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GLOSSARY OF TERMS AND SYMBOLS RELATING TO SOIL ENGINEERING

(First Revision)

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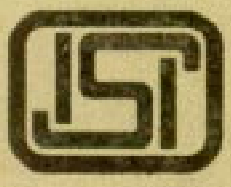

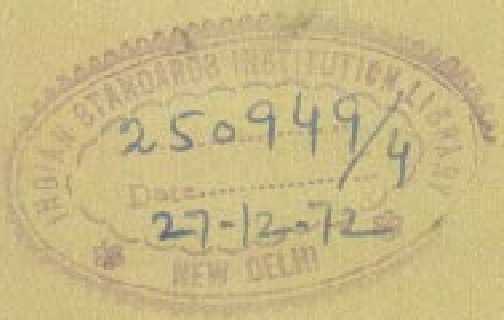

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Indian Standard

GLOSSARY OF TERMS AND SYMBOLS RELATING TO SOIL ENGINEERING

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 25 February 1972, after the draft finalized by the Soil Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 A series of Indian Standards covering soil testing, site investigation for foundations, etc, is being published; this includes a large number of terms relating to soil engineering. The extensive use of these terms has necessitated the preparation of this glossary.

0.3 This standard was first published in 1964. In this revision some new terms have been included; definitions of some terms already included have been changed and the physical dimensions are given in F, L and T instead of M, L and T.

0.4 A number of definitions include symbols, and the units of measurements are also indicated. The symbols appear immediately after the name of the term, followed by the unit in parentheses. No significance should be placed on the order in which the symbols are presented where two or more are given for an individual term. The physical dimensions of quantities are indicated by capital letters as follows:

F = Force
L = Length
T = Time
D = Dimensionless

0.4.1 Where synonymous terms are cross-referenced, the definition is included with the earlier term alphabetically. Where this is not the case, the later term is the more significant.

0.5 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by basing the standard on the following

publications:

ASTM D 653-67 Terms and symbols relating to soil and rock mechanics. American Society for Testing and Materials.

Progress report of the Committee on Definitions and Standards of the Soil Mechanics and Foundations Division. Proceedings of the American Society of Civil Engineers.

1. SCOPE

1.1 This standard covers definitions of terms relating to soil engineering. The symbols that are used to represent some of the terms are also given.

2. DEFINITIONS

2.1 Absorbed Water — Water held mechanically (by surface tension) in a soil mass and having physical properties not different from ordinary water at the same temperature and pressure.

2.2 Active Earth Pressure — *See* ' Earth Pressure '.

2.3 Active State of Plastic Equilibrium — *See* ' Plastic Equilibrium '.

2.4 Activity — Ratio of the plasticity index to the clay fraction.

2.5 Adhesion — Shearing resistance between soil and another material under zero externally applied pressure:

	Symbol	*Unit*
Unit adhesion	c_a	FL^{-2}
Total adhesion	C_a	F or FL^{-1}

2.6 Adobe — A light coloured clay and silt that has been deposited in shallow desert basins or lakes.

2.7 Adsorbed Water — Water in a soil mass, held by physico-chemical forces, having physical properties substantially different from absorbed or free water or chemically combined water at the same temperature and pressure.

2.8 Aeolian Deposits — Wind-deposited material, such as dune sands and loess deposits.

2.9 'A' Horizon — *See* ' Horizon '.

2.10 Air Entry Value — The minimum pressure of air or suction that destroys the capillary tension of water in the pores of a saturated porous stone.

2.11 Air-Space Ratio, G_a (D) — Ratio of volume of water that can be drained from a saturated soil under the action of the force of gravity to total volume of voids, as determined in a specified testing method.

2.12 Air Void Ratio e_a (D) — The ratio of the volume of air space to the volume of solids in a soil mass.

2.13 Allowable Bearing Pressure (Gross), q_a (*Gross*) (FL^{-2}) — The maximum allowable gross loading intensity on the ground in any given case, taking into account the maximum safe bearing capacity (gross), the amount and kind of settlement expected, and the ability of the given structure to take up this settlement. It is, therefore, a combined function of both the site conditions and characteristics of the particular structure it is proposed to erect thereon.

2.14 Allowable Bearing Pressure (Nett), q_a (*Nett*) (FL^{-2}) — The allowable bearing pressure (gross) minus the surcharge.

2.15 Allowable Pile Bearing Load (Allowable Load on Pile), Q_a (F) — The load which may be safely applied to a pile after taking into account its ultimate bearing resistance, pile spacing, overall bearing capacity of the ground below the piles and allowable settlement.

2.16 Alluvium — A general term for all detrital deposits resulting from the operation of rivers, thus including the sediments laid down in river beds, flood plains, lakes, fans at the foot of mountain slopes and estuaries. Unless otherwise indicated alluvium is unconsolidated.

2.17 Angle of Internal Friction (Angle of Shearing Resistance), ϕ (Degrees) — Angle between the abscissa and the tangent to the curve representing the relationship between the shearing resistance at failure to normal stress acting within a soil.

2.18 Angle of Obliquity, Ψ (Degrees) — The angle between the direction of the resultant stress or force acting on a given plane and the normal to that plane.

2.19 Angle of Repose, α (Degrees) — Angle between the horizontal and the maximum slope that a soil assumes through natural processes. For granular soils the effect of the height of slope is negligible; for cohesive soils the effect of height of slope is so great that the angle of repose is meaningless.

2.20 Angle of Wall Friction, δ — Angle between the abscissa and the tangent of the curve representing the relationship of shearing resistance to normal stress acting between soil and surface of another material.

2.21 Anisotropic Mass — A mass having different properties in different directions at any given point.

2.22 Apparent Cohesion — *See* ' Cohesion '.

2.23 Aquifer — A water bearing formation that provides a ground water reservoir.

2.24 Arching — The transfer of load by shear from a yielding part of a soil mass to adjoining less-yielding or restrained parts of mass.

2.25 Area of Influence of a Well, a (L^{-2}) — Area surrounding a well within which the piezometric surface has been lowered when pumping has produced the maximum steady rate of flow.

2.26 Area Ratio of a Sampling Spoon, Sampler or Sampling Tube, A_r (D) — The area ratio is an indication of the volume of soil displaced by the sampler in proportion to the volume of the sample, calculated as follows:

$$A_r\ (\%) = \frac{D_e^2 - D_i^2}{D_i^2} \times 100$$

where

D_e = maximum external diameter of the sampling spoon, and

D_i = minimum internal diameter of the sampling spoon at the cutting edge.

2.27 Base Course (Base) — A layer of specified or selected material of planned thickness constructed on the subgrade or sub-base for the purpose of serving one or more functions, such as distributing load, providing drainage and minimizing frost action.

2.28 Base Exchange — The physico-chemical process whereby one type of ions (cations) adsorbed on soil particles are replaced by another type. The base exchange capacity signifies the capacity of soil to retain bases up to its highest limit; it also defines the power of the soil to combine with base in such a manner that they cannot be easily removed by leaching with water, but can be exchanged by an equivalent amount of other bases. In other words it represents a limit beyond which the saloids would be highly hydrolyzed.

2.29 Bearing Capacity Factor (D) — Non-dimensional factors first proposed by Terzaghi for the computation of bearing capacity.

2.30 Bearing Capacity, Maximum Safe, q_o (FL^{-2}) — The maximum intensity of loading that the soil will safely carry with a factor of safety against shear failure irrespective of any settlement that may result.

