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Shrinkage Cracks in Concrete

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Newly-placed concrete develops tensile stresses as differences in temperature and moisture content develop in the drying concrete. These stresses are relieved by cracking. A number of factors can influence the development of such stresses.

Control of Crack Locations

Control joints are sometimes installed in an attempt to determine the areas at which concrete will crack. Control joints are grooves pressed into the concrete during the finishing process. Because the concrete slab is thinner and weaker at these grooved areas, it tends to develop cracks in these grooves first.

Because of the many factors which can influence the locations at which cracks develop, they sometimes appear in areas other than at control joints.

Restraint to Shrinkage

According to the Portland Cement Association, restraint to shrinkage is the most common cause of concrete cracking. This condition is inherent in continuously-poured concrete slabs. In applications such as concrete slabs and residential foundation walls, cracking is inevitable and expected.

As the surface of concrete dries, water evaporates from the spaces between particles. As this water dissipates, the particles move closer together, resulting in shrinkage of the concrete. Because the surface of a concrete slab is exposed to air but the underlying concrete is not, concrete near the surface dries and shrinks at a rate different from that of the underlying concrete. The underlying concrete acts as a restraint to shrinkage, resulting in cracking of the surface layer.

Factors Influencing Locations of Crack Development

- **Thermal cracking:**
  Temperature differences can contribute to the development of cracks.
  The chemical hydration process through which concrete hardens produces heat which causes concrete to expand. At the same time, concrete at the surface of the slab is exposed to air and loses water through evaporation. Both of these conditions contribute to cooling and shrinking of the concrete near the surface.

  The hot, expanding underlying concrete acts as a restraint to shrinkage of the cooling, shrinking surface concrete. This condition produces tensile stresses which are relieved by cracking of concrete near the surface.

- **Plastic cracking:**
  Water may sometimes evaporate from the surface concrete faster than moisture can

migrate from the underlying concrete to replace it. When this happens, surface concrete will dry more quickly than underlying concrete. The resulting differences in moisture content produce tensile stresses which are relieved by cracking of concrete near the surface.

- **Shrinkage cracking:**
  When concrete is mixed, more water than is needed for hydration is mixed with the dry components, such as sand, cement and an aggregate. Most of the water will eventually evaporate, causing shrinkage of the concrete slab.

  Since water evaporates from the surface, which is exposed to air, at a rate different from the underlying concrete, this differential shrinkage rate produces tensile stresses which are relieved by cracking of concrete near the surface.

Identifying Shrinkage Cracks

The following are visual clues which help to differentiate shrinkage cracks from other types of cracks which can appear in concrete slabs and foundation walls.

- **Vertical displacement:**
  Cracks which are caused by soil settlement or heaving typically exhibit vertical displacement of the concrete; concrete on one side of the crack will be higher than concrete on the other side.

- **Linear crack continuity:**
  Cracks caused by shrinkage are typically not linearly continuous. Although they make look continuous at first, if viewed closely, interruptions in the crack line can be seen.

- **Continuity through the slab:**
  Shrinkage cracks are not continuous through the slab, but are actually cracks in the concrete surface.

- **Corrosion:**
  When reinforcement steel is placed too near the surface, it can corrode. Expansion results as steel is converted to iron oxide through corrosion. This expansion can crack the concrete surface. When the crack is caused by corroding steel, corrosion is typically visible at the slab surface.

- **Alkali-aggregate reaction:**
  Alkali-aggregate reaction is deterioration resulting from the reaction of an aggregate with alkali hydroxides in the concrete. Indications of this type of deterioration may be a network of cracks, closed or spalling joints, or displacement of different portions of a structure.