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Assessing the Impact of Improper Placement on Reinforced Concrete Beam Behaviour

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Abstract

The recent construction booms in Dubai and China have often required the use of unskilled labour, which can lead to defects in the structure such as voids in reinforced concrete members. The goal of this research was to use sensors to explore the impact of poor concrete placement on reinforced concrete behaviour. Two beam specimens were constructed: a control, which was well vibrated, and a defective beam, which was not well vibrated resulting in extensive voids. Distributed fibre optic strain sensors were installed on both the longitudinal and transverse reinforcement bars. Digital image correlation was used to track crack development. It was found that the poor concrete placement had no impact on stiffness, capacity or failure mode. The distributed strain and digital image correlation data highlighted subtle differences in strain and cracking behaviour between the two specimens.

Keywords: reinforced concrete, beams, fibre optic sensors, digital image correlation, honeycombing, construction defects.

1 Introduction

Historically infrastructure development tends to happen in cycles where during peak times there can be a shortage of skilled construction labour and site supervision. This in turn can result in construction defects such as honeycombing and even voids in reinforced concrete. Examples of this exist in North America for structures that were built in the post war construction booms of the 1940s and 50s. For example, Figure 1 shows a reinforced concrete beam with poor concrete placement including areas where the reinforcement is visible. This lack of construction quality control has also been prevalent in more recent infrastructure booms such as the development in China that started in the 1990s [1]. Much research has been carried out as to the reasons for this lack of construction quality control [1] but there is limited research about the impact of it on structural performance. This is perhaps because with proper quality control, large defects should be eliminated, however as illustrated by Figure 1, this is not always the case.

Honeycombing and larger voids could affect the behaviour of an RC beam in a number of different ways. These include reducing the flexural strength, stiffness, ductility, and resistance to chloride ingress as well as altering the beam's behaviour in terms of reinforcement bond, stress distributions, cracking, and even failure mode. While load and deflection measurements from beam tests enable the effects on strength, stiffness, and ductility to be quantified, localized effects such as bond loss, stress distribution, and cracking are more difficult to quantify.

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