The dynamic elastic-plastic analysis of frame-shear wall structure of a power plant main building

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Abstract: The main machine hall has the characteristics of the uneven distribution of mass and stiffness. It is important to research the structural seismic performance to ensure the normal operation of power plant, prevent serious damage to important equipment and personnel. This paper uses the general finite element software ABAQUS to investigate seismic performance of structures under strong earthquakes, the various parts of the inelastic phase sequence, damage degree and distribution, and on this basis puts forward opinions and suggestions on structure scheme. The analysis results show that the structural maximum interlayer displacement Angle can meet the demands of 1/100 limit, the seismic fortification standard of "no collapse under strong earthquake" can be achieved and the results can provide important basis for design.

Keywords: The main workshop; Fiber model; Elastic-plastic time history analysis; Seismic performance evaluation.

1. Introduction
Earthquake hazards are well known to 5.12 wenchuan earthquake as an example, the wenchuan earthquake is the biggest in China since the tangshan earthquake in 1976 of a destructive earthquake, the earthquake, wenchuan county and the city of beichuan is almost completely damaged, chengdu, guangyuan, deyang, mianyang and other cities have different degrees of houses collapsed and casualties, economic losses, Arouses the society from all walks of life to the building structure seismic design extensive concern. In the 5.12 Wenchuan earthquake, Sichuan Jiangyou Power Plant suffered a rare earthquake of 7 degrees. The main structure of the plant entered the elastoplastic stage and was seriously damaged, resulting in the interruption of power supply.

As the lifeline of modern society, the electric power system is related to every aspect of our life and plays an important role in the national economy. Therefore, to improve the seismic performance of electric buildings is to determine whether they can be on the ground

Should, the important factor that recoups national economy loss. Due to the increasing capacity of thermal power plants, which play the function of lifeline and provide power supply units in time, more strict requirements are put forward for structural design and construction technology. New structural forms, high strength materials are not

Break into the construction of electric power industry. Modern large-span heavy-duty thermal power plant building has the characteristics of large structural span, complex form, component section and self-
weight, large vertical load, high technology requirements. Therefore, choosing the appropriate structure form of the main building of thermal power plant and continuously improving the design and construction technology level of the main building play an important role in improving the safety of thermal power structure under earthquake action [1-2].

The dynamic elastoplastic time-history analysis method [3] can calculate the internal force and deformation form of the structure in the whole process of earthquake response, find the place where the stress and plastic deformation are concentrated, and then identify the yield mechanism, weak links and possible types of failure of the structure. At the same time, the bending moment and curvature relationship calculated by the fiber model method can be used to describe the variation relationship between structural element forces and deformation [4-5], so it is considered to be the most reliable method for structural elasto-plastic analysis [6]. In this paper, the short-leg reinforced concrete shear wall structure of the main building of a thermal power plant is taken as the research object, the applicability of this method in the short-leg shear wall structure is investigated, and the seismic performance index of the main building of the thermal power plant is analyzed, and its seismic performance is evaluated, which provides a strong basis for the rational design of the main building of the thermal power plant.

2. Project Overview
The transverse structure system of the deaeration room of the steam engine room is a frame shear structure, and the longitudinal structure system is a frame shear structure composed of columns, longitudinal beams and shear walls. Steam engine house surface uses double slope solid belly type steel beam, light roof. This project has a total of 8 floors, with a length of 90 meters, a width of 46.5 meters and a height of 30.974 meters. The structural layout of the main workshop is shown in Figure 1-3. Basic wind pressure 0.40kN/m² (once in 50 years), 0.45kN/m² (once in 100 years); The basic snow pressure is 0.25kN/m², and the maximum snow thickness in the past years is 140mm. The peak acceleration of ground motion in the factory area is 0.173g, the basic seismic intensity is 7 degrees, the construction site category is Ⅲ class, the design earthquake group is the first group, the seismic grade of concrete frame is 2, the seismic grade of steel frame is 2, the seismic grade of shear wall is 1.

