Third edition of ISO 3010 “Bases for Design of Structures - Seismic Actions on Structures”

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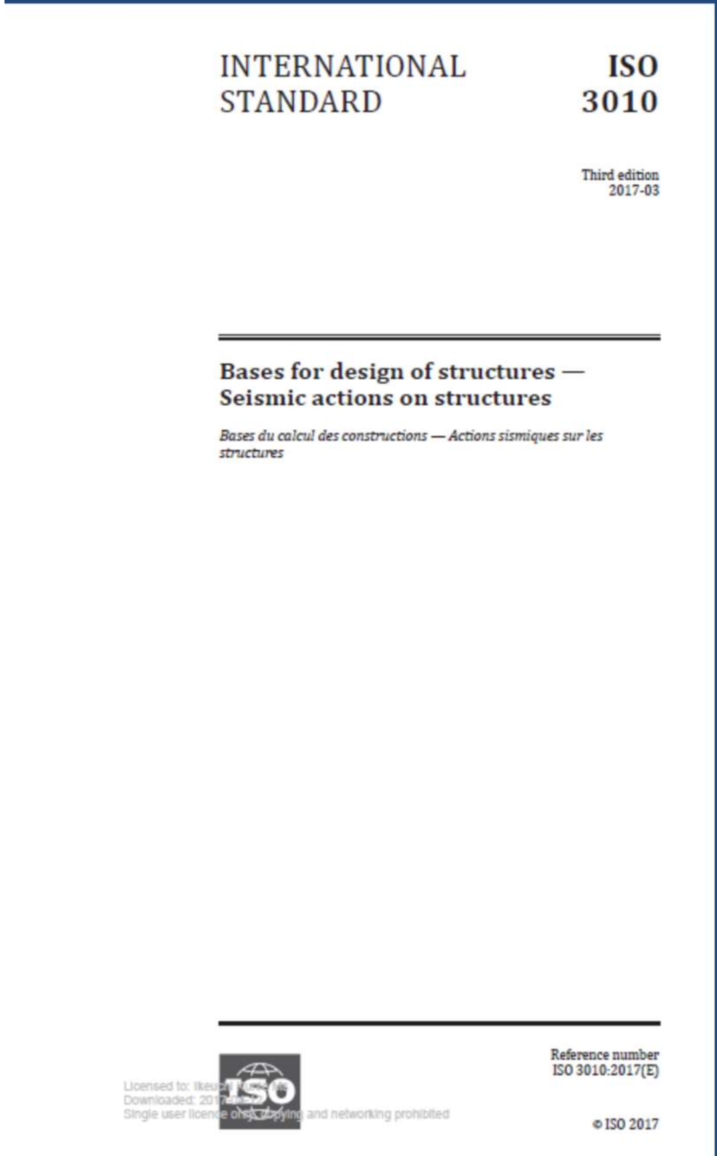
ISO/TC98
“Bases for design of structures”

- ISO/TC98 was organized in 1961;
  24 participating countries (P members) and
  36 observer countries (O members)
- Provides coherent design system of International Standards in the field of building and civil engineering works
- Consists of three sub-committees
  - SC1 : Terminology and symbols
  - SC2 : Reliability of structures
  - SC3 : Loads, forces and other actions
    - WG9 : Seismic actions on structures

ISO 3010 “Bases for Design of Structures - Seismic Action on Structures”



INTERNATIONAL STANDARD | ISO 3010

Third edition
2017-03

Bases for design of structures — Seismic actions on structures

Bases du calcul des constructions — Actions sismiques sur les structures

Reference number
ISO 3010:2017(E)

- 1st edition (1988)
- 2nd edition (2001)
- 3rd edition (2017)

Companion documents

- ISO 23469 Seismic actions for designing geotechnical works (2005)
- ISO 13033 Seismic actions on nonstructural components for building applications (2013)

Basic concepts of ISO 3010

- Incorporate limit states based on ISO 2394 “General principles on reliability for structures”
  - ✓ serviceability limit state (SLS) and ultimate limit state (ULS)
- Specifies principles of evaluating seismic actions for the seismic design of buildings and other structures.
- Not a legally binding nor enforceable code. Source document to be used in the development of codes
- Code for code writers (umbrella code)

