INTERNATIONAL STANDARD

ISO 14688-2

First edition
2004-07-15

Geotechnical investigation and testing — Identification and classification of soil —

Part 2: Principles for a classification

Reconnaissance et essais géotechniques — Dénomination, description et classification des sols —

Partie 2: Principes pour une classification

Reference number
ISO 14688-2:2004(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14688-2 was prepared by Technical Committee ISO/TC 182, *Geotechnics*, Subcommittee SC 1, *Geotechnical investigation and testing*.

ISO 14688 consists of the following parts, under the general title *Geotechnical investigation and testing — Identification and classification of soil*:

— *Part 1: Identification and description*

— *Part 2: Principles for a classification*

— *Part 3: Electronic exchange of data on identification and description of soil*

Geotechnical investigation and testing — Identification and classification of soil —

Part 2: Principles for a classification

1 Scope

This part of ISO 14688, together with ISO 14688-1, establishes the basic principles for the identification and classification of soils on the basis of those material and mass characteristics most commonly used for soils for engineering purposes. The relevant characteristics may vary and therefore, for particular projects or materials, more detailed subdivisions of the descriptive and classification terms may be appropriate.

Identification and description of soil are covered by ISO 14688-1.

The classification principles established in this part of ISO 14688 permit soils to be grouped into classes of similar composition and geotechnical properties and, with respect to their suitability for geotechnical engineering purposes, such as

— foundations,

— ground improvements,

— roads,

— embankments,

— dams, and

— drainage systems.

This part of ISO 14688 is applicable to natural soil and similar man-made material *in situ* and redeposited, but it is not a classification of soil by itself.

Identification and description of rock are covered by ISO 14689-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 3310-2, *Test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate*

ISO 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description*

ISO 14689-1, *Geotechnical investigation and testing — Identification and classification of rock — Part 1: Identification and description*

3 Terms and definitions

For the purposes of this document, the terms and definitions of ISO 14688-1 and the following apply.

3.1
soil classification
assignment of soil into soil groups on the basis of certain characteristics, criteria and genesis

3.2
soil group
a particular collection of soils of similar composition and geotechnical properties

3.3
uniformity coefficient
C_U
measure of the shape of the grading curve within the range from d_{10} to d_{60}
$C_U = d_{60}/d_{10}$

NOTE d_{10} and d_{60} are the particle sizes corresponding to the ordinates 10 % and 60 % by mass of the percentage passing.

3.4
coefficient of curvature
C_C
measure of the shape of the grading curve within the range from d_{10}, d_{30} to d_{60}
$C_C = (d_{30})^2/(d_{10} \cdot d_{60})$

3.5
water content
w
mass of water which can be removed from the soil, usually by drying, expressed as a percentage of the dry mass

3.6
liquid limit
w_L
water content at which a fine soil passes from the liquid to the plastic condition, as determined by the liquid limit test

3.7
plastic limit
w_P
water content at which a fine soil becomes too dry to be in a plastic condition, as determined by the plastic limit test

3.8
plasticity index
I_P
numerical difference between the liquid limit and plastic limit of a fine soil
$I_P = w_L - w_P$

3.9
liquidity index
I_L
numerical difference between the natural water content and the plastic limit expressed as a percentage ratio of the plasticity index
$I_L = (w - w_P)/I_P$

3.10
consistency index
I_C
numerical difference between the liquid limit and the natural water content expressed as a percentage ratio of the plasticity index
$I_C = (w_L - w)/I_P$

3.11
density index
I_D
⟨coarse soils (sands and gravels)⟩ index dependent upon the void ratio (e) and the void ratios corresponding to the minimum density (e_{max}) and the maximum density (e_{min}), as measured in the laboratory
$I_D = (e_{max} - e)/(e_{max} - e_{min})$

3.12
undrained shear strength
c_u
shear resistance of soil in the undrained condition

3.13
void ratio
ratio of the volume of voids to the volume of solids of a soil

3.14
compressibility index
C_c
compressibility index is defined according to the relation

$$C_c = -\frac{\Delta e}{\lg\left[(\sigma' + \Delta\sigma')/\sigma'\right]} = -\frac{\Delta e}{\Delta(\lg\sigma')}$$

NOTE Δe is the change in void ratio (negative value when Δe decreases) and $\frac{\Delta e}{\Delta(\lg\sigma')}$ is the change in void ratio Δe for a relative increase of effective stress from $\lg\sigma'$ to $\lg(\sigma' + \Delta\sigma')$.

