# Concrete Tech Tip # 5

# Plastic Shrinkage Cracking

Reviewed & Revised 2016

**1. WHAT is Plastic Shrinkage Cracking?**

Plastic shrinkage cracks appear in the surface of fresh concrete soon after it is placed and while it is still plastic. The cracks appear mostly on horizontal surfaces. They are usually parallel to each other on the order 30 - 90 mm apart, and 10 to 50 mm deep. The cracks occur randomly and seldom intersect the perimeter of the slab. Plastic Shrinkage cracking is more likely to occur when high evaporation rates cause the concrete surface to dry out before it has set.

Plastic shrinkage cracks rarely impair the strength of concrete floors and pavements, nevertheless, they are unsightly. The development of these cracks can be minimized if appropriate measures are taken prior to and during construction.

**Note**: Plastic shrinkage cracks should be distinguished from other early or pre-hardening cracks caused by settlement of the concrete around reinforcing bars, formwork movement, early age thermal cracking or differential settlement at a change from a thin to a deep section of concrete.

**2. WHY Do Plastic Shrinkage Cracks Occur?**

The most common explanation for the occurrence of plastic shrinkage cracking is that the rate of evaporation of surface moisture exceeds the rate at which it is being replaced by bleed water. This causes shrinkage of the surface while the underlying plastic concrete remains the same volume. Water receding below the concrete surface forms menisci between the fine particles of cement and aggregate causing a tensile force to develop in the surface layers. If the concrete surface has started to set and has developed sufficient tensile strength to resist the tensile forces, the cracks do not form. If the surface dries very rapidly, the concrete may still be plastic, and cracks do not develop at that time; but plastic shrinkage cracks will surely form as soon as the concrete starts to stiffen. Synthetic fiber reinforcement incorporated in the concrete mixture can help resist the tension when concrete is very weak.

The following are examples of weather conditions which increase the rate of evaporation and, therefore, the risk of plastic shrinkage cracking.

A) Decrease in relative humidity. Changes in relative humidity have pronounced effects on the rate of evaporation. If the relative humidity changes from 90% -50%, the rate of evaporation is increased by 5 times.

B) Increase in wind velocity. When wind blows across the surface of concrete during placement and finishing the evaporation of surface moisture will increase. For example an increase in wind speed from 0 to 15 km/h will quadruple rate of the evaporation.

C) Temperature. If the temperature of both the concrete and the surrounding air rises, the rate of evaporation will increase. For instance, when the temperature of both concrete and air increases from 10 to 20°C the rate of evaporation of water from the surface can double.

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References:
1. Hot Weather Concreting, ACI 305R, American Concrete Institute, Farmington Hills, MI.
2. Guide for Concrete Floor and Slab Construction, ACI 302.1R, American Concrete Institute, Farmington Hills, MI.
3. Standard Practice for Curing Concrete, ACI 308, American Concrete Institute, Farmington Hills, MI.
4. Concrete Slab Surface Defects: Causes, Prevention, Repair, IS 177T, Portland Cement Association, Skokie, IL
5. Bruce A. Suprenant Curing During the Pour, Concrete Construction, June 1997.
6. Eugene Goeb, Common Field Problems, Concrete Construction, October 1985.
7. CSA A23.1 - 14 Concrete materials and methods of construction, CSA Group, Mississauga, Ontario, Canada.
8. Concrete in Practice # 5: Plastic Shrinkage Cracking with permission from the National Ready-Mixed Concrete Association.

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D) Rapid evaporation and plastic cracking may also occur when the temperature of the concrete is significantly higher than the air temperature (and the "dew point" temperature). This can occur in cold weather with heated concrete even when the humidity is high and the concrete is placed indoors where the wind velocity is negligible.

Many factors other than those associated with rate of evaporation come into play when it comes to plastic shrinkage cracking. Concrete mixtures with an inherent reduced rate of bleeding or quantity of bleed water are susceptible to plastic shrinkage cracking even when evaporation rates are low. Factors that reduce the rate or quantity of bleeding include high cementitious materials content, high fines content, reduced water content, entrained air, high concrete temperature (as mentioned previously) and thinner sections. Concrete containing silica fume requires particular attention to avoid surface drying during placement due to its very low rate of bleeding. Any factor which delays setting increases the possibility of plastic shrinkage cracking. Delayed setting can result from the combination of one or more of the following: cool weather, cool subgrades, high water contents, lower cement contents, retarders, some water reducers, and supplementary cementitious materials.

**3. HOW To Minimize Plastic Shrinkage Cracks**

Attempts to eliminate plastic shrinkage cracking by modifying the concrete mixture composition to affect bleeding characteristics have not been found to be consistently effective. To reduce plastic shrinkage cracking it is important to recognize ahead of time, before placement, when weather conditions may occur that are conducive to plastic shrinkage cracking. Precautions can then be taken to minimize its occurrence:

A) When adverse conditions exist, erect temporary wind breaks to reduce wind velocity over the surface of the concrete and, if possible provide sunshades to control the surface temperature of the slab. If conditions become critical, schedule placement to begin in the late afternoon or early evening. However, in very hot conditions, early morning placement can afford better control of concrete temperatures.

B) In very hot and dry periods, use fogs sprays to discharge a very fine mist upwind and into the air above the concrete. Fog sprays reduce the rate of evaporation from the concrete surface and should be maintained until suitable curing materials can be applied.

C) If concrete is to be placed on a dry subgrade or on previously placed concrete, the subgrade or the concrete base should be thoroughly dampened. The form work and reinforcement should also be dampened.

D) Have proper manpower, equipment and supplies on hand so that the concrete can be placed and finished promptly. If delays occur, cover the concrete with wet burlap, polyethylene sheeting or building paper between finishing operations. Some contractors find that plastic shrinkage cracks can be prevented in hot dry climates by spraying an evaporation retarder on the surface behind the screeding operation and before floating or troweling.

E) Start curing the concrete as soon as possible. Spray the surface with liquid membrane curing compound or cover the surface with non-woven geotextile and polypropylene sheets and keep it continuously moist for a minimum of 3 days and at a minimum of 10°C.

**Follow These Rules To Minimize Shrinkage Cracking:**

1. Dampen the subgrade and forms.
2. Prevent excessive surface moisture evaporation by providing fog sprays and erecting windbreaks.
3. Cover concrete with wet burlap or polyethylene sheets between finishing operations.
4. Use cooler concrete in hot weather and avoid overheating the concrete in cold weather.
5. Cure properly as soon as finishing has been completed.

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