TECH Data

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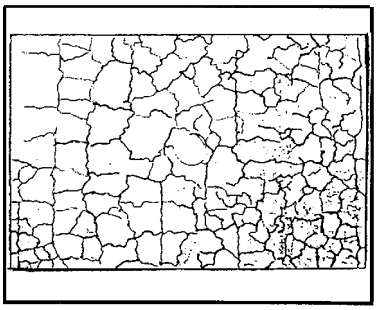
IDENTIFYING AND MINIMIZING CONCRETE CRACKS

Craze Cracks

Crazing or craze cracks, also called map cracks, are a series of small, interconnected and very shallow cracks in the surface of concrete slabs. Crazing is a cosmetic condition, not a structural problem. Crazing occurs when the very top of a slab shrinks more than the rest of the slab. This extra shrinkage happens because the surface has a higher water content or higher "water cement ratio" than the concrete to which it is bonded. Crazing can also occur if the slab goes through cycles of wetting and drying prior to gaining most of its ultimate strength.



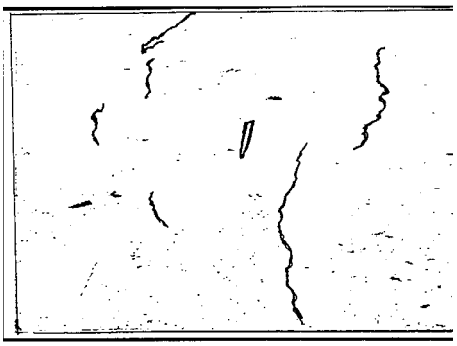
The leading cause of crazing is from finishing water into the surface during bull floating or troweling. This surface water can come from bleedwater, rainwater or water sprayed onto the surface to ease finishing. Bleedwater on the surface of a slab must be allowed to evaporate before further finishing operations take place. Concrete mixes placed at a higher than designed slump or mixes with poorly graded sand tend to bleed and therefore lead to crazing. One of the ways to reduce bleedwater is by the use of mid to high range water reducers. This will give the finisher the high slump, flowable concrete that is desired but without the excess water in the mix.

Synthetic fiber is another way to reduce bleedwater and has many other benefits that add to the quality of the concrete slab. Air entrained concrete bleeds far less than non air entrained concrete, but may not be suitable for smooth trowel finishes. Air entrained concrete is, however, a must for exterior slabs exposed to freeze/thaw cycles.

Another way that water can migrate to the surface of concrete slabs is by overworking or over finishing. Overworking a slab is difficult to define and sometimes hard to avoid. One example is making 6 or 7 passes with the bull float trying to achieve perfection when 2 or 3 passes would have done the job. Another example would be utilizing a power trowel or fresno before the concrete has set up sufficiently. These are two examples of over finishing that stem from the finishers desire to do a very good job, but can unfortunately result in crazing. The best rule of thumb to avoid over finishing, and therefore crazing, is to use the minimum number of passes with each finishing operation. This technique has the added benefits of minimizing labor costs and reducing the time until curing commences.

Plastic Shrinkage Cracks

No matter how much care is taken when placing concrete, plastic shrinkage cracks can appear on the surface of a freshly placed concrete slab, both during the finishing process and/or shortly after. These cracks form before initial set and usually occur in a parallel direction to each other. Rarely will they intersect or connect to the outer boundary of the slab. This type of cracking will usually be spaced from one to three feet apart, and about one to two inches deep into the top of the slab.



The most common reason why plastic shrinkage cracking occurs is because the evaporation rate of the water on the surface of the concrete is greater than the rate it is being replaced by bleedwater from underneath the surface. This situation will cause the concrete surface to shrink and crack even though the volume of the plastic concrete underneath the surface has remained the same.

Cement paste will shrink during the early stages of hydration. In many cases the shrinkage cracks are so small that you can't see them. When the rate of evaporation is high in the early stages of hydration, the micro cracks become plastic shrinkage cracks. When concrete is plastic, it has very low tensile strength and cannot withstand the tensile stress caused by shrinkage. Therefore, plastic shrinkage cracks occur.

Weather conditions will effect the risk of plastic shrinkage cracking. Any combination of wind velocity, low humidity and high air temperature can and will cause rapid evaporation and increase the potential for plastic shrinkage cracks. Plastic shrinkage cracks can occur in cold, dry weather also. This may happen if the concrete is heated and placed at a temperature considerably higher than the air temperature.

