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Analytical Model of Cost Effective Base Isolation System

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Abstract - *In this paper, a new base isolation system for structures in earthquake areas is present. Earthquake by itself, is not a scourge, it is natural phenomenon result from ground movement, sometimes violent. One of the most commonly executed and approved seismic protection systems is base isolation. This paper includes an analytical exploration of three story symmetrical building frame subjected to harmonic motion with and without Base Isolation. The time history and displacement of building frame were recorded and compare with the frame having base isolation, to observe the inefficiency of Base Isolation for leading appurtenant response.*

KeyWords*: *Base Isolation, Multi-story, Aluminium, Symmetric

1. INTRODUCTION

The earthquake resistant structures can be categorized into flexible structures and rigid structure. In flexible structures, the base-isolated buildings and the key control approach is to reduce the excitation input with the use of Isolators and dampers. In rigid structures with the help of diagonal bracing, the installation of shear walls and the use of composite materials the control methods that are applied to withstand extreme loads are basically reducing the inter-story displacement. Due to the long-lasting established knowledge and the maturity of technologies felicitous to structural stiffening, the control strategies of rigid structures were preferred to be earthquake hazard extenuation alternatives. Under large scale of earthquake the floor acceleration of highly stiffening structure and significant inter-story drift of structure increase risks of severe destruction of the building. Flexible structures, i.e. High-rise buildings can avoid effectively reduce structural responses and resonant condition. Structures are expected to be damaged during strong earthquake, but to remain standing when they are built according to code specification. This conventional method of seismic design is not satisfactory for critical structures such as fire stations, telecommunications centers and hospitals. The real reduction of inter-story drift in the floor of a base isolation structure can confirm the lowest destruction of facilities and also human safety. The concept of the base isolation structure had been proposed in the past few decades and the existing technologies and the knowledge of base isolation structure are getting developed and well established. Seismic isolation structures are more effective when applied to high stiffness, low-rise buildings, owing to their three capacities to change the characteristic of the building from rigid to flexible. An increasing number of structures to be isolated reflects the fact that the base isolation structure is progressively becoming accepted as a verified technology in earthquake hazard mitigation. Base isolation is an anti-seismic design strategy that can reduce the effect of earthquake ground motion by uncoupling the super-structure from the foundation.

The structure can be decoupled from the horizontal components of the ground motion by interposing structural elements with low horizontal stiffness between the foundation and superstructure After investigating these buildings that experienced the Kobe earthquake in 1995 in Japan, the performance of base-isolated buildings, subjected to a large scale earthquake has proven to be excellent as predicted. Hence, engineers have devoted tome and research to this topic and the isolation system technologies have been well developed and established in terms of theory, design and construction stages [1].

The performance of base-isolation devices in mitigating inertia forces due to intense earthquakes strongly depends on the proper calibration of the isolator own frequency, that should be carefully dimensioned taking into account both the dynamical characteristics of the superstructure and the frequency content of the expected disturbance. Generally speaking, the isolator should dissipate energy at frequencies dynamically interacting with the structure and transmit only energy acting in a frequency range that poorly excites the structure.

Actually it is important to take into account, in the design stage of the isolator, the interaction effects between the structure itself and the soil characterizing Anyway one should emphasize that a first isolator is always present in all buildings, consisting of the surface layers of the ground on which the building is founded.

The site, since this behaves like a filter as regards to the incoming seismic excitation, mainly affecting its frequency composition and, definitively, its overall dynamic character [2–5].

1.1 BASE ISOLATION

It is a system that may be defined as a flexible or sliding interface positioned between a structure and its foundation, for the purpose of decoupling the horizontal motions of the ground from the horizontal motions of the structure, thereby reducing earthquake damage to the

structure and its contents.Base isolation system absorbs and deflects the energy released from the earthquake before it is transferred to the structure.

