EARTHQUAKE RISK REDUCTION CENTER

KASAN, BHAKTAPUR

By:

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of the requirements for the

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DEPARTMENT OF ARCHITECTURE

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Abstract :

Disasters are uncalled for, both natural and man-made disaster impose threat on human life and resources. They are uncertain and the scale at which they occur can't be predicted but one thing that can be done in case of disaster is that we can be prepared for them which will reduce the impact they have.

Earthquake is the violating shaking of the earth plates to release the trapped energy in those plates. Due to the geographical variation of the earth, some regions on earth are prone to earthquake more than other regions. In case of Nepal, we can see devastating effects that different earthquakes have had in the past. Nepal will always be prone to earthquake with the threat of major earthquake occurring once in every hundred years.

Nepal faces has a huge challenge regarding disaster management , even though a major earthquake occurs only after a certain duration the country experiences earthquake of small magnitude in short period of time. Although, there many government as well as non-governmental organization working for disaster preparedness the recent earthquake exposed the vulnerability of the government regarding disaster management. Lack of proper planning resulted in a chaotic situation during the earthquake with no provision for emergency treatment and rehabilitation of the victims. A proper mechanism and pre-planned activities could have lessened the impact of the earthquake and helped the country recover from the damage.

Disaster risk reduction center for earthquake can play a crucial role when it comes to preparedness for earthquake and reducing its impact when it occurs. The various programs that are run in a disaster risk reduction center focuses on research about these disaster, their cause, effects and ways by which it can be minimized. Other programs like training block which contributes for earthquake preparedness and provide knowledge on how to act under a emergency situation and warehouse is related with storage of essential materials which might be important in case of a crisis. A disaster risk reduction is mainly focused on the pre-disaster management which includes policies for awareness and preparedness beforehand.

Declaration:

I declare that this thesis project, “EarthQuake Risk Reduction Center” is based on my own findings and research. I’ve mentioned the sources wherever necessary which I have used as a reference in this project. My works is a result of my own ideas and inspirations and is not included in any other publication or previous application for a degree.

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Contents

List of Figures:

Chapter 1. Introduction

1.1 Introduction to Disaster

Any incident, whether man-made or natural, that poses a threat to human life and the environment is considered a disaster. Depending on the severity and duration of the incident, it could result in serious harm. Risk can become disastrous if it is not controlled or dealt with beforehand. When a hazard results in injuries, fatalities, and destruction of property and infrastructure, it becomes a disaster. A disaster can be divided into

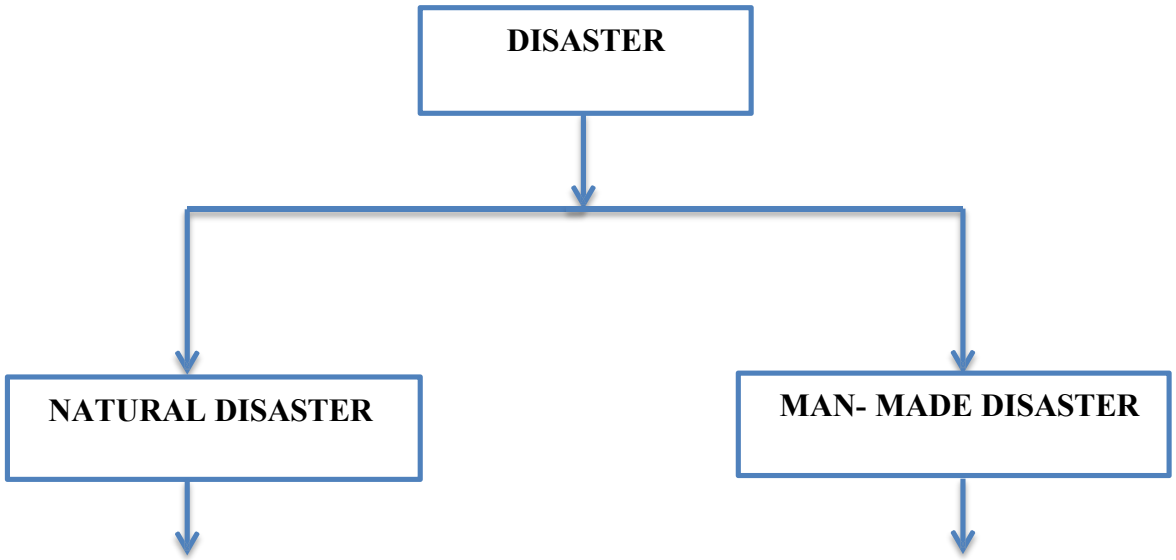
A. Natural disaster:

Natural Disaster can be defined as the disasters which occur due to natural phenomenon like shaking of the earth plates, geographical imbalance etc. which causes loss in life and properties and are more dangerous than man-made disasters.

B. Man-made disaster:

Man- made disasters can be defined as the disasters which are caused by the action of human beings like fire breakouts, nuclear explosion, transport accidents etc.

Figure 1. 1 After Hurricane Mathew hit the United States



1. Earthquake
2. Flood
3. Tsunami
4. Typhoon
5. Hurricane
6. Drought
7. Volcanic Eruption

1. Fire
2. Epidemic
3. War
4. Industrial Accidents
5. Building Collapse
6. Nuclear Explosion

1.2 Disaster in Global Context

Our collective historical record has been shaped and guided by the disruptions caused by disasters. In a moment, entire civilizations have been destroyed. Epidemics and pandemics have often caused significant population declines; during the fourteenth-century bubonic plague (Black Plague) pandemic, for example, the number of people in Europe was reduced by up to 50%. Theorists have even gone so far as to propose that floods, famines, earthquakes, tsunamis, and other widespread calamities, rather than their adversaries, were ultimately responsible for the downfall of many of the great civilizations throughout history, such as the Mayans, the Norse, the Minoans, and the Old Egyptian Empire.

Table 1–1 Selected Notable Disasters Throughout History

Disaster	Year	Number Killed
Mediterranean earthquake (Egypt and Syria)	1201	1,100,000
Shaanzi earthquake (China)	1556	830,000
Calcutta typhoon (India)	1737	300,000
Caribbean hurricane (Martinique, St. Eustatius, Barbados)	1780	22,000
Tamboro volcano (Indonesia)	1815	80,000
Influenza epidemic (world)	1917	20,000,000
Yangtze River flood (China)	1931	3,000,000
Famine (Russia)	1932	5,000,000
Bangladesh cyclone (Bangladesh)	1970	300,000
Tangshan earthquake (China)	1976	655,000

Source: St. Louis University, 1997; NBC News, 2004.

Figure 1. 2 Casualties due to disaster in different period of Human History

Earthquake

Introduction:

Earthquakes are the shaking, rolling or sudden shock of the earth's surface. They are the Earth's natural means of releasing stress. The stress is released as energy, which moves through the Earth in the form of waves, which we feel and call an earthquake. Earthquakes can be felt over large areas although they usually last less than one minute.
It generally occurs by collision between earth plates. Due to earthquake, other natural calamities like volcanic eruption, tsunami etc.

There are about 15 plates of about 100km thick along the surface of the earth that move continuously and slowly past each other the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free.

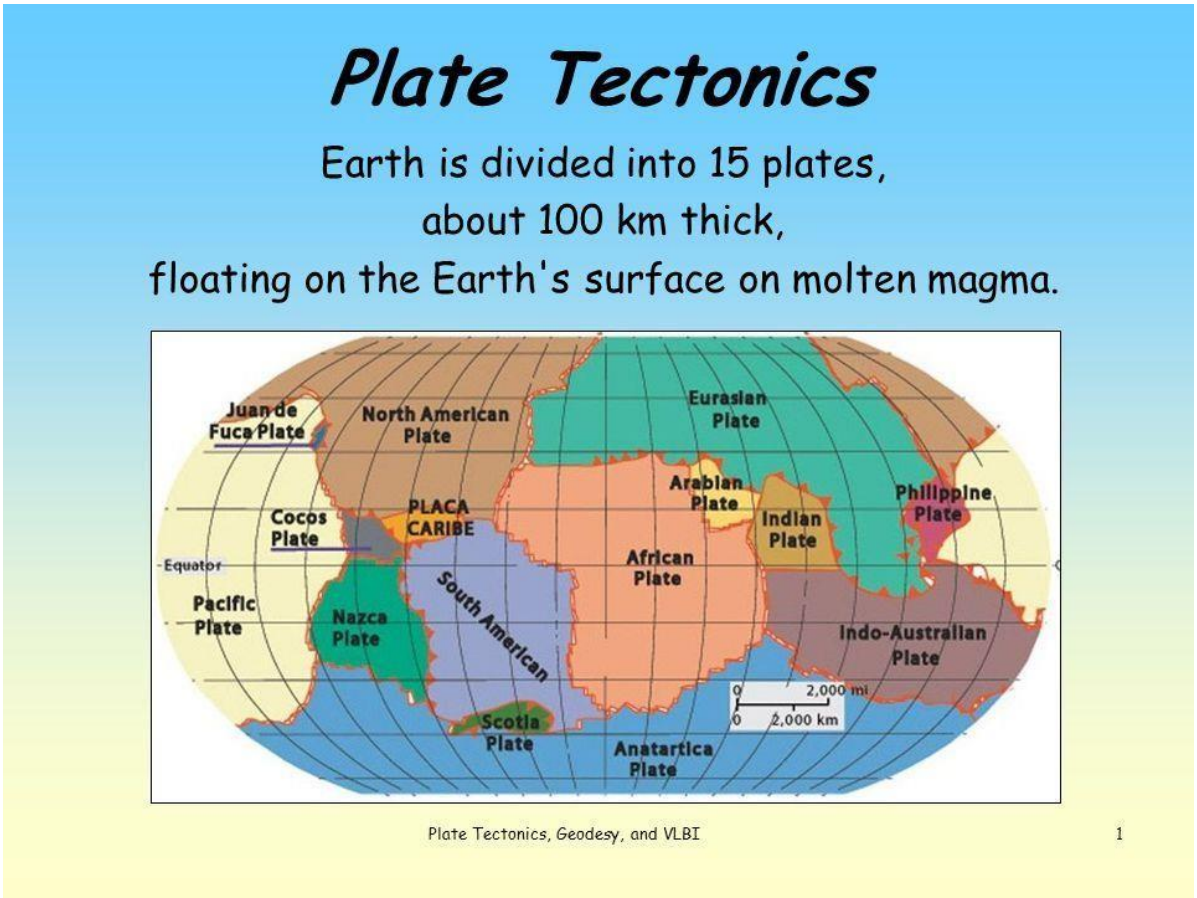


Figure 1. 3 Plates of Earth

Some Terminologies used in Earthquake

- **Hypocenter** is the point within the earth where an earthquake begins.
- An **Epicenter** is **t**he point directly above the focus on the earth's surface**.**
- The shock that is experienced before the major shock after an earthquake is known as **Foreshock.** These shocks are have less intensity that the main after shock. It is likely that we do not know about these foreshocks.
- **After shocks** are the repeated shocks experienced after the earthquake. These shocks can last for weeks, months and years after the earthquake. Normally, the bigger the earthquake the more number of aftershocks and for long duration might occur.
- Earthquakes are measured with the help of **Seismograph.**
- Earthquake is measured in **Richter** scale.

Figure 1. 4 Old Seismograph in National Seismological Center, Lainchour

History of Earthquake in Nepal :

Nepal has experienced several devastating earthquake in its history. The entire territory of Nepal lies in high seismic hazard zone. The country's high seismicity is related to the movement of tectonic plates along the Himalayas that has caused several active faults. A total of 92 active faults have been mapped throughout the country by the Seismic Hazard Mapping and Risk Assessment for Nepal carried out as part of the Building Code Development Project – 1992-1994 (MHPP, 2994). Earthquakes of various magnitudes occur almost every year and have caused heavy losses of lives.

Figure 1. 5 Dharahara after 1934 earthquake

The country has a long history of destructive earthquakes. In this century alone, over 11,000 people have lost their lives in four major earthquakes. A 1934 AD earthquake produced strong shaking in Kathmandu Valley, and destroyed 20 percent and damaged 40 percent of the valley's building stock (NSET, 1999). In Kathmandu itself, one quarter of all homes was destroyed. Many of the temples in Bhaktapur were destroyed as well. This earthquake was not an isolated event. Three earthquakes of similar size occurred in Kathmandu Valley in the 19th Century: in 1810, 1833, and 1866 AD.

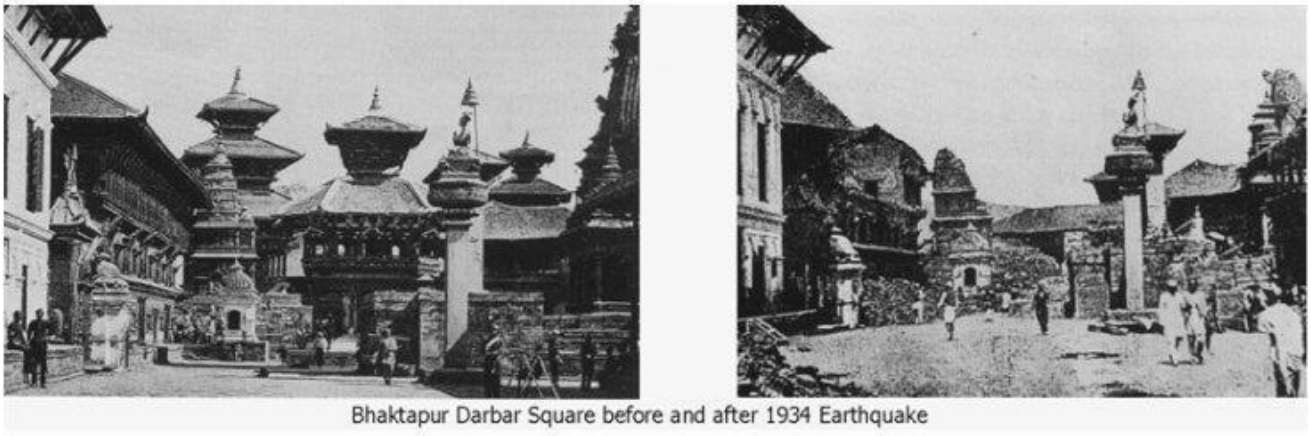


Figure 1. 6 Bhaktapur Durbar Square after 1934 earthquake

2015, Gorkha Earthquake

The rugged southern rim of the High Himalayan range in central Nepal was ravaged by the Gorkha earthquake on April 25, 2015, with a magnitude of M 7.8. Within the first forty-five days after the main shock, 553 earthquakes with a local magnitude of more than 4.0 occurred. Nearly 9,000 individuals lost their lives and nearly 22,000 were injured in the earthquake. April 25, 2015, became the worst day on Mount Everest in history when the earthquake caused an avalanche. In the Lang Tang Valley, another massive avalanche was caused by the earthquake, and 250 people were reported missing.

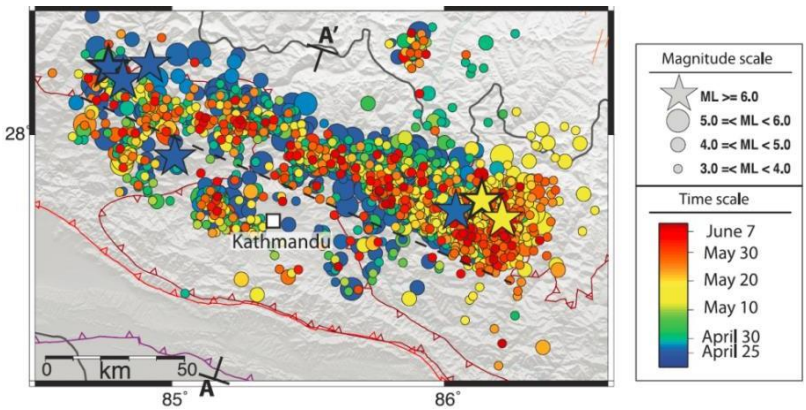


Figure 1. 7 Aftershock after the Gorkha Earthquake from April 25 to June 7

Source : National Seismological Center

Hundreds of thousands of people were made homeless with entire villages flattened, across many districts of the country. Centuries-old buildings were destroyed at UNESCO World Heritage Sites in the Kathmandu Valley, including some at the Kathmandu Durbar Square, the Patan Durbar Square, the Bhaktapur Durbar Square, the Changu Narayan Temple, the Boudhanath stupa and the Swayambhunath Stupa. Geophysicists and other experts had warned for decades that Nepal was vulnerable to a deadly earthquake, particularly because of its geology, urbanization, and architecture.

Figure 1. 8 Dharahara after the 2015 Earthquake

In Nepal, the earthquake left around 8,800 people dead and nearly three times as many injured. The fact that the majority of villagers were working outside when the earthquake struck may have reduced the number of fatalities in the rural areas.6,271 patients, including 1,700 from the aftershock on May 12, were still undergoing treatment as of May 15. There were around 3.5 million homeless persons.

The example of this earthquake shows that loss calculations for hypothetical likely future earthquakes can be reasonably reliable. In 2005, the expected numbers of fatalities due to a hypothetical scenario earthquake near Kathmandu for M8.1 was published. The fatalities at that time were estimated between 21,000 and 42,000. A M7.8 earthquake happened on 25 April 2015 near Kathmandu. It killed only about 10,000 people because it was Saturday and the children were not in the collapsing school buildings. The original estimate was correct within a factor of 2.5 and would have been exactly correct, had it not been for the lucky break children got due to Saturday being a holiday.

The Himalayan Times reported that as many as 20,000 foreign nationals may have been visiting Nepal at the time of the earthquake, although reports of foreign deaths were relatively low.

Casualties by country

Country	Deaths	Injuries	Ref.
Nepal	8,857	22,304	[6][59]
India	78	560	[60]
China	25	383	[61]
Bangladesh	4	200	[62]
Total	**8,964**	**23,447**	

Figure 1. 9 Casualties of the 2015 Earthquake

Source : https://en.wikipedia.org/wiki/April_2015_Nepal_earthquake

1.3 Disaster Management :

Disaster Management refers to managing of the all possible outcomes of a possible disaster by the means of Mitigation and Preparedness, Rescue and Relief and Response and Rehabilitation. The first two steps i.e. Mitigation and Preparedness are taken prior to any disaster. The level to which these steps are planned and executed can help reduce the impact of the disaster ultimately saving lives and properties. Rescue and Relief is done at the time of the disaster or once the disaster has occurred to save people who can be harmful situation after the disaster. The process of Rehabilitation includes activities which helps the people in leading a normal life again.

1.4 Disaster Risk Reduction

Disaster Risk Reduction (DRR) aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through the means of prevention.

Disasters often follow natural hazards. A disaster's severity depends on how much impact a

hazard has on society and the environment. The scale of the impact in turn depends on the choices we make for our lives and for our environment. These choices relate to how we grow our food, where and how we build our homes, what kind of government we have, how our financial system works and even what we teach in schools. Each decision and action makes us more vulnerable to disasters - or more resilient to them. Few methods for DRR:

A. Awareness Program

The risk of any disaster can be reduced by the means of awareness among the people regarding the threats opposed by the disaster and by the means of which itcan be tackled. If proper knowledge and awareness can be developed from the individual to the community and ultimately in the national level the impacts can be decreased.

B. Capacity Building

If we can increase the capacity of a community through surficial rescue training or first aid training, it can play a vital role in case of disaster. Every number of technical manpower who has even the slightest knowledge about disaster management can be the difference at the time of disaster.

C. **Institutionalization** :

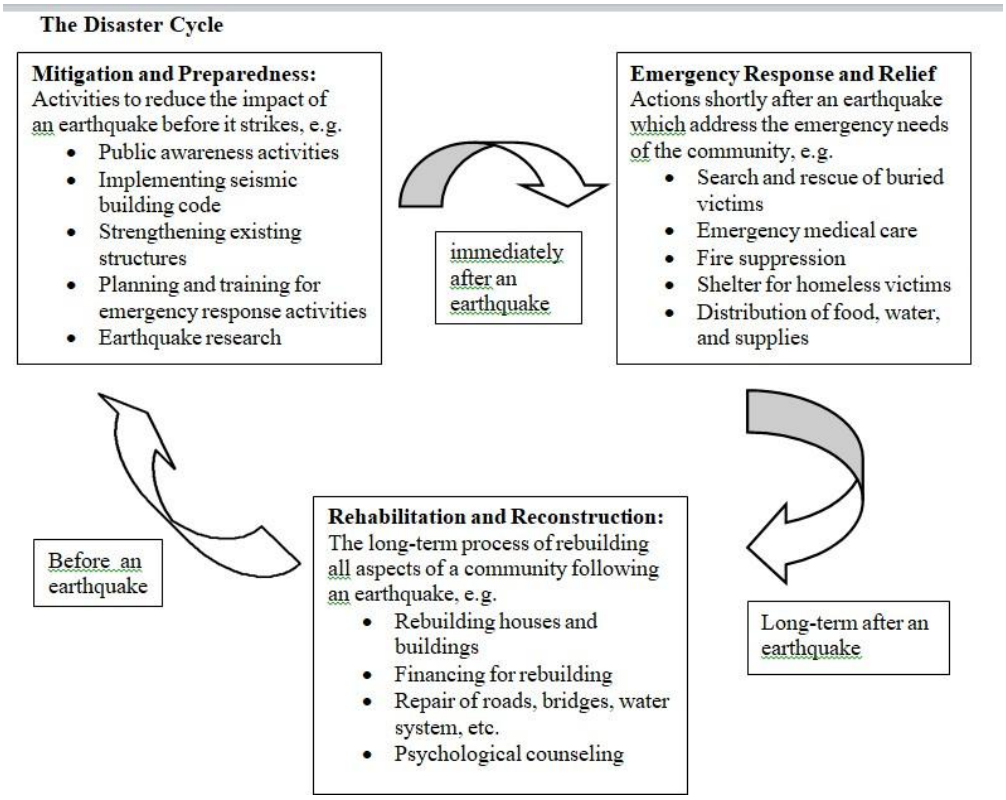
For proper disaster preparedness as well as for the proper response after a disaster has occurred, a proper body or system has to be established in order to reduce the risk opposed by the disasters in human lives and property.

According to Mr. Khadka Oli, Communication Deparment Officer. In most of the developing countries

In cases of Earthquake:

- 80 % of death occurs due to building
- 8% death occurs due to lack of emergency rescue
- 8% death occurs due to lack of medical support
- 4% miscellenous

Hence, In this case **Disaster Risk Reduction** maybe related with Building Earthquake Resilient Buildings as it is accountable for maximum number of loss of lives and causalities .Things like emergency response and medical support come after in the priority in DRR as for those aspects to come in to play we must insure the structures people live in can not only withstands the disasters but also function after the disaster. It may vary depending upon countries and the history of disaster occurred in order to decide about the things to be prioritized for eliminating the risk opposed by disasters.



fgigure 1. 10 Disaster Management Cycle

Community Resilience for Disaster Risk Reduction :

The goal of mitigation initiatives is to either stop hazards from becoming catastrophes in the first place or lessen the impact of disasters when they do happen. Because it concentrates on long-term strategies for lowering or eliminating risk, the mitigation phase is distinct from the other phases. The primary goal of personal mitigation is to identify and steer clear of needless risks. This involves evaluating potential hazards to one's own or one's family's health as well as to one's own property.

Avoiding purchasing real estate in high-risk areas, such as flood plains, landslide regions, or areas experiencing subsidence, is an example of personal non-structural mitigation. Before a hazard occurs, homeowners might not be aware that their house is at risk. On the other hand, risk assessment surveys can be carried out by professionals. Insurance that covers the most common hazards that have been identified arevolunteers, and the access to knowledge and resources necessary which includes search and rescue training operation, capacity building, awareness program etc.

According to Mr. Khadka Oli, Communication Deparment Officer. In the 2015 Gorakha

Earthquake : (Based on Recorded Data)

- **40 teams from all over the world saved 19 people, the situation were the harshest.**
- **Nepal security forces saved 2200 individuals**
- **Community save 22,000 individual**

The data mentioned above signifies the importance of making a community disaster resilient as it is the first form help in case of disaster. If plans and policies are made to train the people in a community regarding technical as well as vocational education regarding light search and rescue operation it can be crucial to save causalities during the time of disaster . Organizations like Red Cross also have started formulating plan regarding building community resilience for DRR after recognizing it is one of the effective means by which disaster effects can be limited.

Mitigation :

Mitigation efforts attempt to prevent hazards from developing into disasters altogether, or to reduce the effects of disasters when they occur. The mitigation phase differs from the other phases because it focuses on long-term measures for reducing or eliminating risk Personal mitigation is mainly about knowing and avoiding unnecessary risks. This includes an assessment of possible risks to personal/family health and to personal property.

An example of personal non-structural mitigation would be to avoid buying property that is exposed to hazards, e.g. in a flood plain, in areas of subsidence or landslides. Homeowners may not be aware of their home being exposed to a hazard until it strikes. However, specialists can be hired to conduct riskassessment surveys. Insurance covering the most prominent identified risks are a common measure.

Preparedness :

In the preparedness phase, emergency managers develop plans of action for when the disaster strikes. Common preparedness measures include:

- The Communication plans
- Development and practice of multi-agency coordination and incident command
- Proper maintenance and training of emergency services
- Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans
- Stockpiling, inventory, and maintenance of supplies and equipment

An emergency operations center (EOC) in conjunction with a region-wide emergency management competence is an effective preparedness measure. Establishing a volunteer response capability among civilian populations is another preparedness step. Volunteers are frequently

placed on the outskirts of a disaster unless they are a recognized and established volunteer group with standards and training, as volunteer response is not necessarily as predictable and plannable as professional response.

Personal preparedness, or planning, is focused on getting ready for actions to be performed in the case of a disaster, as opposed to mitigation efforts, which are meant to stop a disaster from happening. There are numerous ways to be prepared. Shelter building, warning devices, backup life-line utilities (such as water, sewage, and electricity), and practicing an evacuation strategy are a few examples.Two simple measures prepare you for either sitting out the event or evacuating. For evacuation, a disaster supplies kit should be prepared and for sheltering purposes a stockpile of supplies.

Response:

The combination of an emergency operations center (EOC) with a region-wide emergency management competence is an effective preparedness tool. Developing a civilian population's capacity for volunteer reaction is another preparedness step. Unless they are a well-established and reputable volunteer group with standards and training, volunteers are frequently deployed on the outskirts of an emergency because their response is not necessarily as predictable and scheduleable as professional response.
Contrary to mitigation efforts, which try to stop a disaster from happening, personal preparedness efforts focus on planning—that is, getting ready for what to do in the case of a disaster. There are several types of preparedness measures. Examples include building shelters, installing warning systems, preparing an evacuation plan, and having backup life-line utilities (such as water, sanitation, and electricity) avilable..

Chapter 2. Context of Nepal

2.1 Disaster in Context of Nepal

2.1.1 Disaster Management in Nepal

Due to its geophysical structure, high peaks, slopes, geology, fluctuating climate, active tectonic processes, unplanned settlement, growing population, poor economic situation, and low literacy rate, Nepal is vulnerable to a wide range of natural calamities. Other significant barriers to managing natural disasters in Nepal include the absence of modern technology, resource limitations, a lack of technical personnel, a lack of public awareness, the country's remote, rural, and challenging geophysical situation, and a lack of coordination amongst agencies involved in disaster management.

Nepal has come to understand the significance of catastrophe risk reduction and management over time. It appears that the 2015 Gorkha Earthquake served as the much-needed wake-up call for theGovernment
.The Government has put forward the Disaster Risk Reduction Policy 2074 which emphasizes on the importance of disaster management. The policy also focused on including disaster management courses in the school and university curriculum and various types of programs are to be launched

in order to raise the public awareness.

According to the Disaster Relief Act 1982, the organizational structure for disaster Management.

