Bases for design of structures - Seismic actions for designing geotechnical works – ISO/WD23469

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1. Introduction

Unlike the seismic performance of structures constructed above the ground surface, 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 design engineers. In order to present a consistent set of 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 (Convener: Iai, Japan) was established in February 2002 and has been in charge of drafting the ISO23469: Seismic actions for designing geotechnical works. This paper summarizes the primary contents of this ISO Standard.

2. Scope

The working group ISO/TC98/SC3/WG10 met in London, September 2002, and set the scope and principles of this ISO Standard as follows. ISO23469 will describe principles of seismic actions on geotechnical works, including buried structures (e.g. tunnels, box culverts, pipelines), foundations (e.g. shallow foundations, deep foundations, underground diaphragm walls), retaining walls (e.g. quay walls), and soil structures (e.g. embankments, dams). These actions are not fully addressed in the existing ISO3010[1)].

ISO23469 will be written with the following qualifications:

1) ISO23469 will address design principles at a level comparable to ISO3010.
2) ISO23469 should address the future state-of-the-practice as it is expected to develop over the next decade rather than the current practice or current state-of-the-art.
3) Reference to ISO2394[2)] on general principles of design should be made where appropriate.
4) The prospective readership of ISO23469 and other ISO standards produced by ISO/TC98 will be experienced practicing engineers and code writers.
5) ISO23469 will follow ISO practice, consisting of normative and informative clauses; it is expected that more specific issues will be addressed as informative.

3. Primary Issues in ISO23469

During the second meeting held in Brussels, December 2002, the ISO/TC98/SC3/WG10 worked out the 1st draft of ISO/WD23469. This International Standard consists of nine clauses and informative annexes. Clauses 1 through 4 describe scope, normative references, terms and definitions, and symbols. Clauses 5 through 9 describe the primary issues presented below. The relevant informative annexes show more details.

Clause 5 begins by describing that objectives and functions of the facility consisting of the geotechnical work shall be defined in accordance with a broadly categorized utilization mode such as commercial, public, and emergency use. Then, performance requirements for seismic design are set based on the functions during earthquakes by:

- Serviceability during and after an earthquake
- Safety during and after an earthquake

Reference earthquake motion is specified for each performance requirement described above. Performance criteria and limit states are then specified by assigning engineering parameters that characterize the response of geotechnical works to the reference earthquake motions and the design period.

Figure 1 shows the primary issues for specifying seismic actions described in this International Standard. The first stage is to determine basic seismic action variables, including the earthquake motion at the site, the potential for earthquake-associated phenomena such as liquefaction and lateral spread, fault displacements and landslide. These basic variables are used in the second stage for specifying the seismic actions for designing geotechnical works. In the second stage, the models and 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 modelled as an action on a local system
- Detailed: soil-structure interaction of a global system is modelled as a coupled system

Performance of a geotechnical work during earthquakes is typically evaluated by appropriately defining actions, specifying a model for analysis, and determining action effects. More than one model and method of analysis may be available for analyzing a geotechnical work. For example, in the simplified equivalent static analysis of a caisson quay wall, the model is defined for the wall as indicated by the grey area in Figure 2(a). Actions on this model are equivalent static inertia force, seismic earth and fluid pressures. Action effects of this model are the safety margin against 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 of analysis is defined for the entire soil structure system, including caisson, backfill soil, sea water, and foundation soil below the caisson as indicated by the grey area in Figure

