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सत्यमेव जयते



Earthquake Survival

Training Module 1

Earthquake Survival

Training Module 1

Imprint

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The reader is advised to confirm specifications and health hazards described in the booklet before taking any steps, suitability of action requires verifications through other sources also.

Information provided here does not constitute an endorsement or recommendation.

Guiding word



Dr. Dieter Mutz
Director
GIZ-IGEP
Delhi, September 2012

Since 2011, GIZ has been collaborating with the National Civil Defence College, Nagpur for implementing the “Civil Defence and Disaster Risk Management” (CD-DRM) project, aimed at strengthening capacity building initiatives in Civil Defence. The focus of the programme is on risk reduction for disasters caused by natural hazards such as floods, cyclones, drought, or manmade disasters caused by industry. The design and development of training tools such as an internet based training and knowledge management system and blended learning training methodology and the development of training materials are important activities under this project.

It gives me great pleasure to introduce this training module to accompany the hands- on training course for trainers and volunteers. The module will help the development of knowledge and skills in specific thematic areas to reduce the risk of disasters.

I take this opportunity to express appreciation for the commitment of Director National Civil Defence College, the Director General of Civil Defence, Ministry of Home Affairs, Government of India, New Delhi, and ifanos Germany and ifanos India who extended their support and cooperation to this effort. I wish that such modules are used extensively by all stake holders across the country.

Preface



Mr. G.S.Saini (V.S.M.)
Director
NCDC
Nagpur, September 2012

The Civil Defence Organisation in India has been a governmental programme building resilience of individuals and communities, in order to increase survivability during extreme event. Recently, the Govt. of India had amended the Civil Defence Act, 1968 to include measures relating to disaster management in the overall operational capabilities of the Civil Defence Organisation. In view of this, a review of the local and state level training modules was conducted by NCDC and upgraded modules prepared.

NCDC believes that “Strong and Resilient Society” within the Nation can only be possible through volunteer activity, that comes together to serve the Country and its people to overcome catastrophic impact's from disasters. The NCDC has developed training modules to include the survival skill oriented programs so as to sustain higher recovery rate after disaster. The training modules deal with essential task to be performed during and after disaster and provide the necessary force level to the district administration in the form of back up volunteers from the community.

The module on Earthquake survival covers a range of precautionary steps that are necessary for each individual and the community. It also guides common people to undertake volunteer action that can increase their survival during an earthquake.

Objective of the module:

- To learn and understand the cause of earthquake
- To learn and understand conduct of search and rescue after earthquake
- How to take or give relief and recovery measures

Main target group:

- For Civil Defence instructors
- Home Guard Platoon Commanders
- Revenue staff engaged in Disaster Relief Management at State/District level
- Members of NGO's

This module is meant to accompany the hands-on training in earthquake safety

It includes

1. How to rescue in an emergency
2. How to make different types of improvised stretchers, blankets
3. Types of rescuer method.

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1 Introduction

An earthquake is a sudden slipping or movement of part of the earth's crust that is followed by a series of vibrations. (http://www.ready.gov/earthquakes). These vibrations may be transmitted to buildings causing damage or even collapse of parts of the buildings.

Around 65% of India's landmass is prone to moderate, high or serve earthquake risks. In India, earthquakes are considered to be among the most destructive natural disasters with the potential of inflicting huge losses to life and property. Rapid urbanization with haphazard construction has led to the situation that millions of people in various parts of the country are at risk from the impacts of earthquakes. Some earthquake preparedness and response measures have been initiated, but a lot more needs to be done, as evident from several recent earthquakes that turned into national disasters, exposing the urgent need for putting comprehensive earthquake risk management measures in place.

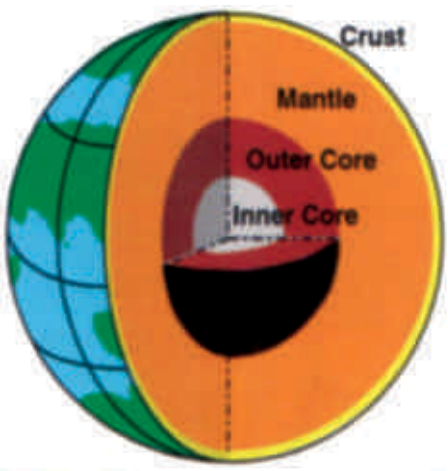


Fig. 1: Inside the earth

Causes of earthquake

The Earth consists of the Inner core (radius -1290 km), the Outer Core (thickness -2200 km), the Mantle (thickness -2900 km) and the Crust (thickness -5 to 40 km). The Inner Core is solid and consists of heavy metals (e.g., basalts and granites). The Outer Core is viscous liquid in form and the Mantle has the ability to flow. At the Core, the temperature is estimated to be 2500 C°, the pressure 4 million atmospheres and density 13.5 gm/cc; this is in contrast to 25 C°, 1 atmosphere and 1.5 gm/cc on the surface of the Earth.

The circulation

Convection currents develop in the viscous mantle because of differences in temperature and pressure gradients between the crust and the core, somewhat like the convective flow of water when heated in a beaker. These convection currents result in circulation of the earth's mass; hot molten lava comes out to the surface and the cold rock mass goes in to the Earth. Many such local circulations take place under the Earth's surface, leading to different directions of movements along the surface.



Fig. 2: Local convective currents in the mantle

Plate tectonics

The convective flows of mantle material cause the crust and some portions of the mantle to slide over the hot molten outer core. This sliding of the Earth's mass takes place in sections called Tectonic Plates. The surface of the Earth consists of seven major tectonic plates and many smaller ones. These plates move in different directions and speeds. Sometimes two plates move away from one another creating rifts. In other cases two plates move side-by-side in the same or opposite direction. The relative movement of plate boundaries varies across the Earth; and the average movement is two to some tens of centimetres per year.

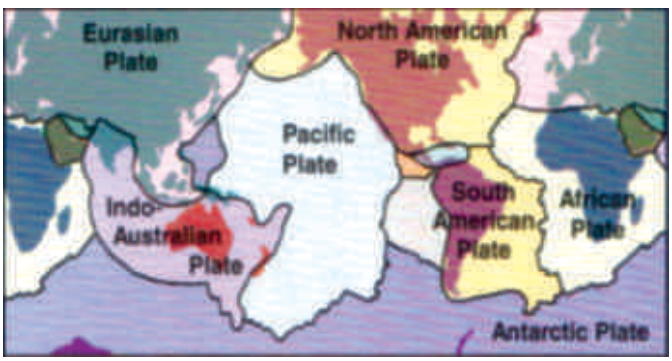


Fig. 3: Major tectonic plates on Earth's surface

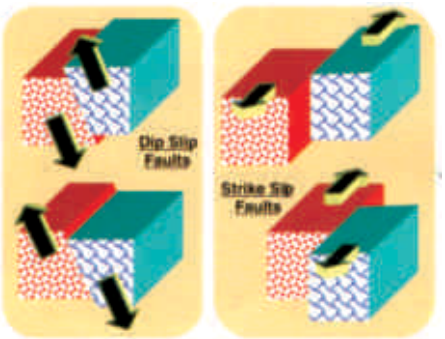


Fig. 4: Types of faults

Earthquake

When a sudden movement has taken place along a weak part of the crust, the opposite sides of the fault (crack) suddenly slip. This releases a huge amount of elastic strain energy stored in interface rocks. For example, the energy released during the 2001 Bhuj (India) earthquake was about 400 times than that released by the atom bomb dropped on Hiroshima!!

The sudden slip at the fault causes the earthquake - a violent shaking of the Earth when the elastic strain energy released spreads out as seismic waves that travel through the body and along the surface of the Earth.

2

Earthquake Hazard Vulnerability In India

Almost the entire northeast region of India, northern Bihar, Himachal Pradesh, Uttarakhand, Jammu & Kashmir and some parts of Gujarat are in seismic zones V, while the entire Gangetic plain and some parts of Rajasthan including the capital of the country are in seismic zone IV.

In the last decade India has experienced several destructive earthquakes, which resulted in the death of a large number of people and caused huge losses to property. These destructive events include the Latur earthquake of 1993, Bhuj earthquake of 2001 and the more recent Sikkim earthquake in 2011. In the span of the last 15 years, India has experienced six earthquakes of moderate magnitude. Although moderate, these earthquakes did cause a disproportionately high degree of loss to human life and property, highlighting the vulnerability of the population and infrastructure to earthquakes and inadequate preparedness to respond to them.

2.1 Earthquake hazard zones

As per the seismic zoning of India published in 1998 the country is divided into 4 seismic zones classified as II to V.

Zone II: The probable intensity is MMI VI (as per the Modified Mercalli Intensity Scale). This zone is referred to as Low Damage Risk Zone.

Zone III: The associated intensity is MMI VII. This is termed as the Moderate Damage Risk Zone.

Zone IV: Gives the area liable to MMI VIII, This, zone is second in severity to zone V. This is referred to as High Damage Risk Zone.

Zone V: Covers the area liable to seismic intensity IX and above on the MMI Scale. This is the most severe seismic zone and is referred to as Very High Damage Risk Zone.

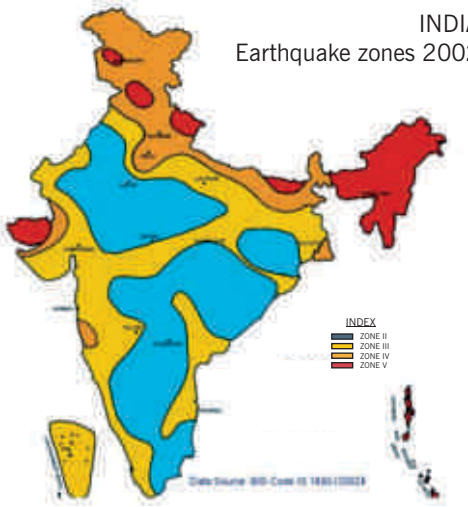


Fig. 5: Various earthquake zones in India

Damage risk levels for earthquakes

The damage risk of various building types as defined based on the Medvedev-Sponheuer-Karnik (MSK) seismic intensity scale are given below:

- **Very High Damage Risk (VH):** Total collapse of buildings.
- **High Damage Risk (H):** Gaps in walls; parts of buildings may collapse; separate parts of the building lose their cohesion; and inner walls collapse.
- **Moderate Damage Risk (M):** Large and deep cracks in walls, fall of chimneys on roofs.
- **Low Damage Risk (L):** Small cracks in walls; fall of fairly large pieces of plaster, roofing tiles slip off; cracks in chimneys, part may fall down.
- **Very Low Damage Risk (VL):** Fine cracks in plaster; fall of small pieces of plaster.

