Air void structure and frost resistance - DTU Orbit (18/12/2018)

Air void structure and frost resistance: A challenge to Powers' spacing factor

This article compiles results from 4 independent laboratory studies. In each study, the same type of concrete is tested at least 10 times, the air void structure being the only variable. For each concrete mix both air void analysis of the hardened concrete and a salt frost scaling test are conducted. Results were not originally presented in a way, which made comparison possible. Here the amount of scaled material is depicted as function of air voids parameters: total air content, specific surface, spacing factor, and total surface area of air voids. The total surface area of air voids is proportional to the product of total air content and specific surface. In all 4 cases, the conclusion is concurrent that the parameter of total surface area of air voids performs equally well or better than the spacing factor when linking air void characteristics to frost resistance (salt frost scaling). This observation is interesting as the parameter of total surface area of air voids normally is not included in air void analysis. The following reason for the finding is suggested: In the air voids conditions are favourable for ice nucleation. When a capillary pore is connected to an air void, ice formation will take place in the air void, being feed from the capillary, but without pressure build-up in the capillary. If the capillary is not connected to an air void, ice formation will take place in the capillary pore, where it can generate substantial pressure. Like this, frost resistance depends on that capillary pores are connected to air voids. The chance that a capillary pore is connected to an air void depends on the total surface area of air voids in the system, not the spacing factor.

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