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JOINT SEALING

a glossary

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Foreword

The joint sealing industry has for years been plagued with incorrect and inaccurate terminology. As a consequence, literature in the field of joint sealing is often difficult to read and interpret. This glossary is an attempt to bring some measure of order to the terminology in the joint sealing field.

This glossary is the result of more than three years of work by a small group composed of members of the Committee on Sealants and Fillers for Joints and Cracks in Pavements. Credit for the major portion of this work belongs to Raymond J. Schutz.

—John P. Cook

A

- abrasion.** The wearing away of a material surface by friction that detaches particles by a combined cutting, shearing, and tearing action.
- abrasion index.** A value expressing abrasive resistance.
- abrasion tester.** A machine for determining abrasion loss quantitatively.
- abrasive.** A special mineral ingredient (as pumice, silica, tripoli, and carborundum) employed to impart abrasive power to rubber articles (as erasers and hard or soft rubber grinding wheels) used for abrading, grinding, or polishing.
- abrasive blade.** A low-cost blade composed of silicon carbide abrasive grain resin bonded with glass-cloth reinforcement and used for sawing green concrete in which soft or favorable aggregates are used.
- accelerate.** To hasten or quicken the natural progress or process of a reaction or event: The drying rate of an adhesive or sealer is hastened or accelerated by increasing the temperature.
- accelerated aging.** Producing in a short time under any set of designed conditions usually employing heat, light, and oxygen, either separately or combined, results that would be obtained under normal conditions of aging—most often accomplished by heating samples in an atmosphere of oxygen at a pressure of 300 pounds per square inch and 70 C (Bierer-Davis) or by heating them in an oven provided with circulating air and maintained at 70 or 100 C (Geer). Sometimes called accelerated life.
- accelerated test.** Usually a severe test that determines the comparative durability in a shorter length of time than that required under service conditions.
- accelerated weathering.** Duplicating or reproducing weather conditions by machine-made means—used particularly in comparing a series of products at the same time.
- accelerator of vulcanization.** Any substance that hastens the vulcanization of rubber causing it to take place in a shorter time or at a lower temperature; a substance that generally enhances tensile properties and improves age resistance; in earlier days basic oxides (as lime, litharge, and magnesia) but today an organic substance containing either nitrogen or sulfur or both: According to potency, or speed of action, accelerators are sometimes classified as slow, medium, rapid, semi-ultra, and ultra.
- acetone.** A liquid, C_3H_6O —used to extract most of the nonrubber constituents in natural rubber and also the free sulfur in vulcanizates. Also called dimethylketone.
- acetone extract.** Material (as free sulfur, fat acids, waxy hydrocarbons, resins, sterols, accelerators, and antioxidants) soluble in and extractable by acetone; also products resulting from the "perishing" of rubber.
- acetylene black.** Carbon black of graphitic nature and having high electrical conductivity—made by the thermal decomposition of acetylene in furnaces and used in preparing electrically conducting rubber sheets.
- acrylate resins.** Polymerization products of certain esters of acrylic acid and methacrylic acid (as methyl and ethyl acrylate) that possess great optical clarity and high degree of light transmission; the nearest approach to an organic glass.
- acrylonitrile.** A volatile liquid, $CH_2=CHCN$, prepared by dehydration of ethylene cyanohydrin and by catalytic addition of hydrogen cyanide to acetylene—used in copolymerization with butadiene in the manufacture of Buna-N or nitrile rubbers. Also called cyanoethylene or vinyl cyanide.

- actinic light rays.** Light rays that consist of the nonvisible spectrum (as infrared and ultraviolet) and that cause a chemical change or have a deteriorating effect on films exposed to them for extended periods: Actinic light rays are strongest in United States in July and weakest in January.
- activator.** A substance that promotes by chemical interaction a specific chemical action of a second substance; substance (as zinc oxide, sometimes with a fat acid, or other metallic oxides) required by most accelerators to bring out their full effect in vulcanization.
- addition polymerization.** Combination of small molecules or monomers to form the polymer molecule, which is usually linear, without the elimination of alcohol, water, or the like. Sometimes called A-polymerization.
- adherend.** A substance held to another by an adhesive.
- adhesion.** The clinging or sticking of two material surfaces to one another; the strength of the bond or union between two rubber surfaces or plies, cured or uncured; the bond between a cured rubber surface and a nonrubber surface (as glass, metal, wood, or fabric).
- adhesion, mechanical.** Adhesion caused by the physical interlocking of the adhesive with the base surface irregularities.
- adhesion, rubber-to-metal.** The bond formed between a metal surface and natural or synthetic rubber surface whose strength must be known regardless of the method used in obtaining the bond and expressed quantitatively as the tension per unit area required to cause a rupture of the rubber-to-metal bond (ASTM Designation D 429).
- adhesion, specific.** Adhesion caused by valence or attraction forces (as those that give rise to cohesion) at the adhesive-base surface interface.
- adhesive.** Substances (as cement, glue, mucilage, or paste) capable of holding materials together by surface attachment; an agent that bonds fresh concrete to hardened concrete: In physical form, adhesives may be called liquid adhesive or tape adhesive; in composition, resin adhesive or rubber adhesive; in end use, paper adhesive or label adhesive; and in application, sprayable adhesive or hot-melt adhesive.
- adhesive failure.** The separation of two surfaces with a force less than specified; the separation of two adjoining surfaces caused by service conditions.
- adhesive setting.** The conditions required to convert the adhesive from its packaged state to a more useful form (as addition of accelerator or catalyst to cure in chemical setting, temperatures below 68 F or 20 C in cold setting, temperatures above 212 F or 100 C in hot setting, temperatures ranging from 87 to 211 F or 31 to 99 C in intermediate temperature setting, and temperatures ranging from 68 to 86 F or 20 to 30 C in room temperature setting).
- adsorption.** The action, which takes place at or near the surface, of a body in condensing and holding gases, dyes, or other substances.
- adsorption, power of.** One of the characteristic properties of matter in the colloidal state and associated with surface energy phenomena of colloiddally dispersed particles.
- age resistance.** Resistance by heat and light to aging caused by oxygen and ozone in the air: Antioxidants help in age resistance although there is no nontoxic substance for use against ozone action on natural rubber, GR-S, neoprene, and nitrile rubbers.
- agglomeration.** The act or condition whereby minute particles dispersed in a liquid or viscous medium become united into larger groups.
- aging.** A progressive change in the chemical and physical properties of rubber, especially vulcanized rubber, usually marked by deterioration, caused primarily by

oxidation or reversion or both in natural rubber and primarily by continued copolymerization in GR-S, and sometimes retarded by the use of antioxidants; the setting aside of rubber goods under specified conditions for the purpose of observing their rate of deterioration.

- aging tests. Determining the endurance of rubber specimens by heating them in air, in air under pressure, or similarly in oxygen to accelerate aging.
- air bomb. A pressure-resisting apparatus in which rubber may be aged rapidly in hot compressed air.
- air-cure. To vulcanize at ordinary room temperatures or without the aid of heat.
- air-dry. To dry a material at ordinary room temperature without the use of artificial heat.
- aliphatic. Pertaining to organic compounds or hydrocarbons (as gasoline, kerosene, paraffin, and natural gas) that have carbon atoms arranged in an open or straight chain and that are prepared by straight-run, overhead distillation of petroleum: Aliphatic solvents are generally confined to reclaimed, natural GR-S and butyl rubber formulas and are about the lowest in price and the least toxic of any of the other common solvents. Sometimes called naphthas.
- alkali. A substance that neutralizes acids to form salt and water, yields hydroxyl, OH-, ions in water solutions, and turns litmus paper blue; a proton acceptor.
- alkalinity. The condition of having or containing hydroxyl, OH-, ions or of containing alkaline substances; the opposite of acidity; the property of turning red litmus paper blue and of neutralizing acids to form salts.
- alligatoring. Cracking of a surface that has the appearance of an alligator hide and is caused by (a) applying one coat over another before the bottom coat is thoroughly hard and dry, skinning the material over so that the lower portion of the film is still soft and elastic, or applying a less elastic material over a more elastic undercoating so that, when the finished article is exposed to actinic rays or changes in temperature and moisture content, expansion or contraction of the film cracks the hard outer crust while the softer core gives without breaking, (b) applying excessively heavy coats of rather dilute materials so that cracking of the outer crust occurs from the shrinking action of the bottom portion, without temperature change, as clay mud is cracked under the summer sun, or (c) evaporating solvents or thinners too rapidly and forcing excessive air into the film during spraying. Usually called checking if fine and incomplete.
- ambient temperature. The temperature of the air in the environment surrounding the object under consideration.
- amorphous. Having no crystalline structure.
- anchorage. The means for obtaining adhesion of rubber to rubber, rubber to fabric, rubber to metal, or rubber to some other material.
- Angstrom unit. A unit of length, equal to 10^{-8} centimeter or 0.1 millimicron or $1/250,000,000$ inch, used to define the short wavelengths of the electromagnetic spectrum (as light, ultraviolet light, and X-rays).
- anhydrous. Having all water removed, particularly water of crystallization or absorbed water.
- anhydride. A compound, usually an acid (as acetic anhydride), from which water has been removed either practically or theoretically.
- aniline point. The temperature at which a hydrocarbon solvent becomes miscible with an equal volume of anhydrous, chemically pure aniline. Sometimes called the critical solution temperature.

- anion.** In solutions of electrolytes during electrolysis, the negatively charged ion that travels toward the positive electrode or anode: When rubber is electrodeposited from aqueous dispersions, the colloidal rubber particles behave as anions and deposit at the anode.
- antichacking agents.** Antioxidants and petroleum waxes that bloom out and absorb ultraviolet light.
- anticoagulant.** A substance (as ammonia, formaldehyde, sodium sulfite, caustic soda, or commercial bactericides) that prevents the coagulation of a colloid suspension or emulsion (as rubber latex that coagulates spontaneously after tapping because of bacterial action and against which ammonia is most commonly used). Also called stabilizer and latex-preservative.
- anticracking agents.** A vulcanizate that has resistance to cracking, high tensility, high tear resistance, high resilience, and strong resistance to heat aging; softening agents and some antioxidants.
- antifoam.** An additive used to reduce foaming tendencies by increasing surface tension particularly in products applied by roller-coating equipment.
- antifoaming agents.** Long chain saturated alcohols, $C_6H_{13}OH$ to $C_{18}H_{37}OH$ (as dodecyl alcohol, $C_{12}H_{25}OH$).
- antigelling agents.** For latex, ammonium hydroxide and other basic substances.
- antioxidant.** A substance, usually organic and nitrogenous, that inhibits or retards oxidation and certain other kinds of aging: Some antioxidants cause staining or discoloration of the rubber compound on exposure to light and are used only in black or dark-colored compounds; others (as phenolic) are nonstaining and are used in white or light-colored compounds.
- application.** The act of applying a substance only once over the entire area to be coated or sealed: When the operator coats the entire surface without repetition, he has made one application. If he immediately goes over the same work again, he has made another application. The principal methods of application are spatula, calking gun, flow gun, pressure extrusion units, and spray gun.
- aromatic.** Chemical compounds that are derivatives of benzene.
- asbestine.** An inert pigment or extender that consists of a fibrous variety of talc (as magnesium silicate), aids in preventing settling of pigments, and adds strength to dried coating films.
- asbestos.** A fibrous mineral from which fine fibers of appreciable length may be separated.
- ash.** The residue of mineral matter when raw or vulcanized rubber is burned that indicates only the approximate composition of the rubber ashed and not always the original mineral ingredients because carbonates and sulfides may be changed to oxides, lead and antimony compounds may be volatilized, and silicates may interact with other substances.
- asphalt.** Solid or semisolid mineral pitch or bitumen (as gilsonite, glance pitch, manjak, grahamite, and Trinidad pitch) that occurs naturally, is more or less soluble in carbon disulfide, naphtha, and turpentine, and is fusible at varying temperatures.
- atmospheric pressure.** The pressure of air at sea level exerted equally in all directions: The standard atmospheric pressure is that at which the mercury stands at 760 millimeters or 14.7 pounds per square inch.
- atmospheric or ozone cracking.** A fissured surface condition that develops on stretched rubber exposed to the atmosphere or to ozonized air. Also called checking if fissures are minute.

