UDC 624.131.2 DEUTSCHE NORM October 1988

Soil classification for civil engineering purposes

DIN 18 196

Erd- und Grundbau; Bodenklassifikation für bautechnische Zwecke

Supersedes June 1970 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

This standard has been jointly prepared by Section *Baugrund* of the *Normenausschuß Bauwesen* (Building and Civil Engineering Standards Committee) of *DIN Deutsches Institut für Normung* and the *Deutsche Gesellschaft für Erd- und Grundbau* (German Association for Earthworks and Foundation Engineering).

Contents

1

Th
en
a
Sc
DI
A
th
pr
Th
pe
sit
pa
to
to
da
sic
da
sy
Th
tic
so
as
co
ca

is of
es.
soil
teria.
com-
lope
as
(1)
ng to
ssing,

Continued on pages 2 to 5

Anwenderinformation

Die Originalfassung der Norm enthält **Elemente, z. B. farbige Abbildungen oder Tabellen,** die in dieser gescannten Form der Norm nicht originalgetreu darstellbar sind. Dies muß bei der Anwendung berücksichtigt werden. Maßgebend für das Anwenden jeder DIN-Norm ist deren Originalfassung mit dem neuesten Ausgabedatum. Vergewissern Sie sich bitte in den DIN-Mitteilungen, im aktuellen DIN-Katalog mit dem neuesten Ergänzungsheft oder in der aktuellen Ausgabe der PERINORM.

Beuth Verlag GmbH, Berlin, has the exclusive right of sale for German Standards (*DIN-Normen*).
08.90

DIN 18 196 Engl. Price group 6
Sales No. 0106

UDC 624.131.2 DEUTSCHE NORM October 1988

Soil classification for civil engineering purposes

DIN 18 196

Erd- und Grundbau; Bodenklassifikation für bautechnische Zwecke

Supersedes June 1970 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

This standard has been jointly prepared by Section *Baugrund* of the *Normenausschuß Bauwesen* (Building and Civil Engineering Standards Committee) of *DIN Deutsches Institut für Normung* and the *Deutsche Gesellschaft für Erd- und Grundbau* (German Association for Earthworks and Foundation Engineering).

Contents

1 Scope and field of application

This standard establishes a soil classification system for engineering purposes. It does not cover rock, or soils with a content of boulders and cobbles exceeding 40 percent. Soil identification and description are covered in DIN 4022 Part 1.

A system of classification of soil and rock with respect to their recoverability (extraction, loading, transport) is provided in DIN 18 300.

The classification system established in this standard permits soils to be grouped into classes of similar composition and physical properties, such as shear strength, compactibility, compressability, permeability, susceptibility to weathering, erosion and frost action, and with respect to their suitability for engineering purposes (e.g. as foundation soil, construction material for unpaved or provisional roads and for road and railway embankments, for dams (shells and impervious elements), and for drainage systems).

The standard also establishes basic principles of classification and provides information on how to assign soils to soil groups. Within any such group, properties may vary as a function of water content in the case of fine and composite soils, or as a function of compactness in the case of coarse and composite soils.

2 Concepts

2.1 Soil classification system

A soil classification system is a system on the basis of which soils can be classified for engineering purposes.

2.2 Classification

Classification is the assignment of soil samples to soil groups on the basis of certain characteristics and criteria.

2.3 Soil group

A soil group comprises all types of soil of similar composition and engineering properties.

2.4 Uniformity coefficient

The uniformity coefficient, U, is a measure of the slope of the grading curve in the range from d_{10} to d_{60} as specified in DIN 18 123, and is given by:

$$U = \frac{d_{60}}{d_{10}} \quad (1)$$

where d_{10} and d_{60} are the particle sizes corresponding to 10 % and 60 % by mass, respectively, of particles passing, as shown in the grading curve.

