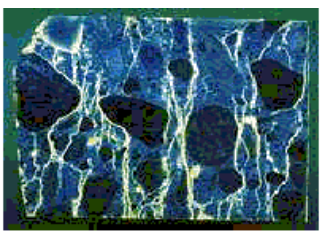
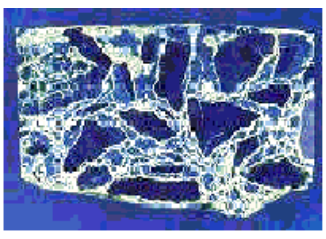
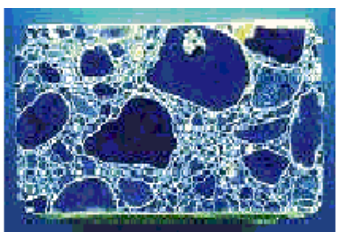
Concrete Experts International has extensive knowledge in theory and diagnosis of concrete deteriorated by freeze thaw actions (F/T). Diagnosing deterioration from freeze thaw action is an integrated part of our petrographic analysis of concrete.

Why may concrete deteriorate from freeze thaw actions?

Deterioration of concrete from freeze thaw actions may occur when the concrete is critically saturated, which is when approximately 91% of its pores are filled with water. When water freezes to ice it occupies 9% more volume than that of water. If there is no space for this volume expansion in a porous, water containing material like concrete, freezing may cause distress in the concrete. Distress to critically saturated concrete from freezing and thawing will commence with the first freeze-thaw cycle and will continue throughout successive winter seasons resulting in repeated loss of concrete surface.

To protect concrete from freeze/thaw damage, it should be air-entrained by adding a surface active agent to the concrete mixture. This creates a large number of closely spaced, small air bubbles in the hardened concrete. The air bubbles relieve the pressure build-up caused by ice formation by acting as expansion chambers. About 4% air by volume is needed and the air-bubbles should be well distributed and have a distance between each other of less than 0.25 mm in the cement paste.

Concrete with high water content and high water to cement ratio is less frost resistant than concrete with lower water content.

Typical example of concrete cracked *Surface parallel cracks in a* *Russian concrete* *Gaps around aggregate in*

deteriorated from freeze thaw Danish concrete suffering by freeze thaw actions. concrete tested for freeze

actions. Non-air-entrained from freeze thaw damage. Gaps are visible around thaw durability. Laboratory

concrete railing. PCA vol. aggregate. test.

19/1, April 1998

Macro- & microscopic appearance

Deterioration of concrete by freeze thaw actions may be difficult to diagnose as other types of deterioration mechanisms such as ASR often go hand in hand with F/T. Often is may be difficult to evaluate which mechanism caused the initial damage, however, if all other mechanisms can be excluded the typical signs of F/T are:

Spalling and scaling of the surface

Large chunks (cm size) are coming off

Exposing of aggregate

Usually exposed aggregate are un-cracked

Surface parallel cracking

Gaps around aggregate - in the ideal case

Source: Concrete Experts International