IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

5th National Conference on Science, Technology and Communication Skills – NCSTCS 2K22

Narula Institute of Technology, Agarpara, Kolkata, India

Vol. 9, Special Issue 2, September 2022

Earthquake Engineering: A Review

Sumit Nandi[1], Vivek Kumar Tiwari[2], Rupa Bhattacharyya[3] and Surajit Banerjee[4]

Associate Professor, Department of Basic Science and Humanities, Narula Institute of Technology, Kolkata, India[1]

Student, Department of Civil Engineering, Narula Institute of Technology, Kolkata, India[2]

Assistant Professor, Department of Basic Science and Humanities, Narula Institute of Technology, Kolkata, India[3,4]

Abstract: Earthquake engineering is an interdisciplinary branch of engineering that designs and analyzes structures, such as buildings and bridges, with earthquakes in mind. It is most useful in reducing the risk population is exposed to by designing new structures so they will racist strong ground shaking.It is an interdisciplinary scientific area, it identifies and solves problems associated with occurrence of earthquakes, with the goal of reducing seismic risks to socio-economically acceptable levels, it requires as it does knowledge and development from geology, seismology, geotechnical, marine and structural engineering and even architecture and insurance.The main objectives of earthquake engineering are to foresee the potential consequences of strong earthquakes on urban areas and civil infrastructure and to design, construct and maintain structures to perform at earthquake exposure up to the expectations and in compliance with building codes.A properly engineered structure does not necessarily have to be extremely strong or expensive. It has to be properly designed to withstand the seismic effects while sustaining an acceptable level of damage.Its overall goal is to make such structures more resistant to earthquakes. An earthquake (or seismic) engineer aims to construct structures that will not be damaged in minor shaking and will avoid serious damage or collapse in a major earthquake.

Keywords: Earthquake; Seismic loads; P-waves; S-waves; L-waves.

I. INTRODUCTION

Vibrations are produced whenever the earth is suddenly struck or disturbed. These vibrations set out in all directions from the place of origin. Where ever the vibrations traverse, an earthquake is said to have taken place. Thus, an earthquake may be defined as the passage of these vibrations in the earth. An earthquake is any sudden shaking of the ground caused by the passage of seismic waves through earth`s rocks.Earthquake engineering is an interdisciplinary branch of engineering that designs and analyse structures, such as buildings and bridges, with the earthquake in mind.Its purpose is to make such structures more resistant to earthquakes.An earthquake engineer with the help of earthquake engineering constructs a structure that will not be damaged in minor shaking or will not collapse in a major earthquake.It is a scientific field thatprotects the natural and man-made environment by limiting seismic risk. Fig.1 shows the design for reducing the earthquake impact on buildings.

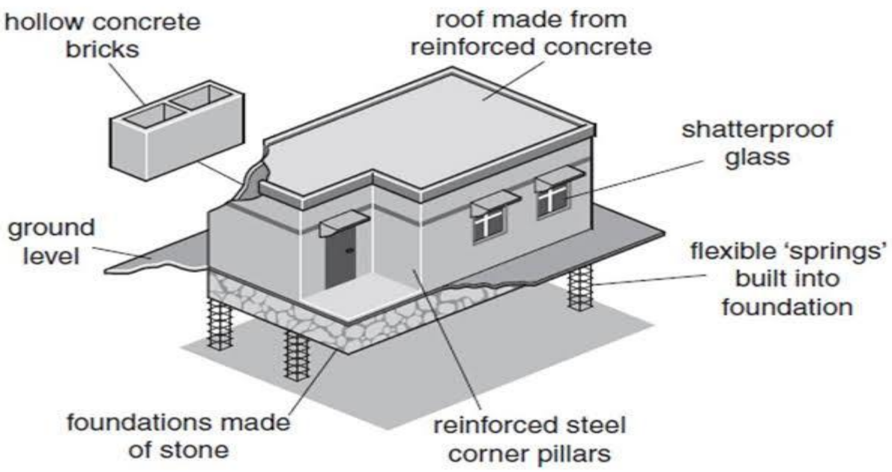


Fig.1 Design for reducing earthquake impact

Richter magnitude scale (Fig. 2):

- The Richter magnitude scale was developed in 1935 by Charles F. Richter.
- Earthquakes with a magnitude of about 2.0 or less are usually called micro earthquakes; are generally recorded only on local seismographs.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
5th National Conference on Science, Technology and Communication Skills – NCSTCS 2K22
Narula Institute of Technology, Agarpara, Kolkata, India
Vol. 9, Special Issue 2, September 2022

- Events with the magnitude of about 405 or greater, are strong enough to be recorded by sensitive seismographs all over the world.
- Great earthquakes have magnitude of 8.0 or higher.
- On the average, one earthquake of such size occurs somewhere in the world each year.

