INSTRUCTIONS FOR EARTHQUAKE PREPAREDNESS

By

Prof. Dr. Mihail Garevski

December 1, 2013

TABLE OF CONTENTS

1. INTRODUCTION

Earthquakes represent one of the biggest natural hazards that affect humanity. They occur unexpectedly, i.e., without any warning, giving rise to a huge loss of human lives and material damage.

The material in this Earthquake Safety Manual provides the reader with a complete insight into the latest knowledge in the field of preparedness and protection against earthquakes.

This manual contains a detailed description of the procedures to be maintained and carried out prior to, during and after an earthquake in order to provide maximum protection of people against these phenomena.

The first part of the Manual provides a simple explanation of the most important issues related to earthquakes that people need to know in order to be able to learn and understand how they should react when a disaster strikes. In fact, some notions from Engineering Seismology will be explained in order to enable successful management of protection against earthquakes.

The second part of the Manual contains the necessary rationale related to structures and earthquake engineering science that is also necessary in order that the user of this manual be able to assess the seismic risk pertaining to the structure in which he/she lives or works. The explanation about which structures are seismically safe and which are not will be given in such a way that it can easily be understood by laymen.

As mentioned above, the last part of the manual contains chapters referring to direct training of the reader as to preparations to be made prior to an earthquake as well as how the reader should behave and what the reader has to do during and after an earthquake.

2. ABOUT EARTHQUAKES

An earthquake represents shaking of the earth. Ground shaking may be of tectonic or volcanic origin, or may take place as a result of failure or collapse of cavities. In the subsequent text, emphasis will be put on earthquakes as tectonic phenomena since the other two types of earthquakes are not devastating, i.e., they do not cause catastrophic consequences.

Although it is said that earthquakes may occur at each location on the Earth, most of them, or more precisely 98% of the earthquakes that occur annually take place within two belts of the Earth. The first belt within which 81% of the annual earthquakes occur, represents the rim of the Pacific Ocean, Fig 1 This zone is also referred to as the Ring of Fire. In this belt, the most catastrophic earthquakes took place in the most recent history of mankind.

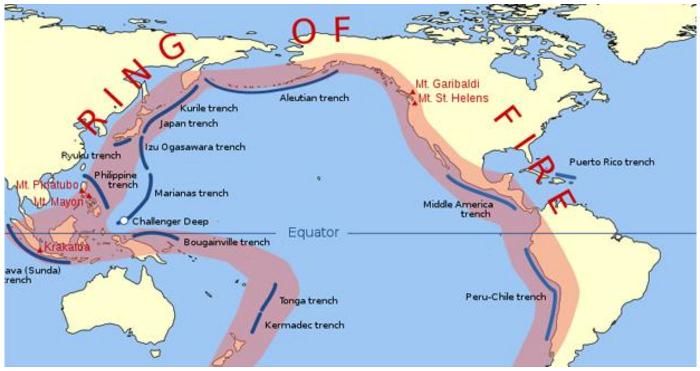

Fig. 1. The Ring of Fire along which most of the devastating earthquakes occur

Seventeen percents (17%) of the total number of earthquakes occur in the second belt, i.e., the Alpide belt(Fig. 2.), starting from the Atlantic, through the Mediterranean, involving part of the Balkan Peninsula, transiting through Turkey and the Himalayas and ending at Java and Sumatra.

Fig. 2. The Alpide belt

Fault, Hypocenter and Epicenter

Earthquakes occur as a result of abrupt movement of two rock blocks in opposite directions along their contact (active fault), Fig. 3a. During the Kobe earthquake (2005), a fault was activated and was later protected by a glass house in order that it could be exhibited for visitors, Fig. 3b.

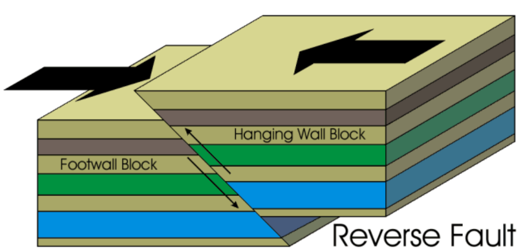

Fig. 3a. Schematic presentation of a fault

Fig. 3b. Real fault exhibited in a museum in Kobe

There are different types of faults (depending on the movement of the blocks), but these are beyond the interest of the user of this Manual. In addition to the notion of fault, it is important to note a few other notions that are useful to be known since the reader of this Manual often hears them when the media report on earthquakes.

The first notion is the *focus (hypocenter)* of an earthquake and it indicates a point on the Earth where displacement is initiated and from where the propagation of elastic waves starts. The point on the Earth's surface which is vertical to the hypocenter is called the *earthquake epicenter*. Fig. 4 shows a fault with its main elements.

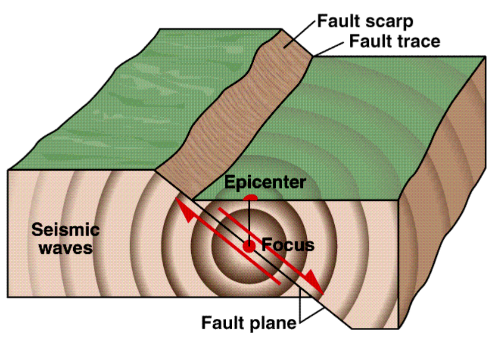

Fig. 4. Main elements of faults

It is necessary that the reader of this Manual learns about a few additional important notions related to earthquakes since this knowledge will contribute to his/her better preparedness for an earthquake event. In addition to the *main shock*, it should be known that some strong earthquakes may be characterized by the occurrence of one or a number of *foreshocks* as predecessors of the main shock. Unlike foreshocks that are often absent before a main shock of a strong earthquake, a series of earthquakes referred to as *aftershocks* regularly occur after a main shock. There may be even several thousands of aftershocks immediately after a main shock, but their number is reduced in the course of time. It may take a year or sometimes more for the ground to settle down. Some of the aftershocks may be strong and cause additional damage to structures. This fact should be taken into account when considering actions to be taken after an earthquake. Fig. 5 displays the sequence of shocks.

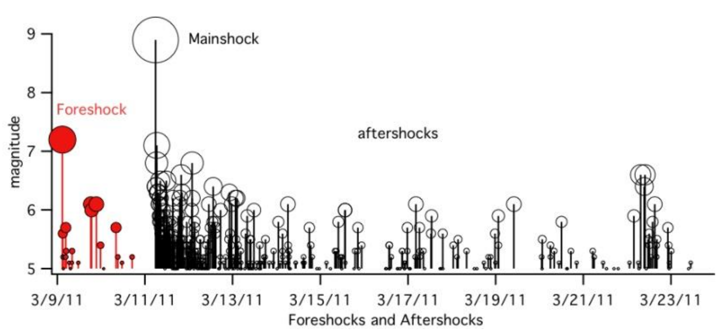

Fig.5. Graphic presentation of foreshocks, main shock and aftershocks

Richter Scale and Macroseismic Intensity Scale

When an earthquake takes place, the information received through the media could be confusing since, sometimes, an information about an earthquake size is expressed in terms of the *Richter's Scale*, while sometimes in terms of the *Macroseismic Intensity Scale*. This Manual will enable the reader to understand and differentiate between these two scales so that the reader will be able to easily understand from the information received through the media whether a large and devastating earthquake or an earthquake that does not cause damage is at stake.

