Research on the Isolation of The Structure of the L - Shaped Large - base Twin Towers

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Abstract

L-shaped flat chassis Twin Towers structure, its lower chassis is usually the mall and the hotel, the upper tower as a residential or office buildings. In this paper, the seismic isolation analysis of the L shaped planar Twin Towers is built, and the seismic model, the base isolation model and the story isolation model are respectively established.Through the Midas/gen software of different models of modal analysis, and rare in case of seismic time history analysis, respectively from the three aspects of story shear, floor displacement and floor acceleration contrasts, indicates that the isolation device structure of the seismic effect is improved obviously.

Keywords

L Plane; Base Isolation; Story Isolation; Time History Analysis.

1. Introduction

With the development of the national economy,more and more styles of building structures have emerged.Large chassis structure of the lower part of the city and the hotel is often composed of the upper tower as a residential or office buildings.This kind of building structure is not regular, so special attention should be paid to the seismic design.The emergence of seismic isolation technology has obviously improved the seismic performance of this kind of irregular structure.The base isolation structure is the base and the upper structure of the building structure or between the upper structure and the structure of the base isolation layer, thereby prolonging the structure of the natural vibration period,so that the seismic effect of the base isolation layer is reduced[1]. In this paper, we study the effect of seismic isolation technology on the structure of the L - shaped flat plate with a large chassis structure of Twin Towers by comparing the seismic model, the base isolation model and the story isolation model.

2. Model Overview

In this paper, the structure of a L-shaped Twin Towers structure is used as an example. As shown in Figure 1-1, the upper and lower part of the structure is a large chassis tower column layout shown in Figure 1-2, 1-3. In Midas/gen software modeling and analysis, substructure floor height is 4.5m, height of the upper structure of the tower is 3M, plate thickness of 180mm column size of 6m x 6m. In order to simplify the model, the column section of the whole structure is 600mm * 600mm, the section size of the beam is 300mm * 600mm. The concrete strength grade is C30, the steel grade is HRB335, the grade is 2KN/m^2, the seismic fortification intensity is 8 degrees, and the area design earthquake is grouped into second groups.

2.1 Isolation bearing parameters

The products are mainly divided into two categories, one is friction sliding isolation bearing, one is rubber bearing. The selection of base isolation bearing is generally based on the vertical bearing capacity and horizontal displacement limit value [2]. In this case, the model is analyzed by PKPM, and the model is selected according to the maximum pressure at the bottom of the column. In this example, the base isolation model is used to share 48 lead rubber bearing, and the isolation and sharing of 32 lead core rubber bearings, the quality and the stiffness of the core are not eccentric. In order to calculate the convenience of our unified selection model for the LRB700 lead core rubber isolation bearings.

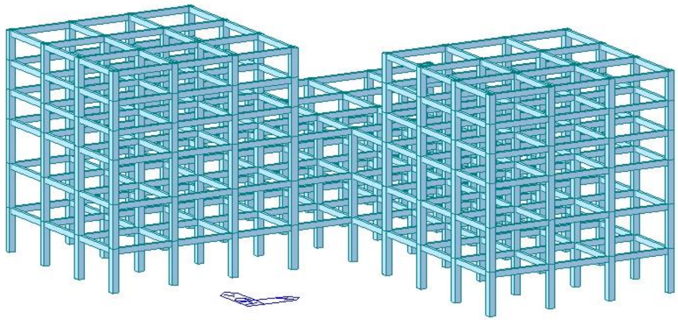

Fig. 1-1 Structure model

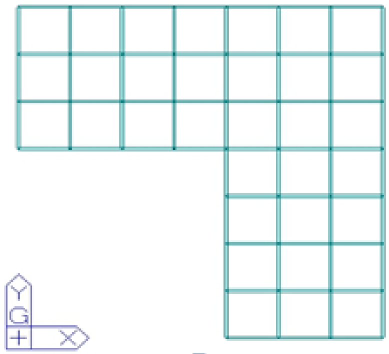

Fig. 1-2 The large chassis column layout

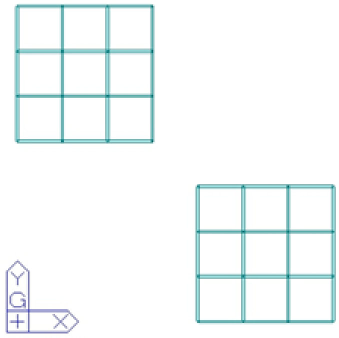

Fig. 1-3 The tower column layout

2.2 Establishment of structural model

Under the action of horizontal earthquake force, we study the effect of seismic isolation technology on the seismic performance of building structures. In this paper, we use the finite element analysis software Midas/gen to build three models. Respectively, for the traditional seismic structure model (Figure 1-1), the base isolation structure model (Figure 1-4), the story isolation structure model (Figure 1-5). In the Midas/gen software, we use its own lead core rubber bearing isolation device to simulate the bearing. By setting the relevant parameters, the connection is based on the bottom of the bottom and the bottom of the two towers. In the following diagram (Figure 1-4, figure 1-5), we can see the position of the isolator in the model and its local coordinate system.

