

## Applied Petrography Group Special Report : SR3 Part 2 (Draft for Comment June 2010)

### DISCLAIMER

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### SR3 Part 2: Concrete Terminology

*(Note: Some definitions are based on National Standard Publications, ASTM and on the definitions in European Standards)*

**Actinolite** –  $\text{Ca}_2(\text{Mg,Fe})_5(\text{Si}_8\text{O}_{22})(\text{OH,F})_2$ , Mineral of the amphibole group which occurs widely in low- to medium-grade schists and some igneous rocks.

**Admixture** – A substance other than binder, aggregate or water, added in small quantities to the concrete mix to alter its properties. These include chemical admixtures such as accelerators, plasticizers, and air-entraining agents and mineral additions such as pozzolanas.

**Aerated concrete** – also known as gas, foamed or cellular concretes and mortars. Used as semi-structural lightweight and insulating materials. Mechanical or chemical foaming replaces the aeration, which consists of discrete bubbles that are one to two magnitudes larger in size than air-entrained bubbles.

**Aggregate** - Granular material used in construction, either processed from natural materials such as rock, gravel or sand, recycled materials, or manufactured such as slag. (BS 6100-6: 2008)(EN 13242, EN 12620).

**Aggregate shrinkage** - Some types of aggregates such as weathered basalts and greywackes contain significant quantities of swelling sheet silicate minerals that can undergo volume changes during cycles of wetting and drying. This can contribute to a shrinkage within the concrete.

**Air-entrainment** – Air entrainment is a process whereby many small air bubbles (typically between 10  $\mu\text{m}$  and 1mm in diameter) are introduced into concrete. Entrained air has a lubricating effect on plastic cement paste and produces more workable concretes and mortars. The primary purpose is to increase the durability of the hardened concrete, especially in increasing resistance to freeze-thaw; the secondary purpose is to increase workability of the concrete while in a plastic state.

**Air void** – A space in cement paste, mortar, or concrete filled with air; an entrapped air void is characteristically 1 mm or more in size and irregular in shape. Air voids can be described as entrained (typically <1mm sized) or entrapped (typically >1mm sized). Entrained air voids are a deliberate addition that can improve the durability of a concrete.

**Alite** –  $(3 \text{ CaO} \cdot \text{SiO}_2)$  ( $\text{C}_3\text{S}$ ) Tricalcium silicate, a calcium silicate and makes up the dominant part of Portland cement. Forms large euhedral pseudo-hexagonal crystals.

**Alkali-silica reaction (ASR)** – The reaction between the alkalis (sodium and potassium) in Portland cement binder, moisture and certain siliceous rocks or minerals, such as opaline chert, microcrystalline quartz, and acidic volcanic glass, present in some aggregates; the products of the reaction may cause abnormal expansion and cracking of concrete in service.

**Alkali-aggregate reaction (AAR)** – A general term covering both ASR and ACR. Chemical reaction in mortar or concrete between alkalis (sodium and potassium) released from Portland cement or from other sources, and certain compounds present in the aggregates; under certain conditions, harmful expansion of the concrete or mortar may be produced.

**Alkali-carbonate reaction (ACR)** – The reaction between the alkalis (sodium and potassium) in Portland cement binder and certain carbonate rocks, particularly calcitic dolomite and dolomitic limestones, containing finely divided clay, present in some aggregates.

**All-in aggregate** – Aggregate consisting of a mixture of coarse aggregate and fine aggregates. *NOTE:* It may be produced without separating into coarse and fine fractions, or it may be produced by combining coarse and fine aggregates. (BS 882:1992) (EN1260).

**Anhydrite** –  $\text{CaSO}_4$ . Produced by calcining (heating at high temperature but below the melting or fusing point) gypsum to temperatures in excess of  $400^\circ\text{C}$  to produce anhydrite.

