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Seismic Protection with Base Isolation Method Using ETABS

Mohammad Muzamil[1], and Manish Kaushal[2]

[1]M. Tech Scholar, Department of Civil Engineering, RIMT University, Mandi Gobindgarh, India
[2]Assistant Professor, Department of Civil Engineering, RIMT University, Mandi Gobindgarh, India

Correspondence should be addressed to Mohammad Muzamil; 007muzamilwani@gmail.com

ABSTRACT- Base isolation is one of the most promising alternatives among the structure control methods. In recent decades, base isolation has been seriously considered for civil structures, such as buildings and bridges, subjected to ground motion. Seismic isolation technique had been applied successfully abroad, especially in Japan, and buildings with seismic isolation design had good performances in the earthquakes before. Seismic isolation technique has developed well in recent years in our country. After the Wenchuan earthquake, some departments revised the Code for Seismic Design of Buildings and relaxed some restraint of seismic isolation design. Using the isolation design correctly the buildings can get a good capability of seismic resistance. It is a good choice for the reconstruction of the important buildings. Focus on description of the concept of seismic design and the design method of base-isolated structure of Zundao CentralSchooland hospital.

KEYWORDS-Earthquake zones, Base isolation, Seismic Forces, Finite Element, ETABS

I. INTRODUCTION

Earthquake by itself, is not a disaster, it is natural phenomenon result from ground, Movement, sometimes violent. These produce surface waves, which cause Vibration of the ground and structures standing on top. Depending on the Characteristics of these vibrations, the ground may develop cracks, fissures and settlements[1]. The possible risk of loss of life adds a very serious dimension to Seismic design, putting a moral responsibility on structural engineers. In recent Times, many new systems have been developed, either to reduce the earthquake Forces acting onthe structure or to absorb a part of seismic energy[2]. The term isolation refers to reduced interaction between structure and the ground. When the seismic isolation system is located under the structure, it is referred as "base isolation"[3]. The decoupling allows the building to behave more flexibly which improves its response to an earthquake. The concept of base isolation can be understood as with the help of an example the building that rest on the frictionless rollers[4]. When there is the lateral movement in the ground, only the frictionless rollers move, but the building that's above these rollers does not move. so, there is no lateral movement to the building as rollers move no building portion gets effected simply, we can understand like that there is no lateral movement experienced by building[5]. Now, if the same structure is rested on those flexible pads that always offer resistance to the lateral movements, then obviously the effects of ground would affect the building and the building will start to shake, resulting in the destruction[6].These flexible pads are known as base-isolators, and the buildings protected through the medium of these devices are known as base-isolated buildings. One of the main features of the base isolation method is that it introduces flexibility in the structure the base isolation technique was developed to less the damage effects due to the lateral movements caused by earthquake in the ground and it is been practically proven that it is the best method to mitigate the effects of earthquake at a lesser pace. This method consists of support mechanism which dissociates the building from Earthquake that persuades ground motions. It allows filter or separate the input forcing functions and to avoid the speeding or acceleration of seismic forces on the building[7]. If the building is decoupled from the ground during an earthquake, the ground is shaking but it will have a very less impact on the structure, buildings and posing a threat to human life, therefore it is necessary to provide effective provision to resist an earthquake waves[8].

Base Isolation-Is one of the most popular means of protecting a structure against earthquake forces? It is a collection of structural elements which should substantially decouple a superstructure from its substructure that is in turn resting on the shaking ground, thus protecting a building or non-building structure's integrity. Base isolation is one of the most powerful tools of earthquake engineering pertaining to the passive structural vibration control technologies. The isolation can be obtained by the use of various techniques like rubber bearings, friction bearings, ball bearings, spring systems and other means[9]. It is meant to enable a building or non-building structure to survive a potentially devastating seismic impact through a proper initial design or subsequent modifications. In some cases, application of base isolation can raise both a structure's seismic performance and its seismic sustainability considerably. Contrary to popular belief base isolation does not make a building earthquake proof[10]. Base isolation system consists of isolation units with or without isolation components, where Isolation units are the basic elements of a base isolation system which are intended to provide the aforementioned decoupling effect to a building or non-building structure. Isolation components are the connections between isolation units and their parts having no decoupling effect of their own[11]. Isolation units

