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1. Research topics

① Research related to dynamic interaction among foundations, ground and structural systems

Numerous structures absorbed tremendous damage during the 1995 Southern Hyogo Prefecture Earthquake, which also greatly impacted Japan's quakeproofing designs. New quakeproofing design standards were subsequently established, and great strides were made on quakeproofing designs, mainly performance-based methods. Many unresolved issues remain, however. Among these issues, the interaction between foundations and the ground, as well as the interactions during a large earthquake, have likely not been made clear enough. Moreover, as techniques for analyzing dynamic interaction grow more sophisticated, they have become harder to understand, and have been slow to gain acceptance among technicians. With that in mind, we have been performing dynamic response analyses on overall foundation, ground and structural systems, sorting the results from these in an attempt to express the effects of these dynamic interactions in a simple way.

② Research regarding the evaluation of soil structures using surface wave methods

Proposed surface wave evaluation methods include measurement techniques that involve using a) an exciter and two or three geophones, or b) a seismic impulse source and multiple geophones. The former measurement technique has been simplified, but it is not used much because some technicians question its reliability, so the latter method prevails. However, the lengths of the lines measured with the latter method tend to get longer because multiple geophones are used. That is a minus because it means a wider space is needed, so we have been using equipment designed for the former method for measurements and the finite element method to conduct dynamic response analyses as part of our efforts to improve precision by clarifying soil survey mechanisms and analytical processes.

③ Research regarding the evaluation of the residual seismic capacity of structures supported by foundations

There is a need to accurately assess the seismic capacity of reinforced concrete structures before earthquakes and after absorbing quake damage to assess their relative level of safety during aftershocks as well as to promote the drafting of rational recovery plans. There is also a need to establish methods for accurately assessing quake-damaged structures' residual seismic capacity to be able to quantitatively establish seismic performance based on safety, serviceability and reparability with regard to performance-based seismic design. With this in mind, we have adopted damage indices that quantitatively express the damage levels of structures at the time of an earthquake as residual seismic capacity—which

represents the seismic capacity of structures. Rates of residual seismic capacity will be reviewed through dynamic response analyses using models of actual bridges.

2. List of published articles

・N. Yamashita and T. Shimabukuro: Residual Seismic Performance Evaluation Of Highway Bridges Using The Damage Index, *Journal of Japan Society of Civil Engineers, Division A (Structural and Earthquake Engineering and Applied Mechanics), Vol. 70, No. 4* (pp. I 1144–1154). 2014.

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・Y. Hata, K. Ichii, S. Kano, T. Tsuchida, L. Li and N. Yamashita: A Simple and Easy Calculation Method to Seismic Response of Embankment considering Horizontal and Vertical Interaction, *Journal of Japan Society of Civil Engineers, Division A (Structural and Earthquake Engineering and Applied Mechanics), Vol. 65, No. 1* (pp. 156–165). 2009.

・S. Saito, T. Harada, G. Mori, H. Wang, and N. Yamashita: A Method of Estimation of Subsurface Ground Structure and Elastic Soil Properties Using Vertical Harmonic Loading on Ground Surface and Its Numerical Verification, *JSCE Journal of Earthquake Engineering*, Vol. 29 (pp. 279–286). 2007.

・N. Yamashita, and T. Harada: A Study Of Nonlinear Response Analysis Of Buried Foundation Considering P-Delta Effect Of Superstructure, *JSCE Journal of Earthquake Engineering*, Vol. 28 (pp. 1–8). 2005.

3. Corporate affiliations

None