Freeze-Thaw Durability of Concrete with Post-Cure Active Shrinking Chitosan Fibers

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Introduction

Concrete is ubiquitous and its usage has an extensive history. Fiber reinforced [1] and prestressing cable reinforced [2] concrete have proven to be beneficial to material properties. Shrinking fiber reinforced concrete combines these two methods for increased tensile strength [3] and better freeze/thaw durability. Chitosan is a natural nitrogen-based biopolymer derived from shrimp shells that shrinks in high pH, as in fresh Portland cement concrete.

Figure 1. Sheets of shrinking chitosan fibers (left), cut active fibers (middle), preshrunk passive fibers (right)

Methods

Concrete blocks reinforced with chitosan fibers were freeze-thaw thermal cycled in an environmental chamber and impact resonance frequency tested. Specimens are wrapped in wet towels and cycled between -20℃ and 20℃. 5 specimens per group are used to achieve a valid average. Each weight ratio has active and passive groups to examine if shrinkage causes potential benefits.

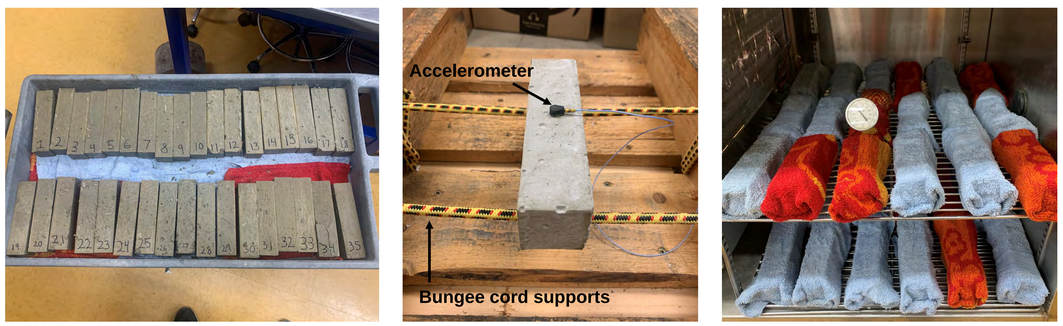

Figure 2. All beams being tested (left), a beam ready to be impact tested (middle), beams wrapped in wet towels in environmental chamber (right)

Results

Two groups perform significantly better than the 0kg/m^3 control group: 2.5 kg/m^3 active shrinking and 5 kg/m^3 active shrinking. This suggests that the addition of a small weight ratio of shrinking chitosan fibers could improve the freeze-thaw resistance of concrete. All groups failed after 182 cycles so no group can be considered totally freeze-thaw resistant. At a ratio of 7.5 kg/m^3 we see a slight increase in the durability but a similar degradation for both the active and passive fiber groups suggesting that it is simply the existence of fibers rather than their shrinkage causing this slight benefit.

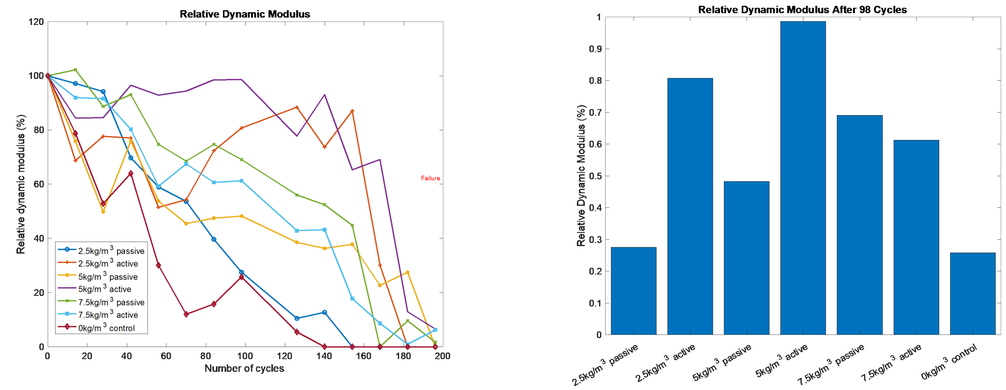

Figure 3. Average relative dynamic moduli of each beam group (left) and each groups relative moduli after 98 cycles (right)

Conclusions

A better maintenance of relative dynamic modulus over time was seen in the 5kg/m^3 active shrinking fiber group. This shows that better freeze thaw durability in concrete can be achieved with the inclusion of shrinking fibers.

Acknowledgments

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References

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