**Anhydrous Portland cement phases** – Mineral phases present in cement powders or clinkers. Portland cement contains four principal phases, tricalcium silicate,  $\beta$ -dicalcium silicate, tricalcium aluminate and tetracalcium aluminoferrite.

**Artificial aggregates** – Industrial by-products (blastfurnace slags, steel slags, lead-zinc slags) and industrial and municipal wastes (fly ash, ash, clinker, demolition wastes).

**Asbestos** – Fibrous minerals used in sheet and pipe manufacture. The principle commercially important asbestos minerals are: chrysotile, crocidolite, amosite and anthophyllite.

**Asbestos – Cement Products** – Manufactured sheet and pipe made of a mix cement, asbestos and usually silica flour (The use of asbestos has been banned in the UK since 1999)

**Bauxite** – An off-white, greyish, brown, yellow, or reddish-brown rock composed of a mixture of various amorphous or crystalline hydrous aluminium oxides and aluminium hydroxides along with free silica, iron hydroxides, and especially clay minerals; a highly aluminous laterite. Bauxite is the principle commercial source of aluminium; the term is also used collectively for lateritic aluminous ores.

**Belite** – Dicalcium silicate.  $(2\text{CaO}.\text{SiO}_2)$  ( $\text{C}_2\text{S}$ ) A calcium orthosilicate present as a constituent of Portland cement clinkers (see also felite).

**Blastfurnace slag (granulated/pelletised)** – By-product produced simultaneously with pig-iron in the reduction of iron ore in the blastfurnace and composed chiefly of calcium and magnesium silicates and alumino-silicates. (BS 1047:1983). The blastfurnace slag can be rapidly cooled to produce granulation. Additional grinding of slag produces a ground granulated blastfurnace slag (GGBS). A pelletisation process and the glassy product is ground to cement fineness or finer for use as an addition or cement replacement material in concrete.

**Bleeding** – Separation of water from the cement matrix of mortar on concrete after placing. Two types are recognised, water flows out to lie on the surface after compaction and water that segregates under aggregate, steel reinforcement and so runs up the interfaces between the concrete and formwork during or after compaction.

**Blended Aggregate** – Coarse or fine aggregate produced by the controlled blending of selected size gradings of gravel or crushed rock.

**Blended Coarse Aggregate** – Coarse aggregate produced by the controlled blending of gravel and crushed rock. (BS 882:1992).

**Blended sand** – Fine aggregate produced by the controlled mixing two or more size fractions in order to meet a specific grading requirement. (BS 882:1992).

**Bound Aggregates** – Aggregates mixed bound together with resin, hydraulic cement or bitumen. Typical uses include pavements, pavement surfacing or decorative features.

**Brucite** – A hexagonal mineral:  $\text{Mg}(\text{OH})_2$ . Can be found as fine-grained encrustations and fillings in concrete attacked by seawater.

**Calcium silicate products** – Calcium silicate products consist of a mixture either of siliceous sand or flour and about 10-15% of a well slaked, high calcium lime or pulverised quick lime. The mixture is pressure moulded while still ‘green’ and the product autoclaved for about 16 hours at around 170°C.

**Calcium sulphate** – see anhydrite.

**Calcium sulphate hydrate** – see gypsum.

**Carbonation** – A process of chemical alteration of calcium hydroxide and CSH by atmospheric carbon dioxide to carbonates. In general terms the transformation of minerals containing calcium, magnesium, potassium, sodium, and iron into carbonates or biocarbonates of these metals is by carbon dioxide contained in water.

**Carbonation (in lime mortar)** - The process by which lime (calcium hydroxide,  $\text{Ca}(\text{OH})_2$ ) reabsorbs carbon dioxide ( $\text{CO}_2$ ) from the ambient environment and reverts to calcium carbonate ( $\text{CaCO}_3$ ). As a result of this chemical change the lime mortar becomes harder, more stable and less soluble than in its uncarbonated form.