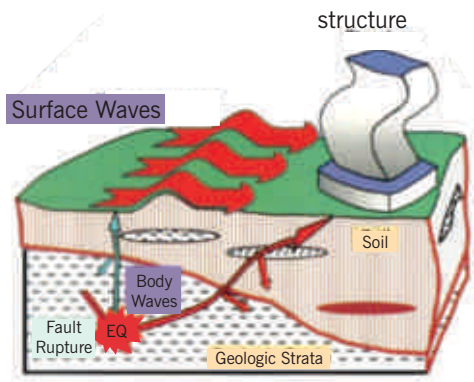


Fig. 6: Arrival of seismic waves at site

2.2 Building design and codes

Building damage in an earthquake more often results from structural weakness or the conditions on the ground underneath rather than from the strength of shock waves

The 5 elements of an earthquake that may cause damage to manmade structures:

- ☑ Strength of waves
- ☑ Length of motion
- ☑ Proximity to the fault
- ☑ Geological foundation
- ☑ Building design

2.2.1 Principles of earthquake resistant building design

Ground vibrations during earthquakes cause stress and deformations in structures and they need to be designed to withstand such forces. An earthquake-resistant building has four characteristics:

1. **Good structural configuration:** The building size, shape and structural system carrying loads are such that they ensure a direct and smooth flow of inertia forces to the ground.

2. **Lateral strength:** The maximum lateral (horizontal) force that the building can resist is such that the damage induced does not result in collapse.

3. **Adequate stiffness:** Its lateral load resisting system is such that the earthquake-induced deformations in the building do not damage its contents under low-to-moderate shaking.

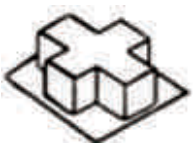
4. **Good ductility:** Its capacity to undergo large deformations under severe earthquake shaking even after yielding is improved by favourable design and detailing aspects.

Damage of buildings and structures is often caused by horizontal forces that are exerted on structures that were intended to absorb only vertical stresses. In addition, there might be uneven resistance in different parts of a structure. As a result, rigid parts may break off or be torn loose. Architectural features that are unfavourable to earthquake resistance of buildings should be avoided or minimized. When irregular features are included in buildings.

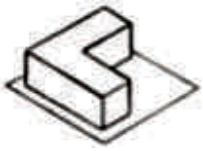
Decisions made at the planning stage on building configuration are more important, or are known to have made greater difference, than accurate determination of code specified design forces.



Split Levels



Cruciform Plan



L-Shaped Plan



Tall, Soft, or Weak First Story

Fig. 7: Examples of building with irregular configurations

The consequences of damage of a particular building have to be taken into consideration during the structural design of a building:

- Infrastructure such as hospitals and fire stations, play a critical role in post-earthquake activities and must remain functional immediately after the earthquake. Therefore these structures should be designed for a higher level of earthquake resistance in order to assure that they sustain only very little damage.

- The collapse of dams during earthquakes or damages on nuclear power plants or chemical plants might cause secondary disasters. These structures therefore must designed for an even higher level of earthquake resistance.

2.2.2 Risk of damage for different house types

The damage risk to various house types is based on the observed average performance when damaging events have occurred in the past. With respect to variations in the architectural planning, structural detailing, quality of construction and care taken in maintenance, the performance of each category in a given event could vary substantially from the average observed.



Fig. 8: Effect of inertia when the building is shaken at its base

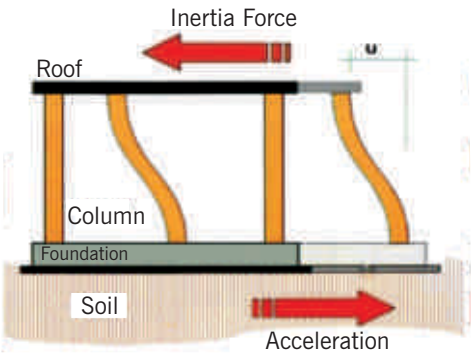


Fig. 9: Inertia force and relative motion within a building

Earthquake resistant design philosophy

Earthquake resistant design philosophy may be summarized as follows.

- Under minor but frequent shaking, the main members of the building that carry vertical and horizontal forces should not be damaged; however building parts that do not carry load may sustain repairable damage.
- Under moderate but occasional shaking, the main members may sustain repairable damage, while the other parts of the building may be damaged to such an extent that they may even have to be replaced after the earthquake; and
- Under strong but rare shaking, the main members may sustain severe (even irreparable) damage, but the building should not collapse.

Summary

Buildings should be designed to resist earthquakes in a way that:

- After a minor shaking, the building should be fully operational within a short time and the repair costs should be small.
- After moderate shaking, the building will be operational once the repair and strengthening of the damaged main members is completed.
- After a strong earthquake, the building may become dysfunctional for further use, but should not collapse to guarantee that people can be evacuated and property recovered.

3

Guidelines for Earthquake Resistant Brick Houses

Human settlements are frequently affected by natural disasters, like earthquakes and others, which take a heavy toll on human lives, destroy buildings and infrastructure and have far reaching economic and social consequences for communities.

The following do's and don'ts give a first advice about brick house construction (From: HUDCO 1999).

Dont's ☒	Do's ☑

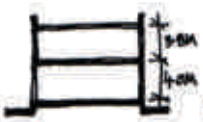
Brick Construction Planning



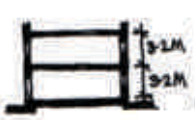
B:A >0.2



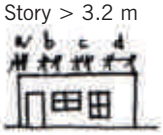
B:A <0.2



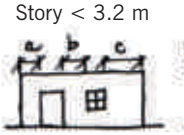
HT. Of each Story > 3.2 m



HT. Of each Story < 3.2 m



a,b,c,d <0.6 m

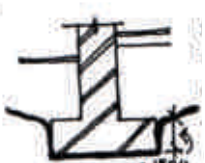


a,b,c,d >0.6 m

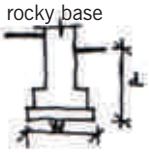
Foundations



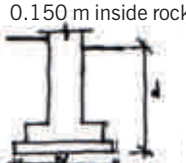
Foundation on rocky base



Foundation atleast 0.150 m inside rocky base



d < 0.5 m
w< 0.75 m in Sandy/moorum soil

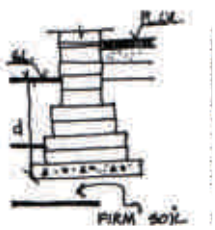


d > 0.5 M, 0.75 M N sandy / Moorum Soil

Dont's ☒	Do's ☑



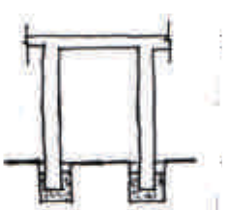
Foundation restws on Black soil where depth of soil less than 1.2 m



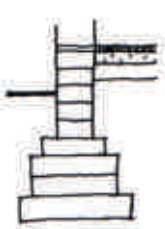
Foundation depth to be more Black soil depth is 1.2m or less



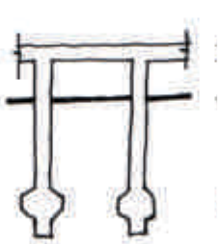
Avoid normal foundation Where depth of black soil Is between 1.2 and 2.0 m.



Use pedestal piles Where of black soil Is between1.2m and 2.0 m



Avoid normal Dr. Pedestal Foundations wherever Depth of black soil is more than 2.0m



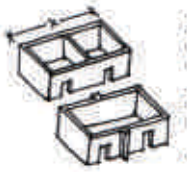
Use under reamed piles Wherever depth of black soil Is more than 2.0m.

Dont's ☒	Do's ☑

Walls



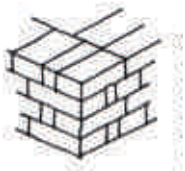
x > 6.0 m



x < 6.0 m
use crosswalls or pilasters



continuation of vertical joints in courses

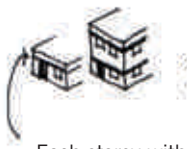


Always discontinue vertical joints in each course

Roofs



Each storey without Lintel band



Each storey with Lintel band



Trusses without Bracings in sloped roofs



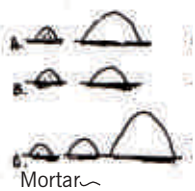
Use bracings at bottom chord and In plane of slope of trusses.

