Seismic Response Analysis of Large-Span Spatial Structure

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Abstract

The reinforced concrete slab is one of the most widely used structural forms at present. The structural researchers and engineers have been deeply researched on the performance of the structures and the response characteristics of the loads and the reasonable design methods and construction measures. With the increasingly complex and changeable modern building functions and the emergence of intelligent buildings, the auxiliary facilities are more and more complex, resulting in a lot of pipelines, lines, elevators are from the floor of the open hole through. The mechanical properties of reinforced concrete slab can be changed after opening, and the stress concentration occurs around the hole. For this reason, this paper discusses the theory of RC slab and analyzes the internal force change of the four-sided solid-open-hole plate in different openings and shapes and different open-hole area with Ansys software, and obtains the law of internal force change, and compares the force-condition under the approximate boundary condition with the three-side solid support plate and the cantilever plate. To get some similar results. At the same time, different mathematical models were established by using the different formulas of shear capacity, and various factors affecting the shear capacity of the plates were analyzed. Starting from the calculation model of reinforced concrete slab, the paper discusses the discrete of steel bar and concrete, the constitutive equation of concrete, and analyses and calculates a reinforced concrete slab with the model discussed. Finally, compared with the experimental results, the calculation method and feasibility of finite element analysis for RC slabs are verified. Some design suggestions are put forward for similar situations in practical projects.

Keywords

Seismic response analysis of large-span spatial structure multi-point input, random vibration method.

1. Introduction

Because of its great span, light weight and simple structure, space structure has been widely used in stadiums, airports, parking lots and other large public buildings. As the large-span space public buildings often have important political, economic and social functions, it is of great practical significance to ensure the structural safety and functional continuity of the large-span public buildings after the earthquake, as the temporary settlements and relief sites of the earthquake disasters occur.

Because the large-span space structure has many problems, such as the number of degrees of freedom, the dense frequency distribution, the complex mode of vibration and the non-negligible nonlinear effect under strong earthquakes, the existing methods are used to analyze the seismic response of structures, and domestic and foreign scholars have been working to improve the traditional methods of seismic response analysis. At the same time, it is a research hotspot in the field of structural earthquake

resistance to seek a new analytical method suitable for engineering application. This paper will mainly introduce the main methods of seismic response analysis of large-span spatial structures, analyze and compare their similarities and differences, summarize the latest research status of seismic input, research direction and other major problems in earthquake resistance of large-span space structures.

2. Research Background of Seismic Response Analysis Method for Large-Span Spatial Structures

With the gradual deepening of people's understanding of earthquake disaster and the gradual accumulation of earthquake-resistant experience, the traditional seismic design method, which focuses on reducing the collapse and casualty of buildings under earthquake, begins to show its limitation. Especially when the building decoration, non-structural components, information technology equipment and other facilities value more than the value of the building structure, the limitations are particularly prominent. This shows that the traditional seismic design [1] method cannot meet the requirements of modern society for structural seismic performance. Therefore, the performance-based seismic design idea can be proposed. The purpose of performance-based seismic design is to effectively control the damage of buildings under different intensity level earthquakes in seismic design, and the buildings meet the requirements of the target of specific performance level. The core idea of performance-resistant seismic design should include the following three points

(1) various seismic fortification targets and their corresponding cost-benefit measurement methods,

(2) Multi-stage seismic design and corresponding analytical means,

(3) Multi-parameter evaluation and the corresponding judgment criterion. To achieve the above-mentioned process, to ensure the structural seismic design to meet the "performance-based" requirements of the foundation.

Under the above background, the engineering field has a new requirement for calculating the structure reaction under the earthquake action. On the one hand, the working state of the structure is no longer divided into the elastic, elastoplastic and other independent stages, which is combined with the owner's demand and socioeconomic status, the structural response performance parameters are determined. The detailed structural seismic performance targets correspond to different structural reaction performance parameters, and the structural analysis work needs to be carried out on a more detailed level, so that the number of seismic conditions that need to be analyzed is increased obviously. On the other hand, the process designers want to use a relatively simple and clear concept of structural analysis methods to achieve structural seismic response analysis, and guidance of seismic design. The contradiction between the above two aspects is more concentrated in the choice of structural seismic response analysis method, in the large-span space structure, the above contradiction is difficult to solve with the existing means. It is the basic principle, application scope and development direction of structural seismic response analysis method, which has the practical value of engineering, and is the basis of further research on seismic response analysis of structures.

3. Research and Research Status of Seismic Response Analysis Methods for Large-Span Spatial Structures

3.1 Random Vibration Method

The stochastic vibration method is also called the power spectrum method, and the power spectra of various responses are obtained by the given excitation power spectrum. It is able to fully consider the statistical probabilistic characteristics of earthquake occurrence. But when the structure is complex and the degree of freedom is many, the stochastic response of the traditional CQC (completequadratic combination) expression is very difficult to be used in engineering calculation. For this reason, the correlation between the modes of vibration is often ignored, and the SRSS (Square Root of the Sum of squares) calculation is used to reduce the computational effort. The analysis results of this method can

satisfy the accuracy requirement when the frequency distribution of the modal states is sparse, and the large error will be produced when the frequency is dense.