**Chalcedony** – A cryptocrystalline, sometimes fibrous, variety of quartz. It has a lower density and lower indices of refraction than ordinary quartz.

**Chert** – A hard, extremely dense or compact, dull to semivitreous, microcrystalline or cryptocrystalline sedimentary rock, which may contain amorphous silica. Chert occurs principally as nodular or concretionary segregations in limestones and dolomites, and less commonly as really extensive layered deposits; it may be an original organic or inorganic precipitate or a replacement product.

**Chrysotile** – A white, grey or greenish material of the serpentine group  $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$ . It is highly fibrous, silky variety of serpentine, and constitutes the most important type of asbestos for industrial use. Formerly used in sheet and pipe forms (banned in the UK since 1999).

**Clinker** - The sintered product of burning limestone and an aluminosilicate rock (clay or shale) at temperatures of up to 1500°C is known as Portland cement ‘clinker’. The grey powder generally called ‘cement’ is produced by inter-grinding the clinker and ~5% gypsum to act as an early set retarder.

**Coarse aggregate** – Aggregate for use in concrete of which not less than 90% is retained on a 5mm test sieve. (BS 1047 : 1983). 4.75mm in the USA (ASTM C33), 4mm (BS EN 12620). In Europe the definition refers to the larger aggregate sizes with  $D$  greater than or equal to 4 mm and  $d$  greater than or equal to 2 mm (EN 12620).

**Compaction** – The process whereby the volume of freshly placed mortar or concrete is reduced to the minimum practical space, usually by vibration, centrifugation, tamping, or some combination of these; to mould it within forms or moulds and around embedded parts and reinforcement, and to eliminate voids other than entrained air.

**Crusher-run aggregate** – Crushed rock that has not been subjected to any subsequent screening process. (BS 6100-6.3:2008).

**DEF (delayed ettringite formation)** – A form of sulphate attack where the source of sulphate is internally derived from the cement rather than from an external source. It is an expansive reaction resulting from the delayed formation of ettringite in a concrete subjected to temperatures above 60°C during curing and a moist environment.

**Drying Shrinkage** - The loss of moisture from a concrete or mortar either during setting or after hardening leads to a volume shrinkage which, if of sufficient magnitude, may lead to the development of cracks. Although the shrinkage is directionally proportional to the loss of water for simple laboratory cement paste specimens, aggregate type, grain sizes, mix design and curing conditions all influence the amount and pattern of drying shrinkage.

**Efflorescence** – superficial coating on concrete surfaces and from cracks due to moisture movement and bleaching of soluble salts from the concrete, evaporation and precipitation of the salts on the surface. The most common is calcium carbonate.

**Entrained Air** – See Air Entrained

**Ettringite** -  $3\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot 3\text{CaSO}_4\cdot 26\text{-}32\text{H}_2\text{O}$  A calcium-sulpho-aluminate-hydrate mineral. Very common in voids in concrete where moisture ingress has occurred. Found in substantial quantities in cracks where sulfate attack has occurred.

**Felite** – An out-dated name given to dicalcium silicate, usually  $\beta\text{C}_2\text{S}$ , see also belite.

**Fine aggregate** – Concrete and mortar. The portion of an aggregate consisting of particles passing a 5mm BS882 test sieve, but retained on a 75 $\mu\text{m}$  sieve, within specified limits. European Standard, EN 12620 sets a 4mm upper limit and ASTM, C125, specifies particles passing 4.76mm sieve but retained on a 74 $\mu\text{m}$  sieve. The European designation refers to the smaller aggregate sizes with  $D$  less than or equal to 4 mm. *NOTE* Fine aggregate can be produced from natural disintegration of rock or gravel and/or by the crushing of rock or gravel or processing of manufactured aggregate (EN 12620).

**Flint aggregate** – A chert (a compact cryptocrystalline form of silica) originating as nodules or layers in Cretaceous chalk.

