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An experimental study of crack development in flexural reinforced concrete members

Annette Beedholm Rasmussen, Bjarke Würtz Sørensen, Mikkel Skov, Peter Kolt Rasmussen, Lars German Hagsten

Aarhus University, School of Engineering, Denmark

Contact: abra@ase.au.dk

Abstract

This paper presents the results of an experimental program of eight reinforced concrete beams carried out in order to investigate the development of cracks related to flexure. To be able to investigate possible size effects with respect to cracking, beams of two different depths were tested. The crack development was continuously measured based on digital image correlation. From observation of the tests, two crack systems was identified; the primary flexural cracks and local secondary cracks. The development of these two crack systems with respect to increasing load, within the service load range, was analyzed and illustrated. The analysis showed different characteristics for the two crack types depending on the depth of the members. The measured average crack spacings and crack widths of the the primary flexural cracks showed a linear proportionality to the member depth. The measured crack spacings, for both crack systems, were compared to existing tests as well as selected models estimating flexural cracking.

Keywords: cracking in flexural members, modeling of reinforced concrete, serviceability, spacing of cracks, test results, width of cracks.

1 Introduction

The behavior of reinforced concrete structures under service loads is, among other things, highly dependent on the reinforcement layout and concrete geometry. Our design of structures often becomes reliant on serviceability requirements, where reinforcement is sometimes added to meet them compared to the strength requirements.

To be able to predict serviceability conditions (e.g. crack widths, stress levels and deformations) knowledge of the development and location of cracks is important. When consulting existing literature, it appears that a majority of the models addressing the development of cracks, in members subjected to primarily flexure, are empirical or are derived from mechanisms observed from test of uniaxial tension members. The models mainly address only one system of cracks, whereas two different systems have been identified through experimental studies [1-3]. In these studies, the two different cracks systems is particularly evident in deep beams where a distinction is made between cracks penetrating to the position of the neutral axis and minor cracks forming around the longitudinal reinforcement.

The following experimental investigation, aims to contribute to a better understanding of the behavior with respect to crack development in flexural members subjected to service loads, to create a basis for a sound and economical reinforcement and concrete design.

2 Reinforced concrete beam tests

2.1 Test specimens

Tests of eight simply supported beams, subjected to two symmetrically placed forces, were performed [4]. The geometry and reinforcement layout is sketched in Fig. 1 and the properties are listed in Table 1. Two identical beams were tested for each of the specimen types in Table 1.

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