Implementing Fiber-Reinforced, Self-Consolidating Concrete as a Repair Material for AASHTO Prestressed Concrete Girders

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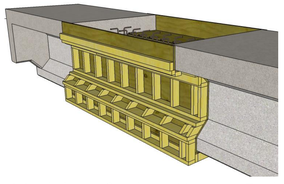
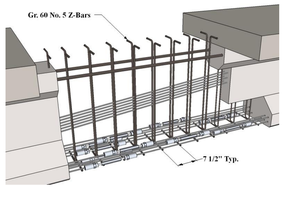
Introduction

Concrete structures account for almost half of the nation's bridges & to fix a damaged concrete member, it is common practice to replace the entire member or perform multipart repairs. Either options are costly & time consuming. Single, all-encompassing repairs by casting replacement concrete can provide a quicker, economical solution. However, in repairing prestressed concrete members by casting new concrete there are issues with shrinkage cracking & cohesive transfer of stress between concretes. Fiber-reinforced, self-consolidating concrete has proven itself as a viable solution, however, when introducing partial replacement of cementitious material with a shrinkage-compensating replacement, cracking can be significantly reduced.

Damage from Initial North End Testing , East Side(Above)



Models of the North End Repair Formwork (Above) & the Repair Internal Reinforcing for the Girder Portion (Below)

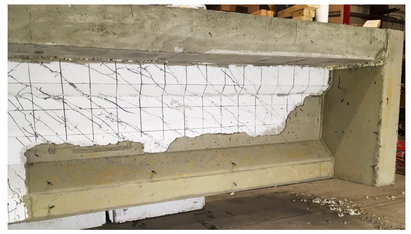


Repair Method

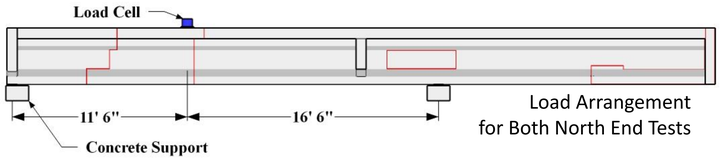
Repair consisted of three major parts:
1) removal of damaged concrete, 2) repair/replacement of internal reinforcing, & 3) casting the replacing repair material.

North End During Damage Removal

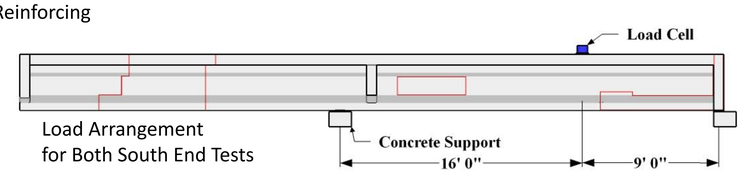
North End Girder & Deck Repair Reinforcing



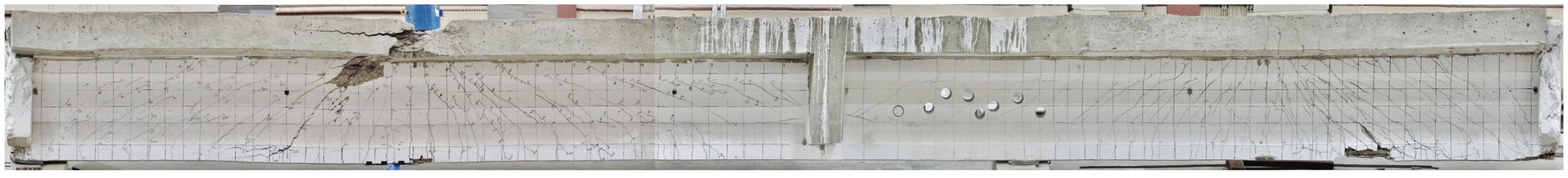
South End Repair After Removing Forms



Load Arrangement for Both North End Tests



Load Arrangement for Both South End Tests

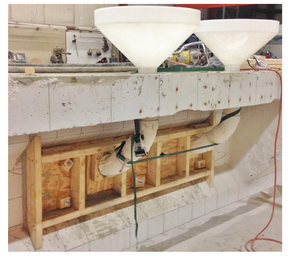


West Elevation of Resulting Damage from Initial Testing (Above) & Resulting Damage from Repair Testing (Below)

