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PLASTIC SHRINKAGE CRACKS

What, Why & How?

CONMIX Technical Article—001 @ 2024

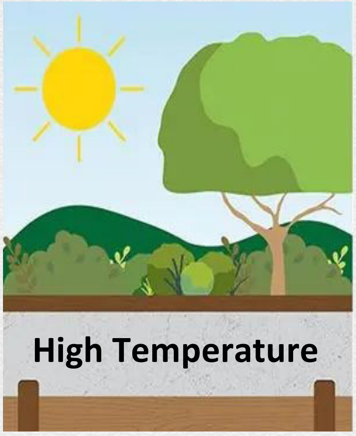
WHAT is Plastic Shrinkage Cracking?

Plastic shrinkage cracks emerge on the surface of freshly poured concrete, while it is still in a plastic state. These cracks predominantly form on flat surfaces, running parallel to each other, spaced about 1 to 3 feet apart. They are typically shallow and do not extend to the edges of the slab. High evaporation rates, leading to rapid surface drying before the concrete has fully hardened, increase the likelihood of their occurrence.

While plastic shrinkage cracks are mainly cosmetic, they can allow the penetration of water aggressively, affecting the long-term durability of concrete floors if not treated properly. To minimize the formation of these cracks, it is crucial to take appropriate measures before and during the pouring and finishing of concrete.

It is important to differentiate plastic shrinkage cracks from other types of early or pre- hardening cracks, which can result from factors such as settling of concrete around reinforcement bars, movement of formwork, early-age thermal cracking, or differential settlement between thin and thick concrete sections.

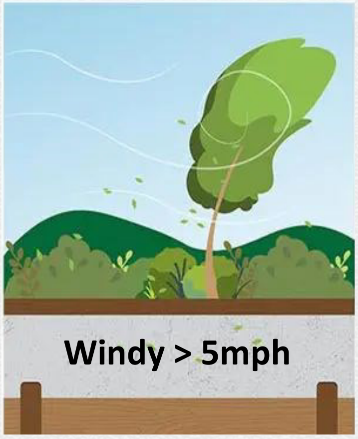
WHY do Plastic Shrinkage Cracks Occur?



onditions that lead to high evaporation rates from the concrete surface, increasing the risk of plastic shrinkage cracking, include:

- Wind speeds exceeding 5 mph
- Low relative humidity
- Elevated ambient and/or concrete temperatures

Even small changes in these conditions can significantly affect the rate of water evaporation from the concrete surface. The American Concrete Institute's ACI 305R publication offers a chart for estimating evaporation rates and determining when special precautions may be necessary. However, it's important to note that the chart's accuracy is limited because numerous factors beyond just the rate of evaporation are involved.



Concrete mixtures with reduced bleeding or bleed water quantity are also prone to plastic shrinkage cracking, even under low evaporation rates. Factors that decrease bleeding rate or quantity include high cementitious materials content, high fines content, low water content, air entrainment, high concrete temperature, and thinner sections. Concrete containing silica fume requires particular attention to prevent surface drying during placement due to its extremely low bleeding rate.

Any factor that delays the setting of concrete increases the risk of plastic shrinkage cracking. Delayed setting can result from various factors, including cool weather, cool subgrades, excessive water content, retarders, certain water reducers, and supplementary cementitious materials.

HOW to Minimize Plastic Shrinkage Cracking?

Efforts to mitigate plastic shrinkage cracking by adjusting the composition of the concrete mix to influence bleeding behavior have yielded inconsistent results. To minimize the risk of plastic shrinkage cracking, it is essential to identify potential weather conditions that could lead to its occurrence before pouring the concrete. Precautions can then be taken to reduce the likelihood of cracking:

- Install temporary windbreaks to reduce wind speeds over the concrete surface, and if possible, provide sunshades to control the surface temperature of the slab. Consider scheduling the placement for late afternoon or early evening if conditions are critical. In very hot weather, early morning placement might offer better control over concrete temperatures.