4 Principles of soil classifications

4.1 General

Soils shall be classified into soil groups on the basis of their nature which is the composition only, irrespective of their water content or compactness, taking into account the following characteristics:

— particle size distribution (grading);

— plasticity;

— organic content;

— genesis.

NOTE Some principles for soil classification are given in Annex A.

4.2 Fractions

Soil is a mixture of materials of different particle size, which are grouped into fractions as specified in ISO 14688-1.

Classification of coarse and very coarse soils is to be based on the particle size distribution alone (see 4.3 and Table 1).

Table 1 — Classification of very coarse soil

Fraction	Percent by mass	Term
Boulders	< 5	low boulder content
	5 to 20	medium boulder content
	> 20	high boulder content
Cobbles	< 10	low cobble content
	10 to 20	medium cobble content
	> 20	high cobble content

NOTE The classification of very coarse soils requires a very large sample. It is not possible to recover representative samples from boreholes to use this classification.

In the case of soils composed of both fine and coarse material, classification is to be based on both plasticity and particle size distribution (see 4.3 and 4.4).

4.3 Particle size distribution (grading)

The particle sizes and their distribution in a soil are determined by mechanical analysis carried out as follows:

— the separation of the coarser fractions by sieving on a series of standard sieves according to ISO 3310-1 and ISO 3310-2;

— the determination of the finer fractions by an accepted process (e.g. sedimentation, optical methods).

NOTE An example of how this can be done is given in Annex B.

The results of the sieving and sedimentation process are plotted as a grading curve.

When designating the coarse fractions, a distinction may be drawn between well graded, poorly graded and gap-graded particle size distributions. In this connection the coefficient of curvature (C_C) and the uniformity coefficient (C_U) provide quantitative means for describing the shape of the grading curve. If certain grain sizes are absent, the term gap-graded is used. The median d_{50} of the grading curve, together with C_U and C_C may also be used to indicate the particle size grading (see Table 2).

Table 2 — Shape of grading curve

Shape of grading curve	C_U	C_C
Multi-graded	> 15	$1 < C_C < 3$
Medium-graded	6 to 15	< 1
Even-graded	< 6	< 1
Gap-graded	Usually high	Any (usually < 0,5)

4.4 Plasticity

The fine fractions of soil, represented by clay and silt and containing clay minerals (see also ISO 14688-1), both alone or in mixtures with coarser material, are usually classified according to their plasticity characteristics. This is carried out on the basis of laboratory tests to determine the liquid limit w_L and plastic limit w_P.

The degree of plasticity of fine soils should be classified using the following terms:

a) non-plastic;

b) low plasticity;

c) intermediate plasticity;

d) high plasticity.

4.5 Organic content

When soils with organic constituents are classified according to their organic content (see Table 3), a distinction is to be made between organic soils and mineral soils with an organic content.

Table 3 — Classification of soils with organic constituents

Soil	Organic content ($\leqslant$ 2 mm) % of dry mass
Low-organic	2 to 6
Medium-organic	6 to 20
High-organic	$>$ 20

Classification of coarse and composite organic soils accumulated *in situ* is based on the type of organic matter and that of organic soils, on the genetic origin and the degree of decomposition of the organic constituents.

5 Other principles suitable for soil classification

5.1 General

There is a variety of quantifying terms which can be used to describe soils which include density, undrained shear strength and consistency index.

5.2 Correlations of density terms for sands and gravels

The terms used for the classification of density index I_D are very loose, loose, medium dense, dense and very dense (see Table 4). Density index can be related to the results of field tests (see, for example, EN 1997-2). Such field tests are, for example, Dynamic Probing (DP) according to ISO 22476-2, Standard Penetration Test (SPT) according to ISO 22476-3, cone penetration tests (CPT) according to ISO 22476-1 and pressuremeter tests (PMT) according to ISO 22476-4, ISO 22476-6 and ISO 22476-8. These documents are being prepared.