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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

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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).

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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

Table 2 *(continued)*

Term	Identification by hand test	Unconfined compressive strength MPa
Strong	Specimen requires more than one blow of geological hammer to fracture it	50 to 100
Very strong	Specimen requires many blows of geological hammer to fracture it	100 to 250
Extremely strong	Specimen can only be chipped with geological hammer	Greater than 250

Materials with a strength below 0,6 MPa should be classed and described as soil.

Index tests such as the point load test can be used as a measurement indicative of strength in the field, or where appropriate samples for unconfined compressive strength testing cannot be obtained.

Any report describing compressive strength tests shall mention the specimen size, the test procedure, the anisotropy of the specimen and its water content.

5.4 Weathering and alteration effects

The effects of weathering should be recorded in the description of rocks as a full factual description of the degree and extent of weathering and any products that remain from the weathering process.

The information to be recorded includes the following aspects in rock material.

— The degree and extent of **colour changes** which are associated with weathering should be identified and described.

— The original **strength** of the rock material and any changes in that strength associated with weathering should be identified and described.

The processes of weathering/alteration of rock material which can be described are given in Table 3. Any or all of the descriptive terms can be used to describe weathering/alteration. It should be noted that weathering normally decreases material strength, but can result in an increase in strength.

Table 3 — Terms to describe weathering/alteration of rock

Term	Description
Fresh	No visible sign of weathering/alteration of the rock
Discoloured	The colour of the original fresh rock is changed and is evidence of weathering/alteration. The degree of change from the original colour should be indicated. If the colour change is confined to particular mineral constituents, this should be mentioned.
Disintegrated	The rock is broken up by physical weathering, so that bonding between grains is lost and the rock is weathered/altered towards the condition of a soil in which the original material fabric is still intact. The rock material is friable but the mineral grains are not decomposed.
Decomposed	The rock is weathered by the chemical alteration of the mineral grains to the condition of a soil in which the original material fabric is still intact; some or all of the mineral grains are decomposed.

The weathering terms given in Table 3 may be subdivided using qualifying terms, for example, “partially discoloured”, “wholly discoloured” and “slightly discoloured”, as this will aid the description of the material being examined. The last three terms may be used in combination, for example, “wholly discoloured and slightly decomposed”.

5.5 Carbonate content

The carbonate content is assessed by the application of droplets of dilute hydrochloric acid (10 % HCl). The following characteristics can be distinguished:

a) **non-calcareous** if the addition of HCl produces no effervescence;

b) **slightly calcareous** if the addition of HCl produces weak or sporadic effervescence;

c) **calcareous** if the addition of HCl produces clear, but not sustained, effervescence;

d) **highly calcareous** if the addition of HCl produces strong and sustained effervescence.

NOTE 1 In wet or moist rocks, the effervescence usually occurs with some delay.

NOTE 2 Dolomitic carbonate rocks will effervesce very slowly in cold hydrochloric acid.

NOTE 3 10 % hydrochloric acid is 3,6 molar.

5.6 Degradation of rock material

The degradation of rock material when it is exposed to a new environment after sampling should be assessed where the relevant conditions can be determined (see Table 4). The age of the sample at the time of the observation should be noted.

Table 4 — Stability of rock in air

Term	Description
Stable	No changes
Fairly stable	Specimen surface crumbles, slakes
Unstable	Specimen disintegrates

The behaviour of the rock when immersed in water should be described using the terms in Table 5, together with a description of the test undertaken. Some rocks disintegrate in water only after being dried, and some rocks are soluble in water.

Table 5 — Stability of rock in water

Term	Description (after 24 h in water)	Grade
Stable	No changes	1
Fairly stable	A few fissures are formed, or specimen surface crumbles slightly	2
	Many fissures are formed and broken into small lumps, or specimen surface crumbles highly	3
Unstable	Specimen disintegrates, or nearly the whole specimen surface crumbles	4
	The whole specimen becomes muddy, or disintegrates into sand	5

6 Rock mass description

6.1 General

The description of rock mass shall include:

a) delineation of different rock types;

b) structure and bedding;

c) discontinuities;

d) weathering;

e) any apparent groundwater.

6.2 Rock types

The rock type(s) present and their distribution shall be identified as given in 4.2 and detailed in Annex A.

6.3 Structure and bedding

The structure of the rock mass shall be described with relation to the larger scale interrelations of geological features and the associations between rock types in the rock mass.

