



Home Owner's Guide to Earthquake Safety





This guide has been prepared under **Asian Development Bank (ADB)** Technical Assistance Project for Capacity Building for Earthquake Rehabilitation and Reconstruction and **The Gujarat State Disaster Management Authority (GSDMA)**

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**The Gujarat State
Disaster Management Authority**

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Foreword

I am very pleased that the GSDMA is publishing this small and effective book, “*Homeowner’s Guide*” for the people of Gujarat.

This booklet is published at a time when Gujarat is passing through a great phase of rebuilding and reconstruction after the January 26, 2001 earthquake.

While the Government of Gujarat through its apex disaster management agency GSDMA is engaged in major programmes of strengthening Infrastructure and helping the victims of the earthquake, it is for the individual families to see that the houses they make or purchase are earthquake resistant.

Natural hazards like cyclones and floods are predictable, but earthquake cannot be predicted. This is the reason why we should see preparedness as a way of life. Making your home earthquake resistant is one of the most important steps towards this.

Home means security and protection. Our homes should be built scientifically in such a way that they are capable of giving you the security and safety we expect. This book leads you to building a home which is true to the meaning of the word—through various easy-to-follow steps.



Narendra Modi
Chief Minister of Gujarat

The death and destruction caused by the January 26 earthquake has taught everyone in Gujarat, many lessons and wisdom lies in putting these lessons into action.

As a responsible and caring head of the family you need to take charge. This book will help you in taking charge. And remember that preparedness is meaningful only when you make it a way of your life. Begin with making your house earthquake resistant.

Wishing you a happy and prosperous life in which hazards do not turn into disasters.

Preface

The Bhuj 2001 earthquake brought home the harsh reality that earthquakes do not kill people, vulnerable buildings do. Living in the state of Gujarat exposes almost everyone to varying levels of seismic hazard. With increasing development, urbanization and the accompanying densification, more and more communities are at seismic risk. Lack of preparedness during earthquakes contributes in a considerable way to this seismic risk. It is therefore necessary that every citizen must have rudimentary knowledge of what to do during and after an earthquake and what steps he can take for mitigating seismic risk.

It is true that we cannot avoid future earthquakes but we can certainly prepare for them and reduce the extent of damage and loss. In developing countries, a lot of the government's limited resources are used up in rebuilding homes for affected citizens which could have been utilized for retrofitting and reconstructing public facilities, lifelines and other essential services. The community as a whole can assist the government in this regard and alleviate the trauma to themselves in an earthquake by improving the seismic behaviour of their homes through retrofitting their old structures and when constructing new buildings, they can ensure that such constructions are earthquake resistant.

This *homeowner's guide* is meant as a basic reference tool to help sensitize a citizen to the issues concerning him and his home in an earthquake. It assists a homeowner to evaluate the vulnerability of his home in an earthquake. The guide tells the owner how he should go about improving the seismic safety of his home and provides a checklist of issues to be considered when building or buying a new house. The guide also tell him how to stay prepared for an earthquake.

The guide has been prepared for Gujarat State Disaster Management Authority (GSDMA) through the ADB Capacity Building Technical Assistance Grant 3644.

The author would like to acknowledge the efforts of the entire team of Babtie Consultants India Ltd. for their continuous assistance and support especially seismic expert Dr. Allan Mann and Mr. Douglas Walker who have made major contributions to the present form of the Guide. Mr. Sanjeev Datta has contributed the photographs and 'Sobhagya' Advertising Service have designed this guide. IIT Kanpur professors Prof. Sudhir Jain, Prof. C.V.R. Murty and Dr. Durgesh Rai have reviewed numerous drafts of the guide patiently and given very valuable suggestions. Dr. A.S. Arya, seismic advisor, GSDMA was also kind enough to go through the guide. Mr. V. Thiruppugazh, Jt. CEO, GSDMA has been a source of continuous support and encouragement. My thanks to all of them.

It is hoped that this guide will be of use to the homeowners and citizens for whom it is meant. We will welcome suggestion for ways to improve it.

Alpa Sheth
Seismic Consultant
GSDMA

March, 2003



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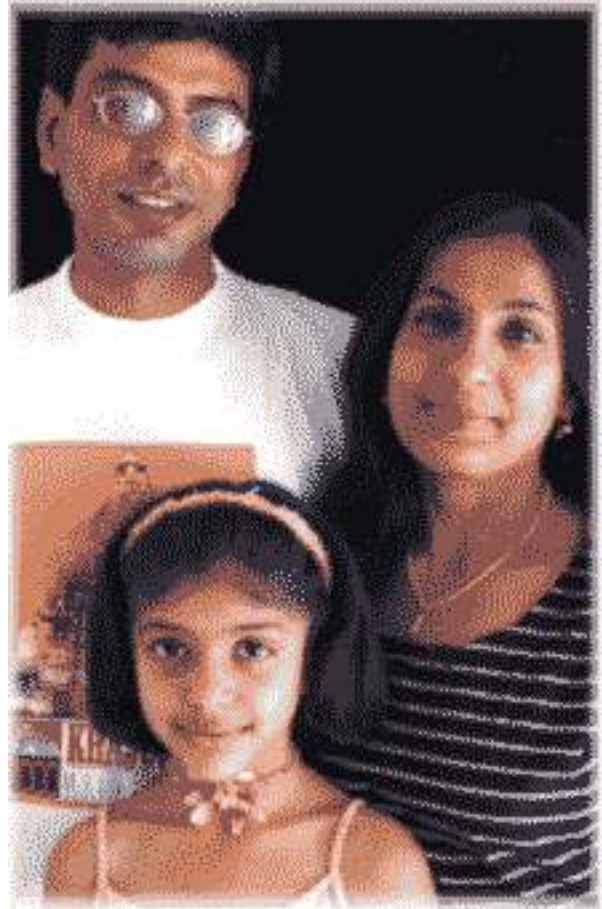
Every family needs the protection of a safe house

Introduction

Who should read this Guide?

