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Detection of trainloads of suspension bridges with bridge responses: a comparative study using displacement and stress

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ABSTRACT

Trainloads play an essential role in the fatigue life of railway bridges as they cause important repetitive stress cycles at critical locations. Therefore, estimating such loads is relevant for preventive maintenance plans. This paper investigates an approach to detect trainloads using responses of the bridge, such as displacement and stress. Firstly, the temperature-response correlation is investigated to assess the influence of possible effects on the detection. Secondly, two response characteristics are proposed to detect trainloads: amplitude and duration. Statistical analysis of the two characteristics is then conducted to get the statistical distributions for both displacement and stress responses. Thirdly,
a multi-step detection procedure is applied to detect the trainloads. A road-rail suspension bridge is introduced as the case study, which monitoring system includes sensors for temperature, displacement, stress, and a train weigh-in-motion (WIM) system. The study of trainload detection in this paper can provide guidance for the predictive maintenance of bridges to avoid premature damage.

Keywords: Trainloads; displacement; stress; weigh-in-motion; statistical analysis.

1 INTRODUCTION

Trains have carried passengers and cargo to various destinations since their invention more than one hundred years ago, thus facilitating our society's daily life and economy. The railway network extended to more areas thanks to the spanning capacity of bridges over rivers, valleys, etc. During the service life of railway bridges, trainloads should be carefully evaluated to consider capacity and fatigue issues.

Static weighing is widely adopted at highway toll collection stations to obtain roadway vehicle weight. Still, it implies interrupting the traffic, and it is rarely adopted on the railway. Meanwhile, weight in motion (WIM) has developed extensively in recent years as it provides vehicle weight and velocity information without affecting the traffic flow (Cantero 2021; Chen et al. 2021).

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