Team 11: Design of Highway Bridges Incorporating Concrete Filled Composite (CFFT) Columns

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Conventional reinforced concrete (RC) columns are very common in bridge construction, yet they possess many shortcomings that must be addressed. The construction of cast-in-place reinforced concrete columns is time-consuming, costly and complicated. In addition, RC columns are not sufficiently resilient to environmental hazards and extreme events. In the course of the lifetime of a bridge, there is a high likelihood that a flood, fire, earthquake, blast or other extreme event will pose a significant test to the resiliency of the structure. Since columns are typically the most vulnerable members of a bridge structure, they are often a key determining factor in the longevity and durability of the bridge.

Minimally reinforced concrete-filled fiber reinforced polymer (CFFT) columns have been proposed in order to meet the demand for a system that is superior to conventional reinforced concrete columns. This innovative column system has proven—both in laboratory experiments and in field applications—to be more simply constructed, more resilient, and more cost-effective over the course of the lifetime of the bridge with less environmental impact than conventional reinforced concrete columns.

To conduct a comprehensive comparison between the RC and CFFT column systems, the columns of two bridges with reinforced concrete columns – Bear River Bridge in California and Townsend Bridge in Connecticut – were redesigned while maintaining the superstructure and other aspects of the bridge. First, SAP2000 was used to model the existing RC columns and determine their capacities. These values were then used to design CFFT columns with comparable capacities. Models of the two bridges – one using RCs and one with CFFTs – were generated using CSIBridge. Once the design was determined, AutoCAD was employed to generate new bridge plans for the proposed redesign using CFFT columns.

In addition to redesigning the columns, a comprehensive comparison of both the lifetime cost and environmental impacts of the two systems was conducted. All of these analyses demonstrated the superiority of the CFFT system in terms of multi-hazard resilience, lifetime cost and environmental impact.