

# Seismic Behaviour of Soft Storey RCC Frame Building and its Analysis

Ms. Vaishnavi Rajesh Pawar<sup>1</sup> Ms. Siddhi Prakash Suryawanshi<sup>2</sup> Ms. Vaishnavi Nitin Chandratre<sup>3</sup>  
Ms. Komal Yogesh Bakare<sup>4</sup> Mr. Vijay Sonawane<sup>5</sup>

<sup>5</sup>B.E. Civil Professor (Guide)

<sup>1,2,3,4,5</sup>Department of Civil Engineering

<sup>1,2,3,4,5</sup>K. K. Wagh Polytechnic, Nashik, India

*Abstract*— Being one of most destructive disasters, earthquake causes an adverse effect on human, properties and life on earth in various ways. These devastating effects of earthquake are needed to be control on a very serious note. Keeping the modern techniques apart which are well documented in codes of practice, there are some other earthquake resistance techniques which have proved to be effective for resisting earthquake loading and are cost effective with easy constructability as well. In this paper we have discuss the methods of prevent the earthquake and solution which can be applied in order to overcome these effects and to strengthen the structure elements are also explain. The retrofitting, jacketing and shear wall method are explained. The present paper deals with the base isolation and seismic damper methods. The paper explained the frames which help in resisting earthquake as well.

**Key words:** Base Isolation, Seismic Damper System, Bracing

seismometers. An earthquake point of initial rupture is called its focus or hypocenter. Epicenter is point at ground level directly above hypocenter.

When this quake takes place, enormous amount of energy is released that is far greater than big nuclear bomb.



## I. INTRODUCTION

### A. Earthquake

Earthquake is a major natural disaster caused as a result of a sudden release of energy in the earth's crust, which causes a lot of destructive effects in many areas of world. Earthquakes are measured using observation from seismometer. An earthquake point of initial rupture is called its focus or hypocenter. Epicenter is the point at ground level directly above the hypocenter.

### B. Destructive Effects

The earthquake affects the life on earth in a huge devastating manner. The effects are caused by an earthquake on natural environment including surface faulting, tectonic uplift and subsidence, tsunamis, soil liquefaction, ground resonance, landslides and ground failure, either directly links to the earthquakes. Sources are provided by the ground shaking. Both surface deformation and faulting and shaking related geological effects not only leave permanent imprints in the environment, but also dramatically affects human structures.

### C. Remedial Measures

The present paper shows how to deal with the buildings suffering from major earthquakes that have been occurring till date. Most effective methods to prevent this dangerous disaster are explained in the paper.

## II. WHAT IS AN EARTHQUAKE?

Earthquake is shaking of surface of an earthquake (also known as quake, tremor, and temblor) as a result of a sudden release of energy in earth's crust that creates seismic waves. Earthquakes are measured using observation from

### A. Types

- 1) Aftershock
- 2) Blind trust earthquake
- 3) Cry seism
- 4) Deep focus earthquake
- 5) Doublet earthquake
- 6) Earthquake swarm
- 7) Foreshock
- 8) Harmonic tremor
- 9) Mega thrust
- 10) Slow earthquake
- 11) Summative earthquake
- 12) Super shear earthquake
- 13) Tsunami earthquake
- 14) Volcano tectonic earthquake
- 15) Interpolate earthquake

### B. Waves

The waves of some energy are observed to be released during the occurrence of an earthquake, commonly known as seismic waves.

It appears like replies created in water, if a stone is thrown in it.

Seismic waves are those waves that can travel through inside of earth and on the surface of earth as well recorded on seismographs.

There are various different kind of seismic waves moving in different ways. Earthquake radiates seismic energy as both body and surface waves. There are two main types of waves that are- 1. Body waves

### C. Surface waves

#### 1) Body waves:

Body waves can travel through the earth's inner layer. They originate at the epicenter of the earthquake and travel at amazing speeds.

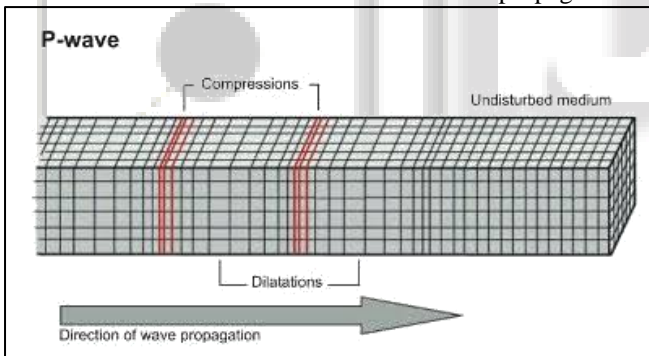
Travelling through the interior of the earth, body waves arrive before the surface waves emitted by an earthquake. These waves are of a higher frequency than surface waves.

