

UTC Project Information	
Project Title	MPC 502- Experimental and Computational Study of Self-Consolidating Concrete for Prestressed Bridge Girders
University	South Dakota State University
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Brief Description of Research Project	<p>Self-Consolidating Concrete (SCC) consisting of water, cement, large portion of fine and coarse aggregates, and chemical admixtures is a highly flowable, non-segregating concrete. SCC was initially developed in the 1980's [Error! Reference source not found.] by concrete researchers at the University of Tokyo in Japan. SCC has significantly different characteristics compared to Conventional Concrete (CC) [1-7]. Specifically, SCC is normally characterized by a slump of 26 to 28 inch in diameter [Error! Reference source not found.] that is different from CC as shown in Figure 1. It means that SCC has its high flowability related to workability that enables to spread into highly dense reinforcement areas under its self-weight and to fill any small voids without mechanical vibration. As a result of the high workability, SCC provides additional benefits as follows [Error! Reference source not found.]:</p> <ul style="list-style-type: none"> • Low noise-level in the plants and construction sites • Eliminated problems associated with vibration

- Less labor involved
- Faster construction
- Improved quality and durability, and
- Higher strength



(a)



(b)

Figure 1 Slump Test: (a) SCC and (b) CC [Error! Reference source not found.].

With these benefits, the use of SCC can result in better construction quality, productivity, and safety [Error! Reference source not

found.]; thus, construction contractors, producers and owners who are faced with tougher environmental and stricter safety guidelines, and increased construction costs have attempted to use SCC in many construction applications [**Error! Reference source not found., Error! Reference source not found.**]. Further, SCC has high potential for precast, prestressed concrete industry and for cast-in-place construction in the United States [**Error! Reference source not found.**]. For example, a National Cooperative Highway Research Program (NCHRP) research project has been initiated to establish SCC bridge girder design and construction guidelines to be added to the AASHTO LRFD Specifications. The South Carolina State Department of Transportation (SCDOT) was to study the use of SCC in drilled shafts [**Error! Reference source not found.**] and in replacement of four structurally deficient bridges [**Error! Reference source not found.**]. These studies have helped SCDOT use SCC in the drilled shafts and bridges. Prestressed SCC girders used for the bridges' replacement can be shown in Figure 2. Also, the Kansas State Department of Transportation (KSDOT) performed a study of the fresh and hardened properties of SCC for use in Kansas prestressed concrete bridge girders. KSDOT built a three-span bridge using SCC in only one span while the remaining two spans were built using CC [**Error! Reference source not found.**]. The bridge is instrumented and monitored for five years to evaluate its long-term performance. In addition to the field studies, experimental studies for SCC concrete bridge girders have been performed by South Dakota State University (SDSU) in cooperation with the South Dakota DOT (SDDOT) [**Error! Reference source not found.**]. The flexural behavior of prestressed SCC bridge girders subjected to monotonic and fatigue loading was experimentally examined at the Lohr Structures Laboratory at SDSU. In this testing, three full-scale prestressed bridge girders were made and tested until failure. One girder was constructed using CC as a reference specimen, while the other two girders were constructed using SCC. It was concluded that SCC and CC bridge girders showed similar behavior under monotonic and fatigue loading. Figure 3 shows a sample picture for the representative SCC bridge girder used for the testing at SDSU.



Figure 2 Use of Prestressed SSC Bridge Girders at SCDOT [Error! Reference source not found.].



Figure 3 Testing of Representative Prestressed SSC Bridge Girder at SDSU [Error! Reference source not found.].

From the brief literature review, it can be concluded that relevant studies [1-7] to understand the structural behaviors of prestressed SCC bridge girders and attempt to use SCC in actual prestressed bridge girders based upon individual state bridge design guidelines and

	<p>construction methods have been completed. However, there has been no specific test data to investigate the material properties (i.e., modulus, shrinkage, and creep) of prestressed SCC bridge girders related to time-dependent characteristics, flexural stiffness change, and prestress losses. Considering these effects is critical for the use of SCC in prestressed bridge girders because the structural performance of prestressed girders is typically related to the material properties associated with time-dependent factors. In particular, the material properties of SCC used by precast prestressed girder suppliers to the Wisconsin Department of Transportation (WisDOT) have not been examined yet. Lacking substantiated data on the material properties, WisDOT has not allowed the use of SCC in prestressed bridge girders in Wisconsin. Even precasters have not been able to consistently mix, deliver and place SCC in prestressed bridge girder construction. Although WisDOT attempted to use SCC in some prestressed girders, the producer had difficulty in maintaining uniformity of the mix, and problems were observed with excessive segregation of wet batches during placement. Hence, widely accepted, uniform recommendations for SCC mix design that achieves desired performance for use in prestressed girders for WisDOT should be developed for ensuring safety in its construction.</p> <p>Research Objectives</p> <p>SCC has high potential prestressed bridge construction in Wisconsin, but there is a lack of definitive data on its material properties for WisDOT. The primary objective of the work proposed herein is to develop a Wisconsin specific mix design and its specification for the use of SCC in prestressed girders used on WisDOT bridge projects. To accomplish this objective, this project will test several SCC samples for examining the following characteristics:</p> <ul style="list-style-type: none"> • Material Properties • Time-Dependent Characteristics • Prestress Losses <p>This project will not only help in better understanding the material properties of prestressed SCC girders, but will also provide recommendations related to its design and guidance that can be useful for a full-scale implementation on one of the department’s bridge projects. This implementation will be coordinated with WisDOT Bureau of Structures and a Precast Girder Producer for the design, implementation, testing, monitoring and documentation. Field monitoring-based structural evaluation process will also be included to evaluate the structural performance of a test prestressed SCC bridge girder on the project.</p>
<p>Describe Implementation of Research Outcomes (or why not implemented)</p> <p>Place Any Photos Here</p>	<p>Through this project, recommendations for SCC mixture design were established to promote use of SCC in prestressed bridge girders in Wisconsin. Key findings indicate that the full-scale SCC and CC girders exhibited almost identical long-term camber and prestress losses, but the transfer length of SCC girder was</p>

	somewhat lesser than that for the CC girder.
Impacts/Benefits of Implementation (actual, not anticipated)	The recommendations for SCC mixture design that achieves desired performance for use in prestressed SCC girders for WisDOT will be widely accepted across Wisconsin and utilized for ensuring safety in bridge construction.
Web Links <ul style="list-style-type: none">• Reports• Project Website	http://www.ugpti.org/resources/reports/details.php?id=891