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学 位 論 文 の 概 要 及 び 要 旨

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題　　目　Rocking Response Analysis of Liquid Storage Tanks under Seismic Ground Excitation（液体貯蔵タンクの地震時ロッキング応答に関する研究）

学位論文の概要及び要旨

This dissertation aims at presenting a method to analyze the time history of rocking response of liquid storage tanks by developing several mechanical models that enable to analytically describe uplift phenomenon of liquid storage tanks from several aspects. The study consists of three parts: the first part confirms a role of rotational inertia force of content liquid and the condition for commencement of uplifting of tank bottom, the second part develops a mechanical model of liquid storage tanks for rocking motion, and the third part validates the proposed method for analyzing the tank rocking motion. The results of this study point out the oversight in conventional calculation methods.

In Chapter 1, the structures of above-ground liquid storage tanks and their typical damage found during the several reconnaissance surveys performed after earthquakes are briefly reviewed. A review is also made on earlier studies on rocking response of liquid storage tanks due to seismic ground excitation. Finally, the objectives of the work are described.

In Chapter 2, preliminary preparations for the development of a method of tank rocking response analysis are conducted, including (1) selection of a suitable method for describing the uplift displacement-width relationship, (2) investigation of contribution of rotational inertia force of content liquid to the tank rocking motion, and (3) investigation of uplift commencement condition. These are conducted to determine the essential conditions and parameters for tank rocking response analysis. In this chapter, significant contribution of the rotational inertia force of the content liquid to the tank rocking motion is confirmed by comparing the angular acceleration extracted from FE analysis and that calculated from the equilibrium between the overturning moment, the restoring moment and the rotational inertia force, inferred from the equation of motion presented herein. Furthermore, shaking table tests conducted herein highlight the presence of added mass contributing to the uplift commencement condition.

In Chapter 3, equations of motion for the mechanical model of a liquid storage tank in rock are derived based on the analogy between a two-degree-of-freedom model which has the translational and rotational freedoms and the tank in rock. Furthermore, A computational method of the equations of motion

for the mechanical model of liquid storage tanks is also described.

In Chapter 4, the accuracy of the proposed method is verified by comparing uplift displacement between the calculation results by the proposed method and those by the dynamic FE analysis as well as observational record. In addition, comparison between the calculation results of uplift displacement by the proposed method and those by the conventional methods reveals that the proposed method gives better approximation compared to the conventional methods.

Finally, the results obtained in this study are summarized in Chapter 5. Although more work remains to be done for improving the proposed method, the purpose of this research, the development of a tank rocking response analysis, has been achieved.