Sisodo the above-mentioned virtual excitation method is applied to the spatial grid structure multidimensional multi-point non-stationary random seismic response analysis, the theoretical formula of the multi-dimensional virtual excitation stochastic vibration analysis method, the peak response estimation method, the stochastic model of multidimensional seismic motion and the parameter selection are discussed. The random seismic response of reticulated shell structure is analyzed by a special computer program.

3.2 Reaction Spectrum Method

The response spectrum method is the most widely used seismic analysis method, and the response spectrum method is used as the main seismic design method in the national seismic code. 1941 Biot first proposed the concept of response spectrum, because of the lack of sufficient strong earthquake records, this response spectrum method is difficult to obtain practical application, simplifying the use of envelope response spectrum as an approximation [13]. As a result of the complexity of the random vibration method of multi-point input, many scholars also want to put forward a simple and easy calculation method of multi-point response spectrum based on the traditional uniform excitation response spectrum method. The multi-point reaction spectrum method is based on the traditional response spectrum curve, and the characteristic of the traditional reaction spectrum method is established.

However, it is not possible to maintain the advantages of the traditional response spectrum method, which is inconsistent with the original intention of simplifying the calculation by using the reaction spectrum method. The theory of multi-point input reaction spectrum has a great development space in practical engineering applications.

3.3 Time-History Analysis Method

Deterministic dynamic analysis method includes time domain and frequency domain analysis method, in which the time-history analysis method is more mature and applied. It can accurately consider the interaction between the structure, the soil and the deep foundation, the phase difference effect of the seismic wave and the multi-component multi-point input of different ground waves. At the same time, the influence of geometrical and material nonlinearity and the nonlinear properties of various vibration isolation devices on seismic response of structures can be considered. Review is a direct integration method, which includes linear acceleration method, wilson-θ method and Newmark method. Compared with the reaction spectrum method, the odometry has wider applicability, considering the nonlinearity of the structure, determining the order of the plastic hinge and the position of the weak structure, and its disadvantage is the lack of statistical significance and the use of specific seismic waves. Due to the large deviation of the results obtained from different seismic waves, the Cheng is used as a complement to the response spectrum method for nonlinear analysis of structures. Many researchers use Odometry to analyze the response of large-span structures under multi-dimensional earthquakes. Because the time odometry analysis uses the real seismic wave, it is used to test the rationality of other methods and provides the basis for further study.

4. Research Prospect

In general, large-span structures multi-point input from the research response from the actual engineering applications as well as large. There are the following issues still to be resolved:

(1) multi-point input structure response analysis method is not yet mature. Deep method of random vibration theory, applied to practical engineering difficult and now finite element method software is not easy to achieve; multi-input response spectrum method cannot guarantee the accuracy of the calculated amount of both, the actual application is difficult engineering; time history analysis Although the method can be non-linear analysis, currently subject to excessive computing, fruit

depends largely on the selected seismic waves. Three methods each have their own advantages and disadvantages, there is greater room for development, long-term in-depth studies are needed. Experimental Study (2) in response to multi-point input structure is still in its infancy. Conventional multi-point input Response Analysis methods are obtained in response to the input reference consistent analysis method is dynamic properties (in particular the damping characteristics) in both cases, but not necessarily the same input. Therefore, experimental research of multi-input, multi discuss structural dynamic characteristics in the case of inputs is of great importance. But due to the small number of laboratory shaker array, field tests and difficult to expand, there is much room for development in this field.

Research (3) structure of the multi-point input seismic response characteristics have been used, due to the different types of construction and selection of parameters,

(4) difficult to obtain a regular conclusion, to bind to the future practical engineering. Existing studies show that, with the multi-touch input structure response characteristics vary greatly. In particular it is necessary to structure multi-parameter analysis, response law cable structure, the input structure of study failure mechanism in a case where a multi-point, to guide the final actual engineering design

5. Epilogue

Under the background of performance-based seismic design, the method of seismic response analysis for large-span space structure performance-resistant seismic design needs to be developed urgently. In the structural calculation model, the randomness of geometry, material, damage and other problems are considered, and the uncertainty of the seismic action of the structure is considered in the analysis method, and the relatively simple method is used to calculate the seismic response considering the nonlinear effect of the structure, which is in the background of performance-based seismic design. The hot direction of seismic response analysis method for large-span spatial structures. Scholars and engineers at home and abroad have mastered the characteristics and laws of seismic response of spatial structures to some extent based on the existing calculation methods, and some scholars have synthesized them by using more and more mature structural seismic response analysis methods, and developed a new solution method. However, the existing methods of calculation and analysis are lagging behind the practical application of engineering, and it is still necessary to further develop a simple and efficient seismic response analysis method for large-span spatial structures.

The exploration and research of structural seismic response analysis method should be based on engineering application. In the study, we should pay attention to the theoretical analysis, numerical calculation, structural measurement, model test four methods of mutual cooperation, and to deal with the analytical method of complex accuracy and simple ease of use of the coordination system

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