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Defining rail track input conditions using an instrumented revenue vehicle

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Abstract

To model the dynamic response of a train running over a given length of rail, the input conditions must be adequately defined. This paper explores the use of an instrumented rail vehicle to assist in the definition of this input condition. The benefits of using instrumented rail vehicle for condition assessment of track and rolling stock are gaining popularity. Railway track and rolling stock condition monitoring is essential in ensuring the safe and efficient function of railway systems. The ability to use an instrumented revenue vehicle for the condition assessment of rail tracks is particularly significant because this capability will not require track access during inspection. This instrumented vehicle can also provide useful data for the definition of the rail track input conditions for the assessment of the stability of a rail vehicle when traversing along the track. This information can be used to establish the wagon speed limits to ensure safe operation of the asset. To be able to predict the dynamic response of a rail vehicle, the dynamic input conditions imposed by the track will need to be identified. This paper will discuss some initial studies on the use of an instrumented rail vehicle to define the input conditions imposed by the rail track. The ability to define the rail input conditions is demonstrated by associating the results with features on the track that are identifiable.

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1. Introduction

Tracks are “continuous” linear assets that are distributed over a region [1]. They comprise several components including rails, sleepers, rail clips, ballast and sub-ballast. The maintenance of these assets is expensive given that this asset is expected to cover a large area. A well maintained ballast is crucial for the safe operation of trains [2]. Similarly,

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the operating conditions of rail tracks is critical for safety. This has led to the development of on-board monitoring strategies [3-6]. These works lead to a very real practical solution for the monitoring of these continuous structures because they offer the potential of mounting monitoring equipment on board an operating vehicle or wagon [7-8]. The ability to relate the dynamics of the rail vehicle as it travels along a given length of track can facilitate the development of monitoring tools to assess track geometric irregularities [8-9] and the ballast conditions [10-11].

The stability of a rail vehicle when traversing along a track is dependent on the state of the rolling stock, the rail track and the ballast (subgrade). Information about the dynamic response of the rail vehicle can be used to determine the state of the vehicle/rail interaction. This information can be used to establish the wagon speed limits to ensure safe operation of the asset [12-13]. To be able to predict the dynamic response of a rail vehicle, the dynamic input conditions imposed by the track will need to be identified. Given the continuous nature of rail tracks, the idea of being able to classify this input using an instrumented rail vehicle is attractive. This is because data collection of this nature will not interrupt normal train operation and will have zero impact on the revenue of the rail car. Indeed, there now numerous efforts to achieve this [13] & [14]. The economic and engineering benefits of using an instrumented revenue car cannot be overstated.

Monash University (Australia) and the Institut Teknologi Sepuluh Nopember (Surabaya, Indonesia) is collaborating on a project for the management of rail assets. This project involves the Australian Rail Track Corporation, Indonesian Rail (PT KAI) and East Java Government Office for Land Transportation (Dinas Perhubungan). This paper will report on one of the foci of the collaboration. The aim of this paper is to demonstrate the use of an instrumented passenger vehicle to classify the input condition imposed by the rail track on the train. The results presented will show the sensitivity of this input conditions imposed by features of the track (i.e. level crossings and bridges). The ability to define the track input is compared with physical track features that are clearly identifiable.

2. Instrumented Rail Vehicle (IRV)

The IRV sensor package was installed onto a single passenger rail car scheduled to make repeated round trips between Surabaya and Lamongan. The IRV travelled on two separate tracks; North Track (towards Lamongan) and South Track (towards Surabaya) each track is about 40.8 km in length. The IRV was running normal operations including stopping and starting at stations (seven stations on each track) and taking on passengers. The rail vehicle was instrumented by engineers from the IRT. Figure 1 shows the rail vehicle that was instrumented for this work. The instrumentation was installed on the front vehicle. All cablings were routed into the driver cabin in the front and were connected to the SOMAT data collector.

Fig. 1. Vehicle used in this project.

The accelerometers, Acc1, Acc2, Acc3, and Acc4, were uni-axial accelerometers recording vertical (z-direction) acceleration only. These accelerometers were mounted on the unsprung mass of the vehicle and will be sensitive to varying track and wheel conditions. A GPS was also located on the rail vehicle to identify its position during the test-runs. The acceleration data along with its GPS location will be used to identify the location along the track associated with the vibration levels. When on the North Track, Acc1 and Acc4 will be on the leading section of the train. Whilst