By using the Isolators the building is decoupled from the ground motion of any earthquake and the transmission of seismic energy to the building is damped. This is done by lowering the vibrational frequency, allowing the building to move or displace and lowering the shock acceleration of the seismic event. If the earthquake has natural frequency with high energy that match the natural frequencies of building, it will cause the building to oscillate violating in harmony with the earthquake frequency. However, if the natural frequency of the building can be changed to a frequency that does not coincide with that of earthquakes, the building is less likely to fail. This is exactly what a base isolator does. The base isolator reduces the stiffness of the structure and thereby lowers its natural frequency. In this condition, the building's superstructure will react to the vibrations as a rigid unit in its place of resonating with the vibrations.

2. DESCRIPTION OF ANALYTICAL STRUCTURE

The structure which is used for analysis is a symmetrical three storied structure and it is made up of column and slab. Two types of materials are used for making structure i.e. aluminium and steel. The geometric properties of analytical structure are shown in table (1). Analysis this structure in SAP2000 software with fixed base condition. The structure is shown in figure (1).

Table 1: Geometric Properties of Analytical Model

Sr. No.	Part	Dimension in mm		
		Depth (D) mm	Width (B) mm	Length (L) mm
1	Aluminium Column	D_A= 3.00	B_A= 25.11	L_A= 1200.00
2	Aluminium Slab	D_B= 12.70	B_B= 150.00	L_B= 300.00

DESCRIPTION OF ANALYTICAL BASE ISOLATION MODEL

The base isolation model which used for analysis is made up of slab and bar. Two types of material used for making base isolation model i.e. aluminum and steel. The geometric properties of analytical model are shown in table (2).

Table 2: Geometrical Properties of Base Isolation Model

Sr.No	Part	Dimension in (mm)		Mass (gm)
1	Aluminum top plate & bottom plate	Length(L)	300	2000
		Width(W)	300	
		Thickness(t)	4	
2	Four Stainless steel bar	diameter(d)	2	0.112
		Length(L)	270	

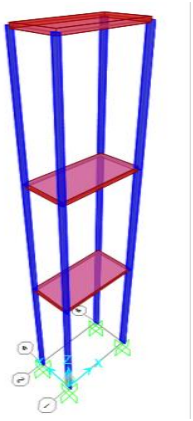

Fig. 1. Model of the structure used in SAP2000

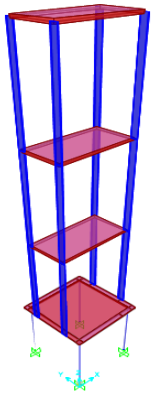

Fig. 2. Model of structure with base Isolation used in SAP2000

RESULT AND DISCUSSION

From analysis the result obtained are tabulated in Table 3 and 4. It is observed that the proposed isolation model is effective against the fix base model by maximum of 35.47%.

Table 3: Result Obtained From SAP2000 with Fixed Base Structure

Mode	Time Period	Frequency	Displacement in x-direction (mm)		
			1st Floor	2nd Floor	3rd Floor
Mode 1	0.3486	2.86	94.813	170.132	229.239
Mode 2	0.1254	7.97	43.515	19.252	37.261
Mode 3	0.0875	11.42	13.221	16.178	8.325

Table 4: Result Obtained From SAP2000 with Base Isolated Structure

Mode	Time Period	Frequency	Displacement in x-direction (mm)		
			1st Floor	2nd Floor	3rd Floor
Mode 1	0.5208	1.92	82.26	142.172	169.209
Mode 2	0.1941	5.15	34.873	15.51	29.428
Mode 3	0.1140	8.77	9.016	13.466	6.856

3. CONCLUSIONS

The Multi-storied structure with and without base isolation device were analysis in SAP2000 Software.

1. The Base Isolation is effective in reducing the linear response of symmetric structure.
2. The Base Isolation is effectively reduces the deformation in structure i.e. structure shown maximum displacement at natural frequencies these deformation of structure at model frequencies is effectively reduced using Base Isolation.

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