The magnitude scale was introduced by Richter in 1935. The maximum magnitude is defined through the maximum amplitude measured by a seismograph, i.e., a seismograph record the maximum acceleration. The magnitude represents a logarithmic value of the recorded maximum amplitude of seismic waves. There are different magnitudes, but the local magnitude is the magnitude that is reported by the media when an earthquake strikes. In seismology, the magnitude value points to the size of an earthquake. Table 1 shows the classification of earthquakes according to magnitude size.

Table 1. Classification of earthquakes according to magnitude size

Class	Magnitude
Great	8 or more
Major	7 – 7.9
Strong	6 – 6.9
Moderate	5 – 5.9
Light	4 – 4.9
Minor	3 – 3.9

While the intensity scales are linear scales, the Richter's Scale is a logarithmic one. In order that the user of this manual could understand the difference between the two magnitudes, an example will be provided, whereat explanation about how this computation is done will not be given since it is not important for the reader of this manual. An earthquake with a magnitude of 8.7 is about 794 times larger on the seismogram than an earthquake with a magnitude of 5.8. An even more striking is the comparison from the aspect of energy released at an earthquake hypocenter. Such a computation shows that an earthquake with a magnitude of 8.7 degrees is 23 000 times stronger than an earthquake with a magnitude of 5.8, meaning that 23 000 earthquakes with a magnitude of 5.8 will give rise to an energy released by an earthquake with a magnitude of 8.7 degrees. Such comparisons between the two magnitudes are figuratively presented in Fig.6 From the above presented fact, it is quite clear why these earthquakes belong to the group of large earthquakes. It is understood that, if an epicenter of such an earthquake is in the vicinity of an inhabited place, it will cause catastrophic consequences for the population and their material property.

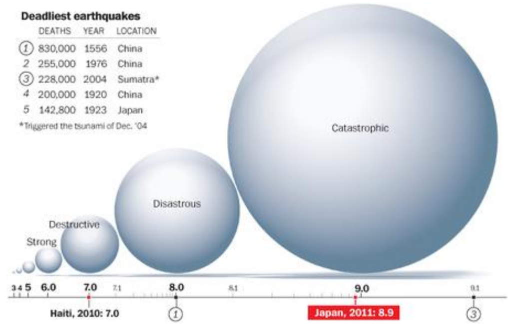

Fig. 6.Comparison of size of earthquake according to magnitude

People often think that the risk of occurrence of a disastrous earthquake at a certain place is smaller if a number of minor magnitude earthquakes occur within a certain time period. From the above stated example, it is clear that thousands of smaller earthquakes are necessary to occur at the same location in order to annul the risk related to occurrence of a strong earthquake.

There is a number of macroseismic intensity scales: the European Macroseismic Intensity Scale, the Mercalli Scale (which has a few modifications and is used in the USA), the Japanese (JMA Scale), etc. With the exception of the Japanese scale, which has 10 degrees, all the remaining scales display 12 degrees. It should be mentioned that the intensity scale expressed through integer numbers is based on whether the people can sense an earthquake and also physical observation of the inflicted damage to the structures and the terrain. This means that this scale is not based on some measurements made by instruments. The reader should know that intensity depends on a number of factors and that intensity can vary widely at different locations of an inhabited place affected by an earthquake. If we use the European Macroseismic Scale (this holds for the other scales, as well), in the place affected by an earthquake of, say, 6.4 degrees, there will be different locations affected by different intensities. For example, there will be intensities of 5 degrees (causing no damage) as well as intensities of 9 or 10 manifested by severe damage and failure of structures. This means that, in the case of a given earthquake, the magnitude will be the same, while the intensities around the epicenter will be different.

IMPORTANT INFORMATION ABOUT EARTHQUAKES

When an earthquake happens, different untrue news often reaches people and may cause panic and fear. It is not a rare example that after an earthquake with a magnitude greater than 3.5 that can be felt by most of the population, rumors about the occurrence of a new earthquake that will be much stronger than the previous one at an exactly defined time during the same day, are spread among the population. Due to such and similar news that are often spread among the citizens, an explanation will be given below as to which of these are true and which are not.

Is it possible to predict earthquakes?

There have been some earlier attempts to predict earthquakes, but it can explicitly be said that, according to the present state-of-the-art of the earthquake science, one cannot predict when an earthquake will occur.

Presented further will be some interesting data related to earthquake prediction, but first of all, definition of earthquake prediction is given.

The term “earthquake prediction” means predicting the occurrence of a future earthquake in advance, i.e., prediction of the time, the location and the magnitude of a future earthquake event in advance.

It can be said that the present level of development of the earthquake science is such that the locations of future earthquakes and expected magnitudes can be defined with a great accuracy. Today, there are the so called seismic hazard maps on which one can see the maximum accelerations that can be expected at certain locations for defined return periods of time. Unlike the location and the magnitude, the attempts to predict the time of occurrence of earthquakes have failed although research programs dedicated to this problem have been financed by the Former Soviet Union, China, Japan and the USA.

In addition to the attempts to make predictions based on the probability theory and statistics, there is a certain enthusiasm among researchers that some anomalies and phenomena occurring prior to earthquakes can be defined and that these precede earthquakes. An iPhone application for the prediction of earthquakes exists but, as already said, prediction of earthquakes is still not possible.

Fig. 7. Although advertised, predicting earthquakes is not possible

Can animals predict earthquakes?

Particularly popular are articles in the journals and newspapers in which it is asserted that animals (dogs, frogs, snakes and even ants) can predict earthquakes since they have the sixth sense and are evidently disturbed when they feel that an earthquake will happen. In literature, there are articles on unusual behavior of animals prior to an earthquake, but it is well known that animals change their behavior out of other reasons, as well. Scientists consider that animals cannot predict earthquakes and that it is only that animals will sense the earthquake a few seconds earlier than people, i.e., they will be the first to sense the primary waves after which people will sense the secondary waves generated from the earthquake hypocenter.

Fig. 8. The dogs can be clairvoyant

Prediction of earthquakes by radon release

The second potential predictor of earthquakes for which investigations have been carried out is the emission of radon. It is found in small quantities in rocks and can easily be detected upon its release. In literature, some investigations pointing to release of radon prior to earthquakes are reported. However, it has been concluded that this is not a rule and that there have been many earthquakes that have not been preceded by radon emission.

Can earthquakes be predicted by electromagnetic anomalies?

There have been attempts to monitor electromagnetic variations and predict potential earthquake occurrence. However, rules to be used to predict earthquakes cannot be established by such monitoring, as well.

Interesting examples of predictions

Presented below is an interesting prediction experiment, which is scientifically based and the users of this manual have perhaps not heard about it. A successful evacuation prior to a catastrophic earthquake will be presented and comments on such prediction will be given. Finally, an earthquake prediction that has aroused a great interest among the people due to sensational articles in newspapers will be discussed.

Parkfield earthquake prediction experiment

Based on statistic data, it was noticed that a segment of the Californian St. Andreas fault passing near Parkfield was almost regularly activated at each 22 with ± 4.3 years causing an earthquake with a magnitude of 6 degrees. It is exactly due to this regularity that predictions were made that there was a 95% chance for an earthquake of such a magnitude to happen in 1988 or by 1993 at the latest. A project was therefore initiated by the Californian authorities and USGS involving monitoring of this segment of the fault. A network of different instruments (the most dense in the World) was installed in the part of the fault where an earthquake was expected for the purpose of recording anomalies as precursors for earthquake prediction. However, as always, being unpredictable, an earthquake with a magnitude of 6 degrees occurred not by 1993 at the latest, but a decade later, i.e., in 2004. Moreover, the instruments did not record any anomalies before the earthquake that could serve for future prediction of earthquakes.