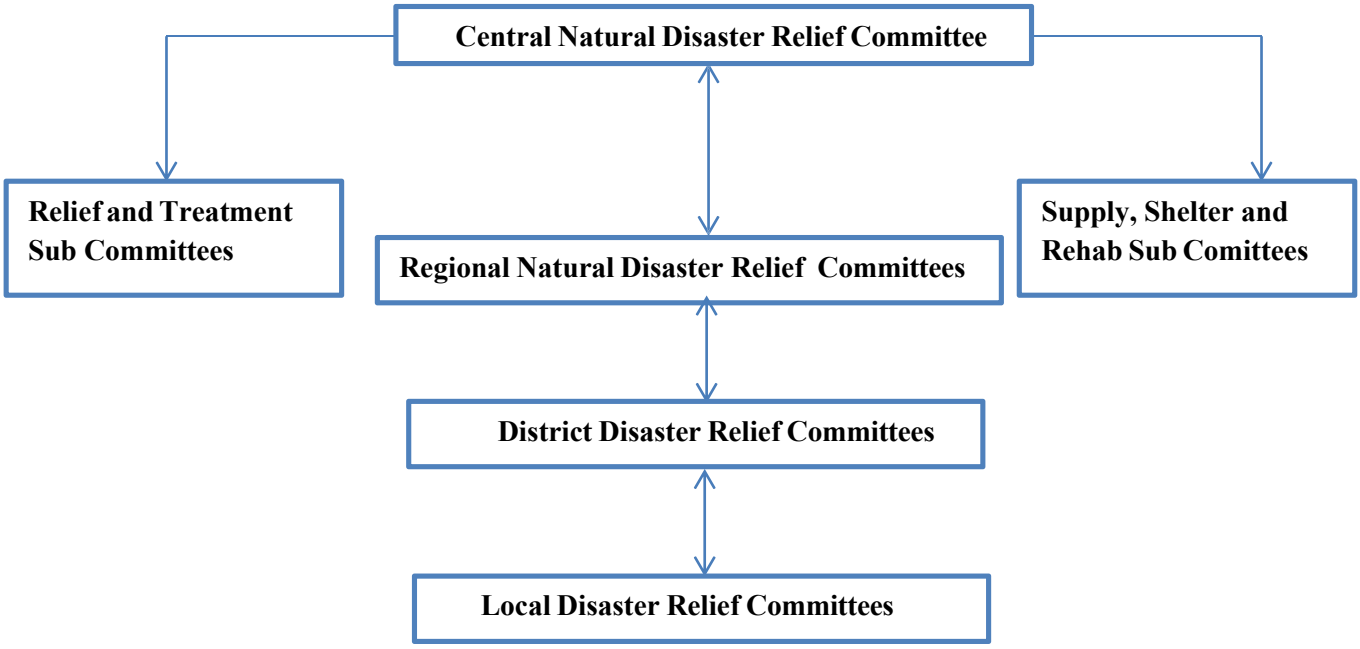


fig 2. 1 National Institutions for Natural Disaster Management

2.1.2 National Commission for Disaster Risk Management (NCDRM)

The prime minister chairs the NCDRM. Ex officio, the Leader of the Opposition is the Commission's Deputy Chairperson. A minimum of two representatives from Civil Society, the Chief of the Army Staff, the Inspector General of Police, the Inspector General of the Armed Police, the Ministers of Communication, Defense, Home Affairs, Foreign Affairs, Finance, Education, and Social Welfare, as well as any other reputable individual chosen or co-opted by the Chairperson, may be considered additional members.

The NCDRM has the following functions:

• Endorse national policies on disaster risk management

• Approve the National DRM Plan, sectoral plans for DRM, and the national programs

for the reduction of specific natural hazards.

• Arrange for, and oversee, the provision of funds for disaster risk reduction,

Preparedness, response and recovery measures, and

The operating arm of the NCDRM will be the National Authority for Disaster Risk

Management (NADRM), which is described below.

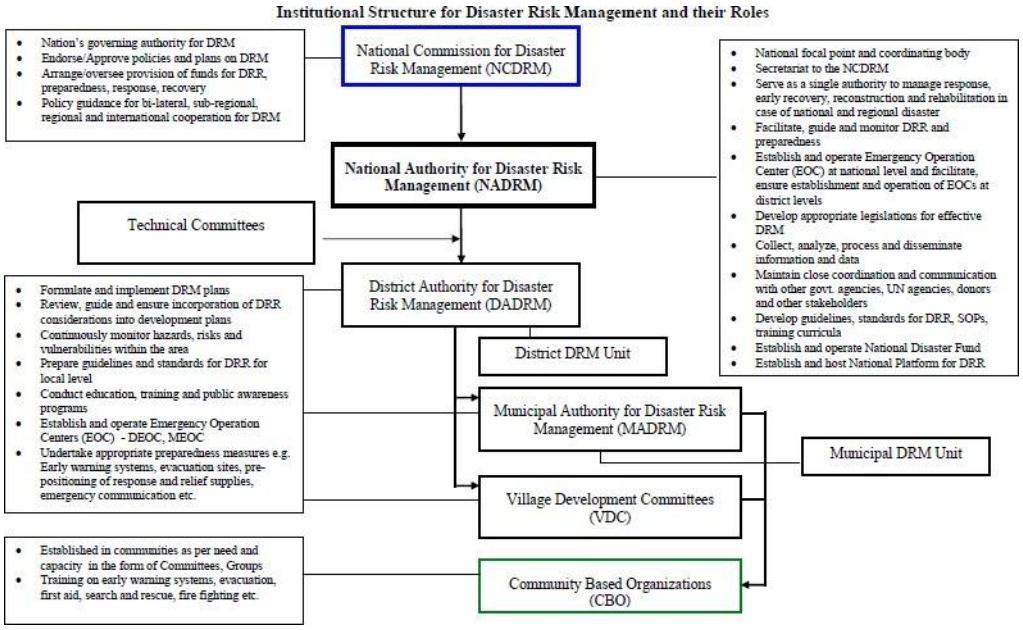


Fig 2. 2 : Institutional Structure for Disaster Risk Management

Source : National Strategy for Disaster Risk Management in Nepal,2008, Final Draft

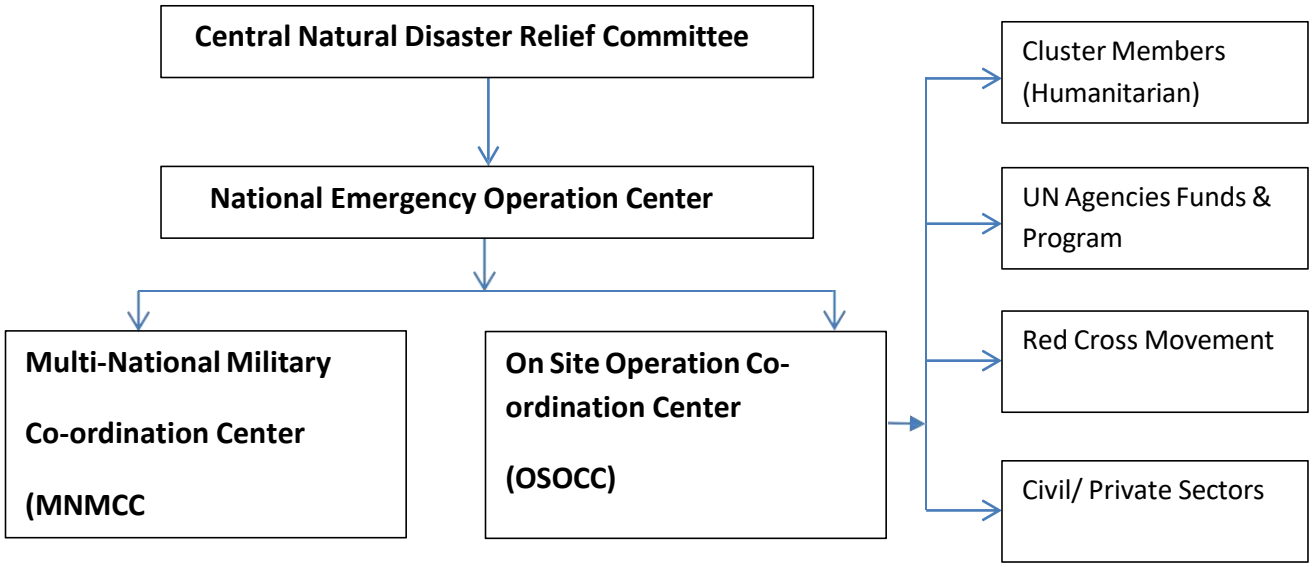


Fig 2. 3: Co-ordination mechanism between International and National Actors

2.1.3 Disaster Risk Reduction Policy 2074

Background :

Nepal is prone to natural disasters. Disasters such as floods, landslides, lightning, traffic

accidents, and other man-made or natural epidemics cause a significant number of fatalities in Nepal each year. Nepal's topography makes it vulnerable to earthquakes, which have historically caused significant damage. Both human casualties and economic losses were caused by the Gorkha earthquake of 2072, the flood, and the landslide that happened in 2071 and 2074.

In terms of disaster risk reduction, the Nepali government has proposed a number of measures and regulations. These regulations include the Global Warming Act of 2067, the National Disaster Management Act of 2066, the Disaster and Natural Calimities Act of 2039, and the Building Bye Laws of 2055. The Disaster Risk Reduction Act and the Local Governance Act were released by the government in 2074. Theestablishment National Body, State Body and Local Body has been some important organization included in the The Disaster Risk Reduction and Management Act 2074 .

Vision :

The long term goal of this policy is to ensure safety from different disaster and to contribute for long-term of the country.

Goal :

To reduce the effect caused by disaster on different sectors like agriculture, trade, water supply, road , health care etc and uplift these sectors for increasing the economy of the country.

Policy :

1. To include Disaster Risk subject in school and high school level curriculum.
2. By the help of media portals, ,make sure that the public awareness program reaches different levels of the country.
3. Regular Monitoring and Measurement of Natural and Man-Made Disaster.
4. Developing disaster risk accounting system and identifying the effected group and helping them.
5. **To establish National Disaster Risk Reduction, Research and Training Center for increase the capacity in terms of Disaster Risk study and research , disaster prevention, preparedness, search and rescue, rescue and rehabilitation**
6. To establish Union, State and Local level committee and increase the capacity in disaster management.
7. Establishing and Develop National Disaster Risk Reduction and Management Authority, Volunteering Agencies, Flying Squad, Fire Brigade, Emergency Units and Emergency Health Services

Source : drrportal.gov.np

2.1.4 National Disaster Risk Reduction Action Plan (2017 – 2030 A.D) :

Background :

In the present constitution of Nepal, the topic Disaster Risk Reduction and Management has been divided in to different parts. In part 4 and section 51 (छ), under the Natural means and source conservation and use related policy, control water born disaster and the natural disaster risk reduction has been mentioned. Similarly, constitution schedule 8 states that natural or man-made disaster preparedness, rescue and relief program is the right of union and state body. The schedule 9 states that disaster management is the right of the union, state and local body.

Chapter 5 : Priority Received Area -2, State and Local Level Disaster Risk Official Method Strengthening

5.1 Organizational Structure Establishment and Strengthening

1.For the purpose of Disaster Risk Reduction and Management establishing National Risk Reduction and Management Authority

2. Developing State and Local level Disaster Risk Management Committee and Organizational Structure

3. Establishing Co-ordination Mechanism in state and local level for the implementation of Disaster Risk Reduction and Management Policy

4. Establishing funds and inspection committee for existing infrastructures like private buildings,school,hospital,stadium,theatres,shopping mall etc which are not in good condition

5. Establishing Disaster Management Committee in schools and hospitals

6. Establishing Emergency Work Operation Center in Every State and Local Level

7. Establishing Policy and Work Operation System in State and Local Level for Emergency Fund and Food Bank

Source : drrportal.gov.np

2.2 Aims and Objectives of the Project:

1. To gain in-depth knowledge about disaster, its management and act as a center for research.
2. To bring all the disaster related bodies under a same roof.
3. To identify the problems and recommend contextual solutions.
4. To conduct an awareness program as a precaution for the prevention and control of the possible events of the natural disaster.
5. To enhance coordination between the government and non-government organizations in disaster preparedness, prevention, mitigation, rescue, relief, and rehabilitation.
6. To work for the protection of the environment in order to mitigate natural disasters
7. To rehabilitate the victims of the disaster, provide all the necessary post disaster facilities.

2.3 Project Justification:

I believe that a project like the Disaster Risk Reduction Center is urgently needed in a nation like Nepal that is vulnerable to many types of calamities. Although there are many different kinds of disasters, earthquakes are the primary focus of my study. Our memories of the 2015 earthquake's devastation and destruction are still vivid. I am inclined to use this as my thesis project for a number of reasons. One is my personal experience of poor management during the 2015 earthquake in terms of preparation for the disaster, prompt response and relief, and a lack of urgency in the recovery process. After taking the Disaster Risk Management course in the eighth semester, my interest in this subject increased.after being aware about the governmental bodies related to Disaster Management and how fragmented they are regarding the working process.

Fig 2. 4 : House destroyed after 2015 earthquake in Kathmandu

In the present context, as time has passed people seem to have forgotten or ignored the damage caused by the 2015 earthquake although we are still experiencing aftershock of the Gorkha Earthquake. The violation of the building by-laws and preparedness for earthquake of that scale does not seem to be in consideration of neither the public nor the government. Hence, Nepal being a country which is always under a threat of some kind of natural disaster which results in large amount of casualties and destruction I think a Disaster Risk Reduction Center can play an important role in the mitigation and preparedness aspect of Disaster as well as play a crucial role during the time of disaster.

During the process of case study, I got a chance to interact with different personals working for different organization which are involved in Disaster Management namely

Red Cross, NSET these interactions were very informative as well as challenging as I was dealing with people who had been working in this field for a long time. They expressed their views regarding the necessity of local level disaster management bodies or authorities for disaster preparedness . Through the interaction I also came to know about the new "Community Resilience" model organizations like Red Cross and NSET are planning to bring in implementation.

According to Mr. Khadka Oli, Communication Deparment Officer. In the 2015 Gorkha Earthquake : (Based on Recorded Data)

- **40 teams from all over the world saved 19 people, the situation were the harshest.**
- **Nepal security forces saved 2200 individuals**
- **Community save 22,000 individual**

These organizations have realized the important role a community plays at the time of earthquake .Local level training and awareness programs might play a crucial role in decreasing the effect caused by earthquakes. So, the proposed Disaster Risk Reduction Center which will focus on developing skills in the local level through the community resilience model .

The different action plans put forward by the government for disaster management also supports and focus on establishing national as well as state level bodies for disaster management .

According to the **Disaster Risk Reduction Policy 2074 :**

Policy :

8. To include Disaster Risk subject in school and high school level curriculum.
9. By the help of media portals, ,make sure that the public awareness program reaches different levels of the country.
10. Regular Monitoring and Measurement of Natural and Man-Made Disaster.
11. Developing disaster risk accounting system and identifying the effected group and helping them.
12. **To establish National Disaster Risk Reduction, Research and Training Center for increase the capacity in terms of Disaster Risk study and research , disaster prevention, preparedness, search and rescue, rescue and rehabilitation**
13. To establish Union, State and Local level committee and increase the capacity in disaster management.
14. Establishing and Develop National Disaster Risk Reduction and Management Authority, Volunteering Agencies, Flying Squad, Fire Brigade, Emergency Units and Emergency

Health Services

Different governmental as well as non-governmental bodies working in the field of disaster have focused on the importance of national and local level disaster management bodies and communities for effective DRR. Considering the past events and threat opposed by the earthquake in future I feel the need of Disaster Risk Reduction is justified.

2.4 Methodology :

Chapter 3. Literature Review :

For my thesis project, Disaster Risk Management and Training center for Earthquake and Fire Hazard, based on my research and analysis I've included following programs :

1. **Administration Block**
2. **Museum**
3. **Multipurpose Hall**
4. **Training Block**
5. **Research Center**
6. **Warehouse**
7. **Accommodation Block**

"According to Mr. Khadka Oli, Communication Deparment Officer. In most of the developing countries

In cases of Earthquake:

- 80 % of death occurs due to building."

Hence , I feel it is important to include ways or measures for ensuring building safety from earthquakes and fire hazard. So, that will also be a part of my literature review. Also, I feel design considerations for differently abled people is important in the present context hence that is also included my literature review.

3.1 Museum :

A museum is an institution that conserves or collects of artifacts and other objects of artistic, cultural, historical, or scientific importance. Museums are public spaces where people can view important historical artifacts. Museums can be grand as well as small in scale there are numbers of museums located around the world which have varying aims, ranging from serving researchers and specialists to serving the general public.

There are many types of museums :

1. Art museums,
2. Natural history museums
3. Science museums
4. War museums
5. Children's

Functions :

1. Collection of book and other research materials
2. Conservation of important documents and books
3. Acts as a display center
4. Acts as a community center

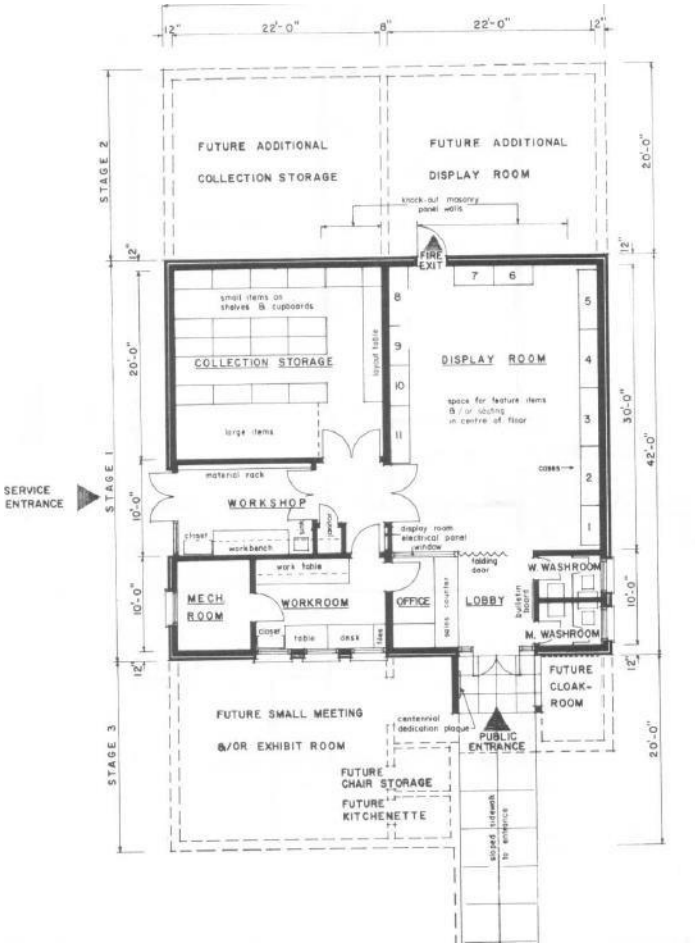


Fig 3. 1 : Space organization of a small library

The space constituents of a museum can be :

1. Reception
2. Display Room
3. Public and Private Areas
4. Reserve Collection Storage
5. Office Spaces

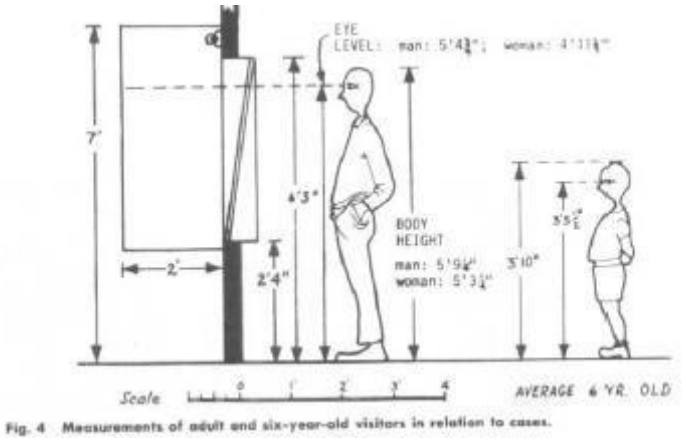


Fig. 4 Measurements of adult and six-year-old visitors in relation to cases.

Fig 3. 2: Eye levels with regards to age group in consideration with display items

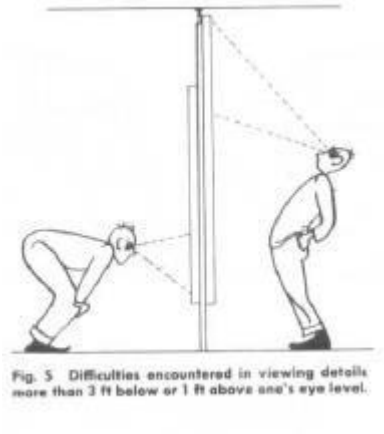


Fig. 5 Difficulties encountered in viewing details more than 3 ft below or 1 ft above one's eye level.

Fig 3. 3 :Visual discomfort, above and below the eye level

When it comes to a museum, it is very necessary to ensure the proper arrangement and location of display items. Items should be managed in such a way that it can be easily view with considering the visual limitations of a user and appropriate to ensure the items safety.

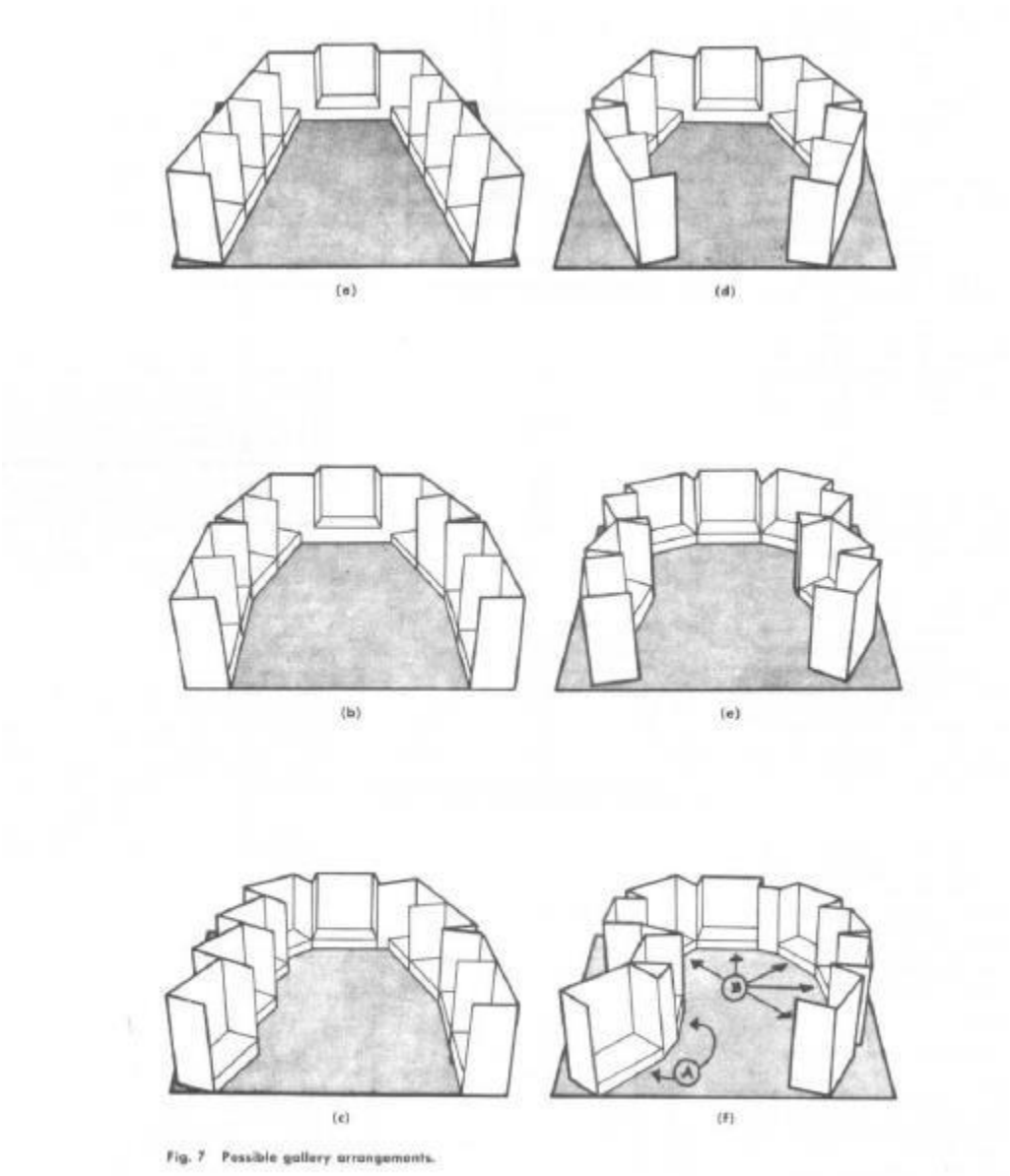


Fig. 7 Possible gallery arrangements.

Fig 3. 4 : Arrangement of gallery items

3.2 Library :

Libraries perform a range of functions in society. There are different types of library prevalent all around the world. It is a great place to acquire necessary knowledge or information regarding any specific topic, different types of libraries have different functions. Some of them are :

A. Academic Library :

An academic library obtains, collects and stores literature for education and research purposes and are open to general public.

B. Public Library

A public library provides ommunities with a wide choice of more genreral information which a person might be able to borrow by depositing his\her personal information. In case of these libraries being located in a commnuity, these libraries might hold information and documents regarding the history of that particular place which in itself holds a high importance.

C. National Library

This are large libraries compared to a academic or public library. They collect and store literature and hostorical documentation of the country and are opent to the public.

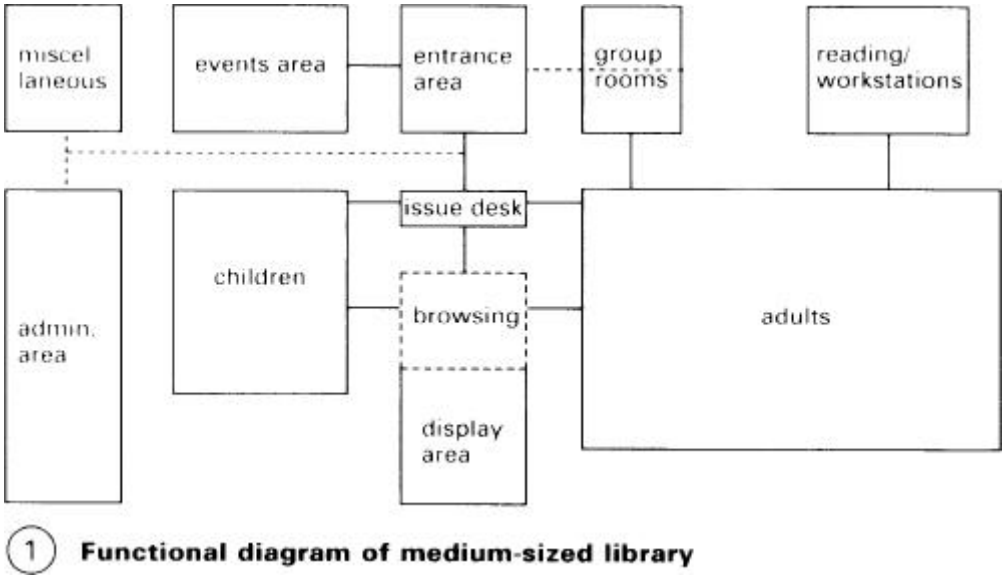


Fig 3. 5 : General Layout of Library

The spaces included in a typical library maybe :

1. Children's Reading Room
2. Adult Reading Room
3. Reception
4. Control Room

5. Store
6. Toilets

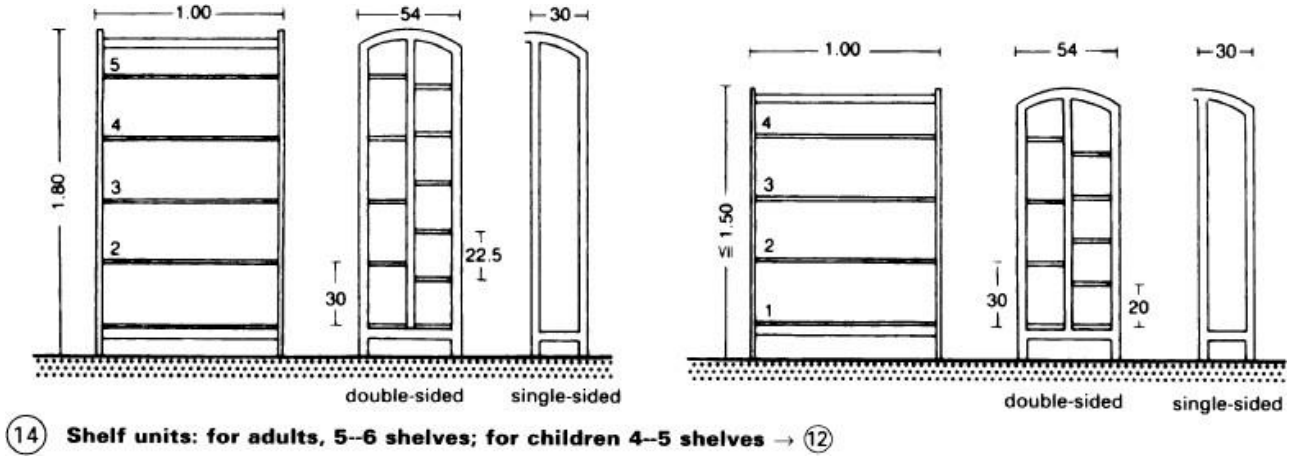


Fig 3. 6 : Different shelves dimension for different age group

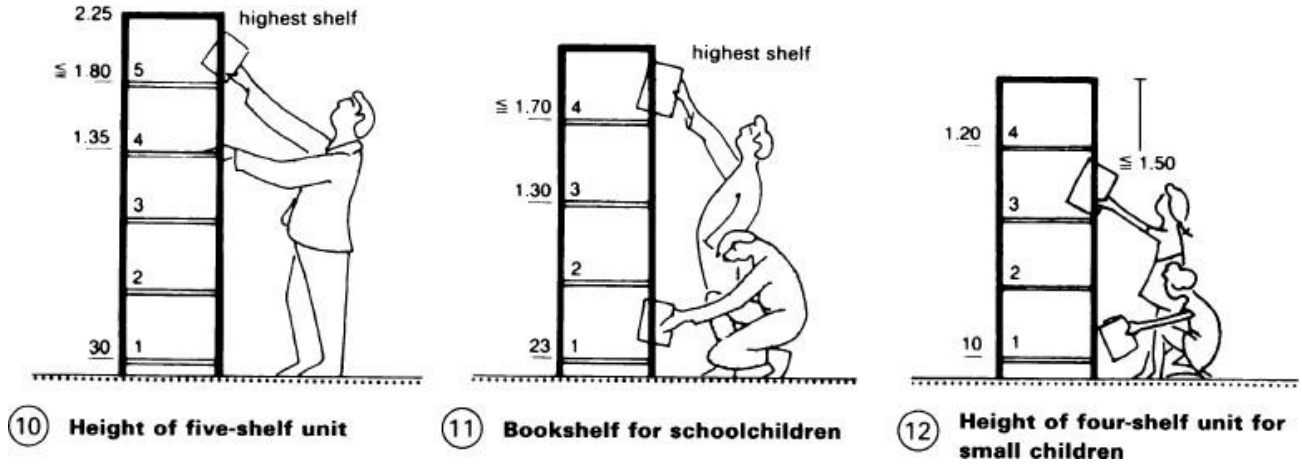


Fig 3. 7 : Height of different shelves unit

It is important that the books in libraries are easily accessible to all age groups which can be achieved through separation of adult and children section.

