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Analysis of multistoried building using E-Tabs

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ABSTRACT

The main objective of this project is to protect the building by designing it as earthquake resistance structure. "Base Isolation'' is one of the most widely accepted seismic protection system used in building a structure in an earthquake-prone area. There are many types of base isolation systems but Lead Rubber Bearing (LRB) is used as base isolation system in this project, LRB is most widely used as isolation system for a building. So, in this paper, we analyzed the structure with base isolation by using E-Tab software & by adopting a Time History Analysis Method. Base Isolation system for the building is introduced to decouple the building structure from potentially damaging effect by earthquake motion and to make a comparison between the isolated base & fixed base building.

Keywords— *Base isolation, E-Tab software, Time history analysis, Isolator, LRB (Lead Rubber bearing), Acceleration and displacement*

1. INTRODUCTION

1.1 General

An earthquake is a naturally occurring hazard, because of that thousands of people lost their life. No one can predict the earthquake. It is not possible to find out the time & the place of the earthquake. Researchers interest last many years to design & construct the building in such a way that to resist the earthquake. They also try to measure the frequency & intensity of earthquake for the future design of the structure. The parameters like Safety, Strength a performance which are to be considered while designing structure in seismic zones.

For that reason, codes & guidelines are prepared by engineering societies which can be used to design the building. The following factors responsible for the failure of the structure under seismic:

(a) Wrong and weak structure and irregularities in the planning phase.
(b) Unplanned and Non- Scientific construction activities.

1.2 Necessity

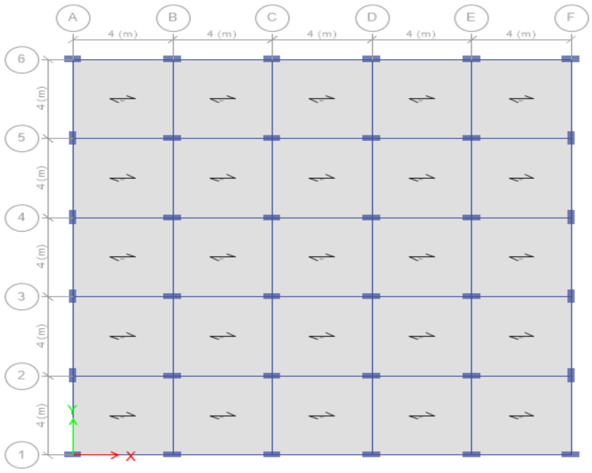
- There is very high human as well as economic loss due to the non-predictable earthquake. Therefore it is necessary to analyze, design and execute the earthquake resistant building.
- It is necessary to create awareness of building with consideration of base isolation system.
- It is necessary to try to find out the response of building by consideration of base isolation system which is one of the earthquake resistance systems.
- To minimizes the future loss in many senses due to the harmful effect of earthquakes.

1.3 Objective

- To study the base isolation system for earthquake resistance structure.
- To study the various factors affecting the base isolation system.
- To get the basic idea about the working of the base isolation system.
- To study the various types of different materials having different properties used in base isolation.
- Comparing the behavior of fixed base and isolated base building.
- To know the most efficient material in base isolation system.
- To study the dynamic response of building for various isolated material.

2. METHODOLOGY

In the present paper, two structural models of G+12 storied with or without base isolation multi-storied buildings were modelled & analyzed using E-TABS V 16.2.0. The conventional building was modelled with fixed support & the base isolated building was modelled lead rubber bearing. Plan area of the structure is 20 * 20 m i.e. 5 bays of 4m length in X-direction and 5 bays of 4m length in Y-direction. There are two methods of analysis of earthquake 1. Response Spectrum Method. 2. Time History Method. For Time History Analysis, Bhuj earthquake data is considered. IS codes like IS 1893-2016 (Part 1), IS 456-2000, IS 800-2007is required. So, base isolation is important to reduce the effect of the earthquake on the building.



3. PERFORMANCE CRITERIA

For a normal building, there are mainly two performance criteria: Maximum Displacement and Drift. But in case of high rise building due to the slenderness of building acceleration or also important performance criteria. If acceleration goes above comfort level, the building will be unserviceable.

3.1 Displacement

According to IS 456 lateral deflection at the top of the building should not be greater than H/500, where H is the total height of the structure.
Maximum Displacement = 0.6432m

3.2 Acceleration

Any Indian Code does not give detailed criteria about maximum acceleration level in the building. According to research papers, human beings can sense acceleration above 0.1 m/sec^2 and 0.1 to 0.2 is noticeable. At levels 0.4 to 0.5 human faces difficulty to walk on the floor. A human can sustain acceleration up to 0.7 m/sec^2 and above this level objects in the building starts falling.

4. SCOPE

Earthquake affects our lives economically as well as ecologically. Vast destruction and damage of structure occur due to an earthquake that can be prevented by efficient planning which includes the method of base isolation that reduces the effect of the earthquake on the structure.

