NOVEMBER 2008 MEETING

Wednesday, November 12, 2008

TECHNICAL PROGRAM

Causes and Cures of Cracking in Concrete

Speaker: David W. Fowler, Ph.D., P.E. with University of Texas, Austin; Austin TX,Tel. 512-232-2575

PRESENTATION SUMMARY

To an audience of about 100 at the HESS Club, Dr. Fowler, Civil Engineering Professor at UT Austin who holds BS and MS degrees in Architectural Engineering and a Ph.D. in Civil Engineering, and is licensed as a professional engineer in Texas gave a slide presentation titled, "Causes and Cures of Cracking in Concrete", based on his concrete-related research spanning over 30 years.

Dr. Fowler introduced the topic saying concrete cracks because it is weak in tension, since it has only one-tenth the strength in tension as it has in compression. He described the cracks that occur before and after the mix sets. While the mix is plastic, cracks occur due to plastic shrinkage, resulting from rapid moisture loss that causes differential volume changes in the top layer. An old rule of thumb for the evaporation rate of concrete was 0.2 lbs. water/SF/Hour, however it can be less now depending on the additives used in the mix. Factors causing rapid moisture loss include concrete and air temperature, relative humidity, and wind velocity. Plastic shrinkage cracks are normally shallow, short, and parallel.

Dr. Fowler said that cracks occur in hardened concrete for many reasons including drying shrinkage, reinforcement corrosion, chemical reactions, soil movement, poor construction, and inadequate design. With respect to drying shrinkage cracks, Dr. Fowler noted that concrete will shrink about 0.15" over 20 feet as it sets. Rebar will not stop cracking; it only keeps the cracks widths small by distributing additional cracks more uniformly over the surface. Unlike plastic shrinkage cracks, drying shrinkage cracks will extend through the slab. Dr. Fowler said if you plan to use crack control joints, which are typically saw-cut one-fourth the slab depth, they must be cut the same day as the concrete placement and just as soon as workers can get on the slab in order to be effective. He said curing is important to reduce shrinkage cracks and that any curing method that reduces the rate of moisture migration to the air, such as chemical curing compounds or wet burlap, is good.

With respect to corrosion of rebar, Dr. Fowler said use of epoxy coated rebar has not had good success and is not allowed by some DOT's. Corrosion cracking occurs because the steel rusts and increases in volume as carbon dioxide enters the concrete, lowering its original pH that starts at about 13 during placement. In a cross section, the concrete's cracks will appear both vertical and horizontal from the rebar. The more common cracking caused by chemical reactions is Alkali-Silca Reaction (ASR). ASR is is caused by a reaction of alkalies in the cement with silica aggregates. In a petrographic section the aggregate will show a gel around it and will be cracked through it.

In addition to presenting some case histories, Dr. Fowler discussed repair of concrete cracks. He discussed several methods, with epoxy injection being the best. It is important to first determine the cause of cracks before any repairs are made. He said that although some homeowner warranties allow concrete cracks up to 0.25" in thickness, if the member requires load transfer across the crack, it needs to be repaired at about one-tenth of that width, or 0.025" to ensure full load transfer across the crack. ACI-224R-90 gives tolerable crack widths for different concrete uses. For example, it recommends that crack thicknesses of 0.004" be repaired if the concrete is conventionally reinforced and must retain water.

Dr. Fowler described his recommended method for properly sealing pavement cracks and offered it for download to anyone that is interested. To download a copy of Dr. Fowler's sample specification for sealing pavement cracks, click here.

To download a copy of Dr. Fowler's slide presentation, click here.