ISO 3010 : 11 Clauses

1. Scope
2. Normative references
3. Terms and definitions
4. Symbols and abbreviated terms
5. Bases of seismic design
6. Principles of seismic design
7. Principles of evaluating seismic actions
8. Evaluation of seismic actions by equivalent static analysis
9. Evaluation of seismic actions by dynamic analysis
10. Non-linear static analysis
11. Estimation of paraseismic influences

Annexes (16)

Bases of seismic design

Basic philosophy of seismic design

In the event of earthquakes,

- to prevent human casualties
- to ensure continuity of vital services, and
- to reduce damage to property.

In addition, societal goals for the environment should be considered.

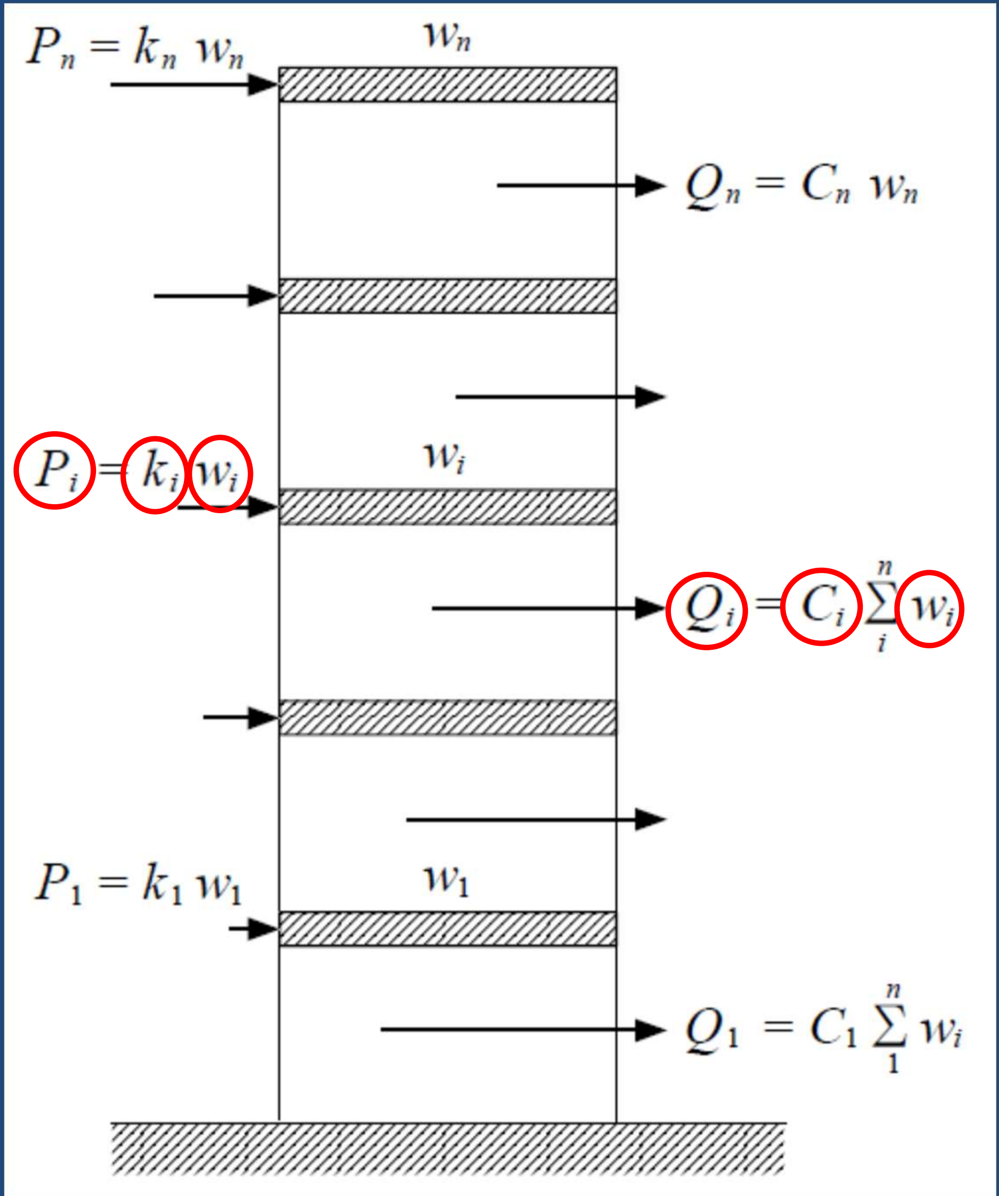
Basic principles

- The structure should not collapse due to severe earthquake ground motions that could occur at the site (ultimate limit state: ULS).
- The structure should withstand moderate earthquake ground motions which may be expected to occur at the site with damage within accepted limits (serviceability limit state: SLS).

Principles of evaluating seismic actions

- Equivalent static analysis
  - ordinary and regular structures
- Dynamic analysis (response spectrum or response history analysis)
  - be applied for structures with irregularities and very tall structures, recommended for structures with innovative structural systems.
