

# Tech Specs

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**ICPI's mission is to deliver education and technical guidance leading to awareness, acceptance and use of segmental concrete pavement systems in the United States and Canada. ICPI has developed Tech Specs to support this mission.**

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The Interlocking Concrete Pavement Institute (ICPI) is the authority for concrete pavers and slabs in North America, bringing together producers, contractors, dealers/distributors, industry suppliers and designers in an industry-wide effort to create high-quality products and deliver the best results for both residential and commercial customers. ICPI members represent the top segmental concrete paver and slab producers in North America and other countries like South Africa.

## Glossary of Terms for Segmental Concrete Pavement

**AASHTO:** American Association of State Highway and Transportation Officials is an association that includes U.S. state and Canadian provincial highway engineers. AASHTO publishes structural design methods for pavement, material standards and test methods, as well as many other documents on roads, highways and transportation.

**Abrasion:** The mechanical wearing, grinding, scraping or rubbing away (or down) of segmental concrete paving unit surface by friction or impact, or both.

**Absorption:** Weight of water drawn/soaked into a segmental concrete unit during immersion under prescribed conditions, typically expressed as a percentage relating to the dry weight of the unit.

**ADA Design Guidelines:** Americans with Disabilities Act Design Guidelines that include requirements for pavement transitions, openings, curb ramps and detectable warnings. The guidelines are administered by the U.S. Access Board.

**Admixture:** Prepared chemicals added to the concrete during the mixing process to improve production efficiencies and/or hardened properties such as density, absorption, efflorescence control, visual appeal, durability and strength.

**Aggregate:** Sand, gravel, shell, slag, or crushed stone used in road construction, base materials, mixed with cement to make concrete, or mixed with bitumen to make asphalt.

**Albedo:** The ratio of outbound reflected solar radiation from a pavement surface to inbound radiation.

**Angularity:** The sharpness of edges and corners of particles. Used to describe sand and aggregates.

**Aspect Ratio:** The overall length of a segmental concrete paving unit divided by its thickness. Example: A 4 in. (100 mm) wide by 8 in. (200 mm) long by 3 1/8 in. (80 mm) thick paver has an aspect ratio of 2.5. Compare to Plan Ratio.

**Asphalt-treated Base:** A crushed stone road base mixed with asphalt to increase its stiffness and resistance to rutting from wheel loads.

**ASTM C936:** American Society for Testing and Materials, Standard Specification for Solid Concrete Interlocking Paving Units. This product standard defines dimensions, dimensional tolerances, maximum absorption, minimum compressive strength, abrasion and freeze-thaw durability through various test methods.

**ASTM C1319:** Product standard for concrete grid paving units.

**ASTM C1782:** Product standard for utility or common segmental concrete paving slabs.

**Aquifer:** A porous, water-bearing geologic formation that yields water for consumption.

**Band Cutter:** A plier-like tool designed to cut metal or plastic bands around cubes and bundles of segmental concrete paving units without injury.

**Base or Base Course:** A material of a designed thickness placed between the segmental concrete units and bedding, and the sub-base (where used) and subgrade. The base can be open-graded or dense-graded aggregate with or without cement or asphalt stabilization, asphalt or concrete.

**Base Rake:** A rake with a flat and toothed side to move and level aggregate base (similar in appearance to an asphalt lute). A base rake also can be used to evenly spread joint sand on the surface of segmental concrete units for faster drying.

**Bedding Layer:** The aggregate material directly below the segmental concrete unit that, amongst other things, allows for bedding of the pavement surface during installation. In non-permeable applications, it is a 1 to 1.5 inch (25 to 40mm) thick layer of natural or manufactured sand conforming to ASTM C33 or CSA A23.1 with limits on the percent passing the No. 200 (0.075 mm) sieve; commonly referred to as the bedding sand layer. In permeable applications, it is a 2 inch (50 mm) thick layer of open-graded angular aggregate typically ASTM No. 8 stone or similar sized material; commonly referred to as bedding course.

**Bedding Sand Degradation Tests:** Evaluation of the degree of attrition of sand. Tests are conducted with steel balls or other abrading devices agitated with a sand sample in a container. Pre- and post-testing sieve analyses are conducted to determine the increase in fines. The tests are used to evaluate the durability of bedding sand under heavy loads or channelized traffic. Tests are often called Micro-Deval tests.

**Bentonite Clay:** Clay with a high content of the mineral montmorillonite, usually characterized by high swelling on wetting that can be used to help seal paver joints.

**Best Management Practice (BMP):** A structural device or non-structural program designed to reduce stormwater runoff and water pollution.

**Bishop's Hat:** A five-sided paver often used as an edge paver with a 45° herringbone pattern.

**Bitumen Setting Bed:** A bitumen/sand mix used for the bedding layer to which a neoprene-asphalt mastic is used to adhere the segmental concrete paving units. The bituminous bedding layer is typically less than 1 in. (25mm) thick and is typically placed over a concrete base.

**Blending:** The act of mixing segmental concrete units from three or four bundles or cubes when placing them to ensure an even color distribution.

**Bulge or Belly:** Convex sides on a segmental concrete unit that result from excessive water in the concrete mix during production.