- During extremely hot and dry periods, use fog sprays to disperse a fine mist upwind and over the concrete. This helps decrease evaporation from the surface and should continue until appropriate curing materials can be applied.

- If placing concrete on a dry, absorbent subgrade in hot, dry weather, lightly dampen the subgrade, ensuring there is no standing water before placement. Also, dampen the formwork and reinforcement.

- The use of vapor retarders under a slab on grade can increase the risk of plastic shrinkage cracking. However, it may be necessary for interior slabs that will be covered with flooring at any point during their service life. Refer to CIP 29 for more information.

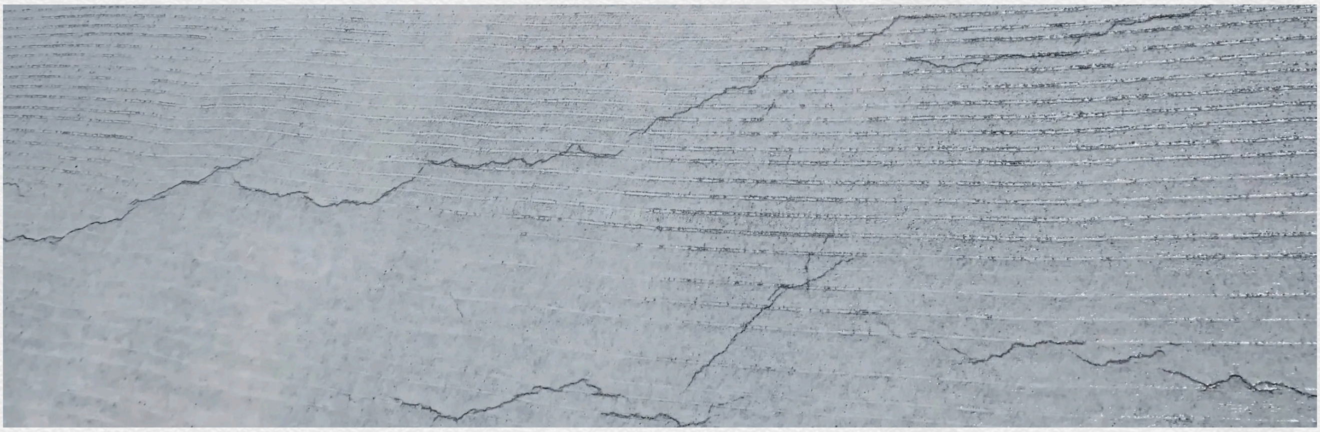
- Ensure sufficient manpower, equipment, and supplies are available so that concrete can be placed and finished promptly. If delays occur, cover the concrete with moisture- retaining materials like wet burlap, polyethylene sheeting, or building paper between finishing operations. In hot, dry climates, some contractors find that spraying an evaporation retardant on the surface behind the screeding operation and continuing to float or trowel as needed until curing begins can prevent plastic shrinkage cracks.

- Begin curing the concrete as soon as possible. Apply a liquid membrane curing compound to the surface or cover it with wet burlap, keeping it consistently moist for at least 3 days.

- Consider using synthetic fibers (ASTM C1116) to reduce plastic shrinkage cracking.

