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ANALYSIS OF STEEL BRACED RCC BUILDING USING DESIGNED BASE ISOLATOR

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Abstract

Effect of earthquake can be very hazardous to the structure influenced by these forces. There are many traditional methods for protection of structure against earthquake effects. But there are some disadvantages in these methods. Increasing strength and stiffness are some of the traditional methods. But they lead to higher sections and result in uneconomic design. To overcome these disadvantages associated with the traditional method, many vibration-control measures, called structural control, have been studied and remarkable advances in this respect have been made over recent years. This paper describes the effect of use of steel bracing, dampers and base isolator (lead rubber bearing) in a structure subjected to earthquake motion. The structure is designed in ETABs and then bracings, dampers, base isolator are applied respectively in 3 different models and results are compared. Force of ground motion that is earthquake force is applied to structure by using seismic coefficient method. Base isolated structure gives improved performance against seismic vibrations than conventional structure. The essential characteristics of base isolation system are isolation, energy dissipation, and restoring mechanism. It is shown that under design conditions, all base isolators can significantly reduce the acceleration transmitted to superstructure. Bracing and dampers are also useful reduction of storey drift and base shear

1. INTRODUCTION

For seismic design of building structures, the traditional method, i.e., strengthening the Stiffness, strength, and ductility of the structures, has been in common use for a long time. Therefore, the dimensions of structural members and the consumption of material are expected to be increased, which leads to higher cost of the buildings as well as larger seismic responses due to larger stiffness of the structures. Thus, the efficiency of the traditional method is constrained. To overcome these disadvantages associated with the traditional method, many vibration-control measures, called structural control, have been studied and remarkable advances in this respect have been made over recent years. Structural Control is a diverse field of study. Structural Control is the one of the areas of current research aims to reduce structural vibrations during loading such as earthquakes and strong winds. In terms of different vibration absorption methods, structural control can be classified into active control, passive control, hybrid control, semi-active control. Base isolation is a passive vibration control system that does not require any external power source for its operation and utilizes the motion of the structure to develop the control forces.

2. LITERATURE SURVEY

Kalantari, Naderpour, Vaez [1]

Investigated the effect of using two different types of seismic isolators in decreasing the base shear and story shears of structure. Four structural models with 2, 5, 8 and 12 stories for three cases including fixed-base, lead-rubber isolator and friction pendulum isolator with different stiffness have been modeled. All models have been analyzed under earthquake characteristics of Manjil, Naghan, Tabas and Elcentro using a nonlinear finite element program. The results indicate that by using lead-rubber isolators, maximum displacements of stories in low-rise structures have been increased in comparison with fixed-base model. In contrast, in majority of cases, applying the FPS isolators doesn't guarantee the displacement requirement.

Providakis [2]

performed nonlinear time history analyses using a commercial structural analysis software package to study the influence of isolation damping on base and superstructure drift. Various lead-rubber bearing (LRB) isolation systems were systematically compared and discussed for aseismic performances of two actual reinforced concrete (RC) buildings. Parametric analysis of the buildings fitted with isolation devices was carried out to choose the appropriate design parameters. The efficiency of providing supplemental viscous damping for reducing the isolator displacements while keeping the substructure forces in reasonable ranges was also investigated.

Braga, Laterza [3]

They had done experimental studies on a series of dynamic snap-back tests. This test was carried out on a residence building in southern Italy at Rapolla (Potenza–Basilicata). The aim of the research was to investigate the seismic behavior of low-rise base isolated structures mounted on rubber bearings only, or with a hybrid isolation system (sliding bearings for isolation and steel rubber bearings to have a re-centering force).

3. METHODS OF ANALYSIS

1. Begin a new model.

To star with new model, we use built in setting with display units are metric SI and for steel structure database use Indian standard, for designing steel structure use IS800:2007, and to design concrete structure use IS456:2002

2. **Story and grid data:**

Create grid data and storey data as per building dimension. For the study 10 sorey building is considered with 3mheight of each storey and grid is made with 5 bays of 4m*4m in x direction and y direction.

3. Material selection

The material and its properties are added by using command ‘Define Material’

Step 3.1 to define new material go to define the select material properties, the material is added according to region, material type, standards and grade. We can change material properties as we required.

