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NONLINEAR STATIC ANALYSIS OF FRAMED ASYMMETRIC BUILDING WITH ISOLATOR AND DAMPER

RINCY M A
MTech, Structural engineering and construction management
Christ knowledge city, EKM
Kerala, India
rincyma20@gmail.com

SHWETHA SAJU
Assistant professor
Dept of Civil Engineering
Christ knowledge city, EKM
Kerala, India
shwethasaju@gmail.com

ABSTRACT
Buildings have irregular configurations both in plan and elevation will be more subjected to devastating earthquakes than the building with regular configuration. So certain techniques were adopted to reduce the earthquake effect on building . Seismic improvement techniques adopted to improve the stiffness and flexibility of the structure are base isolation and provision of damping devices. Analysis of these structures is done by pushover analysis and response spectrum method with the help of finite element software. Comparative analysis of structures with fixed base, structure with viscous damper and structure with HDRB isolator were done. Storey time period,base shear and torsional moments were analysed with the help of SAP software.

Keywords
Isolator; Damper; pushover analysis;

1. INTRODUCTION
Earthquake is unpredictable to the engineers and after effects of such earthquake is severe. India has experienced most devastating earthquakes in the world and during this earthquake lot of people lost their lives and most structures have collapsed . Therefore it is essential to protect structures from future earthquakes. The existing building found inadequate for resisting future probable earthquake. The buildings with regular geometry and uniformly distributed stiffness and mass both plan and in elevation undergo much less damage as compared to the building with irregular configurations. To reduce the earthquake effects on building, certain seismic control techniques were adopted.

Conventional seismic design of building attempt to make buildings that not to undergo compete collapse during strong earthquake shaking, but may sustain damage to non-structural elements and structural members in the building. Special techniques are required to design buildings such that structure remaining undamaged even in a severe earthquake. Two seismic control techniques are used to protect buildings from damaging earthquake effects are Base Isolation Devices and Seismic Dampers. The provision of isolators in the structure isolate the building from the ground, such that earthquake motions are not transmitted through the building. Seismic dampers are the special devices provided in the building to absorb the energy produced by the strong ground motion during earthquake. The main concept of the base isolation and provision of dampers in building is to introduce flexibility in structures. The seismic improvement is helpful to withstand structure against collapse during severe earthquakes.

2. LITERATURE REVIEW
. Mohammed Asim Khan and Prof. Shaik Abdulla explained the seismic performance of the building by analysing nine models of building with two different techniques such as lead rubber bearing isolator and masonry infill walls, and the analysis is done using the software SAP2000V15. From the study asymmetric R C framed building with Lead Rubber Isolation shows better performance than building with infill walls. Base shear, torsional moments, natural period and the displacement of the building with fixed base, building with lead rubber isolator and infill wall were analysed. The study shows that natural time period increases when base isolators are provided in the structure and storey displacements get reduced by the provision of infill walls. Dhananjay A. Chikhalekar and M. M. Murudi, In this paper, ten storey structures with fixed base and structure with high damping rubber bearing and viscous damper are considered and analysis is carried out using response spectrum method and non linear static analysis . Storey displacement, storey drift, natural time period and performance point of the structure were compared using the software SAP. Study shows that performance of base isolated structure against seismic effect is high when compared to the structure with viscous damper. Swathirani.K,

Muralidhara.G.B and Santosh kumar.N.B ; In this paper comparison between the fixed base building and various isolation systems such as friction pendulum isolator , high damping rubber isolator and lead rubber isolator subjected to strong earthquakes were analysed. The study shows the high damping rubber isolated frame is performing better as compared to the other isolator stiffness. Julie S and Sajeeb R studied the seismic performance of the base isolators and mass dampers in the vibration control of the building.. Displacement, story drift and base shear of the structure is compared. The study shows that base isolators are superior in controlling the acceleration response

3. BASE ISOLATION

Seismic isolation separates the superstructure from the substructure and it prevents the transfer of ground motion from foundation to superstructure. Isolated structure has the fundamental frequency much lower than that of the fundamental frequency of fixed base structure. The technique of base isolation has been developed in an attempt to reduce response on the buildings and their contents during the earthquake attacks and has proven that it is one of the most effective methods for a wide range of seismic problems on buildings. Seismic isolation consists of the installation of mechanisms which decouple the structures from the possibly damaging earthquake-induced ground motions. Base isolators lengthen the fundamental period of the structure to be controlled.

Base isolators are flexible pads , whereas the structures protected by these devices are called base-isolated buildings. The main feature of the base isolation technology is that it provides flexibility to the structure. The isolators are designed to absorb energy and thus add damping to the system. This helps in reducing the seismic response of the building.Mainly two types of isolators; they are elastomeric bearings and sliding bearings. Elastomeric isolators use low lateral stiffness of the material to increase the fundamental period whereas sliding systems use the characteristics of a pendulum to lengthen the period. Isolators are provided at the base of the building.