- Do you own a house or an apartment?
- Are you renting one?
- Do you plan to buy one?
- Do you plan to build a house?
- As a citizen, are you concerned about public safety?

If the answer to **any** of the above questions is **yes**, this guide is for you!!



What you will find in this Guide

- Guidance to help you improve the general safety of your present house in an earthquake
- The questions you should ask regarding earthquake safety when buying or renting a house/apartment
- Tips to ensure that the house you are planning to build or buy is designed to resist earthquakes
- Information on how to be prepared for an earthquake

There are Two common ways to measure an earthquake— Magnitude & Intensity

Background

What is an earthquake?

The vibrations of earth's surface caused by the waves coming from a source of disturbance inside the earth are described as an earthquake. These may be caused either by natural activities going on inside the earth or due to manmade phenomena such as a nuclear explosion.

How are earthquakes measured?

There are two common ways used to measure an earthquake—Magnitude and Intensity.

"Magnitude" of an earthquake is a measure that quantifies the energy released in an earthquake. It is popularly known as Richter Scale. An increase in

magnitude by 1 implies that 31 times more energy is released. For e.g. an M8 earthquake releases 31 times more energy than an M7 earthquake and about 1000 (31x31) times more energy than an M6 earthquake. Earthquakes are classified as great to minor based on their magnitude. India has had many earthquakes in the past of which four of them were "great" earthquakes (of magnitude higher than 8) in the past 53 years.

"Intensity" is a qualitative scale for measuring earthquakes. It indicates the level of shaking experienced at a given location and is based on

perception of living beings, behaviour of buildings and effects in the environment. It is measured in Roman Numerals varying from I to XII (most severe) and is commonly referred to as Modified Mercalli Scale (MMI).



Is it possible to predict earthquakes?

There are some events which are supposed to be precursors of earthquakes. These are the swelling of rocks, some fore shocks, ground creep and animal behaviour. These have not been adequately substantiated. Very rarely have earthquakes been predicted accurately. There is presently no scientifically reliable method of predicting earthquake.

Why should one design buildings for earthquakes?

Unlike other natural disasters, there is almost no forewarning of an earthquake. Earthquakes last for short duration and the devastation is caused in a matter of a few minutes leaving us with no response time.

The devastation caused in an earthquake can be huge in terms of human, social and economic losses and it takes decades for countries to recover from an earthquake.

Thus it is in your interest to ensure that you do your bit in minimizing the earthquake risk you face by ensuring that your home is designed to resist earthquakes.

Ensure all wall hung cabinets are fully anchored into supporting walls and contents are not prone to falling out from the cabinets

Why do some buildings fall in an earthquake while others don't?

An earthquake shakes all structures including houses. If these structures are well designed and well constructed on safe foundation soil, then even violent earthquake will not be able to destroy them.

Your Existing Home

How safe is it?

Even as you ensure that the structure of your house is safe against an earthquake, make sure you have also checked that there are no elements within your house which can fall, or collapse in the event of an earthquake and can cause damage or injury.

What you can do to make the interiors of your house safe



- Make sure that all heavy wall hung cabinets in the kitchen and elsewhere are fully anchored into the supporting wall
- Check if your wall hung bookcases, showcases and refrigerators are also similarly anchored
- Ensure that your water boiler (geyser) is properly strapped to the supporting wall
- Do not place potted plants on any unenclosed projection, on balcony parapet or top of compound wall

A structural engineer is a professional who knows how to build a safe house.

How do you check the earthquake safety of your building structure?

Do you live in an apartment building, which you are not quite sure is designed to resist earthquakes?

If you live in an apartment building, it is not enough that you are the only one concerned about the safety of your apartment.

All the building residents need to work together to ensure the safety of their building.

So your first task will be to sensitize your neighbours about the risks they face in an earthquake. It may be a

good idea to form a residents committee who can share the work involved in organizing repairs and keeping people informed.

The next thing you will need to do is to get your building reviewed for earthquake safety by a competent and experienced registered structural engineer.

Who is a structural engineer?

A structural engineer is one who has the training and experience to understand how buildings stand up and be able to recognize weaknesses which may cause it to collapse in an earthquake event. He will be able to survey your building and give you advice on whether strengthening is necessary and if so how this should be done. He should also be able to supervise or find you a competent person for supervision of repair work on your behalf to make sure that it is done properly.



How do I find a registered structural engineer?

Appointing a competent structural engineer to advise you will be the most important decision you and your fellow residents will make. Your life and that of your family could depend on the advice which you are given and it will be too late to find out that the advice was wrong if your building collapses.

Remember to ask your structural engineer about the experience of handling quake resistant buildings.



The local municipal or urban development authority usually registers engineers who are qualified to undertake structural work and obtaining lists of names from them will be a good place to start. However, not all of these engineers, will be experienced in designing buildings to withstand earthquakes. It is important that you ask questions and obtain references regarding their experience. Some questions you might ask will be:

- What type of work has he/she been involved with in the past?
- Has he/she been involved in designing and supervising strengthening works to existing buildings?

Can references be obtained from clients that will back up claims of experience?

Remember always to follow up the references and talk to the person who provided it. Always agree what has to be done in writing and also agree how much you will pay for professional advice. It is quite normal to commission work in stages e.g. preliminary report, more detailed report, design of strengthening works and supervision of work on site might all comprise separate stages of the appointment. And don't just choose the cheapest engineer you can find. (If you needed life saving surgery would you choose the surgeon who was the cheapest or the one who had the most patients who survived?)

Also ask for references of previous clients.

An earthquake resistant house may be damaged irreparably in a severe earthquake but it would not collapse... so no danger to people living in it.

What is an “earthquake resistant” building?