2.31 Bearing Capacity of Pile, Ultimate, Q_p (F) — The load per pile required to produce a condition of failure.

2.32 Bearing Capacity, Ultimate — *See* ' Ultimate Bearing Capacity '.

2.33 Bearing Pressure, Allowable — *See* ' Allowable Bearing Pressure '.

2.34 Bedrock (Ledge) — Any *in-situ* solid rock below soil.

2.35 Bentonitic Clay (Bentonite) — A clay with a high content of the mineral montmorillonite, usually characterized by high swelling on wetting.

2.36 Berm — A shelf that breaks the continuity of a slope.

2.37 'B' Horizon — *See* 'Horizon'.

2.38 Black Cotton Soil — Black cotton soils are inorganic clays of medium to high compressibility and form a major soil group in India. They are predominantly montmorillonitic in structure and black or blackish grey in colour. They are characterized by high shrinkage and swelling properties.

2.39 Boglime (Lake Marl) — A white fine-grained powdery calcareous deposit precipitated by plant action, on the bottom of many ponds; also found in glaciated areas and closely associated with peat deposits.

2.40 Boulder — A more or less rounded block or fragment of rock and of average dimension 300 mm or greater. Usually boulders are rounded by being carried or rolled along by water or ice; sometimes also by weathering in place in which case they are known as boulders of weathering, disintegration or exploitation.

2.41 Bulb of Pressure — *See* 'Pressure Bulb'.

2.42 Bulking — The increase in volume of a material due to handling. Rock bulk upon excavation; damp sand bulks if loosely deposited, as by dumping, because the apparent cohesion prevents movement of the soil particles to form a reduced volume.

2.43 Caliche — Soil cemented by porous calcium carbonate.

2.44 California Bearing Ratio, CBR (D) — The ratio of the force per unit area required to penetrate a soil mass with a circular piston of 50 mm diameter at the rate of 1·25 mm/min to that required for corresponding penetration of a standard material. The ratio is usually determined for penetrations of 2·5 mm and 5 mm. Where the ratio at 5 mm is consistently higher than that at 2·5 mm, the ratio at 5 mm is used.

2.45 Capillary Action (Capillarity) — The rise or movement of water in the interstices of a soil due to capillary forces.

2.46 Capillary Flow — *See* 'Capillary Migration'.

2.47 Capillary Fringe Zone — The zone above the free water elevation in which water is held by capillary action.

2.48 Capillary Head, h (L) — The potential, expressed in head of water, that causes the water to flow by capillary action.

2.49 Capillary Migration (Capillary Flow) — The movement of water by capillary action.

2.50 Capillary Rise (Height of Capillary Rise), h_c (L) — The height above a free water elevation to which water will rise by capillary action.

2.51 Capillary Water — Water subject to the influence of capillary action.

2.52 Centrifuge Moisture Equivalent, CME — *See* 'Moisture Equivalent'.

2.53 'C' Horizon — *See* 'Horizon'.

2.54 Clay — An aggregate of microscopic and submicroscopic particles derived from the chemical decomposition and disintegration of rock constituents. It is plastic within a moderate to wide range of water content.

2.55 Clay Size — That portion of the soil finer than 0·002 mm.

2.56 Cobble — A rock fragment, usually rounded or semi-rounded, with an average dimension between 80 and 300 mm.

2.57 Coefficient of Absolute Viscosity — *See* 'Coefficient of Viscosity'.

2.58 Coefficient of Active Earth Pressure — *See* 'Coefficient of Earth Pressure'.

2.59 Coefficient of Compressibility (Coefficient of Compression) (a_v) ($L^2 F^{-1}$) — The secant slope, for a given pressure increment, of the effective pressure-void ratio curve.

2.60 Coefficient of Consolidation, c_v ($L^2 T^{-1}$) — A coefficient utilized in the theory of consolidation, containing the physical constants of a soil affecting its rate of volume change:

$$c_v = \frac{k\,(1+e)}{a_v\ \gamma_w}$$

where

k = coefficient of permeability, LT^{-1};

e = void ratio, D;

a_v = coefficient of compressibility, $L^2 F^{-1}$; and

γ_w = unit weight of water, FL^{-3}.

NOTE — In the literature published prior to 1935, the coefficient of consolidation, usually designated c, was defined by the equation:

$$c = \frac{k}{a_v\,\gamma_w\,(1+e)}$$

This original definition of the coefficient of consolidation may be found in some more recent papers and care should be taken to avoid confusion.

2.61 Coefficient of Curvature (C_c) — It is given by $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

where D_{10}, D_{30}, D_{60} are the diameters of particles corresponding to 10, 30, and 60 percent finer.

2.62 Coefficient of Earth Pressure, K (D) — The ratio between the lateral effective pressure and vertical effective pressure at any point in the soil mass.

2.62.1 *Coefficient of Earth Pressure, Active, K_A* (D) — The smallest value of the coefficient of earth pressure resulting when the soil expands laterally till failure.

2.62.2 *Coefficient of Earth Pressure, at Rest, K_o* (D) — Value of the coefficient of earth pressure when the soil is permitted neither to expand nor compress laterally.

2.62.3 *Coefficient of Earth Pressure, Passive, K_P* (D) — The maximum value of coefficient of earth pressure resulting when the soil is compressed laterally thereby inducing failure in the soil.

2.63 Coefficient of Permeability (Permeability), k (LT^{-1}) — The rate of flow of water under laminar flow conditions through a unit cross-sectional area of porous medium under a unit hydraulic gradient and standard temperature conditions (usually 27°C).

2.64 Coefficient of Subgrade Reaction (Modulus of Subgrade Reaction), k (FL^{-3}) — Ratio of load per unit area (applied through a centrally loaded rigid body) of horizontal surface of a mass of soil to corresponding settlement of the surface. It is determined as the slope of the secant drawn between the point corresponding to zero settlement and the point of 1·25 mm settlement, of a load-settlement curve obtained from a plate load test on a soil using a 75-cm or greater loading plate.

2.65 Coefficient of Uniformity, C_u (D) — The ratio D_{60}/D_{10}, where D_{60} is the particle diameter corresponding to 60 percent finer on the grain size curve and D_{10} is the particle diameter corresponding to 10 percent finer on the grain-size curve.

2.66 Coefficient of Viscosity (Coefficient of Absolute Viscosity), μ (FTL^{-2}) — The shearing force per unit area required to maintain a unit difference in velocity between two parallel layers of a fluid, a unit distance apart.

2.67 Coefficient of Volume Compressibility (Modulus of Volume Change), m_v ($L^{-2}F^{-1}$) — The compression of a soil layer per unit of original thickness due to a given unit increase in pressure. It is numerically

equal to the coefficient of compressibility divided by one plus the original void ratio, or

$$\frac{a_v}{1+e}$$

2.68 Cohesion, c (FL^{-2}) — The portion of the shear strength of a soil indicated by the term c, in Coulomb's equation, $s = c + p \tan \phi$.

2.68.1 *Cohesion, Apparent* — Cohesion in granular soils due to capillary forces.

2.69 Cohesionless Soil — A soil that when unconfined has little or no strength when air-dried and that has little or no cohesion when submerged.

2.70 Cohesive Soils — A soil that when unconfined has considerable strength when air-dried and that has significant cohesion when submerged.