could consist of shear or sliding units. This technology can be used for both new structural design and seismic retrofit. In process of seismic retrofit, some of the most prominent U.S. monuments, e.g. Pasadena City Hall, San Francisco City Hall, Salt Lake City and County Building or LA City Hall were mounted on base isolation systems. It required creating rigidity diaphragms and moats around the buildings, as well as making provisions against overturning and Effect. Base isolation is also used on a smaller scale—sometimes down to a single room in a building. Isolated raised-floor systems are used to safeguard essential equipment against earthquakes. The technique has been incorporated to protect statues and other works of art—see, for instance, Rodin's Gates of Hell at the National Museum of Western Art in Tokyo's Park. Base isolator bearings were pioneered in New Zealand by DR Bill Robinson during the 1970s[12]. The bearing, which consists of layers of rubber and steel with a lead core, was invented by Dr Robinson in 1974.Some of the earliest uses of base isolation systems date back all the way to 550 B.C. in the construction of the Tomb of Cyrus the Great in Pasargadae, Iran[13]. More than 90% of Iran's territory, including this historic site, is located in the Alpine-Himalaya belt, which is one of the Earth's most active seismic zones. Historians discovered that this structure, predominantly composed of limestone, was designed to have two foundations[14]. The first and lower foundation composed of stones that were bonded together with a lime plaster and sand mortar, known as Saroj mortar, was designed to move in the case of an earthquake. The top foundation layer, which formed a large plate that was in no way attached to the structure's base, was composed of polished stones. The reason this second foundation was not tied down to the base was that in the case of an earthquake, this plate-like layer would be able to slide freely over the structure's first foundation[15]. As historians discovered thousands of years later, this system worked exactly as its designers had predicted, and as a result, the Tomb of Cyrus the Great still stands today. The development of the idea of base isolation can be divided into two eras. In ancient times the isolation was performed through the construction of multi-layered cut stones (or by laying sand or gravel under the foundation) while in recent history, beside layers of gravel or sand as an foundation are used[16].

II. MODELLING

ETABS, a finite element software, is used to model the buildings. All components that influence the mass, strength, stiffness, and deformability of the structure are included in the building's analytical models[17]. Beams, columns, and slabs make up the structural system of a building. Non-structural features that have little impact on the building's behaviour are not modelled. Models are subjected to modal analysis and response spectrum analysis. In this study, a 3D RC 9-story building with 7 different dimensions according to aspect ratio differing by 0.5 and a total area of 400 m2 in zone III was used, with two examples considered: one with a fixed foundation and the other with a base isolation employing Lead rubber bearing. The models' details are displayed. Table-1Buildingsmodel descriptions [18]

Result: The building model description is shown in Table-1. Whereas the Figure-1 & 2 shows the Plan and Elevation of Model-1, and Figure 3 shows the Elevation of Model 1 with isolated base (LRB).