Dont's ☒	Do's ☑

Mortar

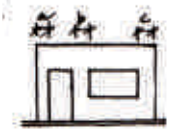


Mortar
Cement: Sand 1:9



Mortar
A. Cement : Sand 1:6
B. Lime : Sand 1:3
C. Cement : Lime: Sand 1:2:9

Mud Construction Planning

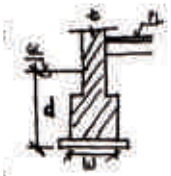


a,b,c,d <1.2 m

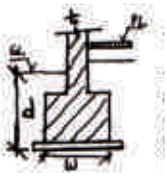


a,b,c >1.2 m
a,b,c <1.2 m

Foundations



T <1.5 x w
D < 0.5 m



T >1.5 x w
D > 0.5 m

Walls

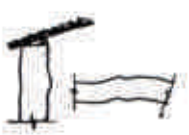


Do not plaster the outer surface of an external wall with plain mud plaster



Plaster the outer surface with water proof mud plaster mixed with 27. Bitumen cutback

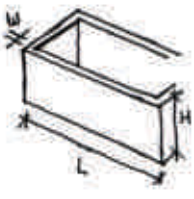
Dont's ☒	Do's ☑



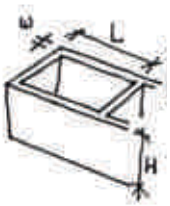
Crooked/Misaligned walls in Length/Height



Maintain thickness of wall. Use a stone Slab/Wood plank over the wall



L > 10 x w
H > B x w



L < 10 x w
H < B x w



House more than $1^1/_2$ storey high. Ground floor walls less than 0.35 m thick.



House to be 1 or $1^1/_2$ storey high. Ground floor walls at least 0.35 m thick.

Roofs



Gable wall without Gable Band



Gable wall with Gable Band

Dont's ☒	Do's ☑



Heavy and loose elements on the roof.



Light WT. material like sheets as roofing material. Tie all elements together and with wall suitably.

Flood Prone Areas



In non- abailability of natural elevation- construction at ground level.



Build on stilts to elevate the building.



Building at less than minimum safe pistance from coastline.



Building at safe pistance from coastline.



Residential/Important building in flood plain of river



Observe flood plain zoning



Projections hinder free flok



No projections are best

4

Seismic Design Codes

Seismic codes help to improve the behaviour of structures so that they may withstand earthquake effects without significant loss of life and property. Seismic codes are unique to a particular region or country. They take into account:

- the local seismology
- accepted level of seismic risk
- building typologies
- materials and methods used in construction

Seismic design codes are also indicative to the level of progress a country has made in the field of earthquake engineering.

Indian seismic codes

The first formal seismic code in India, namely IS 1893, was published in 1962. Today, the Bureau of Indian Standards (BIS) has the following seismic codes:

- IS 1893 (part 1), 2002, Indian Standard Criteria for Earthquake Resistant Design of Structures (5th Revision).
- IS 4326, 1993, Indian Standard code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision).
- IS 13827, 1993, Indian Standard Guidelines for Improving Earthquake Resistance of Earthen Buildings.
- IS 13828, 1993, Indian Standard Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings.
- IS 13920, 1993, Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
- IS 13935, 1993, Indian Standard Guidelines for Repair and Seismic Strengthening Buildings.

Note: The regulations in these standards do not ensure that structures suffer no damage during earthquake of all magnitudes. But, to the extent possible, they ensure that structures are able to respond to earthquake shakings of moderate intensities without structural damage and heavy intensities without total collapse.

5

Earthquake Safety Rules and Precautions

Trapped victim location techniques

Once surface and/or lightly trapped victims are removed, surface search and rescue operations should focus on searching for, locating and marking positions where contact is established with victims and where voids in rubble that potentially contain victims are discovered. The techniques used to achieve this include line and hail search and canine search.

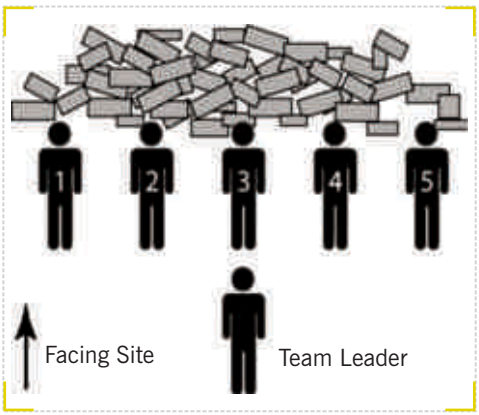
Line and hail search technique



The line and hail search procedure offers a structured and systematic approach to ensure that all areas of the site are searched. Its main objective is to locate live victims who may be trapped below the surface of the rubble.

Conducting a line and hail search

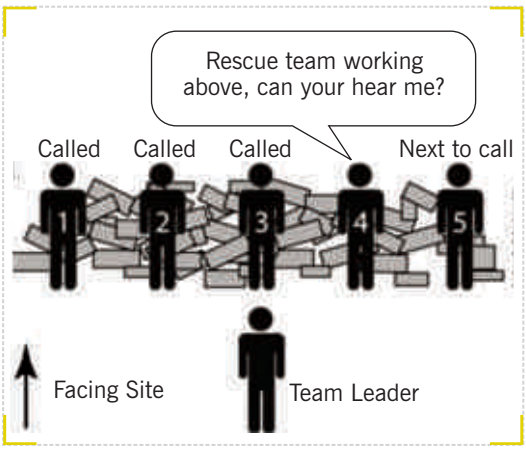
A Search area of the collapse site is selected in accordance with the search priorities that have been established. To ensure that no area is left unsearched, mark the search line position prior to any adjustment. This provides a point to which it should return.



The line and hail search team members excluding the team leader, stand in a straight line approximately 1.5 m to 2 m apart at the edge of the structure collapse site.

The team leader coordinates the search from behind the team or from a vantage point, ensuring he/she can see all the team members. This ensures the team leader can listen and watch for signs of a response as indicated by the team members. The line of team members is numbered sequentially from the team leader's left-hand side, starting with number one.

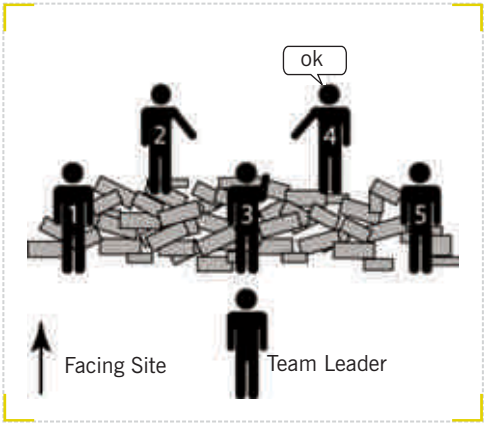
The team leader gives the order, 'Quiet on the site', and instructs team member number one to commence the search call. The first team member calls into the rubble, 'Rescue team working above, can you hear me?' The entire rescue team listens for a response for 15 to 20 seconds. If nothing is heard the team member shouts, 'Nothing heard'. The next member in line then repeats the call. After all team members have called and there is no audible contact, the team leader instructs the team to advance 1 m into the search area, where the process is repeated.



Actions upon hearing a victim

Any team member who hears a call or any other noise coming from the structure collapse site must raise an arm until acknowledged by the team leader. He or she must then point with an arm fully extended in the direction he or she believes the noise is coming from and remain in that position until otherwise directed by the team leader.

The team leader can then move individual team members to pinpoint the source of the noise



Action upon establishing contact with a victim

If contact is established, the rescuer must question the victim if the victim is able to speak. The questions should focus on receiving information, which will help the team leader to assess the situation. Conversation with a trapped person must always be of a reassuring nature and the questions should focus on the

- Nature of the victim's injury (if any),
- Possible openings in the vicinity of the victim,
- The number of other victims trapped in the vicinity, and
- Any other relevant information.

During the assessment the team leader should try to establish if any breaking, breaching or shoring is required to rescue the trapped victims. If the trapped victims can be removed without breaking, breaching or shoring, extricate the victim. If this is not the case, the first responder must try to find ways to reach and free the trapped victim after securing the walls and passage with timber planks.

The first responder search team undertaking the line and hail search must mark the position of the trapped victim and leave one team member with the trapped victim to maintain contact until the technical SAR operators arrive. Once communication has been established with a trapped victim, it should be maintained as far as it is practically possible to do so. The communications will:

- Maintain the victims' morale

- Help them to withstand whatever pain and discomfort they may be suffering (and may even keep them alive)
- Help technical SAR operators to work in the right direction (sometimes a difficult task in the dark), and
- Assist the technical SAR response personnel with information about displacement or movement in the debris that is likely to cause further injury.

The actual movement of an earthquake seldom causes death or injury. The actual hazards are caused by collapsing buildings and other structures. Although it is probably safer to stay inside a modern building which has been constructed to resist earthquakes damage, frightened people tend to rush outside during an earthquake. However, this probably is the worst thing they can do because most casualties result from falling objects and debris, such as collapsing walls, falling masonry and splitting glass.

Threats for human life during an earthquake

- Falling bricks/stones and plaster
- Splintering glass
- Toppling furniture, collapsing walls
- Rockslides and landslides
- Fallen power lines
- Sea waves generated by earthquakes
- Fires or explosions resulting from broken gas pipes, spillage of kerosene and other flammable materials
- Drastic human actions resulting from panic

5.1 Safety rules before an earthquake

1. Be aware about the disasters that put you at risk and understand your vulnerability.

2. Think about what might happen. In thinking about what you, your family or household might do in an emergency, bear in mind that you may be in a situation where
   - You may be separated from each other, for example children at school and parents at work
   - Normal communications might be difficult or impossible
   - Power supplies may be cut
   - You may be injured, and others may be injured or deceased

- There may be fire or other dangerous elements present, and
- Information about the emergency may be limited in the early stage of the event.

3. Talk with your family, household members and neighbours about things you could do.

4. Involve your family or household
   - Decide how family members will stay in touch in the event of or after an emergency
   - Agree on how you will contact each other if not at home, who will collect family members, and who will check on neighbours
   - Identify an out-of-town person your family or household members can contact in case you are separated. Make a list of that person's contact details (home, mobile and work phone numbers, e-mail) and provide them to your workplace and to your children's school
   - Agree on a place for family or household members to meet if separated
   - Make arrangements for pets to ensure they will be safe, have food and water.

5. Store important documents safely
   - Store important documents including wills, passports, photos, birth and marriage certificates, powers of attorney and insurance policies in a fire and water-proof container or safe deposit box. Review your insurance policies to ensure they are current and adequate. If you keep them in your home, try to take them with you if you evacuate. Consider arranging authorized copies to be kept at an alternate secure location.