2.71 Colloidal Particles — Soil particles that are so small that the surface activity has an appreciable influence on the properties of the mass. The physico-chemical forces dominate the gravitational forces.

2.72 Compaction — The densification of a soil by means of mechanical manipulation.

2.73 Compaction Curve (Moisture-Density Curve) — The curve showing the relationship between the dry unit weight (density) and the water content of a soil for a given compactive effort.

2.74 Compaction Test (Moisture-Density Test) — A laboratory compaction test procedure whereby a soil at a known water content is placed in a specified manner into a mould of given dimensions, subjected to a compactive effort of controlled magnitude and the resulting unit weight determined. The procedure is repeated for various water contents sufficient to establish a relation between water content and dry unit weight.

2.75 Compressibility — Property of a soil pertaining to its susceptibility to decrease in volume when subjected to load.

2.76 Compression Curve — *See* ' Pressure-Void Ratio Curve '.

2.77 Compression Index, C_c (D) — The slope of the linear portion of the pressure-void ratio curve on a semi-log plot, with pressure on the log scale.

2.78 Concentration Factor, n (D) — A parameter used in modifying the Bussinesq equations to describe various distributions of vertical stress.

2.79 Consistency — The degree of resistance offered by a fine grained soil to deformation.

2.80 Consistency Index (Relative Consistency), I_c (D) — Ratio of the liquid limit minus the natural water content to the plasticity

index of a soil:

$$I_c = \frac{w_L - w_o}{I_p}$$

where

w_L = liquid limit,

w_o = natural moisture content, and

I_p = plasticity index.

2.81 Consolidated-Drained Test (Slow Shear Test) — A soil test in which a soil specimen is first allowed to consolidate fully under an applied stress and shear stresses are then applied in such a manner that there is full dissipation of excess pore water pressure developed during shear.

2.82 Consolidated-Undrained Test (Consolidated Quick Test) — In this case, the soil is consolidated under applied normal loads but no drainage of water from the soil is permitted to take place during shear.

2.83 Consolidation — The gradual reduction in volume of a soil mass partly or fully saturated resulting from an increase in and continued application of compressive stress and is due to the expulsion of water from the pores.

2.83.1 *Initial Consolidation (Initial Compression)* — A comparatively sudden reduction in volume of a soil mass under an applied load due principally to expulsion and compression of gas in the soil voids preceding primary consolidation.

2.83.2 *Primary Consolidation (Primary Compression) (Primary Time Effect)* — The reduction in volume of a soil mass caused by the application of a sustained load to the mass and due principally to a squeezing out of water from the void spaces of the mass and accompanied by a transfer of the load from the soil water to the soil solids.

2.83.3 *Secondary Consolidation (Secondary Compression) (Secondary Time Effect)* — The reduction in volume of a soil mass caused by the application of a sustained load to the mass and due principally to the adjustment of the internal structure of the soil mass after most of the load has been transferred from the soil water to the soil solids.

2.84 Consolidation Curve — *See* 'Consolidation Time Curve'.

2.85 Consolidation Ratio, U_z (D) — The ratio of the amount of consolidation at a given point within the subsoil and at a given time to the total amount of consolidation obtainable at that point under a given stress increment.

2.86 Consolidation Test, One Dimensional — A test in which the specimen is laterally confined in a ring and is compressed between porous plates.

2.87 Consolidation Time Curve (Time Curve) (Consolidation Curve) (Theoretical Time Curve) — A curve that shows the relation between the degree of consolidation, and the elapsed time after the application of given increment of load.

2.88 Contact Pressure, p (FL^{-2}) — The soil reaction per unit area at the surface of contact between the foundation and the underlying soil mass, produced by the self weight of the foundation and all the forces acting on it.

2.89 Controlled Strain Test — A test in which the load is so applied that a controlled rate of strain results (a test in which a specific rate of deformation is applied and the reaction to this deformation is measured).

2.90 Controlled Stress Test — A test in which the stress to which a specimen is subjected is applied at a controlled rate.

2.91 Creep

a) Slow movement of soil and rock waste down slopes usually imperceptible except to observations of long duration.

b) The time dependent deformation behaviour of soil under constant compressive stress.

2.92 Critical Circle (Critical Surface) — The sliding surface assumed in a theoretical analysis of the stability of a soil mass for which the factor of safety is a minimum.

2.93 Critical Density — The unit weight of a saturated granular material below which it will lose strength and above which it will gain strength when subjected to rapid deformation.

2.94 Critical Height, H_c (L) — The maximum height at which a vertical or sloped bank of soil will stand unsupported under a given set of conditions.

2.95 Critical Hydraulic Gradient — *See* ' Hydraulic Gradient '.

2.96 Critical Slope — The maximum angle with the horizontal at which a sloped bank of soil of given height will stand unsupported.

2.97 Critical Surface — *See* ' Critical Circle '.

2.98 Critical Void Ratio, e_c (D) — Void ratio prior to the process of shear in which nett volume change at failure is zero.

2.99 Cryology — The study of the properties of snow ice and frozen ground.

2.100 Deflocculating Agent (Deflocculant) (Dispersing Agent) — An agent that prevents fine soil particles in suspension from coalescing to form flocs.

2.101 Degree of Compaction, D_c (D) — The ratio of dry density of compacted material in the field to the laboratory standard maximum dry density of the material multiplied by 100.

2.102 Degree of Consolidation (Percent Consolidation), U (D) — The ratio, expressed as a percentage of the amount of consolidation at a given time, within a soil mass to the total amount of consolidation obtainable under a given stress condition.

2.103 Degree of Saturation (Percent Saturation), S_r (D) — The ratio, expressed as a percentage, of the volume of water in a given soil mass to the total volume of voids.

2.104 Density — *See* ' Unit Weight '.

NOTE — Although it is recognized that density is defined as mass per unit volume, in the field of soil mechanics the term is frequently used in place of unit weight.

2.105 Density Index (Relative Density) (Degree of Density), I_D (D) — The ratio of the difference between the void ratio of a cohesionless soil in the loosest state and any given void ratio, to the difference between its void ratios in the loosest and in the densest states:

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100$$

where

e_{max} = void ratio in loosest state,

e = void ratio in the field, and

e_{min} = void ratio in its densest state obtainable in the laboratory.

2.106 Deviator Stress σd (FL^{-2}) — The difference between the major and minor principal stresses in a triaxial test.

2.107 Dilatancy — The expansion of cohesionless soils when subject to shearing deformation.

2.108 Direct Shear Test — A shear test in which soil under an applied normal load is stressed to failure by moving one section of the soil container (shear box) relative to the other section.

2.109 Discharge Velocity, v (LT^{-1}) — Rate of discharge of water through a porous medium per unit of total area perpendicular to the direction of flow.

2.110 Dispersing Agent — *See* ' Deflocculating Agent '.

2.111 Drawdown (L) — Vertical distance the free water elevation is lowered, or the reduction of the pressure head due to the removal of free water.

2.112 Dry Density (Dry Unit Weight), γ_d **(FL^{-3})** — The weight of oven dry soil per unit volume of soil mass.

2.113 Earth Pressure — The pressure or force exerted by soil on any boundary:

	Symbol	*Unit*
Pressure	p	FL^{-2}
Force	P	F or FL^{-1}

2.113.1 *Active Earth Pressure,* P_A, p_A — The minimum value of earth pressure. This condition exists when a soil mass is permitted to yield sufficiently to cause its internal shearing resistance along a potential failure surface to be completely mobilized.