- Non-linear static analysis
  - To be used for structures where non-linear sequence of behaviour is difficult to predict

Seismic force and shear in equivalent static analysis



P_i: lateral seismic force of the i-th story
Q_i: lateral seismic shear of the i-th story
k_i: lateral seismic factor of the i-th story
C_i: lateral seismic shear factor of the i-th story
w_i: weight of the i-th story

In ISO 3010,
F is used for force and
V is used for shear

Evaluation of seismic actions by equivalent static analysis

Design lateral seismic force for ULS

$$F_{\mathrm{E,u},i} = \gamma_{\mathrm{E,u}}\, k_{\mathrm{Z}}\, k_{\mathrm{E,u}}\, k_{\mathrm{S}}\, k_{D}\, k_{\mathrm{R}}\, k_{\mathrm{F},i} \sum_{j=1}^{n} F_{\mathrm{G},j}$$

Design lateral seismic shear for ULS

$$V_{\mathrm{E,u},i} = \gamma_{\mathrm{E,u}}\, k_{\mathrm{Z}}\, k_{\mathrm{E,u}}\, k_{\mathrm{S}}\, k_{D}\, k_{\mathrm{R}}\, k_{\mathrm{V},i} \sum_{j=i}^{n} F_{\mathrm{G},j}$$

Similar formulae for SLS, where k_{D} is excluded and the subscript "u" is replaced with "s".

$\gamma_{E,u}$ Load factor for reliability (importance factor)

k_Z Zoning factor

$k_{E,u}$ Earthquake ground motion intensity

k_S Effect of soil condition (new factor)

k_D Structural design factor (1/R, 1/q, Ds)

