Concrete attacked by sulfates has a characteristic whitish appearance, damage usually starting at the edges and corners and followed by cracking and spalling of the concrete. The reason for this appearance is that the essence of sulphate attack is the formation of calcium sulphate (gypsum) and calcium suphoaluminate (etteringite). Both products require more space volume than the original compounds that they replace so that internal pressures are subsequently created causing expansion and disruption of hardened concrete, eventually visibly surfacing in the form of delamination, crumbling, cracking, etc.

Small amounts of gypsum are normally added to portland cement clinker in order to prevent flash setting upon hydration of cements tricalcium aluminate (C3A). Gypsum quickly reacts with C3A (tricalcium aluminate) to produce etteringite which is harmless at this stage because the concrete is in a **plastic** state so that expansion can be accommodated. However, a similar reaction producing etteringite may take place when **hardened** concrete is exposed to sulfates from external sources such as from the soil or the atmosphere. In such an occurrence the **hardened** concrete cannot accommodate the etteringite causing the concrete to instead crack. A typical sulphate source is from the groundwater of some clays which contain sodium, calcium or magnesium sulfates. The sulfates react with both Ca(OH)2 (calcium hydroxide) and the hydrated C3A (tricalcium aluminate) to form gypsum and etteringite, respectively.

Magnesium sulphate has a more damaging effect than other sulfates because it leads to the decomposition of the hydrated calcium silicates as well as of Ca(OH)2 (calcium hydroxide) and of hydrated C3A (tricalcium aluminate). Hydrated magnesium silicate is eventually formed, possessing no binding properties.

The extent of sulphate attack depends on its concentration and on the permeability of the affected concrete, i.e. the ease with which sulphate can travel through the pore system. If the sulphate contaminated concrete is highly permeable so that water can percolate right through its thickness Ca(OH)2 (calcium hydroxide) will quickly leach out. Evaporation at the 'far' surface of the affected concrete leaves behind deposits of calcium carbonate, formed by reaction of Ca(OH)2 (calcium hydroxide) with carbon dioxide (C02). This deposit, of whitish appearance, is also called efflorescence. Efflorescence is not generally harmful. However, extensive leeching of Ca(OH)2 (calcium hydroxide) will increase porosity so that the affected concrete becomes progressively weaker and more prone to chemical attack.

Salts attack concrete only in the presence a liquid (usually water / moisture), and never in solid form. The strength of the liquid is expressed as concentration. For instance, as the number of parts by mass of sulphur trioxide (S03) per million parts of water (ppm). A concentration of 1000 ppm is considered to be moderately severe, and 2000 ppm very severe, especially when magnesium sulphate is the predominate constituent.
Many agents attack concrete, destructively altering its chemical composition by means of reaction mechanisms which are partially or incompletely understood. Sea water contacting existing concrete, perhaps largely because of its sulphate content, may be destructive to permeable concrete or those made with cement having a high tricalcium aluminate content. Some polyhydroxyl organic compounds such as glycols, glycerol, and sugars can also slowly attack concrete.

PLEASE NOTE: Permeability is the ease with which liquids or gases can travel through concrete. For normal portland cement concrete permeability is governed by the capillary porosity of the cement paste and the aggregates porosity, normal weight aggregates have permeability similar to that of cement paste. Chemical attack by sulphates, acids, sea water, and also by chloride, which induce electrochemical corrosion of steel reinforcement. Since this attack takes place within the concrete mass, the attacking agent must be able to penetrate throughout the concrete, which therefore has to be permeable. Permeability therefore, is of critical importance. **DEEP SEAL** has the unique ability to greatly diminish permeability of Portland cement concrete, among other things that are also very beneficial to the installation, therefore cutting off the water / moisture supply to its interior, eliminating formation of acids, because this deteriorating process cannot occur without water, the main constituent of acid production. Also if the **DEEP SEAL** treated concrete already has acid existing in its interior this acid will be rendered harmless by the presence of **DEEP SEAL.**