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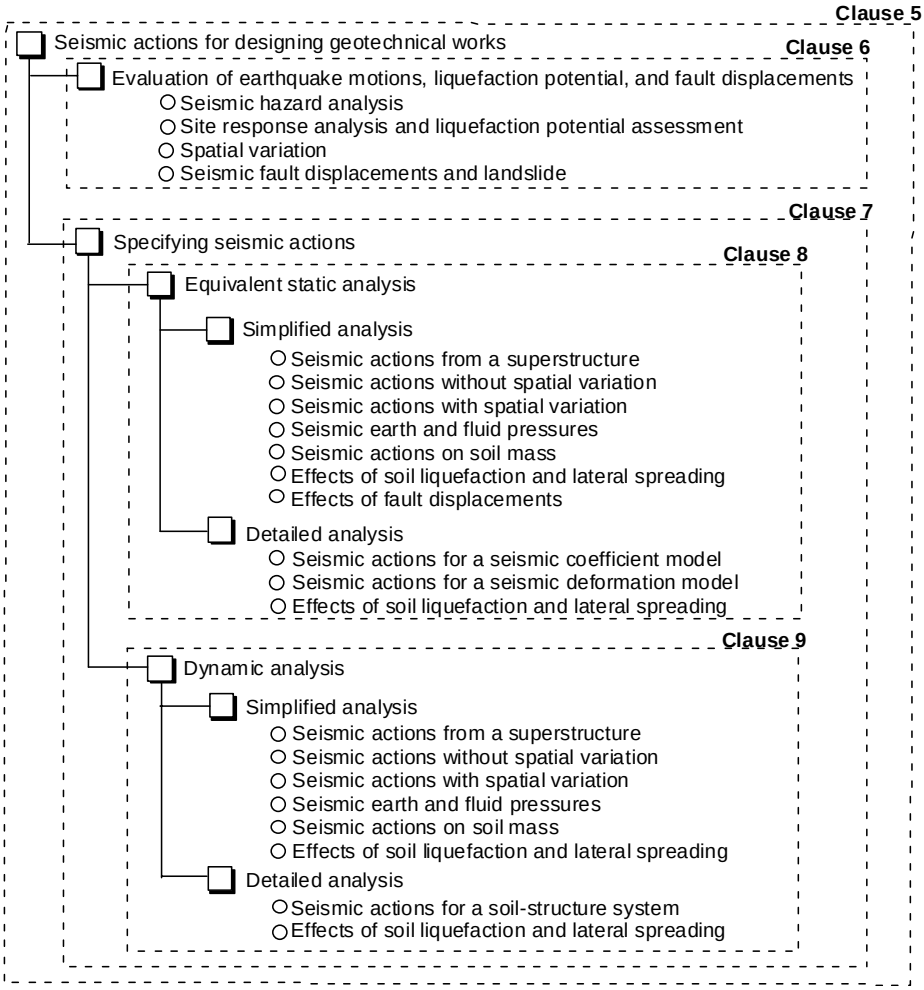
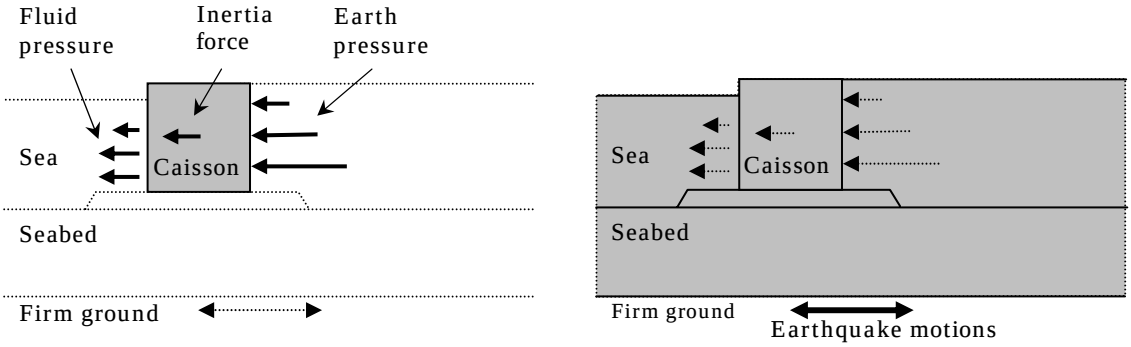


Figure 1 Hierarchy of primary issues for specifying seismic actions



(a) Simplified model (b) Detailed model

Figure 2 Examples of models of analysis of a caisson quay wall

2(b). Actions on this model are input earthquake motions at the bottom 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 and fluid pressures acting on the caisson wall are action effects and computed, rather than specified, from the response analysis. These examples show how actions specified for designing a geotechnical work depend on the model and method of analysis.

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References

1) ISO3010: Bases for design of structures – Seismic actions on structures, pp.1-36, second edition, 2001
2) ISO2349: General principles on reliability for structures, pp.1-73, third edition, 1998