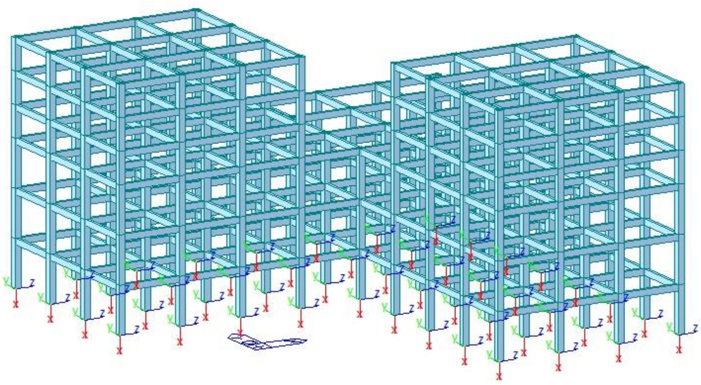

Fig. 1-4 The finite element model of base isolation

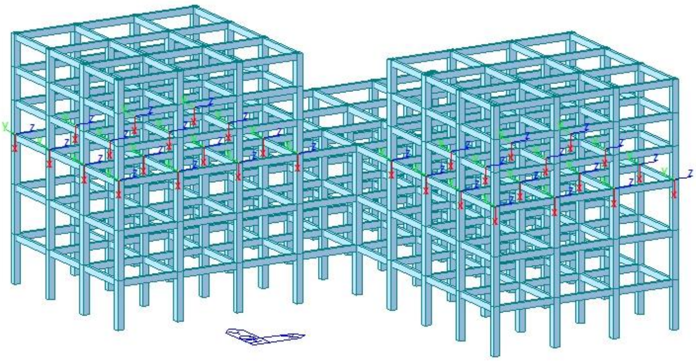

Fig. 1-5 The finite element model of isolation layer

3. Modal analysis of base isolation, story isolation and seismic structure

Modal analysis is an effective method to study the structural dynamic characteristics in modern times [3]. The mode is the natural vibration characteristic of the building structure, each modality has certain natural frequency, damping ratio and modal vibration mode. These modal parameters can be obtained by calculation or test analysis. The process is called modal analysis.

Using Midas/gen software to establish the three-dimensional finite element analysis model of the traditional seismic structure, the base isolation structure and the story isolation structure, the modal analysis is carried out, and the natural vibration period of three kinds of structures (such as 2-1) is obtained.

Table 2-1.The comparison of the 12 order natural vibration period

vibration mode	Aseismic structure	Base isolation		Story isolation	
	natural period(s)	natural period(s)	increase amplitude (%)	natural period(s)	increase amplitude (%)
1	0.9713	2.0396	109.99	1.4262	46.83
2	0.8827	1.9305	118.70	1.3737	55.62
3	0.7998	1.7939	124.29	1.3132	64.19
4	0.2858	0.4098	43.39	0.5045	76.52
5	0.2826	0.4081	44.41	0.5003	77.03
6	0.2620	0.3868	47.63	0.4555	73.85
7	0.1612	0.2122	31.64	0.2395	48.57
8	0.1608	0.2093	30.16	0.2295	42.72
9	0.1513	0.1941	28.29	0.2128	40.65
10	0.0999	0.1255	25.63	0.1627	62.86
11	0.0998	0.1254	25.65	0.1606	60.92
12	0.0943	0.1204	27.68	0.1550	64.37

By means of table 2-1, compared to the traditional seismic structure, we can find that the natural vibration period of the base isolation and the story isolation has an increase of 109.99% and 46.83% respectively. And the other eleven modes of vibration isolation device of the structure has increased than the seismic structure. This also shows that the structure of the base isolation device can improve the flexibility of the structure, so as to improve the structure of the natural vibration period, which also makes the structure can be far from the site of the excellent cycle.