- atomic number.** The number (as 1 for hydrogen, 12 for carbon, 16 for oxygen, and 92 for uranium) indicating the location of an element in the periodic table.
- atomic weight.** The relative weight of an atom of an element as compared with the weight of one atom of oxygen taken as 16.
- autoignition point.** The temperature at which solvent vapor and air mixtures will ignite without the aid of a spark or flame.

B

- binder.** The component of an adhesive or coating composition primarily responsible for the adhesive forces that hold two bodies together.
- bitumen.** Originally, mineral pitch or asphalt; now, any of a number of flammable mineral substances that consist mainly of hydrocarbons and include the hard, brittle varieties of asphalt, the semisolid maltha and mineral tars, the oily petroleum, and even the volatile naphthas.
- black.** The several types of carbon black utilized in the rubber industry; the absence of color; zero brilliance and 100 percent saturation of light waves.
- bleeding.** The migration of plasticizers, waxes, or similar materials to the surface to form a film or beads. Also see bloom.
- blistering.** The forming of pockets of air or gas trapped within an elastomeric vulcanizate.
- blocking.** The undesired adhesion between touching layers of a material, as that occurring under moderate pressure during storage or use.
- bloom.** A discoloration or change in appearance of the surface of a rubber product (as sulfur bloom and wax bloom) caused by the migration of a liquid or solid to the surface: Bloom should not be confused with dust on the surface from external sources.
- blowing.** Porosity or sponginess occurring during cure; in latex goods, a permanent deformation caused when the deposit leaves the form during curing or drying.
- blowing agent.** A substance such as sodium bicarbonate or a nitrogen releasing agent added to a rubber mix to produce gas during vulcanization, thereby bringing about a cellular or spongelike structure.
- blown oils.** Semisolid or petroleum derivatives produced primarily through the action of air on the originally fluid native bitumens that are heated during the blowing process; oils that have had air blown through them to increase their viscosity or to alter other properties.
- blow-up, pavement.** A phenomenon that occurs when expansion joints are absent, widely spaced, or clogged and the pavement expands because of moisture and temperature.
- blush.** A whitish surface appearance where moisture has condensed before the solvent is all evaporated. Also see bloom.
- boiling point.** The temperature at which the vapor pressure of a liquid is equal to the pressure of the atmosphere.
- boiling range.** The thermometer-indicated range within which a liquid boils to dryness.
- bomb.** A heavily constructed, pressure-resisting, steel vessel with bolted, gas-tight cover in which rubber or other material is exposed to oxygen or air under high pressure for accelerated aging, and for which the desired temperature is maintained by placing it in a water or air bath.

- bond.** A coat of finishing material used to improve the adherence of succeeding coats; the attachment at the interface between an adhesive and an adherend; to join materials together with adhesives; to adhere. Also see adhesion.
- bond breaker.** Tape or roving material placed in the bottom of a joint to prevent sealant material from adhering to the bottom surface of the joint.
- bonding agent.** Substance or mixture of substances (as cyclized rubber or rubber isomers, halogenated rubber, rubber hydrochloride, the reaction products of natural rubber and acrylonitrile, and polymers containing diisocyanates) used for attaching rubber to metal, in the process of which, the rubber compound is generally vulcanized by heat.
- bonding range.** The optimum time interval between the application of adhesive and the joining together of the surfaces. Also called the open assembly time.
- bond strength.** The force per unit area or length necessary to rupture a bond.
- bow.** A depression in the surface; curve or displacement in filling threads in fabric.
- break down.** To soften or plasticize rubber by working it on a mixing mill or in an internal mixer before the incorporation of compounding ingredients in mixing; to mill or masticate.
- brittleness.** The tendency to crack or snap when subjected to deformation.
- brittle point.** The temperature at which a rubber test strip attached to a rapidly rotating disc and cooled gradually breaks in two: The kind of rubber and state of vulcanization both influence brittle point (ASTM Designation D 746). Also called brittleness temperature.
- Brookfield synchro-lectric viscosimeter.** A portable form of the rotating cylinder apparatus for determining the viscosity of latex.
- brush.** To clean with a power-driven, wire brush so that all concrete-curing membrane compound, laitance and other foreign matter (except bituminous materials) are completely removed from the side walls and upper edges of the joint.
- BTU.** British thermal unit; the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.
- buffer action.** Resistance by buffer solutions to change in their hydrogen ion concentration on the addition of acid or alkali.
- buffer solution.** A solution containing a weak acid together with a salt of a weak acid, or a weak base together with a salt of a weak base, and capable of neutralizing, within limits, both acids and bases added to it.
- bulking value.** The solid volume of a unit weight of material, usually expressed as gallons per pound; also expressed inversely as pounds per solid gallon and, for practical purposes, this value is 8.33 multiplied by the specific gravity. Also see specific gravity.
- Buna-N.** A synthetic rubber made of the German emulsion copolymer that (a) consists of 75 parts of butadiene and 25 parts of acrylonitrile, the increase of which increases the swelling resistance, (b) is resistant to heat and weather and especially to the swelling action of oils, solvents, and greases, (c) was manufactured in this country during World War II under the title of GR-A, and (d) is now manufactured under the names of Hycar OR by Goodrich, Chemigum N by Goodyear, Butaprene N by Firestone, and Paracril (formerly Perbunan) by U.S. Rubber. Also called nitrile rubber.
- Buna-S.** A synthetic rubber made of the German emulsion copolymer that consists of 75 parts of butadiene and 25 parts of styrene, at about 50 C or 122 F, and manufactured in this country during World War II and afterward under the name GR-S.
- burlap cure.** To control the curing of green concrete by the use of burlap.
- butadiene.** A gaseous hydrocarbon, $\text{CH}_2=\text{CH}=\text{CH}_2$, of the diolefin series, boiling at -5 C , and the chief raw material for making synthetic rubber. When butadiene

is polymerized, it yields polybutadiene. When it is copolymerized with styrene, it yields GR-S, and with acrylonitrile, it yields the various Buna-N or nitrile rubbers. Also called erythrene, divinyl, pyrrollylene.

butalastic. A contraction of synthetic butadiene elastics, the name of a group of commercial interpolymers.

buttering. The applying of mastic in a manner similar to that of spreading butter on a piece of toast.

Butyl. A synthetic rubber that is made of a copolymer of approximately 98 percent isobutene and 2 percent isoprene or butadiene and that has (a) the poorest resistance of all rubber to petroleum oils and gasolines, (b) excellent resistance to vegetable oils, mineral oils, solvents (as acetone, alcohol, phenol, and ethylene glycol), water, gas absorption, and sunlight, (c) above-average resistance to heat, (d) poorer resistance than natural rubber to abrasion, (e) usually low permeability to gases, and (f) satisfactory tensile strength and elongation.

C

calcite. Calcium carbonate, CaCO_3 .

calendar. A machine equipped with three or more heavy, internally heated or cooled rolls revolving in opposite directions and used for continuously sheeting or plying rubber compound and for frictioning or coating fabric with rubber compound.

calking. Cotton or oakum strands pounded into the lower portion of a seam.

calorie, small. The quantity of heat necessary to change the temperature of one gram of water from 3.5 to 4.5 C.

caoutchouc. The French word for crude rubber that is used by some writers to designate the purified rubber substance referred to most generally as rubber or rubber hydrocarbon and that is thought to be derived from South American Indian "Caa-o-chu" meaning weeping tree. Also called Kautschuk in German.

capillarity. The peculiar action that occurs by the surface of liquid being elevated or depressed where it is in contact with a solid (as in a tube) and that depends on the relative attraction of the molecules of the liquid for each other and those of the solid.

carbon black. Finely divided carbon formed by the incomplete combustion of natural gas; the carbon deposited on moving channel irons (as channel carbon black); the carbon formed by the incomplete combustion of natural gas or petroleum in large closed furnaces (as furnace carbon black)—used in tread compounds as reinforcing agents and to increase the abrasion and tear resistance; channel black used in rubber compounds to reduce resilience. Abbreviations are as follows:

HRC	hard processing channel	RF	reinforcing furnace
MPC	medium processing channel	CF	conductive furnace
EPC	easy processing channel	FF	fine furnace
CC	conductive channel	VFF	very fine furnace
HAF	high abrasion furnace	FEF	fast extruding furnace
HMF	high modulus furnace	FT	fine thermal
SRF	semi-reinforcing furnace	MT	medium thermal

carbon gel. An intimate structure formed between rubber and certain carbon blacks of fine-sized particles under proper elevated temperatures during mixing, measurable by a decrease in benzene extract and characterized by complete insolubility in benzene.

catalysis. The action of any substance which, without itself undergoing apparent chemical change, initiates, accelerates, or inhibits a chemical reaction.