6. Find out about your local emergency services
   - Make a record of your local emergency telephone numbers (State or Local Emergency Service, local council, gas electricity, water etc.) and keep the near your phone. Remember to dial 100 for Police, 101 for Fire emergency and 102 for ambulance.

7. Prepare an emergency kit and keep it handy

5.1.1 Prepare

- Know the cut off points for water, electricity and gas and how to operate them
- Fix shelving and bookcases firmly to the walls

- Place heavy objects as low as possible

5.1.2 DURING – Drop, cover and hold on!

If you are inside

- Do not run outside. You are safer inside.
- Move away from glassed windows and doors.
- Shelter in a doorway, under a table, abench, a desk or a bed and hold on.
- If there is no solid furniture, stand against an internal wall and protect your head and neck.
- Move away from the fireplace, windows and balconies.
- Switch off all lights and power supply.
- Turn off all stoves and gas ovens.
- Do not use lifts.
- Do not stay inside buildings with a large roof span unsupported by walls.

If you are outside

- Run to an open space.
- Move away from structures, buildings, high walls, overhead cables, electric cables, water tanks, chimneys and all other structures that could collapse.
- If you are caught near a tall building or in a narrow street take shelter under approach or in a doorway so as to protect yourself from falling objects.

If you are in a car

- Stop the car and stay in it.
- Avoid bridges, culverts, and all other structures that could collapse.

5.1.3 AFTER – Recover

If you are injured

- Don't panic, stay calm.
- Attract attention by all means (use a whistle, knock on walls, etc.).

If you are not injured

- Put out any fires that may have started.
- Switch off all sources of heat and radiators.
- In case of damage, turn off the electricity, water and gas supply.
- Do not use matches or lighters because of the risk of gas leaks.
- Listen to the radio and follow the instructions of those in charge of the rescue operations.
- Provide first aid to the wounded (first aid kit).
- Use the telephone only if lives are in danger. This is so as to not over load the telephone network which is essential for the rescue and medical services.
- Do not enter a damaged building, even if you believe it is safe.
- In case of aftershocks stay where you are and protect yourself.
- Ration your stocks of food and drinking water.
- Assist Emergency Services with information and as volunteer.

6 Emergency Methods of Rescue

Rescue will be conducted under almost every conceivable adverse condition. The method used for casualty removal will depend on the location of the casualty and the type of injury sustained. In some rescue operations, casualties will have to be lowered from the upper floors of buildings. In others, they will have to be hoisted from below through holes in floors, or removed by a combination of these techniques. When casualties are handled by rescue personnel, take care to ensure that further aggravation of injuries does not occur.

Be aware that the safety of the casualty is paramount, even when immediate evacuation from a hazardous environment is necessary.

Make a careful assessment of the casualty's injuries, condition and possible entrapment and make a final check to ensure that the casualty is actually ready to move and is not caught or entangled in an unseen object.

> WARNING
>
> The importance of first-aid training cannot be overstated. All rescuers must be trained to a reasonable qualification level of first aid and life support in order to be able to handle casual ties safely and effectively.

After an earthquake, many casualties will have to be carried over piles of debris and uneven ground before being handed over to the ambulance service or first-aid station. Speed of removal is important, but it must be consistent with safety and proper handling to prevent further injury.

The method used will depend on the immediate situation, the

condition of casualties, types of injury and available equipment. Rescue leaders should conduct frequent exercises in the removal of casualties, using live people as casualties to give team members understanding and confidence in the various methods, enabling them to make decisions promptly in times of emergency. As important as learning the methods, rescuers should experience the physical effort required in transporting casualties, either by stretchers or by some improvised method. The transportation of casualties over long distances is a very tiring task and requires fit personnel.

6.1 Improvised blanketing

Use a small tarpaulin as an alternative method to provide wrap-around protection when no blankets are available:

- Lay the tarpaulin on the stretcher with about 1m overlapping the head end of the stretcher.
- Fold the head end in 200 mm folds to form a headrest.
- Fold the bottom of the covering over the casualty's feet.
- Fold one side of the tarpaulin over the casualty, and fold and tuck in the excess. Repeat the above procedure with the other side.

6.2 Improvised stretchers

In any disaster, there may be insufficient stretchers immediately at hand for the number of casualties involved. Such situations will normally be multi-agency responses, and the resources of all involved agencies should be brought to bear on the problem.

There are many methods of improvisation. Use some imagination when confronted with the problem, however, a number of the more obvious methods are described here.

6.2.1 Platform stretchers

Improvised platform stretchers can readily be devised from doors, sheets of galvanised iron or bed-frames as shown in figures 10 and 11.

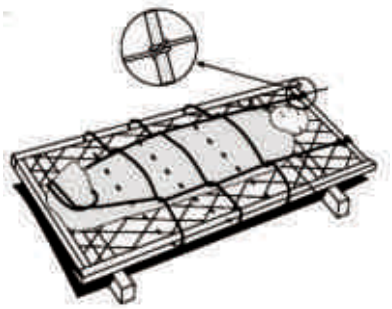


Fig. 10: Bed-frame stretchers

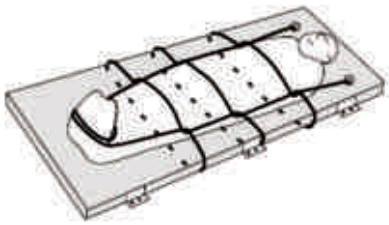


Fig. 11: Door stretcher

6.2.2 Pole stretchers

Pole stretchers are very simple to make and require two poles about m long. Stout broom handles, water pipe or 50 mm x 5 mm timber are quite appropriate for this job.

Lay the poles parallel on the ground and about 600 mm apart. Form the bed of the stretcher with a blanket, sacks, overalls or coats as shown in Figures below

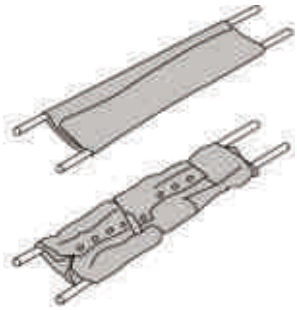


Fig. 12: Pole stretcher

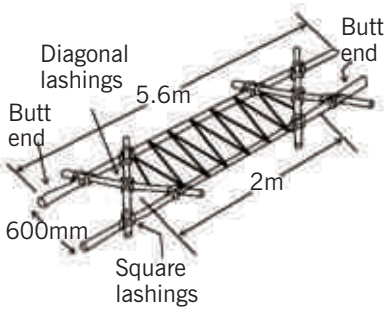


Fig. 13: Bush stretcher

6.2.3 Bush stretchers

A bush stretcher can readily be devised from two timbers about 4 m to 5 m long, strutted and lashed together as shown in Figure below. This is not a makeshift stretcher by any means, and in bush country may be the only suitable means of carrying an injured casualty over long distances.

With the casualty supported on the rope lashings, up to eight rescuers can carry the stretcher at shoulder height over rough ground and bush, thus avoiding many of the obstacles normally in the way of conventional stretchers.

6.2.4 Ladders

Where for any reason a very narrow stretcher is required, such as for passing through small window openings, tunnels etc, a small ladder or one half of a small extension ladder can be used to advantage. Place a decking of boards on the ladder (if available) and then blanket in the normal way.

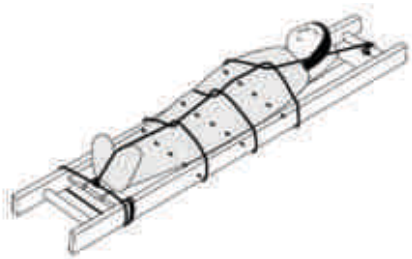


Fig. 14: Ladder

Figure 14 shows a variation to the standard stretcher lashing. Begin with a clove hitch on the stile above the rung nearest the casualty's feet. Then take two loose round turns around the ladder and half-hitch the lashing to the centre of the turns. From here, take three half-hitches around the body in the usual positions. Tie off the lashing with a clover hitch to a rung above the casualty's head.

6.2.5 Chairs

A strong kitchen-style chair can be used to carry casualties without serious injuries as shown in Figure below.



Fig. 15: Chair rescuer

WARNING

During a four-rescuer lift, support the casualty's head and neck at all times. if spinal injuries are suspected, an extra person is required to provide cervical spine stabilisation.

6.2.6 Blanket lift (four or six rescuers)

The blanket lift is an effective method to load or move a casualty in a confined space:

- Make a stretcher ready using one blanket only.
- Roll a blanket lengthwise for half of its width and lay the rolled section along the side of the casualty (casualty flat on back).
- The leader then directs two (or three) rescuers to kneel down on each side of the casualty. The rescuers on one side ease the casualty over and the rolled section of the blanket is pushed well underneath the casualty.
- With the rolled up section of the blanket now under the centre of the casualty, ease the casualty over in the opposite direction and unroll the blanket. The casualty should now be lying flat on two thicknesses of blanket.
- Roll the sides of the blanket up close to the casualty's body to provide handgrips for the bearers (figure 16).
- On the order from the leader, lift the casualty waist high and carry to the stretcher.
- On the order from the leader, lower the casualty onto the stretcher.
- Complete the blanketing with one blanket, leaving the lifting blanket in position.
- This 'blanket carry' can also be used as an improvised stretcher for carrying casualties over moderate distances.

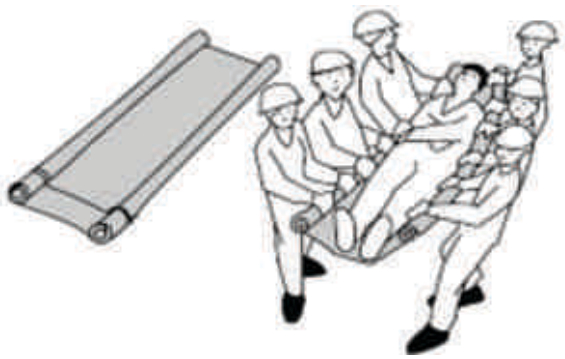


Fig. 16: Blanket lift

WARNING

Suspected spinal-injured casualties can be safely transported by this method with correct immobilisation of the spine and with particular attention paid to the head and neck.

