BRITISH STANDARD

BS 6324-2: 1983

Terms relating to surgical implants —

Part 2: Glossary of terms relating to mechanics

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Surgical Instruments and Medical Equipment Standards Committee (SGC/-) to Technical Committee SGC/18 upon which the following bodies were represented:

British Institute of Surgical Technologists
British Medical Association
British Orthopaedic Association
British Steel Industry
British Surgical Trades Association Incorporated
Department of Health and Social Security
National Association of Drop Forgers and Stampers
Royal College of Surgeons of England
Royal Veterinary College
Society of Thoracic and Cardiovascular Surgeons

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Ministry of Defence
Scottish Health Services
Coopted members

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Contents

Foreword

This British Standard has been prepared under the direction of the Surgical Instruments and Medical Equipment Standards Committee.

Advancements in the field of implant surgery proceed by the collaborative efforts of those skilled in a number of diverse activities, each having a specialized language. Definitions of terms relating to surgical implants were prepared with two main purposes in view, namely:

a) to promote precision and uniformity in the use of terms relating to the various aspects of surgical implants;

b) to enable workers in different fields to understand one another.

The intention has been to provide information on terms used in the biological, medical, engineering and materials science aspects of surgical implants. It is emphasized that many of the terms included in this Part of BS 6324 will be found in British Standards directly concerned with particular disciplines, as well as in many text books. The wording of these definitions has in some instances been modified to facilitate understanding of the concepts by readers who are not specialists in these particular disciplines; the definitions are not otherwise incompatible with the general definitions as used and understood in the relevant industries. Every attempt has been made to align the terms and definitions with modern practice. This glossary does not purport to be a comprehensive list of all terms used in connection with surgical implants and has been restricted to those terms most frequently used. Where terms are considered to be deprecated, this has been stated.

The glossary has been prepared in four Parts as follows:

— *Part 1: Glossary of general medical terms;*

— *Part 2: Glossary of terms relating to mechanics;*

— *Part 3: Glossary of terms relating to materials;*

— *Part 4: Glossary of orthopaedic surgical terms.*

Further consideration is being given to the preparation of other Parts covering such fields as cardiovascular, neuro-surgical and genito-urinary implant surgery.

Attention is also drawn to the Parts of BS 3531 dealing with surgical implants.

Each term in the glossary has been allocated a number of the type 20101 where the first three digits indicate the section number and the first digit of that group indicates the Part of the glossary. The remaining two digits give the term number within the section.

Where two or more terms have the same meaning, the preferred term is given in bold type and the other terms are given in medium type and, if deprecated, are so indicated.

An alphabetical index of the terms contained in each Part of the glossary is given at the end of that Part. Those terms given in italic typeface in the definitions are themselves defined elsewhere in the same Part and are included in the index for ease of reference.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 201. Basic mechanical terms

NOTE Unless otherwise qualified, the definitions contained in this Part of BS 6324 use the term "body" in an engineering sense.