- cataylst.** A substance that markedly speeds up the cure of an adhesive when added in minor quantity as compared to the amounts of primary reactants.
- cellular rubber.** A rubber product that contains cells or small hollow receptacles either open and interconnecting or closed and not interconnecting. ASTM Designation D 1056.
- cement.** A dispersion of "solution" of unvulcanized rubber compound in a suitable solvent (as petroleum naphtha or aromatic hydrocarbons); a latex or water dispersion with or without the addition of organic solvents.
- centipoise.** A centimeter-gram-second unit of viscosity equal to 1/100 poise: The viscosity of water at 20 C is approximately 1 centipoise.
- centistoke.** A centimeter-gram-second unit of kinematic viscosity equal to 1/100 stoke.
- chains, straight, or branched.** The arrangement of atoms that are (a) chiefly straight in polymers because of difficulties in preparing polymers with large branched chains, (b) small branches of phenyl groups in GR-S and polystyrene, and (c) small branches of ethylene (vinyl) from 1, 2-addition butadiene in polybutadiene and in GR-S.
- chalking.** The formation of a powdery surface condition from the disintegration of surface binder or elastomer caused by weathering or other destructive environments.
- channel black.** A form of carbon black made by the channel combustion process from natural gas burned with insufficient air in jets, the flames from which are allowed to impinge on a cool metallic surface (channel) from which the deposited carbon is scraped—used as a reinforcing agent for natural rubber and to make it highly abrasion resistant.
- checking.** Slight breaking in a coating that does not penetrate to the underlying surface and that may be visible by eye or by microscope magnified 100 diameters.
- checking, sunlight.** Minute surface fissuring on rubber articles as a result of exposure to sunlight and of bending or stretching that generally accelerates the fissuring.
- chemical resistance.** The resistance offered by elastomer products to physical or chemical reactions as a result of contact with or immersion in various solvents, acids, alkalies, salts, and the like.
- china clay.** Kaolin; hydrated aluminum silicate, $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$.
- chlorinated hydrocarbons.** Organic compounds in which chlorine has replaced one or more of the hydrogen atoms and which are fairly high-priced, toxic, the main reason for their limited usefulness, and generally not very flammable or not flammable at all—generally used in polysulfide formulas and as fire extinguishers.
- chlorinated rubber.** A white fibrous product, approximately $(\text{C}_{10}\text{H}_{13}\text{Cl}_7)$ X and soluble in benzene, chloroform, and acetone, obtained when chlorine is passed into a solution of crude rubber and substitution as well as addition of chlorine takes place; a tough transparent film, left when solutions evaporate, very resistant to concentrated sulfuric, nitric, and chromic acids; a component of certain rubber to metal adhesives.
- chloroprene.** A volatile, colorless liquid 2-Chloro-1, 3-butadiene, that boils at 59 C and is synthesized from acetylene—used in the manufacture of neoprene, obtained by polymerizing chloroprene under suitable conditions.
- churn.** A vessel in which rubber compounds are stirred into solvents; to stir or mix.
- clay.** Any naturally occurring mineral substance (a) that consists preponderantly of hydrous aluminum silicates, (b) that, when finely divided and mixed with water, yields a more or less plastic mass that can be formed and molded and will retain

its shape on drying, (c) that varies greatly in composition but in its purest form approaches the composition of kaolinite, $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ —used as a compounding ingredient in rubber and, in some cases, as a mild reinforcing agent.

cleavage. The rupturing of adhesive bonds between rigid materials; a prying action.

COC. Cleveland open cup; an instrument and test method used to determine flash points of solvents and, more commonly, of compounded materials (as adhesives, coatings, and sealers).

coefficient of elasticity. A coefficient that expresses the ratio between a stress of force per unit area that acts to deform the body and the corresponding fractional deformation caused by the stress: If a strip of rubber of length, l , and cross section, q , is elongated by an amount, l , when loaded with a weight, p , the relationship among these quantities, according to Hooke's law, is $\Delta l = a(lp/q)$ or, in differential form, $dl = a(ldp/q)$. The proportionality factor, a , is known as the coefficient of elasticity. If l is measured in meters, q in square millimeters, and p in kilograms, the coefficient of elasticity is equal to the elongation that is produced in a strip one meter long and one square millimeter in cross section by a load of one kilogram.

coefficient of expansion. The coefficient of linear expansion is the ratio of the change in length per degree to the length at 0 C; the coefficient of surface expansion is two times the linear coefficient; the coefficient of volume expansion for solids is three times the linear coefficient; the coefficient of volume expansion for liquids is the ratio of the change in volume per degree to the volume at 0 C.

coefficient of friction. The ratio of the force required to move one surface over another and the total force pressing the two surfaces together.

cohesion. That form of attraction by which the particles of a body are held together usually by primary or secondary valence forces; the internal strength of film.

cohesive failure. The tearing apart of the sealant as the joint expands and the adhesive (bone) capabilities of a sealant exceed its cohesive capabilities.

cold flexibility. The flexibility of a material following its exposure to a predetermined low temperature for a predetermined time.

cold flow. The permanent deformation under constant stress; the continuing dimensional change under static load that follows initial instantaneous deformation. Also see creep and compression set.

cold resistant. Withstanding the effect of cold or low temperatures without loss of serviceability.

cold rubber. GR-S polymerized at a temperature of 5 C or 41 F or lower and generally having physical properties (as abrasion resistance) better than those of rubbers polymerized at 50 C or 122 F.

compatibility. The ability of two or more substances to mix or blend without separation or reaction.

compressibility. The resistance offered by substances to high pressure: Natural rubber has extremely small cubic compressibility when pressure is applied to masses that are entirely confined. If a compressive force acts on rubber that is free to be displaced in any direction, it will undergo elastic deformation, storing up its applied energy and returning some of it when the force is removed, the difference being dissipated as heat. Because of this behavior, rubber has found wide use for damping vibration and absorbing shocks (as in mountings for motors and other machinery, cushions for impact hammers, railway-car shock absorbers, bumpers, rubber heels, and the like).

compression modulus. The ratio of either static or dynamic compressive stress to the resulting compressive strain, the latter expressed as a fraction of the original height or thickness in the direction of the force.

- compression set.** The residual decrease in thickness of a test specimen measured 30 minutes after removal from a suitable loading device in which the specimen was subjected for a definite time to compressive deformation under specified conditions of load application and temperature—measured by Method A, if vulcanized rubber under constant load, and by Method B, if vulcanized rubber under constant deflection (ASTM Designation D 395); the permanent deformation of elastomeric sealants when they are compressed too far and their internal structure is partially or completely destroyed so that they no longer possess memory to assume their previous shape.
- condensation.** A chemical reaction in which two different molecules react to form a new compound of greater complexity, with the formation of water, alcohol, and the like as a by-product.
- cone penetrometer.** An instrument that measures viscosity of heavy materials by releasing a cone of standard dimensions and weight on the surface of the material for a specified time interval and measuring the depth of penetration.
- consistency.** The viscosity or solidness of a semisolid or syrupy substance; that property of a body by which it resists deformation or permanent change of shape. Also called resistance to deformation. See viscosity.
- container stability.** The period of time a compound will remain in satisfactory condition when stored in unopened containers. Also called shelf life.
- continuous film.** A coating film that is free of breaks, pinholes, or holidays.
- control.** A product of known characteristics that is included in a series of similar service, or bench, tests to provide a basis for evaluation of one or more unknown products.
- copolymer.** A high polymer consisting of molecules containing large numbers of units of two or more chemically different types in irregular sequence: Butadiene and styrene form a copolymer known as GR-S.
- cracker bar.** A template or steel bar used to create a "handformed" control joint in green concrete.
- cracking.** Surface fissuring that develops on rubber articles exposed to the atmosphere, light, or heat or to repeated bending or stretching. Also called crazing if fissures are minute.
- crazing.** Fine cracks that may extend in a network on or under the surface of, or through a layer of, adhesive.
- creep.** The dimensional change with time of a material under load, following the initial instantaneous elastic deformation. Sometimes called cold flow, if at room temperature.
- cross-link.** To unite two large molecules by means of an atom or a small molecule with two active portions: Sulfur is considered to cross-link rubber molecules during vulcanization, and one 4-divinylbenzene cross-links two long molecules of polystyrene.
- crude rubber.** Natural rubber as it comes on the market.
- cumar resins.** Polymerized fractions of coal tar that contain cumarone and indene hydrocarbons, are neutral, and melt from 50 to 65 C—used in rubber compounding to increase tensile strength and tear resistance.
- cure.** To change the properties of a material by chemical reaction (as condensation, polymerization, or vulcanization) usually by the action of heat and catalysts, alone or in combination, with or without pressure.
- cure time.** The time that is required to produce vulcanization at a given temperature and that varies widely, being dependent on the type of compounding used, the thickness of the product, and the like.

- curing range. In vulcanization, an approximate range of curing times at a given temperature over which the physical properties of a vulcanizate do not change materially.
- curing temperature. The temperature at which the rubber product is vulcanized.
- curl. The tendency of a portland cement concrete pavement slab to arch upward at the center because of high surface temperature and to "dish" because of low surface temperature.
- cut back. A solvent dilution, generally applied to asphalt.
- cyclic. Describing chemical compounds whose structure consists of atoms in a ring arrangement instead of in an open chainlike arrangement: Carbocyclic compounds have a ring of carbon atoms only (as benzene), and heterocyclic compounds have, besides carbon, one or more elements other than carbon in the ring (as pyridine).
- cyclized rubber. Isomeric natural rubber hydrocarbon that (a) is formed by the action of sulfuric acid, sulfonic acids, sulfonyl chlorides, stannic chloride, mixtures of phenols and hydrochloric acid, and also by heat alone, (b) is tough, somewhat elastic, hard, and brittle, and (c) has less unsaturation than the rubber hydrocarbon.

D

- dangerous chemicals. Any substance or mechanical mixture or chemical compound of substances that is volatile or unstable, that tends to oxidize or decompose spontaneously thus creating fire or explosion, that may generate flammable or explosive gas, and that is capable of creating hazard to life or property when designated as such by rule or regulation of the Board of Fire Commissioners, Los Angeles, California, or by the Interstate Commerce Commission.
- deformation. Any change of form or shape produced in a body by a stress or force.
- degradation. Deterioration, usually in the sense of a physical or chemical process rather than a mechanical one.
- degree of dispersion. Fineness of subdivision of dispersed particles. Also see dispersion.
- degree of polymerization. The number of base units per molecule if the molecules are composed of regularly repeating units, or the number of monomeric units per molecule if the molecules have been produced by polymerization from identical monomers.
- dehydration. The removal of water as such from a substance; after formation from a hydrogen and hydroxyl group in a compound, the removal of water by heat or by dehydrating substance.
- dehydrogenation. The removal of hydrogen from a chemical compound usually by heat and generally in the presence of a catalyst (as nickel, copper, chromium oxide, sulfur, selenium, or platinum).
- denaturant. A substance that renders alcohol unfit to use as a beverage.
- density. The ratio of the mass of a body to its volume, or the mass per unit volume of the substance: When centimeter-gram-second units are used, the density of a substance is numerically equal to the specific gravity of the substance referred to water at 4 C, the temperature of maximum density (1.0000) of water. For ordinary practical purposes, density and specific gravity may be regarded as equivalent.
- depolymerization. The separation of a more complex molecule into two or more simpler molecules chemically similar to and having the same empirical composition as the original; the reverse of polymerization.
- depth of cut. The depth of a saw cut, usually from $\frac{1}{6}$ to $\frac{1}{4}$ of the thickness of slab, made to properly control slab cracking at the cut.

