Structural performance analysis and design proposals of Mountainous Building

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Abstract: Construction of buildings in mountain hilly areas, in order to save costs, while ensuring the overall structure of the safe and reliable, in the floor at the natural slope treatment, the abolition of the retaining wall. Due to the cancellation of the retaining wall, the vertical weighing member of the slope construction is subjected to the larger level of earth pressure. In this paper, PKPM and Midas software are used to analyze the slope structure and explore the design method and measures of the slope structure.

Keywords: Slope construction; Structural analysis; Earth pressure

1. GENERAL SITUATION OF THE PROJECT

The 7 story mountainous building is a frame shear wall structure with a total height of 20.4m. The seismic intensity at the building site is 6 degree, Site design for the second category, the design of seismic grouping as a group, the design characteristics of the cycle is 0.35s, the frame seismic rating of four, shear wall seismic rating of three. Ground rough category is the B class, the basic wind pressure of 0.55kN / m2. The main floor of the structure and the site where the terrain is shown in Figure 1, the structure of the plane diagram is shown in Figure 2.

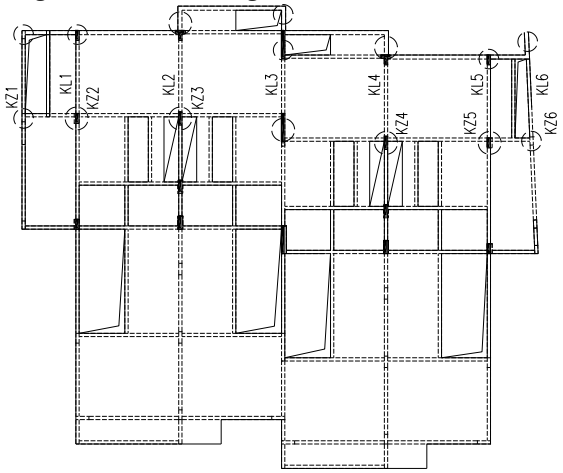


Figure 2. Schematic diagram of the structure

2. CALCULATION MODEL AND RESULT ANALYSIS

In order to analyze the influence of slope on the stability of sloping buildings and ensure the safety and reliability of the structure, Satwe and Midas are used to analyze the structure to ensure the reliability of structural calculation [1]. Through the comparative analysis of the results of these two kinds of structural software, we can understand the influence degree of the slope on the foundation and the structural components and the safety performance of the structure, and provide the reference for the structural design.

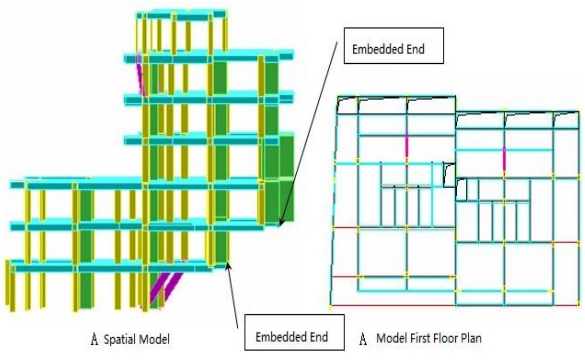
1) Satwe uses the pile-free model to calculate the top surface of the embedded pile (no bearing platform), regardless of the soil to the pile of horizontal earth pressure [2].

2) midas, respectively, using pile-free model and pile model, pile model calculation of the embedded end of the pile to expand the top of the head, and consider the soil on the pile of horizontal earth pressure [2,4].

(1) Model and load diagram

The calculation model A:

The calculation model A is the Satwe model, and its spatial model and the main floor model are shown in the following figure. This model does not consider the pile to participate in the overall effect and earth pressure, the frame of the embedded end of the column to the top of the pile.



The calculation model B:

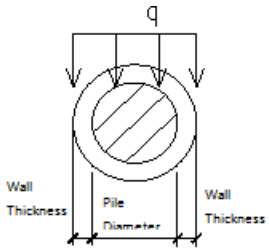
The model B is the Midas model, and its spatial model and the main floor model are shown in the following figure. This model does not consider the pile to participate in the overall effect and earth pressure, the frame of the embedded end of the column to the top of the pile.