Table 1: Building model description

Model	Aspect Ratio	Sizes in Plan
Model-1	1	20mX20m

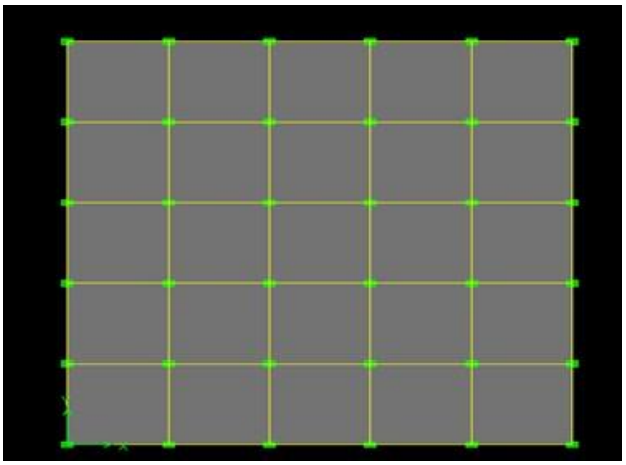

Figure 1: Plan for Model 1

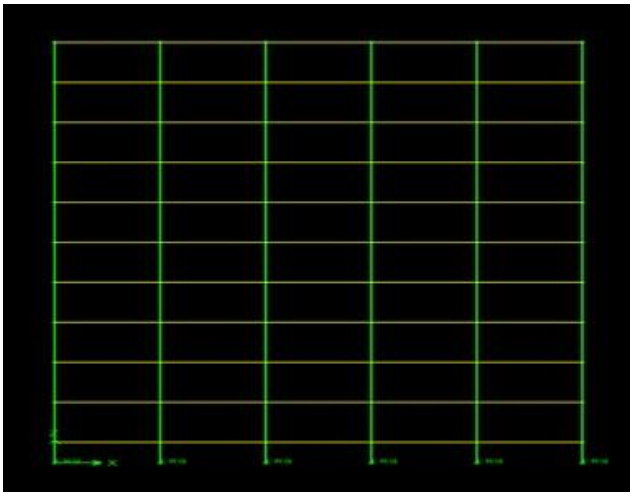

Figure 2: Elevation of model with Fixed base

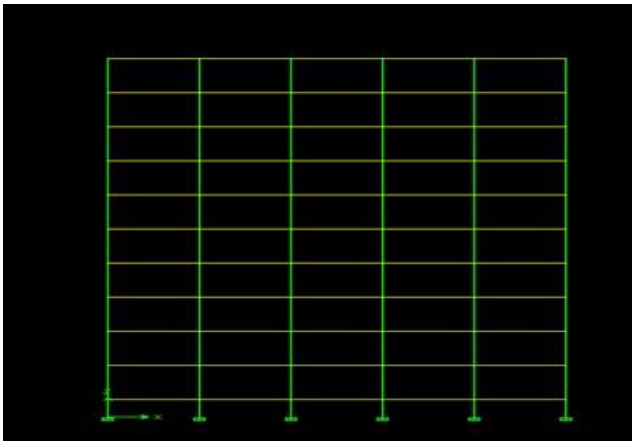

Figure 3: Elevation of Model 1 with isolated base (LRB)

III. COMPARISON OF BASE SHEAR

Table 2 is showing values in base shear, whereas Table 3 shows the Drift values in X direction and Table 4 shows the Drift values in Y direction. From the analysis it can be seen that while comparing manual vs ETABS results significant change has been observed for Zone-II (2.86%), followed by Zone-IV (2.5%), Zone-V (2.3%) and Zone-III (1.32%).

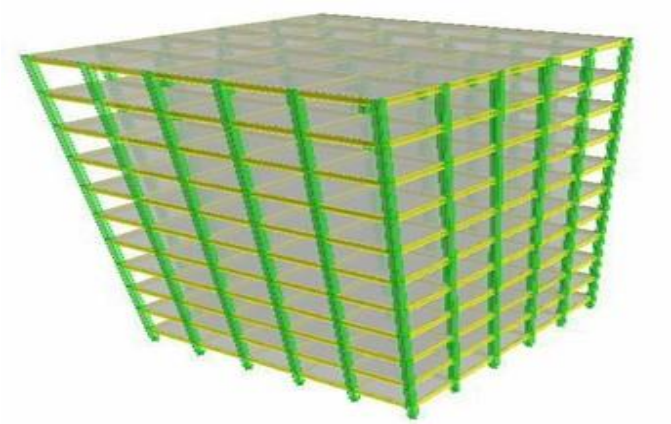

Figure 8: Base Shear in Zone V

Table 2: Values in Base shear

one	Manual	ETABS	% Change
II	1255	1291	2.86
III	2045	2072	1.32
IV	3014	3091	2.55
V	4557	4662	2.3

Table 3: Drift values in X direction

Story Number	Base Fixed Model1	Isolated Base Model
Base	0	0
P	0.0004860	0.0015665
G	0.0013146	0.0012720
1	0.0014660	0.0011951
2	0.0014102	0.0011183
3	0.0013226	0.0010372
4	0.0012190	0.0009433
5	0.0011115	0.0008494
6	0.0009800	0.0007240
7	0.0008087	0.0005769
8	0.0005737	0.0004068
9	0.0003426	0.0003203

Figure 9 shows the drift values in X direction and Fig-10 shows the drift values in Y direction. It can be observed from figures that the drift both in X & Y direction increases up to story 1 in case of fixed base model design and then decreases. Where as in case of isolated base model drift increases upto ground story and then decreases.