k_R Normalized design response spectrum

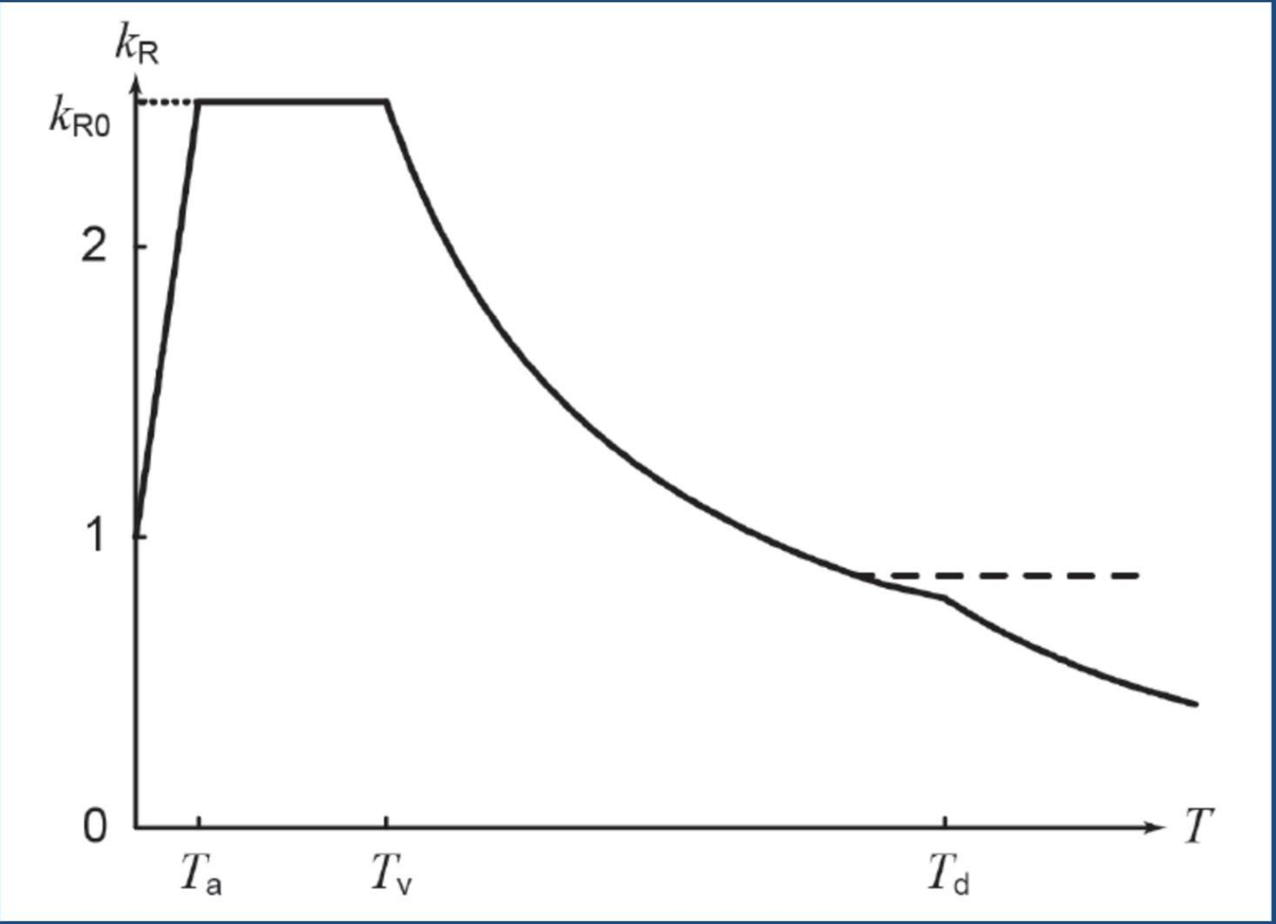
$k_{F,i}$ Seismic force distribution factor $\sum k_{F,i} = 1$

$k_{V,i}$ Seismic shear distribution factor (1.0 at the base and becomes largest at the top)

$F_{G,j}$ Gravity load at *j*-th level (weight of *j*-th story)