- deterioration.** The undesired change in properties of a material caused by aging, weathering, or exposure to other agents and conditions.
- diamond blades.** Steel-centered blades with diamond particles bonded with powdered metal around the rim—used for old concrete or any green concrete containing hard aggregate.
- dialysis.** The separation of crystalloids from colloids in a solution by diffusion through a membrane.
- diluent.** A diluting agent; any liquid or solid that, when added to another liquid or solid, reduces the quantity per unit volume of the base material in the total volume.
- discoloration.** Staining; changing of a color from the standard or control.
- dispersion.** The act of causing colloidal particles of matter to separate and become uniformly scattered throughout a medium; uniformly scattering throughout another phase or medium finely divided colloidal particles of one or more phases or components either solid, liquid, or gaseous although a wholly gaseous system is not considered a dispersion but a simple mixture: Colloidal solutions are examples of liquid dispersions in which the dissolved or dispersed particles are not subdivided down to the molecular state as in true solutions.
- dowel.** One type of load transfer device.
- drying time.** The time required for solvent dissipation after a film is spread; the several stages of the drying process that include (a) the tacky stage that starts almost immediately after application and reaches the optimum point when the adhesive may be touched lightly without transferring material to the finger and when the bond should be made, (b) the dust-free stage in which any dust settling on the film will not become embedded but may be wiped off after the material has been hardened, (c) the tack-free stage in which the finger can touch the film without feeling the slight retention of surface stickiness, (d) the print-free stage in which the finger may touch the film without leaving an imprint on the surface, and (e) the hard-dry stage in which the film becomes thoroughly hard so that it may be handled and polished if necessary.
- dry joint.** Joint wall or joint opening that has an absence of moisture.
- durometer.** An instrument for determining the hardness of rubber by measuring its resistance to the penetration (without puncturing) of a blunt indenter point impressed on the rubber surface against the action of a spring so that the resistance to penetration or "hardness" is indicated on a hand and a special scale that reads from 0 to 100, 0 being very soft and 100 being very hard.
- dyne.** Centimeter-gram-second unit of force equal to the force that produces one centimeter per second per second on a mass of one gram.

E

- elasticity.** The property of matter that causes it to tend to return to its original shape after deformation (as stretching, compression, or torsion); the opposite of plasticity; the stretchiness of rubber; the property of vulcanized rubber that allows it to be stretched to a phenomenal distance without losing its ability to return very nearly to its original shape: In this respect, rubber has the most elasticity of any other substance known.
- elastic limit.** The extent to which a body may be deformed and yet return to its original shape after removal of the deforming force: Steel has a well-defined elastic limit or yield point below which it is perfectly elastic. Vulcanized rubber, on the other hand, shows no definite elastic limit but takes more or less "set" depending on the amount of stretch given to it.

- elastomer.** A substance that can be stretched to at least twice its original length and, after having been stretched and the stress removed, returns to approximately its original length in a short time.
- electrolyte.** Any substance that, when dissolved in water or other suitable solvent, forms a solution that conducts electricity, the conductivity being due to ionic dissociation of the dissolved substance; a solution of an electrolyte.
- elongation.** The increase in length expressed numerically as a fraction or percentage of initial length.
- emulsion.** A dispersion of fine particles or globules of a liquid in another liquid normally incompatible with it and resulting in tight emulsions that cannot be easily broken and loose emulsions that can be easily broken to separate layers of relatively pure liquids; by custom, a term generally misapplied to dispersions, as in the case of "asphalt emulsions."
- endothermic.** A chemical reaction in which heat energy is absorbed: An endothermic compound absorbs heat during formation and is less stable than an exothermic compound; in fact, many endothermic compounds are explosive.
- erosion.** The destruction of metal or other material by the abrasive action of liquid or gas, usually accelerated by the presence of solid particles of matter in suspension and sometimes by corrosion.
- ester.** A compound produced by the reaction between an acid and an alcohol with the elimination of a molecule of water.
- exothermic.** A chemical reaction in which heat energy is liberated: More stable than endothermic compounds, exothermic compounds involve the evolution of heat in their formation. Vulcanization of rubber with sulfur is an exothermic reaction.
- extender.** An ingredient, generally having some binding properties, added to a compound to reduce the proportion of primary binder needed.
- extruder.** A machine with a worm gear used for extruding rubber through a die in preparing rods, strips, tubes, and rubber-covered wire.
- extruded compression joint seal.** An extruded multisectional synthetic rubber compound that is inserted in the joint under compression.
- extrusion failure.** A joint failure resulting from a shortage of sealant material during succeeding cycles of expansion and construction caused by the mastic sealant being forced too far out of its joint to be pulled back when the joint expands, and thus the volume of mastic in the joint is reduced by the amount forced out, which accumulates dirt and is flattened by traffic.

F

- fatigue failure.** The failure of a material under cyclic deformation.
- filler.** A relatively nonadhesive substance added to an adhesive to improve its working properties, permanence, strength, or other qualities.
- fillet.** A rounded bead or a concave junction of sealing compound over or at the edges of structural members.
- film.** A thin layer of material, not necessarily visible: Free films, often called unsupported films, are not attached to any body, but supported films have a flexible backing, usually cloth or paper, to give the film greater support and structural strength.
- flame resistant.** Denoting a material that does not burn too readily when the source of flame is removed.
- flame retardant.** A substance (as highly chlorinated hydrocarbons) mixed with rubber to retard its burning: Neoprene contains a flame retardant and is less flammable than natural rubber and GR-S.

flammable. A volatile liquid or gas that has a flash point of 30 F or lower. Also called inflammable.

flash point. The temperature to which a liquid must be heated before its vapors will flash or burn momentarily when, and only when, a spark or small open flame is applied: The several standard methods for determining flash point may be classified as open cup or closed cup. Most fire departments arbitrarily designate solvents with flash points below 20 F as extremely flammable, between 20 and 80 F as flammable, between 80 and 150 F as combustible, and those liquids with no flash points as nonflammable. Also see ignition point.

flow out. The ability of a material to level after application whether by brush, spray gun, roller, or pressure units. Also see orange peel and sagging.

Ford viscosity. Kinematic viscosity as measured by a Ford cup viscometer (named for the Ford Motor Company where it was first used) that measures the flow of a liquid from an orifice under its own hydrostatic pressure.

G

gage. The relative thickness of materials or articles that are made in different thicknesses; the thickness of fabric or rubber sheet, expressed in millimeters or thousandths of an inch, an instrument for measuring thickness.

gel. A semisolid, jellylike condition of matter; a form of colloidal dispersion in which the dispersed component and the dispersing medium are associated to form a jellylike mass: A solution of gelatin or glue in warm water is liquid and is called a sol, and the jelly into which the liquid changes as it cools is called a gel.

gelation. The change from a liquid to a jellylike state; in colloidal solutions, the change from the sol to the gel condition.

GR-S. See Buna-S and Buna-N.

green concrete. Portland cement concrete that has just been placed and is still workable.

H

hardener. A substance or mixture added to an adhesive to promote or control the curing reaction; a substance added to control hardness of the cured film.

hardness. The property or extent of being hard as measured by the extent to which the indenter point of any one of a number of standard hardness-testing instruments fails to penetrate the product.

heat seal. To bond or weld a material to itself or to another material with the use of heat and with or without the use of adhesive, depending on the nature of the materials.

heterogeneous. The opposite of homogeneous; consisting of dissimilar elements, ingredients, components, or phases; describing the specific association of diverse phases or compounds that characterize colloid systems; describing composition or structure: A composition of matter may be heterogeneous with regard to ingredients but be homogeneous in spatial distribution of these.

homogeneity. The uniformity of composition throughout the material.

homogeneous. The opposite of heterogeneous; consisting of the same element, ingredient, component, or phase throughout; having uniform composition throughout: Crystalloids and crystalloid solutions (true solutions) are usually considered homogeneous systems of matter as opposed to colloids that are heterogeneous or polyphasic.

Hooke's law. The law that the stress on a solid substance is directly proportional to the strain produced, provided the strain is less than the elastic limit of the substance.

humidity. Pounds of water vapor carried by one pound of dry air under any particular conditions.

hydrocarbon. An organic compound that contains only the elements carbon and hydrogen and that may be gaseous (as methane, ethylene, butadiene), liquid (as pentane, benzene), or solid (as rubber, naphthalene): Many thousands of hydrocarbons are known and for convenience are classified into groups having members that possess similar properties and composition.

hydrocarbon, rubber. The hydrocarbon of natural rubber, generally $(C_5H_8)_x$ (because isoprene is obtained from it by pyrolysis), purified by solution and precipitation with alcohol, being about 94 percent in pale crepe and 90 to 95 percent in smoked sheet, and having a molecular weight that varies but may be as high as over 1,000,000.

hydrometer. A device for determining the approximate specific gravity of a liquid by measuring the extent of immersion when the instrument floats in the liquid.

hydrophilic. Having a fondness or attraction for water; describing colloids (as glue, gelatin, agar, starch, gum arabic) that are capable of swelling with water to form reversible gels; the opposite of hydrophobic.

hydrophobic. Having no attraction for water; describing colloids (as rosin or rubber) that do not form gels with water; the opposite of hydrophilic.

hygroscopic. Having the property of attracting moisture.

I

ignition point. The temperature at which the liquid gives off sufficient vapors to burn continuously upon the application of a flame, this temperature ordinarily being 40 to 80 degrees higher than that of the flash point of the liquid. Also see flash point.

immersion. The placing of an article into a fluid so that it is completely covered.

impact. The single instantaneous stroke or contact of a moving body (as a large lump of material dropping on a conveyor belt) with another either moving or at rest.

impact strength. The measure of the toughness of a material (as the energy required to break a specimen in one blow).

impregnate. To fill the interstices of an article (as textile fabrics, yarns, and cords) with a rubber compound.

infrared. The part of the invisible spectrum that is contiguous to the red end of the visible spectrum and that comprises electromagnetic radiations of wavelengths from 0.8 to 1,000 microns: Infrared radiation is used for the spectroscopic examination of high polymers. Infrared absorption spectra of high polymers are usually obtained for wave numbers of 1800 to 600 cm^{-1} and the percentage of absorption recorded on a chart. Comparisons for structure are made of low molecular weight substances that contain what are assumed to be similar groups.

interface. The common boundary surface between two substances; sometimes two surfaces with no space between them as, for example, the air-paper interface where the air contacts this paper.

internal failure. Failure of a sealant under extension that may slowly tear apart internally, usually caused by fatigue or by an air bubble inside the sealant.

internal mixer. An enclosed machine as the Banbury mixer and the Shaw Intermix for mixing rubber or other suitable material, inside of which are two heavy mixing

rotors that revolve in opposite directions with small clearance between themselves and the enclosing walls and a mixing chamber that is jacketed or otherwise arranged for water-cooling and is provided with a feeding hopper that can be closed by means of a pneumatically operated, vertical ram.

intrinsic viscosity. The ratio of the difference between the viscosity of the solution at the given concentration and the viscosity of the pure solvent to the product of the viscosity of the pure solvent and the volume concentration of the solution, expressed as (1 cc solute/100 cc solution); computed on the benzene soluble portion of the elastomer and numerically equal to $[(2.303 \times \log \times \text{relative viscosity})/\text{grams of elastomer per 100 ml of benzene}]$.