Examples of common terms which may be used and which are defined in standard geological practice are shown in Table 6.

Table 6 — Examples of terms which may be used in the description of rock mass structure

Sedimentary	Metamorphic	Igneous
Bedded	Cleaved	Massive
Interbedded	Foliated	Flow-banded
Laminated	Schistose	Folded
Folded	Banded	Lineated
Massive	Lineated	—
Graded	Gneissose	—
—	Folded	—

The thickness of bedding units or other foliations, such as those listed in Table 6, shall be measured in millimetres and can be classified using the terms in Table 7. The bedding or other planes are not necessarily a discontinuity or plane of weakness, but bedding parallel discontinuities can be common. Any planar structure that is also a discontinuity shall additionally be described as such, according to 6.4.

Table 7 — Terms to describe bedding thickness

Term	Spacing mm
Thinly laminated	Less than 6
Thickly laminated	6 to 20
Very thin	20 to 60
Thin	60 to 200
Medium	200 to 600
Thick	600 to 2 000
Very thick	Greater than 2 000

6.4 Discontinuities

6.4.1 General

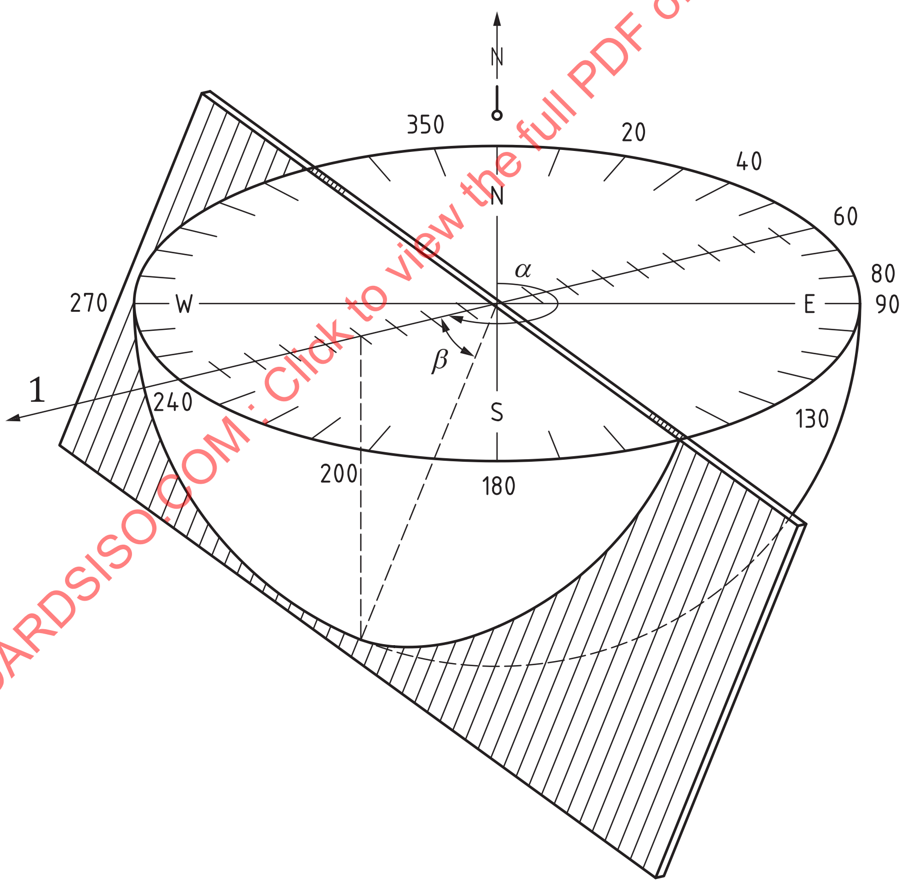
The tensile or shear strength across or along the discontinuity surface is lower than that of the intact rock material. The discontinuities have many modes of origin; for example, those that might form planes of weakness such as bedding planes, cleavage or foliation, and those that have little or no tensile strength such as joints, shears and faults. Each can occur individually or locally in sets of relatively uniform characteristics.

The description of the discontinuities should include the type of discontinuities, their orientations, spacing, persistence, roughness, aperture and filling, and seepage characteristics, the number of sets and the rock block size resulting from their combination. It may often be necessary to describe large or important discontinuities individually. Full information on rock mass discontinuities can only be obtained from exposures of the rock mass that are of sufficient quality and size with respect to the features present.

