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Seismic analysis of multi-storeyed building with floating column using fluid viscous dampers.

Análisis sísmico de edificio de varios pisos con columna flotante mediante amortiguadores de fluido viscoso.

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ABSTRACT

Nowadays many multi-storeyed buildings in India have open ground storey for providing better parking facilities, reception lobbies and other amenities. It is required to have column free space due to shortage of space, increase in population and also for functional and aesthetic requirement.For this purpose, building is provided with floating column at one or more storey.Floating column is a vertical member but its lower end is not connected to the foundation. Its lower end rest on beam which is a horizontal member, this beam transfers the load of floating column to other columns below it.The most common use of a floating column is to build a soft storey on the ground floor to provide extra parking or entrance corridor space.But such features are highly unwanted in seismically active region. The present study proposes a practical solution for reducing the risk of earthquake effects associated with floating column building by strengthening them with using fluid viscous dampers. The main aim of the work is to highlights the performance of floating column building and compare floating column building with and without using fluid viscous dampers. Seismic analysis is carried out by using response spectrum analysis as per IS: 1893-2002. The Seismic assessment is executed by using ETABS software.

Keywords— Fluid viscous dampers, Floating column, ETABS, Response spectrum analysis.

RESUMEN

Hoy en día, muchos edificios de varios pisos en la India tienen un piso al aire libre para proporcionar mejores instalaciones de estacionamiento, vestíbulos de recepción y otras comodidades. Se requiere que la columna tenga espacio libre debido a la escasez de espacio, aumento de la población y también por requerimiento funcional y estético.Para tal efecto, el

edificio cuenta con columna flotante en uno o más pisos.La columna flotante es un miembro vertical pero su inferior. final no está conectado a la fundación. Su extremo inferior descansa sobre una viga que es un miembro horizontal, esta viga transfiere la carga de la columna flotante a otras columnas debajo de ella. El uso más común de una columna flotante es construir un piso suave en la planta baja para proporcionar estacionamiento o entrada adicional. espacio del corredor Pero tales características son altamente indeseadas en una región sísmicamente activa. El presente estudio propone una solución práctica para reducir el riesgo de efectos sísmicos asociados con la construcción de columnas flotantes fortaleciéndolas con el uso de amortiguadores viscosos fluidos. El objetivo principal del trabajo es resaltar el desempeño de la construcción de columnas flotantes y comparar la construcción de columnas flotantes con y sin el uso de amortiguadores viscosos fluidos. El análisis sísmico se lleva a cabo utilizando análisis de espectro de respuesta según IS: 1893-2002. La evaluación sísmica se ejecuta mediante el software ETABS.
Palabras clave: amortiguadores de fluidos viscosos, columna flotante, ETABS, análisis de espectro de respuesta.

INTRODUCTION

Nowadays modern multi-storied building having floating column is an unavoidable feature. Floating columns in the ground level are a typical feature in residential and commercial buildings to provide improved parking facilities. The construction of multistory buildings in metropolitan locations is essential to have column free space due to a lack of space, population growth, as well as aesthetic and functional requirements. For this purpose, building is provided with floating columns at one or more storey. A floating column is a vertical member with a lower end that is not attached to the foundation and rests on a beam. This beam, also known as a transfer beam, is a horizontal member that distributes the load of a floating column to a column below it. Floating column at ground floor has most adverse effect of earthquake. The most important application of floating column is for the construction of soft storey in the ground floor to provide additional parking or entrance corridors space. The lowest storey has a lower strength and stiffness than the above storeys due to the lack of brick infill walls, and it is more prone to damage and collapse during intense ground motion.One of the drawbacks of such a feature is that it is extremely unwelcome in seismically active places. This study emphasizes about recognizing the presence of floating column in multistoried buildings and how to reduce the risk factor of earthquake effects by strengthening the floating columns building by using fluid viscous dampers. The main aim of the work is to highlights the performance of open ground storey building with floating column strengthening by using fluid viscous dampers to protect them from damage during strong earthquake shaking. Response spectrum analysis is done to find out storey displacement, storey drift, frequency and time period. Modelling and seismic analysis is carried out using ETABS 2015.Shayza and Narender [1] focused on the seismic behaviour of G+7 RC open ground-storey buildings with fluid viscous dampers placed in different positions and the responses were compared in seismic zones IV and V. FVDs placed in all exterior bays have shown better and more effective results as compared to all other models. Chukka and Krishnamurthy [2] focused on the comparison of x shaped metallic damper and fluid viscous dampers under eight different earthquake ground motion and influence of its position on the seismic response of the building. Dicleli and Mehta [3] had carried out a study based on the seismic performance of chevron braced steel frames with and without viscous fluid dampers as a function of ground motion and damper characteristics. From the non-linear time history analysis, it is revealed that Seismic performance of chevron braced frame without fluid viscous damper is poor and sensitive to the frequency characteristics and intensity of ground motion due to brace buckling effect. Maitra and Serker [4] were to evaluate the seismic performance of floating column buildings under earthquake loads and to compare buildings with and without floating columns. According to the findings, the location of floating columns, rather than the number of floating columns, determines the torsional irregularity of a structure. In floating column building, the fundamental time period is also very large.

