Leaching And Efflorescence Of Concrete

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In structures such as dam where the flow of water via pores of concrete is high, there could be significant loss of mono-sulfate and ettringite and decalcification of calcium silicate hydrate due to leaching out of these salts to the surface and subsequently washing away. This will lead to reduction in strength of concrete and increases the possibility of further leaching and damage. This article reviews the result of some experimental findings.

Although leaching is a slow process, a significant amount of calcium could be leached out during the service life and this phenomenon could be highly accelerated in the presence of water. In this phenomenon, the Ca(OH)2 and other water-soluble salts are dissolved by the pore water and transported to the surface by capillary action. At the surface, water evaporates leaving crystallized Ca(OH)2 behind, in due course the Ca(OH)2 reacts with CO2 to form CaCO3 which in turn is converted to calcium bicarbonate Ca(HCO3)2 in the presence of moisture. Calcium bicarbonate being soluble in water can be easily washed off by running water. The patches such lime bloom appears generally in the early age of the structure and disappears by natural weathering. The general term used is efflorescence. Lime weeping is another form of lime bloom when a thick white deposit occurs at certain points where there is water leakage – generally near the cracks and joints. To tackle such problem in an area such as behind the retaining wall, weep holes could be provided to allow water to drain out instead of permeating it though the concrete body.

A hot and dry weather followed by a wet and cool period generally enhances leaching phenomenon.

Effects of Leaching

Leaching of calcium from concrete increases porosity, decreases density and decreases the strength of concrete. A typical example of mass loss due to leaching in an accelerated test is shown in figure below (for source of these figures, see at the end of this article).

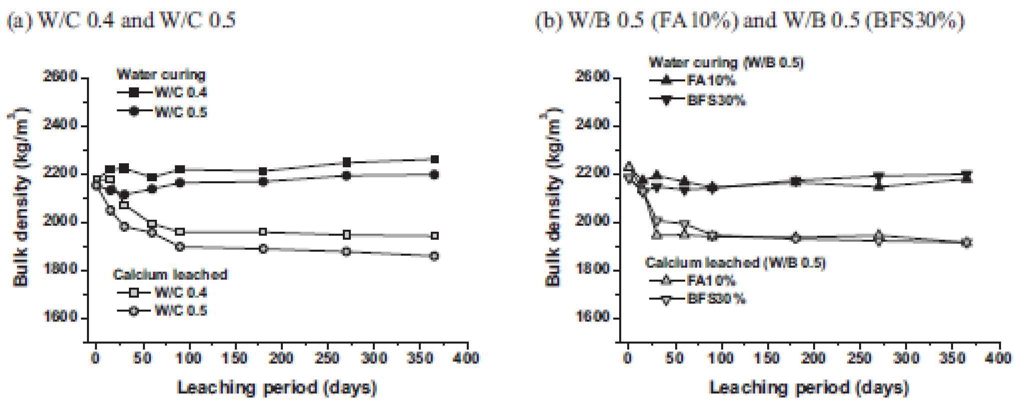
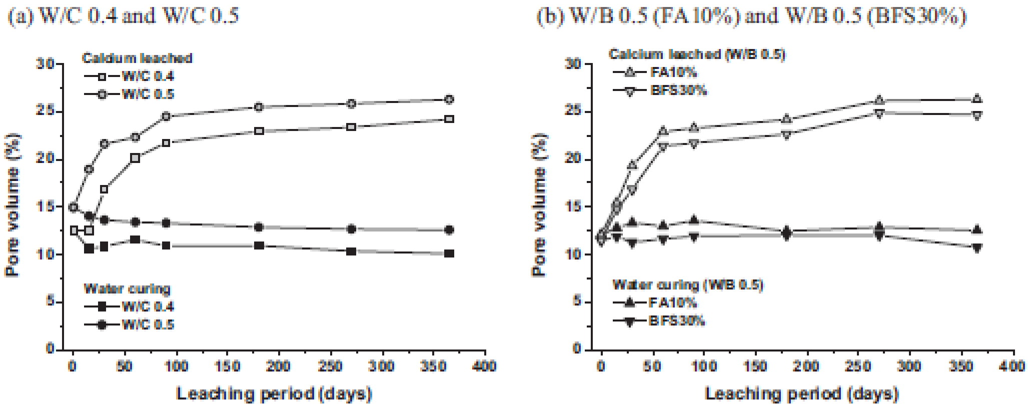


Fig. 4. Relationship between leaching period and bulk density (measured range: surface part 0–10 mm).