An earthquake resistant building does not mean that the building will suffer no damage during a strong shaking.

In an earthquake resistant building:

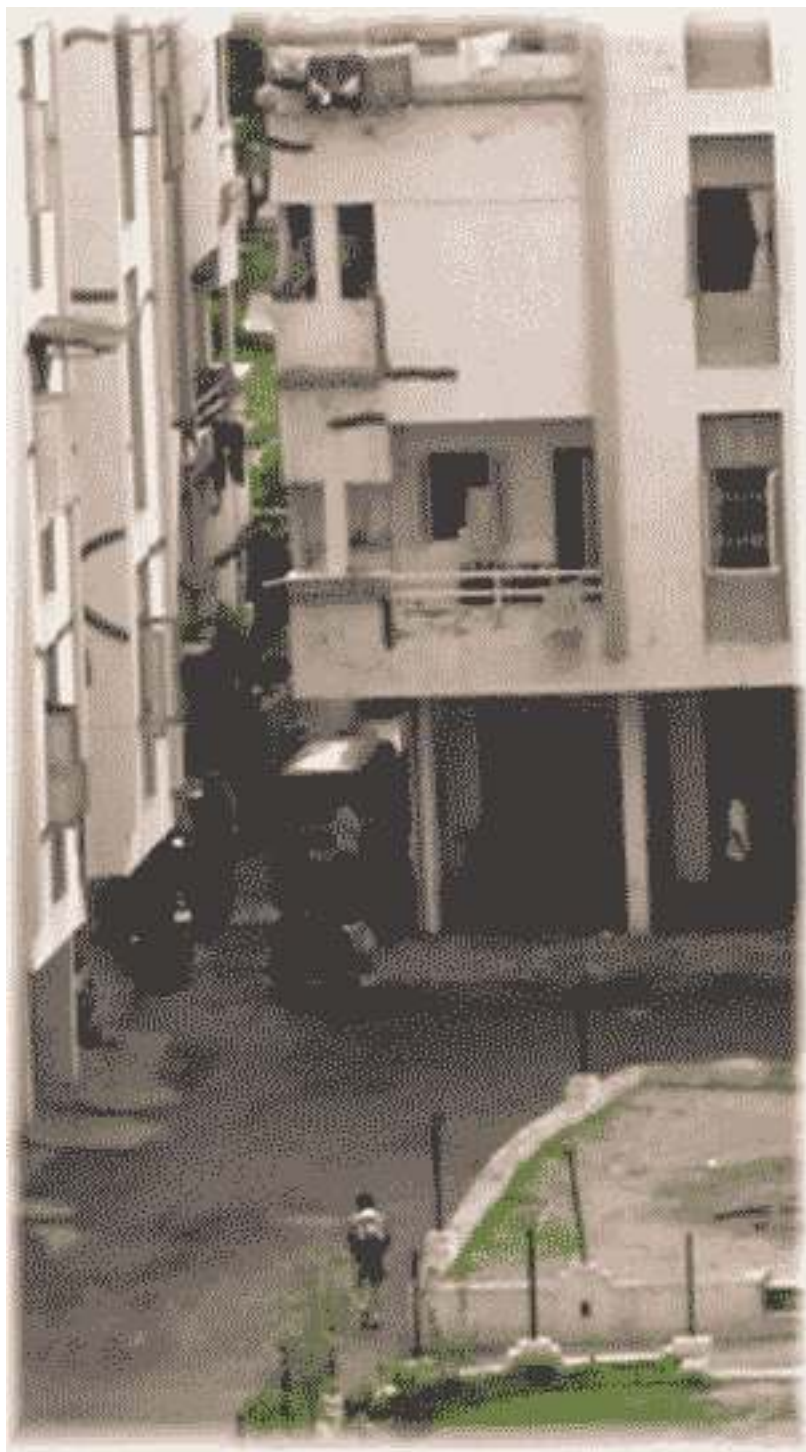
- Under *minor* but frequent ground shaking, the structure of the building shall not be damaged at all. However, building parts



- that do not carry load may sustain repairable damage;
- Under *moderate* but occasional shaking, the structure may sustain repairable damage, while the other parts of the building which do not carry any load (known as non-structural elements) may be damaged such that they may even have to be replaced after the earthquake; and
- Under *strong* but infrequent shaking, the building structure may sustain severe (even irreparable) damage, but the building should not collapse.

Reinforced Concrete Buildings

Most tall buildings are constructed using reinforced concrete frames i.e. beams and columns which support the weight of the floors and the walls. The columns in turn rest on concrete pads or slabs called foundations that spread the load of the building evenly onto the ground. This form of construction works well in supporting the vertical load from the self-weight of the building and the people and furniture that occupy it. Earthquakes, however, shake the building violently from side to side and if the building has not been designed and constructed to resist this shaking, weaknesses will emerge which may cause the building to collapse.



What are the aspects that make reinforced concrete frame buildings vulnerable?

Some of the most common weaknesses are described below.

Buildings on stilts

It is quite common for tall buildings to be constructed with no walls on the ground floor to allow for car parking or other activities to be accommodated. The weight of the buildings is supported on the columns or stilts. Such a ground storey is sometimes called the soft storey as it is not good at resisting sideways shaking from the earthquake. Experience has shown that buildings on stilts do not perform very well in earthquakes unless the column and beam connections on the ground floor have been specially designed to withstand the shaking load.

No tie-beams at the plinth level

Buildings, which have been designed to resist earthquakes, will have their foundations joined together by reinforced concrete beams called tie-beams. Sometimes there are no tie-beams at the ground or plinth level. If the soil is poor and/or foundations are deep, this could cause severe problems in an earthquake.

Inadequate seismic strength in the building

Sometimes buildings are simply not designed for earthquake forces. There may not be enough steel reinforcement in the beams and columns or it may not be tied together in a cage properly. Sometimes, even if the building has been properly designed, it may not have been well constructed. Many things can go wrong if the work is not properly supervised. For example concrete, which is mixed on site, may not be of sufficient strength.