4. Time history analysis of structure

In order to understand the response of the structure under earthquake, we usually have the mode decomposition response spectrum method, the bottom shear force method and the time history analysis method. The response spectrum method and the bottom shear method is the earthquake force approximation is static, but real earthquake force is with the time changing, not entirely true structural response under the earthquake response. The time history analysis method is a real or artificial simulation of the structure of the seismic wave, the final output is more accurate results. In this paper, the time history analysis method is used to analyze three kinds of different structures, and finally, the acceleration of each layer, the shear force and the displacement of the layers are obtained.

4.1 Selection of seismic wave

Scientific research workers in a large number of experiments and simulations show that the impending earthquake prediction is very difficult, if the main parameters of ground motion to take a reasonable choice, the results of numerical simulation can be based on the actual engineering structure of the upcoming earthquake, then reached the target. Domestic and foreign scientific research personnel to carry out the numerical simulation and the actual measurement, the three main factors that the ground motion design parameters are the intensity (amplitude), the spectrum and the holding time, that is, the three elements of the earthquake [4].

In this example, we choose the EL-CENTRO wave, which is commonly used in the two kind of field, and the acceleration time history curve [5] is as shown in figure 3-1. So in the analysis of the structure, we adjust the Midas/gen wave according to the seismic wave adjustment option provided by EL-CENTRO, so that it can meet the standard requirements.

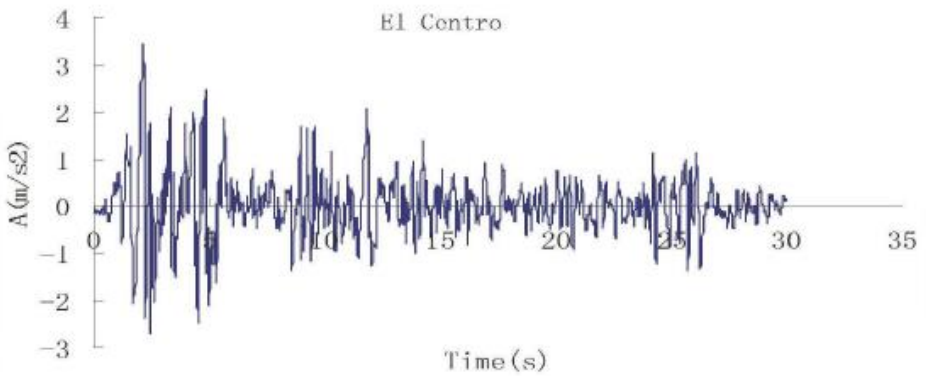

Fig. 3-1 Velocity time history curve of EL-CENTRO seismic wave

4.2 Comparison of Acceleration under seismic wave action

Using Midas/gen finite element software, the time history analysis of the three groups of models is carried out under the rare earthquake, the seismic wave selection of EL-CENTRO wave, the maximum acceleration of each layer is obtained, and the acceleration time history curve of the top floor is output.

Table 3-1. Comparison of the maximum acceleration of each structure layer under the action of seismic wave

Number of stories	Aseismic structure	Base isolation		Story isolation	
	acceleration （cm/s2）	acceleration （cm/s2）	amplitude reduction（%）	acceleration（cm/s2）	amplitude reduction（%）
1	313.15	136.36	56.46	311.36	0.57
2	398.47	221.93	44.30	483.48	-21.33
3	559.62	130.46	76.69	605.05	-8.12
4	699.13	113.48	83.77	269.93	61.39
5	804.96	180.85	77.53	255.22	68.29
6	885.40	209.10	76.38	283.94	67.93

