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SEISMIC ACTIONS FOR DESIGNING GEOTECHNICAL WORKS - ISO23469

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ABSTRACT: The seismic performance of geotechnical works is significantly affected by ground displacement. In particular, soil-structure interaction and effects of liquefaction play major roles and pose difficult problems for engineers. An International Standard, ISO23469, is being developed for addressing these issues in a systematic manner within a consistent framework. This paper gives an overview of this International Standard.

Key Words: Design, Geotechnical Works, Liquefaction, International Standard, Seismic Actions, Seismic Hazard Analysis

INTRODUCTION

In order to provide guidelines to be observed by experienced practicing engineers and code writers when specifying seismic actions in the design of geotechnical works, a working group ISO/TC98/SC3/WG10 was established in 2002 (convener, the author) and has been in charge of drafting a new International Standard ISO23469. In this International Standard, seismic actions are defined as a generalized concept of seismic loads and include the actions due to ground displacement and soil liquefaction. A generalized methodology has been emerging through the WG activities for drafting the International Standard.

SCOPE

The scope of this International Standard is for geotechnical works, including buried structures (e.g. buried tunnels, box culverts, pipelines, and underground storage facilities), foundations (e.g. shallow and deep foundations, and underground diaphragm walls), retaining walls (e.g. soil retaining and quay walls), pile-supported wharves and piers, earth structures (e.g. earth and rockfill dams and embankments), gravity dams, tanks, landfill and waste sites. The seismic performance of geotechnical works is significantly affected by ground displacement. In particular, soil-structure interaction and effects of liquefaction play major roles and pose difficult problems for engineers. This International Standard is drafted for describing these issues in a systematic manner within a consistent framework.

The seismic performance criteria for geotechnical works cover a wide range. If the consequences of failure are minor and the geotechnical works are easily repairable, their failure or collapse may be acceptable. However, geotechnical works that are an essential part of a critical or post-earthquake emergency facility should maintain full operational capacity during and after an earthquake. This International Standard presents a full range of methods for the analysis of geotechnical works, ranging

from simple to sophisticated, from which experienced practicing engineers can choose the most appropriate option for evaluating their performance.

PRIMARY ISSUES

This International Standard consists of nine clauses; Clauses 1 through 4 provide general issues, including scope and terms; Clauses 5 through 9 provide guidelines for specifying seismic actions in the framework shown in Fig. 1.

In this International Standard, the seismic actions are determined through two stages (Clause 5). The first stage determines basic variables used for specifying seismic actions, including the earthquake ground motion at the site, the potential for earthquake-associated phenomena such as liquefaction and induced lateral ground displacement (Clause 6). These basic variables are used, in the second stage, for specifying the seismic actions for designing geotechnical works (Clause 7 through 9).

In the second stage, the soil-structure interaction plays a major role. Types of analyses are classified based on a combination of static/dynamic analyses (Clauses 8/9) and the procedure for soil-structure interaction classified as follows:

- simplified: soil-structure interaction of a global system is modeled as an action on a substructure;
- detailed: soil-structure interaction of a global system.