**Bundle:** Either several layers of segmental concrete units stacked vertically together, or lined up horizontally (specific to larger slabs), that are bound with plastic wrap and/or strapping, placed on pallets, and tagged for shipment to and installation at the site. Bundles not supplied with pallets are strapped together for shipment, and require clamps attached to various wheeled equipment for transportation around the site. Also known as a cube.

**Bundle Buggy:** A wheeled device (with or without an engine) specifically designed to carry a banded together portion of a cube of pavers around a job site.

**California Bearing Ratio (CBR):** A standardized soils test defined as the ratio of: (1) the force per unit area required to penetrate a soil mass with a 3 in. sq. (19 cm sq.) circular piston (approximately 2 in. (51 mm) diameter) at the rate of 0.05 in. (1.3 mm)/min, to (2) that required for corresponding penetration of a standard material. The ratio is usually determined at 0.1in. (2.5 mm) penetration, although other penetrations are sometimes used. See ASTM D1883.

**Cation:** A positively charged atom or group of atoms in soil particles that, through exchange with ions of metals in stormwater runoff, enable those metals to attach themselves to soil particles.

**Cement-Aggregate Ratio:** The proportional weight of cement to fine and coarse aggregate in concrete.

**Cement-treated Base:** Crushed stone base mixed with cement to increase its stiffness and resistance to rutting from wheel loads.

**Cement, Portland:** Hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, and usually containing one or more forms of calcium sulfate.

**Chamfer:** A 45° beveled edge around the top of a segmental concrete paving unit usually 1/16 to 1/4 in. (2-6 mm) wide. It allows water to drain from the surface, facilitates snow removal, helps prevent edge chipping, and delineates the individual paving units.

**Choke Course:** A layer of aggregate placed or compacted into the surface of another layer to provide stability and a smoother surface. The particle sizes of the choke course are generally smaller than those of the surface into which it is being pressed so it blends together, but not so small as to pass through the larger material.

**Clay:** Fine-grained soil or the fine-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of

water contents, and that exhibits considerable strength when air-dry. The term can designate soil particles finer than 0.002 mm.

**Cluster:** A group of paving units forming a single layer that is grabbed, held, and placed by a paver-laying machine typically on a bedding layer.

**Coarse Aggregate:** Aggregate predominantly retained on the U.S. Standard No. 4 (4.75 mm) sieve; or that portion of an aggregate retained on the No. 4 (4.75 mm) sieve.

**Combined Sewer Overflows (CSOs):** Overflows from the combination of stormwater and sanitary sewage in the same conveyance system. Overflows are not treated by a waste water treatment plant and instead are diverted as raw sewage into a receiving body of water.

**Compaction:** The process of inducing close packing of solid particles such as soil, sand, or aggregate.

**Compressive Strength:** The measured maximum resistance of a concrete paver to loading expressed as force per unit area such as pounds per square inch or newtons per square millimeter (megapascals).

**Concrete Grid Paving Units:** Segmental concrete units (generally small slabs) that have 45 to 75 percent open area. The units are no larger than 24 in. (600 mm) by 24 in. (600 mm). Aggregate or grass can be placed in the openings to promote infiltration of stormwater. Grids are generally used for intermittent parking, access lanes, abating runoff and/or controlling erosion. See ASTM C1319, Standard Specification for Concrete Grid Paving Units for product standards.

**Concrete Sand:** Washed sand used in the manufacture of ready-mix concrete which conforms to the grading requirements of ASTM C33 or CSA A23.1 with limits on the percent passing the No. 200 (0.075 mm) sieve. Commonly used as a bedding sand.

**Course:** An installed row of paving units or a row in a bundle or cube.

**Creep:** Slow lateral movement of segmental concrete paving units from horizontal forces such as braking tires.

**Crown:** The slightly convex shape of a road cross section. It is beneficial to surface drainage and interlock.

**Crushed Stone:** A construction material made by mechanical crushing of rocks, boulders, or large cobblestones at a quarry. All faces of each aggregate have well-defined edges resulting from the crushing operation.

**Crusher Run:** The total unscreened product of a stone crusher.

**CSA-A231.1:** Canadian Standards Association product standard for Precast Concrete Paving Slabs that defines standards for dimensionas, minimum flexural strength, and durability under freeze-thaw cycles with deicing salt through various test methods.

**CSA-A231.2:** Canadian Standards Association product standard for Precast Concrete Pavers (interlocking units) that defines standards for dimensions, minimum compressive strength, and durability under freeze-thaw cycles with deicing salt through various test methods.

**Cube(s):** See Bundle.

**Curve Number (CN):** A numerical representation of a given area's hydrological soil group, plant cover, impervious cover, interception, and surface storage. A curve number is used to convert rainfall depth into runoff volume. PICP typically has CNs between 45 and 80. PICP can reduce the post-development CN of a site compared to the pre-development CN.

**DCOF or Dynamic Coefficient of Friction:** A measurement that characterizes the interaction between a wet surface and a passing shoe, and that is used to assess the slip resistance of the wet surface. One DCOF measurement device is called AcuTest which simulates and measures the resistance (or force) that must be overcome to keep one object, already in motion, moving over another object. See ANSI A137.1-2012.