There are two types of body waves-

##### a) P – Waves:

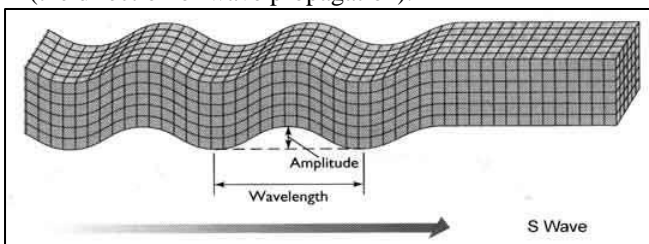
The first kind of body wave is said to be the p wave or primary wave. This has proved to be the fastest kind of seismic wave, and consequently, the first to 'arrive' at a seismic station. The p waves can move through solid rock, and fluids, like water all the liquid layer of the earth. It pushes and pulls the rock it moves through, just like sound waves push and pull the air during a thunder storm, sound of rattle of windows can be heard, the windows rather because the sound waves where pushing and pulling on the window glass much like p waves push and pull on the rock. Sometimes animals can hear the p waves of an earthquake too. For instant, dogs began barking historically just before an earthquake's 'hits'. Usually people can only feel the bump and rattle of those waves.

P waves are also term as compressional waves, because of the pushing and pulling they do. Subject to a p wave, particles move in the same direction that the wave is moving in, which is direction that the energy is travelling in, and is Sometimes called the direction of wave propagation.



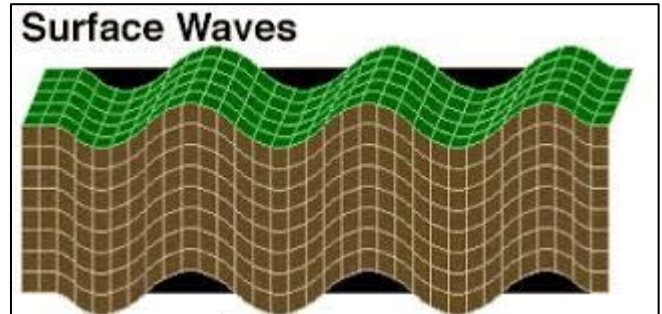
##### b) S – waves:

The second type of body wave is the s waves or secondary wave, which is supposed to be the second wave you feel in an earthquake. An s waves is slow than a p wave and can only move through solid rock, not through any liquid medium. It is this property of s wave that let the seismologist to conclude that the earth's outer core is a liquid. S waves move rock particles up and down, or side to side perpendicular to the direction that the wave is travelling in (the direction of wave propagation).



##### c) Surface waves:

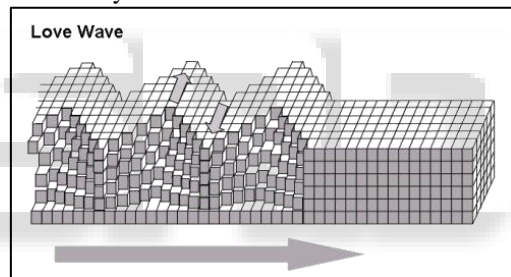
Surface waves are of a lower frequency than body waves, and are easily distinguish on a seismogram as a result. They travel only through the crust. Though they arrive after body waves, the surface waves are said to be almost entirely responsible for the damage and the destruction associated with earthquake. In the deeper earthquakes, this damage and the strength and the surface waves are seemed to be reduced.



There are two types of surface waves-

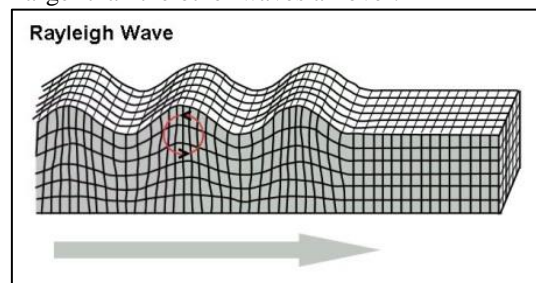
##### (1) Love waves

The first sub type of surface wave is love waves, named after A.E.H. love, a British mathematician who worked out the mathematical model, for this kind of wave in 1911. It moves the ground side to side. It is said to be the fastest surface wave Confined to the crust surface, love waves produced entirely horizontal motion.