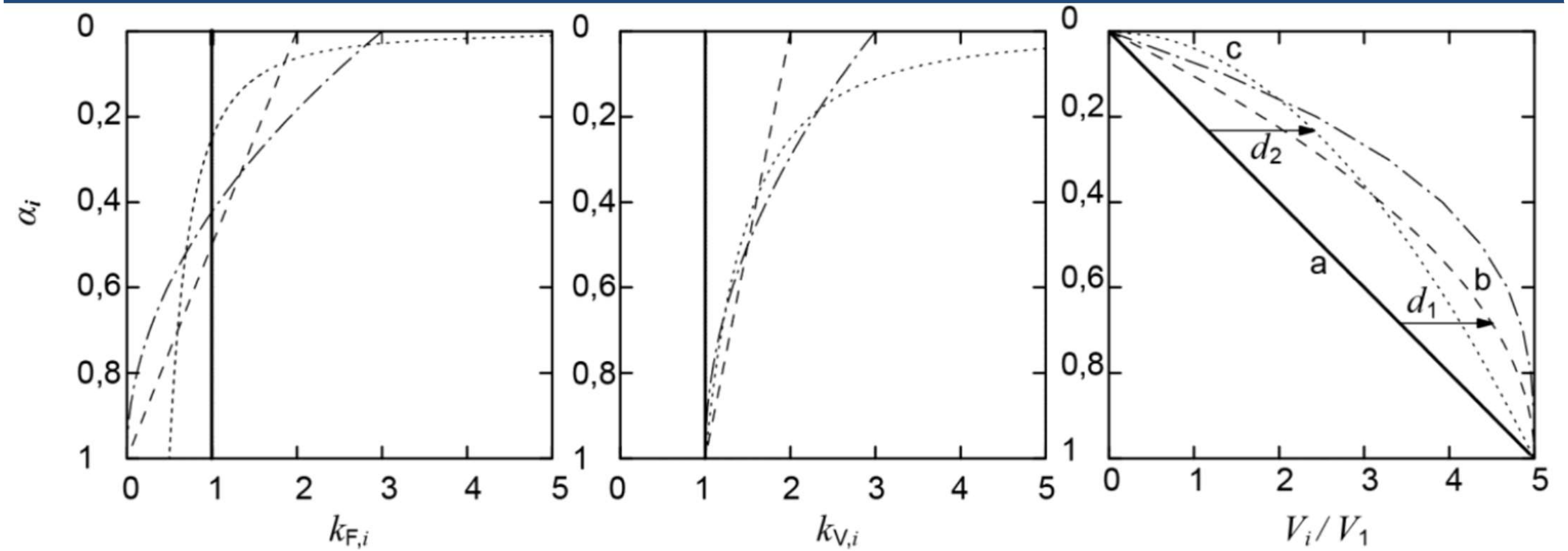
†If "$A = k B$", and when A and B have the same dimension, k should be called a "factor"

Normalized design response spectrum



Acceleration response spectrum normalized by the peak ground acceleration for design purpose

In many seismic codes, the design base shear is distributed to each level using $k_{F,i}$. But it may be more rational to evaluate the design shear for each level using $k_{V,i}$



Seismic force distribution factor $k_{F,i}$

Seismic shear distribution factor $k_{V,i}$

Seismic shear distribution V_i / V_1

Load factor, representative value of earthquake ground motion intensity, etc.

Limit state	Consequence class	Load factors $\gamma_{E,u}$ or $\gamma_{E,s}$	k_Z	$k_{E,u}$ or $k_{E,s}$	Return period for $k_{E,u}$ or $k_{E,s}$
Ultimate	a) High	1,5 to 2,0	1,0	0,4	500 years
	b) Normal	1,0			
	c) Low	0,4 to 0,8			
Serviceability	a) High	1,5 to 3,0	1,0	0,08	20 years
	b) Normal	1,0			
	c) Low	0,4 to 0,8			

Limit state	Consequence class	Load factors $\gamma_{E,u}$ or $\gamma_{E,s}$	k_Z	$k_E = k_{E,u} = k_{E,s}$	Return period for k_E
Ultimate	a) High	3,0 to 4,0	1,0	0,2	100 years
	b) Normal	2,0			
	c) Low	0,8 to 1,6			
Serviceability	a) High	0,6 to 1,2			
	b) Normal	0,4			
	c) Low	0,16 to 0,32			

Annexes

All 16 annexes are informative.

