APPENDIX B: PAPER #2

Monical, J., Unal, E., Barrett, T., Farnam, Y., & Weiss, W. J. (2016). "Reducing Joint Damage in Concrete Pavements: Quantifying Calcium Oxychloride Formation." Paper #2 has been published in *Transportation Research Record: Journal of the Transportation Research Board:*

Appendix B

Reducing Joint Damage in Concrete Pavements: Quantifying Calcium Oxychloride Formation

Jonathan Monical
Purdue University, School of Civil Engineering,
550 Stadium Mall Drive, West Lafayette, IN 47907, USA
Tel: 765-494-7999; Email: jmonica@purdue.edu

Erol Unal
Purdue University, School of Civil Engineering,
550 Stadium Mall Drive, West Lafayette, IN 47907, USA
Tel: 765-494-7999; Email: unal@purdue.edu

Tim Barrett
Purdue University, School of Civil Engineering,
550 Stadium Mall Drive, West Lafayette, IN 47907, USA
Tel: 765-494-7999; Email: barrett1@purdue.edu

Yaghoob Farnam
Purdue University, School of Civil Engineering,
550 Stadium Mall Drive, West Lafayette, IN 47907, USA
Tel: 765-237-7925; Email: yfarnam@purdue.edu

W. Jason Weiss
Edwards Distinguished Professor of Engineering
Oregon State University, School of Civil and Construction Engineering,
111F Kearney Hall, Corvallis OR 97331
Tel: 541-737-1885; Email: jason.weiss@oregonstate.edu

ABSTRACT
Deterioration has been observed at the joints of many portland cement-based concrete pavements in Midwestern states. It has been shown that this damage can be caused by either classic freeze-thaw behavior triggered by high saturation levels or a chemical reaction that occurs between the deicing salt (in this paper $CaCl_2$) and the cementitious matrix. The objective of this paper is to show that low temperature differential scanning calorimetry can be used to quantify the potential for the chemical reaction between the salt and matrix (i.e., calcium oxychloride formation). The formation of calcium oxychloride is expansive and may lead to significant cracking and spalling without being exposed to freeze-thaw cycles. This paper will examine pastes made of ordinary portland cement (OPC), portland limestone cement (PLC), and portland cement combined with fly ash, slag or silica fume. The results indicate that there is not a significant difference in the amount of calcium oxychloride formation that occurs between ordinary portland cements and portland limestone cements. The addition of supplementary cementitious materials (SCM) reduces the formation of the calcium oxychloride presumably due to the reduction of calcium hydroxide due to dilution, the pozzolanic reaction, and a reduction in the alkali content in the pore solution. The results also indicate that sealers can be used to create a barrier between the salt and calcium hydroxide or they can react with the calcium hydroxide thereby reducing calcium oxychloride.

Keywords: cement, concrete, pavement, calcium oxychloride, joints, supplementary cementitious materials