METASTAR™ INCREASES SULPHATE RESISTANCE

MetaStar is a high quality pozzolanic material which is blended with Portland cement in order to improve the durability of concrete and mortars.

The presence of calcium hydroxide and calcium aluminate phases in hydrated Portland cement paste make it vulnerable to attack by sulphates. Deterioration of concrete due to the ingress of, and attack by, sulphate ions is caused by the formation of ettringite (hydrated calcium alumino-sulphate), or gypsum, or a combination of the two.

Normally the sulphate ions arise from gypsum which is common in many environments. Sometimes magnesium sulphate is also present, in which case degradation of the main hydrated silicate phase in the cement paste can also occur. This is because magnesium ions precipitate magnesium hydroxide within the cement paste, which has the effect of reducing the pore water pH and dissolving the calcium silicate hydrate phases.

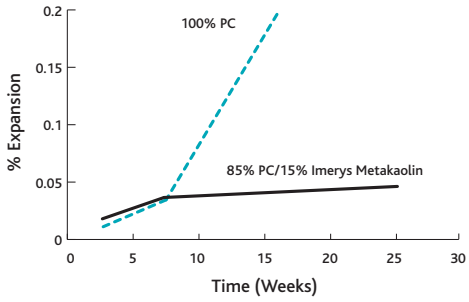
The various chemical reactions thought to be involved in sulphate attack are discussed in detail in Reference 1.

METASTAR has been shown to prevent sulphate attack. One reason is that **MetaStar** reduces the amount of calcium hydroxide in the cured concrete. Also **MetaStar** refines the pore structure and reduces the rate of ingress of sulphate ions. Calcium hydroxide is a necessary component in the formation of ettringite and gypsum: any reductions will limit the formation of these secondary expansive products, and thus reduce the possibility of damage.

Work at the Building Research Establishment has indicated that **MetaStar** effectively provides resistance to sulphate attack if it replaces 15 to 20 mass% of Portland cement in mortars. Figure 1 shows the effect of **MetaStar** on the resistance to attack by 4.4% sodium sulphate solution.

The BRE findings have been independently confirmed by studies at the University of Glamorgan, reference 2. They found that Portland cement containing 7.8 mass% C_3A requires 10 mass% **MetaStar** to prevent expansion due to sulphate attack. Similarly Portland cement containing 11.7 mass % C_3A requires 20 mass% **MetaStar**. Figure 2 shows the effect of increasing substitutions of **MetaStar** on the behaviour of mortar bars exposed to 5% sodium sulphate solution for 90 days.

FIGURE 1: Effect of MetaStar on Sulphate Resistance
(Courtesy of the BRE)



Mix design: water/binder ratio 0.6, agg/binder ratio 3.0
PC: C3A content 7.3%

FIGURE 2: Deterioration of mortar bars immersed in sodium sulphate solution. PC contains 11 mass% C_3A
(Courtesy of the University of Glamorgan)

[1] **W.G. Hime** and **B. Mather**, "Sulfate attack" or is it? Cement and Concrete Research, *vol.29 (1999) 789-791*

[2] **J.M.Khatib** and **S.Wild**, Sulphate Resistance of Metakaolin Mortars, Cement and Concrete Research *vol28(1), 83-92 (1998)*

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