**Deflection:** A small temporary downward movement of a pavement structure due to traffic loads.

**Degradation Testing:** Testing of sands or aggregate to determine resistance to change in particle sizes or gradation under loading.

**Dense-Graded Aggregate:** A compacted crushed stone used in the base and subbase, and whose gradation yields very small voids between the particles with no visible space between them. Most dense-graded aggregates used in bases have particles ranging in size from 1½ in. (38 mm) or ¾ in. (19 mm) down to fines passing the No. 200 (0.075 mm) sieve.

**Density:** The mass per unit volume of a substance.

**Dentated Paver:** A paving unit with indentations formed into the sides to increase the area of their sides so that, when installed, the additional area enhances interlock among neighboring units.

**Detention Pond or Structure:** The temporary storage of stormwater runoff in an area with the objective of decreasing peak discharge rates and providing a settling basin for pollutants.

**Drainage Coefficient:** Factor used to modify the layer coefficient of pavements. The value expresses the extent to which pavement materials can resist weakening when wet or saturated. See Layer Coefficient.

**Dry Mix Joint Sand Stabilizer:** Joint sand treated with chemicals that when placed in contact with water, activates them to bind the sand particles together. This stabilizes the joint sand, reduces its permeability, sand loss and helps prevent weeds.

**Edge Paver or Slab:** A paving unit made with a straight, flush side, or cut straight for placement against an edge restraint.

**Edge Restraint:** A curb, edging, building or other stationary object that borders the perimeter of the segmental concrete pavement and prevents the units from moving horizontally. It can be exposed or hidden from view.

**Efflorescence:** A white deposit of calcium carbonate on concrete surfaces. It results from the reaction of calcium hydroxide with carbon dioxide from the air. The calcium hydroxide is a byproduct when cement hydrates. It is slightly soluble in water and migrates to the surface through capillary action. The calcium hydroxide remains on the surface, reacts with carbon dioxide, which forms calcium carbonate and water. This conversion, depending on weather conditions, will dissipate over time. Calcium carbonate is the most common type of efflorescence. The presence of efflorescence does not compromise the structural integrity and is not indicative of a flawed product.

**Elastic Deformation:** A reaction from applied loads where pavement returns to its original position after the load is removed. Compare to permanent deformation under Rutting.

**Elephant's Foot:** A solid extension formed as part of the bottom of the segmental concrete paving unit typically the result of a rounding at the bottom of the mold due to excessive wear. Also known as legs.

**Embodied Energy:** The energy used through the life-cycle of a pavement material or product to extract, refine, process, fabricate, transport, install, commission, utilize, maintain, remove, and ultimately recycle or dispose of pavement materials.

**Engraved Pavers or Slabs:** Pavers or slabs that have been engraved inscribed with letters or images created by molding during or after manufacture, via shot blasting or wet cutting. Engraved paving units can also refer to those with a cast metal plate set into the surface.

**Environmental Product Declaration or EPD:** A declaration by a manufacturer of the environmental impacts from the manufacture of a product.

**Equivalent Single Axle Loads (ESALs):** Summation of equivalent 18,000 pound-force (80 kN) single axle loads used to combine mixed traffic to a design traffic load for the design period; also expressed as Equivalent Axle Loads or EALs.

**Erosion:** The process of wearing away soil by water, wind, ice and gravity; also the detachment and movement of soil particles by the same forces.

**Face Mix or Hard Facing:** The application of a thin layer of fine aggregate and cement to the top surface of a segmental concrete paving unit. The layer is often colored and is used to provide a more intense appearance, greater abrasion resistance, or provide a base for a textured finish.

**Failure:** The point at which a pavement does not adequately service its intended use. For flexible pavements, rut depth is often a criterion for failure.

**False Joints:** Grooves on the surface of segmental concrete paving units that appear as full joints between units that contribute to the installed joint pattern. False joints can enhance the appearance of the pattern and speed installation compared to placing separate (sub) units. Sometimes called dummy grooves.

**Fines:** Silt and clay particles in a soil or aggregate, generally those smaller than the No. 200 or 0.075 mm sieves.

**Fineness Modulus:** A factor obtained by adding the total percentages by weight of an aggregate sample retained on each of a specified series of sieves, and dividing the sum by 100; in the United States the standard sieve sizes are No. 100 (0.150 mm), No. 50 (0.300 mm), No. 30 (0.600 mm), No. 16 (1.18 mm), No. 8 (2.36 mm) and No. 4 (4.75mm), and ¾ in. (9.5 mm), 1½ in. (37.5 mm), 3 in. (75mm), and 6 in. (150 mm).

**Finished Grade:** The final elevation of a soil, subgrade, subbase, base or pavement surface which is often indicated on construction drawings. Also Finish Elevation.

**Flash:** A thin, brittle layer of cement around the bottom edges or at the top edges of a segmental concrete paving unit composed of cement, typically due to minor leakage of liquid cement between elements of the mold assembly. Also known as Flange.