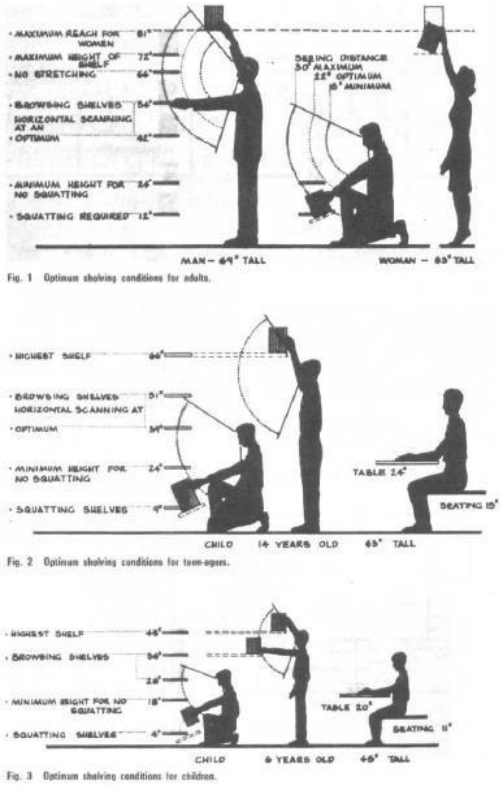


Fig 3. 8 : Different shelving conditions

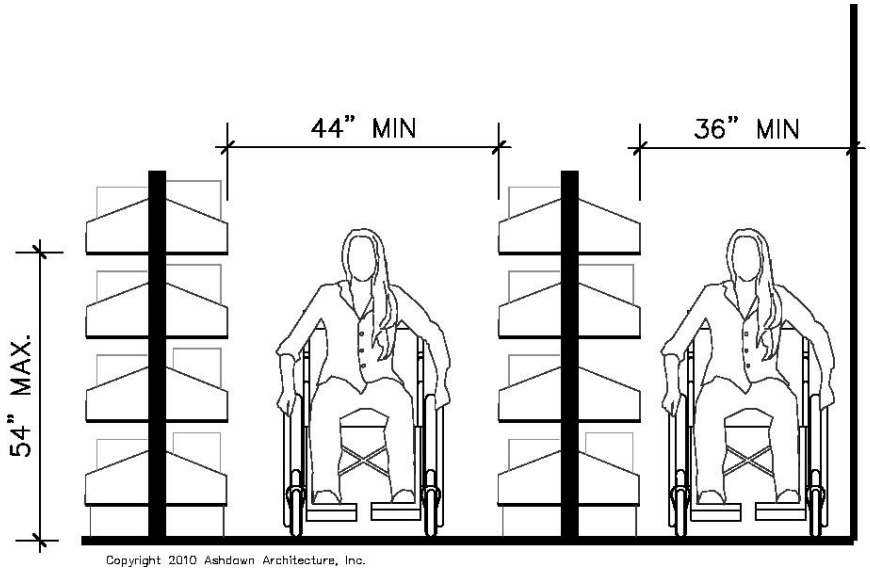


Fig 3. 9 : Considerations for differently abled

3.3 Warehouse:

A warehouse is a commercial building for storage of goods. Warehouses are used by manufacturers, importers, exporters, wholesalers, transport businesses, customs, etc. They are usually large plain buildings in industrial areas of cities, towns and villages.

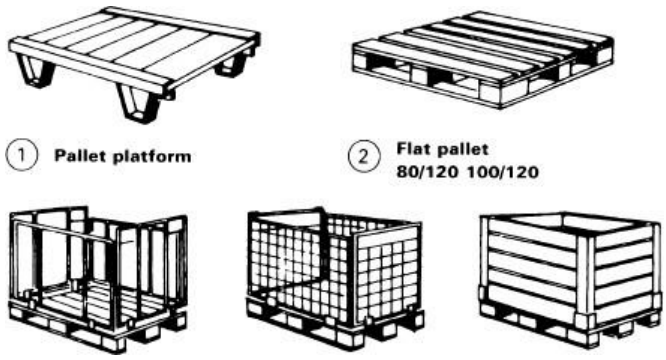


Fig 3. 10 : Platforms and container used in warehouses

Some warehouses are completely automated, and require only operators to work and handle the entire task. Pallets and product move on a system of automated conveyors, cranes and automated storage and retrieval systems coordinated by programmable logic controllers and computers running logistics automation software. These systems are often installed in refrigerated warehouses where temperatures are kept very cold to keep product from spoiling, especially in electronics warehouses that require specific temperatures to avoid damaging parts, and also where land is expensive, as automated storage systems can use vertical space efficiently. These high-bay storage areas are often more than 10 meters (33 feet) high, with some over 20 meters (65 feet) high.

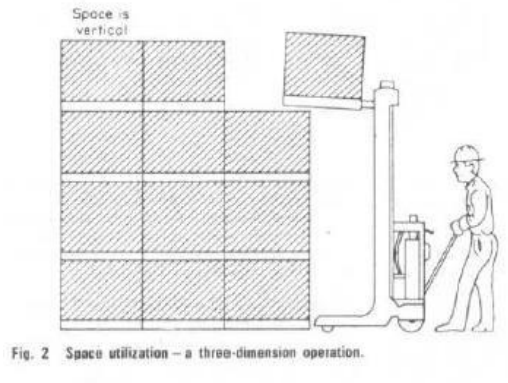


Fig 3. 11 : Stacking of goods

Other warehouses are manually operated and workers store and arrange items in a systemic way so that later the position of the item can be easily identified.

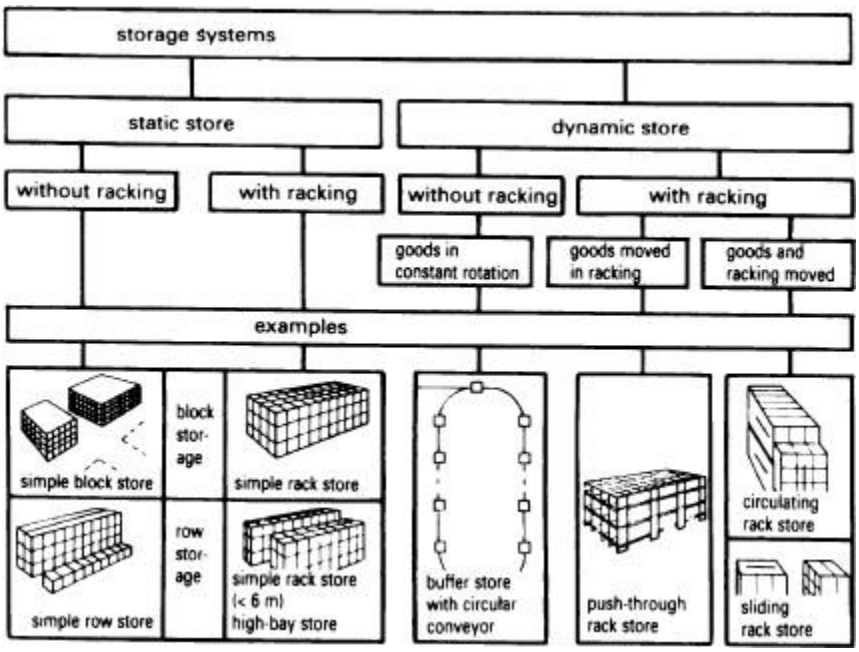


Fig 3. 12 : Classification of storage system in warehouse

According to Legacy Supply Chain Services , Here are 8 things that should be included on warehouse safety checklist in order to ensure maximum workplace safety compliance and maintain a safe warehouse environment:

1. Post safety expectations

Warehouse supervisors should ensure all safety expectations are posted clearly in close proximity to all equipment—forklifts, hydraulic dollies, hand jacks, etc. Doing so assures that employees have constant visual reminders of the inherent dangers of using such equipment, and the safety precautions they should take to avoid injury.

2. Set minimum safety standards

Setting clear minimum safety standards reinforces the expectation that safety is always the priority. This could be something as simple as requiring anyone who enters the warehouse environment to use protective eyewear and/or hard hats.

3. Create periodic pop quizzes

Periodically testing employees on their knowledge of workplace safety can go a long way toward creating a safety-conscious warehouse team. Delegating pop quiz responsibilities to a rotating crew of various levels of management will keep your workforce on its toes.

4. Conduct safety sweeps

Daily, weekly, or monthly safety sweeps allow you to troubleshoot potential safety hazards within your warehouse operation. Using your warehouse safety checklist, walk around your warehouse to ensure all floors are free of slip and trip hazards, all walkways are free of stray cords, liquids and any other potential safety hazard.

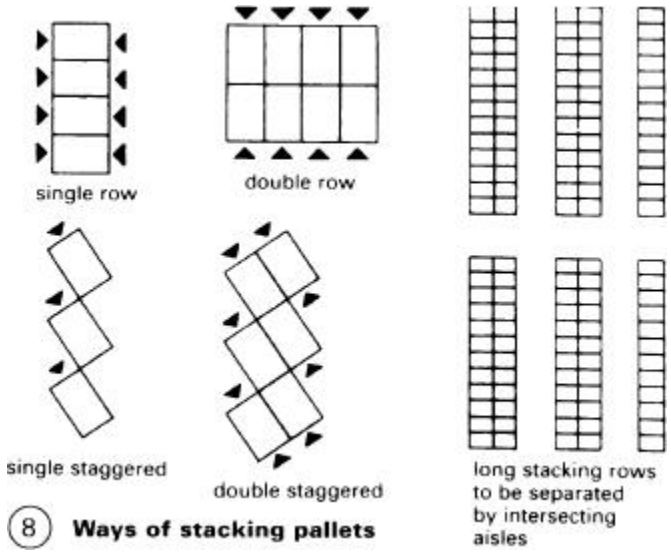


Fig 3. 13 : Ways of Stacking Pallets

5. Provide training

Schedule periodic training sessions to educate and refresh your employees about how to ensure consistent workplace safety practices. It can help to incentivize these meetings with breakfast or lunch, and be sure to make it interactive to promote participation.

6. Reward workplace safety

Encourage employees to report their colleagues recognizing a specific workplace safety situation in which they excelled. Recognizing and rewarding this type of behavior will encourage your employees to follow the rules and establish safe habits.

7. Establish a Safety Committee

Establishing a Safety Committee within your warehouse environment will empower your employees to communicate about and follow through on potential workplace safety hazards or concerns. This committee could also serve as the oversight authority for any future training or refresher courses.

8. Ensure proper emergency signage

It's important for you employees to know how to get to the emergency exit, as well as where to find the closest eye wash station, first-aid kit or fire extinguisher. When seconds matter, making sure your employees can quickly locate safety equipment can mean the difference between a minor and major accident.

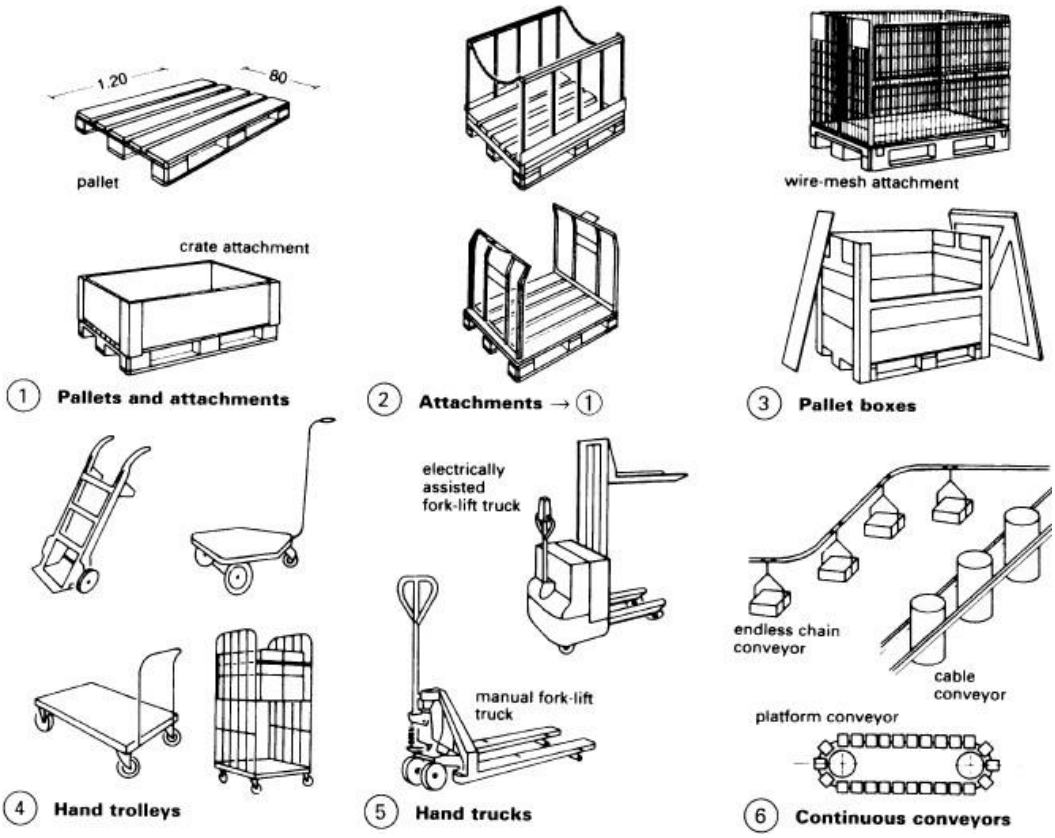


Fig 3. 14 : Handling Mediums in Warehouse

3.4 Office :

An office space should be provide comfort to all the staff members in order to extract maximum output from them. For this proper planning of the office space, furniture arrangement and proper light and sound ventilation system plays a crucial role.

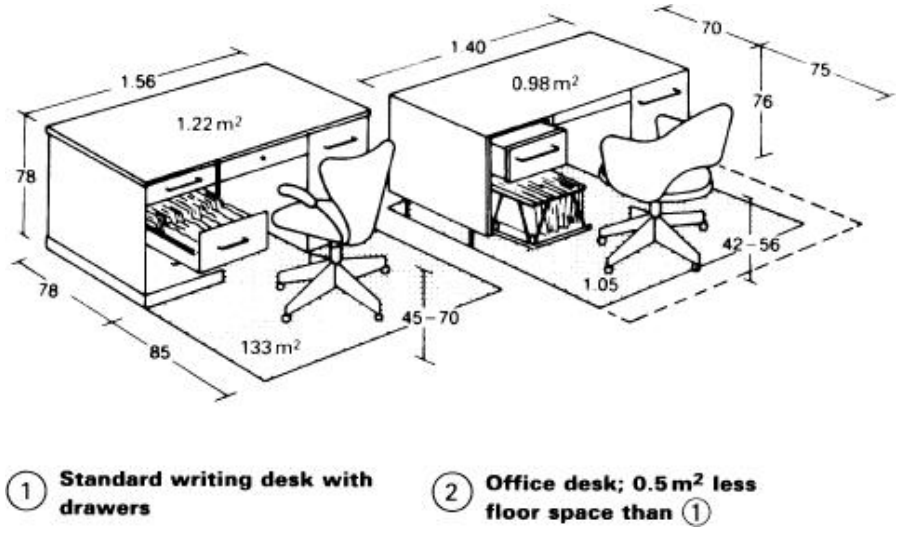


Fig 3. 15 : Standard measurement for office desks

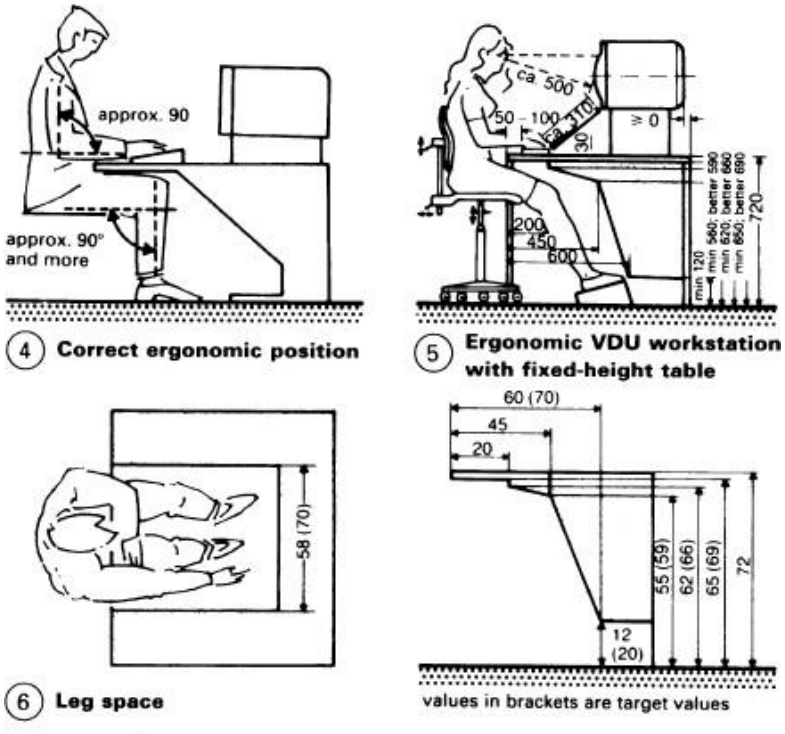
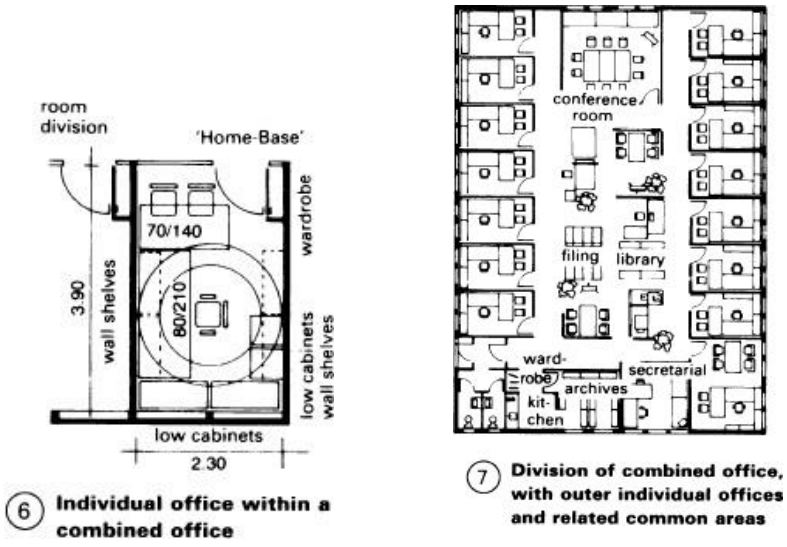


Fig 3. 16 : Correct positions and spaces

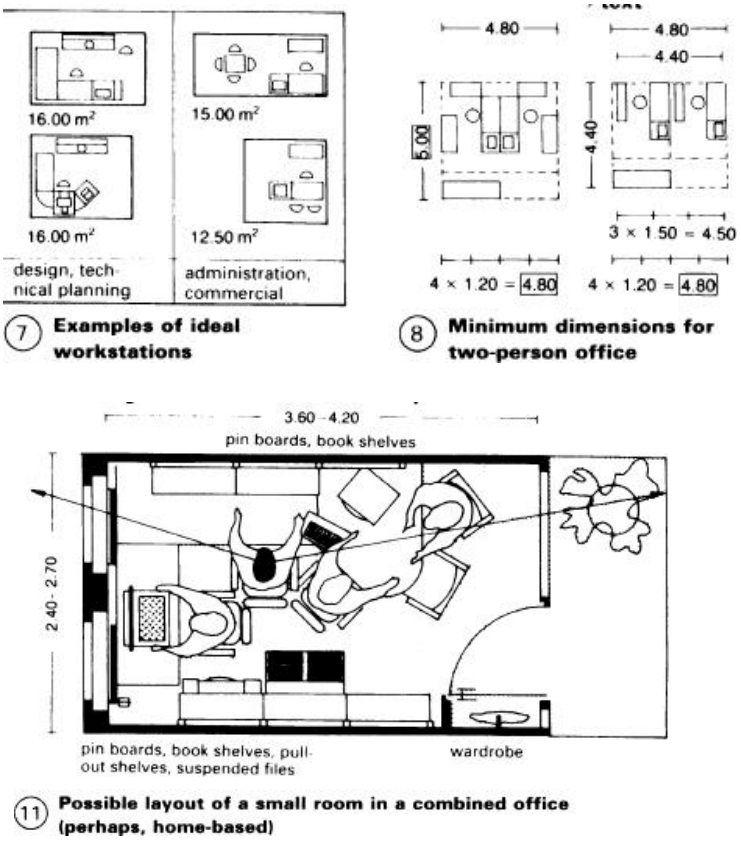


⑥ **Individual office within a combined office**

⑦ **Division of combined office, with outer individual offices and related common areas**

Fig 3. 17 : Division of combined office, with other individual offices

Some general office layouts :



⑦ **Examples of ideal workstations**

⑧ **Minimum dimensions for two-person office**

⑪ **Possible layout of a small room in a combined office (perhaps, home-based)**

Fig 3. 18 : Different office layout

3.5 Considerations for Differently Abled:

We are all physically disabled at some time in our lives. A child, a person with a broken leg, a parent with a pram, an elderly person, etc. are all disabled in one way or another. Those who remain healthy and able-bodied all their lives are few. As far as the built-up environment is concerned, it is important that it should be barrier-free and adapted to fulfill the needs of all people equally. As a matter of fact, the needs of the disabled coincide with the needs of the majority, and all people are at ease with them. As such, planning for the majority implies planning for people with varying abilities and disabilities.

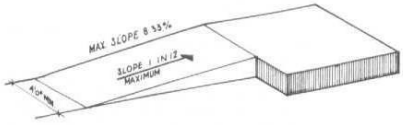


Fig. 1.

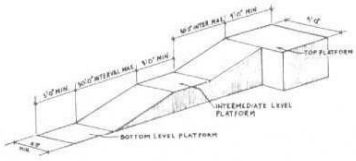


Fig. 2 Straight-run ramp.

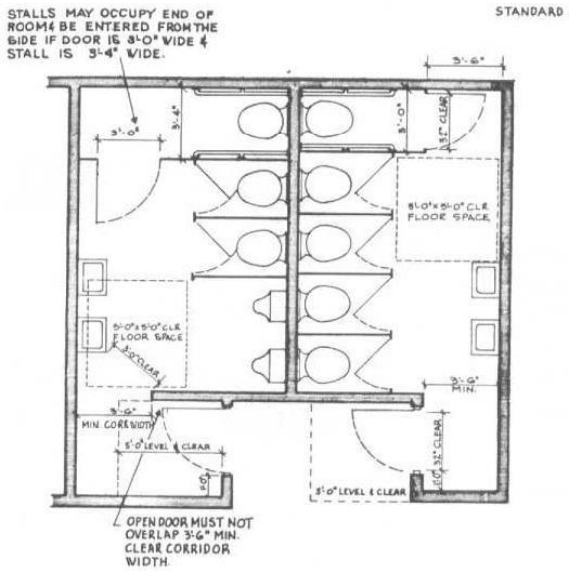


Fig. 2 Suggested entry and privacy screen arrangement to prevent door swinging out into the corridor. Doors may swing in or out.

Fig 3. 19 : Standard ramp and bathroom dimension for differently able

3.6 Earthquake Considerations for Safer Buildings:

In case of earthquakes, loss of life occurs not because of the earthquake itself but from the structures we built without earthquake considerations. Mostly, while building any kind of structure people tend to focus on the economic aspect rather than safety. Earthquake tests the structures we've built and in most cases it is the cause of high number of causalities and loss of life.

"**According to Mr. Khadka Oli, Communication Deparment Officer. In most of the developing countries in cases of Earthquake , 80 % of death occurs due to building" .**

Some of the measures with which a building can be earthquake resilient can be :

1. **Avoid building any kind of structures in areas with active faults .**

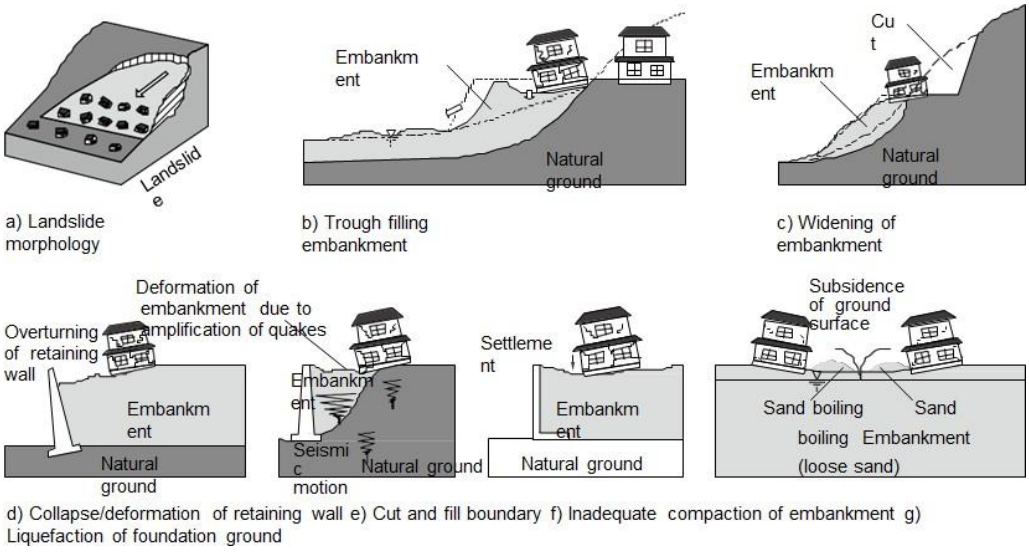


Fig 3. 21 : Foundation Grounds of different housing sites

1.1 Avoid any kind of hillside slopes as they are likely to slide down during an earthquake hence site with a stable slope should only be used for construction of structures.

1.2 The type of soil is also to be checked before constructing any structure on it. Loose sand and clay soil types are likely to be destroyed during an earthquake and can also be liquefied. Although these soils can be compacted it is only feasible for larger projects.

2. Planning and Design Aspects :

2.1 Symmetry: The building should be kept symmetrical about the x and the y axes. Asymmetry design leads to torsion during an earthquake and can be dangerous and case damage.

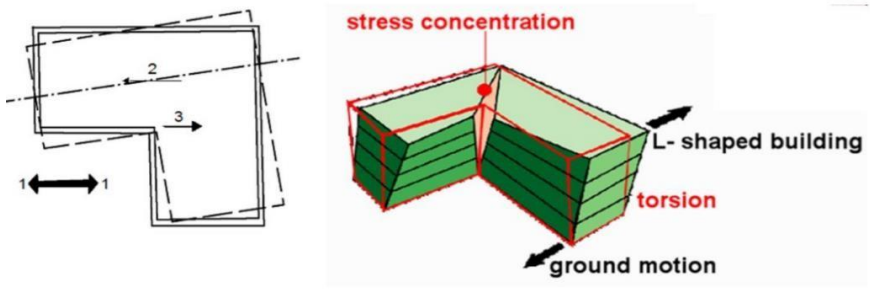


Fig 3. 22 : Torsion of un symmetrical plan

1.1 **Regularity :** In the case of earthquake, simple rectangular shapes building behave better than irregular shaped buildings with many projections. It is desirable for a block length to three times its width to eradicate any torsion effects being produced.

