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PART 4 - STUDYING THE INFLUENCE OF SOILS UNDER THE FOUNDATION ON THE STRUCTURAL SYSTEM WHEN SUBJECTED TO SEISMIC LOADS

Proposes a vibration calculation procedure for high-rise buildings

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Abstract

Big earthquakes with the intensity of earth-quaking from VII degrees to IX degrees were forecasted to be able to occur in Viet Nam. Therefore, studying to calculate the impacts of earthquakes on building structures in Viet Nam is very necessary. This paper studies the influence of different types of soil on the structural system of high-rise buildings when the building is subjected to earthquakes. After analyzing the model in Etabs software, the authors found that different types of ground for displacement, internal force difference up to 167%. At the same time, the authors also proposed a procedure to calculate the earthquake load-bearing structures using the response spectrum of many types of copper vibrations. It helps design engineers to easily apply structural calculations. To achieve the stated objective of the study. The overall content of this study is organized into four parts. Part 1: Methodological content; Part 2: Research model of a high-rise building in earthquake impact analysis; Part 3: Simulate the impact of earthquakes on a high-rise building; Part 4: Proposes a vibration calculation procedure for high-rise buildings.

Keyword: Earthquake, high-rise building, response spectrum, displacement, internal force.

1. INTRODUCTION

With the continuous progress of science and technology, construction works in the world in general and Vietnam, in particular, is developing with radical heights and complexity. The main characteristics of high-rise buildings are the number of floors, their heavyweight, and the impact of horizontal loads. As the height of the building increases, the complexity of design calculations also increases. In particular, they are determining the response of the building to the impact factors of external conditions such as loads due to wind, earthquakes. The study and Calculation of high-rise buildings taking into account earthquake loads is still limited and has not been focused on research.

2. PROPOSING THE CALCULATION PROCEDURE ACCORDING TO THE RESPONSE SPECTRUM METHOD

The vibration response spectrum analysis method is a dynamic structural method that uses an emotional response spectrum of all types of vibrations. The response spectrum of the vibration patterns is determined based on the coordinates of the response spectrum curves suitable for the respective natural periods of oscillation.

Step 1: Determine applicable conditions: applicable to all types of construction works..

Step 2: Determine the ratio value a_{gR}/g

Based on the zoning map of the background acceleration with a repeating cycle of 500 years for type

A foundation, or based on the partitioning of the ground acceleration according to administrative locations to determine the value of the ratio a_{gR}/g (where: a_{gR} - is the peak of the reference ground acceleration at the construction site, g - the acceleration due to gravity). The a_{gR}/g ratio can also be obtained from data provided by the competent professional body.

Note: The values given in the ground acceleration partition map and the ground acceleration partition table according to administrative locations (of the TCVN 9386:2012 standard) are the ratio a_{gR}/g. In addition, the design spectral coordinate parameter $S_d(T)$ of TCXDVN TCVN 9386:2012 does not say anything about the dimension of $S_d(T)$. So in this calculation procedure, to avoid dimensional confusion, the value $S_d(T)$ is replaced by $S_d(T) = S_d(T)/g$, which is a dimensionless quantity.

Step 3: Level and importance factor.

The significance level is characterized by the importance coefficient γ_I . The value of γI is determined according to Article 4.2.5 and Table 4.3 of TCVN 9386:2012 (γ_I = 1.25, 1.00 and 0.75 respectively for works I, II and III).

Step 4: Determine the design ground topsoil acceleration value.

Acceleration of the design ground topsoil ag corresponding to the ultimate limit state is determined as follows (through g): $a_g/g = a_g/g*\gamma_I$

Note: TCVN 9386:2012 stipulates:

- Strong earthquake $a_g/g \geq 0.08$, seismic resistance must be calculated and constructed.
- Earthquake is weak $0.04 \leq a_g/g < 0.08$, apply seismic mitigation solutions that have been mitigated.
- Very weak earthquake $a_g/g < 0.04$, no need for seismic design.

Step 5: Identify ground conditions according to earthquake impact.