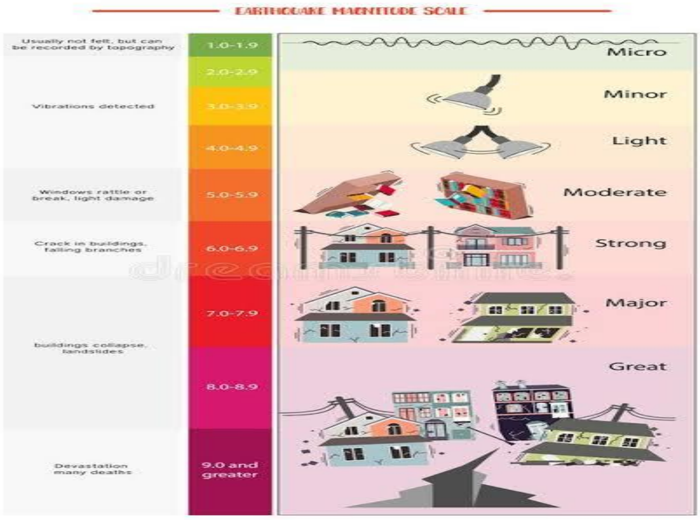


Fig. 2 Earthquake Magnitude Scale

II. REASONS AND EFFECTSOF EARTHQUAKE

Natural causes:
- Tectonic movement
- Volcanic movement
- Induced activity
- Collapsed activity
- Landslides and avalanches
- Faulting and folding in the rock beds are responsible for causing minor earthquakes.

Man -made causes:
- Waste water injection
- Hydraulic fracturing
- Enhanced recovery
- The impounding of large quantities of water behind dams disturbs the crustal balance.
- The shock waves through rocks set up by the undergrounding testing of Atom bombs or Hydrogen bombs may be severe to cause earthquake.

Destructive effects:
- Earthquake cause dismantling of buildings, bridges and other structures at or near epicentre.
- Rails are folded, underground wires broken.
- Earthquakes originate sea wave called tsunamis.
- Earthquakes results in the formation of cracks and fissures on the ground formation.
- The earthquake cause landslide.
- Landslide due to earthquake may block valleys to from lakes.

Primary effect:
- Ground break
- Fault formation

Secondary effects:
- Failure of R. C. structures.
- Failure of railway, highway and bridges.
- Failure of retaining walls.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
5th National Conference on Science, Technology and Communication Skills – NCSTCS 2K22
Narula Institute of Technology, Agarpara, Kolkata, India
Vol. 9, Special Issue 2, September 2022

- Landslide and slope failure.
- Foundation failure.
- Tsunami

Fig. 3 Impact of earthquake

SEISMIC LOADS

- Seismic loads is one of the basic concepts of earthquake engineering which means application of an earthquake generated excitation on a structure. It happens at contact surfaces of a structures either with the ground or with the adjacent structure or with gravity waves from any kind of Tsunami.
- This loads is estimated by seismology engineering.
- It is related to seismic hazard of location.
- For a seismic loads resisting system, a seismic design is necessary.