1.2 **Separation of blocks:** In case of earthquake, due to vigorous shaking of the earth surface there is collision between buildings. In order to prevent hammering and pounding of building blocks against each other it's advised to separate a building into different blocks to obtain regularity and symmetry.

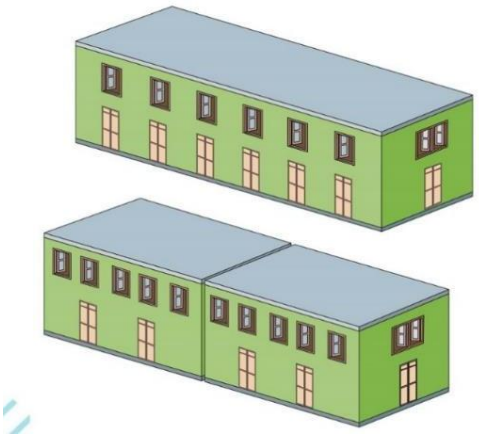


Fig 3. 23: Separating a large building into blocks

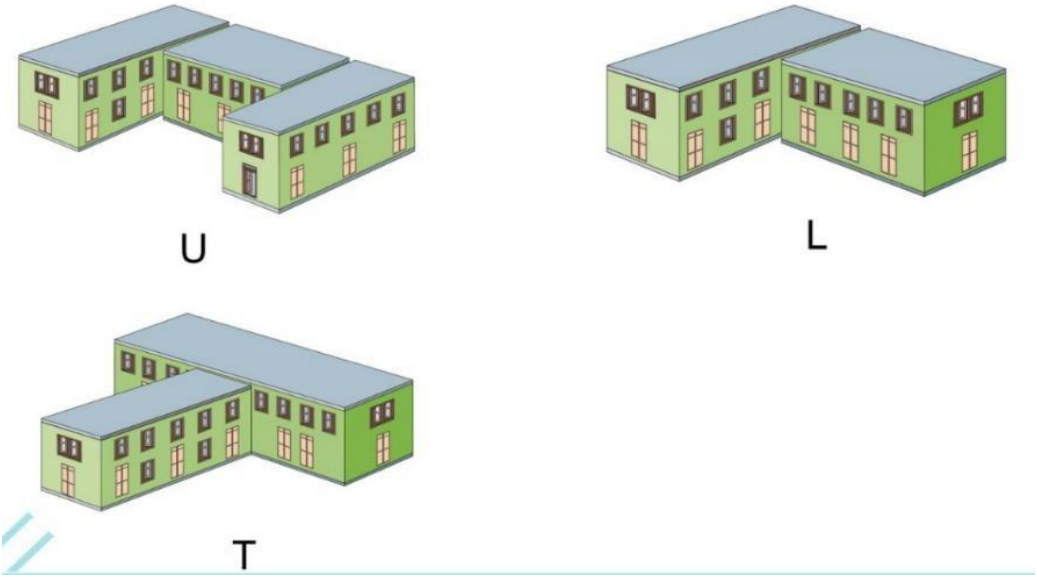


Fig 3. 24 : Shapes to avoided from an earthquake point of view

2.4 Enclosed Space: Buildings are enclosures which gives us space to perform various activities. In case of earthquake, a proper building with interconnected walls acts like a strong box against earthquake. Structurally it is advisable that rather creating a large room it is better to create many enclosed rooms.

2.5 Different buildings for different functions : Buildings are of various types and designed for various functions . Structural considerations are made according to the building type which is done so that the building doesn't fail. Hence, buildings should be used considering the particular functions they were built for so as to extract the maximum building life out of it.

Structural Considerations:

From NSET Publications:

1. **Regular shapes**
   - To prevent from torsion effects regular shapes are preferable in terms of earthquake resilience.
   - Irregular shaped and long structures to be separated into uniform blocks. The distance at which the blocks should be separated depends upon the height of the building; the distance should at least be 2.5 inch for a single floor, 5 inch for two floors and 7.5 inch for 3 floors.
   - The maximum pillar to pillar to distance should not exceed 14 feet 9 inch.
   - The verticality of a building also must be regular

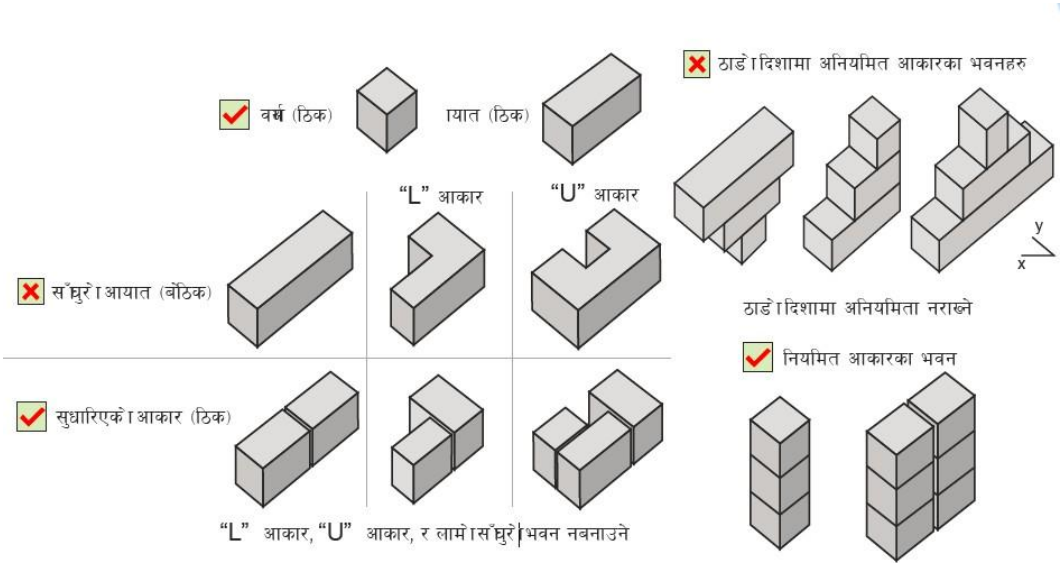


Fig 3. 25 : Right and wrong design regarding regularity and height of a building

2. Shape and size of a building :

- The pillars should be kept the same grid line as possible and every pillar should be connected by the beams.
- The beams should be supported on both sides by the pillars. Beam and beam joint should be avoided.
- Every pillar should be continued from the foundation
- Beams should be placed centrally on the pillars
- Beam level should be uniform in every floor and even in the foundation

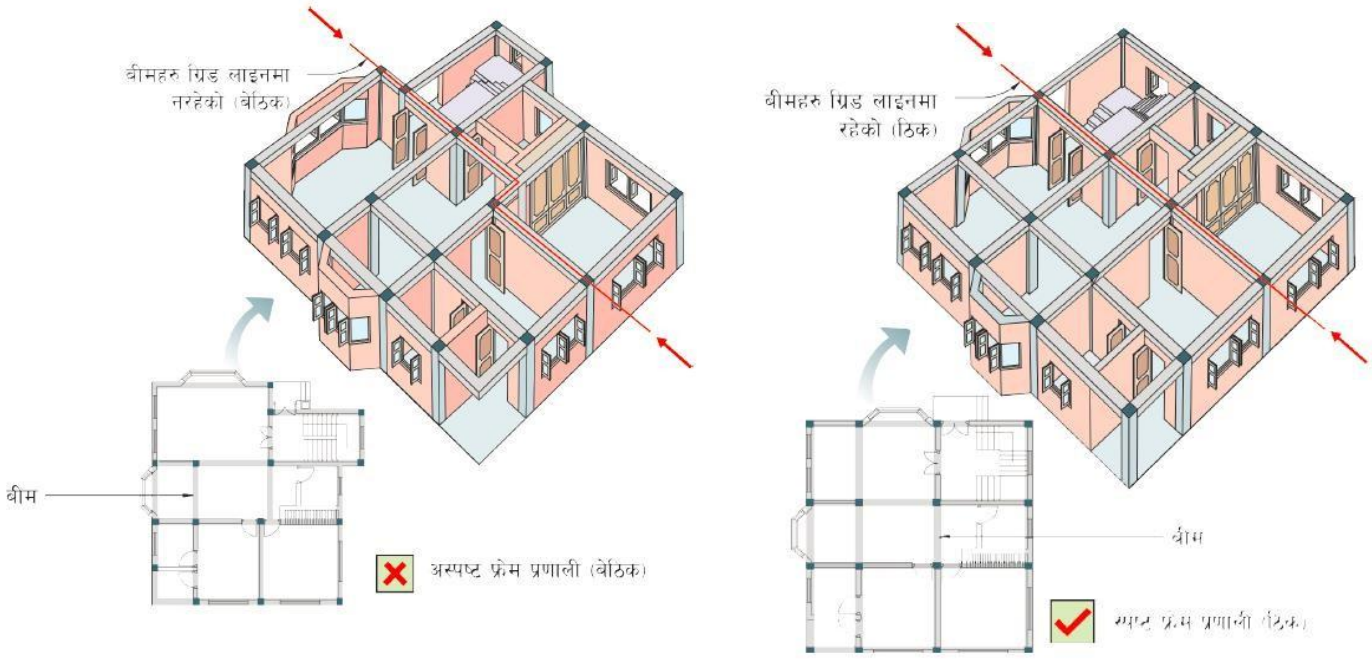


Fig 3. 26 : Not preferred and preferred beam plan

3. Strengthening the structure :

- The structures should at least have 2 bay in both the front and side
- If there is a condition of a single bay house, shear walls should be provided

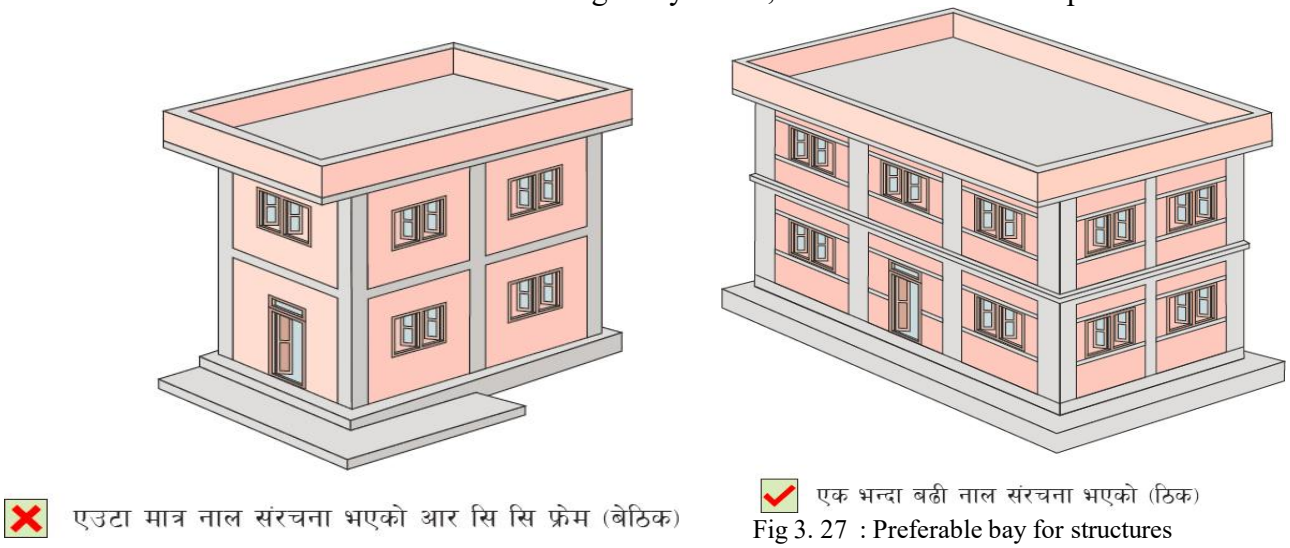


Fig 3. 27 : Preferable bay for structures

4. Pillars and foundation :

- The size of the pillar should at least be 12inch X 12 inch. Even if the building is one-storied this standard should be followed.
- The standard size of the pillar should not be compromised as pillar is the element

of a building which carries all the weight of the building and transmits it to the ground and gives the structure stability.

- In the plinth level, upper tie beam should be provided and in case of weak soil condition isolated footing should be provided with a lower tie beam cone

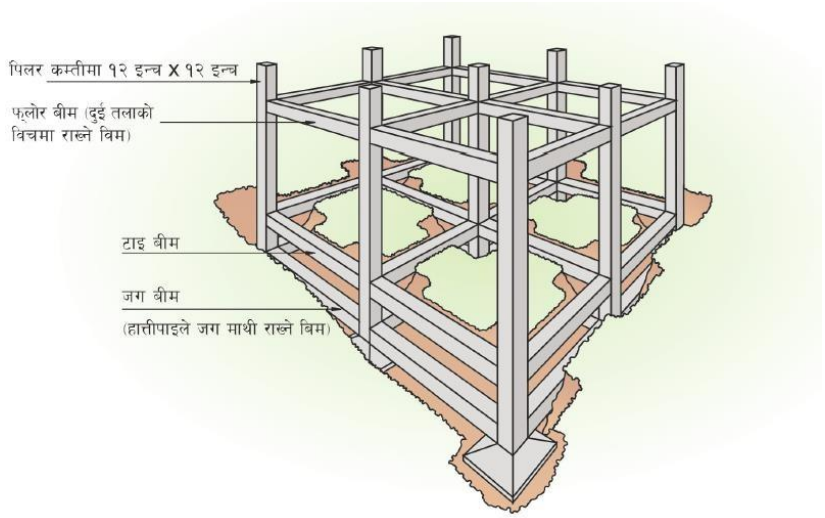


Fig 3. 28 : Structure consideration for pillars and foundation

5. Pillar and beam

- All the structural constituent should be have strong enough to support the building as a whole. But in comparison to the beam the pillars should be more strong as they carry the load of the building during the earthquake.

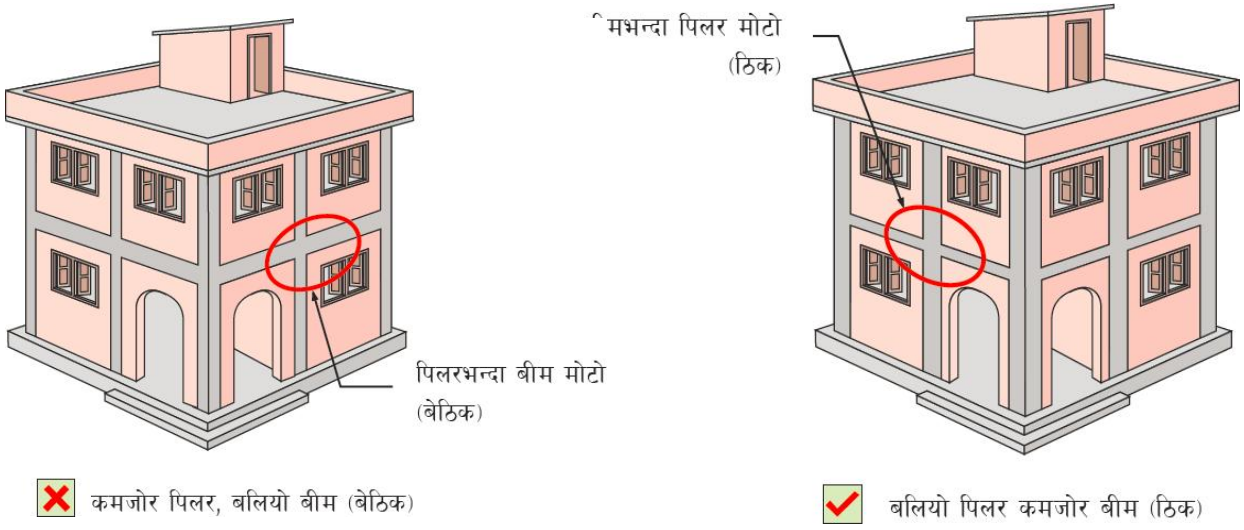


Fig 3. 29 :Pillar and beam sizes

6. **Basement Floors :**
   - The basement floor should not be kept vacant. Active use of basement floors is advised.
   - If the basement floor has to be kept open for the purpose of parking and shops the walls should be strengthen.
   - The pillar size of the basement floor can be increased or shear walls can be constructed for strengthening the basement floor as per the expert advise.
   -

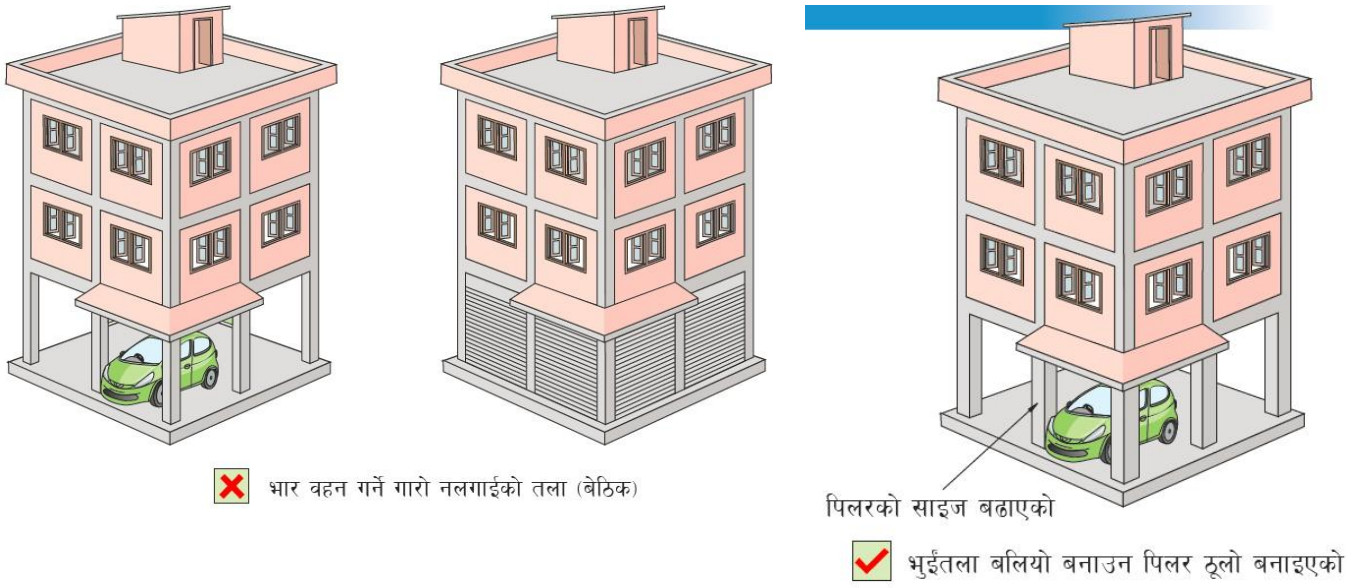


Fig 3. 30 : Considerations for basement floor

7. **Floor slab**
   - Maintain uniformity in the floor level.
   - Different floor levels should be avoided
   - Uniform slab level in floors

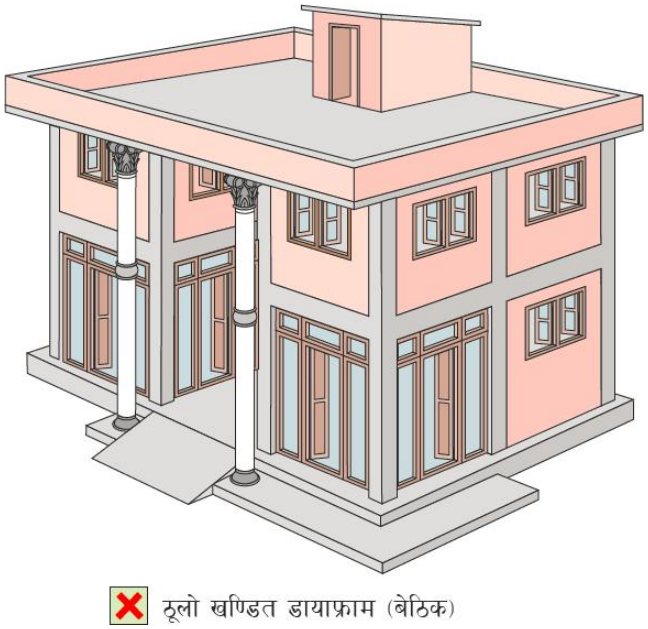


Fig 3. 31 : Considerations for floor level

8. Walls :

- Providing wall ties.
- The wall tie should be connected to pillars on each side and incase there is no pillars the wall tie should be joined to steel rod.
- The width of the wall tie should be equal to the thickness of the wall. The thickness of the wall tie should at least be 3 inch.

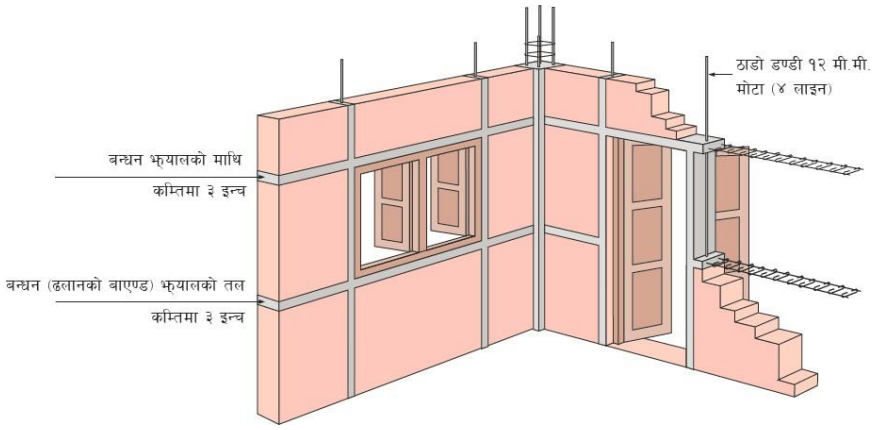


Fig 3. 32 : Considerations for Wall

9. Windows :

- The windows should be not placed close to the walls
- The windows should be placed at a distance of 2 feet from the wall

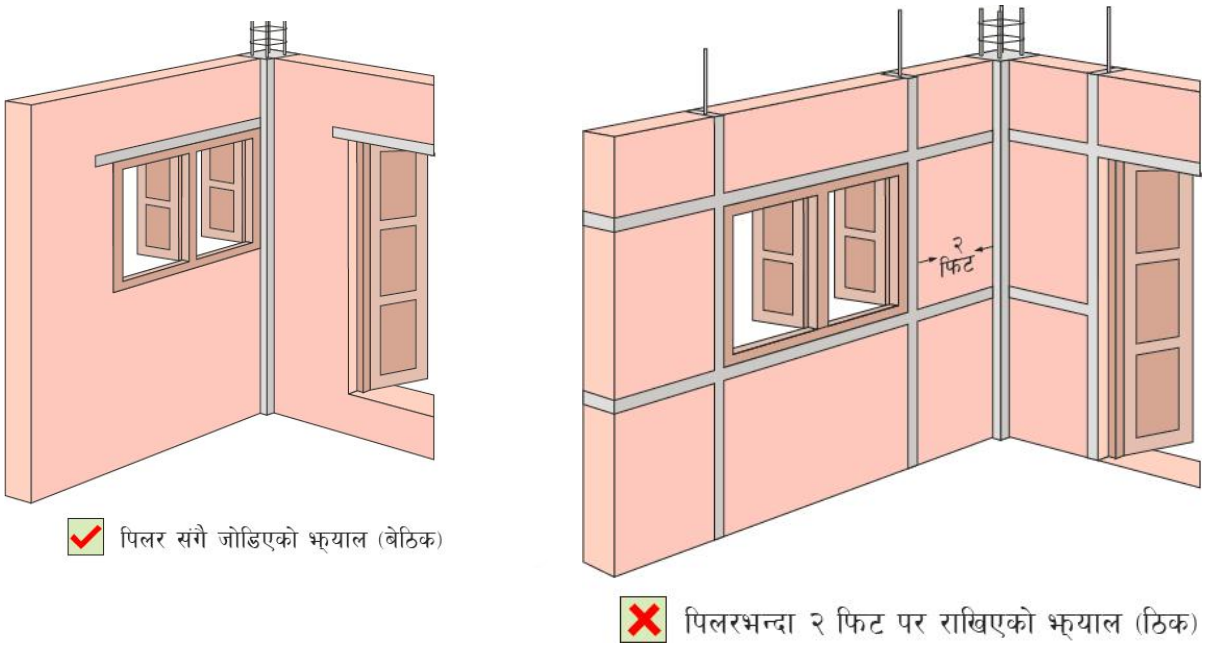


Fig 3. 33 : Considerations for Pillar

3.7 Seismic isolation U-shaped damper :

Seismic isolation system was widely admitted after Hanshin-Awaji (Kobe) Earthquake in Japan. It has been adopted in important buildings that become a disaster prevention base after earthquakes such as public office buildings and fire stations including a private building a lot.

Fig 3. 34 : Typical U-shaped damper, seismic isolation system

Characteristics of U-shaped Steel Damper

An earthquake shakes buildings in all directions horizontally and vertically, and when seismic isolation dampers are provided, they deform greatly, especially horizontally. Thus, it is necessary for a seismic isolation damper to have a homogeneous damping capacity against horizontal deformation force in all 360 degrees without direction- dependency. Nippon Steel's seismic isolation damper is a product engineered based on long-accumulated technologies in the fields of steel material and working. Its material is used in such a unique way that it is actively plasticized to absorb seismic energy through plastic hysteresis, like in unbonded braces for building frames, another product of the company to minimize seismic damage of buildings. A seismic isolation damper deforms under a heavy earthquake by as much as 30 cm or more; this means that it is subjected to a very severe fatigue condition wherein strain as large as about 10% repeats at an ultra-low frequency.

The principal characteristics of Nippon Steel's U-shaped steel damper are as follows:

(1) U shape (directional independency of horizontal damping performance,

excellent fatigue and deformation performance)

A damper element is U-shaped, and its dimensions such as length, width, thickness and height are determined optimally. As a result of the design, the damper material is plasticized under the horizontal deforming force of an earthquake, which may come in any direction of 360 degrees, and the resultant strain is dispersed all over a damper element without local concentration. The design also minimizes the directional dependency of the stiffness, yield shear force and fatigue properties of a damper element under horizontal force.

(2) Cold forming (low cost and high quality)

Press forming in cold of the damper element makes mass production possible, reduces production costs and ensures high product quality.

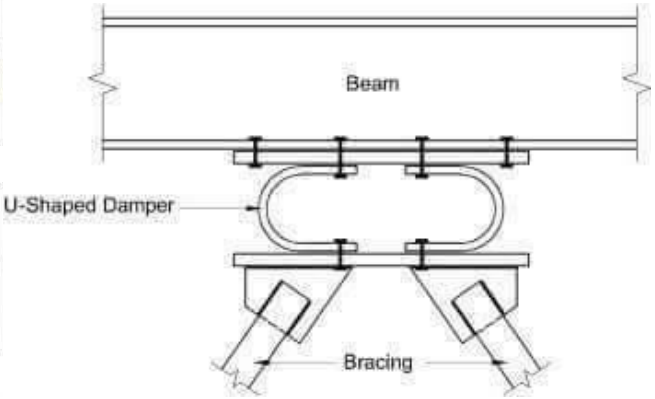
(3) Product lineup (similar element shapes and variable number of elements for a damper unit to realize low production costs and increase the freedom in design) U-shaped elements of similar shapes in different sizes compose the lineup of damper units.


Seismic isolation rubber

Slide bearings


U-shaped damper

Oil damper



Chapter 4 : Case Studies
National Case Studies:

National Emergency Operation Center :

Fig 4.1.1 : NEOC, Singha Durbar

Introduction

Location : Singha Durbar, Kathmandu

Established : 7 December 2010

Operates under : Ministry of home affairs, under the Planning and Special Services Division

Staff : 9 no.s

NEOC has been running by a nine-member personnel team under the leadership of under-secretary. The NEOC is a standalone pre-fabricated building situated on the Ministry of Home Affairs premises in Singha Durbar. The building has been built to earthquake standards and is completely self-contained, including multiple back up power supplies. The NEOC's working time is round o' clock during the disaster period . The emergency meeting which is called after the disaster has occurred happens inside the NEOC building where all the state security forces and organizations working for disaster management gather and plans are prepared.

As part of MOHA's strategy further develop Nepal's emergency preparedness and response capacity, it is planning to establish district emergency operation centers (DEOCs) in all 75 districts. Till end of October 2014 DEOCs have been established in the following 42 districts.

