# MPC-402
## Time Duration 2012-2013

**Project Title:**
Seismic Performance of SCC Bridge Columns

**University:**
South Dakota State University

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**Research Needs:**
Self-consolidating concrete (SCC) is a specially proportioned hydraulic cement concrete that enables the fresh concrete to flow without segregation. Because of its high workability, SCC flows into narrow spaces and form corners, and around closely-spaced steel reinforcement without the need for mechanical vibration.

In seismic regions such as Utah and part of Colorado in Transportation Region 8, the need for a large amount of confinement reinforcement to provide the required ductility often results in columns and joint regions with excessive steel congestion. Steel congestion hinders the placement and proper consolidation of conventional concrete. There are also cases when concrete repair and/or replacement are needed to fix localized damage in bridge structural elements following a seismic event. Highly flowable, yet non-segregating, concrete would be needed to perform the repairs. The high flowability and robustness of SCC make it ideal for the construction and repair of bridge columns and joints designed to meet seismic detailing.

There is an evident lack of research to investigate the ductility and shear strength of SCC bridge columns and joints under seismic loads. In this proposed study, experimental and analytical work will be performed to evaluate the ductility and shear strength of columns and joints under reversed inelastic deformations.

**Research Objectives:**

1. Develop a stress-strain model for SCC under uniaxial compressive stress
2. Evaluate the ductility and shear capacity of SCC bridge columns under inelastic load reversal
3. Evaluate the ductility and shear capacity of SCC bridge columns-beam joints under inelastic load reversal

**Research Methods:**

The stress-strain behavior of SCC under uniaxial compressive stress will be developed from testing standard concrete cylinders in compression. Concrete cylinders from several SCC mixtures with different w/cm ratios will be prepared and tested in the materials lab at SDSU. Conventional concrete (CC) cylinders will also be tested and the results will be compared to those obtained from the SCC mixtures.

Two SCC and two CC large-scale columns will be constructed and tested under reversed lateral loading at the Lohr Structures lab at SDSU. The longitudinal and transverse reinforcement of the four columns will be identical. The columns will be divided into two groups. Each group will consist of one SCC column and one CC column. The applied axial load in the first group and the second group will be approximately $0.1\ f'_c\ A_g$ and $0.2\ f'_c\ A_g$, respectively. The columns will be instrumented to measure the ductility and shear strength of the column specimens.

Lastly, one large-scale SCC frame will be constructed and tested under reversed lateral loading in the plane of the frame. The frame will represent a two-column bridge bent. The purpose for the test is to examine the performance of the beam-column joints.

The applicability of existing analytical models for the analysis of CC columns and joints will be assessed. When needed, adjustments to the existing models will be proposed.

**Expected Outcomes:**

Stress-strain relationships for SCC in compression will be developed. Models for the prediction of column and joint ductility and shear capacity will also be proposed. The results of the study will provide the data needed by state DOT's to adopt the use of SCC for bridge columns and joints in seismic regions.

**Relevance to Strategic Goals:**

1. State of good repair
2. Safety
3. Economic competitiveness

**Educational Benefits:**

Two graduate students will be recruited for this study. The students will be trained to conduct experimental work on large-scale bridge columns and the design of bridge columns and joints for seismic loads.

**Work Plan:**

The project duration is 18 months. The proposed research can be accomplished through following tasks:

Task 1: Review literature regarding SCC practices for bridge structure
Task 2: Construct and test standard concrete cylinders in compression
Task 3: Analyze the data from Task 2
Task 4: Construct and test the column and bent specimens
Task 5: Analyze test data from Task 5
Task 6: Prepare final report

**Project Cost and Duration:**
Project duration: 18 months.
Total Project Costs: $152,976
MPC Funds Requested: $123,793
Matching Funds: $29,183 SDSU (in-kind)

**TRB Keywords:**
SCC Columns, Ductility, Concrete Joints, Bridge columns

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