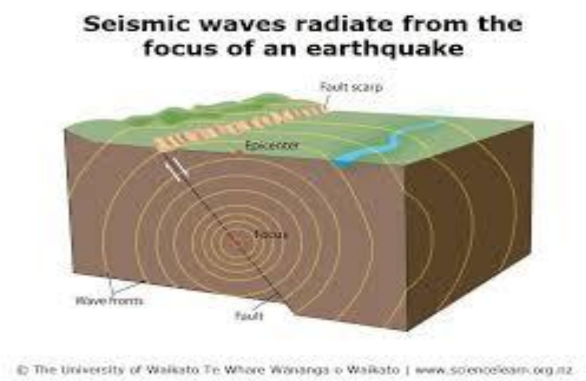


Fig. 4 Seismic waves

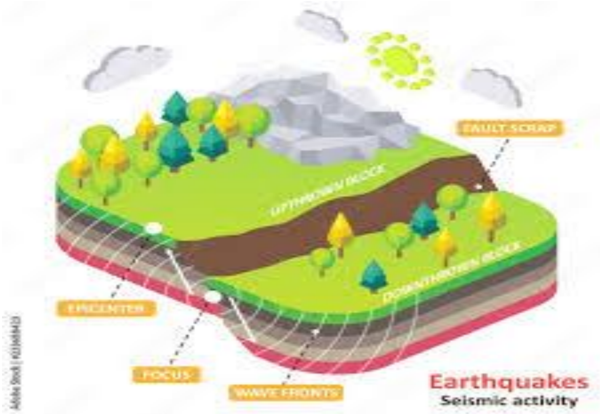


Fig. 5 Earthquake seismic activity

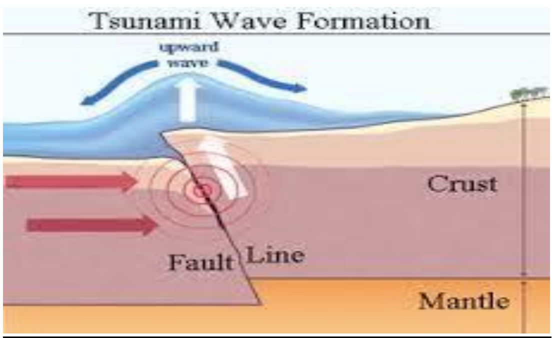


Fig. 6 Tsunami generation

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

5th National Conference on Science, Technology and Communication Skills – NCSTCS 2K22

Narula Institute of Technology, Agarpara, Kolkata, India

Vol. 9, Special Issue 2, September 2022

III. INDIAN EARTHQUAKE ZONES

The regions of Kashmir, the western and Central Himalaya, north and middle Bihar, the north- east Indian region, The Ran of Kutch and the Andaman and Nicobar group of islands falls in this zone. Generally, the area having trap rock or basaltic rock are prone to earthquake (Fig. 7)

The Indian subcontinents has a history of devasting earthquakes. The major reasons for the high frequency and intensity of the earthquakes is that the Indian plate is diving into Asia at a rate of approximately 47nm/year. Geographical statics of India show that almost 58% of the land is vulnerable to earthquakes.

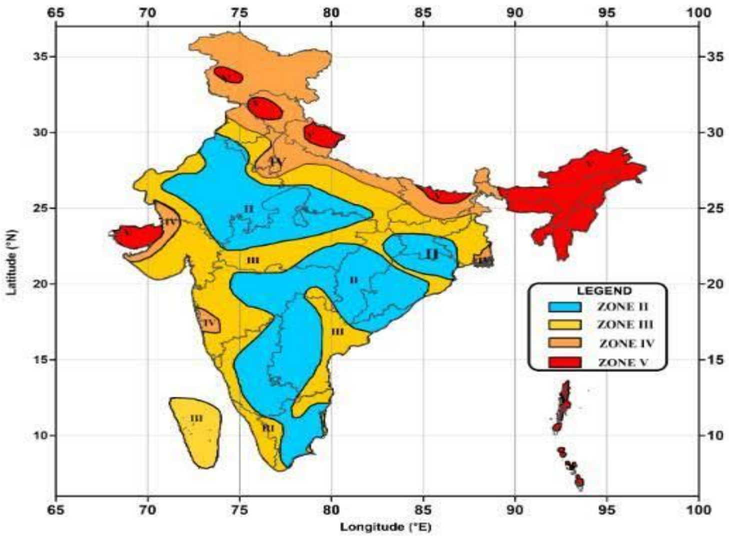


Fig. 7 Indian earthquake zones

SEISMIC BELT:

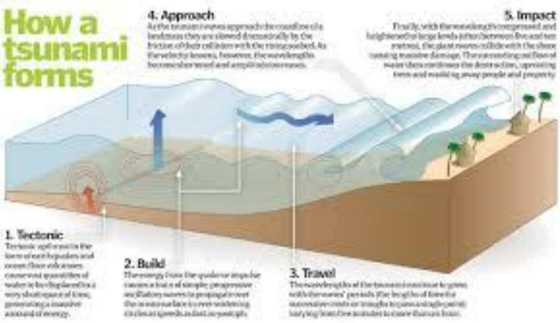
- Narrow geographic zone on the Earth`s surface along which most earthquake activity occurs.
- The outermost layer of the earth(lithosphere) is made up of several large tectonic plates.

