gas pipes and stay out of damaged buildings until the authorities say they are safe. If it is essential to enter a building (eg to rescue someone), follow the procedure outlined below.



- Keep animals under control: they may become agitated or aggressive after a quake.
- Be careful when driving, as roads may be severely damaged and dangerous in places; landslides may block the road or sweep it away.

## Entering buildings

The points listed below are relevant to everyone, but especially those living in urban areas with gas, electricity and water supplies.

- When entering buildings, use extreme caution. Building damage may have occurred where you least expect it. Carefully watch every step you take.
- Examine walls, floors, doors, staircases and windows to make sure that the building is not in danger of collapsing.
- Check for gas leaks. If you smell gas or hear a blowing or hissing noise, open a window and quickly leave the building. Turn off the gas if there is an accessible valve.
- Look for electrical system damage. If you see sparks or broken or frayed wires, or if you smell burning insulation, turn off the electricity at the mains switch or circuit breaker. Avoid stepping in water if the electric power is still on.
- In a city, check for broken water pipes or damage to sewage systems. Water may have been polluted by sewage or household rubbish.



## Church response to an earthquake

Church response to an earthquake will depend partly on the amount of preparation done beforehand. If there is a disaster management committee (see Chapter 2, page 39), a team of trained volunteers (Chapter 2, pages 41–45), a clear contingency plan or available tools and First Aid equipment, the response will be quicker and more effective.

In reality, earthquakes are uncommon and mostly difficult to predict, so they often occur in places which are unprepared. This was true of the January 2010 earthquake

in Haiti, but many urban churches in Port-au-Prince still took action to accommodate and feed hundreds of people in their compounds.

Here are some more ideas:

- Church volunteers may be able to help with search and rescue. Medically trained members can give emergency First Aid for people who have been injured.
- Survivors may be accommodated in a church compound. If the church building, church hall or school is still standing and in safe condition, it could be used as temporary shelter.
- Emotional help and counselling can be offered for people who are bereaved and upset, plus prayer support.
- Funerals and burials will certainly be needed, and should be conducted in culturally appropriate ways.
- As well as shelter, immediate needs are likely to be for water, food, toilets and medical help. The church may be able to arrange some of these through contacts with the local authorities or with NGOs, or by using the labour of its volunteers.
- Care for children and the protection of vulnerable orphans should be a priority for the church. Sunday School teachers and church leadership should be trained to be able to identify those most at risk and take steps to care for them and protect them from abuse and exploitation. Churches should create a safe and secure environment for children and that means zero-tolerance towards child abuse and exploitation. For support please refer to Tearfund's Child Protection Policy: <http://tilz.tearfund.org/Topics/Child+development/Child+Protection+Policy.htm>

More information can be found in Chapter 2: 'Organising ourselves' (pages 37–68) and Chapter 4: 'Displaced people' (pages 95–131).

## Earthquake damage mitigation

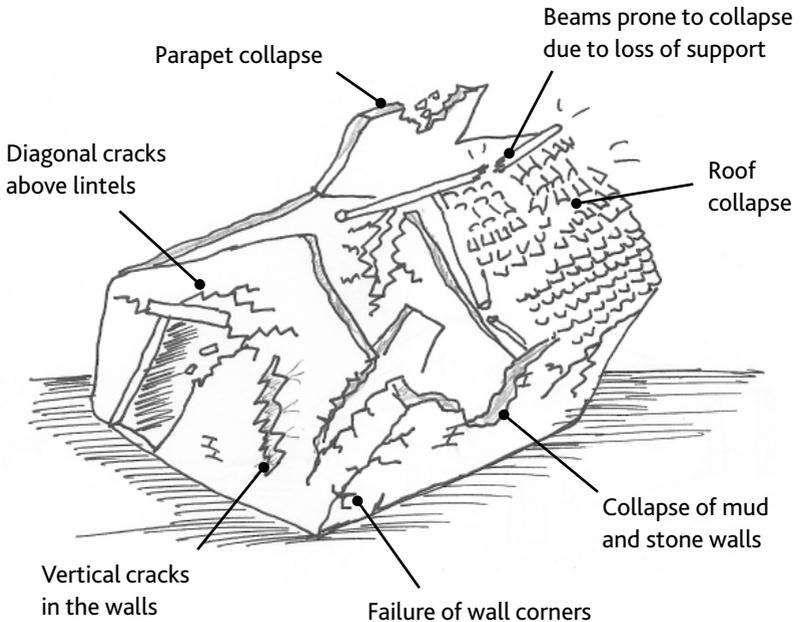
Earthquakes are the result of massive forces working in the earth below us, but it is still possible to limit damage and to reduce deaths and injuries.