Calculate the model C1, C2:

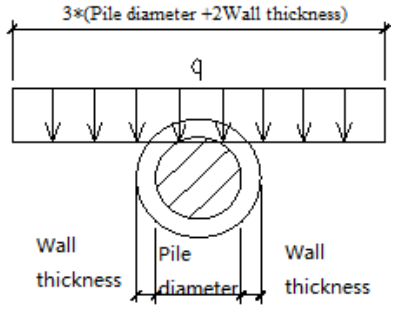
The calculation models C1 and C2 are the Midas model, and the spatial model and the main floor model are shown in the following figure. This model considers the pile to participate in the overall effect and the earth pressure, and the embedded end of the frame column is taken to the top of the pile. The C1 model considers 2 times the thickness of the wall + the earth pressure in the pile diameter range. The C2 model considers 6 times the wall Thickness +3 Earth pressure in pile diameter range.

Earth pressure on the pile of horizontal earth pressure diagram

Figure 3 is the earth pressure on the pile load diagram, pile wall thickness of 150mm, pile diameter of 1200mm and 1400mm, the role of the range of soil pressure were (2 times the wall thickness + pile diameter) and 3 × (2 times the wall Thickness + pile diameter).



(a)



(b)

Figure 3. Schematic diagram of soil pressure on pile

(2) Analysis results

Analysis of Displacement Deformation of Seismic and Wind Loads

Table 1, Table 2 for the three models in the case of earthquake and wind load under the displacement and internal force analysis results. As can be seen from Table 1, regardless of the effect of the pile, that is, model A and model B, the two models of the analysis results, in addition to B model of the vibration period is slightly larger, the other values are closer. Indicating that the results of the two software analysis credible. Compared with the C1 and C2 models, the self-vibration period of the pile is smaller than that of the C1 and C2 models, which indicates that the stiffness of the structure is increased. In addition, under the wind load and the earthquake, the C1-Displacement angle is smaller than the B model, which shows that considering the pile involved in the overall work, can reduce the structure under the action of wind and earthquake displacement.

Table 1 Analysis of displacement and deformation of earthquake and wind load

Calculation model	Seismic action angle	Vibration cycle （Direction factor：X+Y+T）	
		T1 X+Y+T	T2 X+Y+T
A	0 ° 90 °	1.3001 0.98+0.00+0.02	0.7124 0.06+0.07+0.87
B	0 ° 90 °	1.4742 0.99+0.00+0.01	0.8738 0.00+1.00+0.00
C1 C2	0 ° 90 °	1.3894 0.97+0.00+0.03	0.8186 0.05+0.00+0.95

Calculation model	Interlayer elastic displacement angle (max)			
	Wind load		earthquake effect	
	X	Y	X	Y
A	1/1052 (5F)	1/3943 (4F)	1/989 (5F)	1/2343 (5F)
B	1/1164 (5F)	1/3363 (4F)	1/772 (5F)	1/2171 (5F)
C1 C2	1/1160 (5F)	1/3440 (5F)	1/903 (5F)	1/2411 (5F)

Table 2 Analysis of internal force of earthquake and wind load

Calculation software	Seismic action angle	The total shear force of the base under earthquake action (KN) Base total moment (KN.m)	
		X	Y
A	0 ° 90 °	509.78 5661.23	787.13 11195.88
B	0 ° 90 °	561.158 5668.641	659.013 10675.26
C1, C2	0 ° 90 °	456.764 4248.00	604.125 8874.45

Calculation software	The total shear force of the base under wind load (KN) Base total moment (KN.m)		Effective mass coefficient Xdirection Ydirection
	X	Y	
A	493.1 6488.5	648.7 8635.9	98.66% 100.00%
B	425.446 5270.109	615.074 8318.029	100.00% 100.00%

C1、C2	425.662 5274.922	602.758 8118.394	100.00% 100.00%

It can be seen from Table 2, do not consider the effect of the pile, A and B of the seismic shear, bending moments are very close, indicating that the results of the two procedures calculated credible. Compared with C1 and C2, the seismic shear and bending moments of C1 and C2 models are reduced, indicating that the analysis results of A are safe, and it is beneficial to the seismic response of the structure after considering the structure of the pile. , C1, C2 four models of the effective quality of participation coefficient are to meet the requirements of [3].

