
**Seismic design examples based on
ISO 23469**

Exemples de dimensionnement basés sur l'ISO 23469





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Contents

Page

Foreword	vi
Introduction.....	vii
1 Scope	1
2 Purpose and policy of collecting design examples	1
2.1 Purpose of collecting well-chosen examples	1
2.2 Concept and policy of choosing and composing	2
2.3 Development and result	2
2.4 General conclusion of TR12930 obtained through its development	2
2.5 Editors, authors and reviewers	3
2.5.1 Editors	3
2.5.2 Authors	3
2.5.3 Reviewers	4
3 Assessment for conformity with ISO 23469	4
4 First stage of specifying seismic actions - Determination of site-specific earthquake ground motions demonstrated by design examples	4
4.1 General	5
4.1.1 Methodology for empirical method in deterministic approach and examples	5
4.1.2 Examples	6
4.2 Site-specific seismic hazard analysis evaluation	7
4.2.1 Probabilistic approach- Probabilistic seismic hazard analysis with focus on Fourier amplitude and group delay time	8
4.2.1.1 Outline	8
4.2.1.2 Evaluation of Site Amplification Factor	9
4.2.1.3 Earthquake scenarios and probability of occurrence	10
4.2.1.4 Evaluation of Fourier amplitude spectra	11
4.2.1.5 Evaluation of uniform hazard Fourier spectrum	12
4.2.1.6 Evaluation of ground motion time history	13
4.2.1.7 Example of application	13
4.2.2 Site-specific approach on earthquake motions probabilistically evaluated in a LNG tank design considering a specific active fault	18
4.2.2.1 General procedure and design example	18
4.2.3 Deterministic approach - Theoretical ground motion estimation based on hypothetical scenario earthquakes	21
4.2.3.1 Methodology for theoretical ground motion estimation	21
4.2.3.2 Recipe for strong ground motion estimation	23
4.2.3.3 Sedimentary structure model	26
4.2.3.4 Examples of strong ground motion estimation	28
4.2.4 Deterministic approach - Ground motion estimation based on semi empirical approach	29
4.2.4.1 Outline	29
4.2.4.2 Evaluation of site amplification factor	31
4.2.4.3 Evaluation of strong ground motion	34
4.2.4.4 Example of application	39
4.3 Determination of earthquake ground motion to be used in site response analysis	43
4.3.1 Empirical and site simplified analysis approach	43
4.3.1.1 Simplified procedure of Seismic Deformation Method	43
4.3.1.2 Natural period of an example ground	45
4.3.1.3 Ground displacement	46
5 Second stage of specifying seismic actions. Seismic evaluation of geotechnical works demonstrated by design examples	47

5.1	Demonstrations of seismic evaluation using simplified and detailed analyses	47
5.1.1	Simplified static and detailed dynamic analyses in design example of gravity quay wall in port	47
5.1.1.1	Purpose and functions	47
5.1.1.2	Performance objectives for seismic design.....	47
5.1.1.3	Reference earthquake motions.....	48
5.1.1.4	Performance criteria and limit states	48
5.1.1.5	Specific issues related to geotechnical works	50
5.1.1.6	Procedure for determining seismic actions	50
5.1.1.7	Ground failure and other geotechnical hazards	52
5.1.1.8	Spatial variation.....	55
5.1.1.9	Types and models of analysis	55
5.1.1.10	Simplified equivalent static analysis	57
5.1.1.11	Detailed equivalent static analysis.....	61
5.1.1.12	Simplified dynamic analysis	61
5.1.1.13	Detailed dynamic analysis	61
5.1.2	Highway bridge pile foundation	64
5.1.2.1	Outline of the highway bridge.....	64
5.1.2.2	Seismic performance requirements.....	66
5.1.2.3	Input ground motions used in seismic design and analysis model of the entire bridge	68
5.1.2.4	Seismic design of foundations	71
5.1.3	Assessment of seismic performance of the Sutong Bridge, a long cable-stayed bridge (Pile foundation)	79
5.1.3.1	Bridge outline	79
5.1.3.2	Design seismic ground motion and seismic performance	80
5.1.3.3	Seismic performance of foundations.....	82
5.1.4	Earth fill dam	86
5.1.4.1	Purpose and functions	86
5.1.4.2	Performance objectives for seismic design.....	87
5.1.4.3	Procedure for determining seismic actions	88
5.1.4.4	Soil properties and models for detailed dynamic analysis	90
5.1.4.5	Simplified equivalent static analysis: Slip analysis results;	93
5.1.4.1	Detailed dynamic analysis: Results of FEM dynamic analysis;.....	94
5.1.5	Gravity sea wall as coastal structure	97
5.1.5.1	Purpose and functions	97
5.1.5.2	Performance objectives for seismic design.....	97
5.1.5.3	Reference earthquake motions.....	98
5.1.5.4	Performance criteria and limit states	98
5.1.5.5	Specific issues related to geotechnical works	100
5.1.5.6	Procedure for determining seismic actions	100
5.1.5.7	Earthquake ground motions	100
5.1.5.8	Seismic coefficient determinations.....	102
5.1.5.9	Effects of soil liquefaction	105
5.1.5.10	Spatial variation.....	107
5.1.5.11	Procedure for specifying seismic actions.....	107
5.2	Demonstrations evaluating and designing for ground displacement effects	111
5.2.1	Pile foundations of railway bridges	111
5.2.1.1	Outline of railway bridge pier.....	111
5.2.1.2	Seismic performance requirements	112
5.2.1.3	Reference earthquake ground motions	115
5.2.1.4	Site response analysis and assessment of liquefaction potential	117
5.2.1.5	Procedure for specifying seismic actions on piles	119
5.2.1.6	Simplified equivalent static analysis - Seismic Deformation Method	120
5.2.2	Design and actual performance of pile foundation of high R/C smokestack on soft ground	125
5.2.2.1	General remarks	125
5.2.2.2	Purpose and functions	126
5.2.2.3	Performance objectives for seismic design and reference earthquake motions.....	126
5.2.2.4	Performance criteria and limit states	127
5.2.2.5	Policy of determining seismic actions on superstructure and foundation for design	129
5.2.2.6	Features of smokestack and geotechnical characterization.....	131