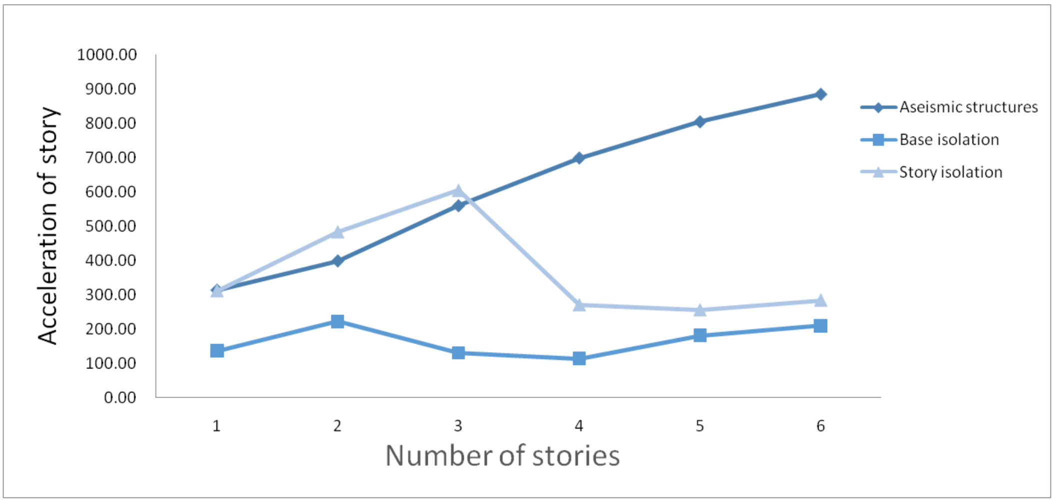

Fig. 3-2 Comparison of the maximum acceleration of each structure layer under the action of seismic wave (cm/s2)

By means of table 3-1 and figure 3-2, it can be seen that the acceleration of each structure layer is reduced, and the acceleration value is reduced by the base isolation and the structure layer. Can also found that base isolation in the acceleration damping of the whole structure to than interlayer seismic isolation structure to large, also shows that the reduced acceleration of the base isolation to interlayer seismic isolation than better. The acceleration of the structure layer of the lower part of the base layer is greater than that of the seismic structure, and the acceleration of the structure of the upper part of the base layer is larger than that of the seismic structure.

4.3 Comparison of floor shear under seismic wave action

Floor shear force under the action of EL-CENTRO (Acceleration peak value is 400cm/s^2), simulation of 8 degree earthquake.

Table 3-2. Comparison of sheer force of each structure under seismic wave action

Number of stories	Aseismic structure	Base isolation		Story isolation	
	floor shear (KN)	floor shear (KN)	amplitude reduction (%)	floor shear (KN)	amplitude reduction (%)
1	12372	4612	62.73	7083	42.75
2	11858	4120	65.26	5212	56.05
3	10176	3349	67.09	3558	65.03
4	7101	2474	65.17	1927	72.86
5	4917	1812	63.14	1309	73.38
6	2553	942	63.12	1295	49.28

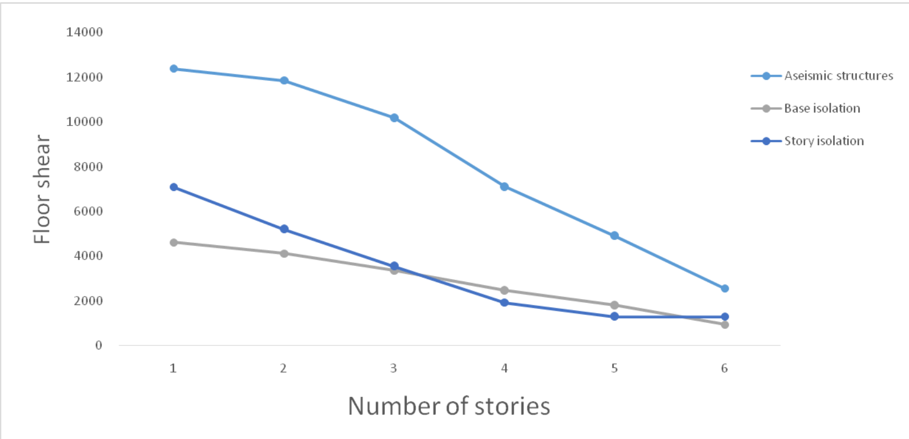

Fig. 3-3 Comparison of sheer force of each structure under seismic wave action (KN)

The table 3-2 and figure 3-3 we can find, isolation device can effectively reduce the layer structure of the shear layer and the base isolation layer shear damping maximum 67.09% and interlayer seismic isolation layer and the maximum shear stress decrease occurred in layer 5, and the decrement was 73.38%. This greatly reduces the possibility of damage to the structure under the earthquake, and ensures the safety of the structure. You can also find interlayer seismic isolation base isolation layer shear are very close, interlayer seismic isolation in the lower structural layer is slightly larger than that of the base isolation, but in isolation layer is arranged at the upper part of the shear layer is slightly smaller than that of the base isolation. Base isolated layer shear change is gentler. This means that in the same condition, the base isolation is more excellent than the story.

4.4 Comparison of floor displacement under seismic wave action

Floor displacement under the action of EL-CENTRO (Acceleration peak value is 400cm/s^2), simulation of 8 degree earthquake.

