TMC – Tinni Management Consulting

PAVEMENT INFORMATION NOTE

Issue No. 27

Edited by Arvo Tinni. Email arvo@tinni.com.au

09.09.2009

Concrete Pavement Slab Replacement – Latest Research

It is a fact that road agencies in Australia and US approach patch design and construction from the mindset of conventional new concrete paving. This results in a number of unique properties and requirements of the patch repair being overlooked.

The goals of the highway agencies should be to provide a method of patching that reduces the time required, allows lower opening strength, reduces coat and still results in a patch with a long life.

In the past High Early Strength concrete has been thought to be the answer for early opening. In the last 15 years Caltrans has replaced 70,000 slabs (322 lane kms). Their current criterion for placement under traffic is 13.8 MPa in 6 hours. In the US there is no consensus between the States on what the required minimum compressive strength should be. The variations range from 13.8 to 20.7 MPa (2.0 to 2.8 MPa).

The RTA NSW requires 25 MPa officially, but local ill-informed decisions have raised this to 30 MPa (cylinder strength) on a number of projects. The proof of this illogic is that 41 years ago when the Warringah Expressway was constructed, the specifies pavement concrete 28 day strength was 17 MPa. To my knowledge no slabs have needed replacement. (RTA also requires the filling in core holes to be 15 MPa).

The following extracts and summaries are from a paper by Jim Grove (FHWA), Jim Cable (Cable Concrete Consultation)and Peter Taylor (NCPTC); **"Concrete Pavement Patching – Simpler Can Be Better"** that was presented at the (FHWA) National Conference on Preservation, Repair and Rehabilitation of Concrete Pavements held in St Louis , Missouri 22 – 24 April, 2009:

What opening strength is needed?

All the minimum opening strengths are empirically established limits and they are more conservative than necessary for concrete pavement maintenance and repair. This is because they were established during the time when the only way to measure pavement strength was by cylinder strengths. It is an accepted fact that the cylinder strength does not represent that of concrete in the patch. Nowadays, however in-place testing methods, like maturity testing, can more closely estimate concrete's in-place strength. This eliminates the safety factors that were built into the application of cylinder strength.

The research by Okamoto et al (1994) and Davis and Darter (1989) determined that the necessary strength needed for opening a concrete pavement to traffic is significantly less than the value commonly used by road authorities.

High Early Strength?

- The faster concrete gains strength, the sooner it will slow or stop, i.e. accelerating early strength gain can sacrifice long-term strength.
- Addition of extras cement may not provide extra early strength (Buch et al 2004), but will increase drying shrinkage, heat, cracking risk and cost of the concrete.
- Usually less strength is required to provide service life corresponding to the remaining life of the pavement.

The latest research

Okamoto research for the FHWA found that for a 254 mm pavement, for compressive strength of 7.18 MPa and flexural strength of 1.38 MPa the pavement would experience no fatigue damage over 10,000 cycles.

It is also stated: **"Interior loading produced virtually no fatigue damage for 254 mm and 305 mm slabs, even if loaded when the compressive strength was 1.8 MPa".**

Davis and Darter in 1989 found that the thicker the patch, the lower the opening strength needed to be. And that for a 254 mm slab, 1.38 MPA flexural strength was sufficient.

Cable et al in 2004 in a very detailed research found that:

- Increased patch depth enhanced the concrete strength gain associated with the heat of hydrationdetern