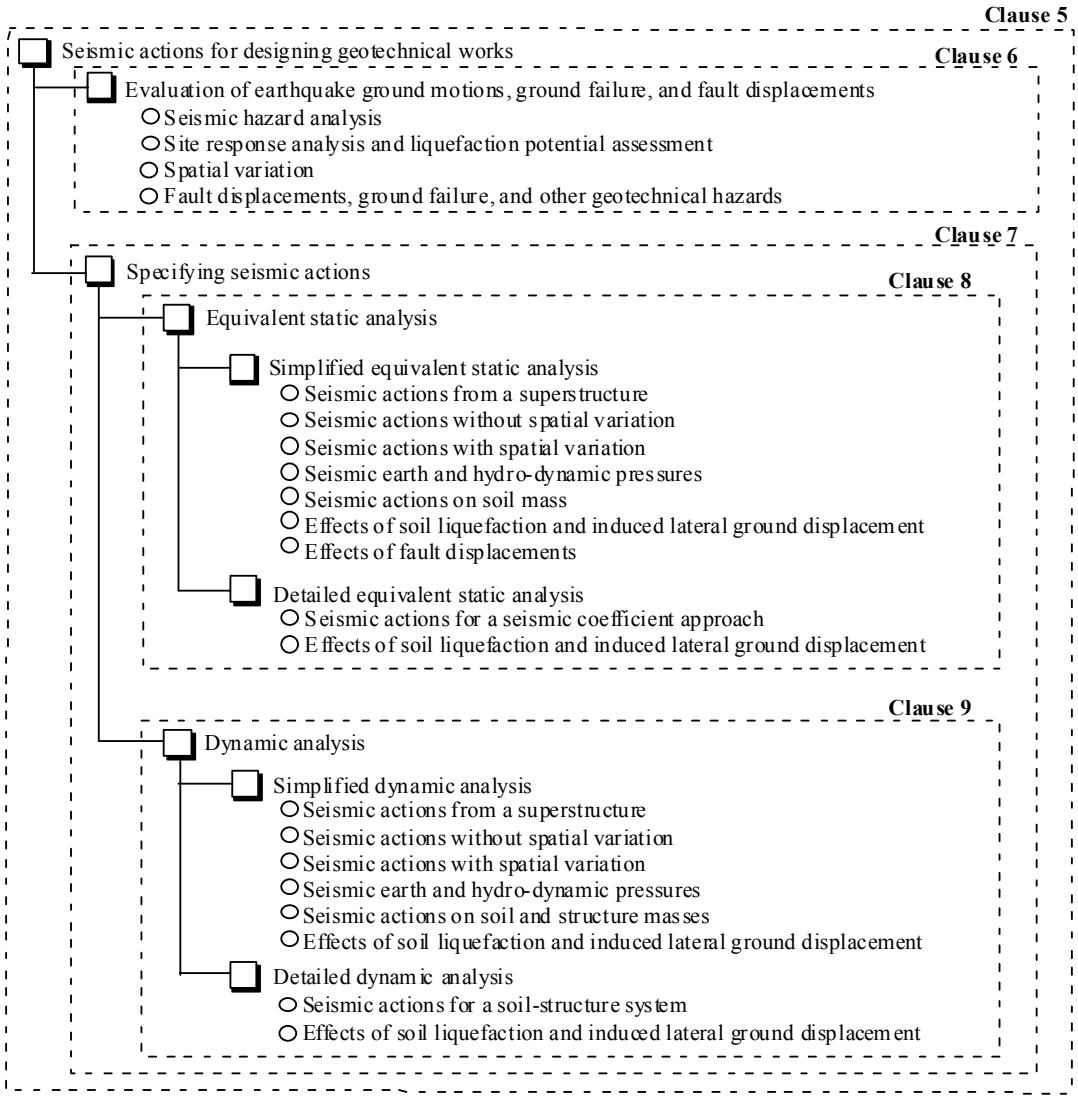
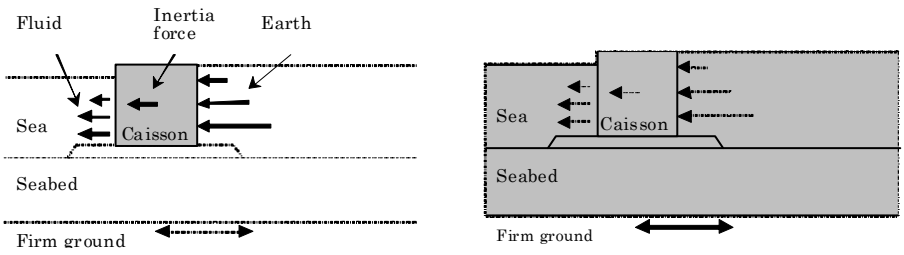


Fig. 1 Primary issues for specifying seismic actions



(a) Simplified model (b) Detailed model

Fig.2 Examples of models of analysis for a caisson quay wall

For example, in the simplified equivalent static analysis of a caisson quay wall, the model for analysis is defined for the wall as indicated by the shaded area in Fig. 2(a). Actions on this model are equivalent static inertia force, seismic earth and hydro-dynamic pressures. Action effects of this model are the margin with respect to the threshold levels beyond which the wall begins to slide, overturn, or lose bearing capacity.

In detailed dynamic analysis of a caisson quay wall, a model for analysis is defined for an entire earth structure system, including caisson, backfill soil, sea water, and foundation soil below the caisson as indicated by the shaded area in Fig. 2(b). Actions on this soil-structure model are input earthquake motions at the boundary of the domain of analysis. Action effects of this model for dynamic analysis are responses of the soil-structure system, including accelerations, velocities, displacements, stresses and strains in various parts of the soil-structure system. In particular, seismic earth pressures and hydro-dynamic pressures acting on the caisson wall are action effects and computed from, rather than specified for, the response analysis. These examples show how actions specified for designing a geotechnical work depend on the model of analysis. This principle provides the basic framework adopted for the International Standard. More details on ISO23469 may be found in Iai (2004).

CONCLUSIONS

The main features of the methodology developed for ISO23469 may be summarized as follows:

(1) Seismic actions on geotechnical works include those due to ground displacements as well as the inertia force. These seismic actions are determined through two stages. The first stage determines basic seismic action variables, including the earthquake ground motion at the site. These variables are used, in the second stage, for specifying the seismic actions for designing geotechnical works.

(2) In the second stage, types of analyses are classified based on a combination of static/dynamic analyses and the procedure for soil-structure interaction classified as follows:
- simplified: soil-structure interaction of a global system is modeled as an action on a substructure;
- detailed: soil-structure interaction of a global system.

ACKNOWLEDGMENTS

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REFERENCE

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