Determination of ground motion parameters by seismic response analysis method of soil layer

ChangXian Zhou¹, ShaoPeng Zheng², YouQuan Ye³, Hao Wang⁴, Ping Fu⁵
Xiamen Seismic Survey Research Center
Xiamen 361021, China, 41500619@qq.com

Abstract: In this paper, the factors affecting the results of seismic response analysis of soil layers are analyzed by substituting trial calculation for various factors in the engineering example of seismic safety evaluation. In the soil response analysis of building site, the lithology of overburden soil, the sudden change of soil structure (interlayer) and the input shear wave value all have influence on the soil seismic response. Among them, the weak interlayer has significant influence on the peak acceleration and characteristic periodic value of seismic response analysis, while the hard interlayer, simple overburden and the type of bedrock soil have little influence on the seismic response of soil. The following construction projects must be evaluated for seismic safety: (1) Major State construction projects; (2) Construction projects that may cause floods, fires, explosions, massive leakage of highly toxic or highly corrosive substances or other serious secondary disasters after being damaged by earthquakes, including reservoir dams, dikes, oil and gas storage, and storage of inflammable, explosive, highly toxic or highly corrosive substances. Facilities and other construction projects that may cause serious secondary disasters; (3) nuclear power plants and facilities that may cause radioactive pollution after earthquake damage; (4) other construction projects that provinces, autonomous regions and municipalities directly under the Central Government consider to be of great value or have significant impact on their respective administrative regions.

1. Introduction
Seismic safety evaluation of engineering site is based on the investigation of seismic and seismic geological environment around construction site and site, the investigation of site seismic engineering geological conditions, the comprehensive evaluation and analysis of seismic geology, geophysics, seismic engineering and other multi-disciplinary data, and according to the type, nature and importance of the project. The earthquake ground motion parameters corresponding to the requirements of engineering seismic fortification and the prediction results of seismic and geological hazards at the site are given scientifically and reasonably. The main contents of seismic safety evaluation include: seismic activity environment evaluation, seismic geological environment evaluation, fault activity identification, seismic risk analysis, determination of design ground motion parameters, seismic geological hazard evaluation, etc.

With the development of China's economy and architectural design technology, and the improvement of social requirements for the quality of construction projects, more and more construction units attach importance to the seismic safety evaluation of construction sites. Seismic safety evaluation of engineering site is based on the investigation of earthquake and seismogeological environment around construction site and site, the investigation of site engineering geological conditions, the comprehensive evaluation and analysis of seismic geology, geophysics, seismic engineering and other multi-disciplinary data, and according to the type, nature and importance of engineering. The parameters of earthquake ground motion corresponding to the requirements of engineering seismic fortification and the evaluation of seismic geological hazards at the site are reasonably given. At present, the main method to determine the relevant parameters of site ground motion is to take the results of
site seismic risk analysis as seismic input and calculate the seismic response of soil layer in site.

Seismic safety evaluation can make seismic fortification of construction projects scientific, reasonable and economical. Major construction projects and construction projects likely to suffer serious secondary disasters require different aseismic fortification requirements from general construction projects. Without seismic safety evaluation, it is difficult to meet the specific conditions of the project site and the allowable risk level of the project by simply applying the intensity zoning map for aseismic design. This kind of seismic fortification obviously lacks scientific basis. If the defense is low, it will bring hidden dangers to the project; if the defense is high, it will increase the construction investment and cause unnecessary waste.

2. Examples of soil seismic response analysis

A Brief Introduction of 2.1 Seismic Response Analysis of Soil Layer

Soil is a highly nonlinear material, and its stress-strain relationship shows complex hysteretic characteristics under earthquake and other irregular loads. The current method of seismic response analysis of soil layers, which is based on equivalent linearization method, simplifies the non-linearity of soil in the sense of overall dynamic effect, which is a breakthrough in dealing with the non-linearity of soil. This method is the basic principle of the present method of soil seismic response analysis. Seismic response analysis of soil layers plays an important role in seismic safety evaluation and seismic design of construction projects. The ese-sla program compiled by Li Xiaojun and others is the most widely used program for seismic response analysis of soil layers in engineering sites. This program is also used for calculation in this paper.

