NCTSPM

Project Information Form

Reporting Period: 07/01/2015 – 12/31/2015

Project Title	Evaluation of Anchor Bolt Clearance Discrepancies
University	University of Alabama at Birmingham
Principal Investigator	Ian Hosch
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Funding Source(s) and Amounts Provided (by each agency or organization)	UTC - $50,000 ALDOT – 50,000
Total Project Cost	$100,000
Agency ID or Contract Number	DTRT12GUTC12
Start and End Dates	01/15/2014 – 07/15/2015
Brief Description of Research Project	The clearance, or stand-off, distance for anchor bolts within a double nut moment joint is defined as the distance between the bottom of the base plate and the top of the concrete foundation. Evidence has shown that there currently exist structures with unleveled stand-off distances as a result from topographical boundaries at the construction site. This discrepancy has produced non-uniform stress distribution within the anchor bolt group due to service loading. Preliminary results of an in situ cantilevered sign support structure with this condition have shown that stress ranges for two of the anchor bolts within the group were higher than the constant amplitude fatigue limit (CAFL), which can potential be more severe for extreme wind loading events. The main objective of this project is to investigate the effect of non-uniform stand-off distances on the stress distribution of the anchor bolts due to fatigue wind and extreme wind events. Analysis will focus on the stress distribution within the anchor bolt group as well as the area above the base plate-to-shaft weld. The main outcome of the project is to create limit-state design equations to be used in the event in which this condition is non-avoidable. The project will involve extensive finite element analysis (FEA) modelling to determine the significance of this condition as well as a limit-state design approach.
Describe Implementation of Research Outcomes (or why not implemented) (Attach Any Photos)	A new innovative, comprehensive, closed-form analytical solution method was derived with this research to analyze stand-off anchor bolt connections with clearance discrepancies. It is based on the load distribution method that is used for the design and analysis of shear walls in buildings. Finite element analysis (FEA) as well as data obtained from previous experimental research was used to validate the analytical solution resulting in successful comparisons. Portions of this research has been published by the peer-reviewed ASCE *Practice Periodical on Structural Analysis and Construction*, and presented

	at the University Transportation Center (UTC) Conference for the Southeastern Region, Georgia Institute of Technology, March 24-25 2014. Additional funding has been sought from the American Institute of Steel Construction (AISC), the National Science Foundation (NSF), and the National Cooperative Highway Research Program (NCHRP), which are currently pending. The proposals sent to these funding agencies seek expenses to perform experimental testing to verify the analytical solutions derived with this NCTSPM research. Implementation of this research is focused on developing limitations for clearance discrepancies for inspection during construction. The limitations are set using the design strength of the anchor bolts: i.e., the constant amplitude fatigue limit (CAFL) for fatigue level wind loading, and the plastic limit for extreme level wind loading. The limitations can be developed using the closed-form analytical solution derived with this research. Further publications are being developed that describe the solution method as well as its implementation.
Impacts/Benefits of Implementation (actual, not anticipated)	The revelations found with this research has gained interest from the ASCE Committee 113 on the ASCE Substation Structure Design Guide and Neil Moore and Associates in Shingle Springs, CA. They have seen similar issues that were investigated in the research, but with electric utility structures.
Web Links • Reports • Project website	http://www.nctspm.gatech.edu/pi/evaluation-anchor-bolt-clearance-discrepancies http://trid.trb.org/view.aspx?id=1303031 http://nctspm.gatech.edu/sites/default/files/u60/NCTSPM_Anchor%20Bolt.pdf http://ascelibrary.org/doi/pdf/10.1061/%28ASCE%29SC.1943-5576.0000286