THERE ARE THREE MAIN SEISMIC BELTS IN THE WORLD:

1. Circum-pacific seismic belt
2. Alpine-Himalayan seismic belt
3. Ridge seismic belt

SEIAMIC WAVES:

- Seismic waves are waves of energy that travel through the Earth`s layers, and a result of earthquakes, volcanic eruption, magma movement, large landslide and large man-made explosion that give out low-frequency acoustic energy.
- Seismic wave fields are recorded by a seismometer, hydrophone (in water), or accelerometer.



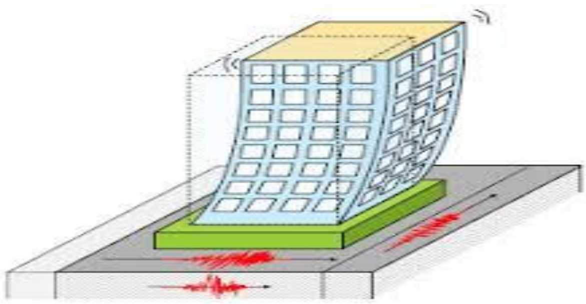


Fig. 8 Tsunami forms

Fig. 9 Earthquake behaviour of buildings

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
5th National Conference on Science, Technology and Communication Skills – NCSTCS 2K22
Narula Institute of Technology, Agarpara, Kolkata, India
Vol. 9, Special Issue 2, September 2022

P-waves:

- P-waves are a type of body wave that travel through a continuum and are the first waves from an earthquake to arrive at a seismograph.
- Typical values for P-waves velocity in earthquake are in the range 5 to 8 km/s.

S-waves:

- S-waves, secondary waves, or shear waves (sometimes called an elastic S-wave) are a type of elastic wave.
- The S-waves moves as a shear or transverse wave, so motion is perpendicular to the direction of wave propagation.Velocity tends to increase with depth and ranges from approximately 2 to 8 km/s in the earth`s crust, up to 13km/h in the deep mantle.

L-waves:

- The third general type of earthquake wave is called a surface wave, reason being is that its motion is restricted to near the ground surface.
- Such waves correspond to ripples of water that travel across a lake.
- The royal range of velocities is between 2 to 6 km/s.

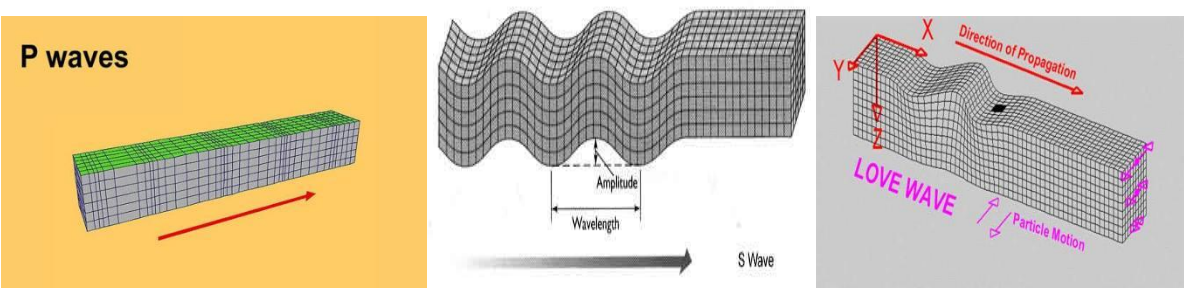


Fig. 10 Seismic waves

IV. HOW TO RESIST EARTHQUAKE

EARTHQUAKE RESISTANT CONSTRUCTION:

- To implement seismic design to enable building and nonbuilding structures.
- To meet the expectations and compliance with the applicable building codes.
- To achieve a good workmanship, detailed guidance is necessary and it should be as simple as possible.