2.113.2 *Earth Pressure at Rest,* P_o, p_o — The value of the earth pressure when the soil mass is in its natural state without having been permitted to yield or without having been compressed.

2.113.3 *Passive Earth Pressure,* P_p, p_p — The maximum value of earth pressure. This condition exists when a soil mass is compressed sufficiently to cause its internal shearing resistance along a potential failure surface to be completely mobilized.

2.114 Effective Diameter (Effective Size), D_{10} **(L)** — Particle diameter corresponding to 10 percent finer on the grain-size curve.

2.115 Effective Drainage Porosity — *See* 'Effective Porosity'.

2.116 Effective Force, $\bar{F}$ **(F)** — The force transmitted through a soil mass by inter-granular pressures.

2.117 Effective Porosity (Effective Drainage Porosity), n_e **(D)** — The ratio of the volume of the voids of a soil mass that can be drained by gravity to the total volume of the mass.

2.118 Effective Pressure — *See* 'Stress'.

2.119 Effective Size — *See* 'Effective Diameter'.

2.120 Effective Stress — *See* 'Stress'.

2.121 Effective Unit Weight — *See* 'Unit Weight'.

2.122 Elastic State of Equilibrium — State of stress within a soil mass when the internal resistance of the mass is not fully mobilized.

2.123 Equipotential Line — Line joining various points in a soil mass at which the piezometric head is the same (that is, water will rise to the same elevation in piezometric tubes).

2.124 Equivalent Diameter (Equivalent Size), *D* (L) — The diameter of a hypothetical sphere composed of material having the same specific gravity as that of the actual soil particle and of such size that it will settle in a given liquid at the same terminal velocity as the actual soil particle.

2.125 Equivalent Fluid — A hypothetical fluid having a unit weight such that it will produce a pressure against a lateral support presumed to be equivalent to that produced by the actual soil. This simplified approach is valid only when deformation conditions are such that the pressure increases linearly with depth and the wall friction is neglected.

2.126 Excess Hydrostatic Pressure — *See* ' Hydrostatic Pressure '.

2.127 Exchange Capacity (Base Exchange Capacity) — The capacity to exchange ions as measured by the quantity of exchangeable ions in a soil.

2.128 Failure by Rupture — *See* ' Shear Failure '.

2.129 Field Moisture Equivalent — *See* ' Moisture Equivalent '.

2.130 Filter (Protective Filter) — A layer or combination of layers of pervious materials designed and installed in such a manner as to provide drainage, yet prevent the movement of soil particles due to percolating water.

2.131 Fines — Portion of a soil finer than a 75-micron IS Sieve.

2.132 Floc — Loose, open-structured mass formed in a suspension by the aggregation of minute particles.

2.133 Flocculation — The process of forming flocs.

2.134 Flocculent Structure — *See* ' Soil Structure '.

2.135 Flow Channel — The portion of a flow net bounded by two adjacent flow lines.

2.136 Flow Curve — The locus of points obtained from a standard liquid limit test using the mechanical device and plotted on a graph representing water content as ordinate on an arithmetic scale and the number of drops as abscissa on a logarithmic scale.

2.137 Flow Failure — Failure in which a soil mass moves over relatively long distances in a fluid-like manner.

2.138 Flow Index, I_f (D) — The slope of the flow curve obtained from a liquid limit test using the mechanical device (given by the difference in water contents at 10 blows and at 100 blows).

2.139 Flow Line — The path that a particle of water follows in its course of seepage under laminar flow conditions.

2.140 Flow Net — A graphical representation of flow lines and equipotential lines used in the study of seepage phenomena.

2.141 Flow Slide — The failure of a sloped bank of soil in which the movement of the soil mass does not take place along a well-defined surface of sliding.

2.142 Flow Value, N_ϕ (Degrees) — A quantity equal to $\tan^2\left(45° + \frac{\phi}{2}\right)$, where ϕ is the angle of internal friction of soil.

2.143 Footing — A spread constructed in brickwork, masonry or concrete under the base of a wall or column for the purpose of distributing the load over a larger area.

2.144 Foundation — That part of the structure which is in direct contact with and transmits loads to the ground.

2.145 Free Water (Gravitational Water) (Ground Water) (Phreatic Water) — Water that is free to move through a soil mass under the influence of gravity.

2.146 Free Water Elevation (Water Table) (Ground Water Surface) (Free Water Surface) (Ground Water Elevation) — Elevations at which the pressure in the ground water is zero with respect to the atmospheric pressure.

2.147 Frost Action — Freezing and thawing of moisture in materials and the resultant effects on these materials and on structures of which they are a part or with which they are in contact.

2.148 Frost Boil

a) Softening of soil occurring during a thawing period due to the liberation of water from ice lenses or layers.

b) The hole formed in flexible pavements by the extrusion of soft soil and melt waters under the action of wheel loads.

c) Breaking of a highway or airfield pavement under traffic and the ejection of subgrade soil in a soft and soupy condition caused by the melting of ice lenses formed by frost action.

2.149 Frost Heave — The raising of a surface due to the accumulation of ice in the underlying soil.

2.150 General Shear Failure — *See* 'Shear Failure'.

2.151 Glacial Till (Till) — Generally unstratified, unconsolidated and heterogenous mixture of clay, sand, gravel and boulders, deposited directly

by glacier-ice, not by glacier waters, though it may be locally modified by them. It may be

a) englacial (carried within the ice mass),

b) superglacial (borne on the ice surface), or

c) subglacial (dragged along beneath the glacier).

2.152 Gradation (Grain-Size Distribution) (Soil Texture) — Proportion of material of each grain size present in a given soil.

2.153 Grain-Size Analysis (Mechanical Analysis) — The process of determining gradation.

2.154 Gravel — Angular, rounded or semi-rounded particles of rock or soil of particle size between 4·75 mm and 80 mm.

2.155 Gravitational Water — *See* ' Free Water '.

2.156 Ground Water — *See* ' Free Water '.

2.157 Ground Water Elevation — *See* ' Free Water Elevation '.

2.158 Ground Water Surface — *See* ' Free Water Elevation '.

2.159 Hardpan — Layer of extremely dense soil.

NOTE — Hardpan is a formation which forms by precipitation of dissolved materials, such as calcium carbonate or silica at depths below the surface year after year. When this accumulation takes place, the subsoil is more or less firmly cemented and limits downward movement of water. This formation does not soften when wetted with water.

2.160 Heave — Upward movement of soil caused by expansion or displacement resulting from phenomena, such as moisture absorption, removal of overburden, driving of piles, frost action and hydrostatic pressure.

2.161 Height of Capillary Rise — *See* ' Capillary Rise '.

2.162 Homogeneous Mass — A mass that exhibits essentially the same physical properties at every point throughout the mass.

2.163 Honeycomb Structure — *See* ' Soil Structure '.

2.164 Horizon (Soil Horizon) — One of the layers of the soil profile, distinguished principally by its texture, colour, structure and chemical content.

2.164.1 ' *A* ' *Horizon* — The uppermost layer of a soil profile from which inorganic colloids and other soluble materials have been leached. Usually contains remnants of organic matter.

2.164.2 ' *B* ' *Horizon* — The layer of a soil profile in which material leached from the overlying ' A ' horizon is accumulated.