6.2.7 Clothing lift (three rescuers)

This is an emergency method that can be used when the casualty's injuries are not too severe and time is critical:



Fig. 17: Clothing lift

- Blanket a stretcher and place it close to the side of the casualty.
- Tie the casualty's hands together with a triangular bandage or similar material if unconscious.
- Roll the casualty's clothes together along the centre of the body.
- Three rescuers take up position on the opposite side of the casualty to the stretcher and position their hands as illustrated in figure 17.
- The normal commands are given ('Prepare to lift' etc) then place the casualty gently on the stretcher.

6.2.8 Webbing bands (five rescuers)

In some cases, it may be necessary to transport a casualty some distance to a place where a stretcher can be loaded. Webbing bands can greatly assist this operation. There are many configurations which can be used, one of which is illustrated in figure 18. Place the bands in position by pushing the long steel handle under the natural body hollows and see-sawing the bands into the required position, which is under the buttocks and shoulders.





Fig. 18: Webbing bands (five rescuers)

After bands are correctly positioned, centre the handles of each band above the middle of the casualty. The five rescuers take up position. Any kind of improvised lifting bands can be used, for example 50 mm flat tape, wide sturdy belts, fire hose etc.

6.2.9 Specialist lifting/loading devices

Specialist lifting/loading/extrication devices such as timber or synthetic spinal boards, scoop stretchers and spinal immobilisation devices or harnesses are readily available from rescue equipment suppliers. Always use these devices in compliance with manufacturers' specifications and recommendations, and follow appropriate specialist training.

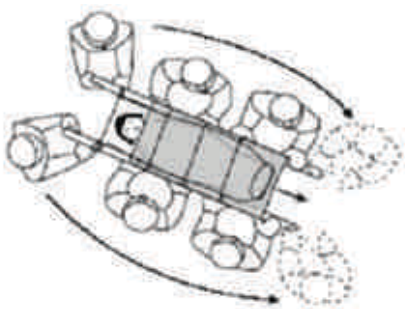


Fig. 19: Specialist lifting

6.3 Rescue techniques using no equipment

This subject is covered under two headings:

- One-rescuer handling techniques.
- Two-rescuer handling techniques.

Clearly understand that the following techniques are for use in an emergency and that seriously injured casualties should, where possible, be placed on a stretcher. Conditions such as fire or imminent danger of building collapse may, however, dictate that removal from the scene is the first priority. In some cases, this may even take precedence over life-sustaining first aid.

6.4 One-rescuer handling techniques

6.4.1 Single-rescuer human crutch

For this method to work, the casualty must be conscious and capable of giving the rescuer some assistance. Figure below clearly indicates how to affect the single-rescuer human crutch. Note the position of the rescuer's hands, one holding the casualty's wrists and the other taking a firm grip of the clothes at the waist on the far side of the body. The injured side of the casualty should be closest to the rescuer.



Fig. 20: Single rescuer human crutch

WARNING

All single rescuer techniques involve the risk of injury to the rescuer.

6.4.2 Pick-a-back

This is an effective method when conducted correctly and the casualty is lighter than the rescuer. When the casualty has been loaded (must be conscious), take care to ensure the casualty is supported well up on the rescuer's hips, with the body literally draped across the rescuer's back.

Rescue crawl



Fig. 21: Pick-a-back

WARNING

The rescuer affecting a pick-a-back carry runs a significant risk of back injury and must take appropriate safety precautions.

This is an invaluable method where a casualty has to be removed from a burning or smoke-filled building. As shown in figure 22, both rescuer and casualty have their heads low down where the clearest and coolest air is to be found if the building is on fire. The entire weight of the casualty does not have to be supported by the rescuer. Cross the casualty's hands and tie with a bandage or similar. Vary the firefighter's crawl method according to personal preference. Probably the most effective method is for the rescuer to place an arm, shoulder and head through the casualty's arms as shown below and support the head with his palm to avoid injury dragging.



Fig. 22: Rescue crawl

Bowling drag

- Turn the casualty on his back and tie his wrists together using a triangular or neck-tie.
- Using on length of 15 feet (4.5 m) such cord or 40 ft. lashing, tie bowline at each end to form the loops.
- Please one loop over the casualty's chest and under his armpits with the knot resting under his head, so that it will keep his head off the ground while he is being pulled.
- The other loop goes on the rescuer, over his shoulders and under his armpits, to form a harness with the knot in line with the centre of his back or between his shoulders.
- The rescuer crawls on his hands and knees and drags the casualty out.

Toe Drag

- Turn the casualty on his back and tie his wrist together using a triangular bandage or neck-tie.
- The rescuer sits down at the casualty's head and places his feet under the casualty's armpits.
- With both hands free the rescuer pulls himself back and at the same time drags the casualty with his feet.

Removal downstairs method

This method is used to recover a heavy casualty down stairs, when the rescuer cannot use the pick-a-back or other methods. However, its use need not be restricted to staircases.

With the casualty lying flat, first tie the wrists together using a triangular bandage or similar. Next, come to the head and lift the casualty into the sitting position. Reach through under the casualty's arms and grasp the wrists. The rescuer is then in a position to drag the casualty backwards and, if a staircase has to be negotiated, a large measure of support can be given to the casualty's trunk by the rescuer using a knee to ease over each successive step. Remember that the strongest part of any staircase is close to the wall.



Fig. 23: Toe drag

Helping a casualty down a ladder

Take great care when helping a person down a ladder, even if that person is conscious and uninjured. Keep in mind that many people are unaccustomed to height and may 'freeze-up' or lose their hold.

- Take a position, one rung below the casualty, with arms encircling the casualty's body and grasping the rungs.
- Keep in step with the casualty, letting the casualty set the pace. Keep knees close together to ensure support in case the casualty loses hold or becomes unconscious.
- Talk to the casualty to help keep up morale and overcome fear.
- If the casualty becomes unconscious, let the casualty slip down until the crutch rests on the rescuer's knee. By repeating this procedure for each step down the ladder, the rescuer can lower the victim to the ground.

WARNING

This technique could exceed the safe working load of the ladder or destabilise the ladder leading to risk of serious injury. A risk assessment must be carried out before attempting this activity.

7 Conclusion

Many areas of India are prone to earthquakes. Living with the risk of earthquakes demands preparedness and adaptation. Collapsing buildings are one of the most severe dangers for human lives in an earthquake; therefore the engineering intention is to make buildings earthquake resistant.

- Earthquake resistant buildings resist the effects of ground shaking, although they may get damaged severely but would not collapse during the strong earthquake.
- Building performance objectives under different intensities of earthquake shaking are: seeking low repairable damage under minor shaking and collapse-prevention under strong shaking.
- Adapting building design to response to earthquake risk during the planning stage might save lives during an earthquake.
- Seismic codes help to support the earthquake resistant buildings.

Knowing what to do before, during and after an earthquake may save your life and the lives of others.

- In most cases it is safer to stay inside a building than to run outside where falling debris might cause severe injuries.
- During an earthquake it is important to avoid injury: Drop, cover and hold on!
- After an earthquake knowing the emergency rescue methods might save lives however the rescuer should be aware of the personal risks during the rescue process and behave accordingly.

9 Glossary and Acronyms

Acronyms

VH	Very High Damage Risk
H	High Damage Risk
M	Moderate Damage Risk
L	Low Damage Risk
VL	Very Low Damage Risk
BIS	Bureau of Indian Standards
IS	Indian Standards

Glossary

Aftershock: An earthquake of similar or lesser intensity that follows the main earthquake.

Earthquake: A sudden slipping or movement of a portion of the earth's crust accompanied and followed by a series of vibrations.

Epicentre: The place on the earth's surface directly above the point on the fault where the earthquake ruptures began. Once fault slippage begins, it expands along the fault during the earthquake and can extend hundreds of miles before stopping.

Fault: The fracture across which displacement has occurred during an earthquake. The slippage may range from less than an inch to more than 10 yards in a severe earthquake.

Magnitude: The amount of energy released during an earthquake, which is computed from the amplitude of the seismic waves. A magnitude of 7.0 on the Richter Scale indicates an extremely strong earthquake. Each whole number

on the scale represents an increase of about 30 times more energy released than the previous whole number represents. Therefore, an earthquake measuring 6.0 is about 30 times more powerful than one measuring 5.0.

Modified Mercalli Intensity Scale: The Modified Mercalli Intensity (MMI) scale depicts shaking severity. An earthquake has a single magnitude that indicates the overall size and energy released by the earthquake. However, the amount of shaking experienced at different locations varies based on not only that overall magnitude, how far you are from the fault that ruptured in the earthquake, and whether you are on rock or thick valley deposits that shake longer and harder than rock. (http://quake.abag.ca.gov/shaking/mmi/)

Seismic Waves: Vibrations that travel outward from the earthquake fault at speeds of several miles per second. Although fault slippage directly under a structure can cause considerable damage, the vibrations of seismic waves cause most of the destruction during earthquakes.

Shoring: Is a general term used in construction to describe the process of supporting a structure in order to prevent collapse so that construction can proceed. The phrase can also be used as a noun to refer to the materials used in the processed.

Clove Hitch: A clove hitch is a type of knot. Along with the bowline and the sheet bend, it is often considered one of the most important knots. It is most effectively used as a crossing knot.

Half Hitch: The half hitch is a simple overhand knot, where the working end of a line is brought over and under the standing part. Insecure on its own, it is a valuable component of a wide variety of useful and reliable hitches, bends, and knots.