No.	Term	Definition
20101	**force**	That which, acting on a body, tends to cause it to undertake linear acceleration. NOTE The SI unit of force is the newton (N).
20102	**couple**	Two equal and opposite *forces* acting along parallel lines of action and tending to cause rotation of the body to which they are applied. NOTE The value of the couple is given by the magnitude of one force multiplied by the perpendicular distance between the lines of action of the forces. The SI unit of couple is the newton metre (N m).
20103	**mass**	The quantity of matter in a body. NOTE The SI unit of mass is the kilogram (kg).
20104	**weight**	That *force* which is exerted on a body by the mutual attraction (gravity) between it and the earth. NOTE The SI unit of weight is the newton (N).
20105	**load**	Any system of *forces* and/or *couples* applied to a body.
20106	**free body diagram**	An illustration of all the loads acting on a body or a part of a body allowing analysis of the loading on each body part. NOTE When the loading on a body component is analysed, a single part or any group of parts may be studied and the equations of equilibrium are satisfied for each part or group of parts. Attention should be paid to all the loads transmitted by the external environment and by the remainder of the body at the section joining this part or group of parts to the rest of the body.
20107	**pressure**	The *force* divided by the area of the surface on which the force acts. NOTE The SI unit of pressure is the pascal (Pa); 1 Pa = 1 N/m^2.
20108	**moment**	The turning effect of a *force* about an axis. NOTE The value of a moment is given by the product of the force and the distance measured perpendicularly from the axis to the line of action of the force. The SI unit of moment is the newton metre (N m).
20109	**torque**	A *moment,* generally about the long axis of a body, that tends to produce twisting *(torsion).* NOTE The SI unit of torque is the newton metre (N m).
20110	**torsion**	The twisting rotation of one end of a body relative to the other, generally about the long axis, caused by *torque*.
20111	**bending moment**	The *moment* acting about an axis perpendicular to the long axis of a body and generally producing lateral deflection. NOTE It is usually applied to a body with one long axis (i.e. with ratio of length to width greater than 6 : 1). The unit of bending moment is the newton metre (N m).
20112	**resultant force and couple**	The single *force* and single *couple* representing the total effect of a system of forces and couples that are acting on a body or part of a body. NOTE The resultant force will produce the same linear acceleration of the body as the system of forces.
20113	**cross-sectional area**	That area which is exposed when a section is taken perpendicular to the longitudinal axis of the body. NOTE The SI unit of cross-sectional area is the square metre (m^2).
20114	**centroid**	The effective geometric centre of an area.

No.	Term	Definition
20115	**centre of gravity**	The point at which the *mass* of all parts of the body may be considered to be concentrated for calculations relating to gravitational and inertial *forces*.
20116	**second moment of area**	A property of a *cross-section* related to its area and the distribution of the area relative to its *centroid*. NOTE It is used in the calculation of *stresses* due to bending in the elastic region and is not to be confused with *second moment of mass*. The SI unit of second moment of area is the metre to the fourth power (m^4).
20117	**second moment of mass** moment of inertia	A property of a body related to its *mass* and the distribution of mass relative to the *centre of gravity*. NOTE It is used in the calculation of angular acceleration due to *torque* and is not to be confused with *second moment of area*. The unit of second moment of mass is the kilogram metre squared ($kg \cdot m^2$).
20118	**polar moment of area**	A property of the *cross-section* of a circular bar and the distribution of area relative to the *centroid*. NOTE It is used in the calculation of *shear stress* due to *torsion* of a bar of circular cross-section. The unit of polar moment of area is the metre to the fourth power (m^4).
20119	**axial force** normal force	The *force* whose line of action coincides with the line joining the *centroids* of successive *cross-sections* of a part of a body.
20120	**tensile force** extensional force	A *force* tending to increase the length of a part of a body.
20121	**compressive force**	A *force* tending to produce shortening of the length of a part of a body.
20122	**shear force**	That component of the *resultant force* acting on a cross-section of a body and having a line of action perpendicular to the axis of that body, or acting on the surface of a body and having a line of action tangential to the surface.
20123	**work**	The product of a *force* and the distance moved by the point of application of the force along the line of action of the force. NOTE Similarly, work is done when a *couple* produces an angular displacement. The SI unit of work is the joule (J); 1 J = 1 N·m.
20124	**energy**	The capacity for doing *work*. NOTE In mechanical systems this will be in the form of potential energy (relating to the possibility of *work* being done by gravity); kinetic energy (corresponding to the instantaneous linear and/or angular velocity of the body) or strain energy corresponding to the energy stored and available for release in a deformed body. The SI unit of energy is the joule (J); $1\ kW \cdot h = 3.6 \times 10^6$ J.
20125	**power**	The rate of doing *work* or supplying *energy*. NOTE The SI unit of power is the watt (W); 1 W = 1 J/s.
20126	**instantaneous centre**	The imaginary point, not necessarily in the body, about which a body having general motion may, at a given instant, be considered to be rotating or moving, relative to another body. NOTE The principle is exemplified by the human knee joint in which the tibial and femoral condyles slide in relation to one another during flexion. The instantaneous centre thus traces a path around a selected condyle.
20127	**fluid**	A substance that flows and that differs from a solid in that it can offer no permanent resistance to change of shape.
20128	**gas**	The state of matter in which molecules move freely, thereby expanding indefinitely and occupying the total volume of any vessel in which the matter is contained.