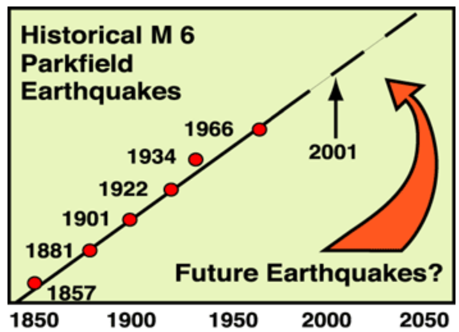

Fig. 9. Frequency of Parkfield earthquakes

Are large precipitations or floods followed by a catastrophic earthquake?

Many people believe that earthquakes occur after some extreme weather conditions and such beliefs are rooted in those who experienced some catastrophic earthquake that accidentally occurred after some extreme bad weather conditions. Sometimes, an opinion is established among citizens that a catastrophic earthquake follows a big flood. For example, most of the Skopje (R. Macedonia) citizens have such an opinion since Skopje was heavily flooded by the Vardar river in 1962 after which a catastrophic earthquake took place in 1963. Such assertions are untrue and are not scientifically based since earthquakes are associated with plate tectonics and occur much deeper where precipitation and temperature cannot exert any effect.

Haicheng city evacuation

Widely known is the prediction of the earthquake of 1975 when the local authorities of the Haicheng city (China) evacuated the city with 1 million citizens a day before the earthquake with a magnitude of 7.3 happened. The loss of human lives due to this earthquake amounted to about 1300 citizens, but it is estimated that it would have been around 150 000 if evacuation had not been effectuated. This is the only known evacuation in the World carried out prior to an earthquake. It is said that the resolution on evacuation was made based on odd behavior of animals and change of the underground water level. However, it seems that the decisive factor for the decision about the evacuation were several strong foreshocks that happened before the earthquake and inflicted minor damage to residential structures. In the then existing China undergoing cultural revolution, it was much easier to make such decisions. In other countries with other social systems, it is very difficult to make evacuation decisions since no acceptable predictors exist. Given that earthquakes occur abruptly and without any warning, the Chinese could not predict the earthquake with the magnitude of 7.6 that struck the Tangshan city the next year. As a consequence of this earthquake, the city with around 1 million of citizens lost about 250 000 human lives. This earthquake was the second deadliest earthquake in the history of mankind.

Can a big earthquake trigger another big earthquake?

Again, by a coincidence, there may happen a big earthquake followed by another big earthquake within days as was the case with the 2010 Haiti earthquake followed by the Chile earthquake after 40 days. Such an information makes people think and fear that the first earthquake caused the second earthquake and that, perhaps, a chain of earthquakes may happen and their living place will be affected. This cannot happen since these hypothetical earthquakes are related to different fault structures, meaning that they do not originate from the same fault. Also, the distances are very large, while the Earth's crust is not sufficiently rigid to transfer the effects of one earthquake to another. However, it is possible that a catastrophic earthquake may trigger another earthquake from the same fault due to redistribution of stresses, whereat the second earthquake will take place near the place affected by the first one.

Can earthquakes shift the Earth's axes?

Some sensational news that the earthquakes that occurred in Sumatra (2004, M = 9.1), Chile (2010, M = 8.8) and Japan (2011, M = 9) had shifted the axes of the Earth giving rise to a shorter day as the result of faster rotation of the Earth were spread around the world at an incredible speed. The news were true since these three earthquake really shifted the axes of the Earth and shortened the day, but their objective was to make a sensation among the people although these changes are extraordinarily small, cannot be felt and do not affect anything.

So, for example, the earthquake that took place in Japan (2011) shifted the axis of rotation for around 16 cm. This may seem a lot to us, but this change is six times less than the annual shift of the axes which is permanent and amounts to around 1 meter. The shortening of the day due to the shifting of the axes is so negligible that it looks funny since, due to the earthquake in Japan, it was shortened for 1.8 millionth part of a second. This means that our days will be shorter for 1.8 millionth part of a second because of the shifting.

Is the number of earthquakes increasing?

For the last several years, there have occurred a few dramatic earthquakes resulting in a huge loss of human lives (Haiti 2010 is considered to have been the deadliest earthquake so far). They caused big waves, the so called tsunami (Sumatra 2004 and Japan 2011), created an island (the last earthquake in Pakistan 2013, M = 7.7), Fig. 10, led to surface rupturing of a fault (the earthquake that struck the Philippines, M = 7.2) and gave rise to the occurrence of liquefaction (the earthquakes in New Zealand 2010). The information on such earthquakes was continuously released through all the media around the World so that there was an impression that the number of earthquakes was on the increase.

Fig. 10. Island formed due to the 2013 Pakistani earthquake

However, it is evident that information on occurred earthquakes has been increased due to the incredible possibilities for transmission of information. This creates an illusion that the number of earthquakes has been increased. Also, the population in the belts where earthquakes occur has considerably been increased. This means an increase of unlicensed construction in these belts which in turn gives rise to a greater risk regarding number of victims in cities affected by earthquakes. This also creates an impression among the people that the number of earthquakes has increased. However, based on the statistics on earthquakes that have been recorded since 1900, it can be concluded that the number of earthquakes has not been increased. According to the mentioned statistics, 17 major earthquakes (7.0 – 7.9) and one great earthquake (8.0 plus) can be expected at an annual level. At an annual level, about 127 strong earthquakes with magnitude between 6 and 6.9 take place around the World. Fig. 1 schematically presents the energy released due to earthquakes of different magnitudes.

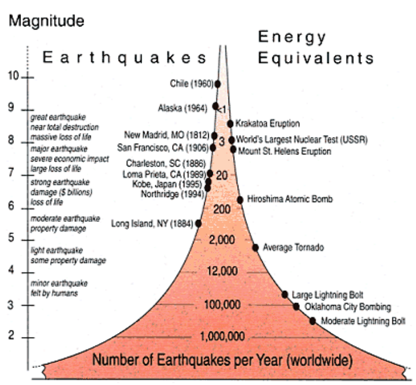

Fig. 11. Schematic presentation of the energy released during earthquakes of different magnitudes

2. EARTHQUAKES AND STRUCTURES

Seismically Safe Structures

In the first chapter of this Manual, we have learned that earthquakes cannot be predicted and that they take place without any warning. Their prediction is important since, knowing the time, the location and the size of an earthquake would help us manage the consequences of such a catastrophe much easier.

The knowledge on the time when an earthquake will strike, its location and size is of an extraordinary importance in carrying out evacuation prior to an earthquake. On time evacuation would reduce the loss of human lives to a minimum which is the most important in managing such a catastrophe. However, the material losses would be almost the same no matter whether we know that an earthquake will occur or not. It is due to this fact that construction of seismically resistant structures should be the main task of each country (a population that lives in a seismically active region).

It is not earthquakes that kill people but structures

There are many similar modifications of this statement made by experts dealing with seismically resistant structures who want to point out that the most important ring in the chain of earthquake management should be structures designed and constructed in compliance with the most recent seismic norms. Given below are some official data on the deadliest earthquakes in the latest history of mankind.