MATERIAL AND METHODS

DESIGN CONSIDERATIONS

Model 1: Open ground storey building with floating columns at outer edges

Model 2: Open groundstorey building with floating columns at outer edges using Fluid Viscous Dampers (FVDs)

The building details are taken from Shayza, S. and B. Narender (2020)

Taylor Devices is the manufacturer of the FVDs used in this investigation. Taylor Devices, Inc., 1956 provided the standard dimensions for the link property data. FVDs with a force of 250 kN are used in this investigation. Fluid viscous dampers are drawn in ETABS using the link property, with the link type set to damper exponential.

Table 1 Building details

Building type	RC building
Number of storey	G+7
Plan size	24m × 24m
Floor height	3m
Concrete grade	M25
Grade of rebar	Fe 415
Column size	400mm ×500m
Beam size	300mm×400mm
Slab thickness	150mm
Thickness of exterior wall	230mm
Thickness of interior wall	155mm
Live load	2kN/m^2
Floor finish	1kN/m^2
Support	Fixed
Seismic zone	V
Zone factor of the building	0.36

Table 2 Fluid viscous damper details

Taylor devices model number	17120
Force (kN)	250 kN
Weight (kg)	44 kg

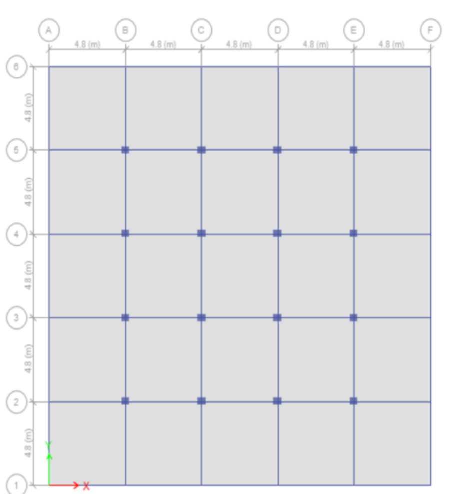

Fig.1 Ground floor plan of model 1

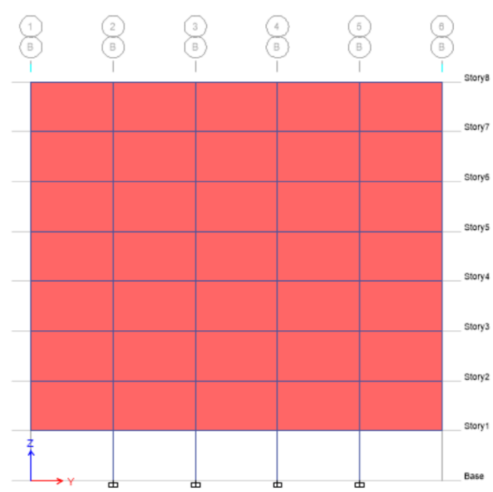

Fig.2 Elevational view of model 1

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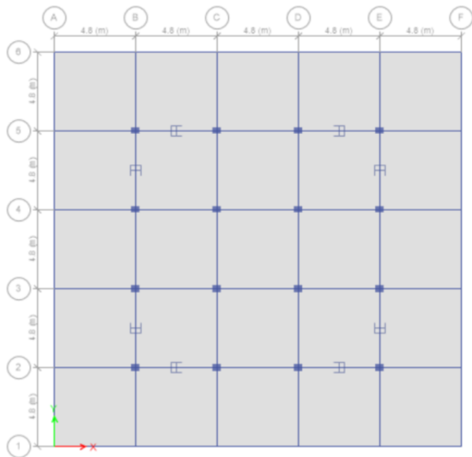

