

Research in Progress Abstract - Construction Practice (Non-Pedagogical Content)

Evaluating Freeze-Thaw Durability of Pervious Concrete Mixtures in Cold Regions

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This project presents a performance-based evaluation on the freeze-thaw durability of pervious concrete mixtures in cold regions. According to a statistical data, northern Arizona has been recorded with a mean annual frequency of 250 freeze-thaw cycles. The daily temperature variations have been significant and become a severe issue on the performance of pervious concrete pavements. In the past years, a few pervious concrete pavements were built in Northern Arizona. However, none of them could last longer than three years due to the effect of freeze thaw cycles. A research has been undertaken to develop pervious concrete mix designs that can better sustain the cold temperatures and high frequency of freeze-thaw cycles. Literature review was performed and a selection of mixture formula was used to produce specimens. However, the compressive strength of the specimens was not satisfied. Therefore, the redevelopment of pervious concrete mixtures was implemented. Based on new mix design, a series of pervious concrete specimens were produced using two single sized aggregates (3/8", and ¼") associated with the addition of admixtures (air entraining, water reducer, hydration stabilizer, etc.). Natural sand, a local product, was used as a replacement of coarse aggregate with up to 5%. The engineering properties of pervious concrete specimens were evaluated for strength and permeability, particularly for their freezing-thawing resistance using a freeze-thaw apparatus compatible with ASTM C666. The objective of the paper is to provide promising pervious concrete mixtures with serviceability, workability, as well durability under a high frequency of freeze-thaw cycles. Pervious concrete mixes were prepared with 1/2"+ #4 aggregate, 3/8" + #4 aggregate, and single #4 aggregate size obtained from two plants. Fiber was added into the 1/2"+ #4 mixes to compare the compressive strength of pervious concrete specimens. Based on compression and permeability tests, combined mixes prepared with 1/2"+ #4 aggregate and 3/8" + #4 aggregate show the greater compressive capacity than the single size #4 mixes. The mixes prepared with 1/2"+ #4 aggregate with fiber displayed significant 15% increase in compression as compared with the same mixes without fiber. The fiber could be added into mixes to improve the strength of pervious concrete. The void of concrete mixes with fiber has the lowest value of 17.2% but is still within the reasonable range. After three promising mix design formulas were determined, the freeze-thaw cycle tests were used to evaluate the effect of freezing-and thawing on the durability of these pervious concrete mixtures. The pervious concrete specimens were tested at a cycle of 50, 100, 150, 200, and 250 to compare their resistance to freeze-thaw effect. The volume and weight of these pervious concrete specimens did not change significantly after 50 and 100 cycles. While the durability tests are still ongoing in the laboratory, the results will be revealed in late January, 2014. After completion of this research project, the mix design formulas will be used by local engineers, governments, and contractors to produce a reliable pervious concrete that can better sustain the climate in the cold regions.

Key Words: Freeze thaw cycles, pervious concrete, durability, permeability