(1) Haiti: Jan. 12, 2010; 7 – magnitude;   316,000 people killed;
(2) Tangshan, China: July 27, 1976; 7.5 - magnitude; 255,000 people killed;
(3) Sumatra, Indonesia: Dec. 26, 2004; 9.1 – magnitude; 227,898 people killed;
(4) Eastern Sichuan, China: May 12, 2008; 7.9 – magnitude; 87,587 people killed;
(5) Pakistan, Oct. 8, 2005; 7.6 – magnitude; 80,361 people killed

We can see that these earthquakes are major or great earthquakes according to their magnitudes with normally expected huge number of victims. It should be mentioned that the people killed on Sumatra were not victims of the earthquake but the tsunami caused by the earthquake. In the case of the other earthquakes, the people killed were victims of failure of structures under the effect of ground motion. Certainly, the number of victims depends on the density of population of the place struck by an earthquake as well as other factors as is the soil on which the structures are founded or the distance of the structures from the earthquake epicenter.

What more can we notice from the above stated data?

It is certainly the fact that this list does not read any highly developed country like Japan, Taiwan or the USA although these countries belong to the group of countries characterized by the highest seismic activity in the world. Haiti and Pakistan belong to the group of underdeveloped countries and the same referred to China until the beginning of the 90-ties of the last century. Hence, it can be concluded that it is not the earthquakes but the low quality construction that kills people.

Structures and earthquake engineering

The mastering of the material in this part of the manual will help the reader and his/her family behave more safely and sober-mindedly during an earthquake with a potential to cause loss of lives, injuries and material damage. Most frequently, we do not have the possibility of changing the city in which we live depending on whether it is located in seismically active zones in the World or not. However, we should, must and can choose seismically safe structures in which we will live and work. The main purpose of this part of the manual is to educate its user how to differentiate between buildings that are seismically safe and those that are risky for living, working or a longer stay.

Learn by yourself how to choose your building for living and working

First of all, we should say that earthquake engineering represents a scientific and technical discipline that teaches us how to design and construct seismically resistant structures. The present level of development of this discipline enables reliable construction of seismically resistant structures.

Which structures are seismically vulnerable?

All structures built without design drawings are very risky structures and these are particularly characteristic of undeveloped countries. Most of these structures are built without construction permit. These structures are also characteristic of the developing countries. All structures (in both undeveloped and developed countries) built prior to the effectuation of the first seismic regulations for the considered country, represent very risky structures. All structures built in compliance with the seismic regulations but not in full compliance with their respective projects, represent vulnerable structures. Risky structures are also those built in compliance with the respective projects but without due consideration of the quality of built-in materials. Most of such structures exist in undeveloped countries but there are examples in the remaining countries, as well. Unfortunately, the defects of these structures come to the surface after big earthquakes. A typical example of low quality structures were the structures that collapsed or were severely damaged by the catastrophic earthquake that happened in Turkey, in the region of Izmit, Golchuk and Ada Pazari cities in 1999. This earthquake gave rise to a huge loss of human lives (around 20 000) and collapse of structures that were built according to the Turkish seismic regulations. The reason for the heavy collapses was the low quality materials, i.e., the extremely low quality concrete and reinforcement.

Which structures are seismically safe?

Seismically safe structures are those in whose design seismic regulations were observed and applied and whose construction was carried out in full compliance with the respective design projects and taking care for the quality of the built-in materials.

Something about seismic regulations

It can be assumed that a large number of users of this Manual think that buildings that are designed in accordance with seismic regulations should not suffer damage. This is not true since design of such structures is neither justified nor economical. Based on seismic regulations, there holds the following philosophy of design. Namely, buildings are mainly designed with consideration of two earthquake levels taken as an input: smaller earthquakes (earthquakes with a greater probability of occurrence in the course of the serviceability period of a building) and maximum possible earthquakes (with no great probability of occurrence during the serviceability period of a building). As to small earthquakes, the structure should be designed such that it should not suffer any structural damage except for minor damage to nonstructural elements. Regarding the second level, i.e., the maximum earthquake level (for example, the return period for Europe is 475 years), even damage to certain parts of the structure but no collapse is allowed.

Fig. 12.Eurocode for seismic design of structures

Fig. 13. Damage to non-bearing elements of frame buildings

Tailor made buildings

Lately, there have been constructed buildings according to wishes of clients, who may require that the building does not suffer any damage to the structural part even under the maximum earthquake that may occur on the site of the respective building. Such design will cost more and cannot be thoroughly justified since there is no greater probability that such an earthquake will occur during the serviceability period of the structure.

How should we choose a safe building for living and how should we know whether the office building in which we work is safe enough?

The first thing we should do when choosing a living place or wanting to know whether the building in which we work is safe is to ask the owner of the building about its year of construction. It is even better if the owner has the project on the building. The year of construction of the building is a good indicator of the seismic safety of the structure because we could easily check when the seismic regulations were passed in the respective country through the Internet. If the structure was built prior to the effectuation of the seismic regulations, it is not safe and we should look for another. Clearly, newer structures should be safer since they are built by employing newer knowledge of their seismic behavior, i.e., they are built in compliance with the modern seismic regulations. It should also be assumed that the materials used for the construction of such buildings are with better strength characteristics than those of the older structures. If the owner has the project, we could give it to an earthquake engineer, who can evaluate whether the structure is safe even more accurately.

The users of this Manual should know the year of construction of the buildings in which they work. This also refers to the school buildings of their children.

Which structural systems exist?

Structures can be constructed from bricks and wood, wood, steel and also reinforced concrete. *Masonry structures with bearing walls* (these structures do not have columns and walls) (Fig…) constructed of bricks exert the most unfavorable behavior during an earthquake. The walls are brittle, with very low bearing capacity and these structures are the first to be damaged or collapse when destructive earthquakes take place (Fig…). Such structures were intensively built in seismic regions until the 60-ties of the last century. Today, these are almost not constructed in seismic regions and are forbidden if a building is planned to have a bigger number of storeys. This system is easily recognized (Fig…) since the bearing walls are about 40 cm thick and can be even thicker. Any intervention meaning making of openings in bearing walls or tearing down walls is not allowed since it will reduce the resistance to seismic forces. Building of additional storeys upon these structures is prohibited.

Timber structures are light and, if well designed, they can sustain seismic forces easily.

If properly designed and constructed, *frame 3D structures* (skeleton structures composed from columns, beams and plates, Fig….) are safe against earthquakes since they will not collapse even under the effect of the maximum possible earthquake for the given location. These structures are constructed of reinforced concrete or steel. They represent flexible systems in which some damage to partition walls may take place due to large inter-storey drifts under stronger earthquakes.

The second efficient system built in seismic regions involves *buildings with reinforced concrete walls* (Fig. ….). If well designed, these are safe even under the maximum expected earthquake at a given site, but due to the big stiffness, they are less economical than the frame systems.

The best system for seismic areas are considered mixed reinforced concrete systems, or the so called dual systems composed of frames and reinforced concrete walls (Fig. 14). This system is neither rigid nor flexible and is therefore economical also because of the smaller displacements even under the maximum earthquakes. If properly designed, such buildings will suffer less damage than the frame systems.

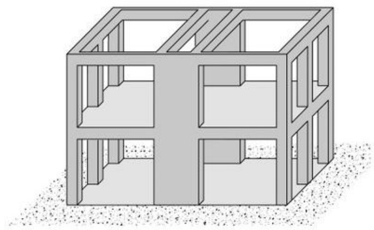

Fig. 14. Dual system (RC columns and shear walls)

It is also good to inform the readers that, in addition to the above mentioned systems with fixed foundation, there are, the so called, *base isolated buildings* (Fig.15). Such structures are placed on bearings – flexible elements that considerably reduce the effect of earthquakes upon the building. This system is implemented in hospitals, fire fighting and emergency facilities since they have to remain functioning during and immediately after an earthquake.