Displacement and Interlayer Displacement Caused by Earth Pressure

Through the Midas analysis of the C1 and C2 models, the maximum displacement of the pile top by the earth pressure is 1.21mm, 3.44mm, which is 1 / 2975,1 / 1046 of the pile length. The maximum displacement of the outer wall of the wall produced by the earth pressure is 1.73mm, 4.99mm, respectively, for the wall height of 1 / 1907,1 / 661. The maximum displacement of the roof caused by earth pressure is 2.21mm, 6.25mm.

In addition, considering the earth pressure, the maximum interlaminar displacement angles of C1, C2 under the action of Y-earthquake and earth pressure are 1/2446 (5F), 1/1885 (5F), respectively, Under the combined action of earth pressure, the maximum interlaminar displacement angles of C1 and C2 are 1/2962 (4F) and 1/2426 (5F), respectively, which meet the requirements of the specification.

The effect of earth pressure on pile and column reinforcement

C1 calculated pile maximum longitudinal reinforcement is: φ1200 pile maximum value of 114cm2, φ1400 pile maximum value of 81cm2. C2 calculated pile maximum longitudinal reinforcement: φ1200 pile maximum value of 323cm2, φ1400 pile maximum 213cm2. Four models and pile connected to the column reinforcement see Table 3:

Table 3 Reinforcement tables with columns connected to each model

Model	Column reinforcement (cm2)					
	KZ1	KZ2	KZ3	KZ4	KZ5	KZ6
A	8	12	16	16	12	8
B	10	14	18	18	13	10
C1	20	32	24	24	32	20
C2	20	32	24	24	32	20

As can be seen from Table 3, considering the earth pressure and the pile to participate in the work together, and the pile connected to the column reinforcement increased a lot. Among them, KZ2 reinforcement changes the largest, reached the A model 2.66 times. This shows that considering the earth pressure and the pile to participate in the common work, and the pile connected to the column is relatively large, to attract attention.

3. CONCLUSION

1. In the earthquake and wind load, Midas no pile when the calculation results and Satwe no pile is very close to the two models of the indicators can meet the requirements.

2. Considering the effect of soil on the horizontal earth pressure of pile, the pile and ground beam participate in the overall structure of the structure, the overall displacement of the structure has increased, but meet the specification requirements. Among them, C1, C2 model, the earth pressure generated by the Y to the roof displacement of 2.21mm, 6.25mm, by the earthquake and wind load generated Y to the roof displacement were 5.36mm, 4.04mm, which shows the earth pressure The displacement of the structure cannot be ignored, need to pay enough attention.

3. With the pile connected to the column, under the action of earth pressure, the internal force has a greater change. Among them, the reinforcement is of the largest change, not to consider the model when the pile 2.66 times, in the reinforcement design, to strengthen the pile connected with the column.

4. The beam and internal force connected to the pile are changed, and the end moment of the beam is increased, and the increase is about 10% ~ 25%. But the bending moment is reduced and the magnitude of the reduction is not large.

4 SUGGESTIONS ON DESIGN OF SLOPE STRUCTURE

1, the appropriate increase with the pile connected to the bottom of the column reinforcement, increase the hoop rate, improve the vertical component of the carrying capacity and ductility.

2, the appropriate increase with the pile connected to the beam of the first cross-section and reinforcement, improve the carrying capacity and structural components ductility.

3, according to the geological survey report and the actual situation, the "stacked soup" building slope for special support design.

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