HAUL-ROAD DEFECT IDENTIFICATION USING MEASURED TRUCK RESPONSE

by Stephan Heyns

Opencast-mine haul-road maintenance is traditionally done at scheduled intervals or after regular inspection. Both these methods can lead to unwarranted expenditure, either through over-maintaining the road, or failure to recognise significant deterioration, resulting in an increase in vehicle operating costs. Predictive maintenance management models for unpaved roads have been developed in recent years. These methods work well for simple cases where variables such as traffic volume can be accurately predicted. However, many mining systems are too complex for such models to be effective, and maintenance management systems for public roads are not easily transferred to mines, which use some of the largest wheeled vehicles on earth. A typical ultra-heavy haul truck is depicted in → 1.

→ *1. Typical haul truck used during opencast mining operations*

A research project - in which mechanical, mining and civil engineers in the School of Engineering joined forces - investigated the possibility of using measured haul truck response to aid with haul-road maintenance management.

The approach adopted for the study was twofold: First, can measured truck response data be used to recognise specific road defects, in terms of location, type and size? This is important since different defect types require different road maintenance strategies. Second, can road roughness be measured on a qualitative basis? If this could be done on an online basis during the normal operation of the vehicle, it could become feasible to link the system to the onboard Global Positioning System and automatically summons maintenance teams to areas on the road in need of maintenance. A mathematical modelling approach was adopted. The truck was characterised in terms of its suspension and tyre properties. Dynamic truck response data were acquired during elaborate field measurements in which the truck was driven over artificially constructed defects of known dimensions. With these data sets available, detailed mathematical modelling and simulation studies became possible.

Quarter and seven degree-of-freedom truck models were utilised to study the vehicle dynamics and fundamentally understand the nature of the measured responses. Based on these investigations a modelling approach that was based on the dynamic equilibrium of a front wheel of the truck was adopted. Using measured suspension forces, the vertical tyre force and eventually the road geometry could be calculated. This proved that defects could be reconstructed from measured truck response data with accuracy sufficient to fulfil the requirements of defect recognition for road maintenance management purposes. → 2 illustrates three actual road defect profiles and the corresponding profiles reconstructed from measured truck response.

Second, a preliminary investigation into the qualitative assessment of road condition via truck response measurements was conducted. The inherent response properties of the truck pertaining to road roughness measurements were studied and a fair degree of correlation between measured suspension motion and road roughness (measured with a high speed profilometer) was found. Although further investigation is required, this indicates some potential in the use of truck response measurements for continuous road roughness assessment.

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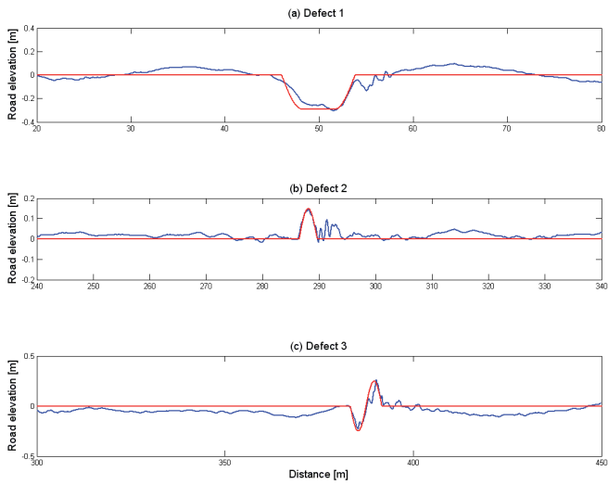

→ *2. Typical comparison between measured and reconstructed road defect geometries.*