Pergamon

Cement and Concrete Research, Vol. 28, No. 1, pp. 153–154, 1998
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0008-8846/98 $19.00 + .00

PII S0008-8846(97)00252-4

DISCUSSION

A REPLY TO THE DISCUSSION OF THE PAPER "UNAMBIGUOUS DEMONSTRATION OF DESTRUCTIVE CRYSTAL GROWTH PRESSURE" BY WILLIAM G. HIME

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(Received October 16, 1997)

First of all we would like to thank Dr. Hime for his interest in our paper.

Dr. Hime is correct in his inference that in general the available volume is not much of importance in any break down due to the crystal growth pressure. However, there is more to it than is apparent.

It is known that each type of crystallographic face has its own specific solubility (1,2). The normally quoted solubility is an average value. For rather large crystals, the crystal growth process removes the high solubility faces so that the normal solubility becomes the average of those of the low solubility faces. Now, consider the case of a test tube partly filled with sodium thiosulphate melt. In the melt, the initial crystallization occurred such that the lowest solubility faces of all the crystals are parallel to the long axis of the test tube, i.e., the main crystal growth direction is normal to the test tube axis and the crystal assembly is two-dimensionally random. During further crystal growth, the crystal assembly will soon reach the tube wall. This will happen even though some spaces are left unoccupied in between the crystals. Some growth will, of course, occur in other directions as well. Once this stage is reached the tube wall will constrain further crystal growth and itself will be subjected to the relevant crystal growth pressure. Under unfavourable conditions the tube will crack, as it happened in our experiments, even though unoccupied space is available within the crystal assembly as well as outside it. Now consider another case where the initial crystallization is three-dimensionally random. In this case, a larger volume of crystallization occurs before crystals reach the tube wall and develop the crystal growth pressure; furthermore, on a suitably large area, the effective destructive crystal growth pressure will be lower than the first case. These are some of the factors affecting the required critical degree of filling referred to in our paper.

It is, however, quite well known that some chemicals, in small quantities, can alter the growth habit of many crystals. One of the best and very common examples is a type of ice known in England as "Lolly-pops." In their production, a mixture of water, sugar, and small quantities of flavouring and colouring agents are frozen in forms. Ice crystals that form in this mixture are fibrous and the intercrystalline bond is very low and the frozen mass is opaque. Similar fibrous ice also form from strongly supercooled water. The fibrous ice crystals can easily slide over each other and make room for further crystallization without causing any break down in the structure. In this case, available volume is utilized. In contrast to above, freezing of water, without any additives, normally forms clear blocky, three-dimensional crystals with high intercrystalline bond. In this case, initially formed ice crystals form a jacket round still unfrozen water. This ice jacket stops unfrozen water from utilizing any available space. As a result, pressure develops within unfrozen water. This continues until the ice jacket and any improperly designed form, if used, are broken (3).

All these only emphasise the complexity of the process.

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