J

joint. The location at which two adherends are held together by an adhesive.

joint, construction. A joint, either transverse or longitudinal, used during construction: A transverse construction joint is created when construction stops, for any reason, and when the location of the stoppage does not coincide with the planned location of a transverse joint. A longitudinal construction joint may be used in lane-at-a-time construction.

joint, contraction. A joint provided to control cracking and to limit to a significant degree the curling or warping stresses induced by temperature and moisture changes in the pavement; usually a transverse joint constructed across a paving lane, perpendicular to the centerline, at designated intervals. Also called weakened plane joint or dummy joint.

joint, dummy. A plane of weakness troweled into concrete pavement to eliminate intermediate cracking.

joint, expansion. A joint, either transverse or longitudinal, provided to prevent excessive stresses in pavements caused by expansion of the concrete or to prevent distortion to a pavement feature through the expansion of an adjoining pavement; a joint constructed to separate from the pavements any structure that projects through, into, or against them, and at certain designated intervals in the pavements.

joint fillers. Strips of nonextruding, resilient, bituminous or nonbituminous materials placed in newly laid concrete pavements to provide a joint: Modern practice is to remove about an inch of the upper portion after the pavement has cured and to refill the space.

joint, insert. Generally a metal or plastic insert that is depressed in plastic or green concrete to create desired plane or weakness.

joint, longitudinal. A joint, either construction or dummy, parallel to a paving lane; a longitudinal construction joint between two pavement lanes placed at different times.

joint residue. An accumulation of foreign matter, laitance, and protrusions that must be removed from joint side walls prior to sealing; an accumulation of old sealant material on the joint walls that must be removed prior to the resealing of joints.

joint, sawed. A transverse or longitudinal contraction joint or a transverse expansion joint cut by a process utilizing a concrete saw.

joint sealers. Materials placed in pavement joints to prevent entrance of water or debris into the joint cavity: Most joint sealers are pourable with either one component or two components, and applied either hot or cold. Also in use are the compression seals, preformed strips of elastomeric materials, that are compressed and inserted into the joint and maintain a seal by continuously exerting pressure against the joint walls rather than by relying entirely on bond to the concrete joint walls as do the pourable sealers.

joint, skewed. A nonsymmetrical joint or joint oblique to the longitudinal axis of the pavement.

joint, transverse. A joint perpendicular to traffic, generally spaced 15 to 60 feet on center, to control cracking as concrete cures.

joint vibrator. Equipment used to displace large aggregate in plastic concrete prior to installation of the joint insert.

joint, wide-top. A sawed joint that has been widened in the upper portion to provide a proper depth-to-width-ratio sealant reservoir and to produce a joint with an improved "shape factor."

jute. See roving.

K

ketones. Compounds that contain the carbonyl group to which is attached two alkyl or aryl groups and those (as methyl ethyl ketone) that are commonly used as solvent for resins and plastics.

L

latex. A milky juice, other than sap, secreted by special cells, usually present in all parts of the plant, of certain plants that, according to their differences, yield latexes with widely varying properties: Hevea latex, of greatest interest, is thin and white like milk and consists of a dispersion of rubber in an aqueous serum containing other substances.

liter. A measure of capacity in the metric system equal to 61.022 cubic inches, 0.908 dry quart, and 1.0567 liquid quarts.

load transfer device. Any mechanical device embedded in the concrete on both sides of a joint, the purpose of which is to prevent vertical movement of the joint under load.

low temperature flexibility. The ability of a rubber product to be flexed, bent, or bowed at low temperatures.

lumps. Surface protrusions, usually of the basic material as distinguished from foreign material.

M

MAC. Maximum allowable concentration, parts per million, of solvents in the atmosphere that constitutes healthful conditions for workers exposed to them: The value given to MAC, in some cases, is quite arbitrary because the effects on the human body from inhalation of some of the solvents are difficult to measure and because some of the solvents now used are relatively new and their effects have not yet been definitely established.

MacMichael viscosimeter. An instrument for measuring the viscosity of fluids that consists of a 1-centimeter diameter cylindrical spindle immersed in the specimen fluid to a depth of 4 centimeters and suspended from wires of different diameters, expressed in B and I gage numbers, in such a manner that any torsion in the wire is indicated on a dial on which the viscosity is read as the specimen in a half-pint can is rotated on a turntable at 20 revolutions per minute.

mastic. An adhesive of such a consistency that it must be applied by notched trowel, gob, or buttering methods.

matrix. A mold or form in which anything is cast or shaped; a continuous medium in which discrete particles are embedded as in mineral ores; the rubber in rubber compounds that is the continuous or outside phase in which compounding ingredients are dispersed.

melting point. The temperature at which a polymer loses its crystalline character as evidenced by X-ray diffraction studies; for low molecular weight solids, the temperature at which a solid melts and becomes liquid. Also called the X-ray melting point.

membrane cure. A liquid spray that may be mixed with pigment to reflect sunlight—used to control rate of cure.

mercaptan. An organic compound containing the -SH group, with either an aliphatic or an aromatic radical attached: Dodecyl mercaptan is used as a modifying agent in the synthesis of rubberlike polymers. Also called a thiol.

methanol. Methyl alcohol, CH_3OH .

methyl ethyl ketone. A useful low-boiling solvent that possesses all the valuable properties of acetone without its extremely high volatility and that has a boiling point at 80 C or 176 F, a flash point at 19 F, and vapor pressure of 77 millimeters per 20 C: Methyl ethyl ketone is a good solvent for nitrile rubber and for some of the more difficult soluble materials like the vinyl resins. Also called MEK.

methyl isobutyl ketone. A solvent with a boiling point at 118 C or 244 F, a flash point at 74 F, and a vapor pressure of 13 millimeters per 20 C. Also called hexone.

migration. The transfer of an ingredient in a rubber compound from one layer to an adjacent layer or to the surface.

mil. A unit of length equal to one-thousandth of an inch.

milliliter. A unit of capacity in the metric system equal to 1/1,000 liter or to one cubic centimeter.

millipoise. A unit of viscosity equal to 1/1,000 poise; millipoises/ $10d^t$ = centistoke, where d^t is the density of a substance at the same temperature, t.

miscible. Soluble or compatible with each other; capable of being mixed to form a homogeneous mass.

mixer. A machine, other than a mill, that mixes rubber compounds, doughs, or cements in a covered chamber or trough where two blades or rotors revolve in opposition to each other with their axes either in a horizontal position (as in the Banbury mixer) or in a vertical position (as in some types of cement mixers), in which case, both the blades and the mixing chamber may rotate.

mixing. The incorporating of the ingredients of a rubber compound into the rubber, usually in a mixing mill or in an internal mixer, in a process that consists of (a) breaking down the rubber, (b) gradually incorporating compounding ingredients, (c) cutting back or final working of the rubber after all ingredients are in, and (d) removing the mixed compound from the mill in sheets; the completed mixture, which may also be called mix.

modulus. In the physical testing of rubber, the ratio of stress to strain, i. e., the load in pounds per square inch or kilograms per square centimeter of initial cross-sectional area necessary to produce a stated percentage elongation; a measure of stiffness and influenced by pigmentation, state of cure, quality of rubber, and other factors.

modulus of elasticity. The length of a column multiplied by the weight of the material per unit volume; the ratio of stress to strain within the elastic range, expressed in pounds per square inch per unit strain: In many nonrubber materials the modulus of elasticity may be taken in tension or compression for the values are approximately

the same, but in rubber materials the assumption that tension modulus equals compression modulus is valid only for extremely small deformations and for certain shapes such as those specified in ASTM Designation D 797 and ASTM Designation D 1053, Section 7. Also called Young's modulus of elasticity.

moisture. Very finely divided particles of water: Moisture in the form of steam or of a jet of water is sometimes used in a kiln to regulate the humidity.

moisture absorption. The absorption of moisture by a rubber or textile product.

mold. A form of matrix for shaping anything in a fluid or plastic state; in rubber manufacturing, the forms in which rubber articles are vulcanized and given the shape desired.

motting. A film defect associated with spraying that appears as a uniform series of imperfections with approximately circular shapes.

N

necking down. The diminution of the cross-sectional area of a rubber product.

nerve. The degree of toughness or resistance to deformation of unvulcanized rubbers or compounds.

nitrile rubber. The various copolymers of butadiene and acrylonitrile that vary essentially in butadiene-acrylonitrile ratios, Mooney values, and staining properties and that are resistant to solvents, oils, greases, heat, and abrasion. Also see Buna-N and Buna-S.

nonblocking. Describing an applied adhesive or coating film that will not adhere to either itself or other surfaces under normal stacked storage conditions.

nonpolar solvent. The aromatic or petroleum hydrocarbon group characterized by low dielectric constants that are relatively nonconductive to electrical current.

nylon. A condensation product of hexamethylene diamine and adipic acid; a polyamide resin.

O

oil, drying. Oil that dries to a varnishlike film on exposure to air and sunlight: Linseed oil, tung oil, and perilla oil are the three principal drying oils used in paint and varnish manufacture.

oil paint. The simplest form of paint having no resin and consisting only of drying oil, thinner, and drier.

opaque. Impervious to light; not transparent; allowing neither light nor an image to be seen through it.

open time. Time interval between spreading the adhesive and completing the bond.

optimum cure. State of vulcanization at which maximum desired property is attained.

orange peel. The surface appearance when a sprayed material does not flow or level.

organisol. A dispersion of extremely finely divided resin particles suspended in a mixture of organic liquids that are incapable of dissolving the resin at normal temperatures.

organosol. A colloidal solution or sol in which the dispersion medium or solvent is an organic liquid.