SOP of NEOC :

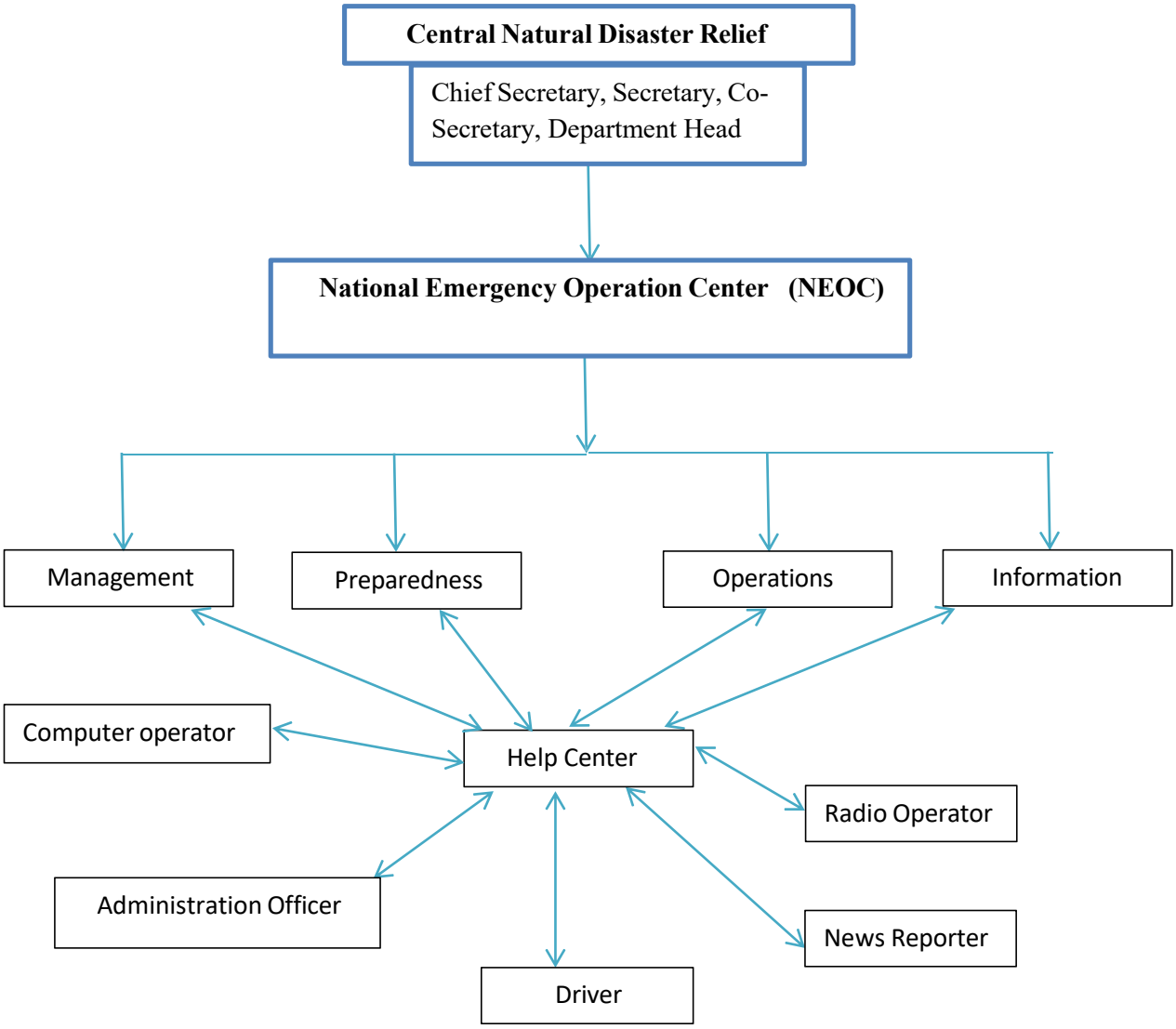


Fig 4. 1 : Sop of NEOC

Role of NEOC in National Disaster Management:

1. To co-ordinate with different groups working for disaster management
2. Mobilize resources and expertise for emergency for response
3. To collect and analyze information on disaster to relevant organization
4. To disseminate information on disaster to relevant organization
5. To promote the preparedness in case of disaster at all level of government
6. To execute policies formulated by CNDRC and MOHA

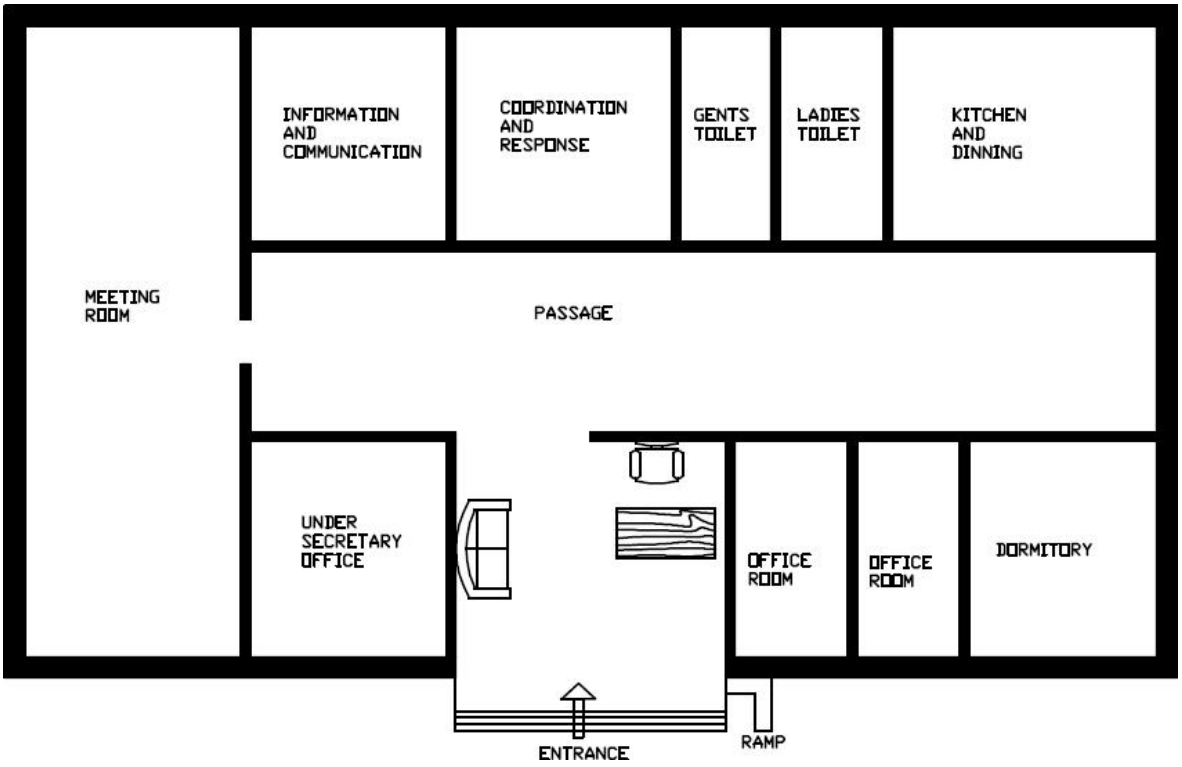


Fig 4. 2 : Layout plan of NEOC building, not to scale

Rooms :

1. Information and communication room :

The room is led by Information and communication officer. It is equipped with communications systems like Hf and Uhf wireless sets and Handheld Uhf radio, satellite phones, broad band global area network etc.

2. Emergency operation room/ meeting room :

This room in normal circumstances functions as a meeting room and contains projector and Tv sets for any kind of presentation to be held inside it. When NEOC is activated during a criss time, the room functions as an emergency room. The meeting room has a capacity of 25 people.2 staffs are always present in the office premises and necessary facilities are provided in the dormitory.

3. Co-ordination and operation room

It is the room where news of the disaster will be issued for the public in all forms of media through press conferences for a limited people only. If larger meetings or press conference are to be held MOHA's meeting hall is used and the meeting room of NEOC is used as operation room, staff briefing and organizational discussions are also held in this room.

NEOC under disaster condition:

At the time of disaster different stakeholders and organizations make the initial assessment of the field situation . The Nepal government and ministry of home affair, un related organizations and other volunteer organization activate the NEOC.

Deactivation of NEOC After the recovery phase is done the Chief of NEOC makes necessary assessment regarding the management and advancement of the process, he recommends the CNDRC through Join Secretary the de-activation of NEOC, hence taking it back to its normal functioning.

Earthquake considerations :

The building itself is simple and regular and build to match all the earthquake standards. It is a stand –alone type of building. As the center is based on information receiving and information distribution, provision of 24hr power supply is provided with a generator facility and fuel stock for and solar power considering its mobilization in disaster condition.

Material used in this building are light weight boards with structural system consisting of steel frames and room made out of CGI sheet, materials used in this building cut down the dead load .It is one storied building.

Criteria Fulfillment	Yes/ No
1. Symmetry	Yes
2. Regularity	Yes
3. Earthquake Resilient	Yes
4. Fire Protection System	Yes

Table 1. 1 : Criteria Fulfillment, NEOC

A. Nepal Red Cross Society, Bhaktapur :

Fig 4.1.11 : Nepal Red Cross Society, Bhaktapur

The NRCS district chapter Bhaktapur, works for DRR and also runs blood donation campaign under it's organizational body " Rakta Sanchar. It provides ambulance service for the area as well as distributes relief material during disaster. It is currently running a program called, " Strengthening Urban Resilience and Engagement" which plans to provide knoweldge to the community resilience for DRR . This project is focued for, Bhaktapur and Madhyapur Area.NRCS, Bhaktapur conducts programs like :

1. Multi Hazard Assesment Training
2. First Aid Training

NRCS Bhaktapur has :

1. Sub-Chapter - 21 no
2. Junior Red Cross - 77 no
3. Youth Red Cross - 15 no.
4. Staff- 60

Fig 4. 13 : Damage caused by 2015 earthquake

The building currently used seems to have been effected by the 2015 earthquake. The building eems fine from the outside, but the side walls are badly damaged and cracks are visible. According to the staff, Retrofiting of the building is going to start soon. The NFRI items are stored outside of the building with proper protection. It stores about 1100 NFRI items currently.

Fig 4. 14 : Warehouse

4.1 3.National Society for Earthquake Technology (NSET), Nepal

1. **Location :** Bhaisepati , Lalitpur
2. **Organization type :** Non-Government Organization
3. **Established :** 1994
4. **Organization goal :** Awarness and Research

Introduction :

The National Society for Earthquake Technology – Nepal (NSET) is a multidisciplinary professional society that registered with the Government of Nepal as a Non-Government Organization in 1994. NSET is a non-profit organization whose main focus is on Earthquake Risk Management (ERM). Membership of the Society comprises professional engineers, architects, scientists and other individuals seriously interested in earthquake phenomena or in the reduction of the effects of earthquakes. The NSET Management Committee consists of five elected members, two nominated members and the immediate past president - a total of eight members. The elected members elect the President and the General Secretary. The Management Committee, under the guidance of the President, monitors NSET's programs and provides policy level guidance.

Fig 4. 15: NSET Building, Bhaisepati, Lalitpur

Vision :

"Earthquake Safe Communities in Nepal by 2020".

Objective :

NSET has a three-pronged strategic objective:

- To sensitize, educate and facilitate all institutions to undertake organized approaches to managing and minimizing earthquake risk by transferring information, technical knowledge and skills, and helping them to mobilize resources for these purposes.

- To advocate for favorable and supportive policies, legal mechanisms, increased investments and a unified and effective national earthquake response mechanism and a system of incentives and disincentives to enable communities to become earthquake safe.

- To build a strong, well-resourced and credible institution that will be the national focal point for earthquake risk management actions, a facilitator and coordinator in the network of earthquake disaster management, and a source of all available information on the

NSET is an active organization when it comes to earthquake research and training programs related to earthquake preparedness and rescue. As I was told, periodic drills happen in every three months where sirens act as a indicator of a disaster condition and evacuation and safety drills are performed by the staff .NSET has published number of books,guidelines,report,articles etc regarding the threat opposed by earthquakes, building design guidelines, nset's work in ensuring safer society.

NSET building:

The building is symmetrical which is desired for earthquake safety. It was designed to perform as an office which it is currently doing. The façade is treated with vertical and horizontal elements with an entrance plaza in the front. The building is four storied with an underground basement. The building premises consist of a guard house, a generator house, a temple and parking space. Being an organization which is actively involved in earthquake risk reduction and mitigation activities, it is built to withstand up to 8 reciter scale earthquake.

Fig 4. 16 : NSET premises, guard & generator house and temple

The office is fully equipped with the computers (all in LAN), printers, photocopier and all other required office machines. A state of the art power generator with 65 KVA capacities provides power back up for ensuring cut-off of power surges and uninterrupted work in case of power failure. An Internet server with optic fiber cable link (with radio link & V-sat link back up) to the ISP provides the necessary infrastructure for the operation and management of its website. The office has floor area exceeding 5000 sq. ft, and the premises security is managed by the Group 4 Flak security service for 24 hours .

Architectural Aspect:

1. **Symmetry :**

   As mentioned in the literature study, a symmetrical and stable building form is desirable in case of earthquake resilience, which is the case in this, building. The plan is also regular and has the desired length: breadth ratio.

2. **Simplicity :**
   The building is simple but is aesthetically good as well with minimal use of design elements. As suggested in the literature any kinds of projections also is avoided which contributes for more earthquake resilience.

3. **Active use of basement :**
   If the basement floor is left vacant and unoccupied there is the short story effect , the difference between the vacant basement floor and occupied ground floor might cause structural damage due to the discontinuity of stiffness. In the case of this building, the basement floor is actively used as library, meeting hall, museum , store and workshop.

The occupancy of the basement help in lowering the center of gravity of the building.

Fig 4. 17 : Basement , Store Area

4. **Proper Grid System :**
   Proper arrangement of the grid gives the structure stability and holds the structure together during the time of the earthquake.

5. **Planning :**
   During the time of earthquake, a clear planning with considerations regarding emergency exit and a fast evacuation route with in the building plays a very crucial role. The NSET building is planned with all the mentioned considerations. There is even rooms which act as a safe room for differently able people at the time of the earthquake in case they are not able to exit the building.

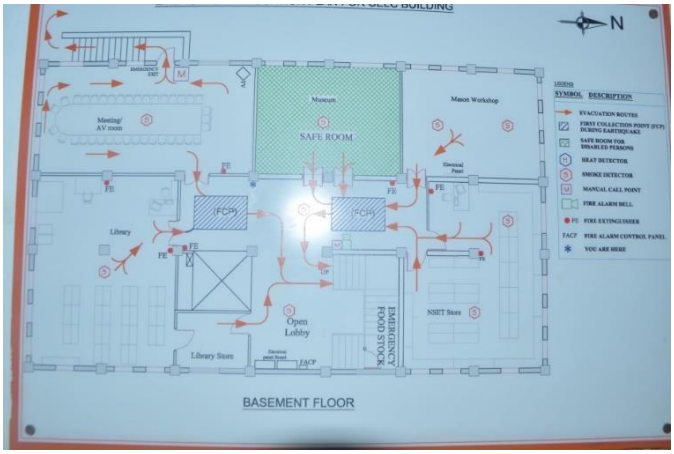


Fig 4. 18: Basement Floor Plan with escape routes,collection points and other indications

Additional Consideration :

1. **Floor Plans and Signage :**
   During the evacuation time, knowing where we are in the building and how close or far the exit maybe a crucial thing. It might be helpful in exiting the building quickly and safely.

2. **Protection from falling furniture :**
   At the time of the earthquake, with the building all the decorative items, furnitures, books are also in motion. If the shaking is very high these items maybe result in casualties and trap people under them. In the building, these proper arrangement has been made these items don't fall off and oppose threat on human life at the time of the earthquake.

Fig 4. 19 : Tie around the book racks

4.Fire extinguisher and fire alarams :

In various cases, earthquake results in fire. In normal cases as well fire can breakout from various reasons such as shot circuit, improper handling. In this building, there is provision of fire extinguisher, smoke detectors and fire alarms in each floor which ensure protection from any kind of sudden fire out burst.

Fig 4. 20 : Fire extinguisher and fire alarams

Fig 4. 21 : Earthquake Musesum

Fig 4. 22 : Meeting room, Basement Floor

Disable Consideration :

In the NSET building design consideration have been made for differently able. In the entrance plaza,there is a lift for the differently able which brings them to the ground level. A safe room is provided for the differently able considering a emergenecy situationa and sudden evacuation.

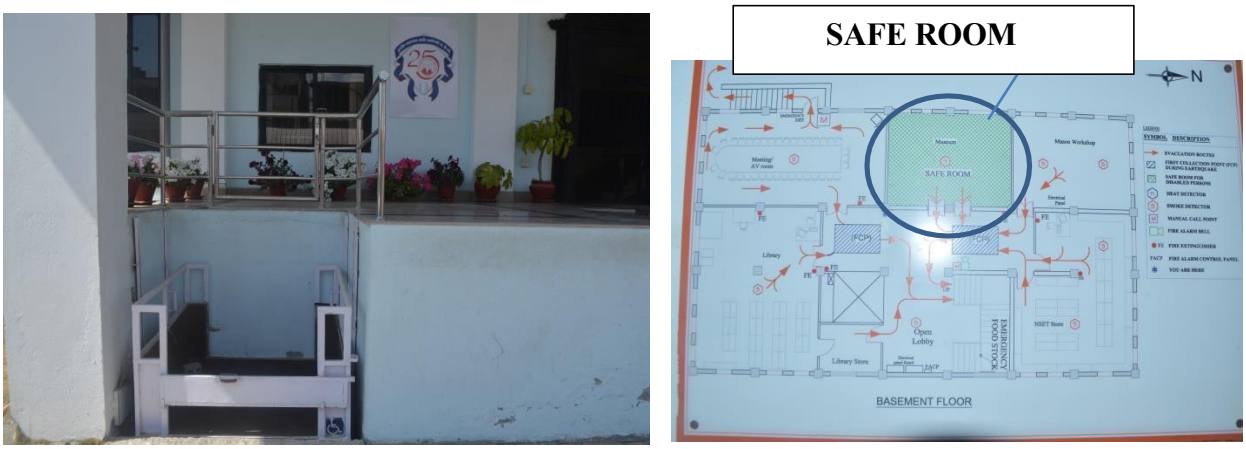


Fig 4. 23 : Disable lift and floor plans

4.1.4. National Seismological Center, Lainchaur

Location : Lainchaur, Kathmandu

Functions under : Department of mines and geology

Established : 1978 A.D

Fig 4. 24 : Seismological Department Building

Introduction :

With the installation of the first short-term vertical seismic station, Phulchoki (PKI), on the hilltop south of Kathmandu, in November 1978, the Department of Mines and Geology (DMG), Ministry of Industry, government of the Federal Democratic Republic of Nepal, in partnership with Laboratoire de Geophysiq Appliquee, Paris University, France, began microseismic monitoring in Nepal. The National Network was created by progressively increasing the number of stations, which included seven accelerometer stations in 2012 and 21 short period seismic stations in 1998. The French Department of Analysis & Surveillance of Environment (DASE) is involved in the network's operation. The Nepal Himalaya's Sub-Himalayan and Lesser Himalayan regions are uniformly occupied by the seven accelerometer stations and twenty-one short-term seismic stations.

At two, the recording is done.The Department of Mines and Geology (DMG), Ministry of Industry, Government of the Federal Democratic Republic of Nepal, in partnership with Laboratoire de Geophysiq Appliquee, Paris University, France, began microseismic monitoring in Nepal in November 1978 by installing the first short period vertical seismic station Phulchoki (PKI) hilltop in the south of Kathmandu. The National Network, which had seven accelerometer stations in 2012 and 21 short period seismic stations in 1998, was created by progressively increasing the number of stations. The network is run in partnership with France's Department of Analysis & Surveillance of Environment (DASE). The Nepal Himalaya's Lesser Himalaya and Sub-Himalayan regions are uniformly occupied by the 21 short-period seismic stations and 7 accelerometer stations.

The recording is done at 2:00

Fig 4. 25 : National Seismological Center , Department of Mines and Geology, Lazimpat

SEISMOTECTONICS:

Our understanding of the seismic cycle in the Himalaya has greatly improved over the last decade thanks to various research projects combining seismological monitoring, geodetic measurements, and geological investigations. These studies have shown that the most active fault is the Main Frontal Thrust fault, which absorbs about 2cm/year of north south convergence.

MICROTREMOR SURVEY:

Damages due to the 1934 earthquake were particularly high in the Kathmandu basin. The basin is filled with up to 600m of poorly consolidated lacustrine and fluviatile deposits which may have contributed to amplifying ground shaking. The NSC has carried on micro tremor surveys which confirmed that the ground motion is indeed generally much higher on the sediments than on the bedrock surrounding the basin. This kind of measurements is key to estimate the characteristics of the ground motion that should be expected in future large earthquakes.

Building analysis:

The NSC building is a load bearing structure. It is a two storied building. There is not proper escape route in case of emergency evacuation. The building is simple but not symmetrical. There is no any projection which adds to the stability of the structure

Table 1. 3. Criteria Fulfillment, National Seismological Center

Criteria Fulfillment	Yes/ No
1. Symmetry	No
2. Regularity	Yes
3. Earthquake Resilient	No
4. Fire Protection System	No

4.1.5 Juddha Barun Yantra, Sallaghar, Bhaktapur

History of Fire Fighting in Nepal :

The "Barun Yantra Karyalaya" is the name of Nepal's fire service. In 1937, the Nepalese fire department opened its first office in Kathmandu, the nation's capital, using a single "MORISH" (an English-made) vehicle. Since there were no motorized roads connecting the Kathmandu Valley at the time, porters carried the vehicle's components and fragments from the Indian border into the city on their shoulders and backs. Even though there were no phone connections in the city at the time, the fire department's requirement was recognized and installed. To keep an eye on whether or not the city was burning, an iron tower was constructed. The firefighters were dispatched as a preventative measure.
The international standard states the ration of one fire truck for 28,000 people which is not the case in Kathmandu Valley. Kathmandu's population of 2.5 million requires 62 fire engines and 3,000 fire fighters. Today, less than 50 fire fighters serve the entire valley with 5 antiquated trucks whose ladders reach 10 stories. Kathmandu's growing numbers

of high-rise buildings are beyond the current ladder reach.

The sallaghari fire brigade in total has :

- Fire trucks – 2 no. (4000 l capacity)
- Rescue vehicle – 2 no
- Bike – 1 no.

DCP Fire Extinguisher for electric fire

Front portion with radio and necessary equipmens

Locker for Hose and water launcher

Water Pumping and water launcher with controls

These bike were said to be effective to prevent small fire and limiting them from spreading. They can be useful to prevent kitchen fire and electric fire until fire trucks approach the scene. The bike is equipped with fire extinguisher, first aid kit and fire blankets. Fire blankets are handy tools which can be used to cover the spread fire or any casualties who have caught fire. It can also be used as a stretcher to carry casualty.

Fig 4. 28 : Fire blanket and wet towels used to cover a small fire

4.2 International Case Study :

Kyoto Disaster Prevention Center :

The Kyoto Disaster Prevention Center is located in Kyoto, Japan. Japan is always under the constant threat of earthquake. Kyoto was the capital city of Japan until 1868 A.D. The earthquake in 1995 that majorly damaged the city of Kobe, also had its impact in the city of Kyoto. Kyoto did not suffer measure damage but its important temples like Nishi Honganji and Koryuji were effected by the earthquake.

Tag line of Kyoto Disaster Prevention Center , **“ We encourage each citizen to try and learn more about disaster prevention. Your action to prevent disaster will prevent your life “.**

Fig 4. 29 : Kyoto Disaster Prevention Center, Kyoto , Japan

Prospectus :

As the saying goes "Great natural disasters come to us when we forget the last ones", No one can foresee when a major disaster, like the Great Hanshin-Awaji Earthquake, will strike and disrupt the peace of our daily lives. It is crucial to develop adequate judgment along with the knowledge to take effective action during a disaster so that you can save lives and limit property damage. At the Disaster Prevention Center you can learn how to protect yourself and how to act against disasters. We hope visitors to the Center will take advantage of our many disaster prevention exhibits to enhance their awareness of disaster prevention in order to protect your lives and property.

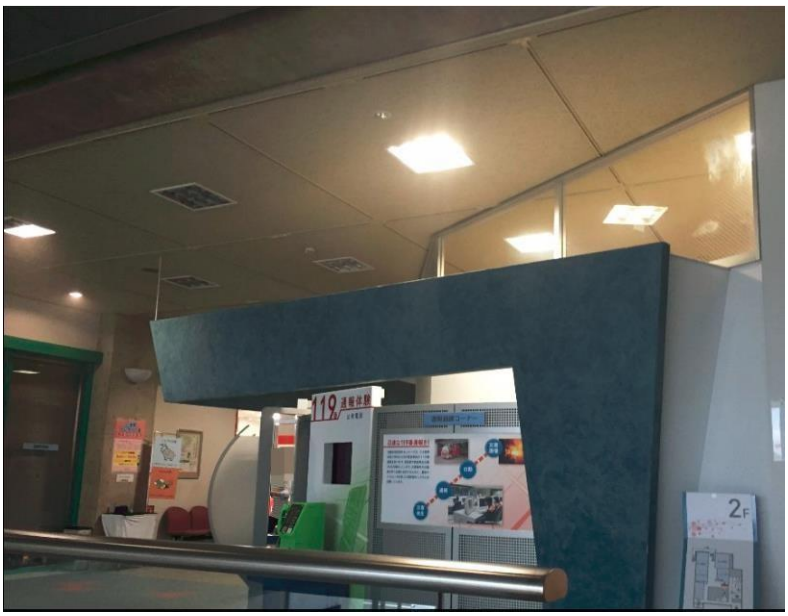


Fig 4. 30 : Reception Area

The Kyoto Disaster Prevention Center is open for registration to anybody who is willing to take their training courses, the center has stimulation room , training room and display room which provide a real life experience of a disastrous situation. As stated on the official website, “To promote knowledge among citizens of disasters and to improve citizens' abilities to address disasters1, the Kyoto City Disaster Prevention Center offers half-day and one-day programs designed to provide simulated experiences of disasters. We hope many citizens will visit the Center.”

List of activities on each floor :

1. First Floor :

A. Reception/Information Desk

B. Orientation Stage

C. Earthquake Simulation Room

D. Typhoon Simulation Room

E. Disaster Education Video Room

F. Fault of Mt. Ogura Display Section

The simulation rooms are located on the first floor along with the disaster education video room where visitors can experience the fear of earthquakes and typhoons. In the disaster education video room, videos are shown of past disasters in Hi- Visual Simulation System and the duration is 15 mins . In the earthquake stimulation room, earthquake of 4-7 intensity is stimulated and consolations will be given on how to prepared against them . A visitor is subjected to a wind speed of 32 meters per second in the typhoon simulation room.

5. **Second Floor:**

A. Fire Fighting Training Room
B. Smoke Simulation Room
C. Emergency Report Training Section
D. General Training Room
E. Safe-Living Room

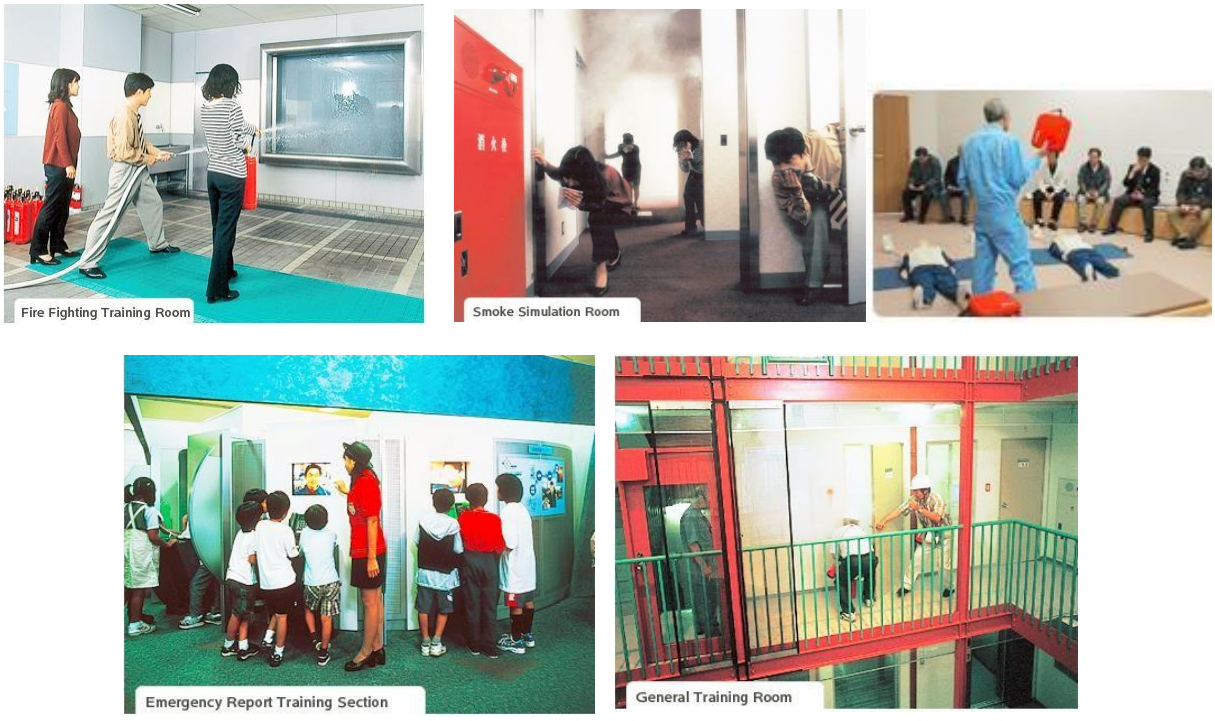


Fig 4. 32 : Rooms in Second Floor, respectively.