Inadequate ductility in the building



The horizontal beams, vertical columns and joints require special attention

What is ductility?

Recall how a coconut tree sways in the breeze. It is able to undergo large horizontal movement while still carrying the leaves and the fruit. Similarly, during an earthquake there are large horizontal movements, which the building should be able to undergo without significant loss of load carrying capacity. This property of the building is called its ductility. For this, the horizontal concrete beams, the vertical columns and the joints require special attention in the way in which the steel reinforcement bars are located and detailed. If such attention is not given, they behave in a brittle manner and are liable to collapse during an earthquake.



Is it possible to improve the behaviour of an existing building in an earthquake?

Yes, though, it depends on the type of problem how easy or difficult it will be to put it right. All problems described earlier have solutions but it is essential to choose the correct solution to fit a particular building. This is why it is so important to seek the advice of a structural engineer who is experienced in this type of work. Your engineer may have to do quite a lot of exploratory work before arriving at a suitable strengthening solution. This might include reviewing the drawings of the original structure, taking samples of concrete, excavating the foundations to see how they have been constructed and checking how well reinforcement has been fixed. Beware of anyone who offers to strengthen your building without taking time to investigate the problems.

Remember, structural retrofitting should be done only under the guidance and supervision of a competent structural engineer.

Remember, structural retrofitting should be done only under the guidance and supervision of a competent structural engineer!

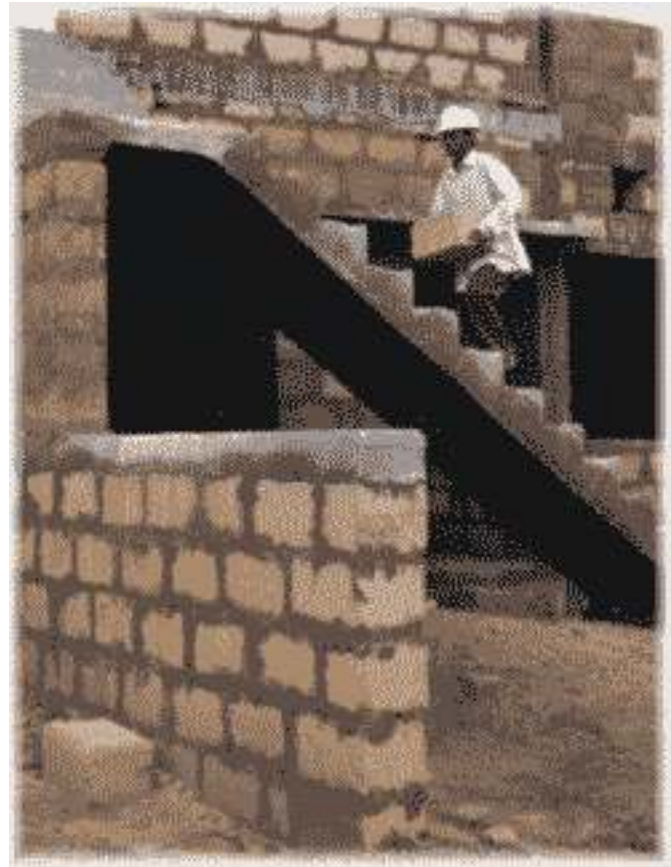


Load Bearing Masonry Buildings

If you are living in a single or double storeyed house without reinforced concrete structural frame consisting of columns and beams, it is very likely that your building is a load bearing structure.

Masonry buildings have large mass and hence attract large horizontal forces during an earthquake. They tend to form numerous cracks under the effect of the earthquake shaking.

A load bearing masonry structure is thus very vulnerable if not adequately reinforced at the corners and provided with continuous bands at various levels to give it a strong box-type behaviour.



The performance of masonry buildings can be improved by providing the following features

- a) A continuous band at lintel level made of wood or reinforced concrete.
- b) Vertical corner reinforcement at the junctions of the walls and continuous reinforcement around openings.
- c) A continuous roof band (this is important if the roof is not in reinforced concrete).
- d) The location of the openings must not be too close to the edge of the wall!!
- e) Very few openings in the walls.
- f) The area of the walls must be uniformly distributed in the plan of the building in both horizontal directions.

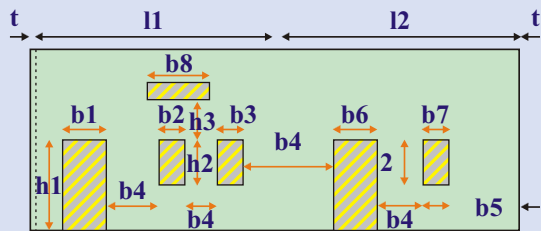
A masonry structure or load bearing structure is thus very vulnerable if not adequately reinforced.



