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Design Methodology of Base Plates with Column Eccentricity in Two Directions under Bidirectional Moment

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Abstract

Base plate is a critical structural component responsible for transferring loads from the structure to the foundation. By increasing the contact surface between the column foot and the foundation, base plates contribute to more manageable distribution of column forces and the resulting stresses in the substructure. The off-center positioning of column on the base plate, which is sometimes unavoidable because of the limitations imposed by elevator shaft, adjacent buildings, etc. could be a major design issue. This paper investigates the effects of column eccentricity on the design and stress distribution of base plates and the impact of stiffeners on the thickness of these plates. In this investigation, a comparison is made between the superposition method and the finite element method in terms of their evaluation of stress levels under the base plate with column eccentricity. The study also aims to determine the magnitude and distribution of maximum stresses with plate's thickness and dimensions and column's position on the plate taken into account. The results show that the superposition method can be confidently used in the force analysis and design of base plates with column eccentricity under bidirectional moments.

Keywords: Base Plate; Bearing Stress; Stiffener; Finite Element; Foundation; Cracking.

1. Introduction

Base plates are the structural components responsible for the transfer of loads from columns to the foundation. Basically, a base plate increases the area of contact between a column and its underlying foundation, thus allowing the designer to control the distribution of column forces over the concrete surface. It is typical to use anchor bolts on base plates for transferring lateral forces and employ stiffeners to reduce the thickness of the plate. The majority of studies in this field utilize either software models or laboratory models in their investigations. What seems to be lacking in these studies is an effort to derive a formula or coefficient for more consistency between the numerical and experimental models. The divergent behavior of the components of column-base plate connections (i.e. column, base plate, anchor bolts, and concrete foundation) can complicate the structural analysis of these connections. Past studies on base plates have utilized both experimental and numerical approaches. In 1970, Fling used the yield line theory for the analysis of base plates. He obtained some limits for the displacement between the plate and the foundation provided that the plate bending remains in the elastic region. Ultimately, he concluded that the method requirement (that the plate bending should remain in the elastic region) make this a conservative method [1]. In 1975, Stockwell investigated the replacement of a rigid base plate with a flexible one and concluded that the uniform bearing pressure below the base plate is not a

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