Some possibilities include:

- improving the design of new houses and buildings so that they are more earthquake-resistant, and avoiding weak, non-resistant extensions
- making existing houses and buildings (including churches) more earthquake-resistant by adding additional strength to key parts of the structure and foundations

- avoiding areas which could be at high risk following an earthquake, eg hillsides vulnerable to landslides, and flat coastal lands at risk from tsunamis.

The picture below highlights the main impacts an earthquake can have on a building. Studying the points of building failure can help us to build structures that are more resistant to earthquakes.



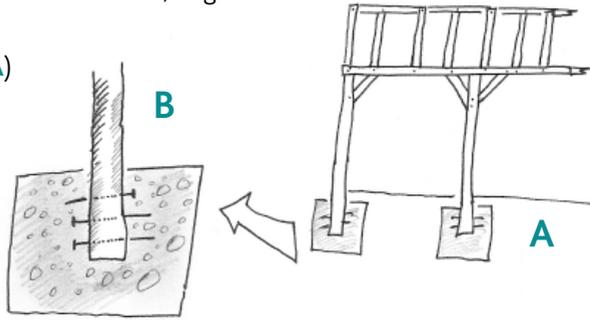
## Building low-cost earthquake-resistant housing

Here are some tips for building earthquake-resistant housing at low cost. They apply to adobe (sun-dried brick) construction. They are also useful in constructing new church buildings or strengthening existing ones. Some of the points are a little technical, but they should be understood by anyone who is a housebuilder or contractor. Earthquake-resistant features may vary for other types of construction.

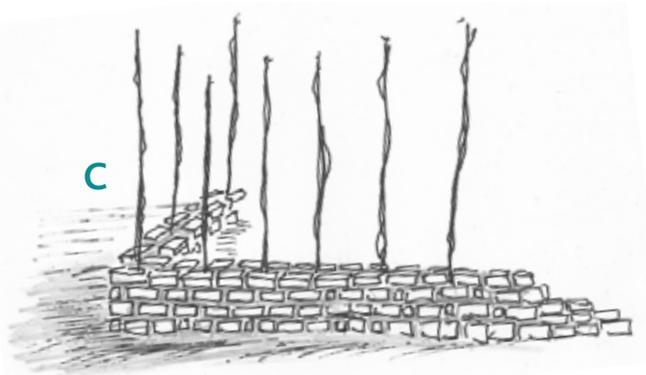
- Try to build one-storey structures only. Two or more storeys are likely to collapse.
- Houses in places with cold winters often have a heavy roof made from beams and compacted earth. These are highly dangerous – it is much better to use an insulated lightweight roof instead. Lightweight metal sheets are less likely to injure people in an earthquake, although in a cyclone, with high winds, metal sheets blow around and cause many casualties.

- Arrange the wall layout to provide mutual support by means of cross-walls and intersecting walls at regular intervals in both directions, or use buttresses.
- Keep the openings in the wall small and well spaced.
- Make sure the foundations are concrete, to give greater stability.

- Use wooden columns (A) treated with tar or pitch to protect them against humidity, concreted into the ground and with nails embedded in the wood at the base to give extra anchorage (B).

