The use of SHM to monitor and evaluate bridge movements – absolute and accumulated – at the structure's bearings and expansion joints

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Abstract

The movements a bridge experiences, both absolute and accumulated over time, can significantly influence the structure's life-cycle performance – especially as it relates to the components that facilitate these movements. Structural health monitoring (SHM) systems, with sensors placed at – or ideally, integrated in – a bridge's bearings and expansion joints, can be used to efficiently record and evaluate these movements, facilitating continuous monitoring of the components' and the structure's performance over time. This can enable potential problems to be recognised at an early stage, and maintenance (e.g. replacement of "wear parts" such as sliding materials) to be optimised. The significance of the frequency at which measurements are recorded must be appreciated, as high-frequency data can capture micro-movements (e.g. due to wind or traffic) that far exceed the slow thermal movements. This paper explores this topic with reference to a number of case studies.

Keywords: SHM; bridge bearings; expansion joints; absolute movements; cumulative movements; monitoring; wireless; LoRa technology.

1 Introduction

Since bridges with significant span lengths are generally equipped with bearings and expansion joints to enable their superstructures to move, thereby avoiding the build-up of large destructive forces, the movement behaviour of bridges at these key components is a significant factor in terms of ensuring the ongoing safety and proper functioning of the bridge, and of the components in particular. Of course, this is true with respect to the absolute movements facilitated by the bearings and expansion joints at any point in time (even during unforeseen events such as earthquakes), which must not exceed the maximum movements for which these components have been designed – since doing so would likely result in severe damage to the component and could jeopardise the bridge and its users. But it is also true with respect to the accumulated movements that build up over time, as the superstructure's movement gaps continually open and close, day after day, due to thermal expansion/contraction and other influences. Long-term, accumulated movements are particularly relevant in terms of their impact on the bearings and expansion joints themselves – which typically accommodate the movements by means of deformation of rubber parts or by displacement at specially designed sliding interfaces (Figures 1 to 4) – since the repeated movements slowly but surely cause deterioration of the relatively soft materials that accommodate the desired deformations or sliding movements.

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