

IDENTIFYING THE TRANSITION SOLUTION OF MOVING INERTIAL OBJECTS BY OPTIMIZATION TECHNIQUES

Zuzana Dimitrovova

IDMEC – Instituto de Engenharia Mecânica

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Abstract

Simplified models of the railway track remain widely used due to its simplicity, computational efficiency, and reasonable approximation of real behavior. When subjected to moving inertial objects, the solution in transformed domain can be obtained in an analytical way, however, time-domain response usually requires numerical approach. In certain cases, it is possible to identify the so-called mass-induced frequencies, corresponding to poles of function to be integrated in inverse Laplace transform, allowing the complete solution to be accurately approximated by unsteady-harmonic motion, except within a small region near the initial stage. In the absence of damping, one might expect the unsteady-harmonic motion to exhibit a constant amplitude, as observed in a one-layer model. However, this does not occur due to energy redistribution caused by point masses within the supporting structure. In such situations, the induced frequencies do not exist because of a step discontinuity in the equivalent flexibility of the supporting structure within the region where they would otherwise appear. Nevertheless, the resulting time series still resemble harmonically damped oscillations.

In damped cases, there are also many cases where the mass-induced frequencies do not exist due to the discontinuities in the equivalent flexibility of the supporting structure. These discontinuities are affecting only stable solutions, and many papers are directed to identify instability, so that these facts seem to be of less importance. Nevertheless, it is also necessary to deal with such cases.

This study demonstrates that the final vibration can be identified by optimizing the local energy comparison combined with an estimation of the real part of the induced frequency associated with the final vibration. Furthermore, the results are compared with models assuming a plane foundation, illustrating the expected differences when the foundation mass is treated as either a distributed parameter or a set of lumped rigid masses. These relationships provide useful insights for improving the design of railway tracks.