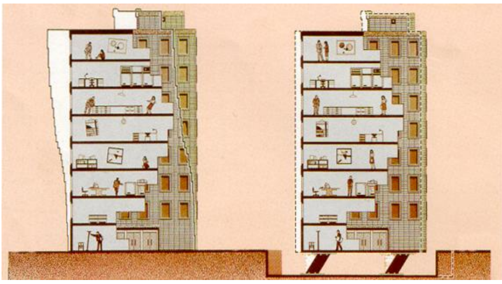

Fig.15. Fixed and base-isolated buildings

Is the number of damaged and collapsed buildings due to catastrophic earthquakes big?

When the term "catastrophic earthquake" is used, it means that such type of an earthquake will cause damage, partial failure and collapse of structures as a result of large ground displacements. It is very difficult to define the extent of damage caused by an earthquake and whether a large number of buildings will collapse since this depends on a number of factors.

Still, based on the previously stated facts and assessment of damage after catastrophic earthquakes, one may make some rough estimations. It can be assumed that most of the non-engineering structures will collapse Fig. 16a and b.

Fig. 16a) Almost all non-engineering structures collapse Fig.16b) Debris left from non-engineering structure

A large number of masonry structures that are not designed to sustain seismic forces will also collapse . Most of such structures will be damaged Fig.17.

Fig.17. Damaged masonry structure due to the L'Aquilla earthquake

What will happen to buildings designed according to seismic regulations?

The situation is completely different in the case of buildings designed according to the seismic regulations. It is very hard to tell that such effects will not cause any collapses, but if there are collapsed buildings, their number will be limited and the collapse will be caused by errors in design or unsatisfying quality of built-in materials. However, there may be a big number of damaged structures.

A modern structure designed according to all regulations and standards for quality of materials is assumed not to collapse.

Can earthquakes cause damage in another way?

Fires

A destructive fire may occur in urban settlements after earthquakes. It results from a gas line break or short circuit in the power supply network. Fire may spread over a larger area and can be destructive in the case of leakage of water reservoirs, disruption of water supply pipelines or inability of fire fighters to intervene and extinguish the fire due to damaged bridges and roads. A typical example of a destructive fire after an earthquake is the fire that broke out after the earthquake in San Francisco in 1906.

Landslides

Earthquakes may trigger landslides that can damage or cause collapse of buildings.

Fig. 18. A landslide due to the Philippines earthquake (2013)

Tsunami

When earthquakes occur on the oceanic bottom, under certain conditions, they may produce water waves that may cause failure of structures and loss of human lives. Examples of earthquakes that created catastrophic tsunami waves are the recent earthquakes in Sumatra (2006) and Japan (2011).

Fig. 19a) Tsunami wave due to Japan Earthquake of 2011

Fig.19b) Devastation caused by the tsunami (Japan earthquake of 2011)

Liquefaction

During an earthquake, under certain vibrations, certain soil becomes liquid and without bearing capacity, giving rise to subsidence or overturning of buildings. Fig. 20 shows this phenomenon.

Fig.20a) Sinking due to Adapzari earthquake   Fig.20b) Sinking and overturning of a building

Surface rupturing

In the case of a catastrophic earthquake, large displacements of a fault may take place, leading to ground surface rupturing (Fig.21). If any building, bridge, railway line or other facility is placed on such a fault, these structures will suffer damage regardless whether they are designed according to seismic regulations or not. Therefore, care should be taken not to construct any buildings or other structures along a fault line.

Fig. 21. Surface rupturing due to activation of a fault

Pre-detection but not prediction

Earthquake Early Warning Systems (EEW) are one of the new tools for successful earthquake management. Some countries in which earthquakes occur more frequently and can be of large magnitudes have started to apply the so called early warning systems. Mexico was the first country to introduce such a system in 1991. The national EEW system of Japan was put into operation in 2007. Such systems exist in California, Taiwan, Turkey and a small part of Romania but are still not in use in developing countries. These systems do not predict but detect earthquakes. In fact, they detect the P-waves that arrive first to a certain location. The S-waves are slower and they come the next. It is the S-waves that cause destruction since they transfer the greatest part of the energy released from the hypocenter. According to the energy of the S-waves, the system will detect the size of the magnitude and should it be moderate to large, it will issue an alarm. The system consists of seismometers, communication, computers and alarm. The greater the number of seismometers the more efficient the system. Therefore, 4235 seismometers are included in the Japanese national network.

Fig. 22a)Sensor for measuring accelerations in three directions

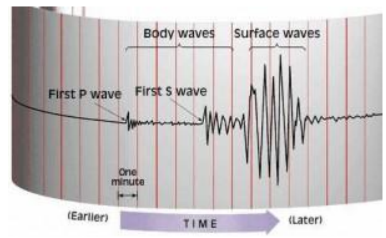

Fig. 22b) P-, S- and surface wave recorded by a sensor

What is the benefit of early warning systems?

Depending on the distance from the epicenter, these systems can issue an alarm 10 to 15 seconds prior to an earthquake. In 2011 when an earthquake with M = 9 took place in Japan, the system was turned on in Sendai 15 seconds earlier. In the case of the 2011 Mexico earthquake with a magnitude of 7.4, the earthquake epicenter was at a distance of 300 km from Mexico city, while the alarm was issued in Mexico city 60 seconds earlier.

Shaking at an epicenter takes place 1 second after the arrival of the P-waves. Therefore, if you are near an epicenter, the alarm will not be activated at all, but if an alarm is activated ten seconds earlier, the benefits of this system are evident. The advantage of having ten seconds and more (depending on the distance of the structure from the epicenter) for the people is that they will be able to get under a solid table on time prior to the shaking, avoiding injuries due to their fall on the floor and possible moving or falling objects. If an alarm is issued much earlier, for example 60 seconds earlier, there will be enough time to even evacuate the buildings. Such a successful evacuation of Mexico City was done for the above mentioned earthquake.

Mode of transfer of the alarm

Unlike 20 years ago, today, there are many possibilities for fast transfer of information through the mobile phone network and the Internet. There are a number of mobile phone networks that offer services related to early earthquake warning. In 2014, in California, it is expected that an application for smart phones based on the principles of the national EEW systems be issued. The application will use sensors that are already incorporated in the phones like accelerometers and gyroscopes that detect motion as well as a GPS function to define the location. The advantage of detecting ground motion is that there are hundreds of millions of smart phones worldwide.

3. EARTHQUAKE PREPAREDNESS

Why should we prepare ourselves for an earthquake?

EBDR has offices in a large number of countries worldwide. Most of the countries where EBRD has branch offices are located in seismically active regions. Therefore, it can be assumed that the employees in the EBRD offices will experience earthquakes on a number of occasions during their working hours. It can even be assumed that some of these earthquakes will cause damage to structures possessed by EBRD, as well. Each employee, starting with the part time employees and ending with the top managers should master this manual whereat it is of a particular importance that they learn how to protect themselves during an earthquake.

The procedures described below refer to what the employees should do for their protection if they are in their working places when an earthquake strikes. However, it is certain that they will transfer the knowledge acquired upon the mastering of this material to their families in order that they could jointly plan protection against earthquakes. The instructions given and explained below refer to managing earthquakes at working places but these are equally applicable to managing earthquakes at home.