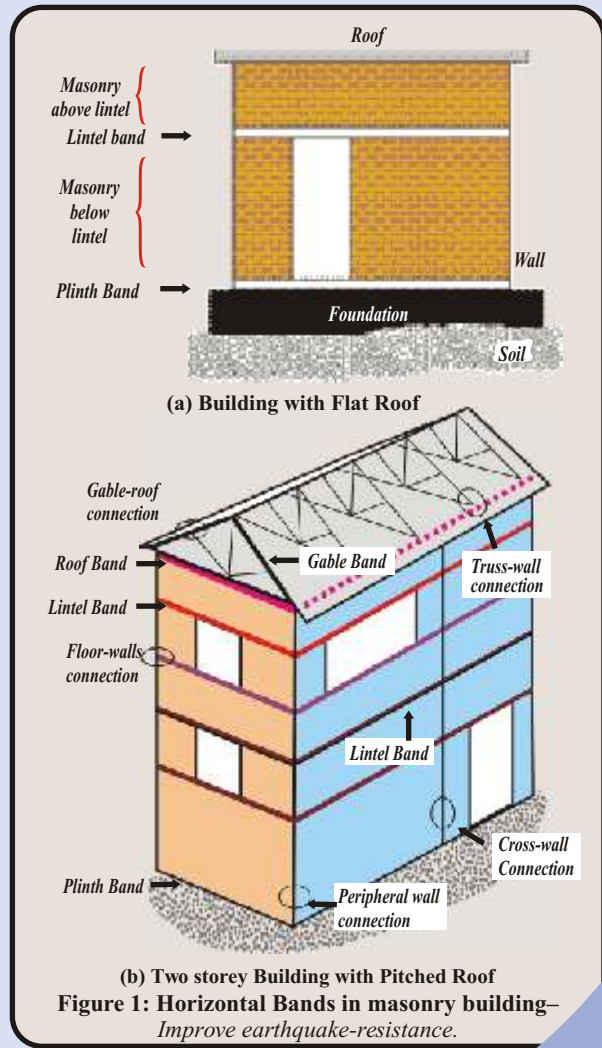
It is not very difficult to strengthen your masonry home. Ask a structural engineer to examine your building and check if the above features are available. There is an Indian Standards code (IS 4326) for this. If your building does not conform, ask him to provide retrofit measures in conformity with IS 13935-1993. You can obtain this code from any office of the Bureau of Indian Standards. Remember you must use the services of a competent structural engineer while retrofitting your building. Also, you will need to employ a builder who is experienced in this type of work to carry out the strengthening.

Remember
you must
use the
services of a
competent
structural
engineer
while
retrofitting
your
building.

PERMITTED DIMENSIONS OF OPENINGS AND PIERS



Position		Category		
		A&B	C	D&E
b5		0	230mm	450mm
(b1+b2+b3)/l1 or (b6+b7)/l2	One storey	0.6	0.55	0.50
	2 storey	0.5	0.46	0.42
	3-4 storey	0.42	0.37	
b4		340	450	560
h3		600	600	600
b8		900	900	900



(b) Two storey Building with Pitched Roof
**Figure 1: Horizontal Bands in masonry building–
 Improve earthquake-resistance.**

Building Category	Number of Storeys	Strengthening Arrangements
A	1-3	Masonry Mortar
	4	Masonry mortar, Lintel band, Roof and gable band
B	1-3	Masonry mortar, Lintel band, Roof and gable band, Bracing in Plan, Plinth band
	4	Same as for above + vertical steel at corners
C	1-2	Masonry mortar, Lintel band, Roof and gable band, Bracing in Plan, Plinth band
	3-4	Same as above + vertical steel at corners and at jambs of openings
D	1-2	Masonry mortar, Lintel band, Roof and gable band, Bracing in Plan, Plinth band + vertical steel at corners and at jambs of openings
	3-4	Same as above + dowel bars
E	1-3	Masonry mortar, Lintel band, Roof and gable band, Bracing in Plan, Plinth band + vertical steel at corners and at jambs of openings + dowel bars

Building Category A and B are for Zone III Category

Building Category C and D are for Zone IV Category

Building Category E are for Zone V Category

Are you building a new house?

Before you embark on building a new house, you may need to ensure many aspects related to the land.

Also, if you are not a civil engineer yourself, you will require considerable professional help. Try and get the best possible professional services.

It is important to have all your clearances before you start building



Verification of ownership of land

When you buy land for your new house, ensure from the relevant government office that:

- The land falls under the Non-Agricultural (N.A.) Category
- You have a No Objection Certificate (the N.O.C) from the government to build a new house on that land
- Obtain a certified copy of the latest plan of the layout where your plan is located, with the approved city survey numbers or revenue numbers of your plot

Whom you should contact for the relevant documents

Type of land	Where to verify from
Municipal Corporation (MC) Land	The concerned Zone/Ward Office
Government land - Urban Development Authority (UDA) and Area Development Authority (ADA)	Collector's Office
Forest Land	Department of Forestry, Government of India
Trust Land	President of the concerned Trust, and Charity Commissioner
Farm Land 7/12 (Sat Bara) Extract	Talati or Tahsildar's Office
Land in dispute or litigation	Bailiff or Arbitrator at the High Court of the State

You have to be sure that there has not been any previous use of the land that renders the site unsuitable. For example, has it been used to bury domestic waste?

Documents of Ownership

Seek legal help to ensure that the following are in order:

- Property Registration Card
- Sale Deed of Property



Land Survey

It is not enough that you have checked that the land is clear and free from any dispute. Get an independent survey of the plot carried out to make sure that the ground is suitable for the development of a building. You have to be sure that there has not been any previous use of the land that renders the site unsuitable. For example, has it been used to bury domestic waste? Land that is prone to flooding should also be avoided and it is a good idea to check with people who live locally if this has ever been a problem. Some soil types suddenly become very weak and can no longer support the weight of the building when they are subjected to shaking in an earthquake. This occurs when they hold water (a bit like a sponge) and the phenomenon is known as liquefaction. This is mainly a problem in coastal areas. You should try to avoid building your house on this type of ground.

Check the following:

- The land is not prone to frequent flooding
- The soil is not soft and is not liquefiable. (This could be a problem particularly in river bed and coastal areas)
- There are no known earthquake faults in your land or very close to it

It is a good idea to show the land you propose to buy to your architect and engineer before you buy it.

Hire an Architect to plan your house better.
A list of registered architects is available at the local urban development authority' office.