**Flexible Pavement:** A pavement structure which maintains intimate contact with and distributes loads to the subgrade. The base and subbase course materials rely on aggregate interlock, particle friction, and cohesion for stability.

**Flexural Strength:** A property of a paver or slab that indicates its ability to resist failure in bending expressed in pounds per square inch or megapascals.

**Flowable Fill:** A low-strength concrete mix used to fill utility trenches and other excavated pavement openings; also known as unshrinkable fill or controlled low strength material (CLSM). See ASTM D6103, D6023, D6024 and D4832.

**Freeze-Thaw Durability Testing:** Tests in which segmental concrete paving units are exposed to cycles of freeze and thaw, partially or totally immersed in water, and with or without salt water.

**Frost Action:** Freezing and thawing of moisture in pavement materials and the resultant effects on them.

**Frost Heave:** The raising of a pavement surface due to the accumulation and expansion of ice in the base, subbase, and/or underlying soil or rock.

**Geogrid:** Geogrids are two dimensional or three dimensional lattices manufactured from various types of plastic. The two dimensional type are flat and have small, square, rectangular or triangular shaped openings. Three dimensional geogrids are 4 to 8 in. (100 to 200 mm) high and provide stability under loads for cohesionless soils and open-graded bases.

**Geotextiles:** Woven or non-woven fabrics made from plastic fibers used for separation, reinforcement, or drainage between pavement layers.

**Gradation:** Expression of the distribution by mass of a soil or aggregate in specified particle-size ranges. Gradation is typically expressed in percent of mass of sample passing a range of sieve sizes. See ASTM C136.

**Grade:** (noun) The slope of finished surface of an excavated area, subbase, base, or pavement usually expressed in percent; (verb) to finish the surface of same by hand or with mechanized equipment.

**Gravel:** Rounded or semi-rounded particles of rock that will pass a 3 in. (75 mm) and be retained on a No. 4 (4.75 mm) sieve which naturally occurs in streambeds or riverbanks that have been smoothed by the action of water. A type of soil as defined by the Unified Soil Classification System having particle sizes ranging from the No. 4 (4.75 mm) sieve size and larger.

**H20 Loading:** A vehicular load used by AASHTO in bridge design and mistakenly applied to pavements.

**Half Stone:** A manufactured half of a paver.

**Herringbone Pattern:** A pattern where joints are no longer than the length of 1 1/2 segmental concrete paving units. Herringbone patterns can be 45° or 90° depending on the orientation of the joints with respect to the direction of the traffic.

**Hotspot:** A land use that can generate highly contaminated runoff with concentrations higher than those typical to stormwater.

**Human Scale:** Using segmental concrete paving unit sizes, patterns, colors and textures next to large buildings or open areas with the intent of reducing the user perception of being overwhelmed by the large scale of these spaces.

**Hydrological Soil Group:** The soils classification system developed by the U.S. Soil Conservation Service, now the Natural Resources Conservation Service that categorizes soils into four groups, A through D, based on runoff potential. A soils have high permeability and low runoff whereas D soils have low permeability and high runoff.

**Impervious Cover:** Surfaces that do not allow rainfall to infiltrate into the underlying soil such as pavements, roofs, sidewalks, driveways, etc.

**Infiltration:** The downward movement of water through a permeable pavement system and into the subgrade soil.

**Infiltration Rate:** The rate at which water moves vertically (i.e. falls) through an unsaturated aggregate or soil, expressed in inches per hour or meters per second. See ASTM C1781, D3385 and D5093. Also the rate at which water enters a permeable pavement. Compare to Permeability.

**Interlock:** Frictional forces between segmental paving units that prevent them from rotating, or moving horizontally or vertically in relation to each other; also defined as the inability of a paving unit to move independently of its neighbors. The friction forces enable load transfer among the paving units. The three kinds of load transfer are vertical interlock, horizontal interlock and rotational interlock. Vertical interlock is achieved by shear transfer of loads to surrounding units through sand in the joints. Horizontal interlock is primarily achieved through the use of laying patterns that disperse forces from braking and accelerating vehicles. The most effective laying patterns for maintaining horizontal interlock are herringbone patterns. Rotational interlock is maintained by the paving unit being of sufficient thickness, placed closely together, and being restrained by a stationary edge such as a curb.

**Interlocking Concrete Pavement:** A segmental concrete pavement which, due to the size, shape and pattern of the units and the use of joint material between the units, has a high degree of surface interlock. A system of paving consisting of discrete, hand-sized paving units with either rectangular or dentated shapes manufactured from concrete. Either type of shape is placed in an interlocking pattern, compacted into coarse bedding sand, the joints filled with sand and compacted again to create structural interlock (load supporting and spreading).

**Joint:** The space between segmental concrete units filled with jointing sand—or with small, open-graded aggregate if the surface is designed for permeability—to prevent units from impacting against each other after installation.

**Joint Filling Sand:** Sand used to fill spaces between concrete pavers. Also called jointing sand.

**Joint Material:** Sand (in non permeable applications) or small aggregate (in permeable applications) used to fill the joints between concrete pavers or slabs and provides interlock between the units.

**Joint Sand Gap:** The vertical distance between the bottom of the chamfer on a segmental paving unit and the top of the sand in the joint.