2.164.3 '*C*' *Horizon* — Undisturbed parent material from which the overlying soil profile has been developed.

2.165 Humus — A brown or black material formed by the partial decomposition of vegetable or animal matter; the organic portion of soil.

2.166 Hydraulic Gradient, *i*, *s* (D) — The difference or drop of hydraulic head per unit distance of flow, $\frac{dh}{dL}$

2.166.1 *Critical Hydraulic Gradient*, i_c (D) — Hydraulic gradient at which the inter-granular pressure in a mass of cohesionless soil is reduced to zero by the upward flow of water.

2.167 Hydrostatic Pressure, u_0 (FL^{-2}) — The pressure in a liquid under static conditions; the product of the unit weight of the liquid and the difference in elevation between the given point and the free water elevation.

2.167.1 *Excess Hydrostatic Pressure* (*Hydrostatic Excess Pressure*), $\bar{u}, u$ (FL^{-2}) — The pressure that exists in pore water in excess of the hydrostatic pressure.

2.168 Hygroscopic Capacity (Hygroscopic Coefficient), w_0 (D) — Ratio of the weight of water absorbed by a dry soil in a saturated atmosphere at a given temperature to the weight of the oven-dried soil.

2.169 Hygroscopic Water Content, w_H (D) — The water content of an air-dried soil.

2.170 Initial Consolidation (Initial Compression) — *See* 'Consolidation'.

2.171 Inorganic Silt — *See* 'Silt'.

2.172 Intergranular Pressure — *See* 'Stress'.

2.173 Intermediate Principal Plane — *See* 'Principal Plane'.

2.174 Intermediate Principal Stress — *See* 'Stress'.

2.175 Isochrone — A curve showing the distribution of the excess hydrostatic pressure in a soil layer or strata at a given time during a process of consolidation.

2.176 Isotropic Mass — A mass having the same property (or properties) in all directions.

2.177 Kaolin — A variety of clay containing a high percentage of kaolinite.

2.178 Laminar Flow (Streamline Flow) (Viscous Flow) — That type of flow in which the path of any particle is not intersected by that of the other particle and in which head loss is proportional to the first power of the velocity.

2.179 Landslide (Landslip) (Slide) — The failure of a sloped bank of soil hillside, or mass of rock or soil, in which movement of the mass takes place.

2.180 Leaching — The removal of soluble soil elements and colloids by percolating water.

2.181 Ledge — *See* ' Bedrock '.

2.182 Linear Expansion, L_E (D) — The increase in one dimension of soil mass, expressed as a percentage of that dimension at the shrinkage limit, when the water content is increased from the shrinkage limit to any given water content.

2.183 Linear Shrinkage, L_s (D) — Decrease in one dimension of a soil mass, expressed as a percentage of the original dimension, when the water content is reduced from a given value to the shrinkage limit.

2.184 Line of Creep — The path that water follows along the surface of contact between the foundation soil and the base of a hydraulic or other structure.

2.185 Line, Phreatic — *See* ' Phreatic Line '.

2.186 Liquidity Index (Water-Plasticity Ratio) (Relative Water Content), I_L (D) — The ratio, expressed as a percentage, of the natural water content of a soil minus its plastic limit to its plasticity index.

2.187 Liquid Limit, w_L — The water content, expressed as a percentage of the weight of the oven dry soil, at the boundary between liquid and plastic states of consistency of soil.

NOTE — For the purpose of determination of liquid limit, it is defined as the water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 12 mm under the impact of 25 blows in a standard liquid limit apparatus; or as the water content of a soil paste, prepared in a specified mould, into which a cone of specified dimensions and weight penetrates by 25 mm when dropped onto the paste in a specified manner.

2.188 Loam — A soil containing sand, silt and clay, or a combination of any of these, with or without organic matter.

2.189 Local Shear Failure — *See* ' Shear Failure '.

2.190 Loess — A uniform, acolian deposit of silty material having an open structure and relatively high cohesion due to cementation of clay or calcarous material at grain contacts. A characteristic of loess deposits is that they can stand with nearly vertical slopes.

2.191 Made-up Ground — Refuse, excavated soil or rock deposited for the purpose of filling a depression or raising a site above the natural surface level of the ground.

2.192 Major Principal Plane — *See* 'Principal Plane'.

2.193 Major Principal Stress — *See* 'Stress'.

2.194 Mass Unit Weight — *See* 'Unit Weight'.

2.195 Mechanical Analysis — *See* 'Grain-Size Analysis'.

2.196 Minor Principal Plane — *See* 'Principal Plane'.

2.197 Minor Principal Stress — *See* 'Stress'.

2.198 Modulus of Elasticity (Modulus of Deformation), E (FL^{-2}) — The ratio of stress to strain for a material under given loading conditions; numerically equal to the slope of the tangent or the secant of a stress-strain curve. The use of the term Modulus of Elasticity is recommended for materials that deform in accordance with Hooke's law; the term Modulus of Deformation for materials that deform otherwise.

2.199 Modulus of Subgrade Reaction — *See* 'Coefficient of Subgrade Reaction'.

2.200 Modulus of Volume Change — *See* 'Coefficient of Volume Compressibility'.

2.201 Mohr Circle — A graphical representation of the stresses acting on the various planes at a given point.

2.202 Mohr Envelope (Rupture Envelope) (Failure Envelope) (Rupture Line) — The envelope of a series of Mohr circles representing stress conditions at failure for a given material. According to Mohr rupture hypothesis, a rupture envelope is the locus of points the co-ordinates of which represent the combinations of normal and shearing stresses that will cause a given material to fail.

2.203 Moisture Content (Water Content), w (D) — The ratio expressed as a percentage of the weight of water in a given soil mass to the weight of solid particles under a specified testing condition.

2.204 Moisture-Density Curve — *See* 'Compaction Curve'.

2.205 Moisture-Density Test — *See* 'Compaction Test'.

2.206 Moisture Equivalent

2.206.1 *Centrifuge Moisture Equivalent, W_c CME* (D) — The water content of a soil after it has been saturated with water and then subjected for one hour to a force equal to 1 000 times that of gravity.

2.206.2 *Field Moisture Equivalent,* FME — The minimum water content expressed as a percentage of the weight of the oven-dried soil, at which a drop of water placed on a smoothed surface of the soil will not

immediately be absorbed by the soil but will spread out over the surface and give it a shiny appearance.

2.207 Moraine — Used to designate unstratified glacial deposit (that has not been subjected to the sorting action of water) consisting of stiff clay (rock flour) packed with subangular stones varying in size range from clay to boulders.

2.208 Muck — An organic soil of very soft consistency.

2.209 Mud — A mixture of soil and water in a fluid or weak solid-state.

2.210 Neutral Stress — *See* ' Stress '.

2.211 Normally Consolidated Soil Deposit — A soil deposit that has never been subjected to an effective pressure greater than the existing effective overburden pressure.

2.212 Normal Stress — *See* ' Stress '.

2.213 Optimum Water Content (Optimum Moisture Content w_o (D) — The water content at which a soil can be compacted to the maximum dry unit weight by a given compactive effort.

2.214 Organic Silt — A silt with high organic content.

2.215 Organic Soil — Soil with high organic content. In general, organic soils are very compressible and have poor load sustaining properties.

2.216 Over-Consolidated Soil Deposit — A soil deposit that has been subjected to an effective pressure greater than the present effective over burden pressure.