Continued on pages 2 to 5

Beuth Verlag GmbH, Berlin, has the exclusive right of sale for German Standards (*DIN-Normen*).
08.90

DIN 18 196 Engl. Price group 6
Sales No. 0106

2.5 Index of curvature

The index of curvature, C_c, characterizes the grading curve in the range from d_{10} to d_{60} as specified in DIN 18 123, and is given by:

$$C_c = \frac{(d_{30})^2}{d_{10} \cdot d_{60}} \quad (2)$$

where

d_{10}, d_{30} and d_{60} are the particle sizes corresponding to 10, 30, and 60 % by mass of particles passing, as shown in the grading curve.

3 Principles of soil classification

3.1 Characteristics

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

a) fractions;

b) particle size distribution (grading);

c) plastic properties;

d) organic matter content;

e) formation history.

3.2 Fractions

Mineral soil is a mixture of materials of different particle size, which are grouped into particle size ranges (fractions), as specified in DIN 4022 Part 1.

In soil classification, only particle sizes up to 63 mm are considered. If particle sizes of less than 63 mm are present to more than 95 % in coarse material (particle sizes of more than 0,06 mm), classification is to be based on the particle size distribution (see subclause 3.3 for coarse soils). If fine material (of particle size 0,06 mm or less) is present to 40 % or more in coarse material, classification is to be based on the plastic properties of the soil (see subclause 3.4 for fine soils).

In the case of soils composed of both coarse and fine material (with 5 % to 40 % by mass of fines in material of particle size smaller than 63 mm), classification is to be based on both plastic properties and particle size distribution (see subclauses 3.3 and 3.4 for composite soils).

3.3 Particle size distribution (grading)

For the classification of coarse soils and composite soils, their dominant fraction shall be established in accordance with table 1. Coarse soils shall be further classified in accordance with table 2, considering the uniformity coefficient and the index of curvature, and composite soils, in accordance with table 3, considering the percentage of fines not exceeding 0,06 mm in size.

Table 1. **Soil groups**

Dominant fraction	Symbol	Percentage of particles 2 mm or less in size
Gravel	G	Up to 60
Sand	S	Over 60

Table 2. **Grading of coarse soils as a function of uniformity coefficient and index of curvature**

Term	Symbol	U	C_c
Well graded	E	< 6	Any
Poorly graded	W	≥ 6	1 to 3
Gap graded	I	≥ 6	Less than 1 or more than 3

3.4 Plastic properties

Fine soils shall be classed as lying above or below the A-line (i.e., as clay (T) or silt (U)) in the plasticity chart according to water content at the liquid limit, w_L, and the plasticity index, $I_P = w_L - w_P$ (w_P being the water content at the plastic limit). For composite soils, the fines fraction shall be classed as clay or silt, as appropriate. Fine soils shall be classified in accordance with table 4 according to the water content at the liquid limit.

The consistence limits of organic fine soils (denoted by O) lie always below the A-line.

Composite soils shall be placed into subgroups, as 'clayey' or 'silty' according to the consistence limits, w_L and I_P.

Table 3. **Classification of composite soils according to fines content**

Grading	Symbol	Percentage of fines up to 0,06 mm
Low	U or T	5 to 15
High	$\bar{U}^*$ or $\bar{T}^*$	Over 15 up to 40
Instead of the symbols $\bar{U}$ and $\bar{T}$, U^* and T^* may be used.		

Table 4. **Classification of fine soils according to water content at the liquid limit, w_L**

Degree of plasticity	Symbol	w_L, as a percentage by mass
Low plasticity	L	Less than 35
Intermediate plasticity	M	35 to 50
High plasticity	A	Over 50

3.5 Organic constituents

When soils with organic constituents are classified according to their organic matter content, a distinction is to be made between organic soils (denoted by H or F) and organogenic soils or soils with a high content of organic matter (denoted by O).

Classification of coarse and composite organogenic soils is to be based on the type of organic matter and that of organic soils, on the formation history and the degree of decomposition of the organic constituents.