Main things in engineering which are to be followed in earthquake resistance building are following:

- Heavy and strong foundation.
- Heavy columns with 135degree bend hook shear ring.
- Maximum walls in RCC shear wall concept.

Main things in engineering which are to be followed in earthquake resistance bridges are following:

- Bridge, structure that spans horizontally between supports, whose function is to carry vertical loads.
- The supports must be strong enough to hold the structure up, and the span between supports must be strong enough to carry the loads.
- Spans are generally made as short as possible; long spans are justified where good foundation are limited.
- For example, over estuaries with deep water.

All major bridges are built with the public`s money. Therefore, the bridge design that best serves the public interest as a threefold goal: to be as efficient, as economical, and as elegant as is safely possible. Efficiency is a scientific principle that puts a value on reducing materials while increasing performance.

- There are six basic bridge forms: the beam, the truss, the arch, the cantilever, and the cable-stay.

Beam

The beam bridge is the most common bridge form. A beam carries vertical loads by bending. As the beam bridge bends, it undergoes horizontal compression on the top. At the same time, the bottom of the beam subjected to horizontal tension. When a bridge is made up of beams spanning between only two supports, it is called a simply supported beam bridge. If two or more beams are joined rigidly together over supports, the bridge becomes continuous.

Fig. 11 Manchaca Swamp Bridge

Truss

A single span truss bridge is like a simply supported beam because it carries vertical loads by bending. Bending leads to compression in the top chords, and either tension in the bottom chord, and either tension or compression in the vertical and diagonal members, depending on their orientation. Trusses are popular because they use a relatively small amount of material to carry relatively large loads

Fig. 12 Subdivided Warren truss bridge

Arch

An arch bridge is a bridge with abutments at each end shaped as a curved arch. Arch bridges work by transferring the weight of the bridges and its loads partially into a horizontal thrust restrained by the abutments at either side. A viaduct (a long bridge) may be made from a series of arches, although other more economical structures are typically used today.

Fig. 13 Chenab bridge

Cantilever

A cantilever bridge is abridge built using structures that project horizontally into space, supported on only one end (called cantilever).For small footbridges, the cantilever may be simply beams; however, large cantilever bridge designed to handle road or rail traffic use trusses built from structure steel, or box girders built from prestressed concrete.

Fig. 14 Howrah Bridge

Cable-stay

A cable-stay bridge has one or more towers, from which cables support the bridge deck. A distinctive feature are the cables or stays, which run directly from the tower to the deck, normally forming a fan like patterns or a series of parallel lines.

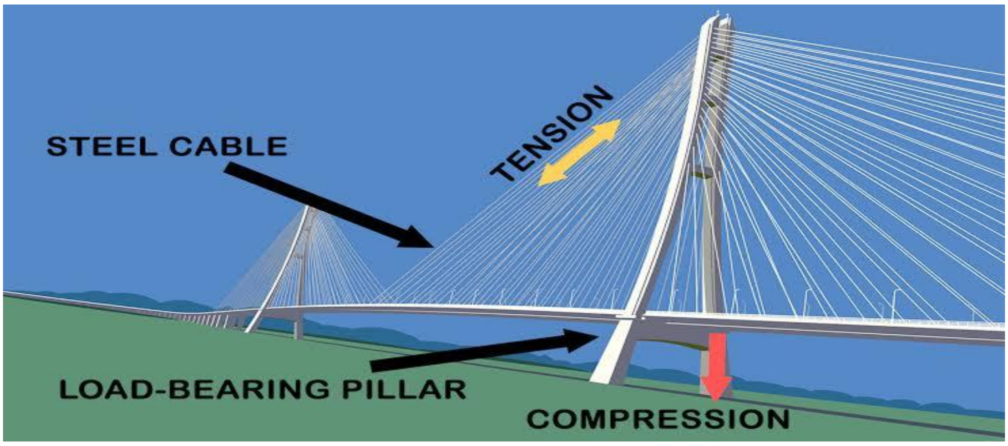


Fig. 15 cable stay bridge module

EARTHQUAKE RESISTANCE STRUCTURES:

Fig. 16 Earthquake resistance buildings

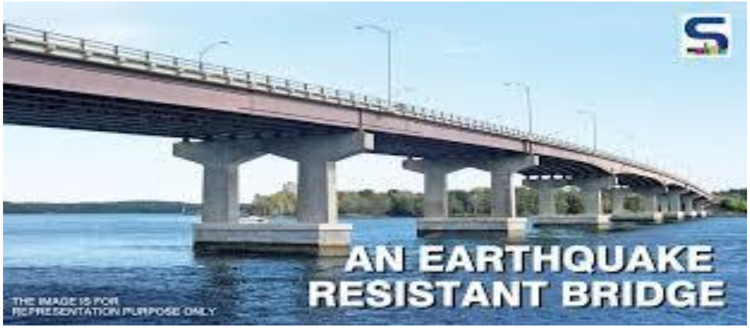


Fig. 17 Earthquake resistance bridge

PRECAUTIONS AND PROTECTION:

- First do the soil test. Structures will be constructed after testing the soils compaction tendency.
- Design of the structures or buildings should be made by professional engineer.
- Use rod according to the foundation type.
- The rod must provide necessary earthquake resistance to the building or structure.
- Maintain the quality of cement, rod and sand. Provide necessary rod in the joint of foundation and grade beam.
- This helps to provide extra earthquake resistance to the structures or buildings.
- Check column and slab design requirements by the authority.
- For earthquake resistance purpose, there will be no connection in the intersection of beam column.
- Columns of the structures or building need to be made strong to provide needed resistance. Column size can be increased from the foundation necessarily.

To protect any structure need to be specially designed structures by which we can safeguard the lives of the surrounding by adopting IS1893-2002, IS 4928-1993, IS 13827-1992, IS 13920-1997, & IS 13935-1993.

V. CONCLUSION

Locating earthquake is not an exact science, only specialized locations can improve accuracy. Structures configuration is a key factor for the safety of seismically controlled structures.Structural irregularities should be avoided for seismic design.To minimize possible losses, construction process should be organized. Each construction project needed a qualified team of professionals.Earthquake shake the ground surface, can cause buildings to collapse, disrupt transport and services, and can cause fires. They can trigger landslide and tsunami.Earthquake occur mainly as a result of plate tectonics, which involves blocks of the earth moving about the earth`s surface. The blocks of the earth move past each other along a fault. Smaller earthquake, called foreshocks, may precede the main earthquake, and aftershocks may occur after the main earthquake. Earthquake are mainly confined to specific areas of the earth known as seismic zones, which coincide mainly with ocean trenches, mid ocean ridges, and mountain ranges.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

5th National Conference on Science, Technology and Communication Skills – NCSTCS 2K22

Narula Institute of Technology, Agarpara, Kolkata, India

Vol. 9, Special Issue 2, September 2022

REFERENCES

[1] https://www.entrust.com/resources/hsm/faq/internet-of-things-iot
[2] https://www.bitdefender.com/blog/hotforsecurity/can-iot-devices-work-without-internet
[3] https://www.cloudcredential.org/blog/knowledge-byte-the-different-types-of-iot/
[4] https://www.oracle.com/internet-of-things/what-is-iot/
[5] https://www.spiceworks.com/tech/iot/articles/top-applications-internet-of-things/
[6] https://www.geeksforgeeks.org/challenges-in-world-of-iot/
[7] Skify labs, "advanced earthquake resistance techniques"-https://www.skyflabs.com/project ideas/advance-earthquake-resistance techniques
[8] https://www.engineeringcivil.com/advanced-earthquake-resistance-techniques.html
[9] https://www.essaycrop.com/blog/earthquake-engineering
[10] https://allshookup.org/quakes/wavetype.htm
[11] tbn0.gstatic.com
[12] https://en.m.wikipedia.org/wiki/earthquake_engineering
[13] https://www.slideshare.net/tarunkumar689/earthquake-engineering-71481944
[14] https://www.britannica.com/science/seismic-wave
[15] https://www.iris.edu/hq/inclass/animation/lovewave_motion
[16] https://www.coursehero.com
[17] https://en.wikipedia.org/wiki/earthquake_zones_of_india
[18] https://www.britannica.com/technology/bridge-engineering