8

Background Reading Material



Seven Steps to Earthquake Safety

The information on this page is from materials created by the Emergency Survival Program (ESP) in 2006, and based on "The Seven Steps to Earthquake Safety" in the handbook, Putting Down Roots in Earthquake Country.

Prepare



Step 1: Secure it now!

Reducing and/or eliminating hazards throughout your home, neighborhood, workplace and school can greatly reduce your risk of injury or death following the next earthquake or other disaster. Conduct a "hazard hunt" to help identify and fix things such as unsecured televisions, computers, bookcases, furniture, unstrapped water heaters, etc. Securing these items now will help to protect you tomorrow.



Step 2: Make a plan

Planning for an earthquake, terrorist attack, or other emergency is not much different from planning for a party or vacation. Make sure that your emergency plan includes evacuation and reunion plans; your out-of-state contact person's name and number; the location of your emergency supplies and other pertinent information. By planning now, you will be ready for the next emergency.

Step 3: Make disaster kits



Everyone should have disaster supplies kits stored in accessible locations at home, at work and in your vehicle. Having emergency supplies readily available can reduce the impact of an earthquake, a terrorist incident or other emergency on you and your family. Your disaster supplies kits should include food, water, flashlights, portable radios, batteries, a first aid kit, cash, extra medications, a whistle, fire extinguisher, etc.



Step 4: Is your place safe?

Most houses are not as safe as they could be. Whether you are a homeowner or a renter, there are things that you can do to improve the structural integrity of your home. Some of the things that you might consider checking include inadequate foundations, unbraced cripple walls, soft first stories, unreinforced masonry and vulnerable pipes. Consult a contractor or engineer to help you identify your building's weaknesses and begin to fix them now.

Survive



Step 5: DROP, COVER, and HOLD ON!

Learn what to do during an earthquake, whether you're at home, at work, at school or just out and about. Taking the proper actions, such as "Drop, Cover, and Hold On", can save lives and reduce your risk of death or injury. During earthquakes, drop to the floor, take cover under a sturdy desk or table, and hold on to it firmly. Be prepared to move with it until the shaking stops.

Recover



Step 6: Check it out!

One of the first things you should do following a major disaster is to check for injuries and damages that need immediate attention. Make sure you are trained in first aid and in damage assessment techniques. You should be able to administer first aid and to identify hazards such as damaged gas, water, sewage and electrical lines. Be prepared to report damage to city or county government.

Step 7: Communicate and recover!



Following a major disaster, communication will be an important step in your recovery efforts. Turn on your portable radio for information and safety advisories. If your home is damaged, contact your insurance agent right away to begin your claims process. For most Presidentially declared disasters, resources will also be available from federal, state, and local government agencies.

Earthquake Training

National Earthquake Technical Assistance Program (NETAP)

The National Earthquake Technical Assistance Program (NETAP) is designed to help state, local, and tribal governments obtain the knowledge, tools, and support that they need to plan and implement effective earthquake mitigation strategies. Resources available through the program include instructor-led training courses, technical assistance, tool-development aid, and special-project support.

- NETAP toolkit for earthquake program managers
- Training schedules
- Background and Authorities
- Assistance available through NETAP
- Obtaining assistance through NETAP
- NETAP training courses and associated materials
- Contact Information

Publications

The Federal Emergency Management Agency (FEMA) develops many Earthquake Publications Related to Training used by building designers, managers, regulators, and others for self-study and instruction in how to reduce the seismic vulnerability of new and existing buildings and their contents. In addition to print, online, and CD-based publications, these resources include presentation slides, course videos, and recorded webinars.

NEHRP Earthquake Coordinators Web Site

FEMA established the online Earthquake Coordinators Web Site as one of its contributions to the National Earthquake Hazards Reduction Program (NEHRP). This site is designed for self-paced, independent study by state or local officials or seismic-safety advocates who are new to earthquake risk-reduction concepts and programs. A series of lessons provides key information about earthquakes, seismic hazards, earthquake risk-assessment and risk-reduction tools and strategies, promotion of seismic safety through public advocacy and programs, and other topics. In addition to online instruction, the site provides printable lesson summaries, a printable glossary, and links to further information.

HAZUS training

FEMA's Hazards-United States (HAZUS) software is a powerful risk-assessment tool used to analyze potential losses from earthquakes, floods, and hurricane winds. HAZUS couples current scientific and engineering knowledge with the latest geographic information system (GIS) technology to produce estimates of damage, economic losses, and social impacts before or after a disaster occurs. States and communities use the HAZUS earthquake module for mitigation, preparedness, response, and recovery planning.

FEMA offers various classroom-based HAZUS training courses through its Emergency Management Institute in Emmitsburg, MD. Online HAZUS courses are also available through a private-sector training partner. Visit HAZUS for further information about this important tool and related training opportunities.

Other FEMA earthquake-related training

FEMA's National Preparedness Directorate provides a large number and variety of training courses through its National Training and Education Division (NTED), Center for Domestic Preparedness (CDP), and Emergency Management Institute (EMI). NTED and the CDP focus on training for first responders and other state and local government personnel involved in responding to natural and man-made disasters, including earthquakes.

In addition to courses about responding or preparing to respond to earthquakes and other disasters, the EMI also provides hazard mitigation training. Mitigation courses show states and localities how to assess and reduce risks posed by earthquakes and other natural hazards, and how to obtain grant support from FEMA for hazard mitigation activities. EMI training is offered through classroom-based courses provided by the EMI or by states, and through online independent study courses.

Earthquakes

One of the most frightening and destructive phenomena of nature is a severe earthquake and its terrible aftereffects. An earthquake is the sudden, rapid shaking of the earth, caused by the breaking and shifting of subterranean rock as it releases strain that has accumulated over a long time.

For hundreds of millions of years, the forces of plate tectonics have shaped the earth, as the huge plates that form the earth's surface slowly move over, under and past each other. Sometimes, the movement is gradual. At other times, the plates are locked together, unable to release accumulated energy. When the accumulated energy grows strong enough, the plates break free. If the earthquake occurs in a populated area, it may cause many deaths and injuries and extensive property damage.

While earthquakes are sometimes believed to be a West Coast occurrence, there are actually 45 states and territories throughout the United States that are at moderate to high risk for earthquakes including the New Madrid fault line in Central U.S.

The 2011 East Coast earthquake illustrated the fact that it is impossible to predict when or where an earthquake will occur, so it is important that you and your family are prepared ahead of time.

Before an earthquake

The following are things you can do to protect yourself, your family and your property in the event of an earthquake.

- To begin preparing, you should build an emergency kit and make a family communications plan.
- Fasten shelves securely to walls.
- Place large or heavy objects on lower shelves.
- Store breakable items such as bottled foods, glass, and china in low, closed cabinets with latches.
- Fasten heavy items such as pictures and mirrors securely to walls and away from beds, couches and anywhere people sit.
- Brace overhead light fixtures and top heavy objects.
- Repair defective electrical wiring and leaky gas connections. These are potential fire risks. Get appropriate professional help. Do not work with gas or electrical lines yourself.
- Install flexible pipe fittings to avoid gas or water leaks. Flexible fittings are more resistant to breakage.
- Secure your water heater, refrigerator, furnace and gas appliances by strapping them to the wall studs and bolting to the floor. If recommended by your gas company, have an automatic gas shut-off valve installed that is triggered by strong vibrations.
- Repair any deep cracks in ceilings or foundations. Get expert advice if there are signs of structural defects.
- Be sure the residence is firmly anchored to its foundation.
- Store weed killers, pesticides, and flammable products securely in closed cabinets with latches and on bottom shelves.
- Locate safe spots in each room under a sturdy table or against an inside wall. Reinforce this information by moving to these places during each drill.
- Hold earthquake drills with your family members: Drop, cover and hold on.

During an earthquake

Drop, cover and Hold On. Minimize your movements to a few steps to a nearby safe place and if you are indoors, stay there until the shaking has stopped and you are sure exiting is safe.

If indoors

- DROP to the ground; take COVER by getting under a sturdy table or other piece of furniture; and HOLD ON until the shaking stops. If there isn't a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.
- Stay away from glass, windows, outside doors and walls, and anything that could fall, such as lighting fixtures or furniture.
- Stay in bed if you are there when the earthquake strikes. Hold on and protect your head with a pillow, unless you are under a heavy light fixture that could fall. In that case, move to the nearest safe place.
- Do not use a doorway except if you know it is a strongly supported, load-bearing doorway and it is close to you. Many inside doorways are lightly constructed and do not offer protection.
- Stay inside until the shaking stops and it is safe to go outside. Do not exit a building during the shaking. Research has shown that most injuries occur when people inside buildings attempt to move to a different location inside the building or try to leave.
- DO NOT use the elevators.
- Be aware that the electricity may go out or the sprinkler systems or fire alarms may turn on.

If outdoors

- Stay there.
- Move away from buildings, streetlights, and utility wires.
- Once in the open, stay there until the shaking stops. The greatest danger exists directly outside buildings, at exits and alongside exterior walls. Many of the 120 fatalities from the 1933 Long Beach earthquake occurred when people ran outside of buildings only to be killed by falling debris from collapsing walls. Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related casualties result from collapsing walls, flying glass, and falling objects.

If in a moving vehicle

- Stop as quickly as safety permits and stay in the vehicle. Avoid stopping near or under buildings, trees, overpasses, and utility wires.
- Proceed cautiously once the earthquake has stopped. Avoid roads, bridges, or ramps that might have been damaged by the earthquake.

If Trapped under debris

- Do not light a match.
- Do not move about or kick up dust.
- Cover your mouth with a handkerchief or clothing.
- Tap on a pipe or wall so rescuers can locate you. Use a whistle if one is available. Shout only as a last resort. Shouting can cause you to inhale dangerous amounts of dust.

