# ABSTRACT

Student, Chiara Villani Ph.D., Purdue University, May 2014. Transport Processes in Partially Saturated Concrete: Testing and Liquid Properties.
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The measurement of transport properties of concrete is considered by many to have the potential to serve as a performance criterion that can be related to concrete durability. However, the sensitivity of transport tests to several parameters combined with the low permeability of concrete complicyates the testing. Gas permeability and diffusivity test methods are attractive due to the ease of testing, their non-destructive nature and their potential to correlate to in-field carbonation of reinforced concrete structures.

This work aimed at investigating the potential of existing gas transport tests as a way to reliably quantify transport properties in concrete. In this study gas permeability and diffusivity test methods were analyzed comparing their performance in terms of repeatability and variability. The influence of several parameters was investigated such as moisture content, mixture proportions and gas flow. A closer look to the influence of pressure revealed an anomalous trend of permeability with respect to pressure. An alternative calculation is proposed in an effort to move towards the determination of intrinsic material properties that can serve as an input for service life prediction models.

The impact of deicing salts exposure was also analyzed with respect to their alteration of the degree of saturation as this may affect gas transport in cementitious materials. Limited information were previously available on liquid properties over a wide range of concentrations. To overcome this limitation, this study quantified surface

tension, viscosity in presence of deicing salts in a broad concentration range and at different temperatures. Existing models were applied to predict the change of fluid properties during drying. Vapor desorption isotherms were obtained to investigate the influence of deicing salts presence on the non-linear moisture diffusion coefficient. Semi-empirical models were used to quantify the initiation and the rate of drying using liquid properties and pore structure information as inputs. Concrete exposed to deicing salts resulted to have a reduced gas transport due to the higher degree of saturation (DOS). The higher DOS is believed to contribute to the premature deterioration observed in concrete pavements exposed to deicing salts.

Moisture diffusion and moisture profiles in concrete are known to directly relate with the stresses generated during shrinkage and creep mechanisms. The alteration due to the presence of shrinkage reducing admixtures (SRA) on drying was also investigated in this work. Changes in surface tension and viscosity as function of SRA concentration were predicted using existing models. Liquid properties were used to predict the diffusion coefficient in presence of SRA. Moisture profiles obtained using Fick's second law for diffusion were compared to relative humidity profiles measured on concrete slabs. Results confirm that a qualitative prediction of drying in concrete elements is realistic when using this type of approach.