4. DAMPERS

Damping is the method that allows a structure to achieve optimal performance when the structure undergo seismic or other types of shock and vibration disturbances. During strong ground motions conventional structures deform well beyond their elastic limits, and eventually fail. The concept of supplemental dampers added to a structure assumes that the energy input to the structure from a transient will be absorbed both structure and supplemental damping elements. An idealized damper is in the form such that the force produced by the damper is such a magnitude and it function that the damper forces do not increase the overall stress in building. Properly implemented damper should be able to reduce both stress and deflection in the structure. Damping devices are suitable for tall buildings which cannot be effectively base isolated.

5. PUSHOVER ANALYSIS

Pushover analysis method is a nonlinear static analysis method. The pushover analysis is a method used to observe the successive damage states of a building. This method is relatively simple to be implemented and provides information on strength, ductility and deformation of the structure and distribution of demands which help in identifying the critical members which reach limit states during the earthquake. This method also assumes a set of incremental lateral load over the height of the structure. Using this analysis local nonlinear effects are modelled and the structure is pushed until a collapse mechanism is developed. Two ways to do pushover analysis are forced controlled and displacement controlled. In forced controlled pushover analysis involves applying lateral or horizontal loads in triangular or uniform pattern to the structure i.e. pushing the structure in horizontal direction. The displacement controlled pushover analysis depends on target displacement of structure. Lateral loads are applied in the form of acceleration or displacement to the structure to reach the target displacement.

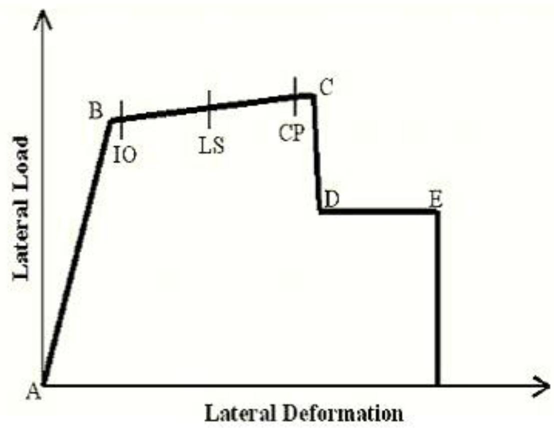

Fig 1: Lateral load versus deformation

6. MODELLING AND ANALYSIS

6.1 Structure details

In this study, a total number of 12 different models of 10, 15 and 20 story R.C framed buildings are considered for analysis. The building has six bays in X direction and three bays in Y direction with the plan dimension of 35 m x 15 m . Spacing of bay is 5m and story height is taken as 3.2 m .The building is kept asymmetric (C shape) in plan. The alignment and size of column is kept same throughout the height of the structure. The building is considered as a Special

Moment resisting frame. The building is founded on medium strength soil through pile footing under the columns. The building is considered to be located in zone IV.

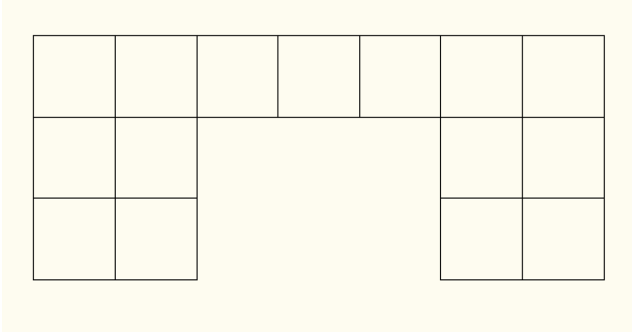

Fig 2: Plan of the model

6.2 Analytical models

1.Model 10 A: 10 storey frame with fixed base

2.Model 10 B: 10 storey frame with Isolator

3.Model 10 C: 10 storey building with damper

4.Model 10 D: 10 storey with isolator and damper

5.Model 15 A: 15 storey frame with fixed base

6.Model 15 B: 15 storey with isolator

7 .Model 15 C : 15 storey frame with damper

8.Model 15 D : 15 storey with Isolator and damper

9.Model 20 A: 20 storey frame with fixed base

10.Model 20 B: 20 storey frame with Isolator

11.Model 20 C : 20 storey frame with damper

12.Model 20 D: 20 storey with isolator and damper

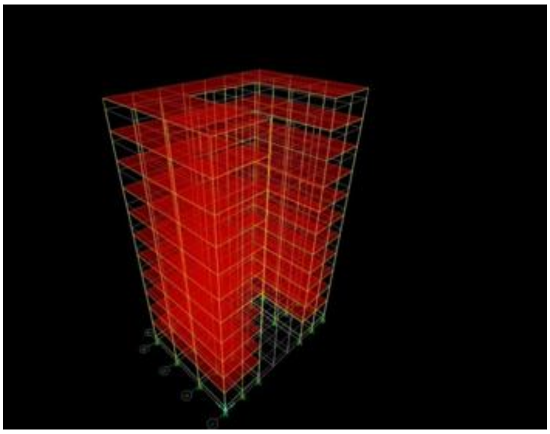

Fig 3. Elevation of structure

7. RESULTS AND DISCUSSION

7.1 Fundamental natural time period

FUNDAMENTAL NATURAL TIME PERIOD	
Model No.	**T in sec**
10A	0.4776
10B	3.5607
10C	0.3852
10D	2.62007
15A	0.8764
15B	4.5859
15C	0.52007
15D	3.62007
20A	1.27643
20B	5.5859
20C	0.6280
20D	4.62007