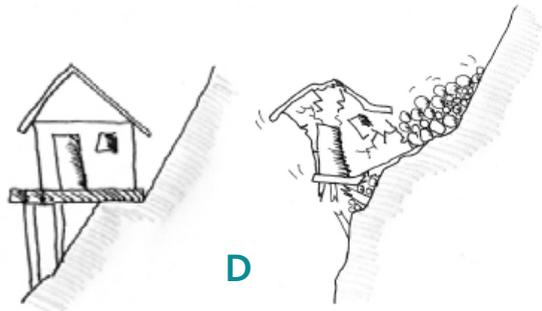


- Reinforce the walls with bamboo rods (C) to provide greater stability.
- Strengthen the roof by nailing roofing material to roof beams and tying the beams to the vertical posts with roof wires or metal bands, to guard against strong wind and earth movement.



- Stabilise adobe with a small amount of cement to give extra strength.

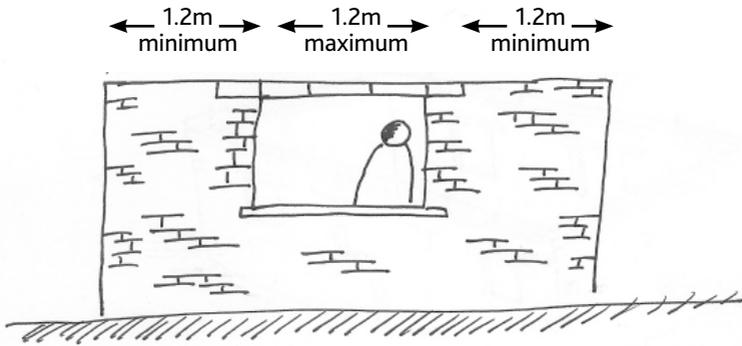
- Reinforce the corners of the building with extra brickwork or buttresses.
- Reinforce lintels with wire mesh or steel rods.
- Avoid building on steep slopes. Buildings supported by pillars on slopes are likely to collapse (D).



## Strengthening the walls

Walls are the main load-bearing elements in an adobe building. They can be made more resistant to earthquakes in the following ways:

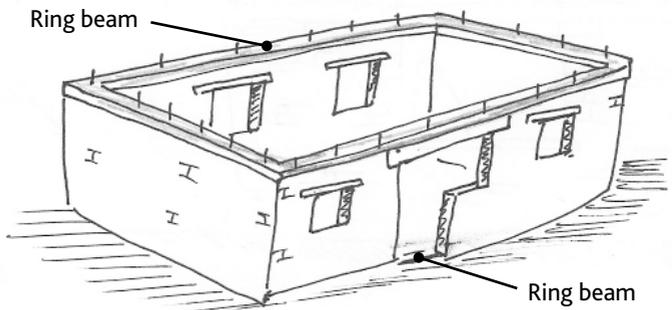
- The wall height should not exceed eight times the wall thickness at the base, and the wall should not be more than 3.5m high.
- The unsupported length of the wall between the cross-walls should not exceed ten times the wall thickness, with a maximum of 7m.
- Wall openings should not exceed one-third of the total wall length.
- No opening should be wider than 1.2m.
- Sections of wall between openings should be at least 1.2m in width.



## Ring beams

A ring beam (also known as a crown, collar, bond or tie beam or seismic band) is a continuous band of wood or concrete around a building, which ties the walls together in a box-like structure. There are usually at least two, one in the foundations and the other just above the windows and doors. They are among the most essential components of earthquake resistance for load-bearing masonry or adobe buildings.

The ring beam must be strong, continuous and well tied to the walls, and it must be attached also to the roof, giving it support. A concrete beam should be reinforced



with steel rods. The corners of the building should also be reinforced with vertical steel rods, tied to the ring beams and tied also to the roof structure.

Earthquake resistance is a technical topic and the best solution is to seek advice from a qualified structural engineer, especially if planning a new church or school.

**NOTE:** Sometimes, buildings are constructed using earthquake-resistant designs, but extensions are then added which do not have the resistant features. The construction process itself may damage ring beams or other essential features, and the whole building becomes weaker. If you are extending a house, make sure that earthquake rules are followed. It is better to add new rooms by the side, not on top of existing rooms.

