

Comparative Study of RC Building with Different Base Isolation System

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ABSTRACT

Earthquakes are one of nature greatest hazards; throughout historic time they have caused significant loss of life and severe damage to property, especially to man-made structures. On the other hand, earthquakes provide architects and engineers with a number of important design criteria foreign to the normal design process. From well established procedures reviewed by many researchers, seismic isolation may be used to provide an effective solution for a wide range of seismic design problems. During earthquake attacks, the traditional building structures in which the base is fixed to the ground, respond with a gradual increase from ground level to the top of the building, like an amplifier. This may result in heavy damage or total collapse of structures. To avoid these results, while at the same time satisfying in-service functional requirements, flexibility is introduced at the base of the structure, usually by placing elastomeric isolators between the structure and its foundation. This study presents information on the design procedure of seismic base isolation systems. Analysis of the seismic responses of isolated structures, which is oriented to give a clear understanding of the effect of base isolation on the nature of the structure and discussion of various isolator types are involved in this work. It presents comparative study of performance of base isolators namely Lead Rubber Bearing (LRB) and Friction Pendulum Bearing (FPB). For this study G+14 R.C building is considered and Time History analysis is carried out using ETABS software.

INTRODUCTION

Seismic isolation is also known as base isolation in structures. It is an innovative design strategy that provides a practical alternate for the earthquake resistant design of new structures and the seismic rehabilitation of existing buildings, bridges and industrial establishments. The concept of base isolation is based on the premise that a structure can be substantially decoupled from damaging horizontal components of earthquake ground motions. Thus, earthquake induced forces could also be reduced by factors of five to ten from those that a conventional fixed-base structure would experience.

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gradual increase from ground level to the highest of the building, like an amplifier. This might result in serious injury or total collapse of structures. To avoid these results, while at the same time satisfying in-service functional requirements, flexibility is introduced at the bottom of the structure then usually we place elastomeric isolators between the structure and its foundation. Further damping is additionally required to regulate the relative displacement between the structure and the ground. Civil Engineers are still unable to carefully predict even in an exceedingly probabilistic approach the masses that structures could get to face up to throughout their useful life. All structures are subjected to vibration. Recent damaging earthquakes in Japan, Indonesia and Nepal have shown however vulnerable our structures and societies stay to natural phenomena. The concept of base isolation can be explained by example of building resting on frictionless rollers. When the ground shakes, the rollers freely roll, but the building higher doesn't move. Thus, no force is transferred to the building due to the shaking of the ground; merely, the building doesn't experience the earthquake.

ETABS is an engineering software product that caters to multi-story building analysis and design. Modeling tools and templates, code-based load prescriptions, analysis methods and solution techniques, all coordinate with the grid-like geometry unique to this class of structure. Basic or advanced systems under static or dynamic conditions may be evaluated using ETABS. Fundamental to ETABS modeling is the generalization that multi-story buildings typically consist of identical or similar floor plans that repeat in the vertical direction. Modeling features that streamline analytical-model generation, and simulate advanced seismic systems.

LITERATURE REVIEW

Izumi Masanory¹ studied on the remained literature, the first base isolated structure was proposed by Kawai in 1981 after the Nobi Earthquake (M=8.0) on journal of Architecture and building Science. His structure has rollers at its foundation mat of logs put on several steps by lengthwise and crosswise manually. After the San Francisco Earthquake (M=7.8) an English doctor J.A. Calantarients patented a construction by putting a talc between the foundations in 1909.

The first base isolated systems actually constructed in the world are the Fudo Bank Buildings in Himeji and Simonoseki, Japan. Garevski A et al. The primary school "Pestalozzi" in Skopje, built in 1969, is the first building in the world for which natural rubber isolators were used for its protection against strong earthquakes. The first base isolated building in the United States is the Foothill Communities of Law And Justice Centre completed in 1985 having four stories high with a full basement and sub-basement for isolation system which consists of 98 isolators of multilayered natural rubber bearings reinforced with steel plates.

Hang13 et al. presented the earthquake responses of the multifunctional vibration- absorption RC mega frame structures decrease significantly in comparison with the normal frame structures, namely 60-80 per cent decrease of the earthquake responses of the major frames and 70-90 per cent decrease of the ones of the minor frames. Mazza and Vulcano studied the nonlinear seismic response of base-isolated framed buildings subjected to near-fault earthquakes to analyze the effects of supplemental damping at the level of the isolation system, commonly adopted to avoid overly large isolators. Aiken11 et al. described the results of a study of an existing seismically isolated building in Southern California which are located near San Andreas Fault, San Jacinto fault and south frontal fault zone. Analysis results for three levels of earthquake were presented and recommendation is made.

METHODOLOGY

Base isolation device can lengthen the natural period of structure, which the dynamic characteristic of the structure will be changed to achieve the aim of reducing the earthquake effect on superstructure. It is main earthquake resistance element, and then others are in on a secondary status. The design method refers to using simplified method for the estimation of isolation layer. According to structural importance, specific site conditions and basic situation of building structure such as the number of layers, building area, it can judge whether or not this building is suitable for adopting base isolation technique, and provide basis for decision-making of structural scheme.