Fig.3 Ground floor plan of model 2

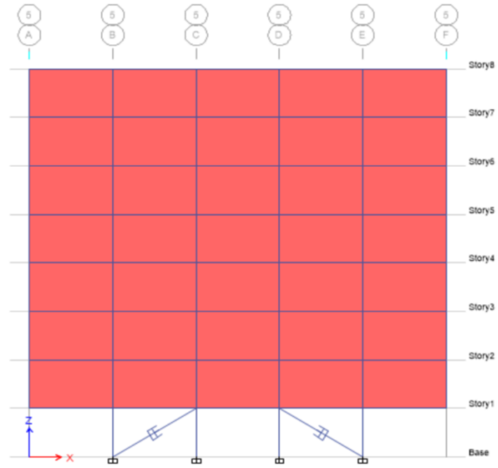

Fig.4 Elevational view of model 2

RESULTS AND DISCUSSION

| Storey displacement is defined as the total displacement of each storey with respect to the ground. Fig.5 shows the comparison of storey displacement in X direction. The maximum storey displacement shown by the model with and without fluid viscous dampersis 7.1 mm and 1.865 mm respectively at the top floor. The maximum storey displacement is reduced by about 73.73% as compared to model without fluid viscous dampers in the X direction.

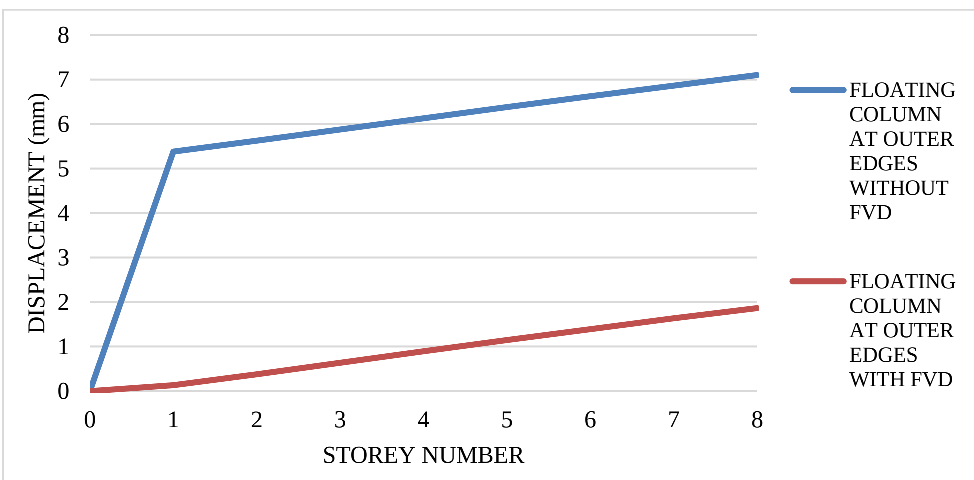

Fig. 5 Comparison of displacement values in X direction

Fig. 6 shows the graph of storey drift in X direction with respect to storey number. The model with FVD helps to reduces storey drift. The sudden increase in the drift on the ground floor is due to the presence of soft storey at ground floor. Open ground storey building with floating column at outer edges using FVD which helps to reduce the drift at the bottom storey by about 97.23% as compared to floating columns at edges without FVD in X direction

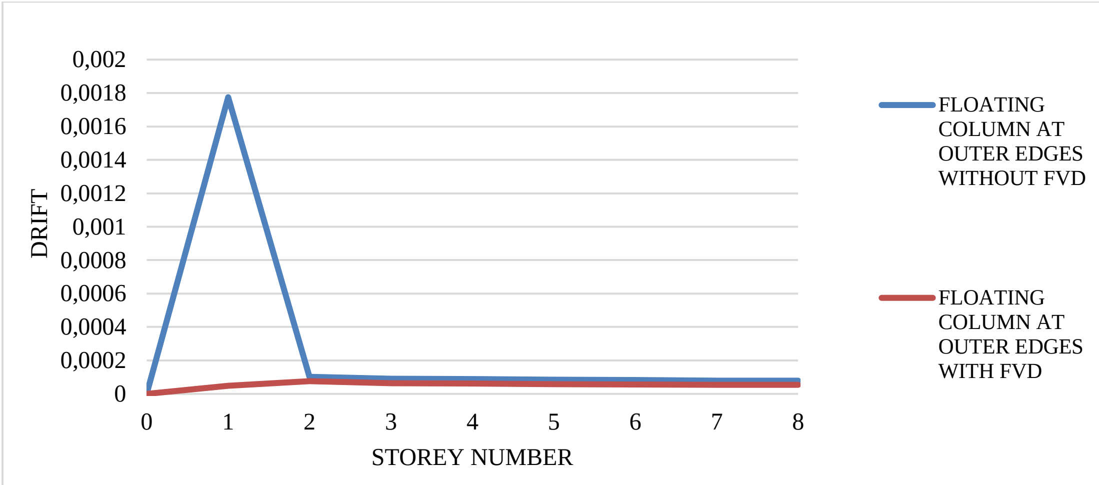

Fig.6 Comparison of drift values in X direction

Fig. 7 shows the comparison of time period with respect to mode number. Higher time period is shown by the model without having fluid viscous dampers. Lesser time period is shown by the model using fluid viscous dampers. The addition of fluid viscous dampers in open ground storey building with floating columns at the outer edges help to reduce the time period of a building by about 75.59% as compared to a model without FVD.