In this part of the manual, three main issues related to earthquake preparedness are included: (1) how to prepare for a big earthquake; (2) how to protect ourselves during earthquake shaking and (3) what steps should be taken after an earthquake. It is generally accepted that there are 7 steps to be taken for earthquake safety.

It is necessary to point out that all the instructions given below are generally accepted worldwide. These instructions are contained in all official brochures (USA, Japan, New Zealand and other countries situated in seismically active regions) of the Red Cross societies and civil defense emergency management agencies of the respective countries. They are also accepted by all researchers as well as emergency experts and managers.

It is important to note that the procedures of protection during an earthquake shaking, namely "drop, cover and hold on" that are explained below represent instructions that are accepted by all agencies working on earthquake risk reduction. This should be stressed out to avoid confusion among the users of this manual due to an information that was spread around the world instructing an opposite procedure. This was the so called "Triangle of Life" procedure about which the employees of the bank and the readers of this manual might have heard. Due to doubts involved in this "Triangle of Life", an explanation as to why it is risky to use this procedure will be given below.

Explained further are the necessary steps to be taken after an earthquake for the purpose of minimization of earthquake consequences and faster return of the employees to their working places.

Preparations prior to an earthquake

STEP 1

Identify all the potential dangers in your office and fix them

Due to the strong shaking of the buildings during an earthquake, the objects in all premises of buildings begin to move. Some of them, particularly the heavier ones fall from the desks, the bookcases and the office furniture. Heavier furniture can overturn. Glass objects and other objects made of fragile materials break. Most of the books and other heavy objects will fall from the bookcases, Fig. 23.

Fig. 23. Fallen books and heavy objects due to ground shaking

Non-structural hazard

Falling and flying heavy objects represent a big threat since they can cause injuries and even death of employees that are in the premises. There could be a big material loss, as well. However, these problems that may occur as a result of motion of objects can be neutralized in a very simple and low-cost way. In the next few paragraphs, the potential hazards in working premises will be defined and an explanation will be given as to how to eliminate these hazards.

If the furniture, other equipment and objects in the premises in which the EBRD personnel work are not properly placed and fixed, they can be life threatening or could cause injuries.

There is a big number of examples of deaths and injuries due to improper placement and fixation of contents in working and living premises. All these damages, victims and injuries could be negligible if timely measures are taken for proper placement and fixation (if necessary) of objects in the premises.

The first thing to consider prior to a strong earthquake is the distribution of the office furniture in the working premises. If there are desks placed next to an external wall, these should be removed to another place since external walls with windows are the most dangerous places during an earthquake due to the big risk of breaking of windows that could cause injuries. The books in the libraries (bookcases, file cabinets), the shelves and the high cabinets can be dangerous objects during an earthquake since they can easily fall and inflict injuries to the personnel. Therefore, if the premises allow, these should be far from the desks where the employees sit.

If, due to lack of space, such a furniture is near your working desks, the first rule to observe is to place heavier books in the lowest shelves. The same also holds for the books that are situated farther from our working desks. The cabinets and the bookcases with doors should be well closed or locked to prevent their opening during an earthquake. It is good if the shelves could have some kind of low fences to prevent falling of the books. The entire furniture should be fixed by flexible fasteners such as nylon straps to prevent overturning.

Electronics

A large number of personal computers are housed in working premises. These can fall and inflict injury to someone and could be damaged, as well. Therefore, they should be fixed by flexible nylon straps and buckles in order that they can be displaced, if necessary. In some premises, there are servers or main frame computers. Motion of the servers can be prevented in the same way as that used for the personal computers. A similar fixation should also be done for the remaining heavy electronic equipment. If there are main frame computers in some of the EBRD offices, these should be made safe against overturning and damage. This is because they are extraordinarily costly. However, it is even more important that they should be functioning even under the strongest earthquakes. Their fixation cannot be done by office employees but experts in earthquake engineering. In order that they could remain functioning during an earthquake, they should be base isolated (Fig….) in which way minimal transfer of seismic forces to the computer will be ensured.

Objects on open shelves and tabletops, suspended objects

Fragile costly objects can be found on open shelves and tabletops. These collectibles, pottery objects, lamps, etc. can be life threatening if not fixed. The simplest way of preventing their motion is to use non-damaging adhesives such as clear quake gel or earthquake putty.

On the walls of premises in which we work, there could be decorative framed pictures and clocks. If these are not properly hanged, there is a danger that they could hurt somebody in case of horizontal motion particularly if they are placed above sofas. To avoid their falling, they should be hanged by use of closed hooks.

Water heaters and gas appliances

Water heaters in office premises should be braced.

If there are rigid connections between gas tubes (in the case of gas water heaters) and water heaters, these should be replaced by flexible ones. The connections of other gas appliances, if any, should also be replaced by flexible ones.

STEP 2

Create a disaster preparedness plan

Planning prior to a major earthquake is of primer importance for successful management of a disaster such as an earthquake. It is necessary that each EBRD office located in a seismic region has a plan about which measures should be taken prior to an earthquake and which rules should be observed during an earthquake. After the earthquake, each EBRD employee should know his/her tasks according to the plan.

In order that the employees could be safe at their working places and that the working process could successfully be carried out, a documented earthquake disaster preparedness plan is necessary. The success of the plan depends on active participation of the employees in the process of its creation. The plan should be revised annually to incorporate new knowledge related to disaster preparedness for the purpose of its better efficiency.

A good plan will enable:

- Identification of potential hazards and their minimization or elimination;
- Minimization of injuries/deaths of e employees and visitors;
- Reduction of expenditures incurred by the caused losses;
- Management of the risk of fire or non-functioning of some utilities;
- Fast return of the bank offices to normal functioning.

Depending on the extent of damage, the earthquake recovery may last for weeks and months and even longer.

Plan what you should do during an earthquake

Check which places in your office and other premises are safe. Check whether there are hard desks and tables that you could use as a shelter.

Leave sufficiently large corridors for motion in offices. This is particularly important when a larger group of people moves through the same place at the same time. The path for evacuation from offices and the path for evacuation from the building should be planned.

When an earthquake strikes, there is not much time to think what to do. Therefore, one should know all the procedures recommended to be carried out during an earthquake through training and exercise. It is very important to practice the “drop, cover and hold on” technique in order to be able to do it automatically when an earthquake strikes. This technique will be explained in details in step 5.

Plan how to protect yourself if an earthquake strikes when you are on other locations (your living place, other public facilities, elevator, open space or car).

What should be taken into account while making the plan is the risk of fire or non-functioning of some utilities.

Plan communication and recovery

Choose the safest place beyond the building as the gathering place of all the employees who are at work when an earthquake strikes.

Fig. 24. People gathered at a safe spot in Dubai after a far-field earthquake

Exercise the plan

Once the plan is made, it should be checked through exercises in order that the employees could understand easily what they should do and see whether the objectives of the plan are achieved. These exercises will enable discovering possible weak points of the preparedness plan.