**Joint Sand Stabilizer:** Liquid penetrating or dry mix applied or materials that provide early stabilization of joint sand, reduces its permeability, sand loss and helps prevent weeds. See Dry Mix Joint Sand Stabilizer and Liquid Penetrating Joint Sand Stabilizer.

**Joint Sand:** Sand swept into the openings between the pavers and slabs in non-permeable applications.

**Joint Spacing:** The distance between the sides of the pavers or slabs, not including the spacers, that is typically filled with joint material or permeable aggregate. The space measured does not include the chamfer.

**Jointing Material Gap:** The vertical distance between the bottom of the chamfer on a paver or slab and the top of the jointing material within the joint.

**Karst Geology:** Regions of the earth underlain by carbonate rock typically with sinkholes and/or limestone caverns.

**K-pattern:** A paving pattern with one square unit surrounded by rectangular units. Sometimes called an I-pattern or muster K pattern.

**Layer Coefficient:** From the AASHTO flexible pavement design procedure; a dimensionless number that expresses the material strength per inch (25 mm) of thickness of a pavement layer (surface, base, or subbase). Example: The layer coefficient of  $3\frac{1}{8}$  in. (80 mm) thick pavers and 1 in. (25 mm) bedding sand is 0.44 per in. (25 mm), therefore, the Structural Number (SN) =  $4\frac{1}{8} \times 0.44 = 1.82$ .

**Laying Face:** The exposed, vertical face of a row of paving units on a bedding sand layer; the working edge of the pavement where the laying of paving units occurs.

**Laying Pattern:** The sequence of placing paving units that creates a repetitive geometry. Laying patterns may be selected for their visual or structural benefits.

**Lean Concrete:** Concrete of low-cement content used as a structural base material or as flowable fill in utility trenches.

**LEED or Leadership in Energy and Environmental Design:** A system of evaluating the sustainability of building materials and systems published by the US Green Building Council. The USGBC also publishes an evaluation system for sites called Sustainable Sites.

**Life-cycle Cost Analysis:** A method of calculating all costs anticipated over the life of the pavement including construction costs. Discounted cash-flow methods are generally used, typically with calculation of present worth and annualized cost. Factors that influence the results include the initial costs, assumptions about maintenance and periodic rehabilitation, pavement user and delay costs, salvage value, inflation, discount rate, and the analysis period. A sensitivity analysis is often performed to determine which variables have the most influence on costs.

**Lift:** A layer of spread and compacted soil fill or aggregate. The compacted soil depth achieved by compaction equipment.

**Lippage:** The difference in vertical distance between the surface of one paving unit and an adjacent unit. An excessive amount of lippage is sometimes called fish scale.

**Liquid Penetrating Joint Sand Stabilizer:** Polymer liquid spread over the surface of pavers or slabs and allowed to penetrate the joint sand. After curing, the material stabilizes the joint sand, reduces its permeability, sand loss and helps prevent weeds.

**Low Impact Development:** A stormwater management approach modeled after nature: manage rainfall at the source using uniformly distributed decentralized micro-scale controls.

**Macro Texture:** The deviations of a pavement surface from a true planar surface with dimensions generally 0.5 mm or greater or those that no longer affect tire-pavement interaction.

**Markers:** The use of concrete pavers or slabs with different colors, textures or shapes to mark underground utilities, traffic direction, parking stalls, lanes, pedestrian/vehicular areas, etc.

**Mechanical Installation:** The use of machines to lift and place layers of segmental concrete paving units on screeded sand in their final

laying pattern. It is used to increase the rate of paving.

**Mechanistic Design:** Elastic analysis of structural response of applied loads through modeling of stresses and strains in a pavement structure.

**Micro Texture:** The deviations of a pavement surface from a true planar surface with dimensions generally less than 0.5 mm.

**Modified Proctor Compaction Test:** A variation of the Standard Proctor Compaction Test used in compaction testing which measures the density-moisture relationship under a higher compaction effort. See ASTM D1557.

**Modulus of Elasticity or Elastic Modulus:** The ratio of stress to strain for a material under given loading conditions.

**Moisture Content:** The percentage by weight of water contained in the pore space of soil or aggregate, sand or base, with respect to the weight of the solid material.

**Mortar:** A mixture of cement paste and fine aggregate (sand).

**Mortar Sand:** Sand used in mortar that typically conforms to ASTM C144 or CSA A179.

**Mortar-set Paving:** Pavers or slabs or adhered directly to a concrete base using mortar, and joints are filled with mortar or stabilized joint material.

**Mosaics:** Pavers or slabs used as pictorial maps, murals, or geometric patterns as a landmark, to emphasize an area, or suggest movement.

**Multi-Colored Paver or Slab (Color Blend):** A paver or slab with two or more colors. The appearance is usually variegated.

**MS4:** Municipal separate storm sewer system. A system of conveyances including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains. MS4s are generally owned by public agencies.

**National Pollutant Discharge Elimination System (NPDES):** A broad regulatory program that seeks to control water pollution by regulating point (sewage discharge) and non-point (runoff discharge) into streams, lakes and bays of the United States. The federal program is implemented at the state and local level via water pollution control plans and a permit system for sewage discharge, as well as runoff from construction sites, urban areas and farmland.