##### (2) Rayleigh waves:

The other kind of surface waves is the Rayleigh wave, named for John William Strutt, Lord Rayleigh who mathematically predicted the existence of this kind of wave in 1885. Just like a wave rolls across the lake or an ocean a Rayleigh wave moves along the ground. Because it rolls, it moves the ground up and down, and side to side in the same direction that the wave is moving. Most of the shaking felt from an earthquake is due to the Rayleigh wave which is much larger than the other waves all over.



### D. Causes

Earthquake can prove to be extremely injurious and harmful for the life on earth. It can cause serious destructions to the property, people and even kills. Earthquake mainly happens

when there is a sudden movement or breaking of tectonic plates. Tectonic plates are nothing but huge rock pieces with in earth's crust. Nearly every year, earthquakes are recorded in various parts of worlds. An earthquake occurs when plates grind and scrap against each other (pacific plate consists of most of Pacific Ocean floor and the California coast line). North American plate comprises most of north American contents and parts of Atlantic ocean.

#### E. Types

##### 1) Plate tectonic monuments:

Majority of earthquakes are caused due to the plate tectonic movement. Plate tectonics is the continued slow movement of the tectonic plates, the outer most part of earth. This motion is what causes earthquakes and volcanoes and has created most of the spectaculars scenery around the world.

##### 2) Volcanic activity:

Volcanic activity causes massive earthquake as well. Earthquakes normally accompany escaping magma as it rises to the crust during a volcanic eruption. Sudden displacement and shaking of underground rocks are same to be the main causes. It creates fault lines and underground disturbances that can impact in to the sudden ripping or falling of the tectonic plates thus realizing the pent-up pressure that moves outward directing all around.

##### 3) Underground explosion:

Underground explosion also seems to generate the seismic waves causing earthquake. It helps in construction of railroads, subway or underground tunnels. However some of the seismic waves produced by these Activities are not strong as those produced by real earthquakes. Underground nuclear test are known to be very dangerous and can produced powerful seismic waves similar to that of a natural earthquake this being an adequate reason, raise the necessity to ban underground nuclear test, globally.

#### F. Effects of Earthquake

The most important effects of earthquake are ground shaking, ground rupture, landslides, tsunamis and liquefaction fires.

##### 1) Ground shaking:

One of the most familiar effect of earthquake is observed to be ground shaking. It is the result of passage of seismic waves the ground. It ranges from quite gentle in small earthquake to incredibly violent in large earthquake.

##### 2) Ground rupture:

It proves to be another major effect of earthquake. When the earthquake movement along a fault actually breaks the earth surface, occurrence of this respective effect can be observed rupture

##### 3) Landslides:

Both earthquakes by direct rupture and by sustained shaking of unstable slopes are caused the land slides. They can easily destroy building in their path or block roads and railroad lines, and take hill top comes along with them as they tumble.

##### 4) Tsunami:

Commonly known as tidal waves, tsunami are a grave hazard to many parts of the world, particularly around the pacific ocean basin

Tsunamis are a series of water waves caused when the sea floor waves vertically in an earthquake, which can travel vast distances in short time.

Tsunami speeds in the deep ocean have been measured at more than 700km/hour. It can rise up to more than 27m (that is 90 feet)

##### 5) Liquefaction subsidence and related effects:

In unconsolidated ground, liquefaction and subsidence of ground proves to be important factors that often cause much of destruction. When sediments grains are laterally made to float in ground water, that causes soil to lose all its solidity, then it can be said to be liquefaction.

The effects of earthquakes prove to pose a grave danger to building, roads, train lines, airport runway, gas lines etc.

##### 6) Fires:

More sources of damage after earthquake can be considered the fires.

Ground rupture and liquefaction can easily rupture nature gas, mains and water mains, both contribute to the ignition of fire and hindering the efforts to control them.

### III. METHODOLOGY

Apparatus – Straws, stick, steel strips, cello tape, wooden base, pipes, rubbers.

