Drying Shrinking Cracks

Submitted by
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Introduction

It is to the credit of concrete that so few complaints are received on the vast amount of construction put in place. While it is easy to determine the properties of the hardened concrete that will be suitable for the intended purpose, great care is required throughout the entire construction process to ensure that the hardened concrete actually has the desired properties. When a blemish appears on the surface of a concrete slab it will likely be one of these: blisters, cracking, crazing, curling, delamination, discoloration, dusting, efflorescence, low spots, scaling.
We all know and noticed the most defect that happens in the slab surface immediately after the concrete pour it is the ***CRACKS*** and even some of these cracks are penetrates the slab thickness mostly caused by lack of experience in dealing with the cement mixture through a process of casting. This paper will discuss main crack causes and suggest number of solutions to reduce or prevent them.

Cracks

Unexpected cracking of concrete is a frequent cause of complaints. Cracking can be the result of one or a combination of factors. One of frequently occurred factor is the drying shrinking crack which is an inherent, unavoidable property of concrete. Shrinkage of plain concrete drying is.٧٢ inches per ١٠٠ ft. from plastic state to a dried state with ٥٠% relative humidity, this shrinkage will take place when the moisture leaves the concrete.
Cracking can be significantly reduced when the causes are taken into account and preventative steps are utilized.
To minimize these cracks we need proper placement of saw cuts, and proper curing to hold the moisture in concrete long enough to get adequate tensile strength gain in the concrete before the moisture leaves and the concrete shrinkages.
Cracks that occur before hardening usually are the result of settlement within the concrete mass, or shrinkage of the surface (plastic-shrinkage cracks) caused by rapid loss of water while the concrete is still plastic. See (Figure ١).

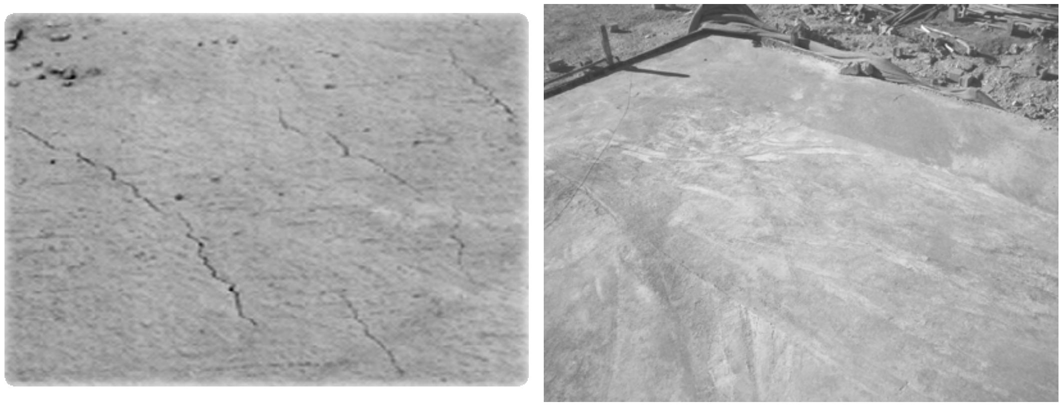

Figure ١
Plastic-shrinkage cracks caused by rapid loss of mix water while the concrete is still plastic

Plastic-shrinkage cracks are relatively short cracks that may occur before final finishing on days when wind, a low humidity, and a high temperature occur. Surface moisture evaporates faster than it can be replaced by rising bleed water, causing the surface to shrink more than the interior concrete. As the interior concrete restrains shrinkage of the surface concrete, stresses develop that exceed the concrete's tensile strength, resulting in surface cracks. (Under certain combinations of conditions, warping or curling can result from these stresses, too). Plastic-shrinkage cracks are of varying lengths, spaced from a few centimeters (inches) up to ٣ m (١٠ ft.) apart, and often penetrate to mid depth of a slab, or even penetrate the holly depth of slab which is the most dangerous and effect kind of crack.
Cracks that occur after hardening usually are the result of drying shrinkage (Figure. ٢), thermal contraction, or subgrade settlement.
While drying, hardened concrete will shrink about ١.٦ mm in ٣ m (١/١٦ in. in ١٠ ft.) of length. To accommodate this shrinkage and control the location of cracks, joints are placed at regular intervals.
The major factor influencing the drying-shrinkage properties of concrete is the total water content of the concrete. As the water content increases, the amount of shrinkage increases proportionally. **[١, ٢]**

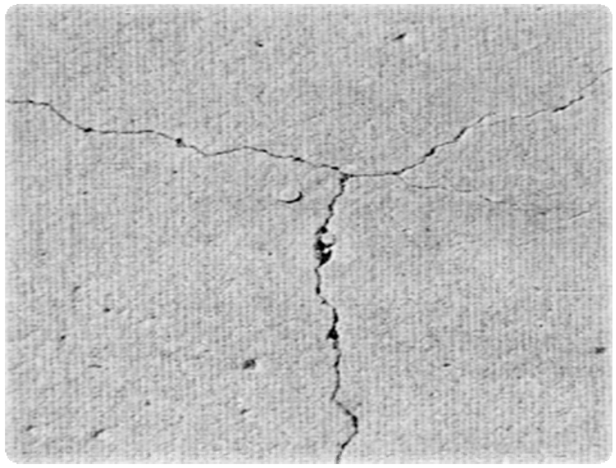

Figure ٢
Drying-shrinkage cracks like these often result from improper joint spacing