**Fly ash** – Pulverised-fuel ash or PFA. This is a generic term for all finely divided residues from pulverised coal collected or precipitated from the flu gases of any coal fired industrial furnace.

**Foamed aggregate** - Aggregate produced by heating natural or artificial minerals which are expanded by entraining gases. (BS 6100-6.3:2008).

**Foamed blastfurnace slag aggregate** - Foamed aggregate produced from blastfurnace slag. (BS 6100-6.3:2008).

**Foamed concrete** – Low density, low strength concrete produced using an air entraining agent and/or air foaming agent. See also aerated concrete.

**Freeze-thaw action/damage** – The mechanical weathering process caused by alternate or repeated cycles of freezing and thawing of water in pores, cracks and other openings. Damage is usually most severe close to the concrete surface.

**Frost damage** - Characteristic features of hardened concrete affected by frost damage are typically the development of shallow surface-parallel cracking, degradation of surface concrete and evidence for moisture ingress such as secondary ettringite formation within voids.

**Furnace bottom ash (FBA)** – This is produced at the bottom of power station furnaces fired with pulverized bituminous coal. It is variable in composition but may be crushed and screened for use as aggregate for block manufacture.

**Gibbsite** -  $\text{Al}(\text{OH})_3$ , one of three main mineral phases that form bauxite (qv) and is one of the hydration products of high alumina cements.

**Glass** – Synthetic or natural amorphous solid formed by rapid cooling which prevents crystallisation.

**Grading of aggregates** - The proportional distribution of particles of granular material of various sizes established by sieving, usually expressed in terms of cumulative mass percentages larger or smaller than each of a series of sizes (sieve openings), or the percentages between certain ranges of sizes. The European definition is given as the particle size distribution expressed as the percentage by mass passing a specified set of sieves. (EN 13242 and 12620)

**Gravel** – Natural coarse aggregate derived from unconsolidated deposits.

**Hardened cement paste** – The cementitious matrix between aggregate particles. Portland cement pastes are principally composed of calcium silicate hydrates, calcium hydroxide and calcium aluminium hydrates.

**Heavy duty concrete floor finishes** – Concrete top layer made with specially selected aggregate of a hardness, surface texture and particle shape suitable for use as a wearing finish laid over a concrete floor. (BS 882:1992).

**Gravel** – Natural coarse aggregate derived from unconsolidated deposits.

**Gypsum** – Calcium sulphate hydrate ( $\text{CaSO}_4$ ) $2\text{H}_2\text{O}$ . A natural mineral which is associated with evaporate deposits, but may also be developed in concrete and mortars attacked by sulphate solutions and sea water.

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**High Alumina Cement** – Aluminous cement, Calcium Aluminate cement or Ciment Fondu made by sintering or melting bauxite and limestone at temperatures in excess of 1400°C. It has the property of setting, hardening and gaining strength rapidly. A principal use is as a refractory.

**Honeycombing** – An area of roughness on a concrete surface resulting from segregation of the aggregate with little fine aggregate to fill gaps between coarse aggregate particles.

**Hydrated cement phases** – The four principle cement constituents  $\text{C}_3\text{S}$ ,  $\text{C}_2\text{S}$ ,  $\text{C}_3\text{A}$  and  $\text{C}_4\text{AF}$  are each hydraulic and thus react with water on mixing to form a range of hydrated phases and calcium hydroxide. These have the general identification of calcium, silicate hydrates or CSH.

**Hydraulic limes** – A dry powder obtained from calcining limestone containing clay materials, or a mixture of similar composition, and fired at temperatures up to 1250°C. Hydraulic lime contains a mix of hydrated lime, silicates and aluminates. Hardening occurs through direct reaction with water and by carbonation.

**Kraft Pulp** – chemically pulped cellulose wood pulp used as an asbestos substitute.

**Laitance** – A cement rich scum developed on the surface of over-trowelled concrete or mortar surfaces. This surface layer has little strength and ‘dusts’ readily.