No.	Term	Definition
20129	**liquid**	The state of matter in which the shape of a given *mass* depends on the containing vessel, but the volume is independent thereof. NOTE A liquid is frequently assumed to be incompressible.
20130	**turbulent flow**	Flow of a *fluid* in which the particle motion at any point varies rapidly in magnitude and direction giving rise to high resistance to flow.
20131	**laminar flow** streamline flow	Flow of a *fluid* in which adjacent layers do not mix, except on a molecular scale. NOTE See also Part 1 of this standard.

Section 202. Mechanics of materials

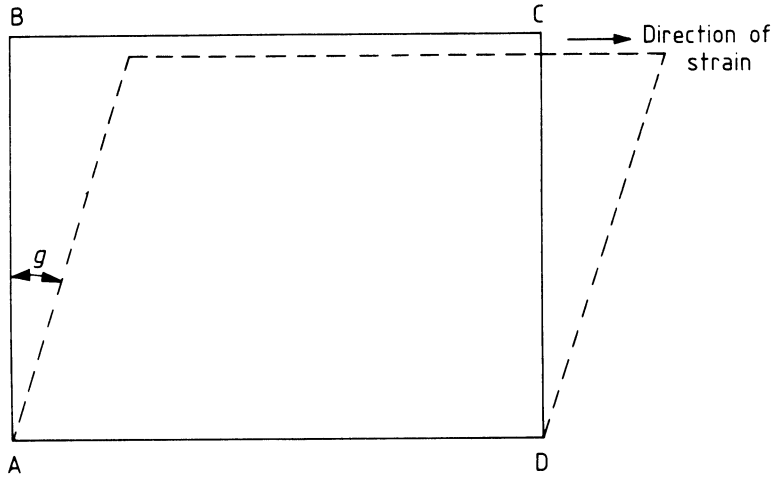
20201	**stress**	The intensity of the internal *forces* (or components of a force) at a point in a body that can act on a given plane through the point. The numerical value of stress is the quotient of the force and the area on which it acts. NOTE Generally a uniform distribution of stress exists only where the resultant *load* is a *tensile or compressive force* whose line of action intersects the *centroid*. The appropriate SI unit of stress is the megapascal (MPa). 1 MPa = 1 MN/m^2 = 1 N/mm^2.
20202	**normal stress** direct stress	The *stress* or component of stress acting perpendicular to a given plane. NOTE A normal stress may be either a *tensile stress* or a *compressive stress* depending on the direction of the *force*.
20203	**tensile stress**	The *stress* caused by a *force* tending to increase the length of a body.
20204	**compressive stress**	The *stress* caused by a *force* tending to decrease the length of a body.
20205	**shear stress**	The *stress* or component of stress acting tangentially to a given plane.
20206	**bending stress**	The *tensile* and *compressive stresses* developed on opposite sides of a body due to the application of a *bending moment*.
20207	**shear stress due to torsion** torsion stress, *deprecated*	The *shear stresses* produced in a body by the application of *torque*.
20208	**volumetric stress** hydrostatic stress	A three-dimensional *tensile* or *compressive stress* system in which the magnitude of the stress is the same in all directions.
20209	**hoop stress**	The *stress* in a circumferential direction in a body of cylindrical or spherical shape.
20210	**radial stress**	The *stress* applied in the radial direction in a body of cylindrical or spherical shape.
20211	**resultant stress**	The single *stress* at a point, representing the total effect of the stresses due to each of several *load* systems acting on a body.
20212	**stress raiser**	A scratch, crack, notch, void, inclusion, change in cross-section or change in contour that causes *stress concentration*.
20213	**stress concentration**	The increased value of *stress* existing in the region of a *stress raiser* compared with that occurring in the same region of a similarly loaded uniform body.
20214	**stress concentration factor**	The ratio of the value of a *stress concentration* to the value occurring at the corresponding point in a uniform body subjected to the same *loading*.