Table 3-3. Comparison of the displacement between different structures under seismic wave action

Number of stories	Aseismic structure	Base isolation		Story isolation	
	inter-story displacement (mm)	inter-story displacement (mm)	amplitude reduction (%)	inter-story displacement (mm)	amplitude reduction (%)
1	28.69	7.39 (63.27)	74.24	14.54	49.34
2	45.22	5.56	87.71	18.19	59.77
3	40.47	4.30	89.38	13.70	66.16
4	20.08	3.47	82.71	8.71 (32.46)	56.62
5	14.65	2.66	81.86	4.74	67.63
6	8.88	1.67	81.16	2.56	71.20

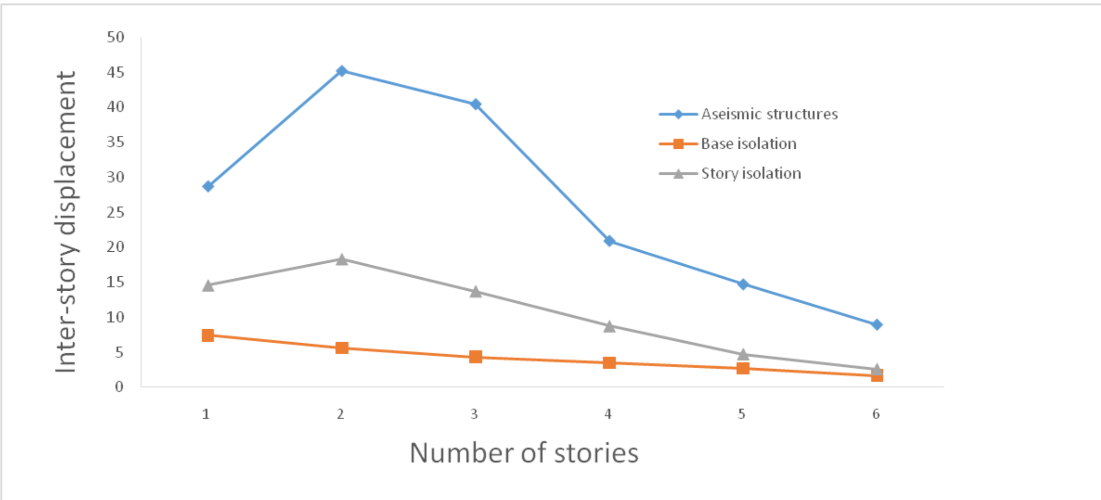

Fig. 3-4 Comparison of the displacement between different structures under seismic wave action (mm)

By means of table 3-3 and 3-4, it can be seen that the structure of the base isolation structure and the inter story displacement of the isolation structure are less than the seismic structure. Base isolation structure in the above isolation layer, the layer displacement are roughly the difference is not too big, relative to the horizontal displacement of isolation layer, the upper part of the structure of displacement is very small, also can think of upper structure with base isolated layer for the translation. It is due to the translation, the building structure in a wide variety of equipment cannot be damaged in the earthquake, indirectly reducing the economic losses when the earthquake happened. The relative seismic structure of the story in the lower part of the base isolation layer is reduced, but the base isolation is generally larger than the base isolation. The displacement of the upper part of the base isolation layer has been reduced. This shows that the increase of the isolation device can obviously reduce the structure layer of the upper part of the base isolation layer, and also has a favorable effect on the displacement of the lower layer.

5. Conclusion

In this paper, the structure of the L - shaped large chassis of Twin Towers is studied and analyzed, and the following conclusions are drawn:

1. Through the comparison of the three models, the structure of the L - shaped flat plate with large base of the Twin Towers structure can effectively improve the seismic performance. Base isolation plan no matter is in acceleration, and the rate of decrease in shear layer or interlayer displacement are slightly superior to that of interlayer seismic isolation, so for this kind of structure selection isolation scheme should be preferred base isolation. However, considering that the isolation layer cannot be set at the bottom of the structure, the overall consideration of the economy (such as the isolation of the building in the upper part, the number of the base isolation scheme is less, the cost will be reduced) and other factors, the final selection of seismic isolation scheme.

2. In some areas of high seismic intensity area, the construction of the L - shaped flat - shaped large chassis structure of Twin Towers is considered. The method of adding base isolation layer can be considered when the seismic performance of the structure is not satisfied.

3. Of course, there are some problems and shortcomings, such as the time history analysis is to increase a set of actual seismic wave and artificial wave to analyze the model, at the same time, this paper is to study the structure of the L - shaped large chassis structure of the base of the research, there is no effect on the structure of the effect on the structure, which need to further modify and research.

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