The strength measurement in the same test is shown below. The red bar shows the strength of unleached sample while grey shows the strength of leached sample. It is clearly seen that the strength loss could be as high as 50%.

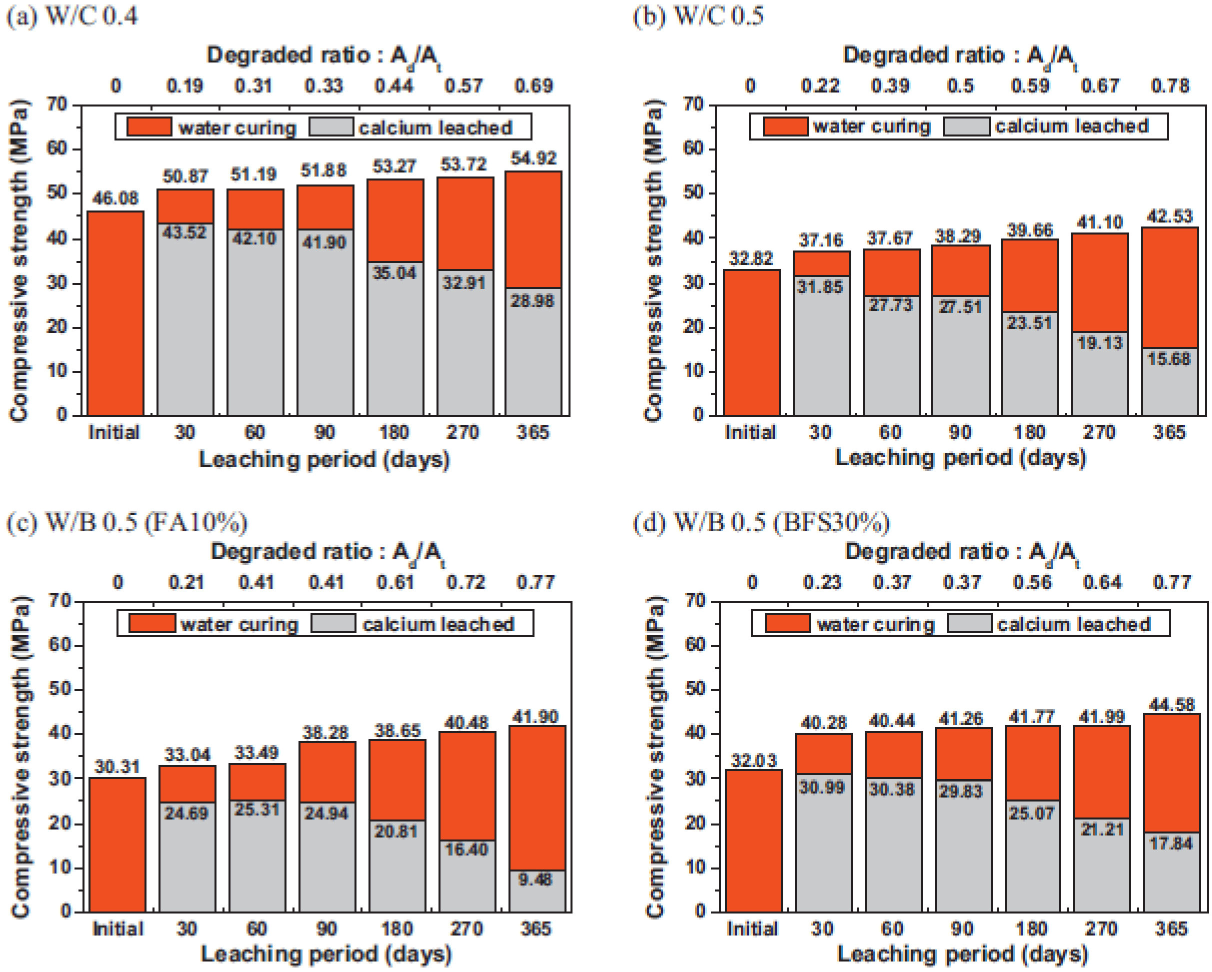
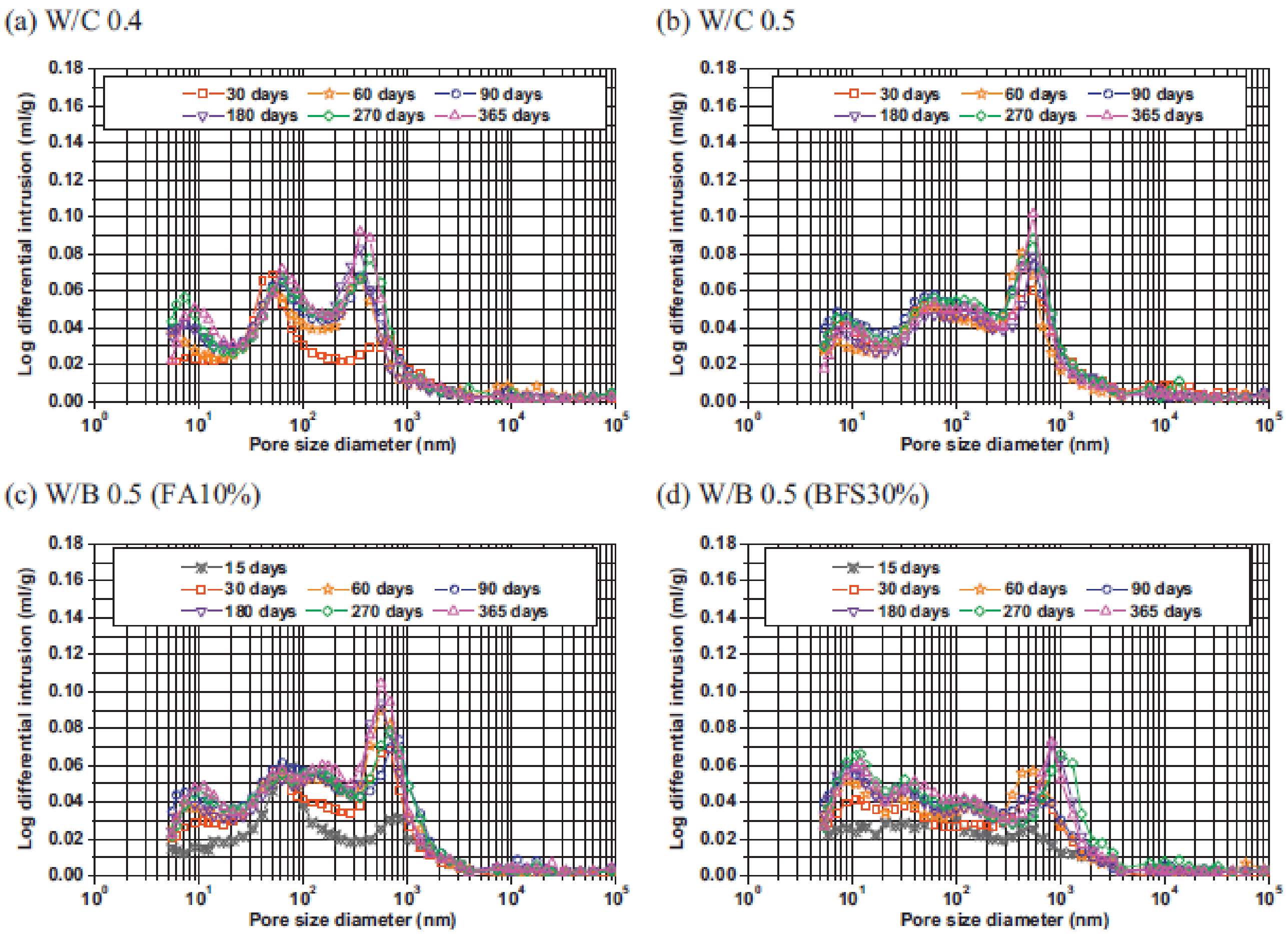


Fig. 8. Result of compressive strength (specimen size: diameter 100 mm, height 200 mm).

The change in pore size distribution before and after leaching is shown in figure below. Notice the increase in volume of larger pores.



The addition of flyash and/or silica fume has slight but not much effect to retain the properties. This is due to the fact that ITZ formation is more effective and contains smaller pore when silica or FA is added.

References:

2013. S. Choi and E. I. Yang, "Effect of calcium leaching on the pore structure, strength, and chloride penetration resistance in concrete specimens," *Nuclear Engineering and Design*, vol. 259, pp. 126–136, Jun. 2013.

2014. Carde and R. François, "Modelling the loss of strength and porosity increase due to the leaching of cement pastes," *Cement and Concrete Composites*, vol. 21, no. 3, pp. 181–188, Jan. 1999.