In ten storey building there is a 86.5 % increase in natural time period when isolators provided and 22.3 % decrease when dampers are provided and also increase of 81% when combination of dampers and isolators are provided. In fifteen storey there is a 81 % increase in natural time period in ten storey when isolators provided and 68.2 % decrease when dampers are provided and also increase of 75% when combination of dampers and isolators are provided. In fifteen storey there is a 77 % increase when isolators provided and increase of 72.2 % when combination of dampers and isolators are provided.

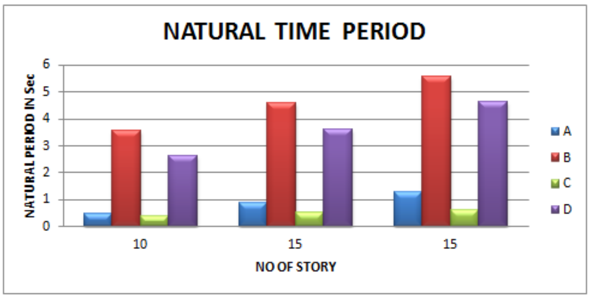

Fig 3 : Natural time period of models

7.2 Base shear

Base shear of the building considerably increases when dampers and isolators are provided on the structure. Model with rubber isolator gives less base shear when compared to other models. Model with combination of isolator and damper gives better results From the chart it is observed that as the height of the increases the base shear decreases.

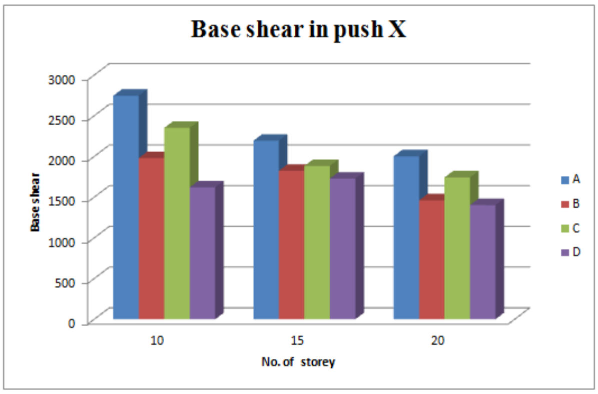

Fig 4 : Base shear in push x direction

From chart it is observed that % reduction of base shear is 38.7%, 16.8% and 69.4% for model 10 B , 10 C and 10 D compared to model 10 A. The % decrease of base shear is 20.2%, 16.4% and 26.9% for model 15 B, 15C and 15 D compared to model 15A. The % decrease of base shear is 40%, 14.8% and 42.8% for model 20 B, 20 C and 20 D compared to model 20 A along x direction.

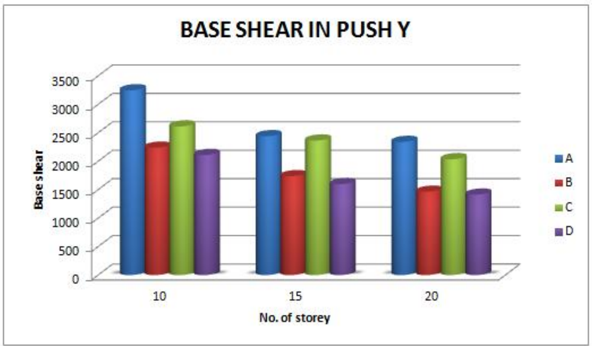

Fig 5 : Base shear in push y direction

Model 20D shows less base shear compared to other models. From table it is observed that % reduction of base shear is 45%, 24.27% and 53.8% for model 10 B , 10 C and 10 D compared to model 10 A. The % reduction of base shear is 40.4%, 32.1% and 52.6% for model 15 B, 15C and 15 D compared to model 15A. The % reduction of base shear is 59.8%, 15% and 65.5% for model 20 B, 20 C and 20 D compared to model 20 A along Y direction.

8. CONCLUSIONS

The fundamental natural period get increases when isolators are provided and time get decreases when viscous dampers are provided. Natural period increases as the height of the building increases when isolators are provided. Base shear of the building considerably increases when dampers and isolators are provided on the structure.

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