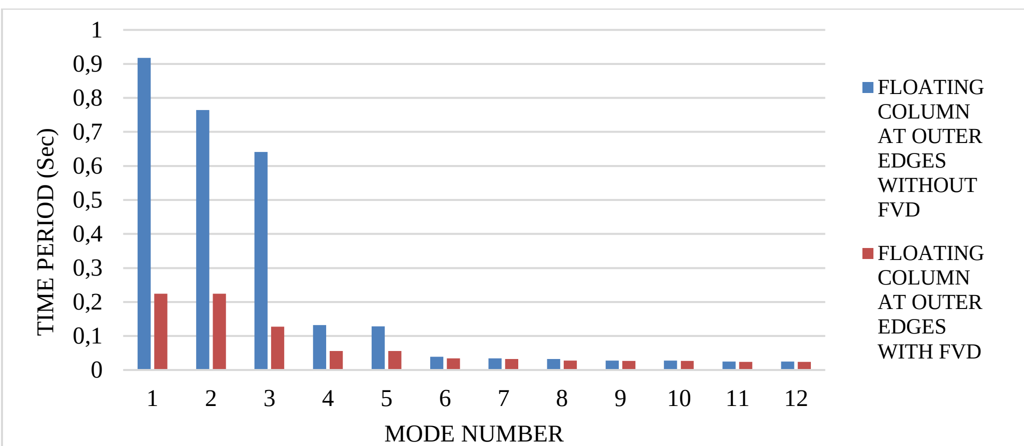

Fig. 7 Comparison of time period

Fig. 8 shows the comparison of frequency with respect to mode number. Higher frequency is shown by an open ground storey building with floating columns at the outer edges using fluid viscous dampers. The addition of fluid viscous damper in open ground soft storey building with floating columns at outer edges help to increase the frequency of a building by about 75.57% as compared to a model without FVD.

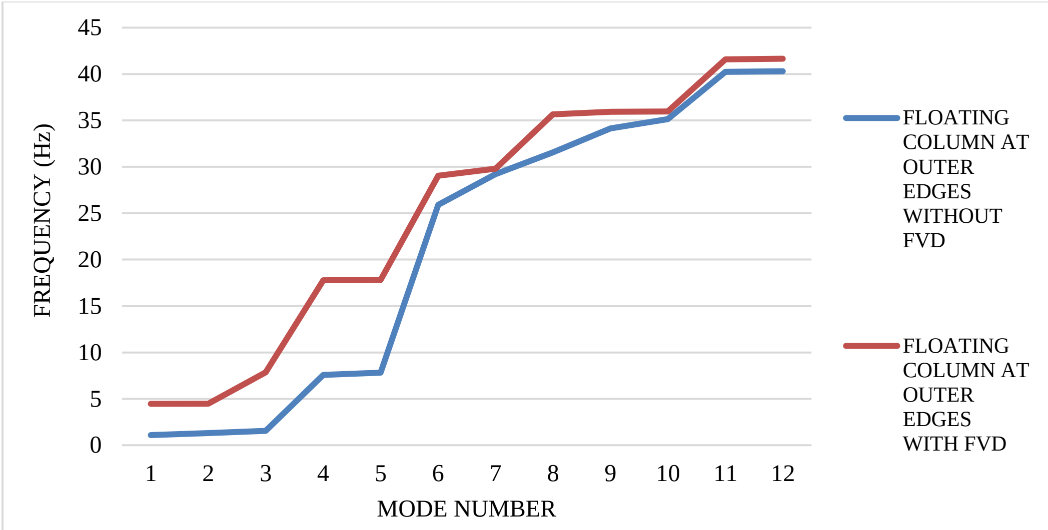

Fig. 8 Comparison of frequency

As conclusion, open ground storey building with floating columns performs poorly under seismic excitation. In open ground storey building with floating columns, the use of fluid viscous dampers reduces maximum storey displacement and maximum storey drift by about 73.73% and 97.23% respectively. The use of fluid viscous dampers helps to decrease the time period of buildings by about 75.59%. The use of fluid viscous dampers helps to increase the frequency of buildings by about 75.57%. Installation of fluid viscous dampers in the building helps to reduce the structural responses of the building during an earthquake effectively by dissipating the input seismic energy.

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