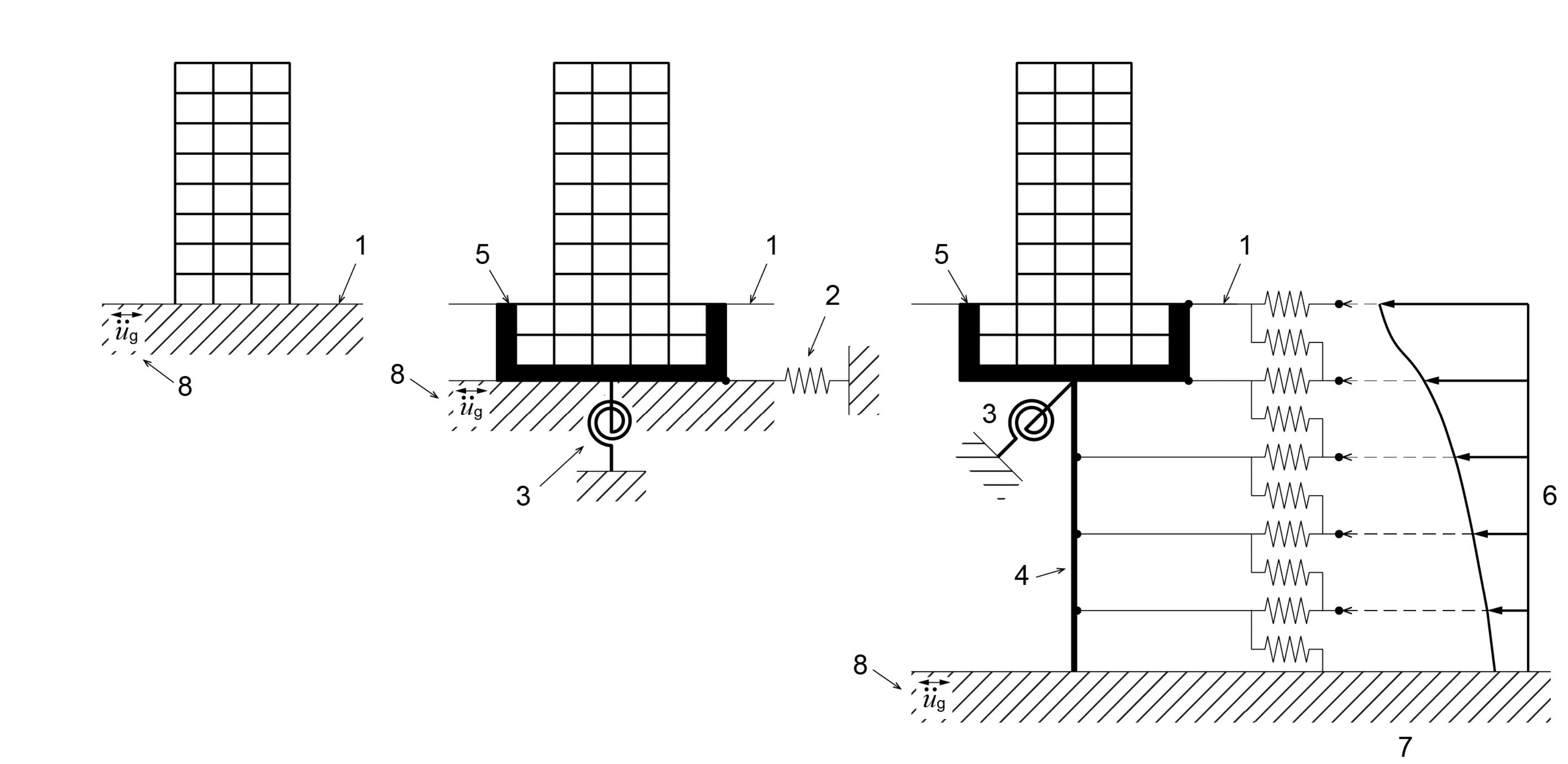
- Annex A : Load factors as related to the reliability of the structure, seismic hazard zoning factor and representative values of earthquake ground motion intensity
- Annex B : Normalized design response spectrum
- Annex C : Seismic force distribution parameters for equivalent static analysis
- Annex D : Structural design factor for linear analysis
- Annex E : Combination of components of seismic action
- Annex F : Torsional moments
- Annex G : Damping ratio
- Annex H : Dynamic analysis

Annexes (continued)

- Annex I : Non-linear static analysis and capacity spectrum method
- Annex J : Soil-structure interaction
- Annex K : Seismic design of high-rise buildings
- Annex L : Deformation limits
- Annex M : Response control systems
- Annex N : Non-engineered construction
- Annex O : Tsunami Actions
- Annex P : Paraseismic influences

(Yellow shows new annexes.)