Table 5. **Soil classification system for engineering purposes**

Co.	1	2	3	4	5	6	7	8			9	10	11	12	13	14	15	16	17	18	19	20	21	Co.
Line	Identification and description							Characteristics (subcolumns applying to lines 15 to 22 only)			Examples	Notes 1)												Line
												Engineering properties						Material suitable for/as						
	Basic soil type	Fraction, as a percentage by mass; Particle size, in mm: 0,06 or less	2 or less	Position with respect to A-line		Soil groups	Symbol 2)	Dry strength	Dilatancy	Plasticity		Shear strength	Compactability	Compressability	Permeability	Susceptibility to erosion and weathering	Susceptibility to frost	Foundations soil	Unpaved roads construction	Road and railway embankments	Impervious elements of dams	Shells of dams	Drainage systems	
1	Coarse soils	Less than 5 %	Up to 60 %	–	Gravel	Well graded gravel	GE	Grading curve steep due to one fraction being overrepresented			River, beach, and terrace gravel, volcanic slag	+	+O	++	––	++	++	+	–	+	––	+	++	1
2						Poorly graded gravel/sand mixtures	GW	Grading curve continuous over several fractions				++	++	++	–O	+	++	++	++	++	––	++	+O	2
3						Gap graded gravel/sand mixtures	GI	Grading curve mostly discontinuous since one or more fractions are not represented				++	+	++	–	O	++	++	+	++	––	++	+O	3
4			Over 60 %	–	Sand	Well graded sand	SE	Grading curve steep due to one fraction being overrepresented			Dune sand, aeolian sand, quicksand, Berlin sand, basin sand, tertiary sand	+	+O	++	–	–	++	+	––	+O	––	O	+	4
5						Poorly graded sand/gravel mixtures	SW	Grading curve continuous over several fractions			Sandy moraine, terrace sand, granite debris	++	++	++	–O	+O	++	++	+	+	––	+	+O	5
6						Gap graded sand/gravel mixtures	SI	Grading curve mostly discontinuous since one or more fractions are not represented				+	+	++	–O	+O	++	++	O	+	––	+	+O	6
7	Composite soils	5 to 40 %	Up to 60 %	–	Gravel/silt mixtures	5 to 15 % not exceeding 0,06 mm	GU	Poorly or gap graded; fines fraction is silty			Gravelly moraine, gravelly weathered material, hillfoot debris, decalcified glacial till	++	+	++	O	+O	–O	++	++	+	–	+	–	7
8						Over 15 up to 40 % not exceeding 0,06 mm	G$\bar{U}$*					+	+O	+	+	–O	––	+	+O	–O	+O	–	––	8
9					Gravel/clay mixtures	5 to 15 % not exceeding 0,06 mm	GT	Poorly or gap graded; fines fraction is clayey				+	+	+	+O	+O	–O	++	++	+	–O	+O	–	9
10						Over 15 up to 40 % not exceeding 0,06 mm	G$\bar{T}$*					+O	O	+O	++	+O	–	+O	+O	+O	+	––	––	10
11			Over 60 %	–	Sand/silt mixtures	5 to 15 % not exceeding 0,06 mm	SU	Poorly or gap graded; fines fraction is silty			Tertiary sand	++	+	+	O	O	O	++	O	+O	O	–O	–	11
12						Over 15 up to 40 % not exceeding 0,06 mm	S$\bar{U}$*				Riverine loam, sandy loess	+	O	+O	+	–	––	O	–O	–O	+O	––	––	12
13					Sand/clay mixtures	5 to 15 % not exceeding 0,06 mm	ST	Poorly or gap graded; fines fraction is clayey			Terrace sand, quicksand	+	+O	+O	+O	O	–O	+	+	+O	O	–	––	13
14						Over 15 up to 40 % not exceeding 0,06 mm	S$\bar{T}$*				Decalcified glacial and calcareous glacial till	+O	–O	+O	++	–O	–	O	O	O	+	––	––	14