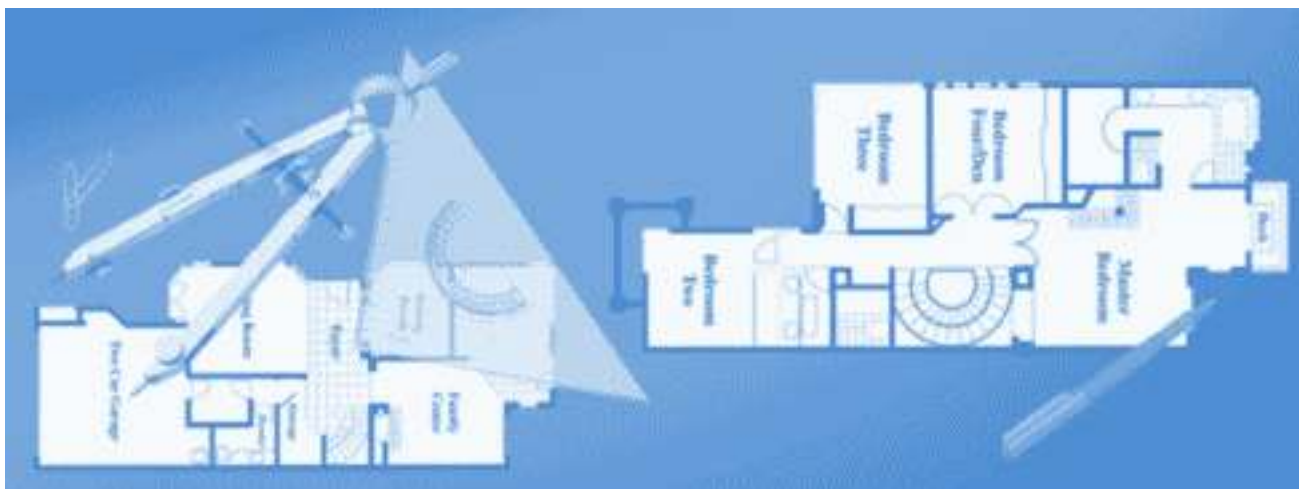
Hiring Professionals

To build the house, you will need to hire the services of professionals:

- a) Architect
- b) Structural Engineer
- c) Geotechnical Engineer
- d) Construction Supervisor
- e) Contractor

Plan your house with the assistance of your architect. Buy a copy of the **Development Control Rules** from the local municipal authorities and ensure that you are adhering to the prescribes rules. Make sure that you check the credentials of these professionals before hiring. A list of registered architects and engineers is available at the local urban development authority and obtaining lists of names will be a good start. Not all of these professionals, however, will be experienced in designing buildings to withstand earthquakes and it is important that you ask questions and obtain references regarding their experience. Some questions you might ask will be:

- What type of work has he/she been involved with in the past?
- Has he/she been involved in designing buildings in earthquake areas in the past?
- Can references be obtained from clients that will back up claims of experience?
- You also need to be clear about how the quality of the construction work will be supervised
- Will your design team do this for you or you need to hire someone to check the work?



Documents for Approval of Building Plans

After you have hired the professionals, you will need to get the following from them:

- Certificate of Undertaking by Architect
- Certificate of Undertaking by Structural Engineer
- Certificate of Undertaking by Construction Supervisor
- Certificate of Undertaking for Hazard Safety requirements (to be signed jointly by you and Structural Engineer)

In addition, you will need:

- Soil Investigation Certificate
- Certified copies of Building Plans
- No Objection Certificates of various authorities will be required before commencing construction

No Objection Certificates of these authorities will be required before commencing construction:

Municipal Corporation/ADA/ UDA	Municipal Tax Clearance Certificate
Municipal Corporation/ ADA/ UDA	Betterment Tax Clearance certificate
Fire Brigade	Especially for High Rise buildings
Traffic Police Department	Any special concerns they may have regarding the impact on the traffic
Local electrical supply authority/company	For electricity supply
Airport Authority of India	If your building is in Airport vicinity
Indian Railways	If your building is near the railway track
Municipal Corporation/ADA/UDA	For drainage, water supply, commencement certificate

Only choose good solid natural ground.
You can investigate the nature of the
ground on the site by digging trial pits.

The other tasks you will need to look into

Check the Foundation Soil

Before designing the house, the structural engineer will need to know that the ground is strong enough to carry the loads and firm enough so that the house does not settle. He will further need to know the depth of the founding soil. In areas at risk from earthquakes, there are additional requirements. Any filled ground (i.e manmade up ground) or naturally loose ground is at risk of compacting when the earthquake shakes the soil, so building on such ground is likely to result in severe damage. In some cases where the ground is loose and the water table high, the whole ground may become very weak and turn into liquid when badly shaken. You have to avoid building on such poor ground. Only choose good solid natural ground. You can investigate the nature of the ground on the site by digging trial pits to see what the ground is like at depth. Generally the

foundations should be based at least about 1m below the surface.

If the building is going to be more than two storeys, or if the ground is suspect, you may want to engage a geotechnical engineer. He will be able to make a technical appraisal of the site and advise on suitable foundations. Development authorities require you to provide a copy of the report of the soil investigation.

Choosing a building system

Under normal circumstances, a structural engineer will choose to build with load bearing brick or stone or concrete block masonry or a reinforced building with beam-column frames (with masonry panel walls as a filler between the columns and beams) and slabs (floors) usually in reinforced concrete. Both these options are acceptable as long as you have taken the correct precautions.



If the building is a **load bearing masonry structure**, remember a few simple points that minimise the risk of damage in the event of an earthquake.

- i) Check with your structural engineer that he has followed the Indian standard IS 4326. This standard covers earthquake resistant features.
- ii) Keep the building form as simple as possible. Avoid too many twists and turns in the building.
- iii) Ensure that there is vertical corner reinforcement at the junction of walls.
- iv) Verify that there is a reinforced lintel band, a roof band and a plinth band.
- v) Make sure that all the windows and doors have the same lintel height.
- vi) Do not have more than 50% openings in any single wall.
- vii) Ensure that the openings for doors and windows are not at the corners of the walls but are placed towards the center.