5.2.2.7	Models of simplified and detailed dynamic analyses for specifying seismic actions	135
5.2.2.8	Results of detailed dynamic analyses	138
5.2.2.9	Verification of models based on vibration tests	139
5.2.2.10	Actual seismic behaviour of ground and smokestack	142
5.2.2.11	Verification of models based on strong motion records	145
5.2.3	Shallow immersed rectangular tunnel in soft soils	150
5.2.3.1	Thessaloniki immersed roadway tunnel	150
5.2.3.2	Behaviour of longitudinal underground structures under seismic loading	151
5.2.3.3	Analysis methods	152
5.2.3.4	Determination of input motion	153
5.2.3.5	Simplified equivalent static analysis	154
5.2.3.6	Detailed equivalent static analysis	156
5.2.3.7	Detailed full dynamic analysis	158
5.2.3.8	Results and discussion	159
5.3	Demonstrations evaluating and designing for liquefaction effects	161
5.3.1	Evaluation of 3D SSI effects of pile foundation of LNG tank model by detailed dynamic analyses	161
5.3.1.1	Problem description	161
5.3.1.2	Results of analyses and discussion	162
5.3.1.3	Consideration of results into design	166
5.3.2	Evaluation of 3-D effects of lattice-arranged numerous piles by detailed dynamic analyses	166
5.3.2.1	Objectives	166
5.3.2.2	Results of analyses and discussion	166
5.3.3	Evaluation of pile-volume effects of a huge number of piles by detailed dynamic analyses	169
5.3.3.1	Introduction	169
5.3.3.2	Results of analyses and discussion	169
5.3.3.3	Consideration of results into design	170
5.4	Demonstrations evaluating and designing for fault displacement effects	171
5.4.1	Seismic design abstract of road embankment taking account of surface fault rupture	171
5.4.1.1	Purpose and functions	171
5.4.1.2	Performance objectives and ground motions for seismic design	172
5.4.1.3	Performance criteria	172
5.4.1.4	Procedure for determining seismic actions	172
5.4.1.5	Ground failure and other geotechnical hazards	173
5.4.1.6	Types of analysis	174
5.4.1.7	Simple static analysis	174
5.4.1.8	Detailed dynamic analysis	174
5.4.2	Shield tunnel subject to fault displacements (Detailed analysis)	176
5.4.2.1	General remarks	176
5.4.2.2	Soil conditions and shield tunnel	176
5.4.2.3	Estimation of fault displacement at base layer	176
5.4.2.4	Method of analysis and modelling nonlinear behaviour of soil	178
5.4.2.5	Results of analyses	180
5.4.2.6	Influence of fault displacement to tunnel	183
5.4.3	Design considerations for a water pipeline access tunnel subject to earthquake hazards	184
5.4.3.1	Purpose and functions	184
5.4.3.2	Project description	184
5.4.3.3	Performance objectives and reference earthquake design levels	186
5.4.3.4	Performance criteria	187
5.4.3.5	Specific issues related to geotechnical works	187
5.4.3.6	Evaluation of earthquake ground motions and fault displacements	188
5.4.3.7	Simplified equivalent static analysis	192
Annex A (informative)	Conformity with provisional sentences in ISO 23469	201
A.1	General	201

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 98, *Bases for design of structures*, sous-comité SC 3, *Loads, forces and other actions*.

Introduction

ISO 23469:2005 provides guidelines to be observed by experienced practicing engineers and code writers when specifying seismic actions in the design of geotechnical works. It might not be so easy for code writers and practitioners to utilize ISO 23469, because that it offers advanced philosophy and general framework of seismic design. The purpose of this Technical Report (TR) is to provide seismic design examples based on ISO 23469 for demonstrating how to utilize ISO 23469 in actual seismic designs to the code writers and the practitioners. The implementation of ISO 23469 will secure the rationality of seismic safety evaluation of the infrastructures in the world, and this TR aims at promoting the implementation.

