Effects of Corrosion on the Capacity of the Nib of Reinforced Concrete Dapped-End Beams

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Abstract

Many studies have been conducted in the past decades to determine the impact of corrosion on public infrastructures such as bridges, due to the deterioration that has been witnessed since their construction, sometimes very early in their working life. This degradation has caused collapses, not only leading to economic losses but also provoking human casualties. The layout of certain structural elements complicates the inspection and maintenance processes, by creating tight spaces or blocking the access to certain surfaces. This is the case for dapped-end (half-joint) beams, whose height at the extremities has been shortened to create a support, called a nib, reducing the floor height and allowing the placement of an expansion joint. However, water can seep into this joint and stagnate on the lower nib if the drainage system and waterproofing are not adequate. During winter, when de-icing salts are spread on roads, this water becomes charged with chloride ions, which are the leading cause of corrosion in reinforced concrete structures. The purpose of this research is to numerically evaluate this reduction, using a non-linear finite-element analysis that is able to represent an evolving crack pattern taking into account both mechanical degradation due to loading and degradation caused by environmental factors.

Keywords: corrosion; dapped-end beams; durability; nonlinear numerical analysis; finite element modeling.

1 Introduction

A dapped-end beam (DEB), or half-joint beam, is a type of beam frequently used in precast construction, whose section has been reduced at the extremities to create a support, see Figure 1. While this geometry allows for a reduced floor height, easier assembly and a greater lateral stability compared to beams supported at their bottom face [1], it creates a locally disturbed region which relies heavily on its reinforcement to transfer the stress into the full depth of the beam.

The major difference between the stress flow inside the nib of a dapped-end beam and a typical corbel is that while the inclined compression force is transmitted to the column in the case of the corbel, for a DEB this force must be resisted by a tensile force in the vertical reinforcement close to the full-depth face of the beam, as illustrated on Figure 2.

To satisfy equilibrium, this tensile force must be equal to the vertical shear force V acting on the nib. A group of stirrups should be placed close to that interface to resist this component, and be correctly anchored to the longitudinal reinforcement. Two typical reinforcement layouts are presented on Figure 3.

The experiments of Mattock and Chan [1] on DEBs revealed that the nib can be designed as a corbel

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