If the building is a load bearing masonry structure, remember a few simple points to minimise the risk of damage in the event of an earthquake.



If the building is a **reinforced concrete frame structure**, it will not be possible for you to check whether the building is designed and detailed for earthquakes unless you have had special training in structural engineering.

You should however ask your structural engineer to confirm to you that he has designed your house conforming to the rules set out in the Indian earthquake code **IS 1893** and that the steel reinforcement will be fixed in accordance with the rules set out in the detailing code **IS 13920**.

It is very important to ensure conformity to various guidelines laid for earthquake resistance.

Important Indian Standards for Earthquake Design IS 1893-2002, IS 13920-1993, IS 4326-1993, IS 13827-1993, IS 13828-1993, IS 13935-1993

IS 1893-2002 "Criteria for Earthquake Resistant Design of Structures" is a code of practice which provides your structural designer with the earthquake forces he should design the building for, based on the characteristics of the building and the earthquake zone in which the building comes under.

IS 13920-1993 "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces" is the code of practice that tells on how to detail reinforced concrete buildings such that the building will have ductile behaviour, that is, it will be able to withstand horizontal movements without collapse.

IS 4326-1993 "Earthquake Resistant Design and Construction of Buildings" is a code of practice which covers special features for design and construction of earthquake resistant buildings including details for achieving higher ductility in reinforced concrete and masonry structures.

IS 13827-1993 "Improving Earthquakes Resistance of Earthen Building" are guidelines dealing with design and construction aspects for improving the earthquake resistance of earthen houses.

IS 13828-1993 "Improving Earthquakes Resistance of Low Strength Masonry Buildings" are guidelines dealing with design and construction aspects for improving the earthquake resistance of low strength masonry.

IS 13935-1993 "Repair and Seismic Strengthening of Buildings" are guidelines covering the selection and techniques to be used for repair and seismic strengthening of earthquake damaged buildings and seismic retrofitting.

Selection of Structural System for the house

What system should you choose? Load Bearing Masonry walls or reinforced concrete frame?

Both masonry and reinforced concrete frame structures when correctly designed and detailed have shown satisfactory behaviour in an earthquake. You must choose based on the following:

- Availability of resources: Availability and cost of manpower and materials to make a new structure and the cost of its repairs and maintenance will guide you towards choosing the correct structure type.
- Height of the building: For buildings taller than ground and two storeys, a reinforced concrete frame is preferable.
- Spans of the structure: If you have large spans, a reinforced concrete structure is preferable.
- Availability of a good structural engineer: If you do not have a competent structural engineer in your area, you may be better off doing a load bearing structure and getting help from the nearest urban center.



Submission of Certificates for Progress / Completion of Works

Intermediate certificates of progress from the architect, structural engineer and construction supervisor are required to be submitted at benchmarked stages during construction.

On completion of construction, a building completion certification must be submitted to the concerned authorities (MC/ADA/UDA). The authority in turn will then inspect the building and issue a “Building Use Permit” or “Occupation certificate”.

What is an Occupation Certificate?

An occupation certificate is a certificate issued by the local building authority which certifies that the building has met all the requirements of the bye-laws and is fit for occupancy.

Maintaining your home

Maintain your house well. If there are any leakages, attend to them urgently. Do not make changes in the structural members or add additional stories onto your building without seeking the advice of a structural engineer. Even quite simple alterations such as the removal of a wall may alter the way in which your house may be able to withstand an earthquake. Get it checked by a structural engineer every few years.

On completion of construction, a building completion certification must be submitted to the concerned authorities (MC/ADA/UDA)



Do you know what all to check before buying an apartment in a building?

Buying a Flat in an Apartment Building

Apartment Buildings in India today are mostly built with a reinforced concrete frame structure. Before buying a flat in such a building you need to check a number of issues. In past earthquakes many buildings of this type have been extensively damaged. It was subsequently found that some of these buildings and others like them had not been designed and/or constructed in accordance with the rules set down in the Indian earthquake codes. After an earthquake many buildings are quickly repaired by their owners but it is not always obvious whether this repair work was just cosmetic or whether these already weakened buildings have really been strengthened sufficiently to resist a future seismic event. It is important therefore before you commit a large sum of money on a new home that you be as sure as you can that the building has been properly designed and well constructed.

What should you check before you buy a flat?

Check the legality of the construction

If the building is already completed and ready for occupancy, you should ask for a copy of the Occupation Certificate.

What is an occupation certificate?

As stated earlier, an occupation certificate is a certificate issued by the local building authority which certifies that the building under consideration has met all the requirements and is fit for occupancy.



Ordinarily this means that the structural engineer has designed the building as per the applicable Indian standard codes for all loads including earthquake loads. However, if you have any doubts, it would be in your interest to get the building design checked independently. Demand a copy of the structural drawings and show these to an independent structural engineer. Ask him to check the design for you and advise you whether it meets the standards required by the Indian earthquake code.

If there are enough buyers who insist on a design check, the builders may then get an independent design check carried out for their buildings at their own cost. However always be cautious about how “independent” a check is when it being paid for by the builder.

If the building has been up for some time you should also try to find out whether it was damaged during a past earthquake and whether any repairs were subsequently carried out. Ask the seller this, but also other people who


Buying an apartment is a lifetime investment. It also involves the safety of your family.



were living in the building or surrounding area at that time. If repairs were undertaken ask who carried these out and if they were supervised by a qualified structural engineer for review. If you have any doubts then seek the advice of a structural engineer.

If the building is under construction, check the following:

- A) Check the Commencement Certificate for the building from the Municipal Authorities. This certificate ensures that the builder has met other requirements such as the no objection certificates from various agencies.



Don't miss out any of these points. Check out everything in detail. It's your money and your safety.