**Nuclear Density Testing:** The use of a nuclear density gauge to accurately and quickly assess the density and moisture content of soils and dense-graded aggregate in the field. The machine uses a probe inserted into compacted soil or aggregate base that emits very low intensity radiation. See ASTM D2922.

**Observation Well:** A perforated pipe inserted vertically into an open-graded base to monitor infiltration rate of water into the underlying soil.

**One/One Hundred Year Storm:** A probability statement on recurrence of a rainfall event that has a 100% chance of occurring within a given year/an event that has a 1% chance of occurring within a given year.

**Open-graded Aggregate:** Washed, crushed stone used in the joints, bedding, base and subbase of permeable pavements, and whose gradation yields large voids between the particles for water infiltration and storage. It can also be used as a drainage course below non-permeable segmental concrete pavements.

**Optimum Moisture Content:** The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.

**Organic Impurities:** Peat, roots, topsoil or decomposing materials in soil, sand or aggregate.

**Organic Soil:** Spongy, compressible soils usually consisting of peat humus or vegetative matter that have undesirable construction characteristics.

**Outlet:** The point at which water is discharged from a pavement system through pipes into a storm sewer or watercourse.

**Partial Infiltration:** A design concept in permeable pavement where some water is detained to allow for infiltration into the soil and some of the excess detained water is released through drain pipes.

**Pavement Performance:** The trend of serviceability under repetitive loads.

**Pavement Rehabilitation:** Work undertaken to extend the service life of an existing pavement. This includes placement of additional surfacing material and/or other work necessary to return an existing roadway to a condition of structural or functional adequacy. This could include the complete removal and replacement of the pavement structure.

**Pavement Structure:** A combination of subbase, base course, and surface course placed on a subgrade to support traffic loads and distribute it to the roadbed.

**Paver Extractor:** A tool used to grab a paver and remove it from the laying pattern.

**Paver Splitter:** A hand operated machine, sometimes hydraulically assisted, for cutting concrete pavers and some slabs; also called a guillotine splitter.

**Peak Discharge Rate:** The maximum instantaneous flow from a detention or retention pond, open-graded base, pavement surface, storm sewer, stream or river; usually related to a specific storm event.

**Performance:** The total number of vehicle or ESAL applications withstood by a pavement before it reaches failure, rehabilitation, or a lower level of serviceability.

**Performance Period:** The period of time that an initially constructed or rehabilitated pavement structure will last (perform) before reaching its terminal serviceability. This is also referred to as the design period or life, expressed in years. Twenty to forty years is normally used in North America.

**Permeability:** Measured in the laboratory, the rate of water movement through a soil column under saturated conditions, usually expressed as  $k$  in calculations per specific ASTM or AASHTO tests, and typically expressed in inches per hour or meters per second. See ASTM D2434. Compare to Infiltration.

**Permeable Interlocking Concrete Pavement:** A segmental concrete pavement with wide joints (typically 5 to 10 mm) between the units, and the use of open-graded aggregates for the joint, bedding, base and subbase materials, that allows for the surface infiltration of stormwater, storage, infiltration into the subgrade and discharge through an outlet.

**Pervious or Permeable Surfaces/Cover:** Surfaces that allow the infiltration of rainfall such as vegetated areas, grid pavers, or permeable pavers/slabs.

**Plan Ratio:** The overall length of a segmental concrete paving unit divided by its width. Compare to Aspect Ratio.

**Plastic Limit:** (1) The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil. (2) Water content at which a soil will just begin to crumble when rolled into a thread approximately  $\frac{1}{8}$  in. (3.2 mm) in diameter.

**Plate Compactor:** Also known as a plate vibrator, which is used to compact/vibrate the subgrade/base/subbed material, bed segmental concrete units into the bedding layer, and vibrate joint material into the unit joints.

**Porosity:** The volume of voids in a soil or aggregate divided by the total volume of the material.

**Pozzolanic Materials:** Fly ash, pozzolan, silica fume, or blast furnace slag used as substitutes for cement. They are generally used in the concrete mix to increase density and durability of concrete pavers.

**Prepared Roadbed:** In-place roadbed soils compacted or stabilized according to provisions of applicable specifications.

**Present Serviceability Index (PSI):** A rating, usually between 0 (completely non-functional) and 5 (new/perfect) that generalizes several measurements of the condition of pavement. It is a convenient method of rating the overall condition and usefulness of a pavement over time and is from AASHTO pavement design methods.

**Pre-treatment:** BMPs that provide storage and filtering of pollutants before they enter another BMP for additional filtering, settling, and/or processing of stormwater pollutants.

**Proctor Compaction Test:** A test which measures the relationship of soil density with respect to soil moisture content under a standard compaction effort. This test identifies the maximum density obtainable at optimum moisture content. See ASTM D698.

**Progressive Stiffening:** The tendency of pavements to stiffen over time. Interlocking concrete pavement stiffens as it receives increasing traffic loads thereby offering increased structural contribution; also referred to as "lock-up."