15	Fine soils	Over 40 %	–	$I_P \leq 4\%$, or below A-line	Silt	Silts of low plasticity $w_L < 35\%$	UL	Low	High	None to low	Loess, flood loam	–O	–O	+O	+O	––	––	+O	––	–O	O	––	––	15
16						Silts of intermediate plasticity $35\% \leq w_L \leq 50\%$	UM	Low to medium	Slow	Low to intermediate	Lacustrine clay, basin silt	–O	–	–O	+	–	––	O	–	–O	+O	––	––	16
17						Highly compressible silts $w_L > 50\%$	UA	High	No reaction to low	Intermediate to high	Volcanic soils, pumice soils	–	–	–	++	–O	–O	–O	–	–	–O	––	––	17
18				$I_P \geq 7\%$, and above A-line	Clay	Clays of low plasticity $w_L < 35\%$	TL	Medium to high	No reaction to low	Low	Calcareous glacial till, bedded clay	–O	–O	O	+	–	––	O	–	–O	++	––	––	18
19						Clays of intermediate plasticity $35\% \leq w_L \leq 50\%$	TM	High	No reaction	Intermediate	Loes loam, basin clay, Keuper clay, lacustrine clay	–	–	–O	++	–O	–O	O	–	–O	+	––	––	19
20						Clays of high plasticity $w_L > 50\%$	TA	Very high	No reaction	High	Tarras, Lauenburg clay, basin clay	––	––	––	++	O	+O	–O	––	–	–	––	––	20
21	Organogenic soils 3) and soils with organic components	Over 40%	–	$I_P \geq 7\%$, and below A-line	Non-combustible or non-smouldering	Silts with organic components, and organogenic 3) silts $35\% \leq w_L \leq 50\%$	OU	Medium	Low to high	Intermediate	Lacustrine lime, kieselguhr, topsoil	–O	–	–O	+O	––	––	––	––	––	–	––	––	21
22						Clays with organic components, and organogenic 3) clays $w_L > 50\%$	OT	High	No reaction	High	Mud, sea-marsh soil, tertiary coal clays	––	––	–	++	–O	–O	––	––	––	–	––	––	22
23		Up to 40%		–		Coarse to composite soils with humic components	OH	Containing plant material, mostly dark colour, musty odour, loss on ignition up to about 20% by mass			Topsoil, flossil soil	O	–O	–O	O	+O	–O	–	O	–	––	––	––	23
24						Coarse to composite soils with calcareous or siliceous components	OK	Containing mineral components, mostly light colour, of low density and high porosity			Calcareous sand, tufa sand, bog lime	+	O	–O	–O	O	+O	–O	O	–O	––	––	––	24
25	Organic soils	–	–	–	Combustible or smouldering	Not decomposed to moderately decomposed peats	HN	Organic material grown at site	Degree of decomposition 1 to 5, fibrous, rich in wood, light brown to brown		Low moor peat, raised bog peat, forest-swamp peat	–	––	––	O	+O	–	––	––	––	––	––	––	25
26						Decomposed peats	HZ		Degree of decomposition 6 to 10, dark brown to black			––	––	––	+O	–	––	––	––	––	––	––	––	26
27						Mud, collective term comprising putrid mud, peaty mud, gyttja, dy and sapropel	F	Deposited by water, consisting of plant remains, faecal pellets, microorganisms, often containing sand, clay, lime; bluish black or greenish to yellowish brown; elstic, soft/spongy			Peaty mud, putrid mud	––	––	––	+O	–	––	––	––	––	––	––	––	27
28	Made ground	–	–	–	Made ground of natural material (with relevant group symbol given in square brackets)		[ ]	–				–												28
29					Made ground of altered or artificial material		A				Domestic waste, slag, rubble, industrial waste													29

