



Damage detection in prestressed concrete bridges using moving-loads

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Summary

This paper focuses on the condition assessment and the early damage detection in bridges. The main objectives are to discuss the “in-service” behaviour of reinforced and prestressed concrete bridges under moving-loads and to assess the feasibility of detecting damage such as prestress-losses using moving-loads data. A reduced-scale laboratorial model of a reinforced and prestressed concrete frame was chosen as the case study. Firstly, the baseline condition, in which the structure is assumed to operate normally, is thoroughly characterized. The prestressing strands tensioning was monitored and the results are carefully analysed, and the structural response of the frame under moving-loads is discussed. Second, a 15% prestress loss has been prompted and the structural response recorded under moving-loads in this damaged condition is used to demonstrate the feasibility of detecting the structural condition change based on moving-loads data.

Keywords: Structural health monitoring; concrete bridges; moving-loads; non-linear behaviour; prestress losses; damage detection; laboratorial model.

1. Introduction

Bridges are susceptible to structural damage due to many factors, such as, ageing, operating loads, fatigue, corrosion and unforeseen defects, both internally and externally. Therefore, ensuring the integrity and safety, and a cost-effective management of structures is of paramount importance [1]. In this context, over the last three decades, the evaluation of the structural condition as well as the monitoring of bridges has been given a huge attention [2].

This paper focuses on the condition assessment and the early damage detection in reinforced and prestressed concrete bridges. Among the problems that may arise in this type of structures, the prestress losses are one of the most critical. The possibility of avoiding permanent cracks, leading to the improvement of both the durability and the overall stiffness of the structure, is one of the major advantages of prestressed structures [3]. Therefore, a significant prestress loss may lead to severe problems in the serviceability and safety of the structure. In this work, the structural condition assessment is mainly based on moving-loads data. The variation of the response due to a truck or carriage traversing a bridge, presented, in general, graphically in the form of influence lines, provides significant information as regards its structural behaviour. Thus, these data may play an important role for characterizing the structural condition of a bridge as well as for early damage detection [4].

A reduced-scale laboratorial model of a reinforced and prestressed concrete frame was chosen as the case study for the research presented in this paper. The main objectives are to discuss the “in-service” behaviour of a reinforced and prestressed concrete structure under moving-loads and to assess the feasibility of detecting prestress losses using moving-loads data. First, the results of the prestressing strands tensioning are presented and discussed. Thereafter, the structural behaviour of the frame under moving-loads is evaluated. Finally, the response after a 15% prestress loss is collected and the feasibility of detecting damage based on the comparison of the moving-loads data obtained in both structural conditions is demonstrated.