## Building houses, building community

Following a major earthquake, there is an opportunity to use the reconstruction phase to learn new skills and build better, more resistant houses. At the same time, there is a parallel opportunity to strengthen cooperation between members of the community.

The following steps describe a typical process which community groups could follow, perhaps under the leadership of members of the church with appropriate skills.

1. Community meetings are held to review the faults of previous housing designs and to discuss why they were vulnerable to earthquake damage.
2. Members of the community are trained by an experienced architect and builder in how to make low-cost houses which are earthquake-resistant.
3. Families design their own homes, using the suggestions from the earthquake resistance training sessions.
4. Community members then start building, applying their new skills, working in small groups to build each other's houses.



**NOTE:** In places where building is always done by masons and carpenters, these artisans should be trained in earthquake-resistant construction methods.

## Case study

### Earthquake-resistant housing in Peru

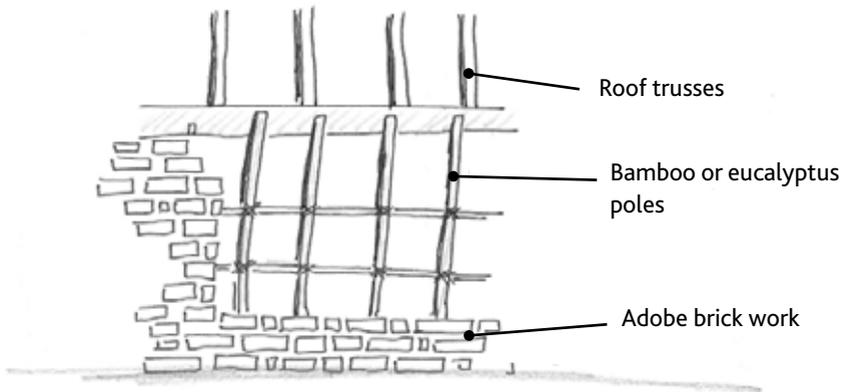
Traditional adobe houses are built of sun-dried brick. They have been used for centuries in Peru and are popular because adobe, consisting of straw and clay, is readily available and inexpensive. The houses can be built by unskilled workers and are fire-resistant. However, adobe lacks the strength to withstand earthquakes.

Adobe buildings house some 65 per cent of the rural and 35 per cent of the urban population in Peru. During the earthquake of 1970, 50,000 people died and more than 60,000 houses were destroyed – a level of destruction that can largely be attributed to traditional housing styles. When an earthquake occurs, the walls of these houses collapse outwards and the dried mud roof, which can weigh up to ten tonnes, falls and crushes the occupants.

The new construction methods include reinforcing the walls with inexpensive bamboo or eucalyptus poles anchored to the foundations, together with horizontal canes tied to the poles at every fourth row of bricks. The poles are secured to parallel wooden beams on top of the walls, which also act as roof supports.

These structural changes allow the walls and roof to react to the vibrations of an earthquake as a structural unit rather than as separate elements. The improved methods were tested at the Pontificia Universidad Católica del Perú on a 'seismic table', which simulates earthquakes. The improvements have succeeded in making the adobe constructions resistant to the force of Peru's most severe earthquakes.

Source: Practical Action Peru



**BIBLE STUDY****The Philippian jailer** Acts 16:22–30

In the Bible, earthquakes sometimes have a meaning and purpose. At other times, they are merely historical events.



**1 KINGS 19:11–12** Elijah flees from Queen Jezebel and meets with God on Mount Horeb. There is a strong wind and then an earthquake and a fire – but God chooses to reveal himself not in these but in a 'gentle whisper'.

**ISAIAH 29:6** The prophet writes: 'The Lord Almighty will come with thunder and earthquake and great noise, with windstorm and tempest and flames of a devouring fire.' He will assist his people against their enemies.

**AMOS 1:1 AND ZECHARIAH 14:5** A particular earthquake during the reign of King Uzziah is used to mark the date of Amos's ministry, and is referred to as a historical event by Zechariah.