6.4.2 Measurement of discontinuity orientation

The maximum declination (dip) of the mean plane of the discontinuity from the horizontal shall be measured with the clinometer in the range 0° to 90° and should be expressed in degrees as a two-digit number, e.g. 50. The azimuth of the dip (dip direction) shall be measured in degrees in the range 0° to 360° counted clockwise from true north and expressed as a three-digit number, e.g. 240 or 015. The dip direction and dip should be recorded with the three-digit and two-digit numbers separated by a slash, e.g. 240/50. The pair of numbers represents the dip vector. The relationship between dip and dip direction is given in Figure 1. The reporting can be either as dip/dip direction or as dip direction/dip but the nomenclature in use shall be reported.

In vertical drill cores, the dip can be reported. If the core is inclined or if the dip direction is also to be measured, orientation of the core or logging of the borehole walls is required.



Key

1 dip direction

α dip direction (dip azimuth) = 240°

β dip (dip angle) = 50°

plane of discontinuity 240/50

Figure 1 — Diagram indicating dip and dip direction

The orientation of a plane can also be defined by the strike which is the normal to the dip direction. The direction of the dip also needs to be reported.

6.4.3 Discontinuity spacing

The term "spacing" refers to the mean or modal spacing of a set of discontinuities and is the perpendicular distance between adjacent discontinuities. The number of discontinuity sets, the differences in spacing and the angles between the sets shall be reported as these determine the block shape. The discontinuity spacing should be measured in millimetres and can be classified using the terms in Table 8.

Table 8 — Terms to describe discontinuity spacing

Term	Spacing mm
Extremely close	Less than 20
Very close	20 to 60
Close	60 to 200
Medium	200 to 600
Wide	600 to 2 000
Very wide	Greater than 2 000

In drill cores, it is difficult to measure the true discontinuity spacing when the discontinuities are sub-parallel to the core axis (usually vertical) when measurements can be made along the core axis. The method of measurement shall be reported.

6.4.4 Rock block shapes in three dimensions

Discontinuity spacing in three dimensions should be measured using scan lines, preferably in three orthogonal directions. The results of the scan line measurements should be reported in accordance with Reference [7]. The arrangement of discontinuities in three dimensions can be described using the approach given in Annex C.

The size of rock blocks can be determined by the length of the sides or by the volume.

For the length of the sides of the blocks, the scheme in Table 9 can be used.

Table 9 — Lengths of sides of rock blocks

Term	Average length of block sides mm
Very small	Less than 60
Small	60 to 200
Medium	200 to 600
Large	600 to 2 000
Very large	Greater than 2 000

Alternatively, the "block volume" as given in Table 10 can be used.

Table 10 — Block volume sizes

Term	Block volume
Very small	<1 dm^3
Small	1 dm^3 to 30 dm^3
Medium	0,03 m^3 to 1 m^3
Large	1 m^3 to 30 m^3
Very large	Greater than 30 m^3

The spacing of discontinuities can also be measured as the volumetric joint count (Jv) using the terms given in Table 11 or reported as numbers.

Table 11 — Classification of the volumetric joint count

Term	Volumetric joint count (Jv)
Extremely low	<0,3
Very low	0,3 to 1
Low	1 to 3
Moderately high	3 to 10
High	10 to 30
Very high	30 to 100
Extremely high (crushed)	>100

6.4.5 Persistence of discontinuities

The linear extent of discontinuities from their inception to their termination in solid rock mass or against other discontinuities or outside the exposure shall be reported. The size of the exposure shall also be recorded. If possible and appropriate, measurements should be made in two or preferably three orthogonal directions.

6.4.6 Roughness

The surface condition and the shape of discontinuities shall be described on the basis of three scales of observation, respectively, and using the terms given in Table 9 and illustrated in Figure 2:

a) small scale (several millimetres) — smooth or rough;

b) medium scale (several centimetres) — planar, stepped or undulating;

c) large scale (several metres) — straight, curved or wavy.

The profiles in Figure 2 can be printed out to the lengths given in Table 12 and then compared with the discontinuity exposure to arrive at the relevant roughness term.

A discontinuity surface could thus be described combining large or medium and small scale terms to give descriptions such as “stepped smooth” or “planar rough”. For total clarity of description, it may be necessary to give wavelength and amplitude measurements of the larger scale features. In addition, discontinuities may be slickensided (or striated) but this description should only be used when there is clear evidence of shear displacement along the discontinuity; these surfaces can be polished and reflect light.

