Distributed fibre optic sensor system to measure the progressive axial shortening of a high-rise building during construction

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Abstract

A novel approach is being used to measure the progressive axial shortening of key structural elements of Principal Tower, a 50-storey reinforced concrete building in London, as it is being built. Distributed fibre optic sensor (DFOS) cables are embedded inside two columns and two core walls, from which the axial strain profile can be measured along the whole height of the constructed elements. Measurements are being taken regularly throughout the construction process, making it possible to observe the change in strain, and thus the axial shortening, within these elements, at any stage of the construction. This helps the design engineers and contractor verify the predicted differential shortening and adjust the column height presets if necessary. The purpose of this paper is to describe the monitoring system and to present initial data recorded from the first five levels of the building.

Keywords: axial shortening; differential shortening; high-rise; tall buildings; jumpform; monitoring; distributed fibre optic sensors; Brillouin sensing; Brillouin optical time domain analysis (BOTDA).

1 Introduction

Axial shortening of vertical load-bearing elements is a critical parameter in the design and construction of reinforced concrete high-rise buildings. Differences between the shortening of adjacent columns, and between the shortening of columns and shear core walls, give rise to additional forces in the connecting floor slabs and beams [1], which need to be catered for in the structural design. Differential shortening can also damage non-structural elements such as finishes, external cladding, mechanical services and partition walls, if these are not installed with sufficient tolerance and inbuilt flexibility [2]. Therefore, it is important to have an *a-priori* understanding of the long-term site-specific behaviour of the structural members, in order to

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