2.217 Parent Material — Material from which a soil has been derived.

2.218 Passive Earth Pressure — *See* ' Earth Pressure '.

2.219 Passive State of Plastic Equilibrium — *See* ' Plastic Equilibrium '.

2.220 Peat — A fibrous mass of organic matter in various stages of decomposition generally dark brown to black in colour and of spongy consistency.

2.221 Penetration Resistance, P_R — Force required to produce a given penetration into soil of a pile, casing, sampling tube or penetrometer.

2.222 Penetration Resistance Curve (Penetration Curve) — The curve showing the relationship between the penetration resistance and the water content.

2.223 Percentage Air Voids, n_a — Volume of air in a soil mass to the total volume of the soil mass.

2.224 Percent Compaction — The ratio expressed as a percentage of dry unit weight of a soil to maximum dry unit weight obtained in the laboratory compaction test over the same soil.

2.225 Percent Consolidation — *See* ' Degree of Consolidation '.

2.226 Percent Saturation — *See* ' Degree of Saturation '.

2.227 Perched Water Table — A water table usually of limited area maintained above the normal free water elevation by the presence of an intervening relatively impervious confining stratum.

2.228 Percolation — *See* ' Seepage '.

2.229 Permafrost — Perennially frozen soil.

2.230 Permeability — The property of soil which permits percolation.

2.231 *p*H (D) — The *p*H value of hydrogen-ion concentration is a measure of the acidity or alkalinity (basicity) of a soil. It is expressed as follows:

$$pH = \log \frac{1}{(H^+)}$$

where

H^+ = the hydrogen-ion concentration in moles/l.

2.232 Phreatic Line — The upper free water surface of the zone of seepage.

2.233 Phreatic Surface — *See* ' Free Water Elevation '.

2.234 Phreatic Water — *See* ' Free Water '.

2.235 Piezometer — An instrument for measuring pressure in the pore fluid.

2.236 Piezometric Surface — The surface at which water will stand in a series of piezometers.

2.237 Pile — Relatively slender structural element which is driven, or otherwise introduced, into the soil, usually for the purpose of providing vertical or lateral support.

2.238 Piping — The movement of soil particles by percolating water leading to internal erosion and the development of channels in the soil mass.

2.239 Plastic Deformation — *See* ' Plastic Flow '.

2.240 Plastic Equilibrium — State of stress within a soil mass or a portion thereof, which has been deformed to such an extent that its ultimate shearing resistance is mobilized.

2.240.1 *Active State of Plastic Equilibrium* — Plastic equilibrium obtained by an expansion of a mass.

2.240.2 *Passive State of Plastic Equilibrium* — Plastic equilibrium obtained by a compression of a mass.

2.241 Plastic Flow (Plastic Deformation) — The deformation of a material beyond the point of recovery, accompanied by continuing deformation with no further increase in stress.

2.242 Plasticity — The property of a soil which allows it to the deformed beyond the point of recovery without cracking or appreciable volume change.

2.243 Plasticity Index, I_p (D) — Numerical difference between the liquid limit and the plastic limit.

2.244 Plastic Limit, w_p (D) — The water content, expressed as a percentage of the weight of oven dry soil, at the boundary between the plastic and the semi-solid states of consistency of the soil.

NOTE — For purposes of determination, plastic limit is defined as the water content at which a soil will just begin to crumble when rolled into a thread approximately 3 mm in diameter.

2.245 Plastic Range (Plastic State) — The range of consistency within which a soil exhibits plastic properties. The water content in this range varies between the liquid limit and the plastic limit.

2.246 Plastic Soil — A soil that exhibits plasticity.

2.247 Pore Pressure (Pore Water Pressure) — *See* 'Neutral Stress' under 'Stress'.

2.248 Pore Pressure Coefficients (D) — The change in pore pressure due to changes in applied stresses is expressed in terms of empirical coefficients known as pore pressure coefficients.

2.249 Porosity, n (D) — The ratio, usually expressed as a percentage, of the volume of voids of a given soil mass, to the total volume of the soil mass.

2.250 Potential Drop, $\triangle h$ (L) — The difference in pressure head between two equipotential lines.

2.251 Preconsolidation Pressure (Prestress), p_0 (FL^{-2}) — The maximum effective pressure to which a soil has been subjected.

2.252 Pressure, p (FL^{-2}) — The load divided by the area over which it acts.

2.253 Pressure Bulb — The zone in a loaded soil mass bounded by an arbitrarily selected isobar of stress.

2.254 Pressure Void Ratio Curve (Compression Curve) — A curve representing the relationship between effective pressure and void ratio of a soil as obtained from a consolidation test. The curve has a characteristic shape when plotted on a semilog paper with pressure on the log-scale.

2.255 Primary Consolidation (Primary Compression) (Primary Time Effect) — *See* 'Consolidation'.

2.256 Principal Plane — Each of three mutually perpendicular planes through a point in a soil mass on which the sheering stress is zero.

2.256.1 *Intermediate Principal Plane* — The plane normal to the direction of the intermediate principal stress.

2.256.2 *Major Principal Plane* — The plane normal to the direction of the major principal stress.

2.256.3 *Minor Principal Plane* — The plane normal to the direction of the minor principal stress.

2.257 Principal Stress — *See* ' Stress '.

2.258 Profile — *See* ' Soil Profile '.

2.259 Progressive Failure — Failure in which the ultimate shearing resistance is progressively mobilized along the failure surface.

NOTE — In progressive failure, the ultimate sheering resistance may be considerably less than the peak shearing resistance.

2.260 Protective Filter — *See* ' Filter '.

2.261 Quick Condition (Quick Sand) — Condition in which water is flowing upwards with sufficient velocity to reduce the shear resistance of the soil through a decrease in inter-granular pressure.

2.262 Quick Test — *See* ' Unconsolidated-Undrained Test '.

2.263 Radius of Influence of a Well (L) — Distance from the centre of well to the closest point at which the piezometric surface is not lowered when pumping has produced the maximum steady rate of flow.

2.264 Relative Consistency — *See* ' Consistency Index '.

2.265 Relative Density — *See* ' Density Index '.

2.266 Remoulded Soil — Soil that has had its natural structure modified by manipulation.

2.267 Residual Soil — Soil formed by the in-situ weathering of the parent rock.

2.268 Rock — Natural solid mineral matter connected by strong and permanent cohesive forces, occurring in large masses or fragments.

2.269 Rock Flour — *See* ' Silt '.

2.270 Rupture Envelope (Rupture Line) — *See* ' Mohr Envelope '.

2.271 Sand — Cohesionless aggregates of angular, sub-angular, sub-rounded, rounded, flaky or flat fragments of more or less unaltered rocks, or mineral of size between 4·75 mm and 75 microns.

2.272 Sand Boil — The loosening and lifting up of soil particles due to quick conditions prevailing in the soil mass.

2.273 Saturated Unit Weight — *See* ' Unit Weight '.

2.274 Saturation Curve — *See* ' Zero Air Voids Curve '.

2.275 Secondary Consolidation (Secondary Compression) (Secondary Time Effect) — *See* ' Consolidation '.

2.276 Seepage (Percolation) — Slow movement of gravitational water through the soil.

2.277 Seepage Force, f (F) — The force transmitted to the soil grains by seepage.

2.278 Seepage Line — The path that water follows during seepage.

2.279 Seepage Velocity v_s (LT^{-1}) — The rate of discharge of seepage water through a porous medium per unit area of void space perpendicular to the direction of flow.