After an earthquake

- When the shaking stops, look around to make sure it is safe to move. Then exit the building.
- Expect aftershocks. These secondary shockwaves are usually less violent than the main quake but can be strong enough to do additional damage to weakened structures and can occur in the first hours, days, weeks, or even months after the quake.
- Help injured or trapped persons. Remember to help your neighbors who may require special assistance such as infants, the elderly and people with access and functional needs. Give first aid where appropriate. Do not move seriously injured persons unless they are in immediate danger of further injury. Call for help.
- Look for and extinguish small fires. Fire is the most common hazard after an earthquake.
- Listen to a battery-operated radio or television for the latest emergency information.
- Be aware of possible tsunamis if you live in coastal areas. These are also known as seismic sea waves (mistakenly called "tidal waves"). When local authorities issue a tsunami warning, assume that a series of dangerous waves is on the way. Stay away from the beach.
- Use the telephone only for emergency calls.
- Go to a designated public shelter if your home had been damaged and is no longer safe. Text SHELTER + your ZIP code to 43362 (4FEMA) to find the nearest shelter in your area (example: shelter 12345).

- Stay away from damaged areas. Stay away unless your assistance has been specifically requested by police, fire, or relief organizations. Return home only when authorities say it is safe.
- Be careful when driving after an earthquake and anticipate traffic light outages.
- After it is determined that its' safe to return, your safety should be your primary priority as you begin clean up and recovery.
- Open cabinets cautiously. Beware of objects that can fall off shelves.
- Find out how to keep food safe during and after and emergency by visiting: http://www.foodsafety.gov/keep/emergency/index.html
- Put on long pants, a long-sleeved shirt, sturdy shoes and work gloves to protect against injury from broken objects.
- Clean up spilled medicines, bleaches, gasoline or other flammable liquids immediately. Leave the area if you smell gas or fumes from other chemicals.
- Inspect the entire length of chimneys for damage. Unnoticed damage could lead to a fire.
- Inspect utilities.
- Check for gas leaks. If you smell gas or hear blowing or hissing noise, open a window and quickly leave the building. Turn off the gas at the outside main valve if you can and call the gas company from a neighbor's home. If you turn off the gas for any reason, it must be turned back on by a professional.
- Look for electrical system damage. If you see sparks or broken or frayed wires, or if you smell hot insulation, turn off the electricity at the main fuse box or circuit breaker. If you have to step in water to get to the fuse box or circuit breaker, call an electrician first for advice.
- Check for sewage and water lines damage. If you suspect sewage lines are damaged, avoid using the toilets and call a plumber. If water pipes are damaged, contact the water company and avoid using water from the tap. You can obtain safe water by melting ice cubes.

FEMA publications

If you require more information about any of these topics, the following resources may be helpful.

- Avoiding Earthquake Damage: A Checklist for Homeowners. Safety tips for before, during and after an earthquake.
- Earthquake Preparedness: What Every Childcare Provider Should Know. FEMA 240. Publication form teachers and for presentation to children.

- How to Guides to Protect Your Property or Business from Earthquakes. Available online at http://www.fema.gov/library/viewRecord.do?id=3260

Related websites

Find additional information on how to plan and prepare for an earthquake and learn about available resources by visiting the following websites:

- Federal Emergency Management Agency
- NOAA Watch
- American Red Cross
- The Shake Out
- U.S. Geological Survey Earthquake Hazards Program
- Earthquake Country Alliance

Listen to local officials

Learn about the emergency plans that have been established in your area by your state and local government. In any emergency, always listen to the instructions given by local emergency management officials.

Building safety and earthquakes

Part A: Earthquake shaking and building response

Introduction

This Briefing Paper 1, Building Safety and Earthquakes, consists of four parts describing earthquakes and their effects on buildings. Part A provides an overview of how earthquakes occur and the ground shaking motion they produce. It also explains why different individual buildings respond differently to the same ground motion. Parts B to D build on that information to explain how earthquake motion creates forces acting on a building, to describe the structural systems used to resist earthquakes, and to define the "load paths" of earthquake forces within buildings.

Severely damaging earthquakes have repeatedly demonstrated the importance of improving the quality of both earthquake design and construction. The objective of Briefing Paper 1 (Parts A to D) is to inform the

stakeholders and participants in the design and construction process, including building inspectors and owners, about the basic principles of earthquake-resistant building design.

Earthquake causes and effects

Most earthquakes are caused by rock movement along rupturing faults located in the earth's crust. On a global scale, the earth's crust is divided into separate sections known as plates, as shown in Figure 1. Major faults are typically located at plate boundaries. In California, many lesser faults occur near the boundary of the Pacific and the North American plates, which, in California, is defined by the San Andreas fault. However other parts of California also contain faults. In fact, there are more than 160 known active faults located in this state. New faults continue to be discovered, usually when an unexpected earthquake occurs. Essentially, earthquakes can affect any location within California, potentially causing significant damage and loss of life.

> There are more than 160 known active faults located in California

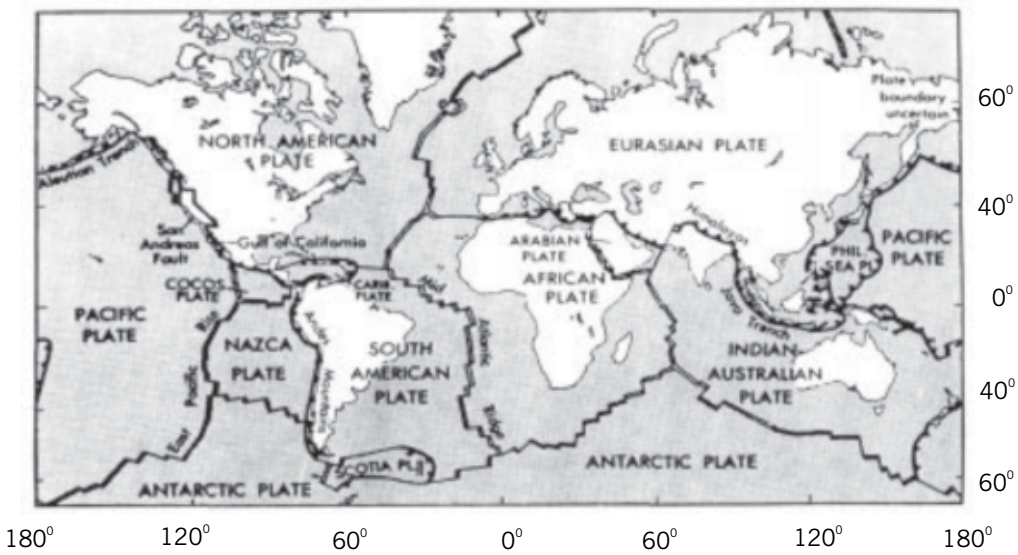


Fig. 24: Global plates and plate boundaries.

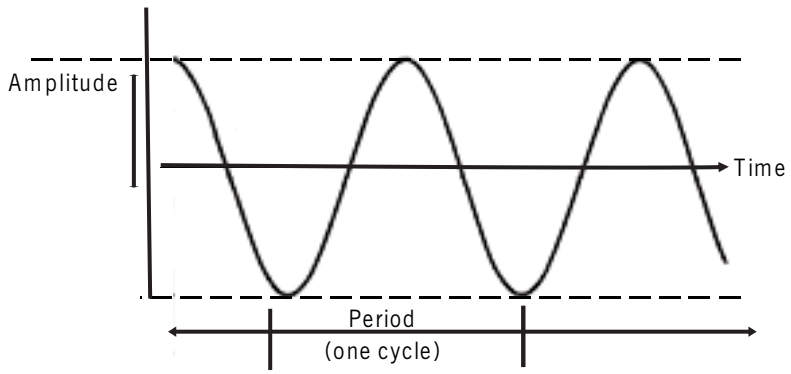


Fig. 25: Cyclic wave of constant amplitude and period

Faults move or “slip” when shear stresses deep underground exceed the ability of the compressed faulted rock to resist those stresses. Fault slip can move the nearest ground surface vertically, laterally, or in some combination. When this slip occurs suddenly, it causes seismic shock waves to travel through the ground, similar to the effect seen when tossing a pebble onto the surface of still water. These seismic waves cause the ground shaking that is felt during an earthquake.

A magnitude 7.0 earthquake releases 31.5 times more energy than does a magnitude 6.0 earthquake.

Ground motion contains a mix of seismic waves having two primary characteristics as shown in Figure 2. One is the wave amplitude, which is a measure of the size of the wave. The other is its period, which is a measurement of the time interval between the arrival of successive peaks or valleys, known as one cycle. This concept of a time measurement can also be expressed as frequency = 1/period, the number of cycles occurring per second.

Everything in the path of a seismic wave will be shaken. However, the amount of ground motion at any given location depends on three primary factors. One factor is the distance between the site and the source location of the earthquake, known as the focus or hypocenter, which in California may range from 2 to 15 miles underground. The shallower the focus, the stronger the waves will be when they reach the surface.

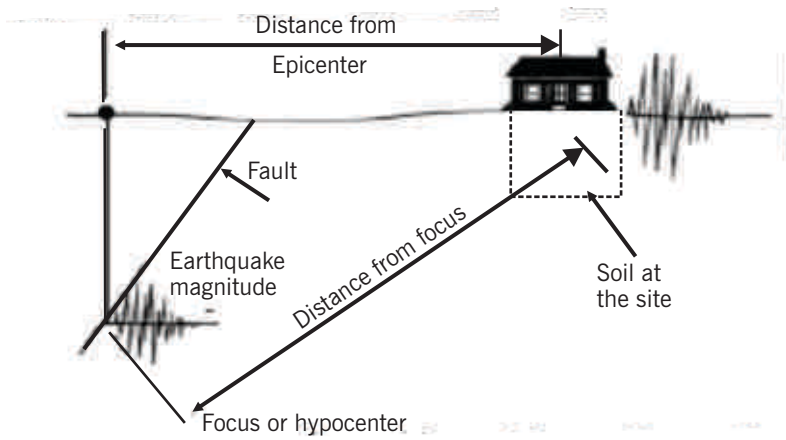


Fig. 26: Common terms and factors affecting shaking intensity at a given site.