2.2 Project Survey

A high-rise residential area, the main building is a number of 32-storey residential buildings. In the work of seismic safety evaluation, three engineering geological drilling holes were drilled, and the shear wave velocity per meter of soil layer was measured by single hole method. The overlay thickness of the site is 46m, and the equivalent shear wave velocity is 210m/s. According to the seismic code of the building, the site soil is medium-soft site soil, and the site type is class II site. The lithological structure and physical property data of the three holes do not change much. Taking the representative lithological structure of K2 hole as an example, the soil response analysis model is established.

The horizontal peak acceleration and acceleration response spectra of the site with 50-year exceedance probability of 63%, 50-year exceedance probability of 10%, 50-year exceedance probability of 2% were calculated by ese-sla program. In this paper, we only discuss the response analysis of 10% exceeding probability in 50 years. The results are as follows: Table 2 (1, 2 and 3 are the results of three-time stochastic synthesis of earthquake motions, respectively): Peak acceleration (gal) characteristic period (s)

2.3 Discussion on the effect of erathquake response analysis on social

In order to explore the influence of soil lithology on seismic response analysis of soil layers, the author calculated the changes of soil lithology in order to observe the influence of the changes of soil lithology and structure on seismic response analysis of soil layers, in addition to calculating the actual situation of engineering site (original model, represented by a). Trial calculations are made in the following cases: b, change the fifth layer into sand; c, change the lithology of the input layer into silty clay; d, change the fifth layer into weak layer (change the shear wave velocity value to 160); e, change the fifth layer into hard interlayer (change the shear wave velocity value to 500); f, reduce the natural density of all soil layers by 10%; g; The input shear wave velocity increases (to 650). All the above substitutions are single-factor substitutions only on the original model. The calculation results are as follows:

it can be seen that different physical parameters of soil layer and soil structure have different effects on seismic response of soil layer (others). For example, the most significant effect on soil layer response is the presence of weak soil interlayer in soil layer structure, which makes the characteristic period (tg) of site longer to 0.6s. In Anyang City, the seismic design code is 0.35s, and the results of seismic response analysis of specific seismic safety evaluation are only 0.4s. This result will have a great impact on seismic design. Hard interlayer (example e) has no weak interlayer, which has a great influence on the calculation results. This shows that the equivalent linearization in seismic response analysis of soil layer is inaccurate in dealing with the non-linear effect of soil. This conclusion is also expressed in relevant literature (Bojingshan; Liu Dedong). Liu Dedong and others think that the equivalent linearization in the current soil response analysis program enlarges the nonlinearity of the soil layer when there is a weak layer, but this calculation result also shows from another aspect that the site with a weak layer is a disadvantageous factor, and the seismic design cannot meet the requirements if only referring to
the code. The example f shows that if the equivalent shear wave velocity of the site soil layer is between 150 m/s and 250 m/s and the covering layer is less than 50 m, it is not possible to simply judge the site as Class II site according to the code.

3. Conclusion
From the above discussion, we know that in the analysis of soil response of building site, the lithology of overburden soil, structural mutation (interlayer) and input shear wave value have influence on soil seismic response. Among them, the weak interlayer has significant influence on the peak acceleration and characteristic periodic value of seismic response analysis, and it also reflects that the presence of weak interlayer is a disadvantageous factor for engineering; the input shear wave velocity value of bedrock has a great influence on the seismic response analysis of soil layer; while the hard interlayer, simple overburden and bedrock layer have a great influence on the seismic response analysis of soil layer. Soil types have little influence on soil response analysis. It is pointed out that the accuracy of the current equivalent linearization program itself for some special lithologic structures is worth further discussion.

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