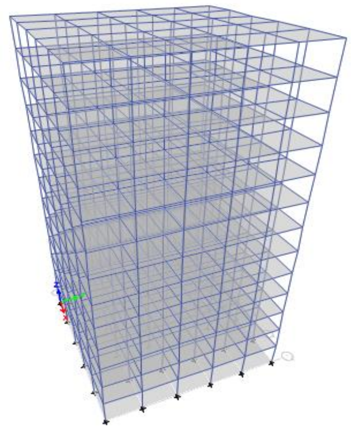
5. TIME HISTORY ANALYSIS

Time History involves the linear or Non-linear evaluation of the dynamic response of the structure to a specified loading which may vary according to time. In Time history analysis the structural response is computed at a number of subsequent time instants. It is a detailed analysis in which response is calculated for each time step. It requires more time but gives a good result.
Procedure for using Time History method of analysis in Etabs:
Step 1: Step 1: Defining the time history function.

Step 2: Step 2. Defining the target response spectrum.

Step 3: Step 3. Assigning time history as a load case.
Scale factor = I.G/ R
I = Importance factor = 1
G = Acceleration due to gravity = 9.81 m/s^2
R = Response & reduction factor

Step 4: Step4. Next run the analysis and get the result.



6. DESCRIPTION OF THE STRUCTURE

Plan Dimensions = 20m * 20m (X*Y)
Floor to Floor height = 3m (Z)
Total height of the building = 39m
Type of the structure = OMRF
Soil type (as per IS 1893 (part 1) 2002) = Medium
Response reduction factor = 3
Importance factor = 1
Seismic zone factor = 0.36 (zone v)
Grade of concrete and steel = M30 and Fe500
Beam size = 0.23m * 0.48m
Column size = 0.30m * 0.70m
Slab thickness = 0.150m

Load combinations = $1.2[DL+IL+(EL_X+0.3EL_y)]$
$1.2[DL+IL-(EL_x-0.3ELy)]$
$1.2[DL+IL+(EL_y+0.3EL_x)]$
$1.2[DL+IL-(EL_y-0.3EL_x)]$
$1.5[DL+(EL_x+0.3EL_y)]$
$1.5[DL-(EL_x-0.3EL_y)]$
$1.5[DL+(EL_y-0.3EL_x)]$
$1.5[DL+(EL_y+0.3EL_x)]$
$0.9DL+1.5(EL_x+0.3EL_y)$
$0.9DL-1.5(EL_x-0.3EL_y)$
$0.9DL+1.5(EL_y+0.3EL_X)$
$0.9DL-1.5(EL_y-0.3EL_X)$

Load Applied
Dead Load = Calculated as per self weight
Floor Finish = 1KN/m^2
Live Load = 3KN/m^2
Seismic Load = Calculated as per IS 1893:20

6.1 Material properties

Grade of concrete = M30 (column) and M30 (Beams and Slab)
Grade of steel = Fe500
Density of concrete = 25KN/m^3
Density of brick infill wall = 20KN/m^3

6.2 Section Properties

Beam size = 230mm * 480mm
Column size = 300mm * 700mm
Slab thickness = 150mm
Wall thickness = 250mm
Link element = 0.5m

6.3 Load Consideration

6.3.1 Gravity Load:

Dead Load = Column, Beam, Slab
Live Load = 3KN/m^2
Floor Finish = 1.5KN/m^2
Wall Load = 12.5KN/m^2

7. LEAD RUBBER BEARING

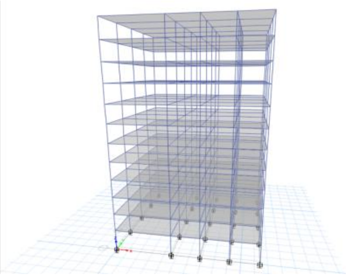
Lead Rubber Bearings (LRB) consists of a laminated rubber and steel bearing with steel Flange plates for mounting to the structure. It works on the principle of base isolation and limits the energy transferred from the ground to the structure in the event of an earthquake.

The LRB has functions listed below:

a. It has energy restoring capability.
b. Due to its property of vertical stiffness is functions as load supporter.
c. It can be easily installed since no separate damper is required.

The following properties are calculated:

- Effective stiffness
- Vertical stiffness
- Horizontal stiffness



8. CONCLUSION

In the present work, the response of multistoreyed building due to earthquake excitations has been carried out using finite element analysis on G+12 storey i.e. RC bared structure with a fixed base which is model 1 and model 2 is with lead rubber bearing. Based on the studies carried out, the following conclusions are drawn:

8.1 Mode Period

It clearly shows that the mode period of model 2 is higher than model 1 due to its flexibility.

8.2 Storey Displacement

It increased with the period at different storey level for the base isolated building.

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