Examples of soil-structure interaction models (Annex H: Dynamic analysis)

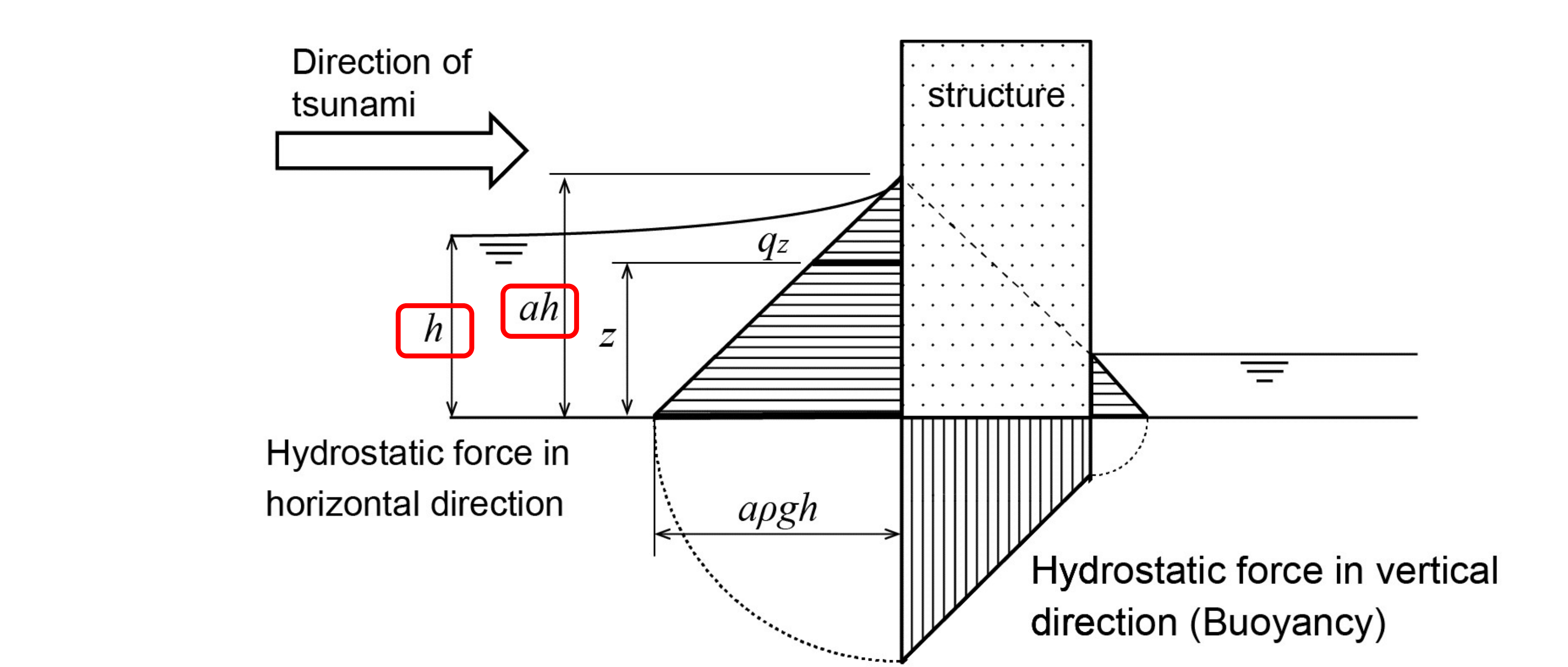


a) Fixed model

b) Sway-rocking (SR) model

c) Interaction model of structure with piles

Annex O: Tsunami actions



a	water depth factor
h	design inundation depth (m)
z	height of the building at the level concerned (m)
q_z	hydrostatic pressure

Summary

- ISO 3010 "Seismic actions on structures" was published in March 2017.
- The basic concept of the third edition remains the same as the previous editions.
- A new factor for equivalent static analysis, i.e. soil factor k_S, is introduced.
- New annexes are included, i.e. H Non-linear static analysis and capacity spectrum method, J Soil-structure interaction, K Seismic design of high-rise buildings, L Deformation limits, N Non-engineered construction and O Tsunami actions.
- ISO 3010 is expected to be used as a guideline for developing new regulations or revising existing regulations.
- ISO 3010 will be accepted to be JIS: Japanese Industrial Standard.