Fire can breakout anytime. A general idea of fire prevention can prove to be effective at the time of such outbreaks. The second floor consists of Fire training and stimulation room where a visitor can experience a fire breakout situation as well as learn how to put out or fight fire. In the fire training room, one shoots water and extinguish a picture of fire on a screen. Here he/she learns how to properly put out a fire. In the stimulation room one gets trapped in a hotel fire and learn how to survive from such situation. In the general training room, one gets traped inside a store, hotel, apartment etch and learns how to act in the immediate building floor once it catches fire.

6. Third Floor :
   A. Disaster Simulation Room
   B. Fire Helicopter (Air Rescue Simulator)
   C. Enlist in the Kids' Fire Brigade!
   D. Transform into a Firefighter!
   E. Dangers of Underpasses
   F. 4D Theater: The Fear of a Flooding Underground Arcade
   G. Audio Visual Room
   H. Disaster-related Information Section

Fig 4. 33 : Room layout of third floor, respectively

A visitor can experience evacuation procedures in an earthquake stimulated sound and graphics in the disaster stimulation room. In the Kid's Fire Brigade Room, kids learn about origin of fire in a house and is designated specially to stop children from playing with fire. A visitor can discover is firefighting avatar by standing in front of the display in the transforming into fire fighter room. In the disaster audio visual room, disaster related information is provided through videos, here knowledge is given regarding the condition leading to fire and disaster and measures we can take to prevent them.

The Great Hanshin-Awaji Earthquake Memorial Disaster Reduction and Human Renovation Institution
Location : Kobe Japan

In 1995, which is twenty-two years ago, Kobe City was hit by a large earthquake that caused great tragedies to ensue. The incident still remains unforgettable to all, but Kobe City undergone intensive renovation and reconstruction, so much so that it became a popular destination for tourists all over the world to visit. The Great Hanshi-Awaji Earthquake Memorial disaster Reduction and Human Renovation Institution is a museum that offers information regarding the Hanji-Awaji earthquake as well as other natural hazards that occurred in Japan. It also introduces the method in which the Japanese cope with these natural disasters and how international aid was given.

You can experience the simulated earthquake in the form of models that are exhibited in one corner of the museum and learn about the security measurements against earthquakes installed in

the structure of Japanese buildings. Visitors can remember the tragedies of natural disasters while learning the ways to handle them in real life.

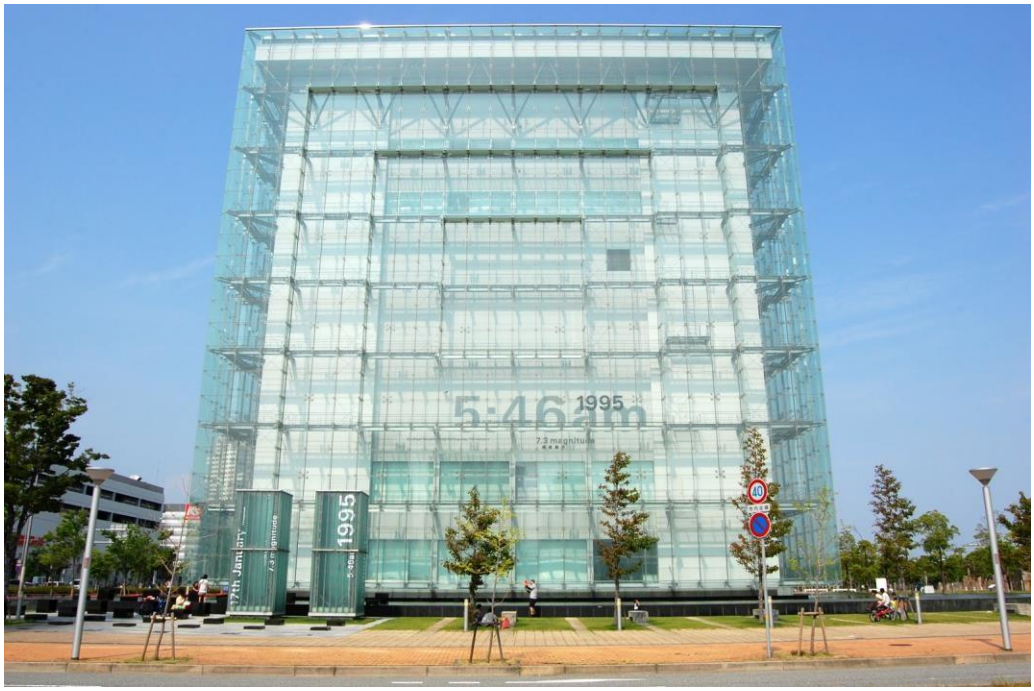


Fig 4. 34 : The Great Hanshin-Awaji Earthquake Memorial Disaster Reduction and Human Renovation Institution

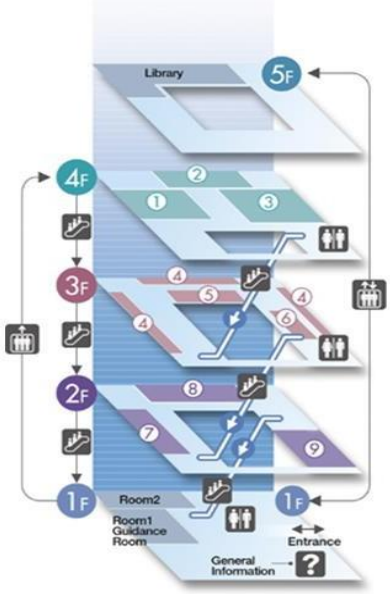


Fig 4. 35 : Floor Plan, West Block

The floor consists of :

1. Theater

2. Streets just after the Quake
3. The Great Earthquake Hall
4. Memories Corner
5. Dioramas, showing the road to recovery from the earthquake
6. Recital Corner
Station, providing the latest
information of natural disasters
7. Workshop of disaster prevention and disaster mitigation
8. Gallery of disaster prevention for the future
9. Gallery of disaster prevention for the future
10. 1(F) Guidance Room

1. Theater :

The Earthquake's tremendous power and devastation are described on a large screen using dynamic audio visual effects.

Fig 4. 36 : Theater Area

2. Streets Just after the earthquake

Scenes immediately after the Earthquake are reproduced using dioramas.

3. The Great Earthquake Hall

Documentary program is shown that describes how communities and residents have worked for reconstruction.

Fig 4. 38 : The Great Earthquake Hall

4. Memories Corner

Earthquake-related items and records are displayed together with remarks by contributors regarding their experience of the Quake.

Fig 4. 39 : Memorial Wall

5. Dioramas, showing the road to recovery from the earthquake

The condition just after the earthquake and lives of people and cities during recovery from the earthquake are explained by messages and graphic images (dioramas).

Fig 4. 40 : Graphical Representation Area

6. Recital Corner Station, providing the latest information of natural disasters

Movies about what happened during and after the Quake are shown and Earthquake survivors talk about their experience.

7. Workshop of disaster prevention and disaster mitigation

This station provides the latest information of natural disasters, which have recently occurred in the world.

8. Gallery of disaster prevention for the future

At this workshop, visitors can learn practical expertise on disaster prevention and mitigation through experiments and games.

Fig 4. 41 : Workshop Area

Disaster Prevention and Education Center in Istanbul by Dimcho Nedev & Binyo Yovchev

- **Architects:** Dimcho Nedev, Binyo Yovchev
- **Project:** Disaster Prevention and Education Center
- **Location:** Istanbul

Design philosophy by the architect, "Natural disasters are caused by the basic elements/powers – fire, air, earth, water. Humans can be added to the list because often man through his actions can have a negative effect on nature. As a result these changing elements become five in total. The regular pentagon symbolizes the harmony between man and the elements. Therefore we chose it as a starting point for our form shaping."

Design Concept :

The concept behind the Istanbul Disaster Prevention and Education Centre is to increase the awareness of the community for the prevention of disasters and to educate people how to deal with them. This is a new type of building for the territory of Istanbul and it brings particular message to the society.

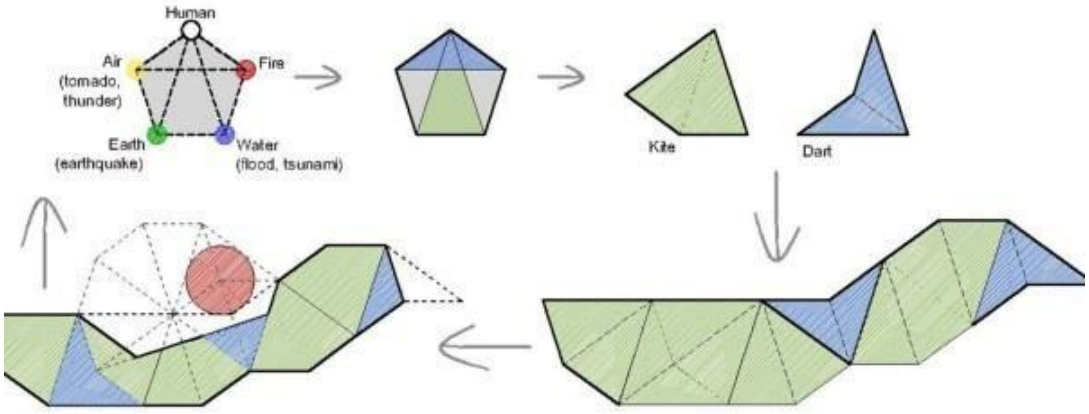


Fig 4. 42 : Concept development for the Project

The regular pentagon can be divided into sectors (golden triangles) from which two forms are derived: “Kite” and “Dart”. They are the main components of a peculiar type of mosaic – , typical for Turkey and the islamic world. Mathematicians noticed this and in 1974 Roger Penrose proved that the whole plain can be covered with these two forms.

Fig 4. 43 : Girih Tiles

Inspiration for the design :

Words from the architects:

Inspired by the five elements symbolism and by the Girih tilling we designed the building using this form shaping. We established that it brings us the following advantages:

•It symbolizes the elements and their connection to humans;

•By using Girih we pay attention to the cultural identity of the environment;

•Rich variety of shapes which can be achieved by using only two elements;

Our decision to use this particular form shaping brings us both a variety of potential choices and an identity to the respective form (building). As a result this building blends in well with the concept of being a cultural site for the city which every tourist would like to see.

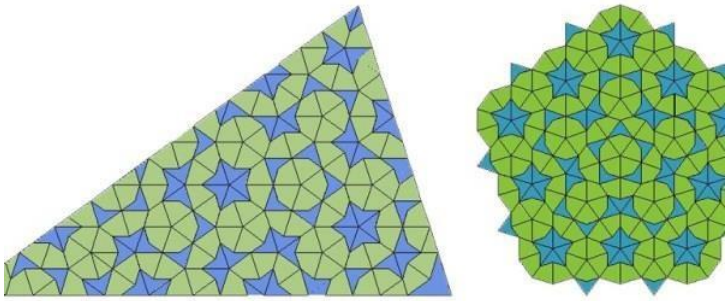


Fig 4. 44 : Girih tile and patterns formed by the combination of dart and kite shape

ARCHITECTURAL DESIGN CONCEPT

The building has linear structure with multi-functional spaces, intertwined with new age technologies.

From the inside the building is completely open, welcoming, merging the indoor and outdoor activities of the centre. Open parking is situated between the boulevard and the building. The large canopy in front of the building allows for various meetings, entertainment, fun activities, etc.

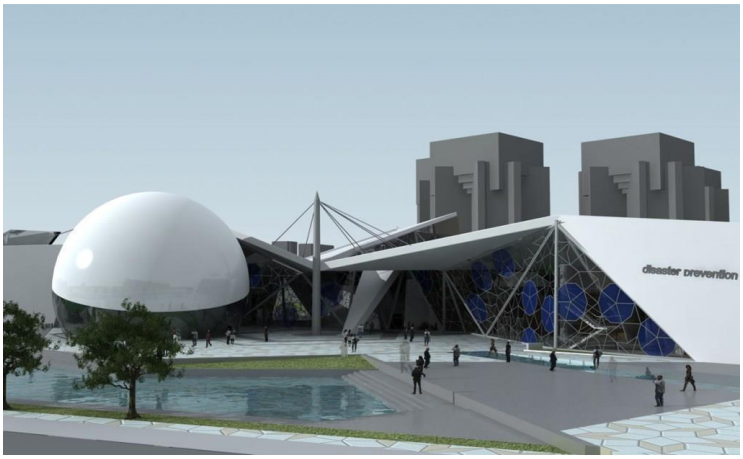


Fig 4. 45 : Space for meetings, entertainment and fun activities

It is a three-floor building, with no underground level. A large, once again linear in shape entrance hall receives the visitors. It is common for both centers – Disaster Prevention Centre и Education Centre, their main entrances situated to the north.Information Centre is situated on the lower ground floor level, as well as Children Centre, bookstore, souvenir shop and exhibition area.

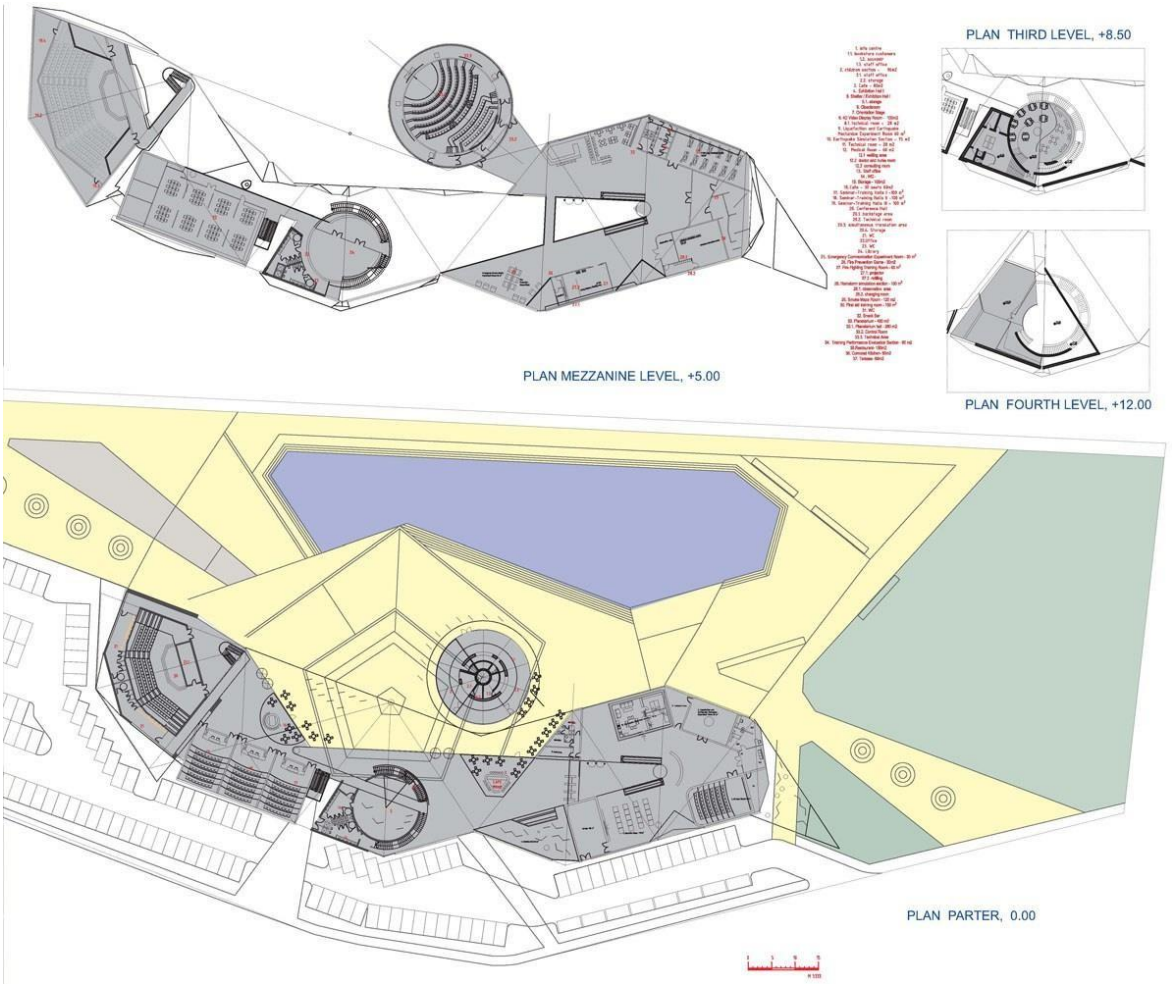


Fig 4. 46 : Ground Floor

Public spaces as entrance hall, reception desk, exhibition area, cafe and Education Centre are situated on the groundfloor level. Paid zone comprises Disaster Prevention Centre, exposition area, planetarium and a Garden of Elements with a cafe-bar which is located in the second floor.

The third level at elevation +15,00m shelters Science Club and a partaining restaurant with and open terrace viewing the sea.

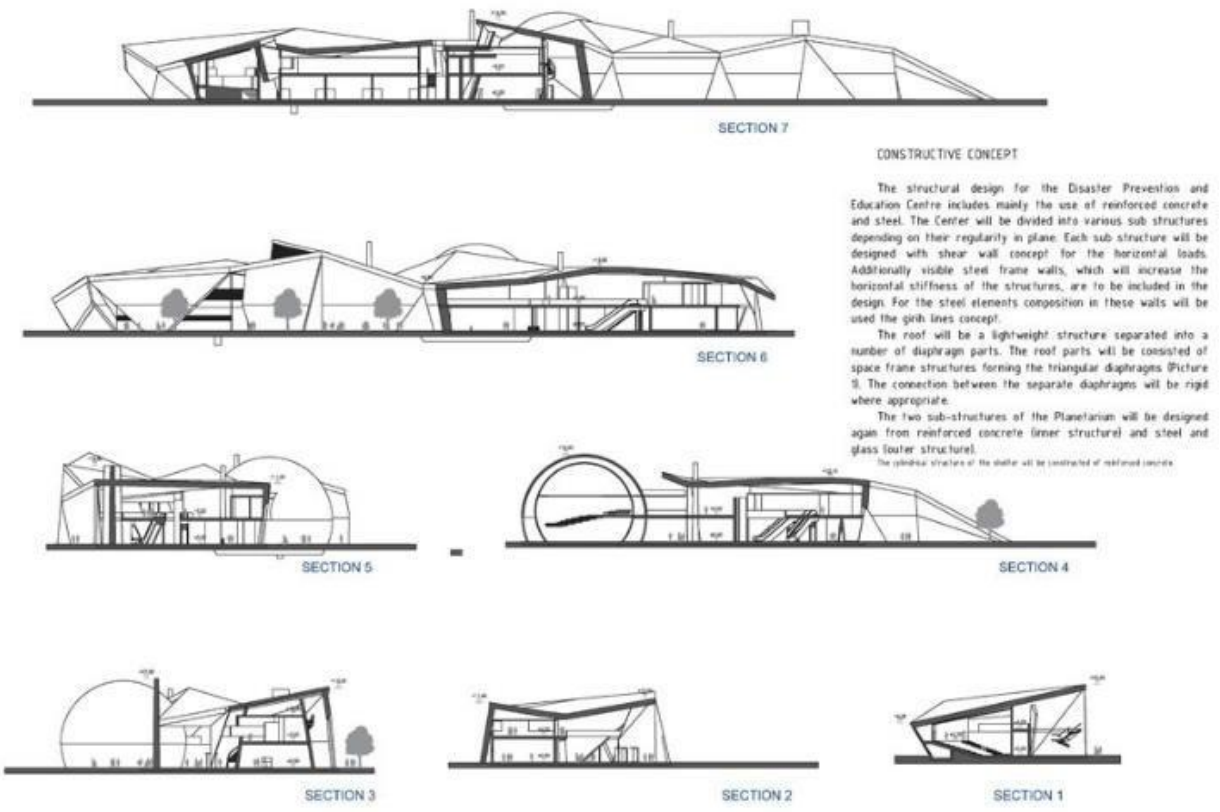


Fig 4. 47 : Section at different levels

Material Used :

The structural design for the Disaster Prevention and Education Centre includes mainly the use of reinforced concrete and steel. The Center is divided into various sub structures. Each sub structure is designed with shear wall concept for the horizontal loads. The roof is lightweight structure separated into a number of diaphragm parts.

The two sub structures of the Planetarium is designed from reinforced concrete (inner structure) and steel and glass (outer structure).

- **TOTAL BULDING AREA :** 7200 m2
- **BUILDING FOOYPRINT AREA :** 3650 m2

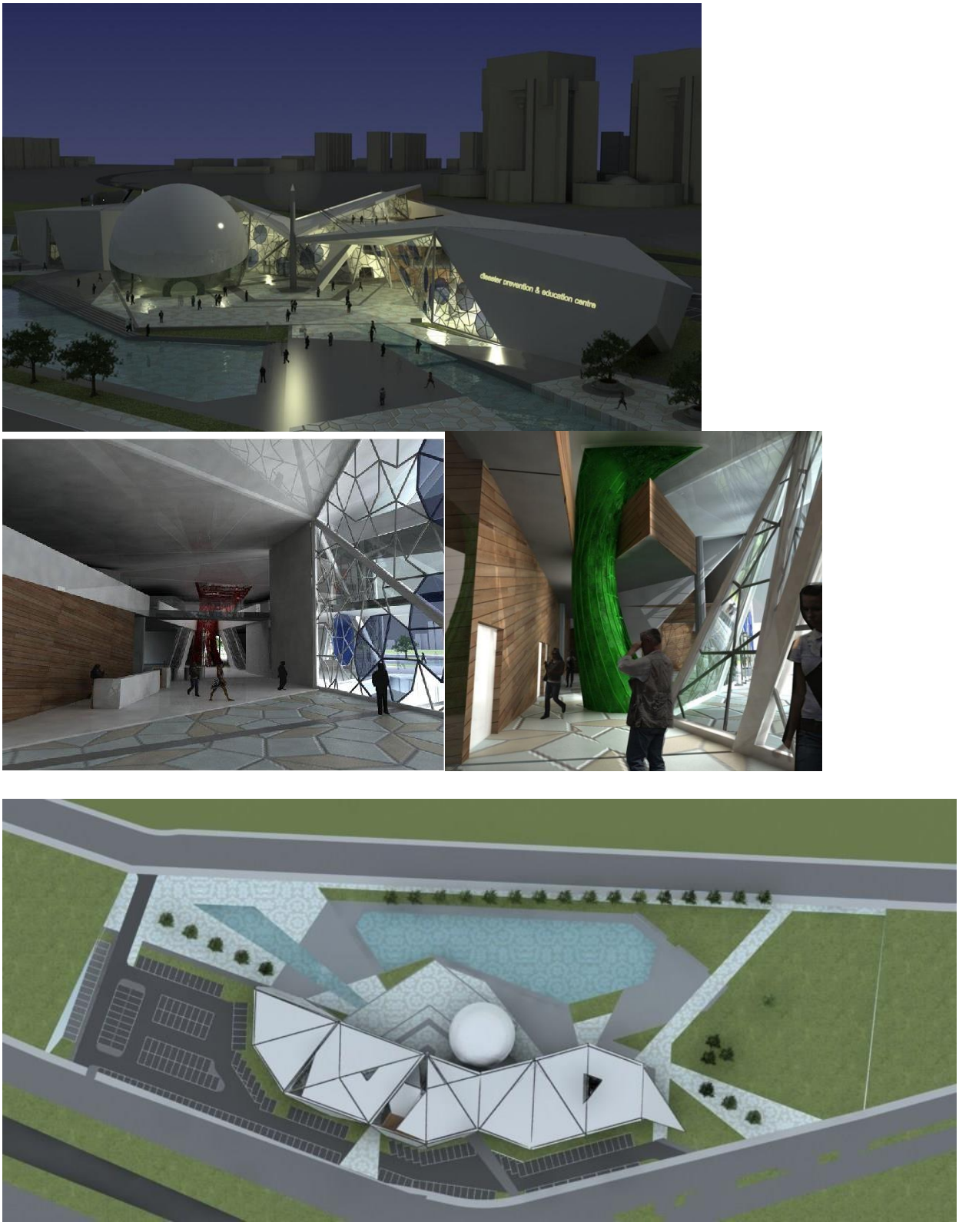


Fig 4. 48 : Different views of the building

SITE ANALYSIS

SITE INTRODUCTION

- Location- BYASI KASAN Bhaktapur
- Area: 45 ropani
- Orientation : East-West
- Vegetation: Fertile lagricultured and
- Topography-Plain
- Ownership- farmers
- Site level: On the road level
- Zoning- Residential

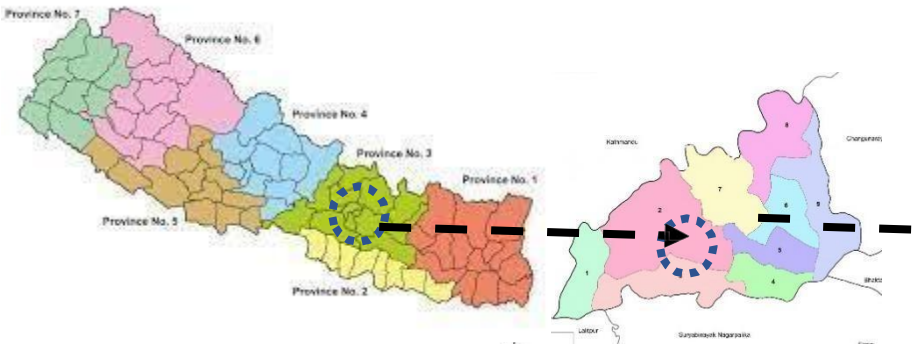


Figure 118 Location of the site

11.2 SITE JUSTIFICATION

The site was chosen as it is centrally located between the cities like Kathmandu, Bhaktapur and Lalitpur and thus, can be accesed from the capital of the country easily. As it lies in the institutional zoning, there are many schools, colleges as well as technical instituitions where flow of people are very high. Similarly, the site is near to the traditional settlement as well, which is a centre of people's attraction and the general people, can access the site which is within the walkable distance.