**Leaching** – Removal of soluble salts by water percolating through permeable material. With Portland cement concrete leaching often results in depletion of portlandite and other water-soluble components in cement paste.

**Lean Mix Concrete** – Concrete with low cement content used for blinding off and typically of low compressive strength.

**Light weight aggregate** – Natural or artificial aggregate materials of high porosity and low apparent specific gravity with aggregate bulk density of 400 – 1200 kg/m<sup>3</sup> (BS 3797, 1990). The European Standards definition is an aggregate of mineral origin having a particle density not exceeding 2000 kg/m<sup>3</sup> (2,00 Mg/m<sup>3</sup>) or a loose bulk density not exceeding 1200 kg/m<sup>3</sup> (1,20 Mg/m<sup>3</sup>) (EN 13055-1).

**Lime** – Quicklime, CaO, formed by calcining limestone at temperatures in excess of 900°C in hydrated form used in mortars and plasters and the manufacture of bricks, blocks etc. Both hydrated and quick limes are used extensively to stabilise soils especially in road construction.

**Long-term drying shrinkage** - Shrinkage cracking that takes place months or years after concrete has hardened. Cracks commonly appear mid-way between shrinkage joints on slabs and panels. The cracks pass through aggregate particles and the cement paste and tend to be parallel-sided.

**Micropore** – A small pore less than 10nm in diameter in hydrated cement paste. Two types are recognised, gel pores in CSH gel and slightly larger capillary pores originally occupied by air or mix water not used in the hydration.

**Microporosity** – Capillary porosity allows water movement through the cementitious matrix, whereas the smaller gel pores are mostly isolated so have minimum permeability.

**Microsilica** – Condensed silica fume. An ultrafine powder, with individual particle sizes between 20nm and 1µm produced by the silicon and ferrosilicon industries. Comprising solid spherical glassy particles of amorphous silica (85-96% SiO<sub>2</sub>). Principally used as a mineral admixture for modifying the properties of a concrete.

**Microsilica clot** – Microsilica agglomerate. Irrespective of the pre-treatment and method of mixing and curing concrete, some agglomerations of silica fume remain in the hardened cement matrix.

**Mortar** - A material composed of one or more inorganic cementitious binders, fine aggregate, water and admixtures used in brick and masonry construction to provide for bedding, jointing and bonding of brick or masonry units.

**No-fines aggregate** – Aggregate in which there is a minimum of particles passing a 10 mm test sieve. (BS 1047 : 1983).

**Particle shape** – The physical shape of particles in a concrete aggregate. Particle shape will significantly influence the properties of the mix as well as the degree of cement/aggregate bonding and component interlock within concrete and consequently the workability and ultimate strength of the concrete. Shapes are often described as equant, tabular, flaky elongate irregular and in terms of roundness and sphericity.

**Particle size distribution** – see grading.

**Partly Crushed** – Natural gravel with the oversize material crushed to reduce its size to the specified grading requirement.

**Pavement wearing surfaces** – The top or running surface of a highway. Concrete pavement surface layers are made with specially selected aggregate of a hardness, surface texture and particle shape suitable for use in concrete pavements and similar surfaces. (BS 882, 1992).

**Pessimum proportion** – In concrete that is affected by alkali-silica reaction it is the proportion of reactive aggregate in the mix which produces the maximum expansion for a given alkali content in the concrete.

**Peripheral cracks** – Cracks that develop around aggregate particles in hardened concrete sometimes produced by aggregate shrinkage or by material defects or reaction such as differential thermal effects, non-adhesion between aggregate and cement matrix or delayed ettringite formation.

**Petrography** – The systematic description and classification of rock in hand specimen and thin section. In the context of concrete it is concerned with identifying aggregates, cementitious binders and features of deterioration.

**Pit slag** – Blastfurnace slag which has been poured in a molten state into prepared pits, canals or large moulds and allowed to solidify therein. (BS 1047, 1983).