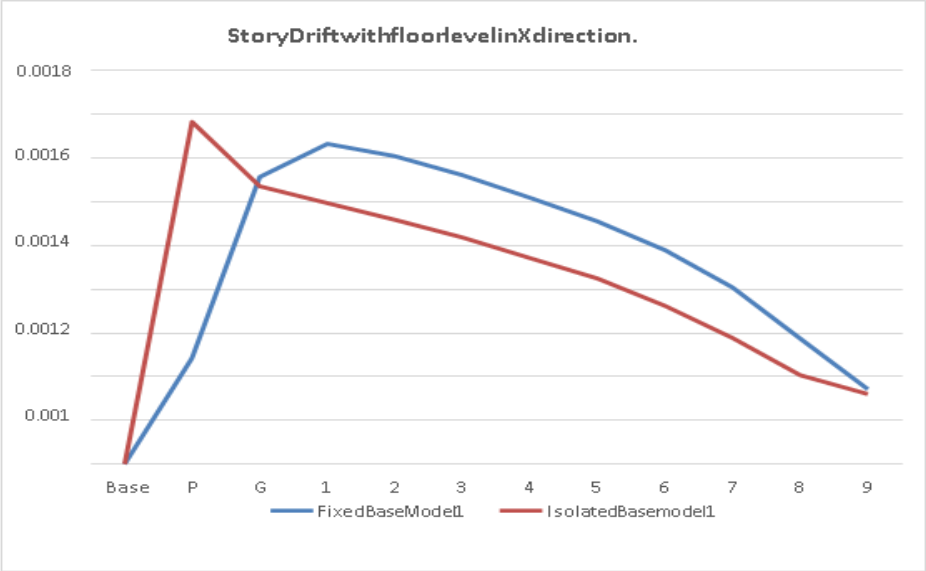

Figure 9: Showing you story drift values in X direction

Table 4: Showing you story drift values in Y direction

Story Number	Base Fixed Model	Isolated Base Model1
Base	0	0
P	0.0005292	0.0018032
G	0.0016012	0.0013564
1	0.0016600	0.0012836
2	0.0015876	0.0012068
3	0.0014881	0.0011200
4	0.0013750	0.0010195
5	0.0012484	0.0009076
6	0.0010946	0.0007720
7	0.0009046	0.0006114
8	0.0006377	0.0004259
9	0.0003528	0.0003286

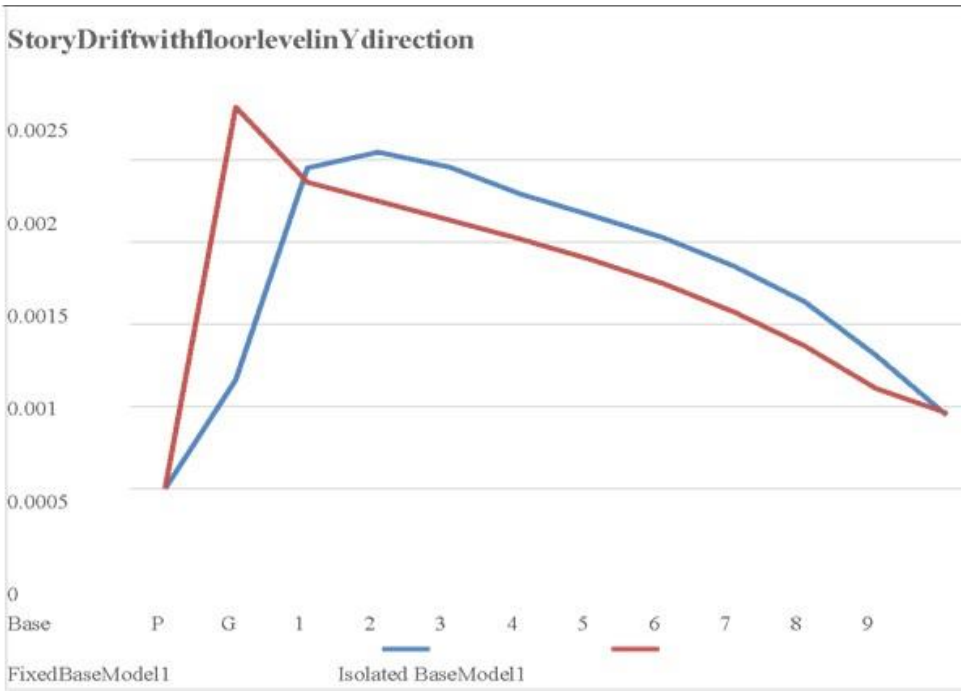

Figure 10: Showing you story drift values in Y direction

III. CONCLUSION

Base isolation has developed into a deep field requiring the work of many engineers and affecting the lives of people across the world, whether they are aware of it or not. By observing and analyzing the physical phenomena that cause buildings to crumble, engineers have devised an effective strategy to sidestep this problem. Rubber, steel and damping systems combine to turn otherwise dangerous earthquakes into minor threats. Through the use of base isolation, buildings such as the USC University Hospital have withstood earthquakes even as severe as the Northridge earthquake (NISEE). As the years go by and more earthquakes hit, this twentieth-century breakthrough in structural design may prove to be a life-saving innovation of historic proportions.

CONFLICTS OF INTEREST

The author declares that they have no conflicts of interest.

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