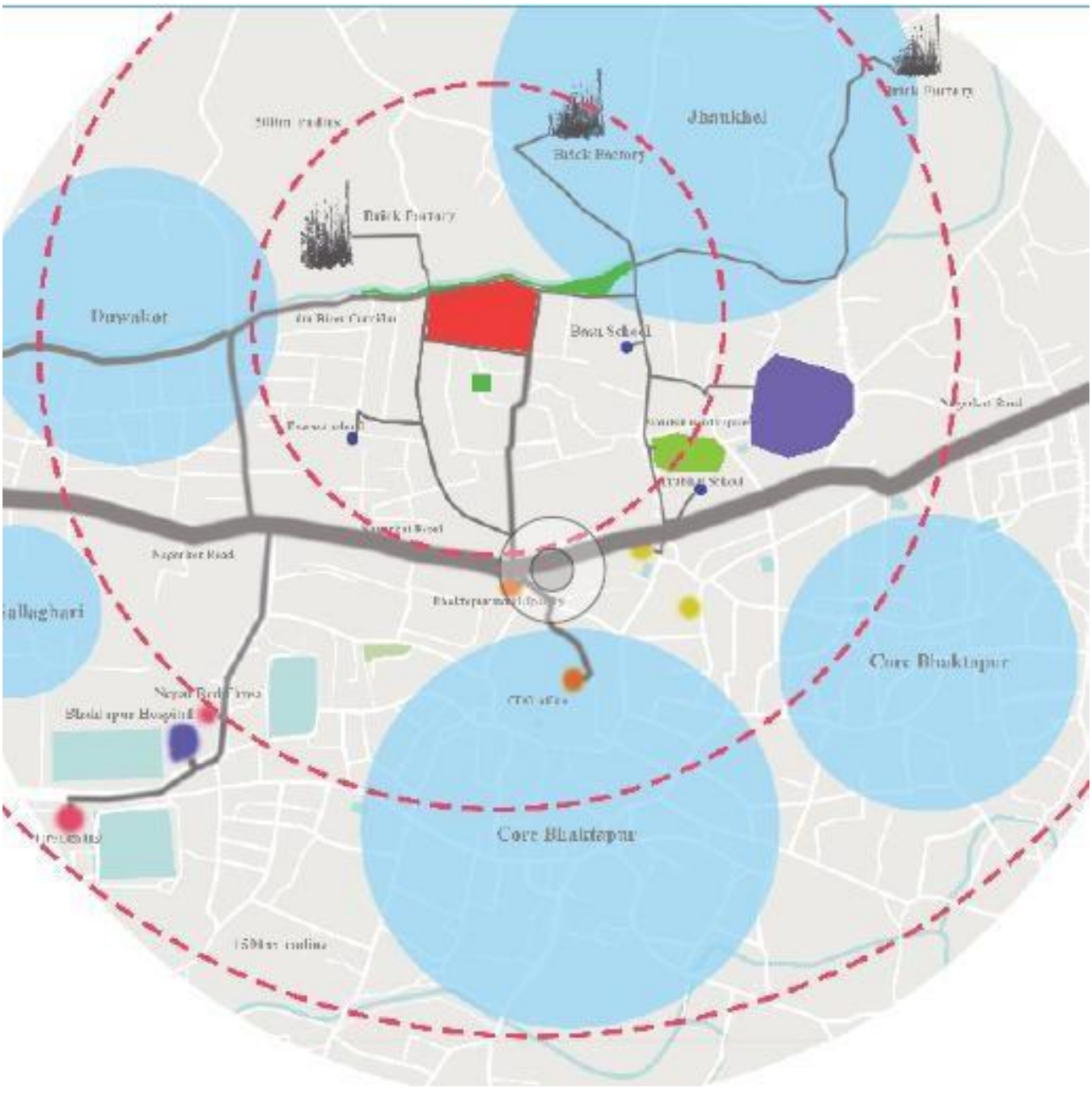
11.3 SITE ACCESSSIBILITY

This site is accessible from both Araniko highway and Purano Thimi Bhaktapur road.The site is 200m away from Bhaktapur municipality, 1.2 km away from district administration office

bhaktapur purano bato road that lies south west and is 13 mins walk away on foot and 2 mins on vehicle. Similarlly I lies on lap of river corridor road, it is 750m away and it take 8 mins to reach site on foot and 2 min on vehicle. From sallaghari chowk, it is 3000m and takes 6min on vehicle and 25 min on foot

11.4 SITE PROXIMITY

Within the 1 km proximity, there are many educational institutions like, Khwopa College Basu school, Bhaktapur municipality, hospitals like Bhaktapur hospital, Sahid Dharma bhakta hospital, Nepal Cancer Hospital NGOS And INGOs like Nepal Red Cross Society District Administration Office etc.



8m River corridor road

Existing Structure in Site

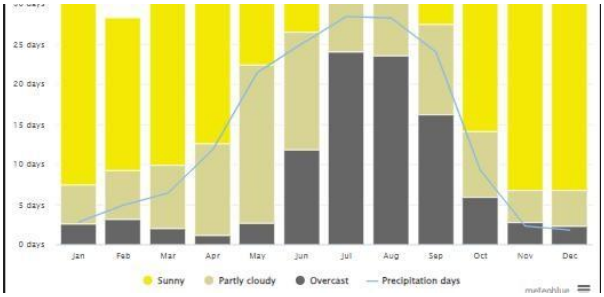
On going Site Filling process

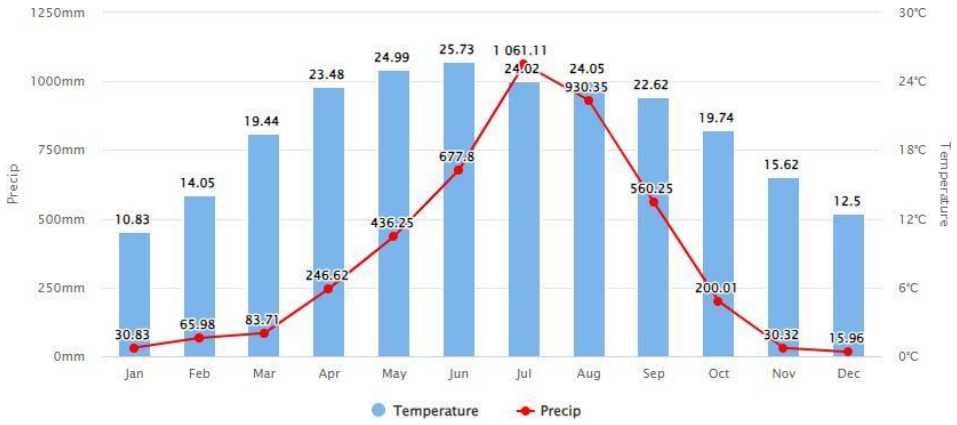
black topped road leading to site from Sallaghari

11.4 SITE SURROUNDING

11.5 CLIMATE CONDITIONS

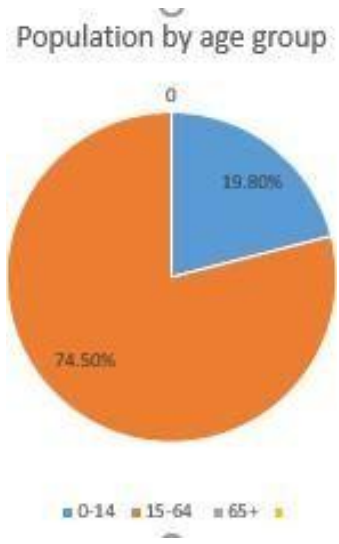
Temperatureis highest during the month of June(25.73)and the lowest temperature recorded is in January(3o). During the June, the weather Is clear .The highest precipitation is in the month of July (1061.11mm) and the lowest precipitation is in the month of December (15.96mm). The wind direction generally flows from south west to north east. The clouds get overcast during the month of july and august when there is maximum precipitation and lowest is in April.The maximum sunny days are recorded during January and December. The shadow length during the noon of June 22 is 0.08m having altitude 85.57^{o} and during December 22 , the shadow is 1.29m having altitude 38.8

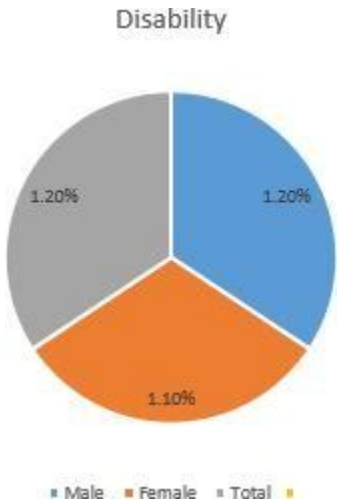


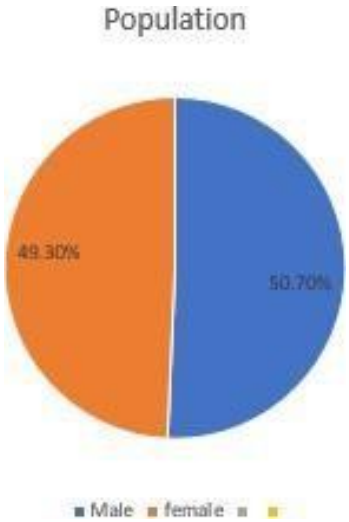


11.6 HUMAN AND CULTURE

The total population of Bhaktapur is 119756 and the population density is in 10441.There are total 31996 house holds and the sex ratio is 103.94 male per 100 female. The ward 2 consist of total 12683 (6634 males and 6229 females).The disability % is 1.2 %(in which 1.1% are female and 1.2% are male). The population mostly consist of from 20- 24 years old, and then children and few elders. According to 2021 census conducted by Central Bureau of Statistics (CBS), Bhaktapur Municipality was inhabitted by mostly the people of Newar caste with total population of 16987,.Along with newars, there are Brahmin - Hill , Chetri, Tamang, Magar , e







11.7 BY-LAWS STATED BY MUNICIPALITY

The site lies in institutional zone

Ground coverage - 50% of total site area

Parking - 20% of total site area

Open space - 10% of the total site area

ROW- 3 m from the center of the road

Setback – 3m from all sides of the boundary of the plot.

FAR- The FAR in industrial zone is 3.5.

Building height- 15m which includes parapet wall also. If there is presence of stair cover, water tank then, additional 2.40m height can be added.

Min ceiling height- The ceiling height is 2.7 m.

Plinth height- for non pitched road, the plinth height is 0.75m from road level

Building min. width- 2.4m and the ratio of length to width is 5:1. If the length is 5 times greater than width, 50mm expansion joints should be used.

Openings (Doors, windows and ventilations) – The openings of a room should be 15% of the floor area or min. 0.3sq.m of the area. This doesn't include non openable windows and ventilations.

Projection- For the topmost projection of the storey, The maximum projection can be 2'6". For the projection in the middle floors , the projection can be 1'6".

Figure 130 View of the east from the site

11.8 SWOT

Strengths

- Site connected to the 8m road making a Easy access
- Near to institutional as well as core area available for public
- Southern part is open so provision of Adequate sunlight
- Comparatively calm environment due to less flow of traffic.
- The site is easy accessible .
- Less populated area
- near core settlement
- -Peaceful Environment
- -Thinly populated , abundance of open spaces
- -Communal harmony and co-operation, helpful for community resilience program
- -Isolated at the same time accessible from the main highway and settlement

Weakness

- High water flow in the river during rainy seasons
- Ø Smoke from the surrounding brick factories

Opportunity

- River in the northern end of the side, useful for landscape purposes
- No institutional building or organiz ation dedicated for disaster management around the area,
- Proposed project might help raise the economic standard of the community and bring in more infrastructure for community

Threat

- Poor drinking water and Security
- No direct route to transportation facility

1. Conclusion :

The programs for my Disaster Risk Reduction centers includes places for research, stimulation rooms and training area it would be in appropriate for these activities to be conducted in an area which consists of compact settlement. The proposed site is appropriate for the project as it offers peaceful environment, a thin settlement but is easily accessible at the same time despite of its segregation from the core settlement area. The people already have a sense of community co-operation among them which will help in building a community resilience model as proposed in the project.

Chapter 6.Program Formulation :

1. **Administration Block**
2. **Museum**
3. **Multipurpose Hall**
4. **Training Block**
5. **Research Center**
6. **Warehouse**
7. **Accommodation Block**

Parking consideration :

Total Number of staff :150
Bike users : 60
Car users : 30

Number of expected visitor's per day : 200
Visitors with bike : 70
Visitors with car : 20
Visitors by bus : 30
Bike area : 217 sq.m
Car area :900 sq.m
Bus : 98 sq.m

Table 2. 1 Program for Administration Block

Administration Block			
S.No	Spaces	Number	Area (sq.m)
1.	Reception	1	40.00
2.	Waiting area	1	10.00
3.	Toilet	2	30.00
4.	Canteen	1	100.00
5.	Meeting Room for Guest	1	100.00
6.	Meeting Hall	1	400.00
7.	Administration	1	50.00
8.	Director's Room	1	60.00
9.	Department Meeting Room	1	40.00
10.	Manager's Room	2	50.00
11.	Finance	1	60.00
12.	Store	1	100.00
13.	Pantry	1	30.00
14.	Library	1	
15.	Information Room	1	40.00

16.	Emergency Room	1	100.00

Museum

S.No	Spaces	Number	Area (sq.m)
1.	Orientation Area	1	30.00
2.	Audio/ Visual Room	1	96.00
3.	Memorial Area	1	30.00
4.	Display Area	1	100.00
5.	Earthquake Stimulation Room	1	84.00
6.	Fire Stimulation Room	1	84.00
7.	Interaction Room	1	96.00
8.	Earthquake Hall	1	144.00
9.	Store	1	100.00
10.	Pantry	1	50.00
11.	Toilet	2	60.00

Table 2. 2 Program for Musesum

Table 2. 3 Program for Multi-Purpose Hall

Multi-Purpose Hall

S.No	Spaces	Number	Area (sq.m)
1.	Multi-Purpose Hall	1	600.00
2.	Stage Area	1	42.00
3.	Back Stage	1	64.00
4.	Store	1	25.00
5.	Canteen	1	550.00
6.	Toilet	2	100

Table 2. 4 Program for Training Block

Training Block

S.No	Spaces	Number	Area (sq.m)
1.	Reception	1	16.00
2.	Meeting Hall	1	256.00
3.	Structural Training Room	1	400.00
4.	Masonry Training	1	169.00
5.	First Aid Training Room	1	256.00
6.	Staging Area	1	324.00

7.	Collapsed Structure Training	2	225.00
8.	Fire Fighting Training	1	196.00
9.	Store	1	100.00
10	Toilet	4	30.00

Research Center			
S.No	Spaces	Number	Area (sq.m)
1.	Reception	1	25.00
2.	Meeting Hall	1	256.00
3.	Seismology Room	1	100.00
4.	Lab	1	196.00
5.	Server Room	1	81.00
6.	Document Room	1	100.00
7.	Soil Testing Room	1	100.00
8.	Equipment Room	1	256.00
9.	Director's Room	1	64.00
10.	Department Meeting Room	1	110.00
11.	Lecture Hall	1	361.00
12.	Store	1	110.00
13.	Pantry	1	49.00
14.	Toilet	4	25.00

Table 2. 5 Program for Research Center

Warehouse			
S.No	Spaces	Number	Area (sq.m)
1.	NFRI Storage	1	400.00
1	FRI Storage	1	256.00
3.	Equipment Room	1	144.00
4.	Administration	1	81.00
5.	Information Room	1	110.00
6.	Document Room	1	110.00
7.	Director's Room	1	64.00
8.	Toilet	2	25.00

Table 2. 6 Program for Warehouse

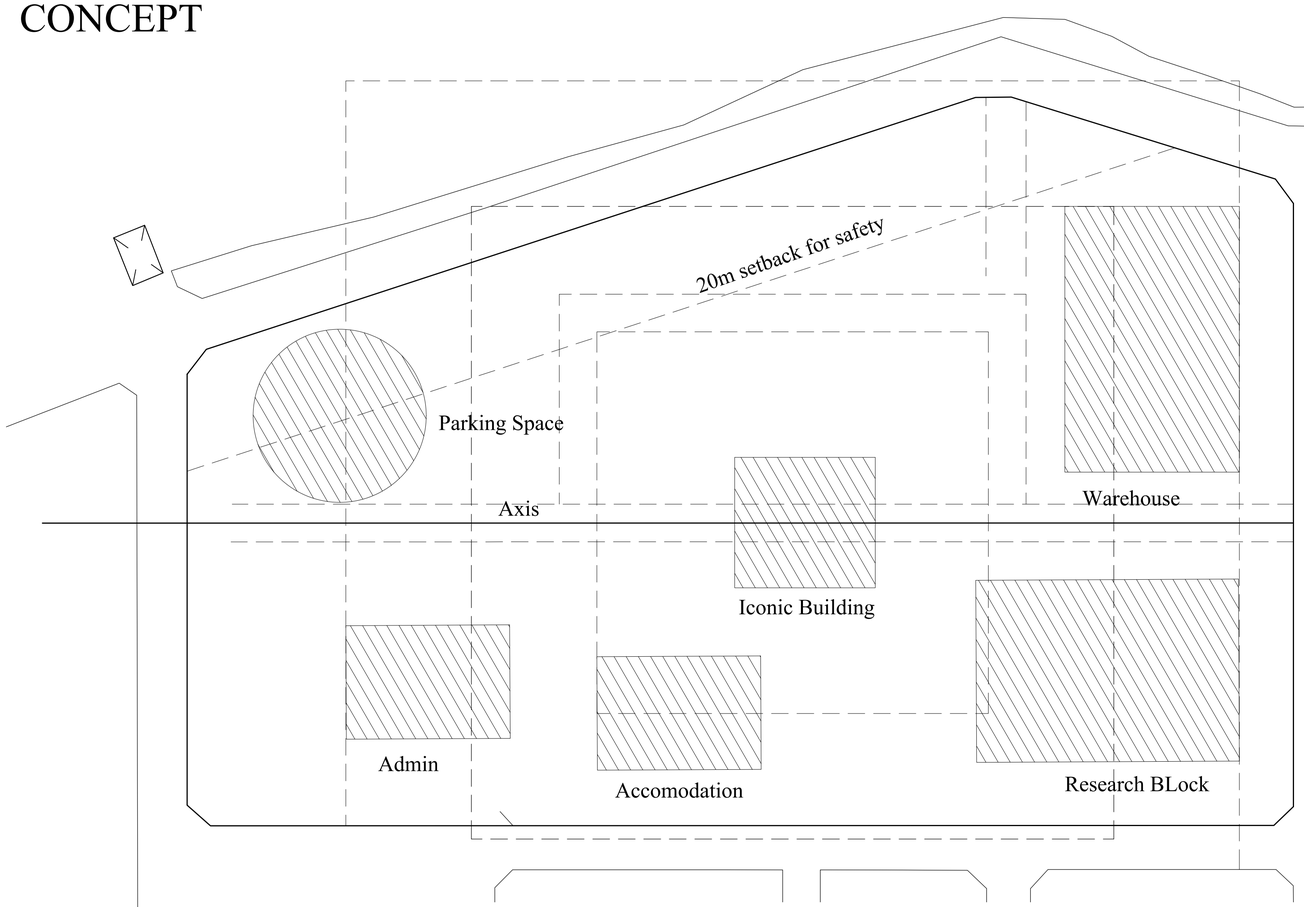
Accommodation Block			
S.No	**Spaces**	**Number**	**Area (sq.m)**
1.	**Bed Room**	**12**	**64.00**
2.	**Entertainment Room**	**1**	**110.00**
3.	**Toilet**	**4**	**30.00**

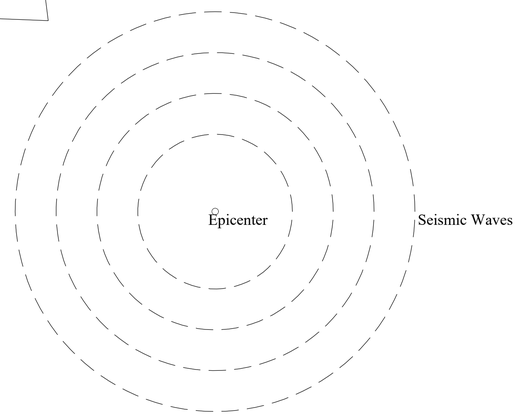
Table 2. 7 Program for Accommodation Block

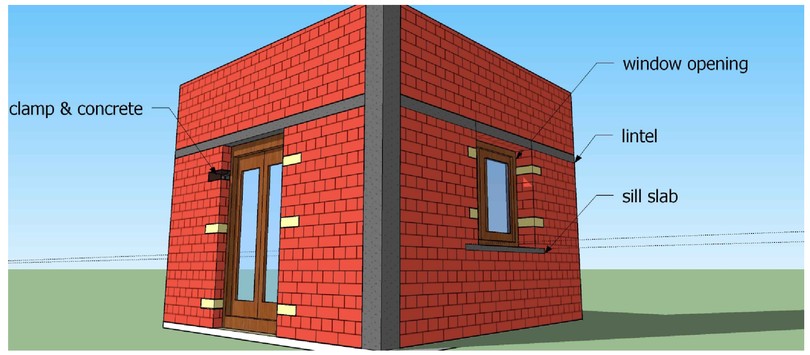
EARTHQUAKE RISK REDUCTION CENTER

BYASI , BHAKTAPUR

CONCEPT



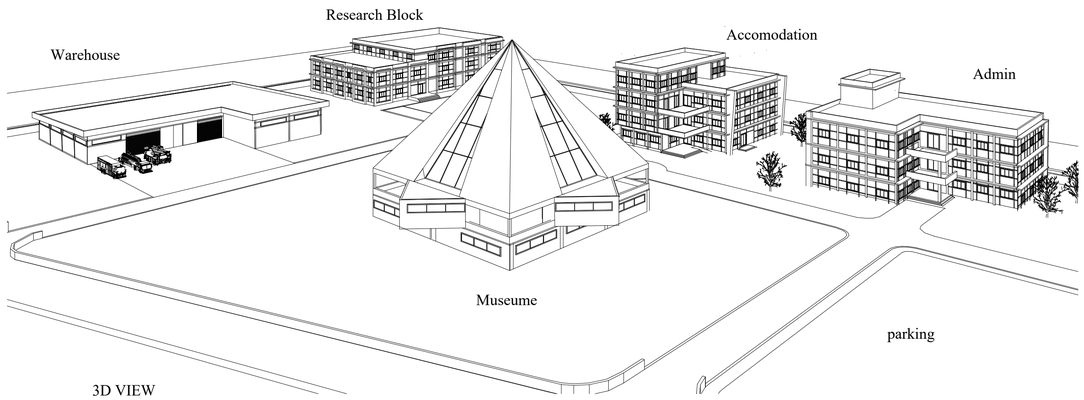




CONCEPT

- Stability through strong geometry form as rectangle and Dome
- Simplification in form through pure geometry
- Basic design principles- hierarchy, axis, rhythm, focus, repetition symmetry, and harmony shown in unified form
- Museum as the focal point, hierarchy of other building emphasizes it
- Open space in the centre is also emphasized

- Museum being focal point, other building blocks are aligned as per museum
- Open space connects all the built forms
- Museum as iconic building



3D VIEW

THESIS PROJECT

SHEET TITLE:- CONCEPT AND 3D VIEW

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

YEAR/ PART:- V/II
DATE:-2082-02-21

EARTHQUAKE RISK REDUCTION CENTER

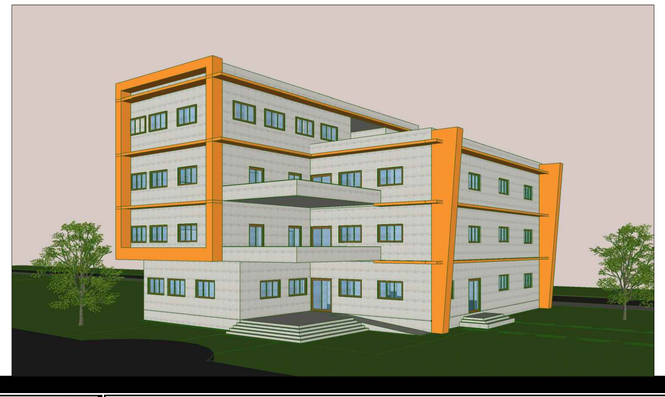
BYASI , BHAKTAPUR

South elevation

West elevation

Two Point Perspective view

EAST elevation



THESIS PROJECT

SHEET TITLE:- ADMINSTRATION BLOCK- 1:150

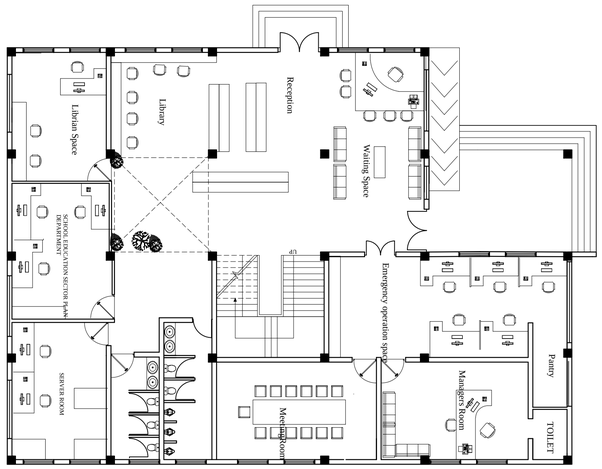
PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