3. Selection of ground motion
Based on the above theory, this project selects two groups of natural ground motion records and one group of artificial waves for time-history analysis. Bidirectional input is adopted for each analysis condition. The intensity ratio of seismic waves in the main and secondary directions is determined at 1: 0.85, and the peak acceleration of rare earthquakes is set at 310 Gal. Fig. 1– 3 respectively show the acceleration time history corresponding to the three groups of seismic waves (" 00 "and" 90 "represent the eastward and westward ground motions).
4. Dynamic elastoplastic analysis of structure

The large universal finite element software ABAQUS was used to investigate the seismic performance of the main workshop structure on conventional islands under large earthquakes [8-9], and the sequence of each component entering the elasto-plastic stage, the degree of damage and the distribution were studied. On this basis, the opinions and suggestions for the original structure scheme were put forward. The seismic capacity of frame structure in the elastoplastic stage is reflected in the deformation bearing capacity, including two aspects:

1) Whether the deformation of the structural member is within its tolerable range, mainly refers to the plastic deformation of the cross section of the frame member (beam, column, support).

2) Inter-layer displacement Angle (Output the displacement time history of the opposite corner points of each layer, then calculate the time history of inter-layer displacement Angle, and take the maximum value. Due to the possible eccentricity of the structure, the center of mass cannot be taken. It is necessary to investigate whether the two points relative to each other in the direction of X and Y in the same layer are within the scope specified by the code.

4.1. The shear wall pressure loss chart

Fig. 4 shows the damage of structural components under the action of natural wave 2 (which has the strongest destructive force). The damage of several typical frames is selected. In the figure, small dots are marked on the damaged frame members, and the color of the dots represents the degree of damage to the members.

As can be seen from the damage diagram of the frame unit:

1) The damage degree of the components is not high. No component damage has reached the stage of serious damage, and all of them are below the level of serious damage. This is mainly because the shear wall greatly improves the lateral stiffness of the structure.

2) At the bottom section of column A with 22m elevation, 1/2 of column A is moderately damaged, and 1/5 is slightly damaged. The damage is more serious, mainly because this layer is the overhanging structure of the roof protruding between the oxygen removal, and the force is greater under the action of earthquake.

3) The damage degree of the frame column is higher than that of the beam, and the moderately damaged columns are mainly concentrated at the top of the fourth layer (elevation 13.7m), namely, the top of the column of the platform layer and the top of the sixth layer (elevation 22m). The damage degree of the coupling beam is relatively high, which is consistent with the design concept of "strong wall is weak coupling beam" of the frame shear wall structure.

4) According to the above seismic performance requirements, the seismic performance of the 4th and 6th floors of the structure can reach the 5th level corresponding to performance objective 4, and the seismic performance of the other floors can reach the 4th level corresponding to performance objective 3.
5. Conclusion

This paper USES the general finite element software ABAQUS to calculate the large thermal power factory workshop structure response of the structure under severe earthquake, and analyzes the structure of the main seismic performance and evaluation, because of the similarity of the structure in power and structure model typicality, analysis the conclusion for coal-fired power plant in domestic ci main workshop also has certain applicability. According to the above analysis results, the following conclusions can be drawn:

1) The maximum inter-storey displacement angles of the vertical and horizontal frames of the structure are 1/246 and 1/138 respectively, neither exceeding 1/100, meeting the requirements of the code.

2) The fourth floor of the structure (elevation 13.7m), namely the maximum inter-floor displacement Angle of the operating platform layer, is 1/182, which meets the standard limit, and this layer has not become a weak layer of the structure.

3) The parts with severe damage of the members are mainly concentrated at the bottom of the 7th column, the top of the 6th column and the top of the 4th column (elevation 13.7m) in column A, but the damage degree is moderate, that is, the maximum bearing capacity of the members is not exceeded, and the structure will not collapse.

4) Except for the 7th layer, the 4th and 6th layers, the damage condition of the other layers is at the 4th level, the performance target is 3, and the ductility is good; The damage condition of the seventh and fourth and sixth layers is at the fifth level, which can meet the requirements of performance objective 4. The fourth and sixth layers are slightly damaged, and it is suggested to be strengthened. On the whole, the whole structure can achieve the fortification goal of "big shock does not fall down".

5) The torsion component of the structure is small in the longitudinal direction, but has obvious torsion in the transverse direction. However, the structure of the main workshop is irregular frame structure, and the seismic performance of the longitudinal frame is obviously better than that of the transverse frame. Considering the influence of torsion effect on the seismic performance of such structures, further study is needed.

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