



METASTAR™ REDUCES EFFLORESCENCE

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

EFFLORESCENCE is the whitish deposit which sometimes spoils the appearance of concrete surfaces when they are exposed to the weather. Although efflorescence does not affect the durability of a structure it has a major detrimental effect on the aesthetic properties of coloured concrete. It occurs on paving slabs, facades and sometimes spreads over brickwork from the mortar layers. Efflorescence occurs in two forms:

PRIMARY EFFLORESCENCE occurs during the process of curing. Excess water within the concrete matrix migrates to the surface where it evaporates. This deposits crystals of soluble salts [including $\text{Ca}(\text{OH})_2$] within the surface pores. The $\text{Ca}(\text{OH})_2$ then reacts with atmospheric carbon dioxide (CO_2) to form CaCO_3 .

SECONDARY EFFLORESCENCE occurs when the hardened concrete is re-wetted and water penetrates the surface to dissolve some of the $\text{Ca}(\text{OH})_2$ remaining within the bulk of the concrete. During subsequent drying, this alkaline solution migrates to the surface and results in secondary efflorescence. Thus efflorescence is a progressive phenomenon and can continue to re-establish itself even if earlier surface layers of calcium carbonate are removed, for example by washing with acid.

Recently, Dow and Glasser¹ have developed a model to explain efflorescence. A thin static film of water on the surface of the concrete is the first requirement. This film dissolves alkali from the concrete, and the resulting alkaline solution rapidly absorbs carbon dioxide from the atmosphere to give carbonate (CO_3) and bicarbonate (HCO_3) ions. These ions diffuse through the liquid layer to the surface of the concrete where they interact

with sparingly-soluble calcium ions. As a result, white crystals of calcium carbonate (efflorescence) are deposited.

METASTAR is thought to control efflorescence in three ways. Firstly, it reduces the alkali content of the concrete, so carbon dioxide is absorbed less rapidly. Secondly, it removes a proportion of the calcium hydroxide which is source of soluble calcium ions needed to precipitate with the carbonate ions. (Note that up to 20-25 mass% replacement of PC by **MetaStar** is required to remove *all* the calcium hydroxide.) Thirdly, **MetaStar** refines the pore structure so absorption of water and diffusion of calcium and hydroxide ions towards the surface is reduced.

Other measures can be taken to help **MetaStar** reduce primary efflorescence. Depending on the exact formulation, these include:

- Preventing the formation of static surface film of water during the initial curing period (up to 14 days).
- Using a low water/binder ratio.
- Replacing part of the PC by auxiliary binders such as ground granulated blast furnace slag.
- Washing with dilute acid after 14-18 days.

It is important to note that efflorescence caused by other soluble salts such as calcium sulphate or sodium chloride will not be prevented by **MetaStar**. However, these other forms of efflorescence are normally removed if the concrete is washed with water.

Regarding secondary efflorescence, because calcium hydroxide is virtually eliminated by the correct use of **MetaStar**, secondary efflorescence cannot occur.

¹Efflorescence on Cement and Concrete Products, C. Dow and F.P. Glasser, 6th Conference of the European Ceramic Society, 20 June 1999.

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