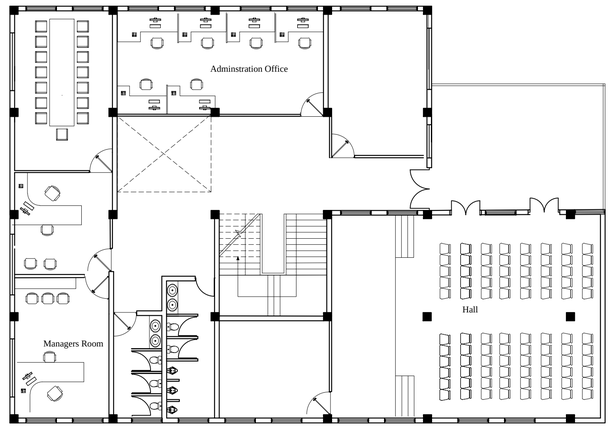
YEAR/ PART:- V/II
DATE:-2082-02-21

EARTHQUAKE RISK REDUCTION CENTER

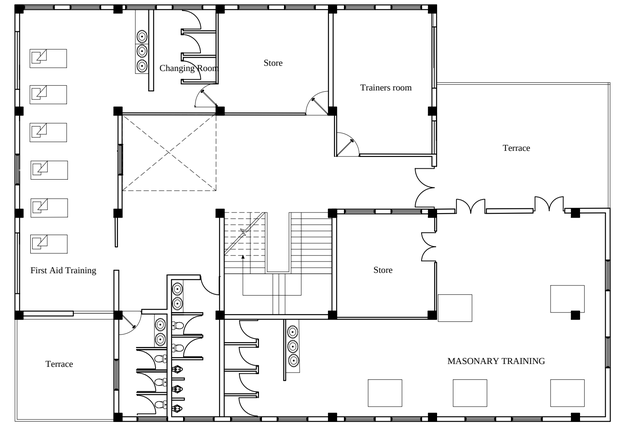
BYASI , BHAKTAPUR



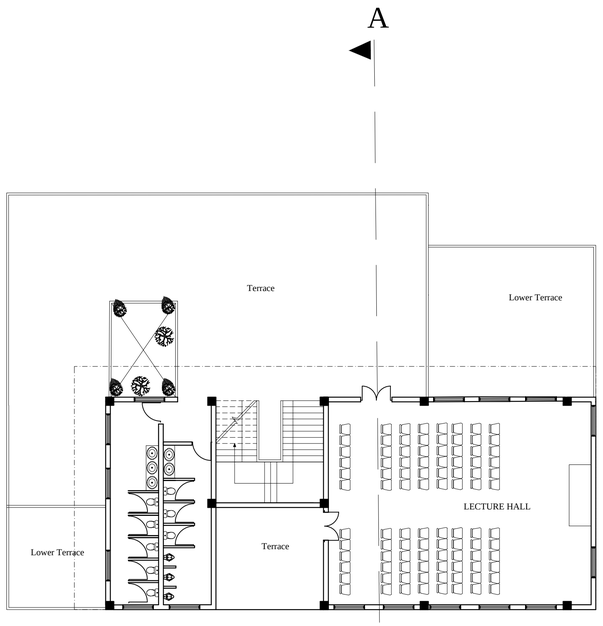
GROUND FLOOR PLAN

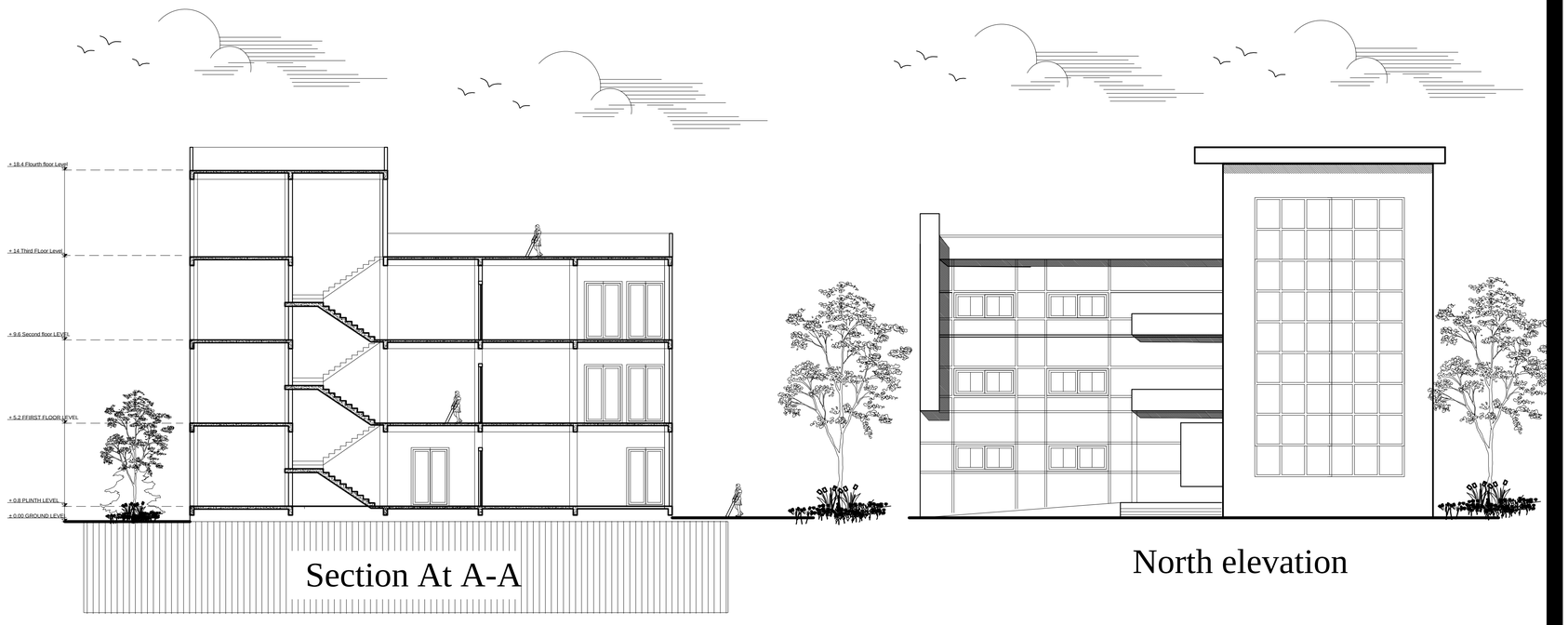


FIRST FLOOR PLAN



SECOND FLOOR PLAN





Section At A-A

North elevation

PROJECT THESIS

SHEET TITLE:- ADMINSTRATION BLOCK- 1:150

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

YEAR/ PART:- V/II
DATE:-2082-02-21

EARTHQUAKE RISK REDUCTION CENTER

BYASI , BHAKTAPUR

North Elevation

East Elevation

South Elevation

West Elevation

THESIS PROJECT

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

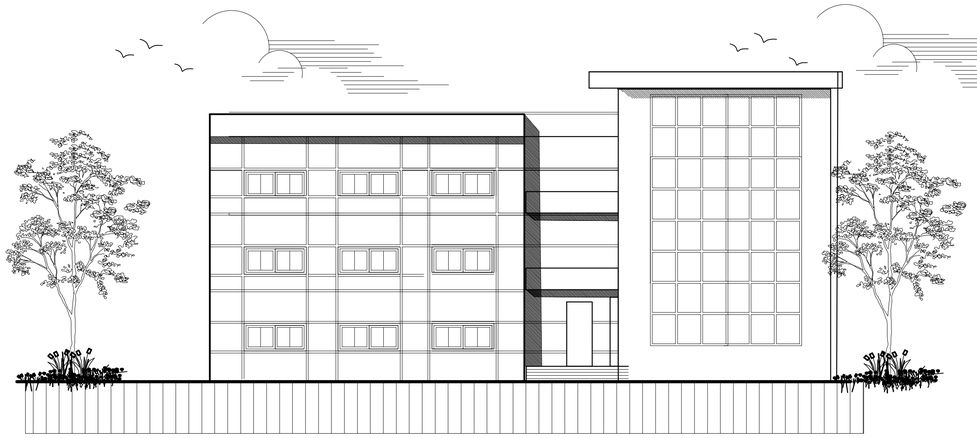
SHEET TITLE:- RESEARCH BLOCK -1:150

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

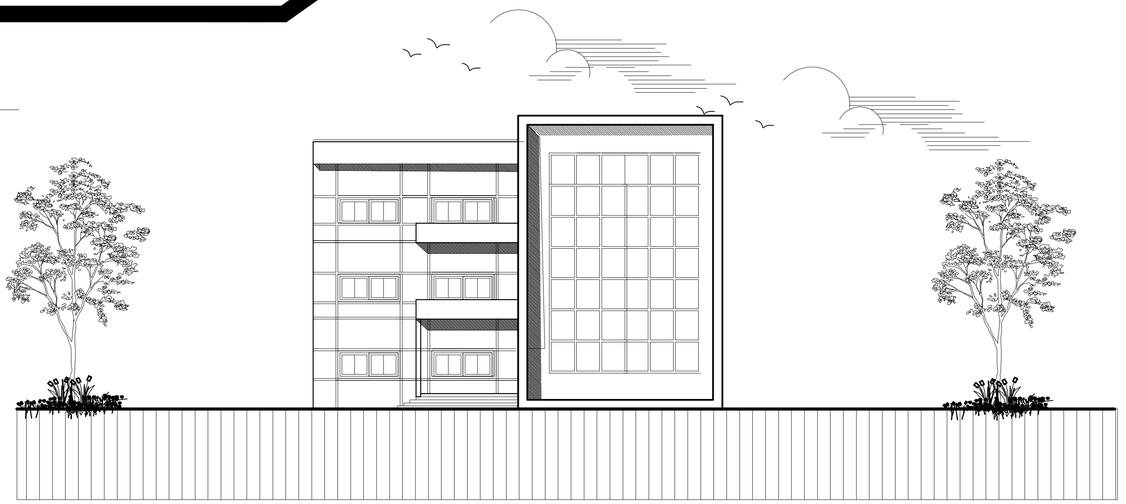
YEAR/ PART:- V/II
DATE:-2082-02-21

EARTHQUAKE RISK REDUCTION CENTER

BYASI , BHAKTAPUR



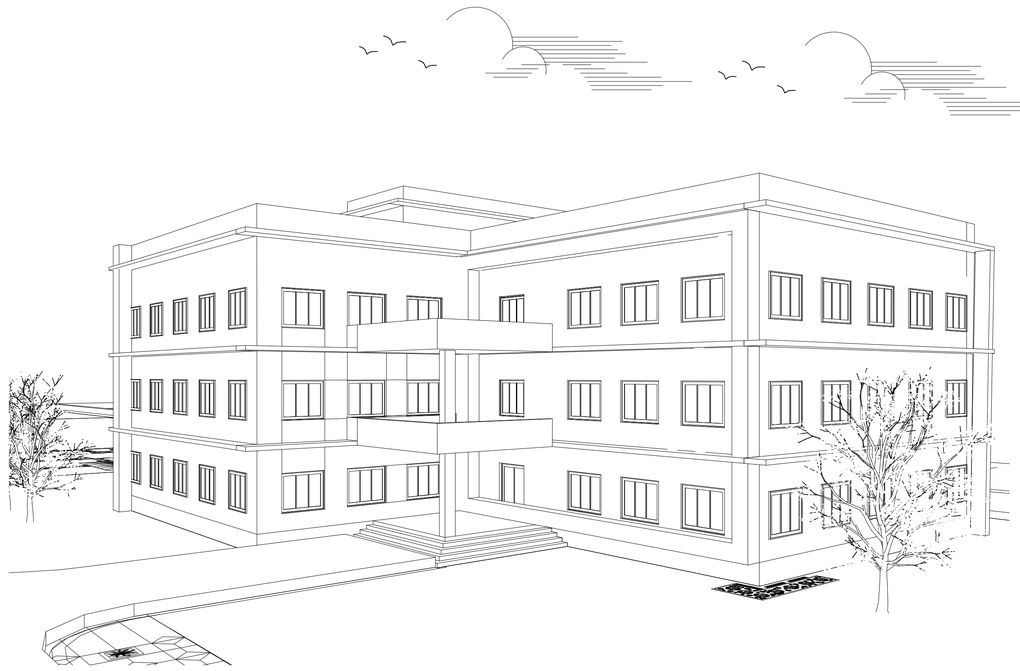
North ELevation



West Elevation

East Elevation

South Elevation



Perspective View

THESIS PROJECT

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

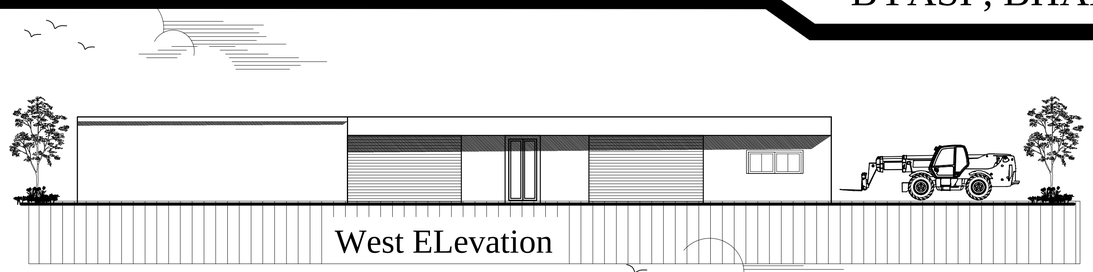
SHEET TITLE:- ACCOMODATION BLOCK -1:150

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

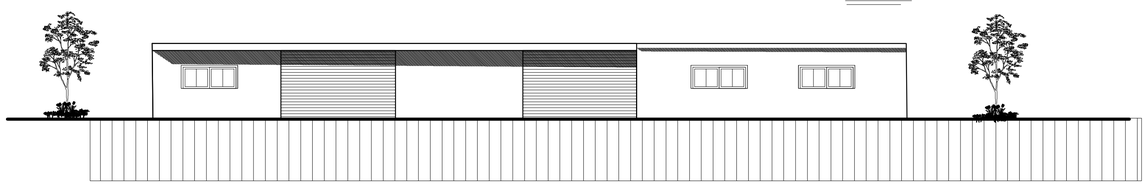
YEAR/ PART:- V/II
DATE:-2082-02-21

EARTHQUAKE RISK REDUCTION CENTER

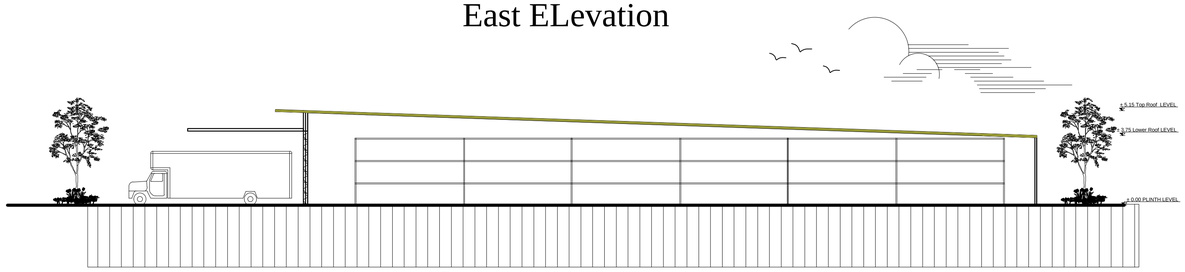
BYASI , BHAKTAPUR



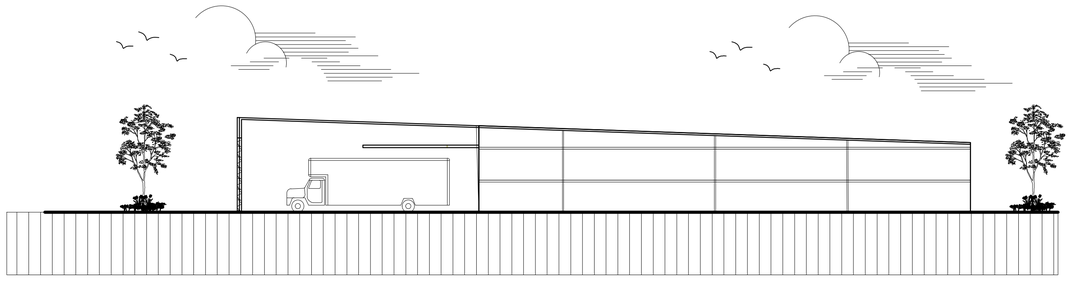
West ELevation



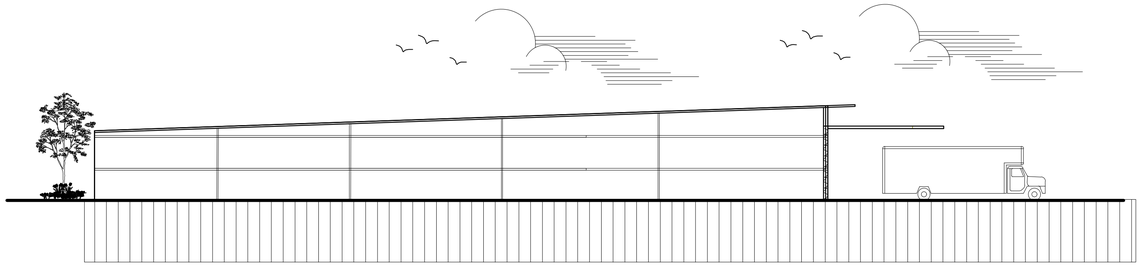
East ELevation



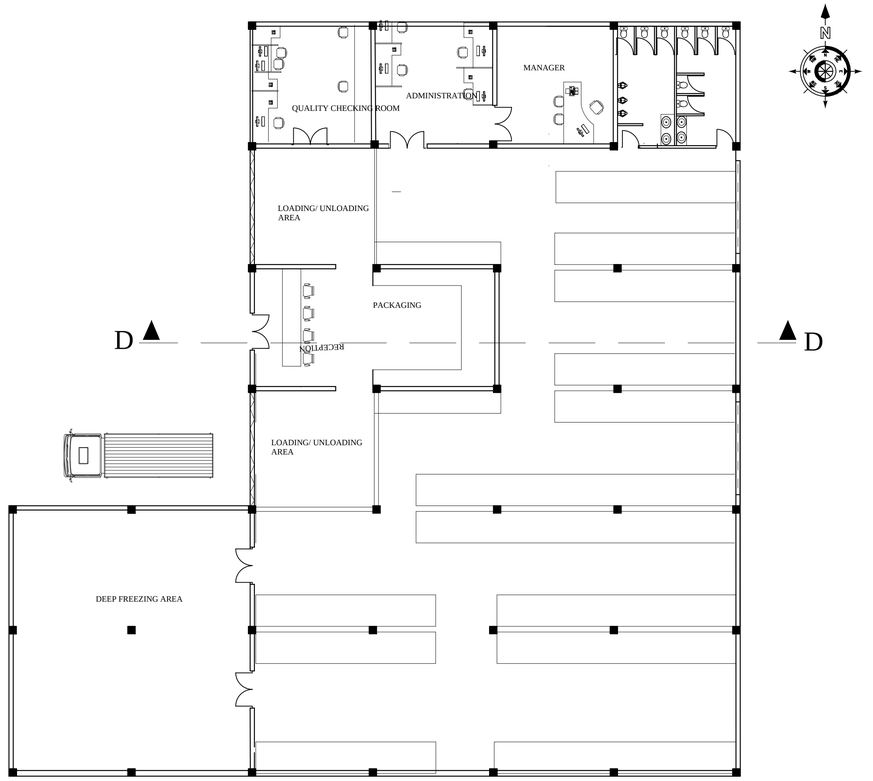
Section At D-D



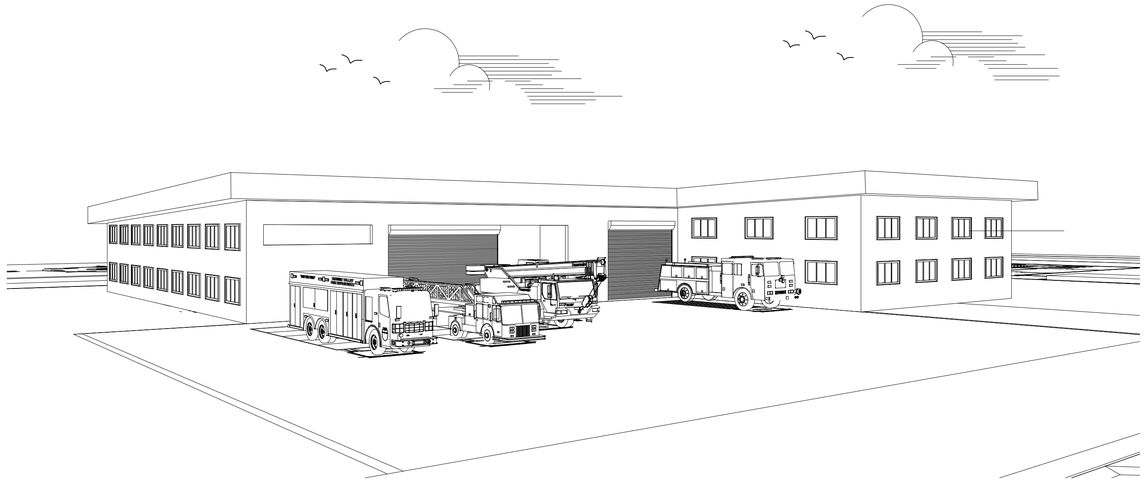
North Elevation



South Elevation



Ground Floor Plan



THESIS PROJECT

SHEET TITLE:- RESEARCH BLOCK -1:150

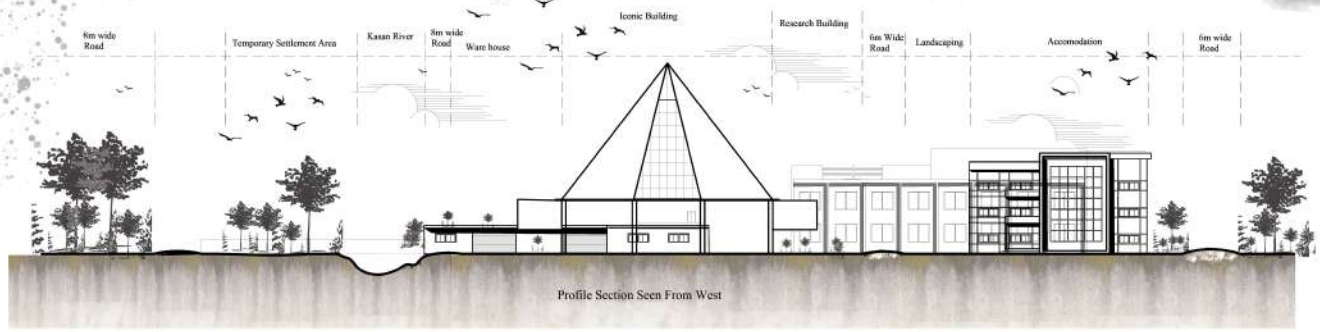
PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

YEAR/ PART:- V/II
DATE:-2082-02-21

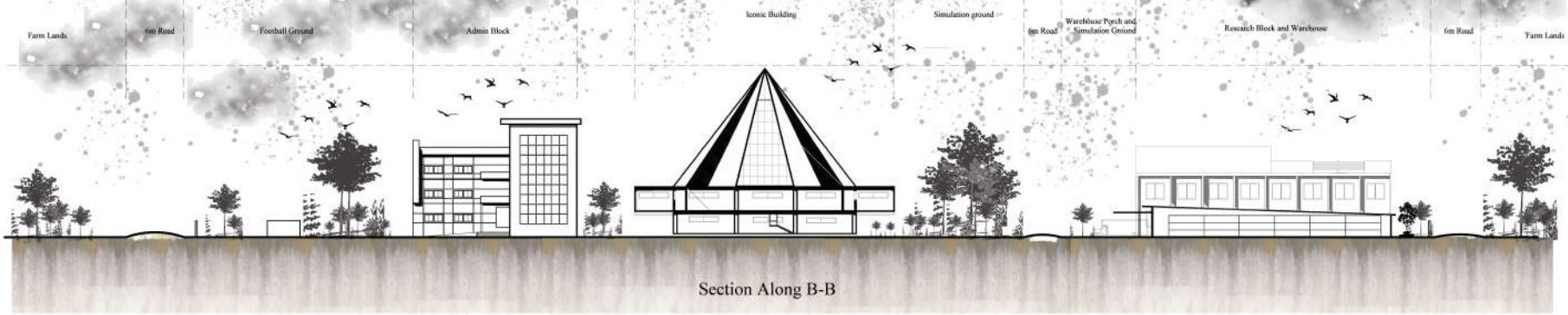
EARTHQUAKE RISK REDUCTION CENTER

BYASI , BHAKTAPUR



Profile Section Seen From West

Profile Section Seen From West



Section Along B-B

THESIS PROJECT

SHEET TITLE:-

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

YEAR/ PART:- V/II
DATE:-2082-02-21


Masterplan WIth Ground Floor
Site Area-27375 sq m
Scale -1:250
N
Amphitheater
Parking
Simulation ground
Master Plan WIth Ground FLoor

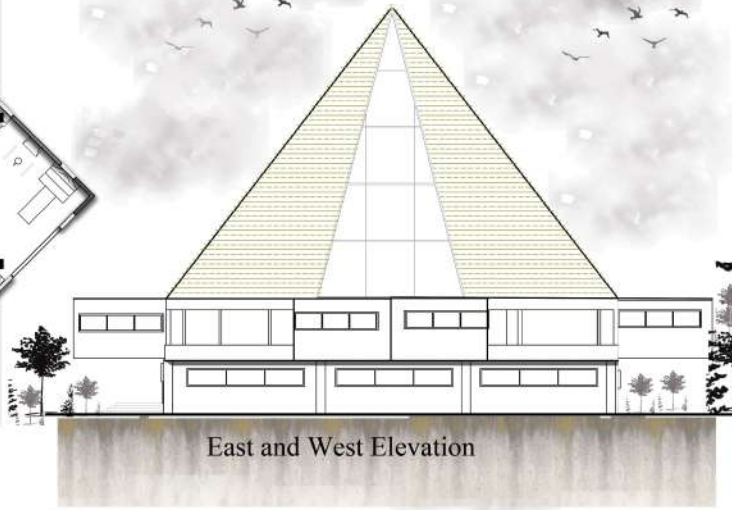
EARTHQUAKE RISK REDUCTION CENTER

BYASI , BHAKTAPUR

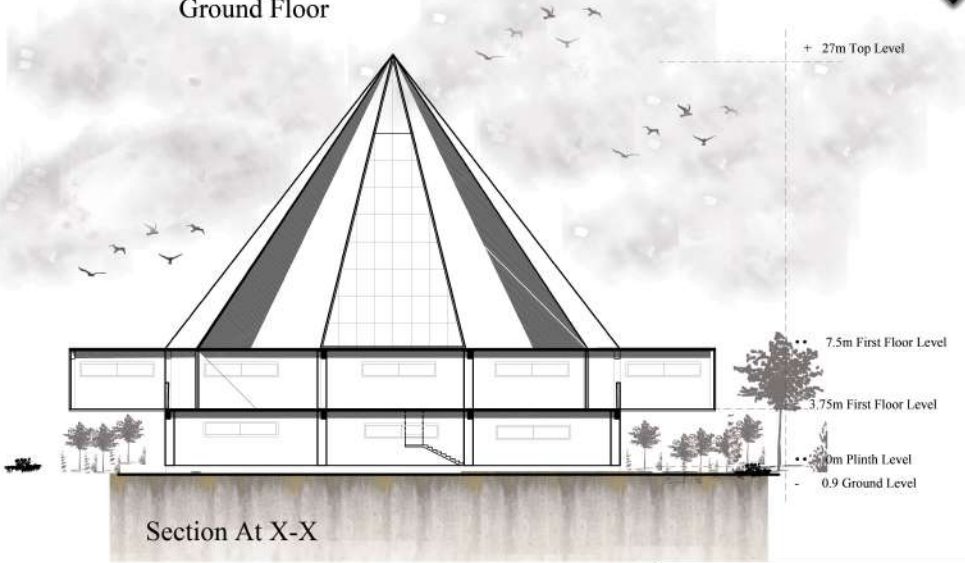
THESIS PROJECT

Ground Floor

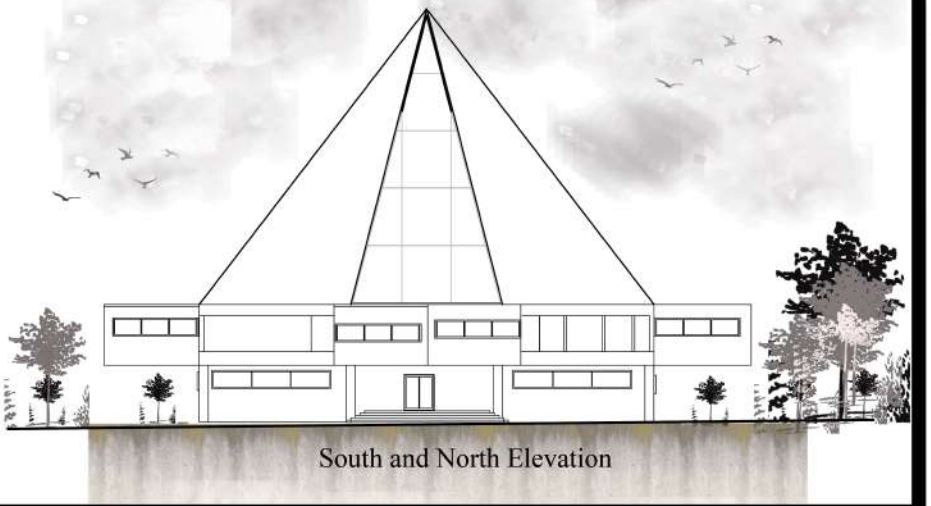
First Floor



East and West Elevation



Section At X-X



South and North Elevation

SHEET TITLE:- Iconic Block -1:150

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

NAME :- RONIJ SANDHA (760134)
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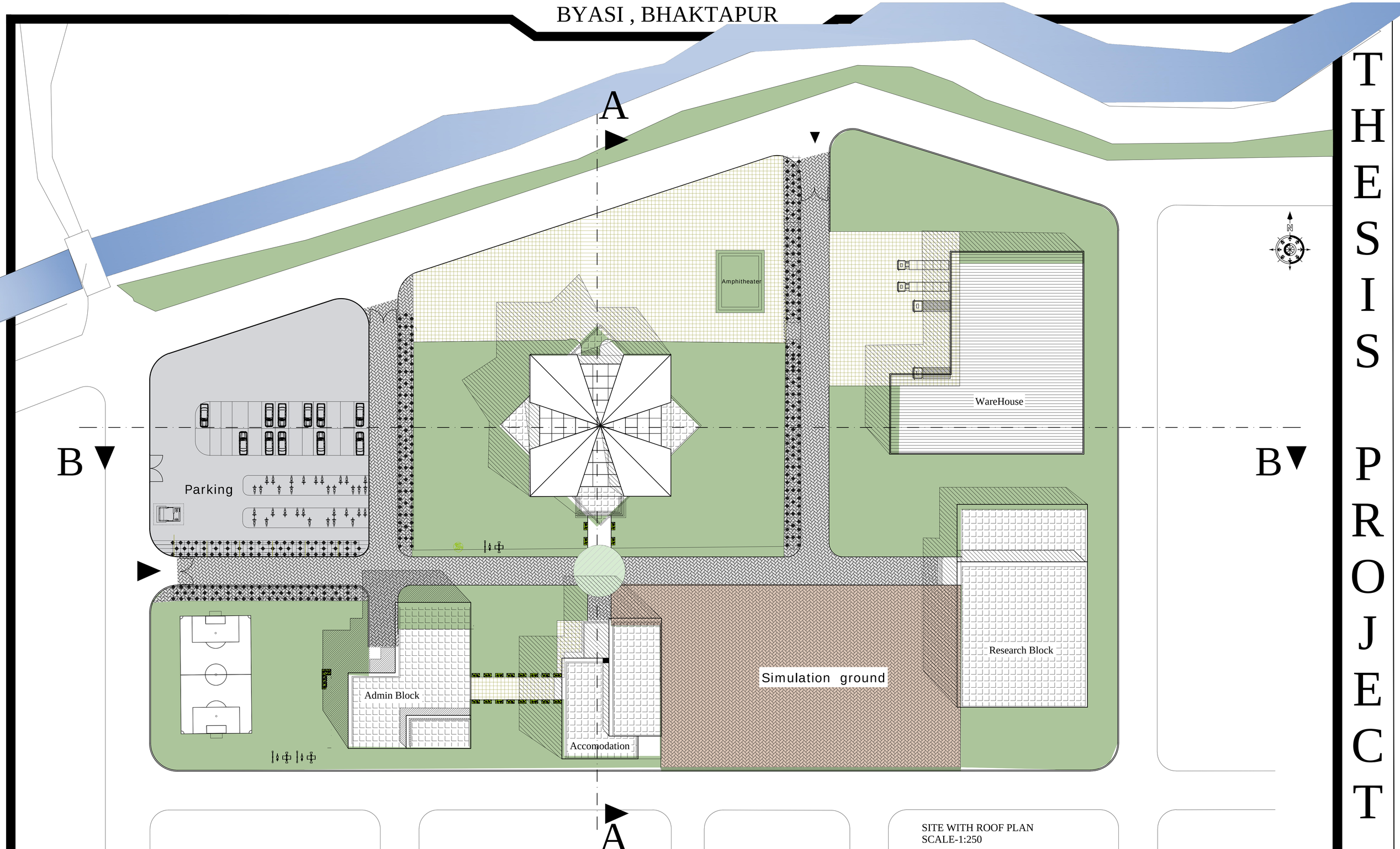
YEAR/ PART:- V/II
DATE:-2082-02-21

EARTHQUAKE RISK REDUCTION CENTER

BYASI , BHAKTAPUR



SITE WITH ROOF PLAN
SCALE-1:250

THESIS PROJECT

PURBANCHAL UNIVERSITY
KHWOPA ENGINEERING COLLEGE
DEPARTMENT OF ARCHITECTURE
LIBALI, BHAKTAPUR

SHEET TITLE:- Master Plan WIth Ground FLoor (1:300)

NAME :- RONIJ SANDHA (760134)
SUPERVISOR:- AR. DIL BHAKTA JAYANA

YEAR/ PART:- V/II
DATE:-2082-02-21