**Plastic settlement cracking** – Early stage cracks in concrete. Commonly seen around reinforcement and typically initiated in concrete before it has hardened - generally during the compaction of concrete with high water/cement ratio.

**Plastic shrinkage cracking** – Early stage network cracking which initiates before concrete has hardened. It may indicate poor curing, high water/cement ratios and/or excessive trowelling of the concrete surface. Cracks of this type tend to be restricted to the cement paste and commonly decrease in width rapidly with depth.

**Plasticiser** – An admixture used in concrete or mortar which will allow increased workability at low water/cement ratios.

**Pleochroite** – A characteristic mineral constituent of hydrated high alumina cement (HAC)  $\text{Ca}_{20}\text{Al}_{32-2x}\text{Mg}_x\text{Si}_x\text{O}_{68}$ , where x can vary from 2.5 to 3.5 that is typically fibrous and pleochroic.

**Point counting** – A statistical method of counting features such as air voids or aggregate types on polished plates or thin sections using a binocular or petrological microscope. This is accomplished by incrementally stepping in x and y directions across the surface of the specimen, identifying the presence or absence of the feature of interest at each step. A method is described in ASTM C457 where it is used to measure volume proportions of features such as aggregate, paste and voids.

**Portland cement** – A world-wide and ubiquitous constructional material. A range of Portland cements are in use. They are all manufactured by heating crushed limestone and clay or shale at temperatures in excess of 1200 °C. The resulting clinker is ground to a fine powder. Gypsum and other materials may be added or blended into the powder.

The types differ in the proportions of the anhydrous minerals they contain, the possible additions of mineral admixtures and their particle size distributions. First patented in 1824.

**Portland cement phases** – See anhydrous Portland cement phases.

**Portland limestone cement** – 6–20% of limestone may be interground with Portland cement clinker. It primarily acts as a diluent allowing the production of a cement requiring less energy input for its manufacture. (BS 7583, 1996)

**Portlandite** - Calcium hydroxide mineral name,  $\text{Ca}(\text{OH})_2$ , one of the products of Portland cement hydration. Portlandite crystals tend to be more abundant and more coarsely crystalline as the water content of concrete mix is increased.

**Pozzolana** – Originally a volcanic dust used at Pozzuoli, Italy. A siliceous, or siliceous and aluminous material, which in itself possesses little or no hydraulic property but in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures in hydrating cement to form compounds possessing hydraulic properties.

**Precast concrete** – This term applies to manufactured concrete products that maybe made as modules or units that are later fitted together in construction.

**Pseudomorphically hydrated cement** - Hydrated cement grains retaining the structure of the original anhydrous grain but replaced by cement hydrates. It is a possible indicator of secondary cement hydration.

**Pulverised-fuel ash (pfa)** – The class of fly ash that is produced as a by-product specifically from the burning of pulverised coal.

**Pulverized-fuel ash aggregate** – Manufactured secondary aggregate made from pulverized-fuel ash. (BS 6100-6.3:2008).

**Quality Assurance** – The assurance we give ourselves, customers, shareholders and regulators that the specified quality is being provided (150-9000, 2000)

**Rosival analysis** - A linear traverse method used for measurement of volume proportions of aggregates or voids in thin sections or polished plates. (see also modal analysis).

**Sand** – A commonly used term for a fine grained material with maximum size of 5mm (UK) 4mm (EU) 4.74mm (USA). Typically for concrete or mortar fine aggregate passing a 5.0 mm BS 410 test sieve and containing no more coarser material than is permitted for the various gradings in the specification BS 882, 1992. (see also Fine Aggregate)

**Partially crushed** –Aggregate produced from a mixture of uncrushed sand and crushed sand resulting from the crushing of associated particles during product processing. (BS 882, 1992).

**Secondary cement hydration** - Occurs as a result of moisture ingress. Commonly results in pseudomorphic cement hydration.