According to soil classification, there are seven types of soil, including A, B, C, D, E, S1, and S2. Based on the stratigraphic cross-section, geotechnical engineering survey data at the construction site and ground conditions according to the seismic impact specified in Article 3.1.2 and Table 3.1 of the standard to identify the foundation soil for the Calculation of seismic resistance.

Step 6: Determine the response coefficient q of the structure. Depending on the type of structure, there are different behavior coefficients according to TCVN 9386:2012.

Step 7: Determine the number of vibrational forms to consider in the response spectrum method.

Suppose the above condition is not satisfied (such as houses and buildings where the torsional vibration contributes significantly). In that case, the minimum number of vibration types k that need to be considered in the Calculation must satisfy the following two conditions:

$$k \geq 3\cdot\sqrt{n} \text{ và } T_k \leq 0,2s \qquad (1)$$

k: number of oscillations to be considered in the Calculation.

n: number of floors above the foundation or top of the hardware below.

T_K: the natural period of oscillation corresponding to the kth form of oscillation.

Step 8: Determine the dimensionless design spectrum $S_d(T_i)$ corresponding to each type of vibration.

i: i-th individual vibration pattern in the X-direction on the plane.

$$\begin{cases} 0 \leq T \leq T_B : \bar{S}_d(T) = \dfrac{a_g}{g}, \text{gg}\left[\dfrac{2}{3} + \dfrac{T}{T_B}\left(\dfrac{2.5}{q} - \dfrac{2}{3}\right)\right] \\ T_B < T \leq T_C : \bar{S}_d(T) = \dfrac{a_g}{g}\text{S}\dfrac{2.5}{\text{q}} \\ T_C < T \leq T_D : \bar{S}_d(T) \begin{cases} = \dfrac{a_g}{g}, \text{gg}\dfrac{2.5}{\text{q}}\dfrac{T_C}{T} \\ \geq \beta\dfrac{a_g}{g} \end{cases} \\ T_D < T \ : \bar{S}_d(T) \begin{cases} = \dfrac{a_g}{g} S \dfrac{2.5}{q}\dfrac{T_C T_D}{T^2} \\ \geq \beta\dfrac{a_g}{g} \end{cases} \end{cases} \qquad (2)$$

In there:

S, T_B, T_C, T_D, determined according to Table 3.2 of TCVN 9386:2012.

T – Period of oscillation of the system (1 degree of freedom);

β – 0.2 (coefficient corresponding to the lower bound of the horizontal design spectrum)

Step 9: Determine the bottom shear force at the foot of the structure corresponding to the ith vibration pattern in the X direction by the following formula:

$$F_{X,i} = \overline{S_d}\left(T_i\right)W_{X,i} \quad (3)$$

$W_{X,i}$: effective weight (in the X-direction on the plane) corresponding to the i-th form of vibration.

$$W_{X,i} = \frac{\left(\sum_{j=1}^{n} X_{i,j} \cdot W_j\right)^2}{\sum_{j=1}^{n} X_{i,j}^2 \cdot W_j} \quad (4)$$

n: total number of degrees of freedom (number of floors) in the X-direction.

$X_{i,j}$: displacement value in the X direction on the plane at the jth weighting point of the ith vibration pattern.

W_j: weight concentrated on the jth floor of the building.

Step 10: Distribute the bottom shear force to the story**.**

$$F_i = F_b \cdot \frac{z_i W_i}{\sum z_j \mathrm{W_j}} \quad (5)$$

Step 11: Combination of vibration patterns. For simplicity, consider the oscillations linearly independent by combining the vibration patterns according to the square root principle of the sum of squares.

3. CONCLUSIONS

The article wants to clarify the influence of different soil types on the structural system during earthquakes. From there, appropriate measures will be taken to ensure the building's bearing capacity under the action of dynamic loads. In the proposed method, the response of all types of vibrations that contribute significantly to the overall response of the building must be considered. This will be satisfied if the project meets one of the following two conditions: The sum of the effective weights of the vibration modes thought accounts for at least 90% of the total weight of the structure; All oscillations with practical consequences greater than 5% of the total weight are taken into account.

4. ACKNOWLEDGEMENT

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