**Pumping:** The ejection of saturated bedding and joint sand, through joints or cracks or along edges of paving units when a load is applied.

**Reflecting:** Using pavers and slabs to mirror geometric patterns, shapes, colors or textures in the surrounding site.

**Retention Pond:** A body of water or structure that collects runoff for the purpose of infiltration into the subgrade. Runoff flowing into the pond that exceeds its storage capacity is released via an overflow device connected to a storm sewer or watercourse.

**Roughness Index:** The sum of the measured vertical change over a pavement surface divided by the length of pavement measured.

**Running Bond Course:** One or two courses of pavers or slabs where the lengths (long side) abut against the edge restraint. Also known as a "sailor course."

**Running or Stretcher Bond:** A laying pattern with continuous joint lines in one direction and segmental concrete paving units are staggered from one row to the next.

**Runoff:** Water that leaves a site during and after a rainstorm.

**Runoff coefficient:** The runoff depth divided by the rainfall depth.

**Run-on:** Water, other than direct precipitation, that enters a site during or immediately after a rainstorm.

**Rutting:** Permanent deformation from repetitive traffic wheel loading that exceeds the ability of the pavement structure to maintain its original profile.

**Sailor Course:** A paver course where longer side of each paver abuts against the edge restraint.

**Sand:** Granular material passing the  $\frac{3}{8}$  in. (5 mm) and retained on the No. 200 (0.075 mm) sieve, made from the natural erosion of rocks, and consisting of subangular or rounded particles. Sands made by crushing of coarse aggregates are called manufactured sands.

**Sand Spreaders:** Broomed attachments to motorized equipment used to efficiently spread joint sand across the surface of segmental concrete pavements.

**Screed Board or Strike Board:** A rigid, straight piece of wood or metal used to level bedding material to proper grade by pulling across guides or rails set on the base course or edge restraints.

**Screed Guides or Bars:** Grade strips such as pipe that will guide the screed in producing the desired elevation of the bedding layer.

**Screenings:** A residual product not suitable for bedding sand. It is a by-product from the crushing of rock, boulders, cobble, gravel, blast-furnace slag or concrete. Most of the aggregate passes the No. 4 (4.75 mm) sieve; typically limestone or granite.

**Sealer:** A material usually applied as a liquid to waterproof, enhance color, and in some cases reduce abrasion of segmental concrete pavements.

**Sediment:** Soils transported and deposited by water, wind, ice or gravity.

**Segmental Concrete Pavement:** A system of segmental concrete paving units consisting of units over a bedding layer and base (also includes subbase where required). Depending on the type of paving unit and aggregates used, the pavement system can be further characterized as an interlocking concrete pavement, permeable interlocking concrete pavement, concrete grid pavement or segmental concrete slabs.

**Segmental Concrete Pavers:** Concrete paving units, rectangular, square or dentated, capable of being placed with one hand into a laying pattern. The surface area is equal to or less than 101 in.<sup>2</sup> (0.065 m<sup>2</sup>) and the overall length to thickness is 4 or less. Compare to Segmental Concrete Paving Slabs.

**Segmental Concrete Paving Slab:** A concrete paving unit with a surface area over 100 in.<sup>2</sup> (0.065 m<sup>2</sup>) and with maximum length and width dimensions of 48 in. by 48 in. (1.2 m x 1.2 m). Its overall length to thickness ratio is greater than 4. Paving slabs do not rely on interlock as the principal means of load distribution.

**Segmental Pavement:** A pavement whose surface consists of discrete units typically made of concrete, clay, or stone.

**Shrinkage:** The reduction in volume in soil when moisture content is reduced.

**Silt:** Soil finer than 0.02 mm and coarser than 0.002 mm.

**Skid Resistance:** A measure of the frictional characteristics of a surface with respect to tires. See *ICPI Tech Spec 13*.

**Slip Resistance:** Resistance against pedestrian slipping; defined as the ratio of a minimum tangential force necessary to initiate sliding of a pedestrian's shoe or related device over a surface. Non-mobility

impaired persons require minimum coefficient of friction values ranging from 0.2-0.3. Wheelchair users require friction values ranging from 0.5-0.7. Crutch users and those with artificial limbs require values from 0.7 to 1.0. Clean concrete pavers generally have values exceeding 0.7. See *ICPI Tech Spec 13*.

**Slump:** A measure of consistency and water content of freshly mixed concrete. Slump is the subsidence measured from a specimen immediately after removal of a cone shaped mold. See ASTM C143. Unlike ready-mixed concrete, pavers are zero slump concrete because of low water content. They are not tested for slump.

**Soil Separation Fabric:** A permeable fabric typically placed between the subgrade and the lowest layer of aggregate (base or subbase) to reduce rutting, also called a geotextile.

**Soil Stabilization:** Chemical or mechanical treatment designed to increase or maintain the stability of a mass of soil or otherwise to improve its engineering properties. Lime, fly ash or cement are typical chemical stabilization materials. Geotextiles and geogrids are typical mechanical materials for soil stabilization.

