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Internal Curing in Concrete Pavements

Internal curing is a recent innovative technology to improve the mechanical properties and performance of concrete. It is defined as: "the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water. The internal water is typically supplied by fine saturated light weight aggregate particles (LWA), although super absorbent polymers (SAP) have also been tried. The LWA is used to replace a portion of the conventional fine aggregate in the mixture.

Because concrete pavements have a large surface to volume ratios and are exposed to the environment, it is particularly difficult to achieve proper curing. This is important as it reduces early age cracking tendencies and shrinkage and improves the fatigue strength of the concrete. There are a number of States and Universities in the US that are now actively researching this technology and have already proved that there can be significant reductions in cracking and improvements in the flexural strength. Apparently this is more significant in concretes with a low w/c ratio and where difficult curing conditions prevail. (A w/c ratio of <0.42 is regarded as "low").

Unplanned cracking, of course, is our perennial problem and it happens when the tensile stress exceeds the tensile strength of the concrete. It only occurs at early ages of concrete as the rate of change of either varies under particular conditions. Moisture loss increases the stress (with increasing shrinkage) and impairs the strength gain. It has been demonstrated that high strength concretes with w/c ratios of less than 0.42 are particularly susceptible to this as these will self-dessicate unless water is added during the curing period. This will lead to autogenous shrinkage, ie due to hydration of the cement, and the potential of internal microcracking to commence. (Qld has already upped the characteristic compressive strength of the base concrete to 40 MPa. This does not compare at all with the Warringah Expressway in Sydney, which this year had its 40th birthday and where we used 17 MPa concrete. No unplanned cracking took place at all – may be there is a lesson to be learnt).

Cracking, of course, is due to shrinkage which occurs entirely in the paste fraction of the concrete. The amount of shrinkage is dependant on the restraint provided by the coarse aggregate. This restraint in turn is dependant on the amount of aggregate in the concrete, its stiffness and the maximum size of the coarse aggregate. Research has demonstrated that the risk of cracking is reduced by the use of larger size coarse aggregate and design of dense graded mixes to reduce the volume of the paste. (May be there is also a lesson for us – adopt larger size coarse aggregate, eg 32 or 40 mm?).

The following are snippets from the various research findings so far:

1 The LWA proportion in the fine aggregate fraction is about 18%.
2 LWA appears to be most effective of the alternatives.
3 Use of LWA, SAP or shrinkage reducing admixtures may decrease the

compressive strength, but increase the tensile strength of concrete.

4 Internal curing decreases the heat of hydration of the conctrete and hence the thermal deformation..
5 In Texas they found that through internal curing the typical increase in compressive strength was about 7 MPa.
6 The Cleveland State University research showed an increase of about 6.4% in the 7 and 28 day compressive strength.
7 internal curing is more necessary with concretes that use silica fume or fly ash as part of the binder.

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Reference: Proceedings of the CPTP Conference in Atlanta, November 2007. Norbert Delatte and John Cleary: "Using Internal Curing in Concrete Pavements".