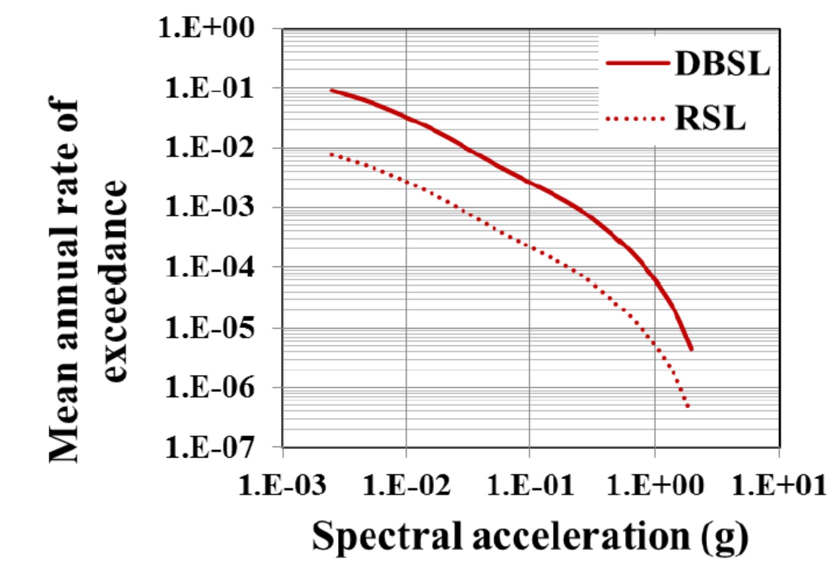
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 19-383 (project 404) | July 2019

Seismic Performance of Circular Concrete Filled Steel Tube Columns for Accelerated Bridge Construction



the ISSUE

Columns used for accelerated bridge construction are usually precast components that can be rapidly installed on-site. One of the main challenges with these columns is to keep their weight within a practical weight range for transporting and handling. Special care is also needed when designing splices to connect the foundation to precast piers in high seismic hazard zones. Circular concrete filled steel tube columns are an approach that addresses both of these concerns. Because it takes nearly a month for the concrete in circular concrete filled steel tube (CCFT) bridge columns to reach their design strength, bridge designers need to know if the columns can perform adequately under gravitational loads and reduced seismic loading before the concrete reaches its design compressive strength.

the RESEARCH

The study assesses the effect of partial concrete compressive strength on the seismic performance of CCFT bridge columns prior to full concrete compressive strength being achieved. If the bridge needs to be open to traffic after a few days, the time required for the columns' concrete to meet the design compressive strength creates a temporary condition. The research evaluates whether this temporary condition increases the seismic probability of failure using as the criterion a comparison of CCFT columns under permanent conditions subjected to design basis seismic load with that of temporary conditions subjected to reduced seismic load. ⤑

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

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Utah State University
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Project Title

Seismic Performance of Concrete Filled Steel Tube (CFST) Bridge Columns for Accelerated Bridge Construction

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the RESEARCH (cont.)

The first phase of the study addresses the design of CCFT columns. These components may require a third less cross-sectional area than the original RC columns to achieve similar capacity under combined axial and bending forces. Because of the highly localized failure mode of CCFT columns, concentrated plasticity models can reliably predict the nonlinear performance of these components up to the collapse limit state. This study calibrates for first time the deteriorating nonlinear parameters required for these numerical simulations.

the FINDINGS

Based on the incremental dynamic analysis (IDA) analysis, the collapse capacity of CCFT columns at 3, 7, and 14 days correspond to 80, 93, and 98 percent of the CCFT collapse capacity at 28 days, when the concrete is expected to reach its design compressive strength. If a conservative temporary condition of one month is assumed for CCFT columns with less than one month of curing, the probability of failure for CCFT columns at 3, 7, and 14 days is about one order of magnitude smaller than that for the CCFT column over the lifespan of 75 years.

Also, the concrete strength gain is not as critical for CCFT columns as in reinforced concrete columns. Thus, the steel tube is largely responsible for initial capacity of the CCFT, as long as the concrete provides lateral constraint, preventing buckling failure.

the IMPACT

Results indicate that CCFT columns with partial design concrete compressive strength can be used for ABC because the relatively low decrease in strength is offset by the reduced seismic loads for this temporal condition. As a result, CCFTs are a light-weight lower-cost option for bridge designers who are developing bridges that can be erected and open for use in limited amounts of time.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=958

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.