THE Concrete DIFFERENCE

Concrete Information for the Owner, Designer, Contractor and Producer

VOLUME CHANGES of Concrete

There are several reasons that concrete changes in volume. Understanding the nature of these changes is useful for all those who design, specify, and work with concrete.

Concrete, like other construction materials, contracts and expands with changes in moisture and temperature, and deflects in response to loading. In addition, concrete begins to change volume as soon as the residual moisture from its initial mixing begins to leave. Concrete that is not cured will begin to lose moisture, and change volume very early in its life.

There are two types of shrinkage commonly associated with concrete: plastic shrinkage and drying shrinkage. Plastic shrinkage often resembles tears in the surface and results from a combination of chemical shrinkage and rapid evaporation of moisture from the surface. Plastic shrinkage cracking can be controlled by the use of spray-on evaporation retarders, or by minimizing surface evaporation through use of plastic sheeting, fogging, wet burlap, wind breaks, or shading.

Drying shrinkage is the volume change in hardened concrete due to moisture loss. As this drying takes place, concrete shrinks. Where there is no restraint, movement occurs freely and no cracks develop. When there is restraint, and when the tensile stress from restrained drying shrinkage exceeds the tensile strength of concrete, cracks develop. Random cracks may develop if joints are not properly provided. Concrete joints for slabs on the ground should be spaced at distances 24 to 36 times the slab thickness to control random cracks. A 4" thick slab should have a maximum joint spacing of 12 feet (4" X 36 = 144" ÷ 12" = 12 feet). **The most important factor affecting drying shrinkage is the paste content of the concrete when placed.** This explains why higher compressive strength concrete mixes have increased shrinkage and cracking.

Curling, or warping, of concrete slabs is a phenomenon that occurs from differences in moisture or temperature between the top and bottom of a slab. When a newly constructed building is enclosed, the relative humidity decreases and the shrinkage gradient increases. Curling will begin and continue until the moisture differences between the top and bottom of the concrete slab, and within the concrete section, cease.

Drying shrinkage cracking

Plastic shrinkage cracking

Follow these steps to help minimize the harmful effects of volume changes:

- Design and use a concrete mix with the lowest paste content that is needed for strength, durability, and workability.
- Specify and use the lowest compressive strength concrete that is required.
- Do not specify a water / cementitious ratio lower than needed for exposure and durability requirements.
- Do not add water to make concrete easier to place or finish. Admixtures can provide increased workability without increasing the paste content of concrete.
- Use a surface evaporation retarder whenever there is a possibility of plastic shrinkage cracking.
- Cure the concrete to maintain its moisture for as long as possible. Wet curing is the best method.
- Provide joints that are properly spaced and deep enough to minimize and control cracking.

References:

PCA – Design and Control of Concrete Mixtures, Fourteenth Edition, Skokie, IL
NRMCA CIP 4 – Cracking Concrete Surfaces, NRMCA, Silver Spring, MD
Concrete International – Why Slabs Curl, Skokie, IL
The Concrete Producer - Controlling Shrinkage, Rosemont, IL
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