No.	Term	Definition
20215	**thermal stress**	The *stress* developed within a body when free thermal expansion or contraction is restrained or the temperature throughout a body is non-uniform.
20216	**residual stress**	The *stress* remaining in a body after removal of any system of external *loads* or temperature gradients.
20217	**deformation**	A change in the dimensions or shape of a body.
20218	**angular deflection**	The angle to which a test piece deflects when subjected to an applied *moment*. NOTE The commonly used unit of angular deflection is the degree (°); the SI unit of plane angle is the radian.
20219	**strain**	The ratio of the *deformation* of a body or part of a body to its original dimension, e.g. an increase in length under tensile *load* divided by the original length.
20220	**normal strain**	The ratio of the change of length of a body to its original length. NOTE Normal strain may be tensile or compressive.
20221	**shear strain** tangential strain	The *strain* resulting from *shear stress.* NOTE Where an element of a body of shape ABDC deforms as shown in Figure 1 the shear strain is defined as angle *g*. The SI unit of shear strain is the radian.
20222	**volumetric strain**	The ratio of change in volume to the original volume.
20223	**strain gauge**	A device affixed usually to the surface of a body to measure *normal strain* in a specified direction over the area of attachment.
20224	**stress/strain curve**	A diagram in which the corresponding values of *stress* and *strain* are plotted against each other. NOTE It is generally obtained from a tensile test of the material (see Figure 2).
20225	**elastic deformation**	The *deformation,* due to the application of a *load,* that diminishes to zero on removal of that load.
20226	**plastic deformation** permanent deformation	The *deformation* that remains after the removal of the *load* that caused it.
20227	**viscoelastic deformation**	*Deformation* that comprises *elastic, plastic* and *fluid* flow components.
20228	**elastic modulus**	The ratio of *stress* to the corresponding *strain* within the initial linear region of the *stress/strain curve* for a material.
20229	**Young's modulus**	The *elastic modulus* relating the *normal stress* to the *strain*. NOTE The appropriate SI unit of Young's modulus is the megapascal (MPa); 1 MPa = 1 MN/m^2 = 1 N/mm^2.
20230	**shear modulus** rigidity modulus	The *elastic modulus* relating the *shear stress* to the *shear strain*. NOTE The appropriate SI unit of shear modulus is the megapascal (MPa); 1 MPa = 1 MN/m^2 = 1 N/mm^2.
20231	**bulk modulus**	The *elastic modulus* relating the *volumetric stress* to the *volumetric strain*. NOTE The appropriate SI unit of bulk modulus is the megapascal (MPa); 1 MPa = 1 MN/m^2 = 1 N/mm^2.
20232	**Poisson's ratio**	The ratio of the lateral *strain* to the longitudinal strain in a body loaded by a *tensile force* only. NOTE See Figure 3.
20233	**load/elongation curve**	The curve of variation of the axial *load* and the elongation on a specified *gauge length* of a tensile test specimen. NOTE With appropriate changes of scales this may be used as a *stress/strain curve.*

