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A Numerical Investigation on Behavior of Column Base Plates with Different Configurations

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Abstract

Base plates are one of the most important types of connections in structures. Due to complicated steel-concrete interaction, simple assumptions of the stress distributions are usually employed for designing the connection. Simple assumptions of compressive stress distribution in concrete may accelerate the design procedure, but they may lead to overdesign results. In this study, six different types of base plates with different configuration were studied numerically using a commercial Finite Element (FE) software and the numerical model was calibrated with an experimental test. The models were subjected to a constant axial load and then a monotonic moment loading was applied. To investigate the effects of the axial load, several axial load level were considered for each configuration. As a result, moment-rotation curves of these base plates, including their rotational stiffness, in the absence and presence of the axial loads, were compared. Moreover, the stress distribution in the concrete was studied in the FE models. For all cases, the stress distribution in the concrete was semi-triangular with the maximum stress between the column flange and the edge of the plate. Based on numerical results, some concepts of simplified assumptions were proposed to find the stress distribution of the base plates. These assumptions are more realistic than current assumptions in structural specifications.

Keywords: Base Plate; Column Base; Concrete Damage Plasticity; CDP; Stress Distribution; Finite Element Modeling.

1. Introduction

Base plates, as particular types of connection, is used to connect the columns to the foundations and distribution of loads. When the column is subjected to a moment, the base plates resists the applied moment by the development of tensile and compressive forces. The compressive force is transferred to the foundation by concrete and the tensile load is carried by the anchor bolts. To distribute the loads of column to the concrete of the foundation on a larger area, a steel plate named base plate can be used.

It is necessary to point that analyzing and determining loads in the structures are related to its boundary conditions, and base plates as the support of the structures, may affect the calculated forces. On the other hand, to design a base plate, applied loads should be known. This means primary design and analysis of the structures are related and an iterative procedure must be employed to achieve an economical and safe design. Therefore, determination of the resistance and the behavior of the base plates are important based on the following reasons: 1) Determination of the base plate rotational stiffness represents the support conditions that have a significant effect on the load distribution. 2) The rigidity of the base plate influences the total displacement and drift of the structure and wrong estimations may cause exaggerated deformations. 3) Effective length and consequently the critical load of the columns in the first floor is a

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