STEP 3

Personal and bulk emergency preparedness supplies

In seismic regions where EBRD office buildings are situated, each employee has to have his/her own disaster kit containing the necessary basic supplies. A small bag or a container is excellent for keeping these supplies in order that the employees could easily bring them in case of evacuation. The bag or the container should be placed in an accessible place. Such a disaster kit must contain basic food, water and other supplies for at least 1 day. At home, we should have a disaster supply kit that will satisfy the needs for at least 3 days. The disaster kit should contain the following basic supplies:

- Snack food high in calories; long lasting food
- Water: in plastic bottles and sufficient to satisfy the needs for a day;
- First aid kit;

- Tools: whistle, led battery (with spare batteries), dust mask, battery radio (with spare batteries), toilet paper, personal hygiene kit, refuse bag.

Fig. 25. A personal disaster kit

When speaking about different tools, we must not forget the smart phones that, thanks to the many useful applications, can serve as excellent flashlights and as a whistle. They enable listening to a huge number of local FM radio stations and use of Internet for additional information and sending messages. SMS is also an excellent way of sending information. The only setback of the smart phones is that the batteries are discharged very fast. These should be always full and with us, but our disaster supply kit should also contain a charger and a full spare battery.

In addition to these supplies, depending on the individual (whether he/she receives some medicines or wears glasses), spare glasses and prescription medicines for at least 3 days should also be kept at the working place.

Sometimes, a disaster kit could be unpractical. If it is robust, there will be no sufficient space to be kept for each employee. If heavy, it will be unsuitable to be carried during evacuation.

A personal disaster kit is more suitable for a small EBRD office. If there is a number of employees in an office, it is uneconomical that each employee has his/her own personal kit for keeping all these kits will be a problem. Therefore, for individual offices, if the individual needs of the personnel (medicines, glasses and alike) are excluded, it is the most convenient to order the same supplies for all the employees in the office.

In shops and on the Internet market (Amazon and alike), there is a big selection of personal kits. However, these are costly and it is the best to make such kits personally by buying the individual supplies.

STEP 4

Structural Hazard

Check the date of construction of the building in which you live and work

It is the duty of each EBRD employee, who works in countries situated in a seismically prone region to know whether his dwelling and the building in which the employee works are designed in compliance with the seismic regulations of the respective country. It is assumed that, upon reading this manual, the employee will be able to understand the structural system of the building in which he/she lives or works. If the employee has a family, it will be his duty to explain to them that their living place and the structure in which the employee works are structures designed in compliance with the seismic regulations of the respective country. If the employee has children, it is understood that the employee should know whether the school or the kindergarten in which his/her children go are safe. All this information that should be known by the EBRD employees and the members of their families will enable easier realization of the prescribed procedures of action during an earthquake. The reaction to an earthquake will be calmer when it is known that the structure is designed according to seismic provisions.

It should be known that newer buildings are seismically safer since they are designed according to the latest seismic codes.

It is assumed that all EBRD buildings in countries where earthquakes occur are designed according to the seismic regulations. These are therefore seismically safe structures, without potential weaknesses, meaning that there is no need for their strengthening.

STEP 5

How to behave and what to do during an earthquake?

Small earthquakes

Minor earthquakes will not be considered in details in this manual since these are not dangerous, but will be mentioned because of their great probability to occur in some of the countries in which EBRD has its own offices. Minor earthquakes are with a very short duration, which is usually a few seconds. Some people can feel them, some not. Whether minor earthquakes will be felt by people depends on whether they are in motion outdoors or in a car or some premises. When we are in a car or outdoors, we can hardly feel such an earthquake. However, if we are in a room or if we are sitting, we shall feel some motion but will not be sure whether it is an earthquake or not. If we are not sure whether an earthquake happened, the best way to check this out is to look at the chandelier in the room, if any. It is almost certain that the chandelier will move in case of an earthquake. This dilemma can be solved fast in another way, as well. You can call your friends and ask them whether they have perhaps felt an earthquake. If there has been an earthquake, some of them have surely felt it. Sometimes, such earthquakes may last a little bit longer. We shall feel them, but as soon as the thought about what to do will run through our minds, the earthquake will stop. As it was said, these earthquakes are harmless and are not the subject of consideration in this manual.

Big earthquake

The time duration of big earthquakes is greater than that of minor earthquakes. This mostly depends on the size of an earthquake and also other factors. The stronger the earthquake the longer its duration. For example, the earthquake that took place in Alaska (1964, M = 9.2) lasted around 240 seconds. After a few seconds following the beginning of a big earthquake, the violent motion phase starts. As the result of ground motion amplification, an acceleration that can be several times greater than the ground acceleration may take place at certain storeys so that one could easily be pushed to fall on the floor if he/she is in a standing position.

What happens during an earthquake?

Some objects fall and break. Bookcases, file cabinets and other furniture that is not fixed can be overturned.

Many services can be disrupted: elevators, lights, telephone communications.

During an earthquake

Do not run out – If an earthquake strikes while you are in the office, do not run out of the building since some flying objects could easily hurt you. During running, you may fall or be hurt by breaking glass or debris. It is dangerous to go out since you can be hurt by possible falling of the façade, architectonic details, etc. Fig. 26. Once the shaking stops completely, you can go out.

Fig. 26. Debris from a fallen facade

Do not use an elevator, but in case you are in an elevator, you have to stop it and exit at the nearest storey.

Have in mind that the fire alarm and the sprinkler system may go off even in the absence of fire.

Do not wait to see whether the earthquake is strong but take immediate measure for your protection. Take the DROP, COVER AND HOLD action.

If you are in your office, at your desk, drop down, take a shelter under your desk and hold on until the earthquake stops, Fig. 27. If there is no table or desk in the vicinity, keep away from windows since they can break and hurt you. Move a few steps toward the inner wall and lie down on the floor. In this position, you will be much more stable than in a standing position and you will still be able to move, if necessary. Protect your head and neck with your hands.

Fig. 27. Schematic presentation of drop, cover and hold procedure

Fig. 28. Sheltering under a) a solid table and b) desk

If you are at home, the procedure is the same. You can protect yourself under some table or desk and hold on some of the legs until the earthquake lasts. If there is no table or desk in the vicinity, make a few steps to the first inner wall and again drop down to the floor and protect your head and neck with your hands. Stay in that position until the shaking is over.

If you are in bed, do not get up. Remain there until the earthquake is over. Try to protect your head with a pillow.

As it was said earlier, aftershocks will occur for a longer period of time after some strong earthquake. These may take place immediately after the main shock. If you have still not fled from the building, during the aftershocks, you can act in the same way as during the main shock.

It is important for the EBRD employees in seismic regions to know that protection against earthquakes by use of the three main steps, namely, “drop, cover and hold”, holds under the assumption that their building will not collapse. The use of this technique will protect us against injuries due to falling caused

Fig. 29. Dangerous debris caused by the Parkfield earthquake of Sept. 28, 2004

by an earthquake. This technique will protect us against injuries and even death caused by flying or falling objects, but none can predict what will happen if a building collapses. No-one can predict the load upon the shelter due to the weight of the collapsed parts. If the weight is too big, the legs of the shelter may be broken and the sheltered person may be killed. It is assumed that the buildings housing the EBRD offices are designed in compliance with the seismic regulations and that the risk of their failure is therefore low.

The Triangle of Life

As it was said previously, the Triangle of Life is a doubtful theory about how we can save ourselves in a catastrophic earthquake. Since it is not based on any serious evidence and research, this theory as well as all other doubtful theories that seem to be very interesting have been spread through a viral email (2004). Perhaps, it should not have been addressed in this text since it is not officially recommended by any organization or institution that seriously deals with protection against earthquakes, but it is still very useful to point out the controversies of this theory.