1) For guidance only, columns 10 to 21 provide a general information on engineering properties and the suitability of soils (with examples given in column 9).
2) The stroke above the symbols U and T, and the asterisk may be omitted.
3) Soils formed with the cooperation of organisms.

7	Composite soils	5 to 40 %	Up to 60 %	–	Gravel/silt mixtures	5 to 15 % not exceeding 0,06 mm	GU	Poorly or gap graded; fines fraction is silty			Gravelly moraine, gravelly weathered material, hillfoot debris, decalcified glacial till	++	+	++	○	+○	−○	++	++	+	–	+	–	7
8						Over 15 up to 40 % not exceeding 0,06 mm	GŪ*					+	+○	+	+	−○	−−	+	+○	−○	+○	–	−−	8
9					Gravel/clay mixtures	5 to 15 % not exceeding 0,06 mm	GT	Poorly or gap graded; fines fraction is clayey				+	+	+	+○	+○	−○	++	++	+	−○	+○	–	9
10						Over 15 up to 40 % not exceeding 0,06 mm	GT̄*					+○	○	+○	++	+○	–	+○	+○	+○	+	−−	−−	10
11			Over 60 %		Sand/silt mixtures	5 to 15 % not exceeding 0,06 mm	SU	Poorly or gap graded; fines fraction is silty			Tertiary sand	++	+	+	○	○	○	++	○	+○	○	−○	–	11
12						Over 15 up to 40 % not exceeding 0,06 mm	SŪ*				Riverine loam, sandy loess	+	○	+○	+	–	−−	○	−○	−○	+○	−−	−−	12
13					Sand/clay mixtures	5 to 15 % not exceeding 0,06 mm	ST	Poorly or gap graded; fines fraction is clayey			Terrace sand, quicksand	+	+○	+○	+○	○	○	+	+	+○	○	–	−−	13
14						Over 15 up to 40 % not exceeding 0,06 mm	ST̄*				Decalcified glacial and calcareous glacial till	+○	−○	+○	++	−○	–	○	○	○	+	−−	−−	14
15	Fine soils	Over 40 %	–	$I_P \leq 4\%$, or below A-line	Silt	Silts of low plasticity $w_L < 35\%$	UL	Low	High	None to low	Loess, flood loam	−○	−○	+○	+○	−−	−−	+○	−−	−○	○	−−	−−	15
16						Silts of intermediate plasticity $35\% \leq w_L \leq 50\%$	UM	Low to medium	Slow	Low to intermediate	Lacustrine clay, basin silt	−○	–	−○	+	–	−−	○	–	−○	+○	−−	−−	16
17						Highly compressible silts $w_L > 50\%$	UA	High	No reaction to low	Intermediate to high	Volcanic soils, pumice soils	–	–	–	++	−○	−○	−○	–	–	−○	−−	−−	17
18				$I_P \geq 7\%$, and above A-line	Clay	Clays of low plasticity $w_L < 35\%$	TL	Medium to high	No reaction to low	Low	Calcareous glacial till, bedded clay	−○	−○	○	+	–	−−	○	–	−○	++	−−	−−	18
19						Clays of intermediate plasticity $35\% \leq w_L \leq 50\%$	TM	High	No reaction	Intermediate	Loess loam, basin clay, Keuper clay, lacustrine clay	–	–	−○	++	−○	−○	○	–	−○	+	−−	−−	19
20						Clays of high plasticity $w_L > 50\%$	TA	Very high	No reaction	High	Terras, Lauenburg clay, basin clay	−−	−−	−−	++	○	+○	−○	−−	–	–	−−	−−	20
21	Organogenic soils[3] and soils with organic components	Over 40%	–	$I_P \geq 7\%$, and below A-line	Non-combustible or non-smouldering	Silts with organic components, and organogenic[3] silts $35\% \leq w_L \leq 50\%$	OU	Medium	Low to high	Intermediate	Lacustrine lime, kiesel-guhr, topsoil	−○	–	−○	+○	−−	−−	−−	−−	−−	–	−−	−−	21
22						Clays with organic components, and organogenic[3] clays $w_L > 50\%$	OT	High	No reaction	High	Mud, sea-marsh soil, tertiary coal clays	−−	−−	–	++	−○	−○	−−	−−	−−	–	−−	−−	22
23		Up to 40%	–	–		Coarse to composite soils with humic components	OH	Containing plant material, mostly dark colour, musty odour, loss on ignition up to about 20% by mass			Topsoil, fossil soil	○	−○	−○	○	+○	−○	–	○	–	−−	−−	−−	23
24						Coarse to composite soils with calcareous or siliceous components	OK	Containing mineral components, mostly light colour, of low density and high porosity			Calcareous sand, tufa sand, bog lime	+	○	−○	−○	○	+○	−○	○	−○	−−	−−	−−	24
25	Organic soils	–	–	–	Combustible or smouldering	Not decomposed to moderately decomposed peats	HN	Organic material grown at site	Degree of decomposition 1 to 5, fibrous, rich in wood, light brown to brown		Low moor peat, raised bog peat, forest swamp peat	–	−−	−−	○	+○	–	−−	−−	−−	−−	−−	−−	25
26						Decomposed peats	HZ		Degree of decomposition 6 to 10, dark brown to black			−−	−−	−−	+○	–	−−	−−	−−	−−	−−	−−	−−	26
27						Mud, collective term comprising putrid mud, peaty mud, gyttja, dy and sapropel	F	Deposited by water, consisting of plant remains, faecal pellets, microorganisms, often containing sand, clay, lime; blueish black or greenish to yellowish brown; elastic, soft/spongy			Peaty mud, putrid mud	−−	−−	−−	+○	–	−−	−−	−−	−−	−−	−−	−−	27
28	Made ground	–	–	–	Made ground of natural material (with relevant group symbol given in square brackets)		[ ]	–																28
29					Made ground of altered or artificial material		A				Domestic waste, slag, rubble, industrial waste													29