**Solar Reflectance:** ASTM C1549 *Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer* is used to determine the solar reflectance of flat, opaque materials in a laboratory or in the field using a commercial portable solar reflectometer. This device is calibrated using specimens of known solar reflectance to determine solar reflectance from measurements at 380 nm, 500 nm, 650 nm and 1220 nm wavelengths.

**Soldier Course:** One or two courses of pavers or slabs where the widths (short side) abut against the edge restraint.

**Solid Color Unit:** A segmental concrete unit with one color created by adding iron oxide, metal oxide, or other mixed metal oxide pigment to the concrete mix.

**Spacer Bars or Nibs:** Small protrusions on each side of the segmental concrete unit (typically 1.5 to 2 mm for non permeable pavers, up to 12mm for permeable pavers) that maintain a minimum space so jointing material can fill into the joints. Spacer bars help prevent edge chipping and spalling. Some spacer bars stop short of the top surface, and are known as "blind spacers." They cannot be seen once the units have been installed.

**Spall:** A fragment, usually in the shape of a flake, detached from the edge or surface of a paving unit by a blow or sudden force, the action of weather, or pressure from adjacent pavers.

**Stabilized Base:** An aggregate base with cement, asphalt or other material added to increase its structural capacity.

**Stabilized Subgrade:** Soil subgrade stabilized with cement, lime, fly ash or other materials to increase its load bearing capacity.

**Stack Bond:** A laying pattern in which the joints in both directions are continuous.

**Standing Screed:** Aluminum screed with handles allowing one person to pull it across bedding material while standing (compared to kneeling while screeding).

**Storm Water Pollution Prevention Plans (SWPPP):** A principal requirement of stormwater permits issued under NPDES that identifies all potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges from the construction site.



A SWPPP also describes practices to be used to reduce pollutants in stormwater discharges from the construction site and assures compliance with the terms and conditions of the construction permit. SWPPP requirements vary from state to state. (from Construction Industry Compliance Assistance Center)

**Strain:** The change in length per unit of length in a given direction.

**Stress:** The force per unit area.

**Structural Number (SN):** The basis of the flexible pavement design method developed by the AASHTO. It is a dimensionless number expressing the relative strength of a pavement structure. The SN is calculated from an analysis of traffic, roadbed soil conditions, and environment. The SN equals the sum of layer coefficients, with each coefficient quantifying the material strength and thickness of each pavement layer.

**Subbase:** The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course. Aggregate sub-bases are typically made of stone pieces larger than that in bases.

**Subgrade:** The soil upon which the pavement structure and shoulders are constructed.

**Sustainable Development:** Development (including pavement) that meets the needs of the present without compromising the ability of future generations to meet their own needs.

**Tactile Pavers:** A paver detectable by sight impaired persons due to change in color or texture from surrounding surfaces. Changes in texture are achieved with detectable warnings e.g., truncated domes.

**Tensile Strength:** Maximum unit stress which a paving unit is capable of resisting under axial tensile loading, based on the cross-sectional area of the specimen before loading.

**Textured or Architectural Finish:** Paving unit surfaces altered by the manufacturing mold or mechanical means, such as shot blasting, bush hammering, tumbling, grinding, polishing, flame treating, or washing. The purpose of such treatments is often to simulate the appearance of stone.

**Time of Concentration:** The time required for water to follow from the most remote point of a watershed or catchment to an outlet.

**Topsoil:** Surface soil, usually containing organic matter.

**Unified Soil Classification System or USCS:** A laboratory process of defining soil type in ASTM D2487 *Standard Practice for Classification of Soils for Engineering Purposes*.

**Urban Heat Island:** An urban area that, due to denuded landscape, impermeable surfaces, surfaces with low albedo, massive buildings, heat-generating cars and machines, and pollutants, is measurably hotter than surrounding rural areas.

**Void Ratio:** The volume of voids in a soil or aggregate divided by the volume of solids.

**Water-Cement Ratio:** The weight of water divided by the weight of cement in a concrete mixture. Segmental concrete paving units typically have a water-cement ratio of 0.27 to 0.33, lower than ordinary concrete, which contributes to strength and durability.

**Wearing course:** Pavement surfacing consisting of segmental concrete units with the designated joint material filling the joints on a bedding layer.

**Wearing surface:** The top surface that contacts traffic.

**Weave or Parquet:** A laying pattern where two or more paving units are placed side-by-side. Adjacent pavers are placed side-by-side, but turned 90° and alternated 90° throughout the pattern.

**Zoning:** Using different paving unit colors, textures, shapes, laying patterns, and surface elevations to delineate pedestrian and vehicular areas or districts.

## References

Aggregate Producers Association of Ontario, *Construction Aggregate Consumers' Guide*, Downsview, Ontario, 1990.

American Association of State Highway and Transportation Officials, *Guide for the Design of Pavement Structures*, 1993, Washington, D.C.

ASTM International, *Annual Book of ASTM Standards*, Vols. 4.02, 4.03, 4.05, 4.08, 4.12, 2000, Conshohocken, Pennsylvania.

Canadian Standards Association, *Precast Concrete Paving Slabs*, CSA A231.1 and *Precast Concrete Pavers*, CSA-A231.2, Rexdale, Ontario. 2014.



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*BOD Approved: February 2017*