2.280 Sensitivity — The ratio of the unconfined compressive strength of an undisturbed specimen of the soil to the unconfined compressive strength of specimen of the same soil after remoulding at unaltered water content. The effect of remoulding on the consistency of a cohesive soil.

2.281 Shaking Test — A test used to indicate the presence of singificant amounts of rock flour, silt, or very fine sand in a fine grained soil. It consists of shaking a pat of wet soil, having a consistency of thick paste, in the palm of the hand observing the surface for a glossy or livery appearance, then squeezing the pat, and observing if a rapid apparent drying and subsequent cracking of the soil occurs.

2.282 Shear Failure (Failure by Rupture) — Failure in which movement caused by shearing stresses in a soil mass is of sufficient magnitude to destroy or seriously endanger a structure.

2.282.1 *General Shear Failure* — Failure in which the ultimate strength of the soil is mobilized along the entire potential surface of sliding.

2.282.2 *Local Shear Failure* — Failure in which the ultimate shearing strength of the soil is mobilized only locally along the potential surface of sliding.

2.283 Shear Strength, s **(FL^{-2})** — The maximum resistance of a soil to shearing stresses.

2.284 Shear Stress (Shearing Stress) (Tangential Stress) — *See* ' Stress '.

2.285 Shrinkage Index, I_s**, (D)** — The numericald ifference between the plastic and shrinkage limit (remoulded soil).

2.286 Shrinkage Limit (Remoulded Soil), w_s **(D)** — The maximum water content expressed as percentage of oven-dry weight at which any further reduction in water content will not cause a decrease in volume of the soil mass, the soil mass being prepared initially from remoulded soil.

2.287 Shrinkage Limit (Undisturbed Soil) w_{su} **(D)** — The maximum water content expressed as percentage of oven-dry weight at which any further reduction in water content will not cause a decrease in volume of the soil mass, the soil mass being initially of soil in its undisturbed state.

2.288 Shrinkage Ratio, R **(D)** — The ratio of a given volume change, expressed as a percentage of the dry volume, to the corresponding change in water content above the appropriate shrinkage limit, expressed as a percentage of the weight of the oven-dried soil.

2.289 Silt (Inorganic Silt) (Rock Flour) — Fine-grained soil or fine-grained portion of soil which exhibits a little or no plasticity and has a little or no strength when air dried.

2.290 Silt Size — The portion of a soil finer than 75-micron IS Sieve and coarser than 0·002 mm and exhibiting properties indicated in **2.289**.

2.291 Single-Grained Structure — *See* ' Soil Structure '.

2.292 Skin Friction, f **(FL^{-2})** — The frictional resistance developed between soil and a structure.

2.293 Slaking — The process of breaking up or sloughing when an indurated soil is immersed in water.

2.294 Slow Test — *See* ' Consolidated-Drained Test '.

2.295 Soil (Earth) — Sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter.

2.296 Soil, Black Cotton — *See* ' Black Cotton Soil '.

2.297 Soil-Forming Factors — Factors, such as parent material, climate, vegetation, topography, organism and time involved in the transformation of an original geologic deposit into a soil profile.

2.298 Soil Horizon — *See* ' Horizon '.

2.299 Soil Mechanics — That branch of engineering which deals with the application of soil science, the static and dynamic laws and principles of mechanics and hydraulics to engineering problems dealing with soil as structural material.

2.300 Soil Profile (Profile) — Vertical section of a soil, showing the nature and sequence of the various layers, as developed by deposition or weathering, or both.

2.301 Soil Stabilization — Chemical or mechanical treatment designed to increase or maintain the stability of a mass of soil or otherwise to improve its engineering properties.

2.302 Soil Structure — Arrangement of soil particles in soil mass.

2.302.1 *Flocculent Structure* — An arrangement composed of flocs of soil particles instead of individual soil particles.

2.302.2 *Honeycomb Structure* — An arrangement of soil particles having a comparatively loose, stable structure resembling a honeycomb.

2.302.3 *Single-Grained Structure* — An arrangement composed of individual soil particles, characteristic structure of coarse-grained soils.

2.303 Soil Suspension — Highly diffused mixture of soil and water.

2.304 Soil Texture — *See* ' Gradation '.

2.305 Specific Gravity

2.305.1 *Apparent Specific Gravity*, G_a (D) — Ratio of the weight in air of a given volume of the impermeable portion of a permeable material (that is, the solid matter including its impermeable pores or voids) at a stated temperature, to the weight in air of an equal volume of distilled water at the stated temperature.

2.305.2 *Bulk Specific Gravity (Specific Mass Gravity)*, G_m (D) — Ratio of the weight in air of a given volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature, to the weight in air of an equal volume of distilled water at the stated temperature.

2.305.3 *Specific Gravity of Solids*, G (D) — Ratio of the weight in air of given volume of soil solids at a stated temperature, to the weight in air of an equal volume of distilled water at the stated temperature.

2.306 Specific Surface (L^{-1}) — The surface area per unit volume of soil particles.

2.307 Stability Number, N_s (D) — A pure number used in the analysis of the stability of a soil embankment, defined by the following equation:

$$N_s = \frac{c_d}{\gamma_c H_c}$$

where

c_d = mobilized cohesion,

γ_e = effective unit weight, and

H_c = critical height of the sloped bank.

2.308 Stability Factor (D) — It is the reciprocal of the stability number.

2.309 Stabilization — *See* ' Soil Stabilization '.

2.310 Standard Compaction — *See* ' Compaction Test '.

2.311 Standard Penetration Resistance — Number of blows required for 30 cm penetration of a standard sampling spoon with a 65 kg hammer falling freely through a height of 75 cm.

2.312 Strain, ε, e **(D)** — The change in length per unit of length in a given direction.

2.313 Streamline Flow — *See* ' Laminar Flow '.

2.314 Stress, σ, p, f **(FL^{-2})** — The force per unit area acting within the soil mass.

2.314.1 *Effective Stress* (*Effective Pressure*) (*Inter-granular Pressure*), $\bar{\sigma}$, $\bar{f}$ (FL^{-2}) — The average normal force per unit area transmitted from grain to grain of a soil mass. It is the stress which to a large extent controls the mechanical behaviour of a soil.

2.314.2 *Neutral Stress* (*Pore Pressure*) (*Pore Water Pressure*), u, u_w (FL^{-2}) — Stress transmitted through the pore water (water filling the voids of the soil).

2.314.3 *Normal Stress*, σ, p (FL^{-2}) — The stress component normal to a given plane.

2.314.4 *Principal Stress*, σ_1, σ_2, σ_3 (FL^{-2}) — Stresses acting normal to three mutually perpendicular planes intersecting at a point in a body, on which the shearing stress is zero.

2.314.4.1 *Intermediate principal stress*, σ_2 (FL^{-2}) — The principal stress whose value is neither the largest nor the smallest (with regard to sign) of the three.

2.314.4.2 *Major principal stress*, σ_1 (FL^{-2}) — The largest (with regard to sign) principal stress.

2.314.4.3 *Minor principal stress*, σ_3 (FL^{-2}) — The smallest (with regard to sign) principal stress.

2.314.5 *Shear Stress* (*Shearing Stress*) (*Tangential Stress*), τ, s (FL^{-2}) — The stress component tangential to a given plane.