1) For guidance only, columns 10 to 21 provide a general information on engineering properties and the suitability of soils (with examples given in column 9).
2) The stroke above the symbols U and T, and the asterisk may be omitted.
3) Soils formed with the cooperation of organisms.

Key to symbols used in columns 10 to 21

Column 10		Column 11		Columns 12 to 15		Columns 16 to 21	
−−	Very low	−−	Very low	−−	Very high	−−	Unsuitable
−	Low	−	Low	−	High	−	Less suitable
−○	Moderate	−○	Moderate	−○	High to medium	−○	Moderately suitable
○	Medium	○	Medium	○	Medium	○	Fairly suitable
+○	High to medium	+○	Fair to medium	+○	Low to medium	+○	Suitable
+	High	+	Fair	+	Very low	+	Very suitable
++	Very high	++	Excellent	++	Extremely low	++	High suitable

Provide

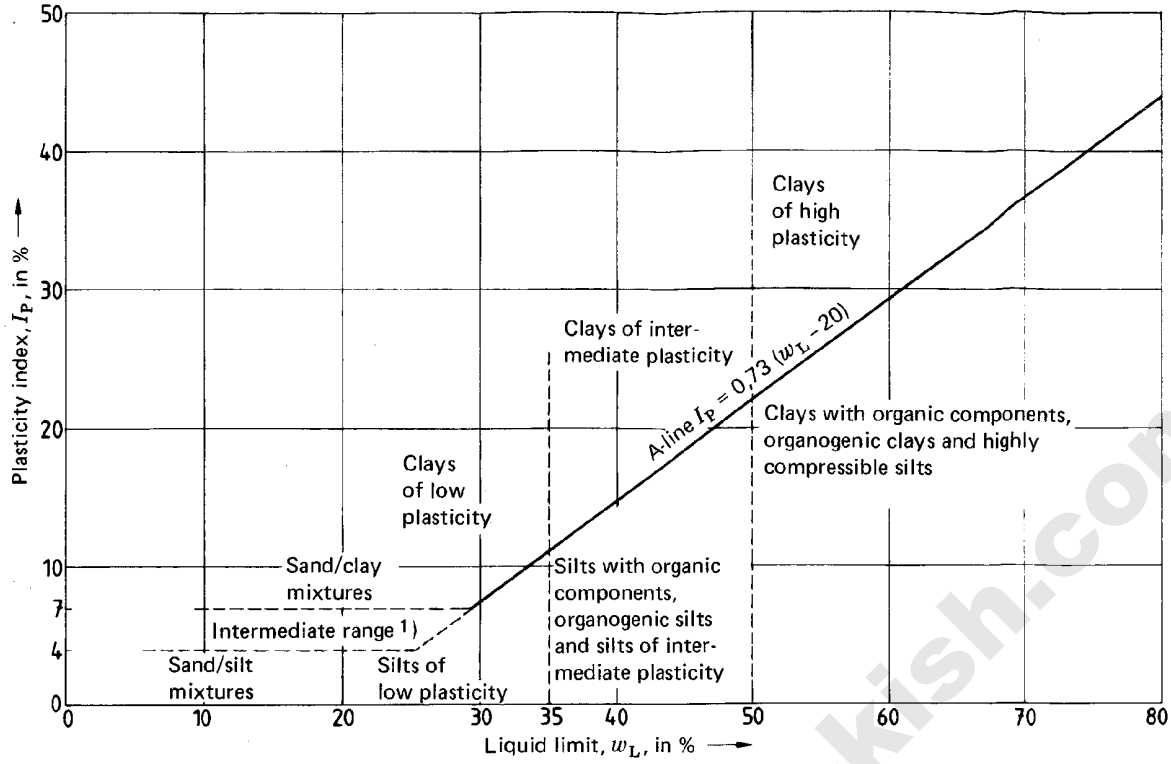

Figure. Plasticity chart for the classification of fine soils

3.6 Formation history

As regards the formation history of organic soils, a distinction is to be made between components that have developed and remained at one and the same location, such as peat (humus, denoted by H), and those deposited by water (denoted by F).

Deposits shall be classified as made ground if they consist of natural inorganic or organic soil material. Made ground formed of altered material (denoted by A) are deposits in which the nature of the material has been modified artificially.

The relevant soil groups shall be stated in square brackets.

3.7 Degree of decomposition

Peats are classed, according to the degree of decomposition, as

a) not decomposed to moderately decomposed (denoted by N).

and

b) decomposed (denoted by Z).

4 Classification of soil samples

A soil sample shall be assigned to a soil group on the basis of table 5 and given the symbol specified in column 7, the letter placed first denoting the dominant fraction and the second letter, any particular qualifying physical property, or the secondary fraction.