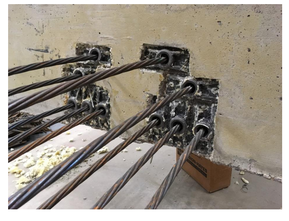
Conclusion

The material properties of the repair material were analogous to the existing concrete with compressive strengths within 8% of the existing concrete. Plus, the FR-SCC was able to fully fill all repair sections without the need for consolidation.

The repair tests were able to restore the member to 80% of its original capacities which equates to approximately 175% of the originally intended demand. The initially tested failure mechanisms were shear-based failures; the repair testing failure mechanisms were flexure-based, mitigating the shear failures. Crack propagation of the repair material was evenly dispersed & there were no signs of delamination at the boundaries of the repair.



Formwork for the Web Section (Above) & South End Post-Tensioning Anchorage (Below)



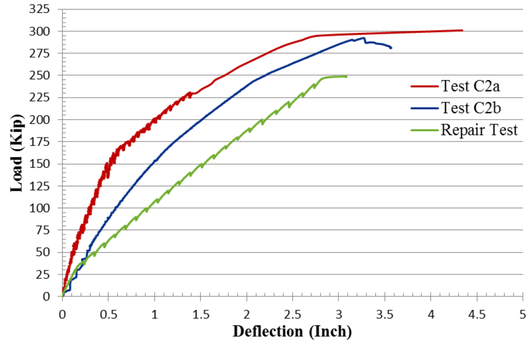
Objectives

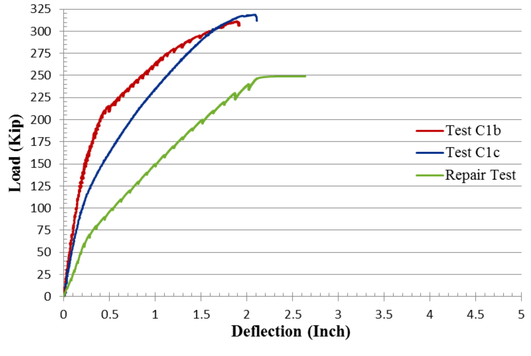
This study is a continuation of two previous Oklahoma Department of Transportation research projects: 1) research & development of fiber-reinforced, self-consolidating concrete (FR-SCC) repair material utilizing shrinkage-compensating cementitious material, 2) initial shear testing of an AASHTO Type II prestressed concrete bridge girder with composite deck.

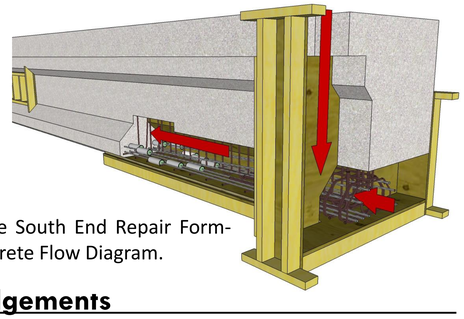
The primary task for this research was to evaluate the practical application of the previously designed FR-SCC as a repair material as well as its effects on the structural performance of the bridge girder when repaired. With the aim of paralleling the initial testing of the girder, the capacity of the girder for each repair test will be analyzed & evaluated in comparison to the originally tested capacities. The anticipated outcome of the study was whether or not the FR-SCC was a realistic solution for industry & if the resulting repair would permit comparable loading behavior to the original testing.

Results

Below are the comparative load versus deflection plots for the North End (left) & the South End (right). Note that the tests "C2a" & "C2b" are the original North End tests & "C1b" & "C1c" are the original South End tests.







Model of the South End Repair Formwork & Concrete Flow Diagram.

Acknowledgements

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