#### A. Procedure

##### 1) Steps 1:

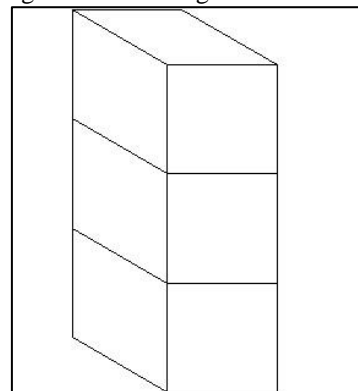
The very first operation, once all the material has been collected is to prepare and appropriate base. The base should be made such that it can shake in forward, backward and sideward direction (i.e. sway action). The base can be of any material. The present test consists of a wooden base which is prepared by assembling the equipment i.e pipes, joints, rubbers, hooks together.

##### 2) Step 2:

Second operation comprises of comparison testing. Step second brings us to prepare a building model which has got no bracings and another model that has proper bracing and base isolation with in. collect wooden sticks of proportion and assembled them in such way that three story building is formed. The ends of the sticks can be connected by using cello tape. Now, four models out of which three models have to be given different bracing and one should have pendulum (damper system)

Bracing can be done in different ways.

Simple building without bracing-



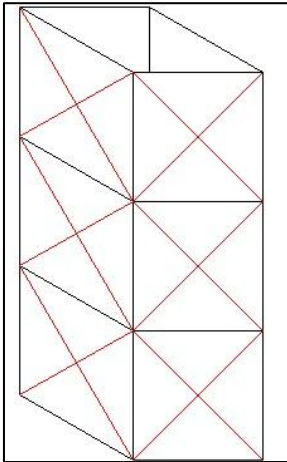


### B. Floor to floor internal

Material like sticks, straw, metal strips can be used to brace the floors of the building model. All the outer faces of the building are provided with bracing connected at the corners in cross-ways, internally.

### C. Floor to floor external

Similarly, in this system the bracing is provided externally on the outer faces of all the floors in cross manner.



### D. Throughout internal/external

In this type of bracing, the bracing constituent is connected from one external/internal corner of outer wall (top) throughout another external/internal corner of the building (bottom). In all the four walls.

### E. Cables system

Cable system is nothing but, the cable used as bracings on the walls to prevent the damage due to earthquake action. Rubbers can be used to indicate the cables in the building. Hooks are provided on each floor on the external/internal. So that the rubber can be attached which would extent such that it can prevent the building frames from collapsing.

### F. Pendulum

The building model can be made stable during earthquake action by providing damper system that is a pendulum which is fixed at one end in building (top) and allow dropping down freely. This is done so that the weight can be balanced properly by the pendulum and the frames are prevented from damage/collapses.

Once all this steps are done, the last operation consists of comparing the methods applied above. The building model without bracing is placed on a shaking/vibrating wooden base. Along with this, all the models with bracing, cables etc. are placed on the base one by one. The vibrating/shaking of the base is created so that both the models experienced earthquake effect as the base goes on shaking, it can be observed that the building with bracings and damper system does not collapse as it consist of internal and external cables, bracing material which holds the frames of building and walls on place and there is no harm caused there. On other hand the building without bracing and cabling collapses within a few minutes and causes harmful effects all over, thus it can be observed that if structure are provided with proper bracing and earthquake

resistance system, it would not collapse and danger to human civilization is prevented.

## IV. ADVANTAGES

- Jacketing increases the seismic capacity and shear strength of the column.
- Steel jacketing does not increase the significant weight of the column and also saves the construction time (curing).
- Confinement of concrete in circular column is increased as well.
- Moving of the roof framing and floor members is also prevented due to the stiffness of the shear wall.
- Stiff buildings suffer less nonstructural damage.
- Shear walls reduces lateral sway significantly.
- Enough well distributed reinforcement.
- Bracing of the building reduces lateral storey displacement, storey drift as well as axial force and bending moment in column to remarkable level.
- In this case concentric bracing has been used which proves to be more effective all over.

## V. USE

To make earthquake resistant high rise buildings.

## VI. CONCLUSION

The result of the present study shows that bracing element will have very important effect on structural behavior under earthquake influence from above test we can calculate that the building mode with “bracing system, the most effective and efficient resistance design is achieved and it gives the best test result among all. Rest of the system proves to be preferable and applicable as well. Thus diagonal bracings shows highly effective and economical design of bracing style, which brings us to construction a safe, rigid, strong and sustainable structure so that all harm and danger to human civilization is prevented.

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