No.	Term	Definition
20234	**proportional limit**	The point in a *stress/strain curve* relating to a tensile test at which there is significant deviation from the initial linear region. NOTE See Figure 2.
20235	**proportional limit stress**	The *stress* at the *proportional limit*.
20236	**elastic limit**	The greatest *stress* that a material is capable of sustaining without any permanent *strain* remaining upon the complete release of the stress. NOTE See Figure 2.
20237	**elastic limit stress**	The *stress* at the *elastic limit*.
20238	**proof stress**	The *stress* in a test piece corresponding to a permanent *strain* or permanent *deformation* of a prescribed amount, e.g. 0.1 %.
20239	**proof load**	The *load* carried by a test piece or structure that corresponds to a permanent *deformation* of a prescribed amount.
20240	**stiffness**	The *load* per unit *deformation* within the *proportional limit*. NOTE Examples are the *force* per unit stretch, the *moment* per unit angular deformation, the *torque* per angle of twist. Contrast with *flexibility*.
20241	**yield**	That part of the *stress/strain curve* relating to a tensile test which is essentially parallel to the *strain* axis and where an increase in strain occurs without an increase in *stress*. NOTE See that part of the curve shown in Figure 2 between the yield point and point K.
20242	**yield stress**	The *load* at *yield* in a tensile test divided by the original *cross-sectional area*.
20243	**tensile strength** ultimate tensile stress	The maximum *force* in a tensile test divided by the original *cross-sectional area* of the test piece, i.e. the *stress* corresponding to the maximum *load*. NOTE The appropriate SI unit of tensile strength is the megapascal (MPa); 1 MPa = 1 MN/m^2 = 1 N/mm^2.
20244	**maximum load** ultimate load	The highest *load* that the test piece withstands in a tensile test. NOTE See Figure 2.
20245	**true stress**	The *stress* in a tensile test calculated from the *cross-sectional area* at the time of measurement of the *load* rather than from the original cross-sectional area.
20246	**hysteresis**	The phenomenon whereby the loading curve differs from the unloading curve for any point in a *stress/strain curve*. NOTE In Figure 2, if the test is conducted up to point K and unloading takes place along line KLM, the typical curve representing reloading follows path MNK. The area KLMN represents the mechanical energy loss.
20247	**creep**	The continuous *deformation* of a material when subjected to *stress* over an extended period. NOTE Generally, the higher the stress and the temperature, the higher will be the rate of deformation. A typical creep curve is shown in Figure 4.
20248	**creep limit** creep strength	The highest *stress* at a given temperature that a material can withstand without excessive *deformation*.
20249	**creep rate**	The rate of *strain* corresponding to particular *load* and temperature conditions as given by the slope of the second stage of the *creep* curve. NOTE See Figure 4. The SI unit for creep rate is the reciprocal second (s^{-1}).

