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Geotechnical investigation and testing — Identification, description and classification of rock

Reconnaissance et essais géotechniques — Identification, description et classification des roches

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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.

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 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 182, *Geotechnics*.

This first edition of ISO 14689 cancels and replaces ISO 14689-1:2003, which has been technically revised.

Introduction

This document gives details of the procedures to be followed in the identification and description of rocks which are to be used at all stages of ground investigation and geotechnical design. This comprises the description of the rock material and the rock mass characteristics in terms of the bedding and discontinuities.

The level of detail in a description will depend on the characteristics of the rock, the size and quality of the rock exposure or sample, and the needs of the particular project. The person carrying out the field identification and description should be suitably qualified, skilled and experienced to make a correct and appropriate description and experienced in the geological materials involved in the investigation.

Practice in rock identification and description varies from country to country, in part reflecting significant differences in geological conditions. In addition, the quality of samples available for description varies due to the investigation methods employed, as methods of investigation have been developed in response to the ground conditions present.

Geotechnical investigation and testing — Identification, description and classification of rock

1 Scope

This document specifies the rules for the identification and description of rock material and mass on the basis of mineralogical composition, genetic aspects, structure, grain size, discontinuities and other parameters. It also provides rules for the description of other characteristics as well as for their designation.

This document applies to the description of rock for geotechnics and engineering geology in civil engineering. The description is carried out on cores and other samples of rock and on exposures of rock masses.

Rock mass classification systems using one or more descriptive parameters to suggest likely rock mass behaviour are beyond the scope of this document (see Bibliography).

NOTE Identification and classification of soil for engineering purposes are covered in ISO 14688-1 and ISO 14688-2. Identification and description of materials intermediate between soil and rock are carried out using the procedures in ISO 14688-1, ISO 14688-2 and this document, as appropriate.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description*

ISO 14688-2, *Geotechnical investigation and testing — Identification and classification of soil — Part 2: Principles for a classification*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
discontinuity
break in the *rock material* (3.7) continuity that is open or can open under the stress increase or reduction as a result of the engineering works

3.2
duricrust
cemented zone occurring in weathered *rock* (3.5) or soil formed by the mobilization and deposition of minerals often due to pedogenic or evaporative processes

3.3
fabric
preferred orientation or spatial arrangement of the constituent grains, crystals and matrix in the *rock* (3.5)

Note 1 to entry: In sedimentary rocks, fabric is the orientation (or lack of it) in space of the constituents of the rock. The term is used in igneous and other crystalline rocks for the patterns produced by non-uniform arrangements of constituents.

3.4
foliation
planar arrangements of constituents such as crystals in any type of *rock* (3.5), especially the parallel *structure* (3.11) that results from flattening, segregation and other processes undergone by the grains in a metamorphic rock

Note 1 to entry: The original planar structure can be disrupted by folding or faulting during tectonic processes.

3.5
rock
naturally occurring assemblage or aggregate of mineral grains, crystals or mineral based particles compacted, cemented or otherwise bound together and which cannot be disaggregated by hand in water

Note 1 to entry: Rocks are generally of greater strength than soils.

3.6
rock mass
rock (3.5) comprising the intact material together with the discontinuities and weathering zones

3.7
rock material
intact *rock* (3.5) between the discontinuities

3.8
rock matrix
groundmass of a *rock material* (3.7) which contains larger crystals, mineral grains or *rock* (3.5) particles

3.9
rock type
natural aggregation of one or more minerals or *rock* (3.5) fragments defined by its petrological composition, predominant grain size, *structure* (3.11), *texture* (3.12) and genetic origin

EXAMPLE Common examples are given in Table A.1.

3.10
solid core
core with at least one full diameter uninterrupted by natural discontinuities, but not necessarily a full circumference, commonly measured along the core axis or other scan line

3.11
structure
pattern of bedding, folds, faults and discontinuities in *rock masses* (3.6), which subdivide the mass into individual domains or *rock* (3.5) blocks

3.12
texture
size, shape and arrangement of the grains or crystals that constitute a *rock* (3.5)

3.13
volumetric joint count
Jv
number of discontinuities (joints) in 1 m^3 volume of *rock mass* (3.6) where Jv = 1/S1 + 1/S2 + 1/S3

Note 1 to entry: S1, S2, S3 are spacings (in metres) of each of the *discontinuity* (3.1) sets at a location.

4 Identification and description of rocks

4.1 General

Rocks shall be identified, described and classified in accordance with this document. The identification and description of soils and the classification of soils shall be carried out in accordance with ISO 14688-1 and ISO 14688-2, respectively.

Identification and description of rocks are sub-divided into the following actions: (i) identification (naming) of the rock (4.2), (ii) description of the rock material (Clause 5) and (iii) description of the characteristics of the rock mass (Clause 6).

Guidance on several aspects of the identification and description of rocks is given in ISRM Suggested Methods[7][8] which can be usefully followed.