Table 12 — Terms for description of surface form of discontinuities

Profile number	Small scale of millimetres	Medium scale of centimetres	Large scale of metres
	Profile on Figure 2 = 10 mm	Profile on Figure 2 = 100 mm	Profile on Figure 2 = 1 000 mm
1 to 3	Striated (in direction of striae)	Planar	Straight
4 to 7	Smooth	Undulating	Curved
8 to 10	Rough	Stepped	Wavy

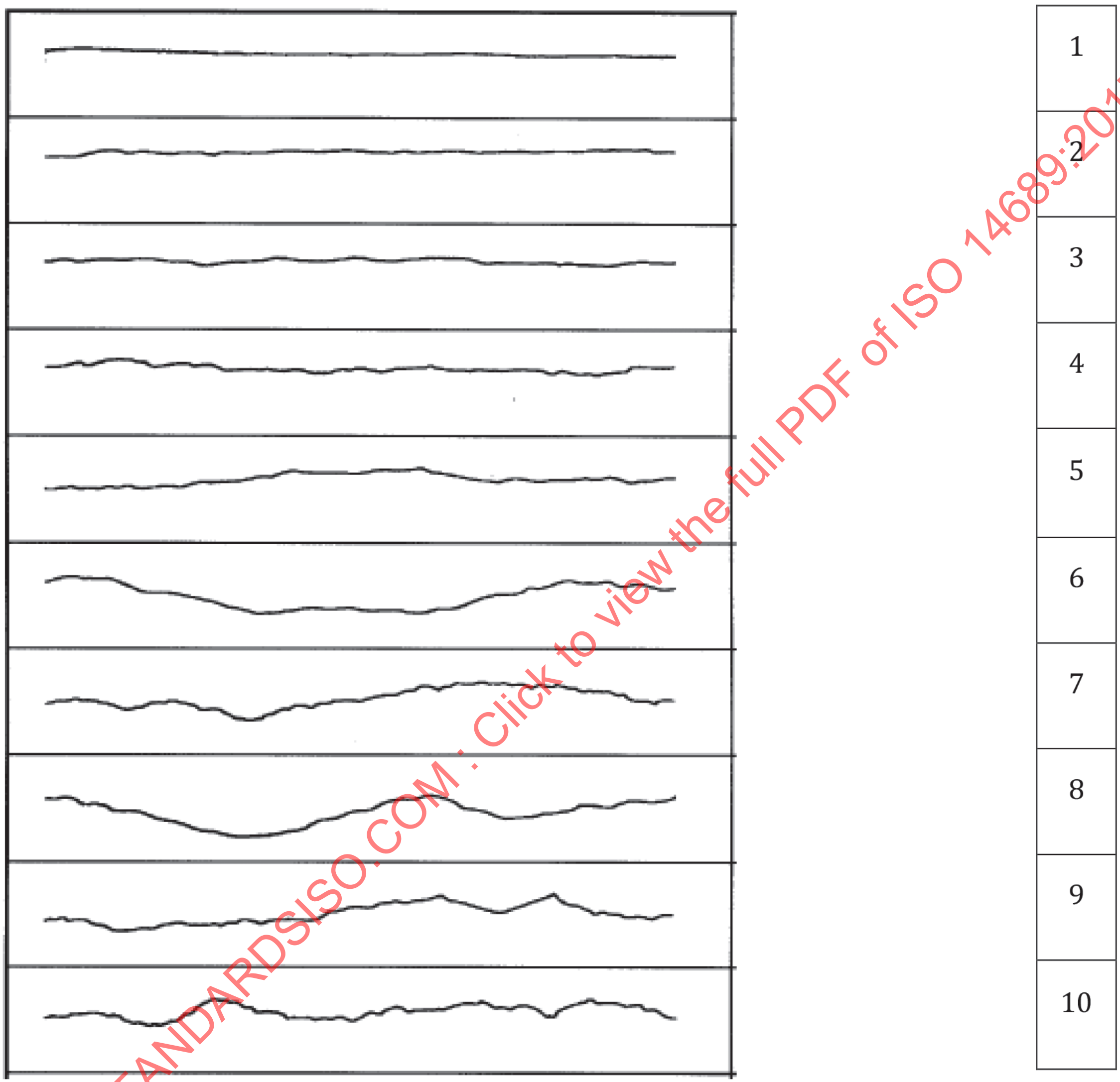


Figure 2 — Joint profiles for use in the field[5] (not to scale but vertical and horizontal scales are equal)

6.4.7 Aperture

The perpendicular distance between the two surfaces of a discontinuity is referred to as the aperture. The range of apertures visible should be measured and reported noting that the maximum aperture is likely to be more significant than the minimum.