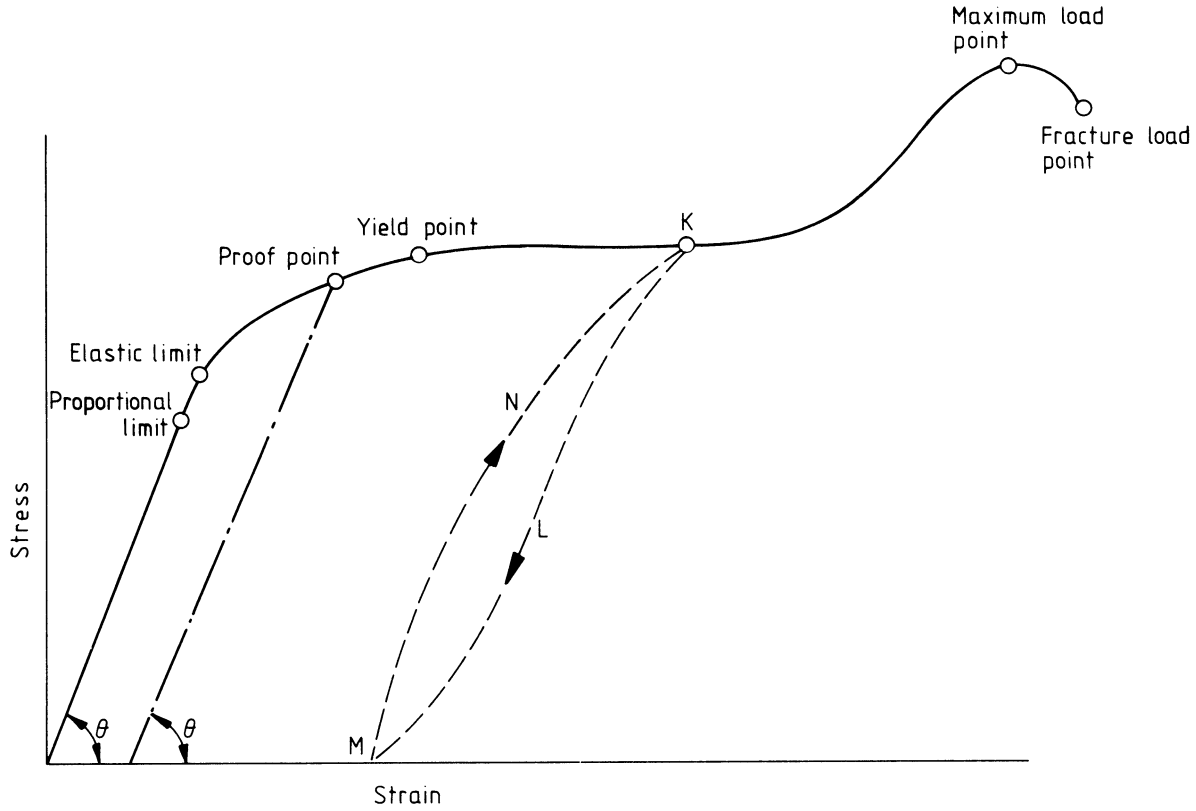
No.	Term	Definition
20250	**ductility**	The capacity of a material to undergo permanent (*plastic*) *deformation*. NOTE In a ductile fracture a cup and cone shape or "ears", together with a finely textured surface appearance corresponding to large amounts of local deformation, are frequently evident.
20251	**brittleness**	The absence of significant *deformation* before fracture. NOTE Some materials may exhibit a transition from ductile to brittle behaviour, depending on the temperature, the speed of application of *load* and the *stress* distribution. In a brittle fracture there is no significant reduction in *cross-sectional area* and the surface may have a bright crystalline appearance.
20252	**flexibility**	*Deformation* per unit *load*. NOTE Contrast with *stiffness*.
20253	**gauge length**	The original length of that portion of the test specimen over which *strain* or change of length is determined.
20254	**extensometer**	An instrument for measuring the average extension on the *gauge length* of a tensile test specimen.
20255	**compression test**	A test conducted, generally on a short specimen of cylindrical form (maximum length/diameter ratio of 2.0), in which a compressive *load* is uniformly applied to each end face.
20256	**reduction in area**	The reduction of *cross-sectional area* of a tensile test piece measured after fracture and expressed as a percentage of the original cross-sectional area.
20257	**elongation**	The increase in *gauge length* of a tensile test piece measured after fracture and expressed as a percentage of the original gauge length. NOTE Generally this value is valid only if the fracture has occurred within the middle third of the gauge length.
20258	**ultimate shear stress**	The maximum *stress* occurring during a test in pure shear (i.e. without *tensile* or *bending stress*). NOTE The ultimate shear stress can be obtained accurately only from a torsional test on a thin tube.
20259	**fatigue failure**	The failure of a test piece or component under repeated cycles of *load,* each less than the maximum load of the test piece.
20260	**S/N curve**	A graph relating stress to the number of cycles of load to failure in a fatigue test.
20261	**fatigue limit stress** fatigue limit; endurance limit	The highest *stress* that will not cause failure regardless of the number of *load* cycles. NOTE This limit is only found in certain metals in non-corrosive environments (see also *corrosion fatigue*). The appropriate SI unit of fatigue limit is the megapascal (MPa); 1 MPa = 1 MN/m^2 = 1 N/mm^2.
20262	**corrosion fatigue**	The failure due to repeated cycles of *load* in a corrosive environment. NOTE Generally, in a corrosive environment, the number of load cycles to failure at a given *stress* is reduced, and there is no *fatigue limit stress.*
20263	**impact test**	A test in which a test piece is dynamically loaded to fracture. NOTE Generally the bar is notched at the region of maximum *stress* and loaded in bending. The maximum *energy* required to fracture the bar is measured. This energy cannot be directly related to other mechanical properties.
20264	**notch sensitivity**	The reduction of the strength of certain materials in the presence of *stress raisers*.
20265	**toughness**	The characteristic of a material that requires high *energy* to cause fracture.