4.2 Rock identification

The identification of rock types shall be based on the determination of the following:

a) genetic group:

   — sedimentary: clastic, chemical, organic;
   — metamorphic;
   — igneous: plutonic, volcanic;
   — duricrusts;

b) structure:

   — bedded, foliated or massive (without discontinuities);
   — isotropy or anisotropy of the rock;

c) grain size:

   — descriptive terms (for various sizes) are given in Table A.1 in correlation to rock types;

d) mineralogical composition:

   — quartz, feldspars and related silicate minerals;
   — dark coloured minerals (e.g. biotite, amphibole, pyroxene);
   — clay minerals;
   — carbonate minerals (e.g. calcite and dolomite);
   — oxide minerals (e.g. magnetite);
   — siliceous amorphous material (e.g. glass);
   — carbonaceous material (e.g. coal and graphite);

— salts [e.g. halite (rock salt), gypsum];

— swelling minerals (e.g. anhydrite and clay minerals);

— sulfide minerals (e.g. pyrite);

e) void content:

— primary voids (e.g. gas bubbles in volcanic rocks);

— secondary voids (e.g. dissolution voids).

NOTE Lithological identification of rocks is necessary to appreciate the geology of an area, to correlate geological profiles seen in boreholes or to distinguish boulders from bedrock. It is also important when rock is required for construction purposes. Engineering properties can only partially be inferred from the identification of rock type.

The names of the more common rock types are given in Table A.1, which presents an aid to rock identification for engineering purposes.

Rock names are given particular combinations of features and correct naming requires recognition of the attributes listed. The rock shall be correctly identified within geological science.

Geological maps and other documents related to the project such as the desk study shall be used for the designation of rocks.

4.3 Geological formation and age

The identification of the rock should include, where possible, the geological formation that includes the rock and its age taking into account all available information. The geological formation is usually recorded after the name of the rock, in parentheses with capital letters.

Knowledge of the geological formation can provide useful information about the rock and the interpolation between the boreholes in order to place a rock stratigraphically and to understand the general geology.

If any age determination is thought to be of importance, experts should be appointed to carry out the determination using appropriate dating methodologies.

5 Rock material description

5.1 Colour

The colour of the rock material shall be described using the simple system given in Table 1 to limit the subjectivity of the description. One term is selected as required from each column and combined as a colour assessment. Colours additional to those given in Table 1 would not often be appropriate.

Examples of use are: yellow, light yellowish brown, reddish brown. If necessary, colour differences can be emphasized separately by the use of terms such as spotted, dappled, mottled, streaked; for example, light yellowish brown spotted with dark brown.

A colour chart provides a useful aid, particularly to improve the consistency between descriptions by different persons and under different lighting conditions. The best lighting conditions are outside or near a window in bright cloudy weather; care should be taken if logging indoors under fluorescent lights which most often give a green hue to the light. Logging areas should be lit by “blue” or “daylight” lighting such as CIE D65 (which represents noon daylight, 6 500 K) or CIE C (which represents average northern daylight, 6 774 K).

If the colour chart has colour codes, such as for hue, value and chroma, then these codes should be included in the description.

Table 1 — Terms for lightness, chroma and hue colour description

Lightness Tertiary descriptor	Chroma Secondary descriptor	Hue Primary descriptor
Light — Dark	Reddish Pinkish Orangish Yellowish Brownish Greenish Bluish Greyish	Red Pink Orange Yellow Cream Brown Green Blue White Grey Black

5.2 Grain size

The grain size(s) of the rock should be described using the descriptive scheme given in Table A.1. Grain size refers to the average dimension of the predominant crystals, minerals or rock fragments comprising the rock. It is usually sufficient to estimate the size by eye, which may be aided by a hand lens in the assessment of fine-grained or amorphous rocks, but separate descriptions of the grains or crystals and the matrix may be appropriate.

The particle size, the degree of cementation and the mineralogical composition of the matrix shall be determined. Mineralogical composition should be described using the terms given in Table A.1 (siliceous, carbonate, carbonaceous, etc.) but may be amplified with such standard geological terms as ferruginous, argillaceous (containing clay minerals), quartzose and others.

5.3 Unconfined compressive strength

The unconfined compressive strength of rock material can be estimated according to Table 2.

Table 2 — Unconfined compressive strength

Term	Identification by hand test	Unconfined compressive strength MPa
Extremely weak	Scratched by thumbnail, gravel size lumps can be crushed between finger and thumb	0,6 to 1
Very weak	Scratched by thumbnail, lumps can be broken by heavy hand pressure, can be peeled easily by a pocket knife, crumbles under firm blows with point of geological hammer	1 to 5
Weak	Thin slabs, corners or edges can be broken off with hand pressure, can be peeled by a pocket knife with difficulty, easily scratched by pocket knife, shallow indentations made by firm blow with point of geological hammer	5 to 12,5
Moderately weak	Thin slabs, corners or edges can be broken off with heavy hand pressure, can be scratched with difficulty by pocket knife, hand-held specimen can be broken with single firm blow of geological hammer	12,5 to 25
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen on a solid surface can be fractured with single firm blow of geological hammer	25 to 50