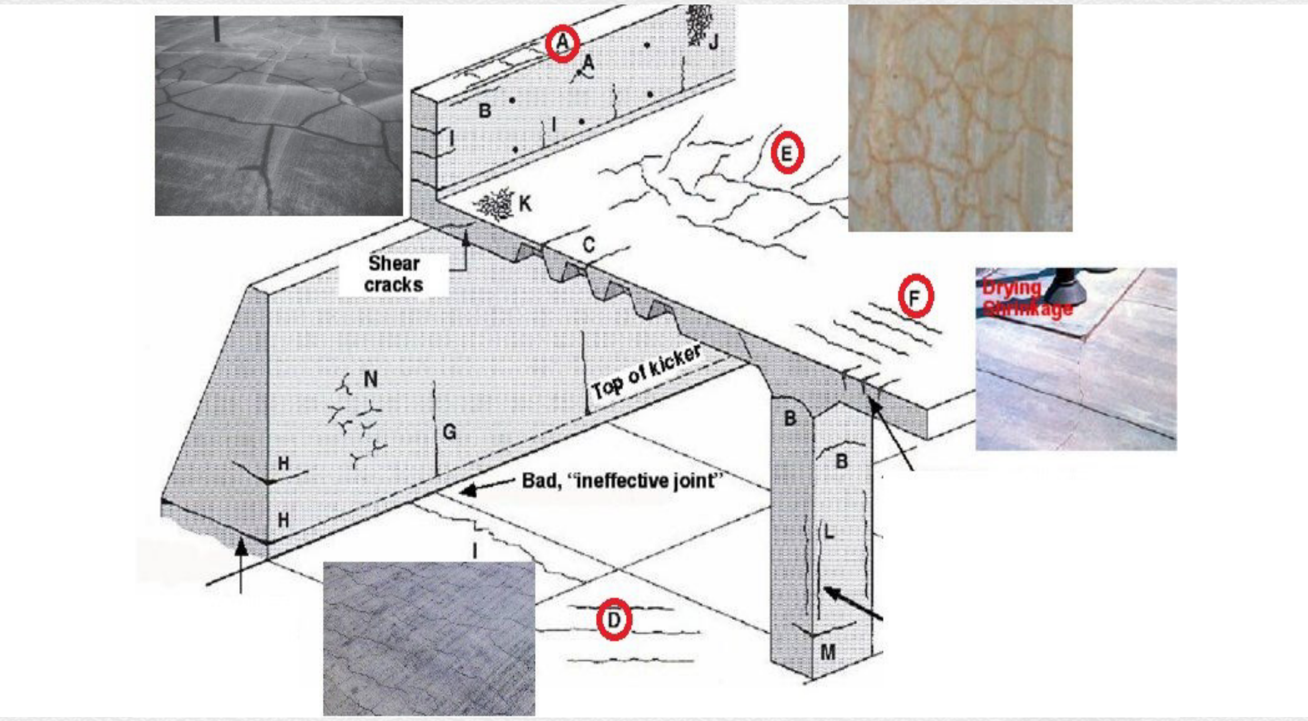
- Accelerate the concrete's setting time and avoid significant temperature differences between the concrete and ambient air temperatures.

If plastic shrinkage cracks appear during final finishing, the mason may be able to close them by refinishing. However, when this occurs, take precautions as discussed above to prevent further cracking.



Rules to Minimize Plastic Shrinkage Cracks

Type of Cracking	Designation	Time of Occurrence	Main Reason
Plastic Shrinkage	A, D, E , F	Thirty minutes to six hours	High Evaporation Rate



Follow These Rules to Minimize Plastic Shrinkage Cracking

1. Moisturize the subgrade and forms when facing conditions conducive to high evaporation rates.
2. Mitigate excessive surface moisture loss by utilizing fog sprays and installing windbreaks.
3. Shield the concrete with damp burlap or polyethylene sheets between finishing stages.
4. Employ cooler concrete in hot conditions and steer clear of elevated concrete temperatures in colder weather.
5. Ensure proper curing immediately after finishing.

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References

1. Hot Weather Concreting, ACI 305R, American Concrete Institute, Farmington Hills, MI., www.concrete.org

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, IS177, Portland Cement Association, Skokie, IL, www.cement.org

5. Bruce A. Suprenant, Curing During the Pour, Concrete Construction, June 1997.

6. Eugene Goeb, Common Field Problems, Concrete Construction, October 1985.

7. Vapor Retarders Under Slabs on Grade, CIP 29, NRMCA, Alexandria, VA, www.nrmca.org

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