This theory advocates procedures opposite to the “drop, cover and hold” one. So for example, the Triangle of Life procedure does not advise sheltering under a table or a desk but curling up in a fetal position next to a strong and heavy object that could be smashed a little and leave a void next to it. It is assumed that the hard object could be a kind of a support to part of the roof/slab that will fall during the collapse of a building. The hard object and the roof/slab will create a space in the form of a triangle in which one can survive (Fig…). The formation of triangular voids is the basis of this method.

Fig. 30. Schematic presentation of the Triangle of Life

The instructions given in the Triangle of Life in the case when we are in bed during an earthquake are quite opposite. Unlike the DCH technique saying that we should remain in bed and cover our head with a pillow, the advice given in the Triangle of Life is quite contrary. According to the Triangle of Life technique, everybody finding himself in bed during an earthquake should roll off the bed since the safe void is around the bed.

The formation of a void in the form of a triangle seems very logical which makes this theory very much accepted by the readers. However, the mode of failure of a building is extraordinarily complex and cannot be predicted in advance. In fact, there are a number of failure mechanisms depending on the structural system and also other factors that are not the subject of this manual. The experts have known for a long time that voids are created when a building collapses due to an earthquake. Actually, all survivors saved from ruins of buildings have been found in the voids in collapsed buildings. One of the numerous disadvantages of the Triangle of Life technique is that it is very difficult to know in advance where these triangles will be formed since large and heavy objects move during earthquakes. There is even a danger of suffering injuries as a result of motion of such objects. However, the biggest setback of this method is that one cannot be sure as on which side of an object a triangle will be formed. There are also other controversies referring to this technique, but these will not be mentioned in this text.

When the above two techniques are compared, the following statements can be made: (1) there is a fundamental difference between these two techniques wherefore they can even be considered incomparable. The first, namely the “drop, cover and hold” technique starts with the assumption that buildings are designed according to seismic regulations and that they will not collapse, whereas the second one starts with the assumption that a building will collapse during an earthquake. Due to these assumptions, the first technique considers modes of protection against flying, falling or breaking objects. The second technique considers the possibility of protection when a building collapses; (2) from the first statement, it is clear that the first technique is superior in case of all buildings until their complete collapse. If one knows that an earthquake of intensity 3 can be felt and that there is no collapse of buildings up to intensity 7, it turns out that a much greater number of people will be protected by applying the steps recommended by the first technique, while the second technique is inapplicable since there will be no collapse under an earthquake with an intensity of up to 7 degrees. Both techniques are inappropriate in case of failure of skeleton structures with failure mechanisms different from the “pancake” mechanism. When a building collapses in the form of a pancake (Fig…), there is a probability that hard objects along with collapsed roof/slabs form triangular voids. In such case, one can assume that the Triangle of Life technique could be more applicable. However, this is almost impossible for people cannot know in advance whether a building will collapse let alone whether the collapse will be pancake like. It should be stressed out once again that one cannot know on which side of the hard object the void will be formed.

Fig. 31. Pancake collapse of two buildings during 1999 Kocaelli earthquake

Fig. 32. Voids made during collapse of a building

From the above statements, it can be concluded that the number of cases in which the “drop, cover and hold” technique should be used is vast, while the use of the Triangle of Life technique is very risky and is not recommended.

If you are outdoors, try to find a space with no trees, lamp posts or power lines. Drop down and remain in that position until the shaking stops.

If you are in a vehicle, move away from buildings immediately since parts of their walls may fall upon your car, Fig.33, find a safe place, a clean location with no trees or electric power lines and stop your vehicle.

Fig. 33. Debris from a building fallen on a car

If you are driving through a mountainous region, watch out for earth- and rockfalls (rolling of stones or landslides). Try to stop at some place with no slopes.

How to behave and what to do after an earthquake?

STEP 6 –When the shaking stops, check for injured and damage

Check whether there are injured

Remain in a safe place until the earthquake is over. Then check whether you are injured. Look around you to see what has happened with the other persons in the room. Provide first aid if there are injured people in the room. Be ready to help the injured go out of the building. If a person is heavily injured, do not move the person if you consider that there is no danger of staying in the building until a stretcher is brought. If there are disabled people in the building, check whether they are injured and help them go out of the building with you. Take the stairs when leaving the building. Go to the safe spot anticipated with the plan where all the employees should meet. Do not enter the building again until it is evaluated as safe.

Fig. 34. Providing first aid to the injured**.**

Check the damage

Employees in charge of the safety of a structure should check whether all small fires, if any, are extinguished. It should be checked whether there are some gas leakages in the building. In the case of gas smell or hissing sound, the main gas valve should be closed since a pipe has most probably been broken.

Fig.35. Leakage of gas

Check the electricity lines

If some wires are broken or damaged, the power should be switched off at the main breaker switch.

Be careful and away from walls and chimneys constructed of bricks, if there are any in the office building. As mentioned in the first part of this manual, brick walls are the most vulnerable elements that are the first to suffer damage during an earthquake. Situated on the roof of a building, chimneys constructed of bricks are the most vulnerable elements and the first to collapse during an earthquake.

STEP 7

Once all the employees meet at a safe place, continue to follow the other instructions anticipated with this plan.

The first day after an earthquake

Once you are out at the anticipated safe spot, the first thing you should do is make contact with your family. Presently, contacts are easily made since it is assumed that you and your family have mobile telephones. In the first minutes of the earthquake, do not use your mobile telephone since you will contribute to the blockage of the telephone lines. This will enable the functioning of the telephone lines for emergency situations. Use your mobile telephone to send an SMS message or e-mail.

Fig. 36.Pakistani office workers speak on their mobile phones on the street after an earthquake in Karachi on September 24, 2013.

Fig. 37.Use of mobile phones for SMS message

Inform yourself about the earthquake by entering the application for FM radio on your smart phone or turn your portable radio on.

The first week after an earthquake

The crisis management plan anticipates as faster as possible beginning of the operation of offices after an occurred earthquake. Therefore, it should, first of all, be evaluated whether a building is damaged and whether it is sufficiently safe for the employees to return to work. Such a decision cannot be made by the employees since the evaluation of the safety of the structure should be made by a professional, i.e., an expert in earthquake engineering, if possible. The expert will assess whether there are damages to the building and will recommend repairs, if necessary. The plan should read a pre-appointed expert in this field.

It is not difficult for an expert to assess the conditions of a structure. A structure may not suffer any damage even under strong earthquakes. In that case, the expert will say that the building can be occupied immediately.

A structure may have visible damage that can be on the structure itself or on the bearing elements only. If the damage is not on the structure, the expert will say again that the building is safe and that it can be occupied. If the occupation of the building is urgent, the expert will assess whether future aftershocks may cause additional damage to elements and whether these damages can cause injuries or not. If there is no such a danger, the building can be occupied immediately, while minor repairs can be done later.

If the expert evaluates that the damages are on the bearing elements, the expert will recommend that the building is unsafe necessitating repair and therefore cannot be occupied. This is the worst scenario that should be anticipated with the disaster preparedness plan. In this case, the plan should also anticipate how the EBRD office in the respective country will continue to work.

If the building is safe, continue to apply the disaster preparedness plan

Prior to making a decision as to the return of the employees to their working places, damaged installations, if any, should be repaired. The functioning of all the equipment should be checked, as well. It is very important to check the electronic devices, particularly the computers. The return of fallen objects to their proper places should be done by the employees themselves. The clearing of the debris is the last task prior to the beginning of the work.