Large increases in the sand content and significant reductions in the size of the coarse aggregate increase shrinkage because total water is increased and because smaller size coarse aggregates provide less internal restraint to shrinkage. Use of high-shrinkage aggregates and calcium chloride admixtures also increases shrinkage. Increases in cement content have little to no effect on shrinkage as long as the water content is not increased significantly. Silica fume can make highly cohesive, sticky concrete, with little bleeding capacity. With little or no bleed water on the surface, silica fume concrete is prone to plastic shrinkage cracking on hot, windy days. Fogging the air above the concrete and erecting wind shades lessen the risk of plastic-shrinkage cracking.
Concrete has a coefficient of thermal expansion and contraction of about {١٠ x ١٠ (-٦) per °C}, {٥.٥ x ١٠(-٦) per °F}. Concrete placed during hot midday temperatures will contract as it cools during the night. A ٢٢°C (٤٠°F) drop in temperature between day and night - not uncommon in some areas - would cause about ٠.٧ mm (٠.٠٣ in.) of contraction in a ٣-m (١٠-ft) length of concrete, sufficient to cause cracking if the concrete is restrained. **[١]**

Thermal expansion can also cause cracking. Insufficiently compacted subgrades and soils(raft foundations or planed concrete under tiles or for garage and sidewalk susceptible to frost heave or swelling can produce cracks in slabs. Overloading of concrete slabs also results in flexural crack formation and possible failure.

Cracks can also be caused by freezing and thawing of saturated concrete, alkali-aggregate* reactivity, sulfate attack, or corrosion of reinforcing steel.
However, cracks from these sources may not appear for years. Proper mix design and selection of suitable concrete materials can significantly reduce or eliminate the formation of cracks and deterioration related to freezing and thawing, alkali-aggregate reactivity, sulfate attack, or steel corrosion.

Solutions :-

Cracking in concrete can be reduced significantly or eliminated by observing the following practices **[١,٢]**

١. Use proper subgrade preparation, including uniform support and proper sub base material at adequate moisture content.

٢. Formwork for the slab should be sit on fixed compacted soil (when there is no concrete base) and not remove the formwork under the slab before giving adequate time for Concrete mixtures to hardening and gain the true strength .

٣. Minimize the mix water content by maximizing the size and amount of coarse aggregate and use low-shrinkage aggregate.

٤. Use the lowest amount of mix water required for workability. (Do not permit overly wet consistencies) this is very Important issue because most of contractors and some of engineers they ask to increase the water ratio when casting the ready mix-concrete.

٥. Prevent extreme changes in temperature. And Prevent rapid loss of surface moisture while the concrete is still plastic through use of spray- applied finishing aids or plastic sheets to avoid plastic-shrinkage cracks.{ this been done and a proved in real worksite here in suliamniya and give ١٠٠% result.}

٦. Provide isolation joints to prevent restraint from adjoining elements of a structure.

٧. Properly place, consolidate, and finish the surface.(We SHOULD NOT perform finishing operations with water present on the surface.)

٨. Avoid calcium chloride admixtures and avoid using excessive amounts of other cementations materials.(Accelerators or other kinds of cementations chemicals materials)

٩. Consider using a shrinkage-reducing admixture to reduce drying shrinkage, which may reduce shrinkage cracking.

١٠. The right way of curing it reduces shrinkage.

Some Researchers advice to consider <u>using synthetic fibers to help control plastic shrinkage cracks</u>**.[٤]**

Conclusion:-

Shrinking cracks is caused by different factors. One the important factors is the condition of the work in the construction site such as the change of temperature between day and night, bad finishing for the slab surface, the increased ratio of water in concert mixture, bad Curing, and the removal of frame before the concrete get his real strength. Another factor is using excessive amounts of cementations materials (Accelerators) in the concert mixture and not applying the standard specification of concert mixture.

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Definition of Alkali-Aggregate Reaction

Alkali-aggregate reaction is a chemical reaction between certain types of aggregates and hydroxyl ions (OH-) associated with alkalis in the cement. Usually, the alkalis come from the Portland cement but they may also come from other ingredients in the concrete or from the environment. Under some conditions, the reaction may result in damaging expansion and cracking of the concrete. Concrete deterioration caused by alkali-aggregate reaction is generally slow, but progressive.**[٥]**

References

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٣. DOW. Company ,*Calcium Chloride in Portland Cement Concrete - Concrete Accelerator Form ١٧٣-٠١٧١٤-٦٠٦XQR –*

٤. Synthetic fibers for concrete, *www.nrmca.org/aboutconcrete/cips/٢٤p.pdf*

٥. *National Research Council Canada, Preventing Concrete Deterioration Due to Alkali-Aggregate Reaction- by P.E. Grattan-Bellew and Lyndon Mitchell. March ٢٠٠٢-ISSN ١٢٠٦-١٢٢٠*

Résumé

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