**MATTHEW 24:7** Jesus mentions earthquakes (along with famine and war) as future events which will be a sign of his imminent return.

**MATTHEW 27:54 AND MATTHEW 28:2** Earthquakes are recorded as occurring in the natural world as signs of major spiritual events – the death of Jesus and his resurrection a few days later.

**ACTS 16:22–30** An earthquake acts as a potential jail-breaker! Paul and Silas, in prison in Philippi, are freed by a violent earthquake.

**REVELATION 16:18** A tremendous earthquake is recorded as part of the awful events taking place on earth, as seen in John's vision of the future.

**Background**

Paul visited Philippi during his second great missionary journey, having been guided by the Holy Spirit to cross into Greece from Asia Minor (modern Turkey) (Acts 16:6–12). Philippi was an important city, a Roman colony, where Roman citizens enjoyed many privileges, including freedom from beatings and arrest. It was here that Paul met Lydia, a trader in purple cloth, and she and her family became the first believers in the city – the nucleus of the first European church. However, opposition soon followed (verses 16–22). The local magistrates, ignorant of Paul and Silas's identity as Roman citizens, ordered them to be whipped and imprisoned (verses 23–24).

Paul and Silas, with their feet restrained and in pain from their injuries, spent the night in prayer and praise, with the other prisoners listening (verse 25). During that night, a violent earthquake occurred.

(Earthquakes were well known in New Testament and early church times. Ephesus, another major first-century city, located just across the sea from Philippi, was severely damaged by earthquakes in AD 23, 262 and 614.)

## Key points

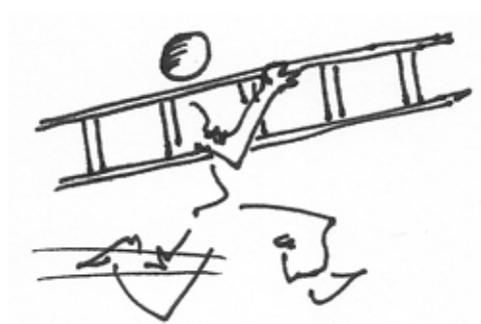
God used the earthquake in Philippi to free Paul and Silas, but also to bring the Christian message to the jailer and his family and probably to other prisoners. The behaviour of Paul and Silas, first by their singing, then by their refusal to escape, had a big impact upon the jailer and the other inmates. A disaster causes much suffering, but God is still able to bring some good, even from the worst disaster.

## Questions

- 1 *How do you think Paul and Silas were feeling after the traumatic events of the day?*
- 2 *What was the immediate impact of the earthquake on the prison building, on Paul and Silas, and on the other prisoners (verse 26)?*
- 3 *What was the first reaction of the jailer to these events (verses 27–28)? (Jailers at that time would be severely punished for losing their prisoners.) How did he respond to Paul's reassurance that none of the prisoners had escaped? How did life change for the jailer and his family after the earthquake?*
- 4 *The first believers in Philippi came from different backgrounds. Lydia was from Thyatira in Asia Minor (now Turkey); other believers were possibly Greek. The slave girl formerly possessed by an evil spirit (verses 16–18) could have come from any of the Mediterranean countries. The jailer and his family were probably Romans. What type of church might we expect to see in Philippi? How does this church illustrate Galatians 3:26–28?*
- 5 *What good can God bring out of the terrible destruction and loss of life usually associated with earthquakes today? How can the behaviour of rescuers have a positive effect? What benefits might come to the community and to the church through the subsequent recovery programme?*

## Review of this chapter

- *What are the main causes of earthquakes and their main effects on a community?*
- *What can churches do to prepare individuals and households for an earthquake?*
- *What can churches do in the aftermath of an earthquake?*
- *What risks do you need to be aware of when entering a building that has been affected by an earthquake?*
- *What tasks can volunteers perform in helping people caught up in an earthquake?*
- *What are some of the things you can do to make low-cost houses more resistant to earthquake damage?*
- *Why is it important to involve the whole community in planning and designing new earthquake-resistant housing?*



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