Any opening of the aperture caused by the creation of the exposure (e.g. drilling, excavation, blasting) should be excluded.

The origin of the exposure, such as natural outcrop, artificial excavated surface, etc. shall be reported. The separation shall be described using the terms in Table 13.

Table 13 — Terms for the description of discontinuity aperture

Aperture size term	Aperture mm
Very tight	Less than 0,1
Tight	0,1 to 0,25
Partly open	0,25 to 0,5
Open	0,5 to 2,5
Moderately wide	2,5 to 10
Wide	10 to 100
Very wide	100 to 1 000
Extremely wide	>1 000

NOTE The aperture of joints cannot normally be measured in cores unless the joint is recovered with infill intact.

6.4.8 Infilling

The infilling material between discontinuity surfaces shall be identified and described (e.g. soil, minerals such as calcite, quartz, epidote, chlorite, anhydrite, clay gouge, rock gouge or breccia). The shear strength of infilling and the potential for infilling to swell or dissolve shall be described, when relevant.

6.4.9 Seepage

Free moisture or water flow visible at individual spots or from discontinuities shall be described where possible in field exposures using the terms “moisture on rock surface” and “dripping water”, respectively. If the rate of flow can be estimated or measured, then the rate of flow may be described using the terms given in Table 14.

Table 14 — Terms to describe seepage rates from discontinuities

Descriptive term	Rate of flow l/s
Small	0,05 to 0,5
Medium	0,5 to 5
Large	Greater than 5

6.4.10 Joint sets

The number of joint sets should be identified and each set described separately.

6.5 Weathering of the rock mass

The weathering of the rock mass shall be described in terms of the distribution and relative proportions of fresh and weathered rock and the effects of weathering on discontinuities. Weathering is a process and any classification should be presented clearly and separately from the description. The information to be recorded includes the features given in 5.4 and the following aspects:

— the fracture state and any changes in that state associated with weathering should be identified and reported;

— the nature and extent of any weathering products using the appropriate soil or rock descriptive terminology given in ISO 14688-1 and this document.

Weathering eventually converts rock to a soil and the weathering profile shall be described in terms of three basic units: rock, rock-and-soil, soil.

To subdivide the different weathering units, a general classification with six distinct grades which may be applicable to a profile in rock is given in Table 15.

Table 15 — Classification of weathering stages of rock mass

Term	Description	Grades
Fresh	No visible sign of rock weathering; perhaps slight discolouration on major discontinuity surfaces.	0
Slightly weathered	Discolouration indicates weathering of rock and discontinuity surfaces.	1
Moderately weathered	Less than half of the rock is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	2
Highly weathered	More than half of the rock is decomposed or disintegrated. Fresh or discoloured rock is present either as a discontinuous framework or as core stones.	3
Completely weathered	All of the rock is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	4
Residual soil	All of the rock is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	5

NOTE Table 15 gives a typical classification which is unlikely to apply to all rock types. More specific local classifications may be available and can be used where they are useful and unambiguous. A more general scheme for the classification of weathering of rocks (material and mass) is given in Annex B.

In logging cores, the distribution of weathering terms (grades, zones or classes) of rock may be recorded; distribution of weathering of the rock mass from which the cores were obtained can be inferred from this type of evidence.

Distribution of weathering grades (or zones or classes) in a rock mass may be determined by mapping natural and artificial exposures. It should be borne in mind, however, that isolated natural exposures of rock and excavations of limited extent are not necessarily representative of the whole rock mass.

7 Fracture indices in cores

The indices of the rock mass in situ as represented by recovered drill core should be measured as given below. The application of these terms is illustrated in Figure 3.

— Total core recovery (TCR) is the length of core recovered (both solid and non-intact) in the core run, expressed as a percentage.

— Solid core recovery (SCR) is the length of solid core recovered in the core run, where solid core has at least one full diameter, expressed as a percentage.