- osmosis.** The tendency of water or crystalloids in aqueous solution to pass through colloidal septa (as animal membranes, vegetable parchment, gelatinous matter): Colloids in solution, or dispersion, move by osmosis only to a slight extent. Also see dialysis.
- osmotic pressure.** The pressure developed on the solution side of a semipermeable membrane.
- overcure.** A state of excessive vulcanization resulting from overstepping the optimum cure, i. e., vulcanizing longer than necessary to attain full development of physical strength: Overcure is manifested by softness or brittleness and impaired age-resisting quality of the vulcanizate.
- oxidation.** The formation of an oxide, or more generally any increase in valence of an element; the act or process that oxidizes, combines, or increases the proportion of oxygen; the degradation of polymeric materials as a result of natural aging, severe working in air, or accelerated aging in high concentrations of oxygen or ozone.
- ozone.** An allotropic form of oxygen, O_3 , and a powerful oxidizing agent, having a characteristic odor and produced by the action of electrical discharges on oxygen: Rubber compounds in a stretched condition are susceptible to the deteriorating action of ozone in the atmosphere, which causes them to crack.
- ozone resistant.** Withstanding the deteriorating effects (generally cracking) of ozone.

P

- paper cure.** A process utilizing paper (as Sisal-Kraft paper) moisture barriers in sheet form to control the curing of concrete.
- parabolic.** Describing the shape of the road surface crown.
- pavement growth.** An increase in length of a group of rigid slabs caused by successive intrusions of incompressibles into the joints; concrete expansion caused by aggregate reactions.
- peelback.** A method for separating a bond of two flexible materials, or a flexible and a rigid material, whereby the flexible material is pulled from the mating surface at a 90 or 180 degree angle to the plane in which it is adhered by concentrating the stress only along the line of immediate separation: Strengths in peelback are expressed in pounds per inch width.
- peeling.** The loosening of a rubber coating or layer from a base material (as cloth or metal) or from another layer of rubber.
- penetrometer.** An instrument for determining the hardness or consistency of plastic or elastic solids (as asphalt, bitumen, tar, rubber) by the penetration of a standard weighted needle impressed on the surface of the sample under standard conditions of time, temperature, and load.
- permanent set.** The amount by which an elastic material fails to return to its original form after a deformation; in the case of elongation, the difference between the length after retraction and the original length, expressed as a percentage of the original length: Permanent set is dependent on quality and type of rubber, degree and type of filler loading, state of vulcanization, and amount of deformation.
- permeability.** The quality or condition of allowing passage of liquids or gases through a rubber layer.
- petroleum.** A mixture of hydrocarbons in a soft semisolid form.
- petroleum ether.** Low boiling aliphatic fraction, derived from crude petroleum by fractional distillation, whose low boiling ranges, near 100 F, and high evaporation

rates restrict its use as a solvent in product manufacture, except where its very fast drying characteristic is preferred: Although petroleum ether bears no resemblance chemically to pure ether, they both have high evaporation rates.

phenolic resins. Thermosetting resinous products obtained by a condensation reaction of phenol with formaldehyde or other aldehyde and sometimes compounded with nitrile rubbers.

pH. Hydrogen ion concentration; the negative logarithm, to the base 10, of the hydrogen ion concentration of a solution: $\text{pH} = \log 1/(\text{H}^+)$.

pickle. A solution or process used to loosen or remove corrosion products (as scale and tarnish) from a metal.

pigment. A dry colored powder used for coloring paint, rubber, or other medium by direct admixture; in biology, any organic coloring matter whose presence in plant or animal tissues gives color to them; in rubber, sometimes fillers and reinforcing agents.

pinholing. A film defect characterized by the presence of tiny holes, generally those caused by solvent bubbling, moisture, other volatile products, dry spraying, or the presence of extraneous particles in the applied film.

pitch. A black or dark heavy liquid or solid substance left as a residue after distilling tar, oil, and similar materials; a substance found naturally as asphalt. Pitch is named according to its source (as bone pitch from bone oil and petroleum pitch from petroleum).

piw. Pounds per inch width.

plastic flow. The moving and flowing of one over another of the internal units of a substance with such tendencies when subjected to a stress and when started by a finite force.

plasticity. The property that is possessed by certain solid materials of keeping the shape or form imparted to them by a deforming force, is characterized by a complete lack of elasticity, and may be regarded as a state of matter in which internal friction and tendency to flow balance each other: Plasticity is produced in many rigid materials by heating them so that they can be shaped in molds under pressure to any desired form. The plasticity of rubber that has been worked on a mill is more or less imperfect; but it is the ability of rubber to assume this plastic state under the influence of mechanical work, heat, and oxygen that enables it to be worked through the various processes of manufacture.

plasticizer. A substance that softens or plasticizes another substance through its solvent action.

plastics. Natural and artificially prepared organic polymers of low extensibility, as compared with rubber, that can be molded, extruded, cut, and worked into a great variety of objects, rigid or nonrigid, and used as substitutes for wood, metals, glass, rubber, leather, fibers, and textile materials and that are formed by condensation polymerization (as in the case of phenol-aldehyde resins) and by vinyl polymerization (as in the case of polyvinyl chloride resins): The first commercial plastic, celluloid was introduced by Hyatt in 1869; and the first commercial thermosetting resin was introduced by Baekeland in 1909. Certain plastics are derived from casein, and some of the most recent products are organo-inorganic (as the silicones). Many are also called synthetic resins.

plastisol. A colloidal dispersion of a resin in a plasticizer.

plastomer. An instrument that measures the plasticity of uncured rubber and may be (a) the type that measures the rate of extrusion of the rubber through an orifice under controlled pressure and temperature, (b) the type (as the Williams and Goodrich instruments) that is based on compression of a definite volume of the rubber between

parallel plates and that under controlled pressure and temperature measures final thickness and recovery, and (c) the type (as the Mooney plastomer), now the most widely used, that measures the shearing action of a definite volume of the rubber between two parallel, rotating metal discs at a controlled temperature: The Pusey-Jones plastometer measures hardness of vulcanizates not plasticity of uncured stocks.

plexiglas. A resinous acrylic derivation.

plowing out. A process utilizing a farm-type tractor with special hook-shaped plow to remove deteriorated sealing material prior to resealing.

poise. The centimeter-gram-second unit of viscosity equal to the viscosity of a fluid in which a stress of one dyne per square centimeter is required to maintain a difference of velocity of one centimeter per second between two parallel planes in the fluid that lie in the direction of flow and are separated by the distance of one centimeter—derived from Poiseuille, the name of the man who discovered the laws of flow.

polar molecule. An unsymmetrical molecule (as that of water or sulfur dioxide) that has electronic charges whose mean center does not coincide with the mean electrical center of the nuclei, that may be regarded as an electric doublet or dipole analogous to a tiny magnet, and that has an electric moment equal to the distance between the two electrical centers multiplied by the total electric charge of either sign in the molecule: Liquid polar molecules in an electric field tend to orient themselves so that their potential energy is reduced to a minimum. When the electrical centers of a molecule coincide, the molecule has no electric moment and is said to be non-polar.

polar solvent. A solvent (as alcohols and ketones) that contains hydroxyl or carbonyl groups, has high dielectric constants, and shows strong polarity.

polyamide resin. A resin (as nylon) usually derived from adipic acid and alkylene diamines.

polybutadiene. Various elastomeric polymers of 1, 3-butadiene, prepared by treatment of butadiene with metallic sodium, by emulsion type of polymerization, and by Alfin catalytic polymerization.

polyisoprene. Elastomeric polymers of isoprene, the first synthetic rubber, prepared in 1879 by G. Bouchardat and in 1884 by William Tilden, who also noted in 1886 the spontaneous polymerization of isoprene probably by the action of peroxides formed by oxygen in the air, prepared in 1910 by Matthews and Strange in England and by Harries in Germany by treatment of isoprene with metallic sodium, and also prepared by treatment of isoprene by emulsion recipes and by the Alfin catalyst: Polyisoprene adds hydrogen chloride to form the hydrochloride, whereas polybutadiene does not.

polymer. A long chain of units, either similar or different, of monomers prepared by means of an addition or a condensation polymerization or both: There are copolymers, dipolymers, tripolymers, quadripolymers, and high polymers.

polymerization. Chemical reaction in which the molecules of a monomer are linked together to form large molecules whose molecular weight is a multiple of that of the original substance. Also see degree of polymerization.

polystyrene. See roving.

polysulfide rubber. A synthetic polymer that is obtained by reaction of sodium polysulfide with organic dichlorides (as dichlorodiethyl formal) alone or mixed with ethylene dichloride, has outstanding resistance to light, oxygen, oils, and solvents, has outstanding impermeability to gases, has resiliency and excellent low temperature flexibility, but has poor tensile strength and abrasion resistance.

- porosity.** Presence of numerous minute voids in the cured material; open cells in the skin of cellular rubber and, in this case, not a defect.
- pot life.** The rating in hours of the time interval following the addition of accelerator before a chemically curing material will become too viscous to pass predetermined viscosity (consistency) requirements. Also see working life.
- pressure sensitive adhesive.** An adhesive that retains its tack even after complete release of the solvent.
- primer.** Special coating designed to provide adequate adhesion of a coating system to new surfaces and, in the case of new wood, used to allow for the exceptional absorption of the medium: Primer for coating metal for steel work contains special anti-corrosive pigments or inhibitors (as red lead, white lead, zinc powder, zinc chromate).
- psi.** Pounds per square inch.
- pyrometer.** A mold, needle, roll, or wall type instrument that measures temperatures, especially those beyond the range of the mercurial thermometer, by using the change of electrical resistance, the production of a thermoelectric current, the expansion of gases, the specific heat of solids, or the intensity of the heat of light radiated.

R

- random cracking.** Irregular and uncontrolled cracking.
- reinforcement.** Stiffening effect of solids (as carbon black) on unvulcanized elastomer mixture; enhancement by solids of properties of vulcanized mixture (as increased modulus, tensile strength, toughness, resistance to abrasion, and tear).
- reflection cracks.** A crack through portland cement or asphaltic concrete overlay directly over a working joint or random crack in original concrete surface.
- relative humidity.** The ratio, expressed as a percentage, of the amount of water present in a given volume of air at a given temperature to the amount required to saturate the air at that temperature: If a given volume of air contains only half as much water vapor as it could hold at that temperature, it is said to be 50 percent saturated or to have a relative humidity of 50 percent.
- resilience.** In metals and some other materials, the amount of energy stored up in a deformed body and also, because no loss of energy is contemplated, the amount of energy recoverable when the force producing the deformation is removed; in rubber or rubberlike materials subjected to and relieved of stress, the ratio, expressed as a percentage, of energy given up on the recovery from deformation to the energy required to produce the deformation.
- resin.** Any one of a class of solid or semisolid organic products of natural or synthetic origin, generally water-insoluble and having little or no tendency to crystallize, although some are readily dispersible in water and a few are readily crystallized.
- resin stages.** In the A-stage, thermosetting resins are in the early stage of reaction and are soluble and fusible. In the B-stage, thermosetting resins are at the intermediate stage of reaction when they soften when heated and swell in contact with liquids but do not entirely fuse or dissolve; this is the preferred stage for the resin and molding compositions. In the C-stage, thermosetting resins are in the final stage of reaction when they are infusible and insoluble; this is the state of the resin in the final molded article.
- retarder.** Any substance whose presence in relatively small proportion retards a chemical reaction; a substance that when added in small proportion to a rubber compound, retards the rate of vulcanization; an antiscorching agent (as phthalic anhydride, or salicylic acid).

