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

Description

Meta Fields

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Primary Sponsor Contact Info : Research and Innovative Technology Administration University Transportation Centers Program 1200 New Jersey Avenue Washington, DC 20590 USA Robin Kline robin.kline@dot.gov (202) 366-2732
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Abstract :

This study will evaluate the seismic performance of concrete filled steel tube (CFST) bridge columns for potential use in emergency or accelerated bridge construction (ABC) projects. The main goal of the study is to determine whether CFST columns can be designed to perform adequately under gravitational loads and seismic hazard before the concrete reaches its design strength. The project will need to investigate the effect of reduced seismic loading for this temporary condition on the CSFT limit states of interest, such as serviceability and ultimate limit state. Columns used for ABC 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. The use of CFST columns largely reduces these problems because the steel tubes are erected prior to pouring the concrete, and can be easily connected to the foundation. Composite columns may be advantageous for ABC because the steel components can be designed to withstand the gravitational deck loads and a reduced seismic hazard. The total seismic capacity of the component is obtained once the filled concrete reaches the design concrete strength. Thus, the bridge performance needs to be analyzed under a seismic hazard for temporary conditions. Several studies have assessed the possibility of reducing seismic hazard for shorter system exposure times. For instance, Amin et al. (1999) developed a methodology for computing reduced seismic loads for nuclear power plant components subjected to temporary conditions. Olson et al. (1994) developed a quantitative procedure for using available site-specific annual seismic hazard curves to determine an acceleration level for evaluating temporary conditions. Application of this procedure for a sample site resulted in seismic accelerations for compliance periods of one month that were about 33% of the design basis. Boggs and Peterka (1992) developed a procedure for specifying the design recurrence interval for a temporary structure such that the probability of failure is the same than that of permanent structures. However, Hill (2004) considered that temporal structures should have the same ability to sustain loads than permanent systems, independently of the exposure time. Cornell and Bandyopadhyay (1996) identified several challenges when applying reduced seismic loads that will be

considered in this study, such as the definition of temporal loads, and license renewal of systems exposed to temporal loading. Regarding the performance of CFST columns, Marson and Bruneau (2004) tested composite columns under axial and lateral loads. The diameters of these columns were 324 and 406 mm, with a D/t ratio ranging from 34 to 64. The columns reached drifts of 7% before a significant loss in moment capacity. Strength deterioration after the maximum strength was reached was slow until fracture occurred during cycling at 7% drift. They indicated that CFST columns provide an effective mechanism to dissipate seismic energy, and can be effective for bridge columns in seismic regions, although they indicated that further research is needed for larger components. Han et al. (2011) also concluded that circular CSFT columns have excellent seismic resistance and confirmed that the lateral load-carrying capacity and ductility decreased as the axial load level in the column increased. Recent studies have performed limited tests to evaluate the effect of concrete strength on the ultimate capacity of CSFT columns. For instance, An et al. (2012) showed that the capacity of CFST columns can be more than twice that of hollow tubes. As expected, the tube's capacity increases as the concrete strength increases, and the concrete strength contribution to CSFT capacity is less significant for columns of large slenderness ratio.

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