B) You may also want to inspect the following:

- Certificate of Undertaking of Registered Architect
- Certificate of Undertaking of Registered Structural Engineer
- Certificate of Undertaking by Construction Supervisor
- Certificate of Undertaking for Hazard Safety requirements
- Notice issued in local press for Title Verification of Land
- Certificate from Solicitor ensuring that all the papers are in order
- Commencement Certificate: whether issued for Residential or Commercial purposes
- FSI (or FSA) permitted, and FSI (or FSA) utilised by the builder
- If any reservation has been made for government flats or any special category
- Whether the Land is covered under Urban Land Ceiling Reservation

Entering into Agreement for Sale

The purchase of the house or apartment must be done through a legal agreement

- The seller and buyer should sign the agreement for sale
- Two witnesses must attest the agreement
- This agreement must be registered with the Collector for it to be treated as a "legal document"
- Stamp Duty should be paid only at the Collector's Office at the time of registration of the agreement

Mode of payment

1. Payments should be made by cheque only. It safeguards your interest.
2. Repayment of loans obtained by you from the Financial Institutions should be made only to the concerned Institutions by you, and not to the builder or developer.

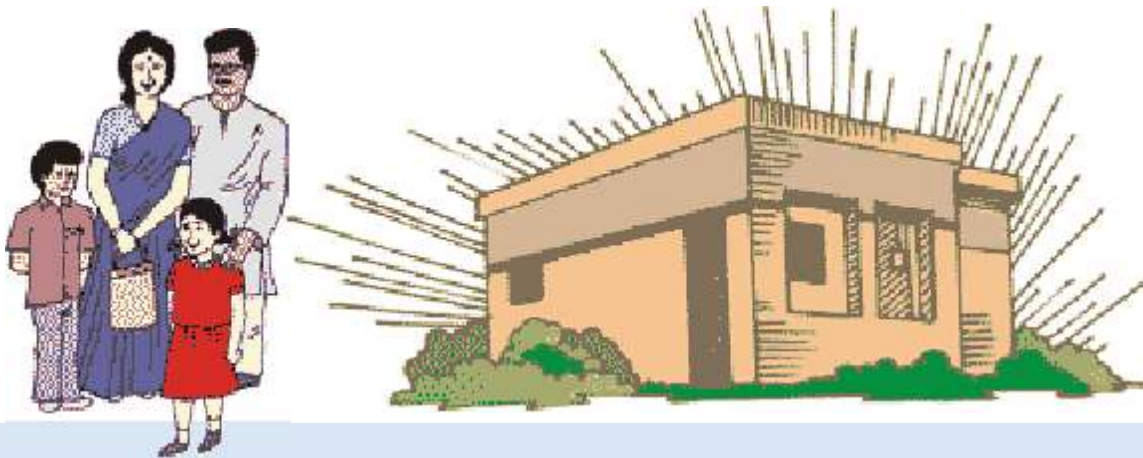
What else you can do to ensure your safety?

Insurance

You should insure yourself against damage in an earthquake. In some countries, it is mandatory to insure your home against an earthquake. There are many insurance policies available. Contact your insurance agent.

Be Prepared

- Earthquakes do not come with warnings. As you live in a state with a significant earthquake risk, be prepared!!
- Tie heavy furniture to walls to prevent toppling
- Tie gas cookers to structure to prevent toppling
- Make sure gas and power can be cut off from outside the building
- Make sure your family knows what to do and have rehearsed what to do
- Make sure exit routes always remain clear
- Keep volatile and inflammable products in lowest shelf of the cabinets and make sure they are stored in stable bottles



Prepare your family and yourself as
earthquake always hits without warning.
Preparedness is a way of life.

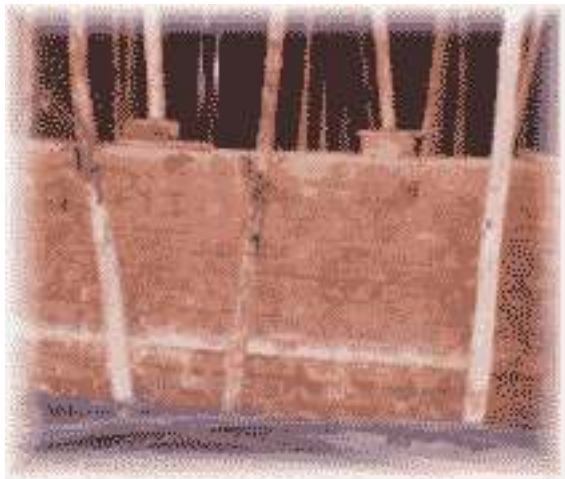
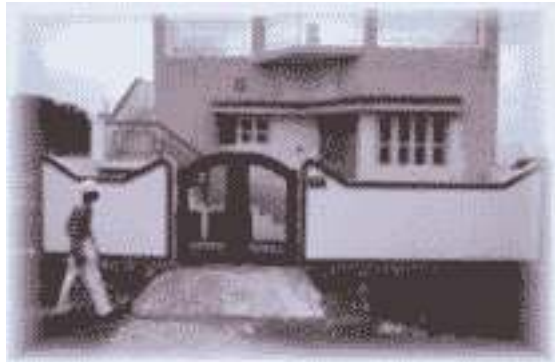
It is important to know what to do before, during and after an earthquake. More important is to practice your knowledge and always remain prepared.

Keep the following at an easy, convenient location in the home where it is easily accessible

- Torch, replace batteries from time to time
- First aid kit and essential medicine supplies
- Some candles and a matchbox
- Some fresh supplies of food and water

In the event of an earthquake

- Exit your home as rapidly and move away from it
- If you cannot get out, get under a table or desk
- Do not stand under wall hung cabinets or near heavy appliances that might topple
- Watch for falling debris inside and outside
- If it is safe, turn off your gas, power and water supply
- Beware of after shocks and do not re-enter your home until the authorities say it is safe to do so





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