4. Define section

The section to be used in the frame is defined by using command ‘section properties’.

Step 4.1: Go to define and the select section properties.

Step 4.2: Go to frame properties then to add section click on add new properties. Then select section shape as ‘concrete rectangular’, select rectangular shape in concrete section.

Step 4.3: Give property name and select material as M20 them add section dimension as per requirement.

Step 4.4: Modify reinforcement data by selecting rebar material, cover provided and size of longitudinal bar and confinement bar.

5. Draw object: -

Now the frame can be drawn by using previously defined frame section by using following steps:

Step 5.1: To draw beam select draw beam and change the property as beam and draw the beam at required passion.

Step 5.2: To draw any member two nodes are required. To create member such as beam and column join two nodes by using draw cursor.

Step 5.3: To draw column select quick draw column then go to drop down menu and change property to Auto column and join nodes of each story to its immediate storey nodes.

6. Add restraints: -

In model all footing nodes fixed by using following procedure.

Step 6.1: Select all nodes of footing to restrain

Go to Assign> Joint > Restraint.

Step 6.2: Now select type of restraint required and click Ok.

7. Assign steel Bracings: -

7.1 Go to define > section properties > frame properties

7.2 Then click on add new property, a dialogue box will appear on screen
Click on auto- select icon, select all sections and add it on right side

7.3 Then finish this command and go to quick draw braces. Then draw
Braces at required locations.

8. Assign Dampers:-

Steps to be performed are as follows –

7.1 Go to define > section properties > frame properties

7.2 Then click on add new property, a dialogue box will appear on screen
Click on auto- select icon, select all sections and add it on right side

7.3 Then finish this command and go to quick draw braces. Then draw
Braces at required locations.

9. Assign Base isolator:-

Steps are as follows –

7.1 Go to define > section properties > link/ support properties

7.2 Then click on add new property, a dialogue box will appear on screen
Click to change the type of property and make it as rubber isolator.

7.3 Then edit the properties and make the per our design based on
Calculations.

7.4 Then go to assign> joints> spring> point springs> add property.
Make this property as default. Then select joints from 1st storey.
Then apply the base isolator to for these joints.

10. Define Load Patterns: -

The loads to be used for seismic analysis are required to define first such as dead load , live load, floor finish load acting on the building , and also load pattern is required to be added.

Step 8.1 Click Define>load patterns Command to bring up define load patterns window. Now enter load name, type of load, self weight multiplier, and codes for load.

Step 8.2: - The seismic parameter equired for equivalent static analysis can be selected by earthquake load type the click modify lateral load

Step 8.3: -Earthquake parameters are added then press ok

11. Assign gravity load: -

In this step all the load which are defined previously are assigned to frame and area loads to the slabs however the earthquake load for equivalent static analysis is not required to assign.

Step 9.1: -The load whose magnitude transfer to the frame like wall load can be assigned by selecting the required member. To assign Go to 'Assign menu> frame load> Distributed.'

12. Define Load Combination: -

The various load combinations can be added to see the output in the form combination

Step 10.1: - Go to define menu > load combination > add new

Step 10.2: - Select load and appropriate scale factor one by one and click on add

13. Check and Run analysis, view the result:-

First check the model for any errors.

Step 11.1: - To check model go to analyze menu > Check model, if no error occure then run the analysis

Step 11.2: - To analyze the structure go to analyze menu> run analysis this will bring window asking 'set load cases to run'.

Step 11.3: - Select the load cases and run the analysis. Analysis will be started.

Step 11.4: - To view the result in tabular form go to, 'Display menu > show Tables' command. It will display window as shown in fig. select the required table by selecting check box.

4. CONCLUSIONS

1. Use of LRB as base isolator increases the maximum storey displacement of the structure by average of 40%. This increases the flexibility of structure and makes the structure stable during earthquake occurrence.
2. Story drift is reduced by 29% due to use of LRB which gives satisfactory performance during events of earthquakes.
3. Story shear is reduced by 31% due to use of LRB. This makes the structure stable during earthquake.
4. Story stiffness is not much affected. It is increased, but with less rate.
5. Time period is considerably increased for base isolated building. This increased time period reduces the acceleration and increases the reaction time for structure. This improves the performance of the structure against the earthquake.

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