Florida Department of Transportation Research

Alternative Support Systems for Cantilever Signal/Sign Structures
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During the 2004 hurricane season, the failure of several foundations of cantilever sign structures occurred along Florida highways, necessitating a review of the design and construction procedures for those foundations (FDOT Research Report BD545-54). In the design at that time, sign support columns were a one-piece design, attached to foundations by anchor bolts secured through an annular plate welded to the bottom of the column. The earlier project found that failures happened when torsion on the support column twisted the anchor bolts in their circular concrete foundations, resulting in shear parallel to the foundation edge which caused concrete breakout. The current project extended the earlier one with primary objectives to identify a viable alternative to transfer load from the superstructure to the foundation other than through anchor bolts and to provide design guidelines for the alternative selected.

Partially excavated foundation showing concrete breakout that leads to collapse of the sign structure (inset, upper right).

A literature review guided the choice of an alternative design for the foundation of cantilevered sign structures and the design of the experimental program. After exploration of a number of options, a two-piece design was selected: an embedded pipe with welded steel plates. Torsion could be transferred through vertical plates, and the flexure could be resolved with an annular plate on the bottom of the pipe. The sign support column would attach to the embedded pipe and must be secured to it through some type of base connection (to be determined in future research).

Expectations for performance of the embedded pipe design were confirmed by testing. Not only was the design a viable alternative to the anchor bolt system, but it had greater strength for a given foundation size than the anchor bolt system. Testing also proved that the American Concrete Institute (ACI) 318 code equations for concrete breakout from applied shear could be modified to yield accurate predictions of the concrete breakout strength of the embedded pipe and plate section. Design guidelines based on these equations accounted for the design of the base connection as well as the foundation, including the pipe and plates section and concrete pedestal and reinforcement.

Implementation of the recommended alternative and design guidelines for foundations of cantilever signal/sign structures should eliminate any concrete breakout problems associated with the previous design. The combination of the embedded pipe and plate section and a selected alternative connection would significantly reduce the number of failures of cantilever signal/sign structures.

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