DESIGN GUIDELINES FOR ANNULAR BASE PLATES

PROBLEM STATEMENT

Base plates are structural elements used to connect structural members to their foundations. They are commonly used in conjunction with tubular high mast poles, roadway light poles, and traffic mast arms. The base plate connects the sign or lighting structure to its foundation with anchor bolts using a double nut installation.

Currently, the Florida Department of Transportation (FDOT) requires a grout pad beneath all signing and lighting structure base plates. Several states are eliminating this requirement, believing that it is detrimental to the maintenance of the structures. Based on recent failures, there is evidence that grout pads are critical to the performance of these structures. The presence (or lack) of a grout pad affects both the structural response and the durability of the installation. Currently, there is little information pertaining to both the structural and serviceability benefits of placing grout pads beneath base plates.

OBJECTIVES

The primary objective of this study was to evaluate the structural behavior of sign and lighting structure base plates by performing tests on ten bolt annular plate installations and consolidating research from previous studies done at the University of Florida. Design criteria for evaluating strength and serviceability were to be developed by combining all of the research data.

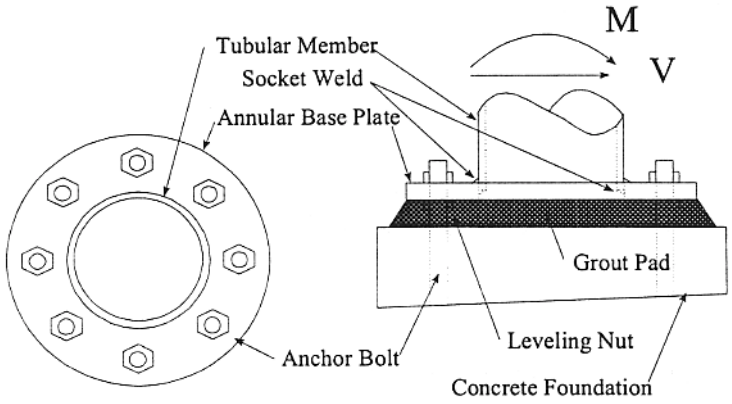

Figure 1.1 – Typical annular base plate with grout pad

FINDINGS AND CONCLUSIONS

This research followed two previous experimental studies (Cook et al. (1995) and Cook et al. (2000)) and an analytical study (Cook et al. (1998)). The Cook et al. (1995) study was initiated to evaluate the strength and general behavior of annular base plate connections subjected to an applied moment. This study was initiated to develop a method to determine the required base plate thickness. Researchers conducted tests on ungrouted annular base plates with four, six, and eight anchor bolts. Researchers investigated several behavioral models, including both elastic models based on plate theory and models based on yield line analysis. Overall, structural rotations due to deformations of both the anchor bolts and base plate were not a primary consideration during the course of this study. Based on the results of the Cook et al. (1995) study, researchers determined that the overall deflection of the annular base plate structure was dependent on both anchor bolt and base plate deformations, as well as deformations of the attached structural member; hence the Cook et al. (1998) finite element study.

This study investigated annular base plate systems representative of the size of systems typically specified by FDOT and of the size of those tested in the Cook et al. (1995) study. The result was a recommendation to evaluate the contribution of both anchor bolt and base plate deformations to the overall displacement of the annular base plate system. In the Cook et al. (2000) study, the effect of grout pads relative to both structural behavior and protection from corrosion was investigated. The results of this study indicated that protection from corrosion is significantly improved with the addition of a grout pad. Researchers suggested recommendations for evaluating both the strength and serviceability behavior of ungrouted and grouted annular base plates.

As a result of this study and the previous studies, researchers have concluded that both the strength and rotational stiffness of the annular base plate are highly indeterminate. For the determination of the required base plate thickness, several approaches were investigated. The approach providing the best relationship to test data was based on a yield line method developed by Mr. Marcus Ansley, the FDOT Project Manager. In order to determine the distribution of load to the anchor bolts, researchers found that the assumption of an elastic distribution of load provides an excellent correlation with test results. From a serviceability perspective (i.e., structural rotation due to deformation of both the anchor bolts and annular base plate), the prediction of rotation is extremely difficult to determine from experimental results due to the fact that the anchors may or may not be de-bonded over their entire length and that the behavior of the base plate is influenced by the performance of the socket weld between the base plate and the structural member.

Cook et al. (2000) recommended a method for evaluating the contribution of the annular base plate and anchor bolts to the overall structural deflection that was based on a rationally developed model, empirically adjusted to reflect both analytical results and test results. The method recommended in Cook et al. (2000) was used to evaluate the test data for the ten bolt annular base plate systems tested during this study. The results of this evaluation indicated that the recommended method for determining the rotation due to deformations of the anchor bolts and annular base plate was conservative when compared to the test results.

This research project was conducted by Ronald A. Cook, Ph.D, P.E., at the University of Florida. For more information, contact Marc Ansley, P.E., at (850) 414-4291, marc.ansley@dot.state.fl.us