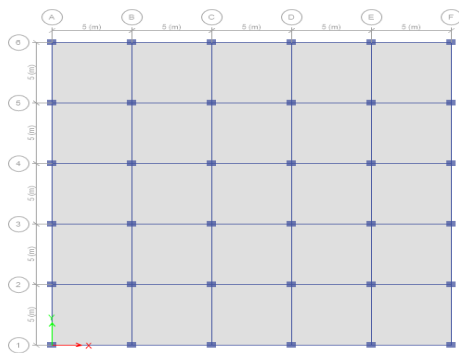


Figure 1 Plan view of RC G+14 Building

Methods of Analysis

Seismic analysis is a subset of structural analysis and is the

calculation of the response of the building structure to earthquake and is a relevant part of structural design where earthquakes are prevalent. The seismic analysis of a structure involves evaluation of the earthquake forces acting at various level of the structure during an earthquake and the effect of such forces on the behavior of the overall structure. The analysis may be static or dynamic in approach as per the code provisions.

During earthquake many of the buildings collapse due to lack of understanding of the inelastic behavior of structure. Elastic analysis gives only elastic capacity of the structure and indicates where the first yielding occurs. It cannot give any information about redistribution of forces and moments and failure mechanism. For study of inelastic behavior of structure nonlinear analysis is necessary. The development of rational methodology that is applicable to the seismic design of new structures using available ground motion information and engineering knowledge, and yet is flexible enough to permit the incorporation of new technology as it becomes available has been supported for sometimes now.

This is the focus of several major research and development efforts throughout the world. In majority of cases nonlinear analysis is used.

RESULT

Table 1 Storey displacement in X and Y -direction

St or y	Fix ed	L R B	F P B	Story	Fix ed	L R B	F P B
	(m m)	(m m)	(m m)		(m m)	(m m)	(m m)
Story 15	76.9	21	54.9	Story 15	94.8	26	60
Story 14	75	20.6	53.7	Story 14	92.8	25.5	58.8
Story 13	72.2	19.9	52	Story 13	89.5	24.7	57
Story 12	68.6	19.1	49.7	Story 12	85.2	23.7	54.6
Story 11	64.3	18	47	Story 11	80.1	22.4	51.7
Story 10	59.4	16.8	44	Story 10	74.2	21	48.5
Story 9	54	15.5	40.6	Story 9	67.7	19.4	44.9
Story 8	48.3	14.2	37	Story 8	60.7	17.7	41
Story 7	42.3	12.7	33.2	Story 7	53.4	16	37
Story 6	36.1	11.2	29.3	Story 6	45.8	14.1	32.8
Story 5	29.9	9.7	25.3	Story 5	38	12.3	28.5

Story 4	23.5	8.1	21.3	Story 4	30.2	10.4	24.2
Story 3	17.2	6.6	17.3	Story 3	22.3	8.5	19.9
Story 2	11	5	13.3	Story 2	14.5	6.6	15.6
Story 1	4.9	3.3	8.7	Story 1	6.8	4.5	10.8

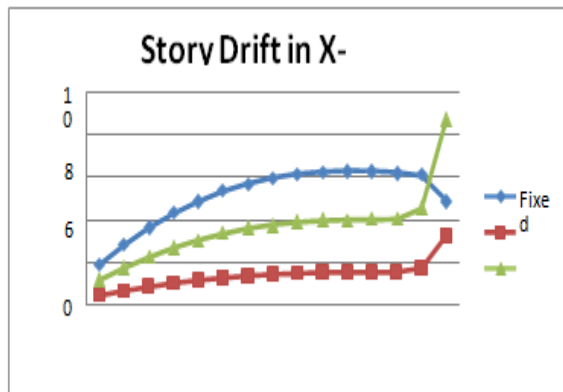


Figure 2 Storey drift graph in X-direction

CONCLUSION

- From the above study, it can be seen that displacement is zero at the base in case of fixed base model and increases as storey height increases. But in case of lead rubber and friction pendulum isolated model, there is a small displacement at the base and increases at a comparatively slower rate when storey height increases.
- From the results, it is shown that reduction in displacement is greater at the top for LRB isolated model in comparison with the fixed base model and FPB isolated model. It is concluded that the LRB is enough to sustain loads than FPB.
- It is seen that the average reduction in storey drift is greater for LRB isolated model in comparison with the fixed base model and FPB isolated model. It can be concluded that the story drift both in X and Y directions is the least in Lead rubber bearing, larger in friction pendulum and the most for fixed base.
- As storey drift is totally dependent on displacement of the structure, the reason for LRB being more advantageous than FPB as same as first conclusion.
- The above study shows that the nature of all the models is different after seismic disturbances. Building having Lead rubber bearing shows the best result and gives a maximum value of story stiffness in both directions as compared to fixed model and FPB isolated model.

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