ISO 23469 is essentially a guideline itself. Therefore, this TR should contain not explicit guidelines but design examples without using the term 'guideline'. Thus, this TR is expected to demonstrate the utilization of ISO 23469 by providing design examples with detailed explanation from the viewpoint of conformity with ISO 23469 for a kind of guidance rather than to provide the detailed recommendation of specific methodologies.

Through the development of this Technical Report, it is concluded that ISO 23469 has been and is going to be an essential and useful guideline of seismic design of geotechnical works for experienced practicing engineers and code writers.

Seismic design examples based on ISO 23469

1 Scope

This Technical Report provides seismic design examples for geotechnical works based on ISO 23469:2005 in order to demonstrate how to use this ISO standard. The design examples are intended to provide guidance to experienced practicing engineers and code writers. Geotechnical works include 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 rock fill dams and embankments), gravity dams, tanks, landfill and waste sites.

ISO 23469 addresses important issues for seismic actions for designing geotechnical works, including effects of site-specific response, ground displacement, soil-structure interaction and liquefaction, in a systematic manner within a consistent framework. 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. Therefore, this Technical Report includes well-chosen design examples that consider these important issues and covering in a balanced way the wide range of the methods of analysis and the types of model which can be used to evaluate seismic actions of geotechnical works.

2 Purpose and policy of collecting design examples

2.1 Purpose of collecting well-chosen examples

This Technical Report aims at collecting design examples that are basically conformable with ISO 23469. They are expected to be design examples dealing with important things need to be covered in ISO 23469 from the point of view of performance-based design approach. This TR should be well-balanced in included design examples;

- Focusing evaluation of reference earthquake ground motions with detailed description as a common issue.
- Having combination of simplified and detailed analyses.
- Based on simplified equivalent static analysis and detailed analysis for retaining walls, buried structures or earth structures.
- Focusing consideration of soil displacements for pile foundations and buried structures.
- Focusing evaluation of effects of liquefaction for retaining walls, earth structures, pile foundations.
- Focusing consideration of spatial variation in the ground motions for long bridges, buried structures, or dams.
- Based on site specific dynamic response by 1-D analysis.
- Based on detailed dynamic analysis by 2-D or 3-D analysis.

2.2 Concept and policy of choosing and composing

To realize the prescribed purpose of this TR, the basic concept of it is targeting to cover major distinguishing and important issues of IS23469 by all the design examples contained in this TR. Thus, the following points are another requirement for choosing and composing design examples.

- Design examples written with cares for readers in terms of conformity with requirement and recommendation in ISO 23469
- The TR should consist of several well-chosen design examples which cover the key issues of the ISO 23469 with well balance between them.
- The TR is anticipated to be well balanced among Japan, Northern America, and Europe.
- For description of manuscript, each design example is requested to
- Be cared in terms of conformity with requirement and recommendation in ISO 23469
- Have stress on methodology recommended by WG
- Be within 20 pages for a complete example and 8 pages for a sub-example basically

2.3 Development and result

After discussing the policy of collecting and choosing design examples, WG10 also had developed an expected table of contents from arguments through three Working Group meetings held in 2006 and correspondence with consideration of design practice situation in member's countries and regions. After registration of NP12825 in the end of this year, the WG10 repeatedly requested all the WG members and participants of the meetings to provide possible design examples for this Technical Report. The table of contents of the TR of design examples was almost fixed and the drafting persons for the examples were assigned in 2008 through more four WG meetings; eight examples for the first stage of specifying seismic action were expected to be prepared by three persons from Japan and one from Turkey and 28 examples for the second were hopefully to be prepared by 17 persons from Japan, three from USA, one from Greece, and one from Italy.

This NP was officially approved with the submission, in 2008, of the first Working Draft of TR12825 containing six examples, but the NWI was subsequently re-numbered as 12930 from an administrative reason. The third and final Working Draft of TR12930, which was developed through another three meetings in two years for waiting design examples to be offered from countries other than Japan was submitted to TC98/SC3 in the end of 2010 then accepted as a Draft Technical Report with a request of addition of description for a few points. The last two year period was mainly aimed at collecting examples from countries excepting Japan. Notwithstanding the total number of attendees in thirteen WG meetings is 87 and they came from Japan, USA, Greece, France, Poland, Canada, Turkey, Italy, South Africa, Germany, Morocco, Romania, and Russia (in order of total number of attendees), only prescribed persons were merely expected. Probably because that the preparing a manuscript is a tough job with few personal incentive; i.e. a completely volunteer work.

2.4 General conclusion of TR12930 obtained through its development

Eventually seven examples for the first stage and 15 examples for the second stage were successfully collected from thirteen persons consisting of eleven from Japan, one from USA, and one from Greece. The total number of the 22 well-chosen design examples can almost cover major distinguishing and important issues of IS23469 as targeting at the beginning. Through the process of preparing and editing the drafts, it was clarified that IS23469 is useful for evaluation, assessment and review in the seismic design. Furthermore, it was demonstrated that assessment for conformity with IS23469 in can be conducted in terms of provisional sentences according to Clause 3 of this TR. Thus, it is concluded that IS23469 has been and is going to be an essential and useful guideline of seismic design of geotechnical works for experienced practicing engineers and code writers.