Unless the performance of laboratory tests is required, the soil group may be established visually or manually, in accordance with DIN 4022 Part 1.

Note. It should be noted that a number of soil types given in column 9 of table 5 (e.g. topsoil, mud, calcareous glacial and decalcified glacial till) may belong to different soil groups, depending on their composition.

The information given in columns 10 to 21 of table 5 permits a qualitative assessment of the engineering properties of soil and its suitability for particular applications but is not to be used for classification purposes.

1) Since the plasticity index of soils having a low liquid limit cannot be exactly established experimentally, soils of intermediate plasticity shall be classed as either clay or silt using different methods, e.g. those suggested in subclauses 8.5 to 8.9 of DIN 4022 Part 1, September 1987 edition.

Standards referred to

DIN 4022 Part 1	Subsoil and groundwater; classification and description of soil and rock; borehole logging of soil and rock not involving continuous core sample recovery
DIN 18 123	Soil analysis; determination of particle size distribution
DIN 18 300	Tendering and performance stipulations in contracts for construction works (VOB). Part C: General technical specifications in contracts for construction works (ATV); earthworks

Previous edition

DIN 18 196: 06.70.

Amendments

The following amendments have been made to the June 1970 edition.

a) Information regarding the engineering properties of soils and of their suitability for civil engineering purposes has been included.

b) The standard has been brought up to standards practice.

International Patent Classification

E 02 D 1/00
G 01 N 33/24