METASTAR™ PREVENTS ALKALI-SILICA REACTION

MetaStar reduces chemically reactive calcium hydroxide (portlandite) in the hardened cement paste, thus preventing ASR.

The world-wide cost of ASR is extremely high taking into account repair costs, and charges for importing cement and aggregates where local supplies are potentially active. For example, the extra cost (per m^3 of concrete) of replacing 10-15 mass% of PC by MetaStar is less than 50% of the cost of hauling aggregate and cement an extra 100 km by road (U.K. data).

CHEMISTRY OF ASR

The fluid which fills the pores of cured concrete contains high concentrations of sodium and potassium hydroxides. Large quantities of calcium hydroxide are also present in the form of crystals of portlandite. This highly alkaline environment can react with some forms of active silica which may be present in the aggregate. Under certain circumstances a polymeric gel is formed: the gel can absorb water and swell, causing the concrete to expand and crack. The phenomenon (alkali-silica reaction, or ASR) is greatly accelerated if the concrete is bathed in salt (sodium chloride) solutions. This often occurs in concrete exposed to sea water or road de-icing salts.

PREVENTING ASR

The deleterious effects of ASR can sometimes be reduced or delayed by using low-alkali Portland cement, or by blending a pozzolanic material such as silica fume, pulverised fuel ash or ground granulated blast furnace slag with the cement.

However, recent research[1,2] has shown that ASR can be prevented completely if a major part of the calcium hydroxide is "removed" from the concrete. Normally this can be achieved by substituting 10 mass% of the PC by **MetaStar.** In certain very exceptional circumstances it may be necessary to increase the proportion of **MetaStar**, for example up to 15 mass%. Figure 1 shows the effect of **MetaStar** on the expansion of concrete prisms cured at 100% relative humidity. Figure 2 shows the added deleterious effect of immersing prisms in saturated sodium chloride solution. Even in the latter conditions, **MetaStar** has prevented the formation of the ASR gel which causes expansion. It is known that **MetaStar 500** and **501** react with more than their own weight of calcium hydroxide. In this respect they are two to five times more effective than other types of pozzolanas such as blast furnace slag and fly ash.

FIGURE 1: The effect of MetaStar on expansion due to ASR

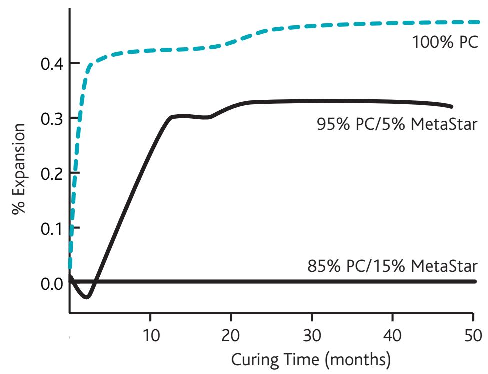
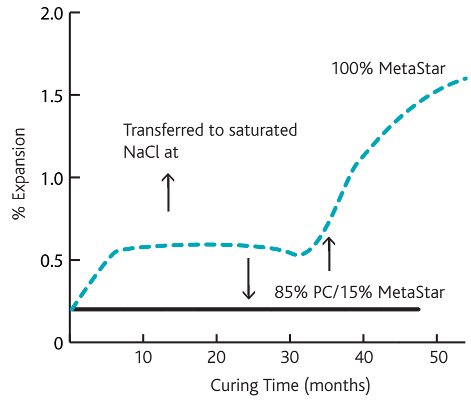


FIGURE 2: The effect of MetaStar on expansion due to ASR



The Building Research Establishment, UK, have recently confirmed[3] that **MetaStar** effectively prevents expansion due to ASR. The BRE used larger castings and outdoor exposure sites for their studies.

The Research Institute of the German cement industry have also carried out laboratory trials using prisms stored outdoors and in a fog room. Their work[4] emphasises the effectiveness of **MetaStar** in preventing expansion due to ASR.

Finally, over the period 1962-79, four dams were constructed in the Amazon basin using highly reactive aggregates and concrete

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which contained local Metakaolin[5,6]. It was reported in 1986 that the metakaolin had inhibited the alkali-silica reaction, and that there was no sign of damage to the dams due to swelling.

SUMMARY

10 mass% (or in the most severe cases, 15 mass%) replacement of Portland cement (PC) by **MetaStar** in a concrete mix will prevent concrete expansion by ASR (even in the presence of concentrated sodium chloride solutions). Other properties of the concrete relating to durability are also improved.

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