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Why Does Salt Do Damage to Some Concrete?

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By Ev Munro

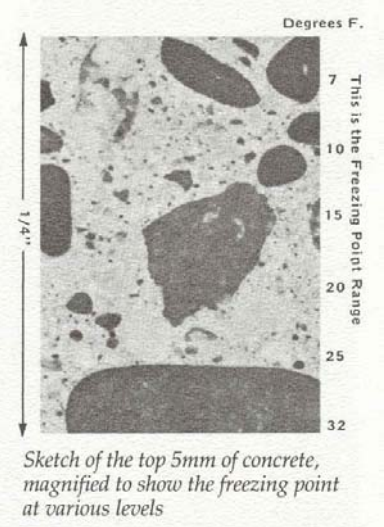
Winter slush is unloved by millions. It is dirty, never seems to freeze, and is very cold on the feet. It is like a mixture of salt in an ice cream churn. The brine is actually colder than the ice it is made from. The melting caused by the salt is an endothermic reaction that consumes large amounts of heat.

When salt is spread on snowy and icy streets, it drops the temperature. Furthermore, the brine produced has a very low freezing point –about -14°c. The brine is absorbed into the curb or sidewalk concrete where it becomes diluted with moisture. At a depth of about 5mm, the solution is so weak that the freezing point is near the 0°C mark. This brings us to the main question... Why does salt cause so much damage to some concrete?

This top layer of concrete is very sensitive to minor temperature changes. Not only is it a narrow freezing zone, it also reacts to all temperature changes from -14° to 0° C. For instance, if the temperature drops from -4° to -5°C, a very thin layer will freeze.

The concrete that is saturated with enough salt to Have a freezing point lower than -5° will remain unfrozen.

We could make finer divisions and say a drop of a three thousandth of a degree would freeze a



Sketch of the top 5mm of concrete, magnified to show the freezing point at various levels

layer of concrete a thousandth of a millimetre thick.

Any change, no matter how small, between 0° and -15° will cause freezing or thawing of a thin layer in that critical top 5mm. Temperature changes caused by a passing cloud, an opened door, or even the infinitesimal change caused by body heat are a few of the hundreds of factors that cause minor fluctuations every day. Each change is a half of a freeze/thaw cycle.

Northern cities like Sudbury used to boast of one freeze/thaw cycle per year. With the advent of salting, they may have several daily. Toronto spends much of the winter in the critical -6° to -1° range and rarely is there a moment when salted concrete is not freezing or thawing.

On freezing, water expands about 10% and, if restrained, creates stresses that no concrete can withstand. De-icing salts merely increase the number of times concrete freezes to an astronomical figure. Its effect is physical rather than chemical. It doesn't produce hydrochloric acid as is sometimes reported. However, there are fertilizers advertised as de-icing agents that are chemically destructive. Ammonium sulfate will damage concrete even in the summer.

The damage caused by salt is due to disruptive hydraulic pressures in the concrete. Purposely-entrained air bubbles act as reservoirs for excess water forced into them by progressing ice fronts in capillaries. Quality concrete air entrainment effectively prevents frost damage. !