No.	Term	Definition
20266	**hardness**	The capacity of a material to resist indentation. NOTE It may correlate with *wear* resistance and *yield stress*. Hardness is usually determined by the use of an indentation type of machine such as Vickers (diamond pyramid hardness) (HV), Brinell (HB) or Rockwell (HR). In each case a dimensionless number is obtained which is reported relative to the test conditions, e.g. Vickers (at the stated load), Brinell (at the stated F/D^2 value), Rockwell (using the stated scale).
20267	**photoelasticity**	The phenomenon in which the transmission of light through certain transparent materials is dependent on local *strain*. NOTE In suitable cases, using plane polarized light, the *stress* at a point in a model can be inferred from the optical fringe patterns produced. If a thin photoelastic coating (stress coat) is applied to a component, an analysis of the fringes allows the determination of the surface strain when the component is loaded.
20268	**finite element stress analysis**	A numerical method of analysis of the *stress* in a component obtained by considering the component to be divided into a finite number of small elements. NOTE Using this technique the behaviour of a complicated component can be predicted under any assumed system of *loads*.
20269	**wear**	Removal or transfer of material from contacting surfaces due to their relative movement under *load*. NOTE Wear may be measured by *mass* change, volume measurement or by the depth of the wear tracks (see also Part 3 of this standard).
20270	**friction coefficient**	The ratio of the tangential friction force to the *axial force* between two surfaces when relative movement is occurring or about to commence.
20271	**lubrication**	The interposition of solid, liquid or gaseous material between two surfaces to reduce the friction or *wear* occurring during relative movement.
20272	**fretting**	The *wear* occurring between two close-fitting surfaces corresponding to repeated small relative movements.



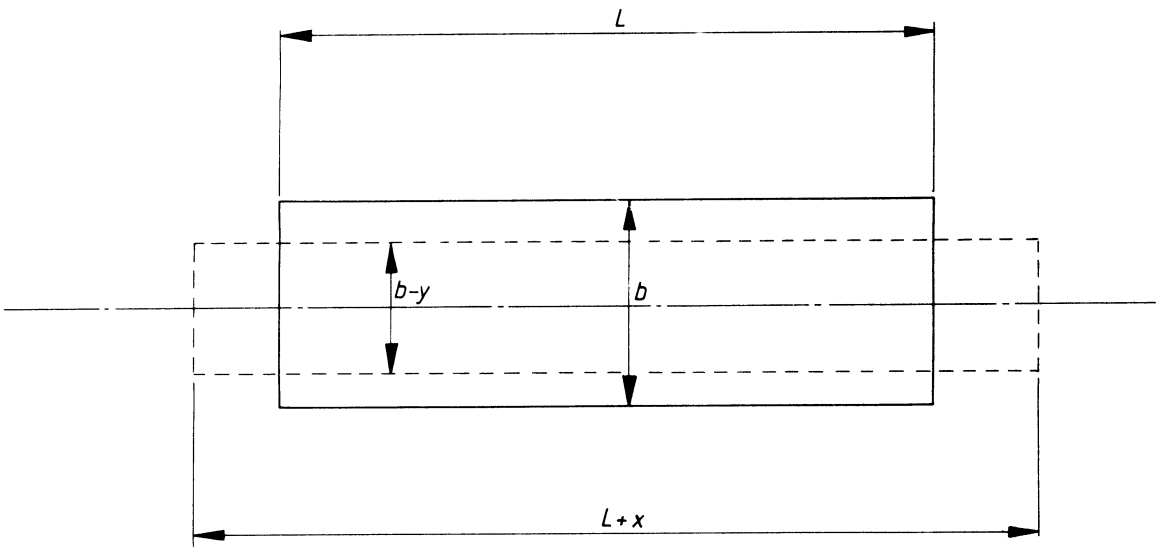
g = shear strain in plane ABCD

Figure 1 — Shear strain diagram



NOTE Hysteresis = area bounded by KLMN

Figure 2 — Typical stress/strain curve from a tensile test



Key
Lateral strain = y/b
Longitudinal strain = x/L
Poisson's ratio = $\frac{y/b}{x/L}$