**Secondary ettringite formation** – Ettringite normally formed during the initial hydration of Portland cement is converted slowly to calcium sulfoaluminate hydrate. Secondary Ettringite is formed by recrystallization of cement hydrates in damp conditions, and tends to form in open cracks and voids. No external source of sulphate is required for secondary ettringite formation.

**Shrinkage** – The irreversible decrease in volume of a material as a result of loss of moisture and/or carbonation and/or temperature drop (plastic, drying & thermal shrinkage).

**Sintered colliery waste aggregate** - Expanded aggregate produced by heating colliery waste. (BS 6100-6.3:2008). Used as a lightweight aggregate.

**Sintered pulverized-fuel ash aggregate** - Sintered aggregate produced from pulverized-fuel ash. (BS 6100-6.3:2008). Used as a lightweight aggregate.

**Slump** – A test involving a cone of concrete slumping under its own weight when the mould is removed. The decrease in height of the cone test concrete is measured as the ‘slump’ (BS 1881-102, 1983)

**Steel fibres** –Used as a method of reinforcing concrete by dispersing short steel fibres (mm to cm in length) in a cement/aggregate mix. Used in fibre/cement composites and sprayed concrete.

**Steel reinforcement** – The use of steel reinforcing bars to increase the tensile strength of structural concrete.

**Steel slags, basic** – Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steel-making furnaces.

**Structural cracking** – Structural cracking refers to the cracking which is the result of structural damage of some kind, for example impact.

**Sulphate attack** – A general term relating to damage to concrete resulting from the expansive formation of secondary sulphate minerals such as minute ettringite or thaumasite crystals forming within the cement paste and in cracks. Generally involves externally derived sources of sulphate and requires damp conditions.

**TF - Thaumasite Formation** – An unusual form of sulphate attack causing deterioration and softening of the outer zones of concrete by the action of external sulphate solutions normally under low temperature conditions in the presence of a source of calcium carbonate. Early stage deposition of thaumasite within voids and pre-existing microcracks. This development is usually non deleterious, but occasionally involves expansive deposition.

**Thaumasite** - A calcium-silicon-sulphate-carbonate-hydrate,  $\text{Ca}_3\text{Si}(\text{OH})_6 \cdot 12\text{H}_2\text{O}(\text{SO}_4)(\text{CO}_3)$  a mineral formed in concrete where there is a source of carbonate and sulphate. Most commonly seen in foundation and subterranean concrete where the ground contains pyrite or gypsum and the groundwater contains dissolved  $\text{CO}_2$ .

**TSA - Thaumasite Sulfate Attack** -Deleterious thaumasite growth forming at the expense of the cement paste matrix, ultimately degrading the cement matrix to a soft mush.

**Thin-section** - A slice of concrete or other material mounted on a glass slide and ground sufficiently thin for it to be transparent in transmitted light. Typical thickness for concrete would be 0.025 -0.020mm.

**Uncrushed** – Natural aggregate that results from the natural disintegration of rock, or by the natural processes of erosion and deposition.

**Uncrushed Gravel** – A naturally unconsolidated gravel, typically from ancient river or beach deposits.

**Vermiculite, exfoliated** – A layered silicate clay mineral of the chlorite family which exfoliates when heated to 750 – 1100°C to produce a light cellular material used for thermal insulation and as a lightweight aggregate.

**Void and voidage** – Most concrete inevitably retains some entrapped air and may contain small bubbles of deliberately entrained air, even when it is efficiently compacted. After hardening of the concrete, these entrapped and entrained bubbles are fixed in place and are referred to as air voids. (see also entrapped and entrained air voids).

**Water/cement ratio** – The ratio by weight between the water and cement in a concrete mix. In general terms the ratio may be considered Low (<0.35), Normal (0.35 – 0.65) and High (>0.65).

**Wood particle aggregate** - Aggregate comprising treated and graded wood particles. (BS 6100-6.3, 2008).