As a general rule, the intensity (severity) of ground shaking diminishes with increasing distance from the source. Buildings located less than 15 kilometers (9.3 miles) from certain types of faults are required by the 1997 Uniform Building Code (UBC) to be designed to withstand the stronger shaking expected in these near-source zones. Maps produced by the California Division of Mines and Geology and available from the International Conference of Building Officials (ICBO) indicate where these faults are located.

The second factor is the total energy released from the earthquake, measured by its magnitude. Because the magnitude scale is logarithmic, a magnitude 7.0 earthquake releases 31.5 times more energy than does a magnitude 6.0 earthquake. The ground shaking intensity at a given location is greater for the magnitude 7.0 earthquake, but not 31.5 times greater. Instead, the larger energy release produces shaking that is felt over larger distances because the ruptured fault length is greater. Also, the shaking from a larger-magnitude earthquake often lasts longer, because more time is needed for the longer rupture to release the greater energy. The last of the three primary factors is the nature of the soil or rock at the site. Generally, sites with deep soft soils or loosely compacted fill will be more strongly shaken than sites with stiff soils, soft rock, or hard rock. For example, during the 1989 Loma Prieta earthquake, the shaking experienced in the San Francisco Marina District, which is underlain by mud nearly 100 feet thick, was from three to four times stronger than the

shaking measured only a few blocks away on bedrock, near the Golden Gate Bridge. The building codes for new construction (e.g., the 1997 UBC) and the NEHRP Guidelines for the Seismic Rehabilitation of Buildings (FEMA-273 report) use adjustment factors to account for the stronger shaking at soft soil sites and fill sites.

To summarize: the intensity of ground motion at a specific site, caused by a specific earthquake, depends primarily on three factors: the distance between the source (also known as focus or hypocenter) and the site, the magnitude of the earthquake (amount of energy released), and the type of soil or rock at the site. These factors are illustrated in Figure 3, which also shows the location of the epicenter (point on ground surface directly above the hypocenter). More complex factors, such as the type of faulting action, the direction of propagation of the fault rupture, and the frequency range of the waves, can increase or decrease the severity (intensity) of the local shaking. Consequently, actual ground motion cannot be precisely predicted. However, based on the recorded motions of past earthquakes obtained from instruments located both inside and outside buildings, it is possible to estimate the probable maximum ground motion given the values for the three factors. These estimates form the basis for seismic design requirements contained in modern building codes.

Building response characteristics

Different individual buildings shaken by the same earthquake respond differently. The effects of earthquake ground shaking depend on the specific response characteristics of the type of structural system used. One important building characteristic is the fundamental period of vibration of the building (measured in seconds). The fundamental period of a building depends in a complex way on the stiffness of the structural system, its mass, and its total height. Seismic waves with periods similar to that of the building will cause resonance, and amplify the intensity of earthquake forces the building must resist.

Structural systems using concrete or masonry shear walls are stiff and result in buildings with short periods,

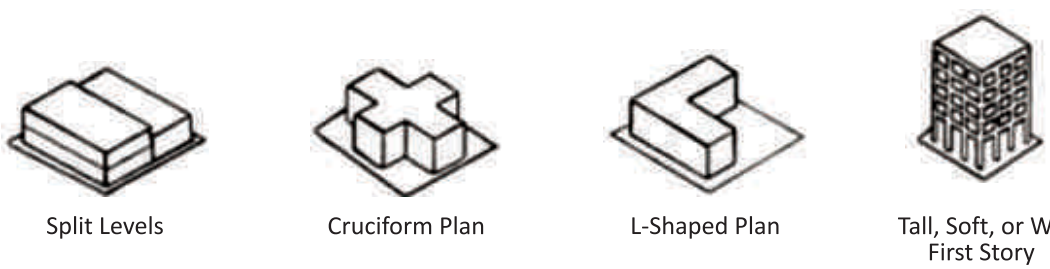


Fig. 27: Examples of building with irregular configurations

whereas more flexible moment frame systems have longer periods. In general, a large portion of the earthquake energy is contained in short-period waves. Therefore, short-period buildings with stiff structural systems are designed for larger forces than long period, flexible, buildings. This concept is also applicable to the amount of force individual structural seismic elements and their components must resist. Stiff elements must be made stronger because they will attempt to resist larger earthquake forces than flexible elements in the same structural system.

Shape or configuration is another important characteristic that affects building response. Earthquake shaking of a simple rectangular building results in a fairly uniform distribution of the forces throughout the building. In a more complex T- or L-shaped building, forces concentrate at the inside corners created by those shapes. Similar problems arise when a building has floor or roof levels of adjacent portions offset vertically (split levels), or when the first story is taller or "softer" than the other stories. Irregularly shaped buildings, shown in Figure 4, are subject to special design rules because otherwise they can suffer greater damage than regularly shaped buildings.

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About this Briefing Paper Series

Briefing papers in this series are concise, easy-to-read summary overviews of important issues and topics that facilitate the improvement of earthquake-resistant building design and construction quality.

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Copies of Briefing Papers can be downloaded from ATC's World Wide Web site (http://www.atcouncil.org), or are available from:

ATC/SEAOC Joint Venture
c/o Applied Technology Council
555 Twin Dolphin Drive, Suite 550
Redwood City, California 94065

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   The establishment of HUDCO in 1970 as a sectoral institution for comprehensively dealing with the problems of growing housing shortages, rising number of slums and for fulfilling the pressing needs of the economically weaker section of the society was one of the significant steps in the series of initiatives taken by Government. Thus the setting up of HUDCO was aimed at accelerating the pace of construction and elimination of housing shortages and for orderly development of urban centres.

2. Material from Civil Defence Training Manual, Govt. of India: http://www.ready.gov/earthquakes

3. The Association of Bay Area Governments is the regional planning agency for the nine counties and 101 cities and towns of the San Francisco Bay region. ABAG is committed to leading the region through advocacy, collaboration, and excellence in planning, research, housing, and member services to advance the quality of life in the San Francisco Bay Area. ABAG's planning and service programs work to address regional economic, social, and environmental challenges.
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http://www.scribd.com/doc/27869832/Emergency-Management-Australia

About NCDC

The first Disaster Management Training Institution of the country was founded on 9th April 1957 at Nagpur as the Central Emergency Relief Training Institute (CERTI) to support the emergency relief organisation of the Government of India. This central institute organized advanced and specialist training for the leaders of disaster relief and response operations to manage the consequences of any natural or man-made disaster.

In 1962, the training curriculum of the college got a Civil Defence twist and in 1968, after the enactment of CD legislation, the college was rechristened as National Civil Defence College.

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Email: ncdcngp@dataone.in
http://www.ncdcnagpur.nic.in, http://www.cddrm-ncdc.org

About GIZ





The services delivered by the Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ) GmbH draw on a wealth of regional and technical expertise and tried and tested management know-how. As a federal enterprise, we support the German Government in achieving its objectives in the field of international cooperation for sustainable development. We are also engaged in international education work around the globe. GIZ currently operates in more than 130 countries worldwide.

GIZ in India

Germany has been cooperating with India by providing expertise through GIZ for more than 50 years. To address India's priority of sustainable and inclusive growth, GIZ's joint efforts with the partners in India currently focus on the following areas:

- Energy - Renewable Energy and Energy Efficiency
- Sustainable Urban and Industrial Development
- Natural Resource Management
- Private Sector Development
- Social Protection
- Financial Systems Development
- HIV/AIDS – Blood Safety



About the Indo-German Environment Partnership (IGEP) programme of GIZ

IGEP builds on the experience of the predecessor Advisory Services in Environment Management (ASEM) programme but at the same time strengthens its thematic profile in the urban and industrial sector, up-scales successful pilots and supports the environmental reform agenda and priority needs of India.

The overall objective of IGEP is that the decision makers at national, state and local level use innovative solutions for the improvement of urban and industrial environmental management and for the development of an environment and climate policy that targets inclusive economic growth de-coupled from resource consumption.

For information visit http://www.igep.in or write at contact@igep.in

About the Ministry of Home Affairs



The Ministry of Home Affairs is the nodal Department responsible for the coordination of Disaster management in the Government of India. Since early 2000, the Government has been focusing on developing the capabilities in the country for preparedness, prevention and mitigation along with developing capabilities for response. The need to eliminate the underlying vulnerabilities through systematic integration of disaster risk reduction in development programmes is being actively pursued at the national and state levels.

Achieving India's development goals and sustainable development are not possible unless it is ensure that all developments are disaster resilient. The Disaster Management Division in MHA is responsible for legislation, policy and administrative measures for capacity building, prevention, mitigation and preparedness to deal with natural and man-made disasters (except drought and epidemics) and for coordinating response, relief and rehabilitation after disaster strike.

(http://www.mha.nic.in)

About the Directorate General of Civil Defence

Directorate General of Civil Defence was established in M. H. A. in 1962 to handle all policy and planning matters related to Civil Defence and its running partners Home Guards and Fire Services.

Civil Defence in the country has been raised on the strength of Civil Defence Act, 1968, C. D. Rules, 1968 and Civil Defence Regulations, 1968. The Civil Defence Legislation is a Central Act, however, C. D. Regulation, 1968 provides all the powers to implement and execute the C. D. Scheme to the State Government. Central Govt. is responsible for making the policies, plans and financing the States for implementing of the different schemes of Civil Defence.

(http;//www.dgcd.nic.in)

List of the Modules

1. **Earthquake Survival**
2. Transport Accidents Safety
3. Elementary Fire Safety
4. Household LPG Safety
5. Emergency Casualty Handling
6. Emergency Resuscitation Procedure
7. Improvised Explosive Devices Safety
8. Flood & Water Safety
9. Community Risk Management
10. Industrial Risk Management
11. Disease Control

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