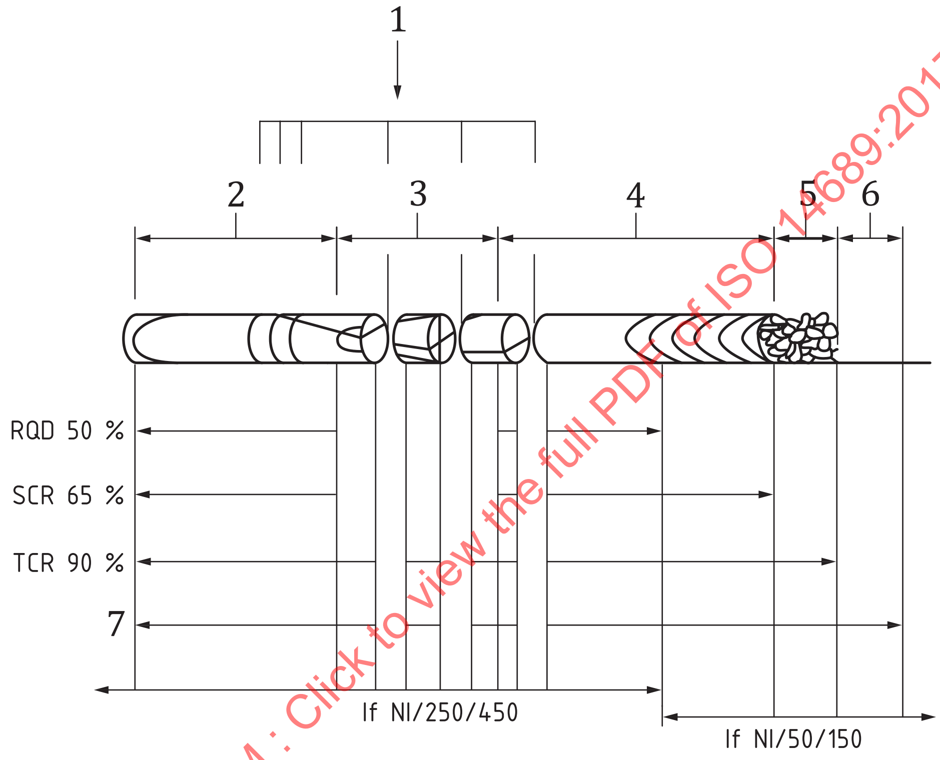
— Rock quality designation (RQD) is the summed length of solid core pieces each with at least one full diameter recovered in the core run where each piece is at least 100 mm long between natural fractures, expressed as a percentage.

— Fracture index (If) is the spacing between natural fractures along the core in zones of uniform character, not per core run. The If can usefully be given as minimum, mode and maximum values within the zone.

The measurement of TCR should be carried out first to ensure that zones of core loss are identified and corrected for and therefore that all depth related records such as boundaries, markers and samples are correct.

The SCR and RQD should also be recorded as they provide useful information on the quality of the rock, and the latter is widely used in rock mass classification schemes.

The measurements for these indices should only consider natural fractures. Those breaks that are due to drilling disturbance and post drilling activities should be excluded in the assessment. The character of natural fractures might be identified from natural or man-made exposures.



Key

1 drilling induced fractures

2 at least one full diameter

3 no single full diameter

4 at least one full diameter

5 non-intact

6 no recovery

7 core run

NOTE All features shown are natural discontinuities unless stated otherwise.

Figure 3 — Application of fracture indices in rock cores

8 Rock mass classification

There are a number of rock mass classification systems applicable to a variety of engineering situations. The state of the rock mass should be determined whenever appropriate using one of these schemes, and the method used shall be reported. The selection of which system to use will depend on the geological situation and the engineering project.

EXAMPLES Terzaghi's rock mass classification, classifications based on stand up time, the Rock Structure Rating (RSR), the Rock Mass Rating (RMR), the volumetric joint count (Jv), Rock Mass Index (RMi), the rock mass quality Q system and the Geological Strength Index (GSI).

Most of these are multi-parameter schemes involving measurement of several features of the rock material and rock mass as outlined in this document. A summary of these schemes is given, for example, in Reference [6].

9 Reporting

The reporting shall clearly state that the identification, description and classification have been made in accordance with this document.

The description of any rock shall contain at least the following information:

— name(s) of person(s) describing the rock;

— date and location of description;

— details of origin of collection and handling of samples (see ISO 22475-1);

— identification, description and classification of each layer of rock;

— key of symbols and terms used.

If investigation results are recorded electronically, data should be transferred using open data transfer systems.

The symbols of the ISO 710 series may be used to represent rocks on borehole legends or on engineering geological maps or cross-sections.