- reversion.** The change that occurs in vulcanized rubber as the result of aging or overcuring in the presence of air or oxygen, usually resulting in a semiplastic mass; the basis of rubber-reclaiming processes in which reversion is aided by the use of swelling solvents, chemical plasticizers, and mechanical disintegration to obtain a workable mass.
- Rex hardness.** The hardness of a "soft" vulcanized rubber or other similar elastic material as measured by the Rex hardness gage.
- rheology.** Science of deformation and flow of matter that also deals with laws of plasticity, elasticity, and viscosity and their connection with paints, plastics, rubber, oils, glass, cement, and the like.
- rigidity.** The property of bodies by which they can resist an instantaneous change of shape; the reciprocal of elasticity.
- roof top.** A description of the shape of the road surface.
- routing.** The removal of old sealant material or the widening of a crack by a power-driven rotating metal bit.
- roving.** A round sliver of material placed at the top of the joint temporarily to prevent a membrane spray-curing compound from contacting the joint side walls; material placed at top to cure the joint; a round sliver of material placed at the bottom of the joint to act as a bond breaker.
- rpm.** Revolutions per minute.
- rubber.** Elastic substances obtained exclusively from latex-bearing tropical shrubs and trees that grow wild or are cultivated on plantations or obtained synthetically by the artificial polymerization of certain unsaturated hydrocarbons, straight or chlorinated, or by the copolymerization of mixtures of unsaturated hydrocarbons or of mixtures of unsaturated hydrocarbons with other polymerizable substances (as acrylonitrile): Tihokol, polyacrylates, and silicones are frequently called rubbers but are more properly called elastomers, a broader classification than rubber.
- rupture.** The fracture of a specimen.
- rupture stress.** The stress at the time the specimen fractures.

S

- sagging.** Running or flowing in the finish of a coating caused by the application of too much material or by material that is too thin or both.
- sandblast.** To thoroughly clean and to completely remove all concrete curing membrane compound, laitance, or other foreign matter or all of these from the side walls and upper edges of the joints.
- scoring.** The effect of a variety of wear in which the working face acquires grooves, axial or circumferential, according to whether the motion is reciprocating or rotary; a similar effect on the rigid member.
- sealer.** A continuous film to prevent the passage of liquids or gaseous media; a high-bodied adhesive generally of low cohesive strength to fill voids of various sizes to prevent passage of liquid or gaseous media; a coating used to seal the sand-scratched surface of a primer in order to obtain a smooth uniform paint base over rough metal: Sealers are products of low pigmentation.
- seam.** A line that results when joint material forms a single ply or layer.
- self-leveling.** Having the same height everywhere; having the ability to flow to a plane parallel to the plane at the horizon or to reach the same horizontal plane.
- selvage edge.** The lengthwise woven edge of a fabric.

- semicure.** To partially cure; the first cure of an article that is given more than one cure in its manufacture.
- set.** The point at which a film either has dried sufficiently, released enough solvent, so that it is tough or hard or has cured sufficiently after the addition of the accelerator to sustain the required load or pressure.
- set, permanent.** See permanent set.
- shape factor.** The major factor in joint design for sealant material; the depth to width proportion.
- shear.** The progressive relative displacement of adjacent layers because of strain or of a lateral motion.
- shear bond.** The apparent bond between a specimen and the stationary substrate obtained by shearing the specimen in such a manner that the moving portion has completely cleared the stationary portion.
- shear test.** A method by which two materials are separated by a force, distributed over the entire bonded area at the same time, that either by compression or tension causes the interfaces to slide over each other: Strengths in a shear test are recorded in pounds per square inch.
- shearing strength.** The maximum load required to shear the specimen in such a manner that the moving portion has completely cleared the stationary portion—usually expressed in pounds per square inch based on the area of the sheared edge or edges.
- shearing stress.** The maximum stress that the specimen undergoes when it is sheared in such a manner that the moving portion has completely cleared the stationary portion.
- shelf aging.** A method for determining the resistance of rubber articles to perishing by storing them under atmospheric conditions, either in light or in darkness, and testing them after definite lapses of time; the natural deterioration of rubber articles kept in storage or "on the shelf" under atmospheric conditions.
- shelf life.** The period of time a packaged adhesive, coating, or sealer can be stored under specified temperature conditions and remain suitable for use.
- Shore hardness.** A value of specific degree of hardness as obtained from the Shore hardness tester or durometer, a small pocket-sized instrument that gives a measure of the resistance of a rubber surface to penetration of a blunt point pressed onto the surface by hand and whose accuracy decreases in the softer range of rubbers (ASTM Designation D 314).
- shoulder.** The riding surface immediately adjacent to the edge of the pavement.
- shrinkage.** The percentage loss in weight of a material when put through a particular process (as the washing and drying of crude rubber); the percentage diminution in area or volume of a piece of processed unvulcanized rubber compound on cooling; the contraction of molded vulcanized rubber on cooling.
- side-wall surface.** That portion of the joint interface that is to be sealed.
- silica gel.** A form of colloidal silica that has the appearance of coarse sand, has many fine pores, is extremely absorbent, and is used as a catalytic material.
- silicone rubber.** A rubber prepared by the action of moisture on dichlorodimethyl silicon, withstands temperatures from -120 to 500 F, and is vulcanized with benzoyl peroxide.
- sizing.** The material used to fill pores on a surface and thus reduce absorption of a subsequently applied adhesive or otherwise modify properties of the adherend to improve adhesion; also the process of applying the material.

- softening point.** The temperature at which a prescribed load will cause the failure of a one square-inch shear bond of cloth to steel: Softening under heat is progressive, increasing with temperature. Rarely is it stated that a product is hard or soft at a certain temperature, but rather what weight per inch of area can it support without failure. A bond under high tension will not withstand as much heat as one under light tension, and raising or lowering the temperature will to a point decrease or increase the apparent strength of an adhesive.
- solid.** A substance that undergoes permanent deformation only when subjected to shearing stress in excess of some finite value characteristic of the substance (yield stress).
- solid, elastic.** A substance in which, for all values of the shearing stress below the rupture stress or shearing strength, the strain is fully determined by the stress regardless of whether the stress is increasing or decreasing.
- solid, plastic.** A substance that does not deform under a shearing stress until the stress attains the yield stress, when the solid deforms permanently.
- solubility.** The degree to which a substance will dissolve in a particular solvent usually expressed as grams dissolved in 100 grams of solvent.
- solution.** A homogeneous mixture in a single phase of two or more components having proportions that may be varied within certain limits.
- solvent.** The medium within which a substance is dissolved; liquids used to bring particular solids into solution, e. g., dichloroethylene is a solvent for rubber.
- solvent swell.** The swelling of nearly all rubber products in solvents that will finally dissolve some of them: The swelling of a product in different solvents or the swelling of different rubbers in the same solvent can be compared by measuring the sizes of the swelled specimens and tabulating the results.
- spalling.** A surface failure of concrete that, if present adjacent to a joint occurrence, is caused by overmanipulation of concrete or sawing too early
- specific gravity.** The ratio of the weight of any volume of a substance to the weight of an equal volume of another substance at stated temperatures taken as a standard, water being the standard for solids or liquids and air or hydrogen being the standard for gases.
- specific volume.** The reciprocal of specific gravity or one divided by specific gravity; the volume in liters of 1 kilogram or the volume in cubic feet of 1,000 pounds or, to be exact, 998.9 pounds; the ratio between the volume of 1 pound or 27.72 cubic inches of water and the volume of 1 pound of the material in question.
- stability.** The property that allows a compound to be stored under specified conditions without loss of its original properties.
- stickiness.** A quality possessed by a solid having a low yield value and high mobility by means of which contact readily results in adhesion. Stickiness is present in substances (as adhesive, varnish, printer's ink, and gold size) under working conditions, but is lost when most of these dry out, set, gel or harden through chemical or other change. Also see tackiness.
- Stormer viscosimeter.** An apparatus consisting of a vertically disposed cylinder that is caused to rotate in latex at a uniform rate for the determination of its viscosity.
- stoke.** A unit of kinetic viscosity equal to the viscosity of a fluid in poises divided by the density of the fluid in grams per cubic centimeter.
- strain.** The ratio of the elongation of the test specimen to its original length, that is, the change in length per unit of original length—expressed as a dimensionless ratio.
- strength.** The maximum stress required to overcome the cohesion of a material; quantitatively, a complex property made up of tensile strength and shearing strength;

the force required to break a bar of unit cross section under tension, that is, the tensile strength: Strength depends not only on the cohesion but also on the consistency and therefore, at least to some extent, on the rate of application of the load. Strength involves the idea of resistance to rupture.

stress. Force per unit of original cross-sectional area required to stretch a specimen to a stated elongation (ASTM Designation D 412).

stress relaxation. The decay in stress in an elastomeric sealant caused by a constant deformation for an extended time period.

stress-strain. The relationship of load and deformation in any soft vulcanized rubber compound or other body under a stress usually expressed in pounds per square inch or kilograms per square centimeter (1 kilogram per square centimeter = 14.22 pounds per square inch) of initial cross-sectional area required to stretch a rubber to a given percentage elongation: The stress-strain curve shows the relationship graphically from zero loading to rupture.

subgrade. The substrata of earthen materials immediately below the pavement slab.

substrate failure. A failure that occurs where the concrete surface of the joint walls are weak and that may be caused by sealants having high tensile strength and tending to tear off concrete or mortar material at the joint face.

surface preparation. The preparation of a foundation surface so that the materials to be adhered will promote optimum performance of an adhesive, coating, or sealer: If higher bond strength is required, surface preparation may involve abrading or acid etching the surface or both to improve the adhesion of the bonding material to the mating surfaces. Common methods of surface preparation are solvent washing, sandblasting, and vapor degreasing.

surface tension. The contractive force in the surface film of a liquid that tends to make the liquid occupy the least possible volume, that is caused by the tendency of the body of liquid to attract the unbalanced surface molecules toward the interior, that is expressed in dynes per centimeter and varies for different liquids, being very high for mercury and very low for ether, and that decreases with increasing temperature: Lyophilic colloids in sol form (as soap and gelatin solutions) lower the surface tension of the medium appreciably, and lyophobic colloids have practically no effect.

suspension. A dispersion of material particles in a liquid medium: Suspensions may vary from coarse-grained mixtures, the particles of which are visible by eye and settle out readily, to colloidal solutions or sols in which the suspended particles, also called suspensoids, are so fine that they can only be seen with the ultramicroscope and show no tendency to settle.

swelling. The property of raw or vulcanized rubber to absorb organic liquids (as benzene or gasoline) and to swell to many times its original volume, the similar property of other colloids in contact with other liquids; any increase in volume of a solid substance caused by the absorption of a liquid.

synthetic rubber. Elastomer manufactured by a chemical process as distinguished from natural rubber obtained from trees.