Figure 3 — Diagram illustrating Poisson's ratio

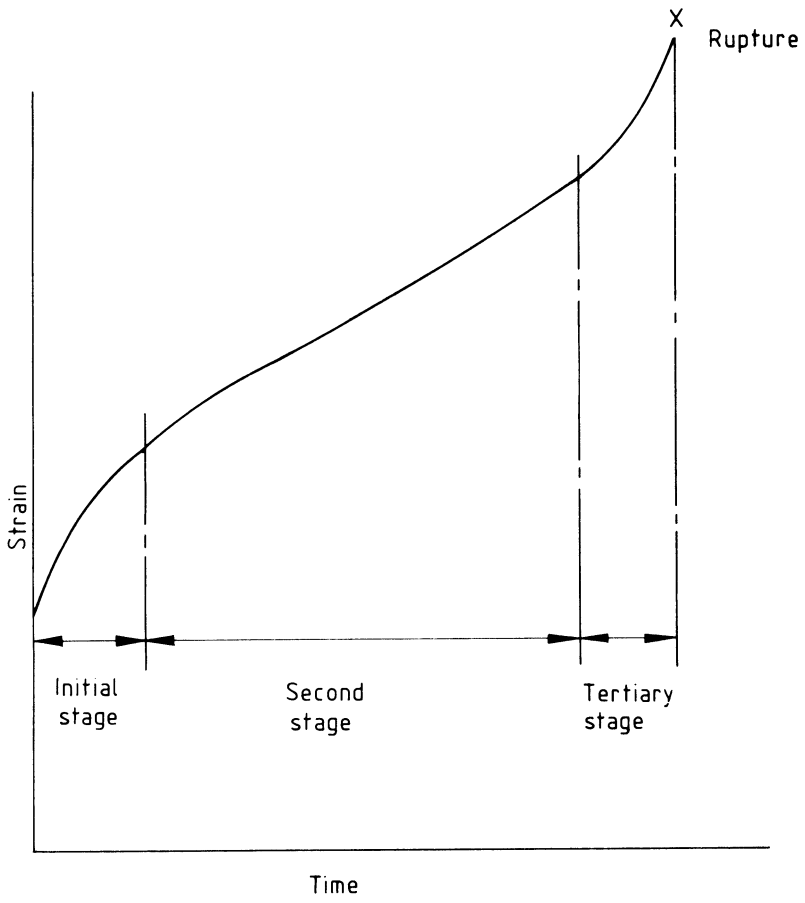


Figure 4 — Typical creep curve

Alphabetical index

The method of alphabetization used in this index is word-by-word.

Entries beginning with the same word are listed in the order:

a) a single word entry;

b) the same word modified by a qualifier;

c) compound entries beginning with the same word.

The references are not to page numbers, but to term numbers. The word "see" against an entry indicates that the term itself is not defined but that information on the term may be found in the indicated entry.

Publications referred to

BS 6324, *Terms relating to surgical implants.*

BS 6324-1, *Glossary of general medical terms.*

BS 6324-3, *Glossary of terms relating to materials.*

BS 6324-4, *Glossary of orthopaedic surgical terms*[1)].

BS 3531, *Surgical implants*[1)].

BS 3531-1, *Specification for basic requirements: Finish, marking and packaging.*

BS 3531-2, *Specification for materials for metal surgical implants.*

BS 3531-3, *Specification for forged components made of wrought stainless steel, wrought titanium and of wrought titanium alloy.*

BS 3531-4, *Specification for castings made of cobalt-chromium-molybdenum alloy.*

BS 3531-5, *Specification for surgical bone screws of 4 mm, 3.5 mm and 3 mm nominal sizes, countersunk surfaces on bone plates, twist drills, taps and screwdrivers.*

BS 3531-6, *Specification for skeletal pins and wires.*

BS 3531-7, *Specification for acrylic bone cement.*

BS 3531-8, *Specification for ceramic materials based on alumina.*

BS 3531-9, *Specification for general requirements for orthopaedic joint replacements.*

BS 3531-10, *Specification for classification, designation of dimensions and general requirements for partial and total hip joint replacements.*

BS 3531-11, *Specification for staples for use in orthopaedic surgery.*

BS 3531-12, *Classification and designation of dimensions for knee joint prostheses.*

[1)] Referred to in the foreword only.

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