2.314.6 *Total Stress*, σ, f (FL^{-2}) — The total force per unit area acting within a mass of soil. It is the sum of the neutral and effective stresses.

2.315 Structure — *See* ' Soil Structure '.

2.316 Sub-base — A layer used in a pavement system between the subgrade and base course, or between the subgrade and cement concrete pavement.

2.317 Subgrade — The soil prepared and compacted to support the pavement system.

2.318 Subgrade Surface — The surface of the earth or rock prepared to support the pavement system.

2.319 Submerged Unit Weight — *See* ' Unit Weight '.

2.320 Subsoil

a) Soil below a subgrade or fill.

b) That part of a soil profile occurring below 'A' horizon.

2.321 Talus — Rock fragments mixed with soil at the foot of a natural slope from which they have been separated.

2.322 Tangential Stress — *See* ' Stress '.

2.323 Theoretical Time Curve — *See* ' Consolidation Time Curve '.

2.324 Thermo-Osmosis — The process by which water is caused to flow in the pores of a soil mass due to differences in temperature within the mass.

2.325 Thixotropy — It is the property of certain clays by virtue of which they regain, on standing for a short time, a part of the original strength lost due to remoulding, at unaltered moisture content.

2.326 Till — *See* ' Glacial Till '.

2.327 Time Curve — *See* ' Consolidation Time Curve '.

2.328 Time Factor, T_v, T (D) — Dimensional factor, utilized in the theory of consolidation, containing the physical constants of a soil stratum influencing its time-rate of consolidation, expressed as follows:

$$T = \frac{k\,(1+e)\,t}{a_v\,\gamma_w \cdot H^2} = \frac{c_v \cdot t}{H^2}$$

where

k = coefficient of permeability (LT^{-1});

e = void ratio (dimensionless);

t = elapsed time that the stratum has been consolidated (T);

a_v = coefficient of compressibility (L^2F^{-1});

γ_w = unit weight of water (FL^{-3});

c_v = coefficient of consolidation ($L^2 T^{-1}$); and

H = thickness of stratum drained on one side only. If stratum is drained on both sides, its thickness equals $2H$ (L).

2.329 Top Soil — Surface soil, usually containing organic matter.

2.330 Torsional Shear Test — A shear test in which a relatively thin test specimen of solid circular or annular cross-section, usually confined between rings, is subjected to an axial load and to shear in torsion. In-place torsion shear tests may be performed by pressing a dentated solid circular or annular plate against the soil and measuring its resistance to rotation under a given axial load.

2.331 Total Stress — *See* 'Stress'.

2.332 Toughness Index I_T (D) — The ratio of the plasticity index to the flow index.

2.333 Transformed Flow Net — A flow net whose boundaries have been properly modified (transformed) so that a net consisting of curvilinear squares can be constructed to represent flow conditions in an anisotropic porous medium.

2.334 Transported Soil — Soil transported from the place of its origin by wind, water, or ice.

2.335 Triaxial Shear Test (Triaxial Compression Test) — A test in which a cylindrical specimen of soil encased in an impervious membrane is subjected to a confining pressure and then loaded axially to failure.

2.336 Turbulent Flow — That type of flow in which any particle may move in any direction with respect to any other particle, and in which the head loss is approximately proportional to the second power of the velocity.

2.337 Ultimate Bearing Capacity (Gross), q_o (*gross*), q_{ult} (*gross*) (FL^{-2}) — The gross intensity of loading at the base of a foundation which causes shear failure of the soil support.

2.338 Ultimate Bearing Capacity (Nett), q_o (*nett*), q_{ult} (*nett*) (FL^{-2}) — The nett intensity of loading at the base of a foundation which causes shear failure of the soil support, in excess of that at the same level due to the surrounding surcharge, that is ultimate bearing capacity (gross) minus the surcharge.

2.339 Unconfined Compressive Strength p_c, q_u (FL^{-2}) — The load per unit area at which an unconfined prismatic or cylindrical specimen of standard dimensions of a soil will fail in a simple compression test.

2.340 Unconsolidated-Undrained Test (Quick Test) — A soil test in which the water content of the test specimen remains practically unchanged during the application of the confining pressure and the additional axial (or shearing force).

2.341 Under-Consolidated Soil Deposit — A deposit that is not fully consolidated under the existing effective overburden pressure.

2.342 Undisturbed Sample — A soil sample that has been obtained by methods in which every precaution has been taken to minimize disturbance to the sample.

2.343 Unit Weight, γ (FL^{-3}) — Weight per unit volume of a soil mass.

2.343.1 *Dry Unit Weight,* γ_d (FL^{-3}) — The weight of oven dry soil (soil solids) per unit of total volume of soil mass.

2.343.2 *Effective Unit Weight,* γ_e (FL^{-3}) — That unit weight of a soil which, when multiplied by the height of the overlying column of soil, yields the effective pressure due to the weight of the over-burden.

2.343.3 *Saturated Unit Weight,* γ_{sat} (FL^{-3}) — The unit weight of a soil mass when saturated.

2.343.4 *Submerged Unit Weight,* γ_{sub} (FL^{-3}) — The weight of the solids in air minus the weight of water displaced by the solids per unit of volume of soil mass; the saturated unit weight minus the unit weight of water.

2.343.5 *Wet Unit Weight (Mass Unit Weight)* γ_m, γ_{wet} (FL^{-3}) — The weight (solids plus water) per unit of total volume of soil mass, irrespective of the degree of saturation.

2.344 Uplift — The upward water pressure on a structure:

	Symbol	*Unit*
Unit uplift	u	FL^{-2}
Total uplift	U	F

2.345 Vane Shear Test — A laboratory or in-place shear test in which a rod with thin radial vanes at the end is forced into the soil and the resistance to rotation of the vane is determined.

2.346 Varved Clay — Alternating thin layers of silt (or fine sand) and clay formed by variations in sedimentation during the various seasons of the year, often exhibiting contrasting colours when partially dried.

2.347 Virgin Compression Curve — *See* ' Compression Curve '.

2.348 Viscous Flow — *See* ' Laminar Flow '.

2.349 Void — Space in a soil mass not occupied by solid mineral matter. This space may be occupied by air, water , or other gaseous or liquid material.

2.350 Void Ratio, e (D) — The ratio of the volume of void space to the volume of solid particles in a given soil mass.

2.350.1 *Critical Void Ratio, e_c* (D) — The void ratio prior to the process of shear in which the nett volume change at failure is zero.

2.351 Volumetric Shrinkage (Volumetric Change), V_s (D) — The decrease in volume, expressed as a percentage of the soil mass when dried, of a soil mass when the water content is reduced from a given percentage to the appropriate shrinkage limit.

2.352 Wall Friction, f' (FL^{-2}) — Frictional resistance mobilized between a wall and the soil in contact with the wall.

2.353 Water Content — *See* ' Moisture Content '.

2.354 Water Holding Capacity (D) — The smallest value to which the water content of a soil can be reduced by gravity drainage.

2.355 Water Plasticity Ratio — *See* ' Liquidity Index '.

2.356 Water Table — *See* ' Free Water Elevation '.

2.357 Water Voids Ratio, e_w (D) — Ratio of volume of water to volume of solids in a soil mass.

2.358 Wet Unit Weight — *See* ' Unit Weight '.

2.359 Zero Air Voids Curve (Saturation Curve) — Dry density moisture content curve for 100 percent saturation.

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