T

tack, dry. Property of certain adhesives, particularly nonvulcanizing rubber adhesives, to adhere on contact to themselves at a stage in evaporation of volatile constituents, even though they seem dry to the touch.

tackiness. The stickiness of the film while in the stage of drying, as a paint or varnish that usually retains a sticky or tacky feel for some time until it is practically

dry. Those compounds that retain tack long after drying are said to be permanently tacky or to possess after tack. Also see stickiness.

talc. Hydrous magnesium silicate, $Mg_3Si_4O_{11} \cdot H_2O$, a soft mineral with a soapy feel and with a specific gravity equal to 2.6 to 2.9, hardness equal to 1, and index of refraction equal to 1.57: In rubber talc acts as a filler and shows no reinforcing property.

TCC. Tagliabue closed cup; the standard test instrument and method by which flash point values for pure and mixed solvents are obtained.

temperature. The degree of heat or cold as measured in terms of degrees Centigrade or Fahrenheit.

tensile strength. The capacity of a material to resist a force tending to stretch it, the force required to stretch a material to rupture, also called breaking load, breaking stress, or ultimate tensile strength; in rubber testing, the load in pounds per square inch or kilograms per square centimeter of original cross-sectional area, supported at the moment of rupture by a piece of rubber, on being elongated at a constant rate.

tension pull. The total pull in pounds shown at the conclusion of a tension test.

tension test. A test in which a subject (as a hose assembly) receives increasing tension load in a suitable testing machine until failure occurs either by separation of the specimen from the end fittings or by rupture of the hose structure.

tension stress-strain testing. The determination of stress and strain, or tensile strength and elongation, with the use of rings or of dumbbell specimens in conformance with ASTM Designation D 412, at ± 23 at 1.1 C or ± 73.4 at 2 F.

thermal contraction. Contraction caused by decrease in temperature.

thermal expansion. Linear or volumetric expansion caused by increase in temperature.

thermoplastic. Capable of being repeatedly softened by heat and hardened by cooling.

thermosetting. Having the property of undergoing a chemical reaction by the action of heat, catalysts, ultraviolet light, and the like leading to a relatively infusible state.

thixotropic. Describing certain colloidal dispersions that assume a gel-like condition when at rest but that are transformed into a liquid condition at ordinary temperatures when agitated, stirred, or subjected to pressure or other mechanical action, which is reversible and can be repeated at will: Thixotropic colloids occur in nature, and the best-known example is bentonite, a colloidal American clay. Rubber dispersions are not thixotropic but can be made to exhibit this property by incorporating with them thixotropic colloids such as bentonite.

tie coat. One layer of a coating system used to improve the adhesion of adjacent or succeeding coats. Also called prime coat or primer.

TOC. Tagliabue open cup; an instrument and test method for determining flash points of solvents and finished compounds (as adhesives, coatings, and sealers): Flash points by the open cup method ordinarily will be 10 to 30 F higher than those determined by the closed cup or TCC method.

toxicity. The physiological effect of absorbing a poisonous substance into the system through either the skin, mucous membranes, or respiratory system: Solvents are usually classified as having high, medium, or low toxicity, depending on whether a solvent vapor concentration of less than 100, 100 to 400, or over 400 parts per million respectively is the maximum amount permissible in the air for safe or healthful working conditions.

A short guide to safe working conditions, supplied by the U.S. Public Health Service to the Army Industrial Hygiene Laboratory, states that, for practical laboratory and plant purposes "in general," the maximum allowable concentrations have

been set variously from 50 to 200 parts per million for the very toxic aromatics (as benzene, toluene, and xylene) and halogenated hydrocarbons (as carbon tetrachloride, trichlorethylene, ethylene dichloride, and propylene dichloride). These solvents may be considered as definitely hazardous. They cannot be endured by the workmen for even a short time except at extremely small concentrations without the possibility of dangerous aftereffects or without affecting their ability to work. An added danger with this group is that the effect is cumulative with prolonged and repeated exposure. Other solvents can be easily eliminated through the lungs and digestive passages, but this group tends to linger in the system and to accumulate to the toxic level.

For the less toxic groups of alcohols, esters, ethers and ketones (as ethyl alcohol, isopropanol, ethyl acetate, butyl acetate, acetone, methyl ethyl ketone, and hexone), a maximum allowable concentration range of 200 to 400 parts per million permits safety. This solvent group is considered mildly hazardous. It can be endured by the workmen for a short time within maximum permissible concentrations without serious disturbances or dangerous aftereffects. According to the guide, "For the not particularly toxic paraffins and naphthas, such as gasoline, petroleum naphtha, Stoddard solvent, mineral spirits and VM&P naphthas, the maximum allowable concentration range was 500 to 1,000 parts per million." These are the solvents that can be considered harmless or that cause no injuries to the workman's health after long association with them in everyday plant routine.

translucent. Permitting the passage of light but diffusing it so that objects beyond cannot be clearly distinguished.

transverse seam. A seam joining two materials across the width of the finish product.

U

ultimate elongation. The elongation at the moment of rupture.

ultraviolet light. A form of luminous energy occupying a position in the spectrum of sunlight beyond the violet, and having wavelengths of less than 3,900 Angstrom units, which is the limit of the visible spectrum: Ultraviolet light rays are very active chemically, exhibit bactericidal action, and cause many substances to fluoresce.

undercure. Degree of cure less than optimum that may be evidenced by tackiness, loginess, or inferior physical properties.

urethane. Synthetic polymers that may be either thermoplastic or thermosetting and that range from soft and rubberlike to hard and brittle, usually made by action of tolylene diisocyanate or another diamine with polyols, polyethers, polyesters, or other materials containing hydroxyl (OH) groups.

V

vehicle. The liquid portion of a finishing material consisting of the binder and volatile thinners.

viscosimeter. An instrument that is used for measuring the viscosity or fluidity of liquids and plastic materials and that, may be based on rate of flow through a tube (as the Saybolt, Redwood, and Engler), on the torsion principle (as Brookfield and Stormer), or on the time taken for a metal ball to fall through a column of the liquid of definite time length: For rubbers, including GR-S, the Mooney viscosimeter is widely used for both the raw and compounded material. Also called viscometer.

viscosity. A manifestation of internal friction; opposition to mobility; the property of fluids by which they resist an instantaneous change of shape, i. e., resistance to flow—measured by the force required to cause two parallel liquid surfaces of unit

area and unit distance apart to slide past each other in the liquid with unit velocity, and expressed in poises or dynes: Water at 20.2 C has a viscosity of 1 centipoise and is taken as the standard for comparison.

viscosity, dough. Viscosity of material that will generally not flow under its own weight, and that is recorded in the range of 150 to 0 cone penetrometer.

viscosity, heavy. Viscosity of any material testing 40 to 100 on a No. 22 MacMichael wire or from 0 to 65 on a No. 18 MacMichael wire.

viscosity, medium. Viscosity of any material testing 40 to 300 on a No. 26 MacMichael wire and up to 40 on a No. 22 MacMichael wire.

viscosity, paste or mush. Viscosity of any material that will flow or slump under its own weight and will not hold its shape in a diameter greater than 1 inch, and that is recorded in the range of 400 to 150 cone penetrometer.

viscosity, syrup. Viscosity of material that slumps under its own weight and will not maintain its shape when made into a ball with a diameter of 1 inch or less.

viscosity, thin. Viscosity of any material tested on a Ford cup viscometer or any material testing up to 40 on a No. 26 MacMichael wire.

void. An area or hole that is not filled.

volatile. Property of liquids to pass away by evaporation.

W

water absorption. The process of assimilating or soaking up water.

water dispersion. A dispersion or suspension of finely divided particles of any colloid or insoluble material in water—used commercially for many dispersions (as re-claimed rubber, vulcanizing agents, and coloring pigments): Water dispersions of GR-S, neoprene, and nitrile rubbers are commonly called latex.

water resistance. The ability to withstand swelling by water for a specified time and temperature, usually 48 hours at 100 C—expressed as percentage swelling or volume increase of specimen.

weatherometer. An apparatus (a) that estimates the comparative resistance of soft vulcanized rubber compounds to deterioration when exposed to light having a frequency range approximating that of sunlight but having a greater intensity in the ultraviolet range than that of sunlight, and (b) that uses as an estimating criterion the percentage decrease in tensile strength and in elongation at break and also the observed extent of surface crazing and cracking: During the weatherometer test, water sprays of clean water are forced on the specimens to simulate the action of rain (ASTM Designation D 750).

working life. The period of time during which an adhesive, sealer, or coating, after being mixed with catalyst, solvent, or other compounding ingredients, remains suitable for use.

Y

yield point. The first point on the stress-strain curve at which an increase in strain occurs without an increase in stress.

yield strength. The stress at which a material exhibits a specified limiting permanent set—determined by a measurable value of plastic yielding of the material, above which the material is considered to be damaged and below which the damaging effects are considered to be negligible.

yield stress. The stress at which the strain exceeds by a specified amount (the offset) an extension of the initial proportional portion of the stress-strain curve—expressed in force per unit area. Also called offset yield strength.

THE NATIONAL ACADEMY OF SCIENCES is a private, honorary organization of more than 700 scientists and engineers elected on the basis of outstanding contributions to knowledge. Established by a Congressional Act of Incorporation signed by Abraham Lincoln on March 3, 1863, and supported by private and public funds, the Academy works to further science and its use for the general welfare by bringing together the most qualified individuals to deal with scientific and technological problems of broad significance.

Under the terms of its Congressional charter, the Academy is also called upon to act as an official—yet independent—adviser to the Federal Government in any matter of science and technology. This provision accounts for the close ties that have always existed between the Academy and the Government, although the Academy is not a governmental agency and its activities are not limited to those on behalf of the Government.

The NATIONAL ACADEMY OF ENGINEERING was established on December 5, 1964. On that date the Council of the National Academy of Sciences, under the authority of its Act of Incorporation, adopted Articles of Organization bringing the National Academy of Engineering into being, independent and autonomous in its organization and the election of its members, and closely coordinated with the National Academy of Sciences in its advisory activities. The two Academies join in the furtherance of science and engineering and share the responsibility of advising the Federal Government, upon request, on any subject of science or technology.

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The HIGHWAY RESEARCH BOARD, an agency of the Division of Engineering, was established November 11, 1920, as a cooperative organization of the highway technologists of America operating under the auspices of the National Research Council and with the support of the several highway departments, the Bureau of Public Roads, and many other organizations interested in the development of transportation. The purpose of the Board is to advance knowledge concerning the nature and performance of transportation systems, through the stimulation of research and dissemination of information derived therefrom.

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