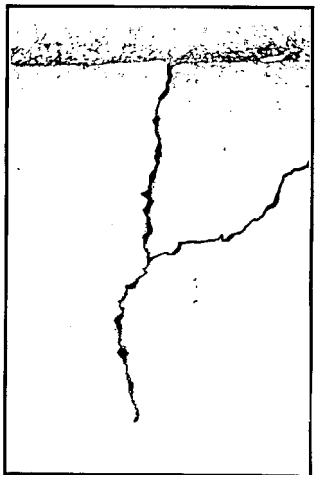
Although plastic shrinkage cracks are unsightly, they rarely do harm to the strength of concrete slabs, floors or pavements. It is possible to reduce the development of these cracks with preparation before placement and by taking proper steps during construction.

When weather conditions occur that promote plastic shrinkage cracking, precautions can be taken to minimize their occurrence.

a) Saturate the sub-grade and forms
b) Lower the temperature of the concrete in hot weather when necessary
c) Use synthetic fibers to significantly reduce plastic shrinkage cracks
d) Erect wind breaks
e) Cover vapor barriers under slabs with at least a two inch layer of damp sand
f) Use fog sprays to prevent rapid surface moisture evaporation
g) Start curing the concrete as soon as possible with curing compound, wet burlap, wet sand or other during procedures

Drying Shrinkage

Unlike other types of cracking problems mentioned in this paper, drying shrinkage cracks in concrete cannot be avoided. This type of crack occurs naturally during the curing phase of concrete. As the concrete dries, the surface dries and shrinks faster than the concrete below the surface. This causes tensile stresses to develop which result in cracks that open on the top surface and ultimately extend through the depth of the slab.



Drying shrinkage cracks cannot be avoided, but they can be controlled. Where the concrete cracks or how much it is going to crack depends on the techniques followed. To reduce cracks caused by drying shrinkage, use a well designed mix, use proper joint spacing, cut joints to the correct depth and observe proper curing procedures.

Concrete mixes are designed with a certain amount of water to meet both workability and strength requirements. Any added water to the mix will increase the drying shrinkage in the concrete. The Portland Cement Association's (PCA) Design and Control of Concrete Mixtures states: "The most important controllable factor affecting shrinkage is the amount of water per unit volume of concrete". Using the largest coarse aggregate economically available in the concrete will also reduce shrinkage because of the lower water demand of the larger aggregate per cubic yard.

Proper jointing creates a "plane of weakness" for a crack to form, basically it controls where the cracks will be. Most cracking problems occur because the joint spacings are greater than the recommendations. The American Concrete Institute's (ACI) 302 Guide for Concrete Floor and Slab Construction says that joint spacing in feet for non-structural slabs should be 2 to 3 times the slab thickness in inches. The PCA says that the spacing should never be more than 2-1/2 times the thickness with a coarse aggregate 3/4" or greater, and no more than 2 times the thickness with a coarse aggregate less than 3/4". In other words, a 4" slab using a concrete with 3/4" coarse aggregate should have joint spacings no further apart than 10 feet.

A common mistake is exceeding the length to width ratio. Panels should never have a length to width ratio of more than 1-1/2 to 1. If that ratio is exceeded, then cracking may occur at an intermediate location. Other mistakes are not cutting or tooling the joint to the proper depth and not jointing early enough. The depth should be at least 1/4 the thickness of the slab. Saw cuts should be done 4-12 hours after the concrete hardens, and the new dry-cut process allows cutting shortly after the final finishing.

Curing is one of the most overlooked aspects of a quality concrete project. Curing is a must! Proper curing allows the concrete to gain adequate strength to help overcome the stresses that cause it to crack.

Remember, concrete is going to crack! Where or how much it is going to crack depends on how these simple techniques are followed.

Tech Tips

Crazing Cracks

- Don't finish concrete with water on the surface
- Avoid wet mixes
- Minimize the number of passes on each finishing operation

Plastic Shrinkage Cracks

- Saturate the sub-grade and forms
- Use fog sprays to prevent rapid surface moisture evaporation
- Start curing as soon as possible
- Erect wind barriers

Drying Shrinkage Cracks

- Use proper joint spacing and keep panels as square as possible (Be sure joints are spaced at 2 1/2 times the thickness in inches converted to feet.)
- Joint depth should be at least 1/4 of the depth of the slab
- Start curing as soon as possible

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