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Letters to the Editor

Comments on Chapter 12 of “Railway Noise and Vibration: Mechanisms, Modelling and Means of Control”, by D. Thompson (with contributions from C. Jones and P.-E. Gautier), Elsevier, 2009

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Abstract

In this "Letter to the Editor", it is detailed how Chapter 12 of the book "Railway Noise and Vibration: Mechanisms, Modelling and Means of Control", by D. Thompson (with contributions from C. Jones and P.-E. Gautier), Elsevier, 2009, offers a rather incomplete review of the topic of the generation of ground vibrations by high-speed trains, in particular by trans-Rayleigh trains. As a result of this limited review, readers unfamiliar with the history of the problem will gain an incorrect impression of the topic and a rather incomplete knowledge of past work on it. This letter attempts to supply a more appropriate review.

The aim of this Letter is to point out deficiencies in the review of previous work in Chapter 12 of the book [1] authored by David Thompson (with contributions from Chris Jones and Pierre-Etienne Gautier). The book was reviewed in *Applied Acoustics* in 2010 (see Ref. [2]). Chapter 12 of this book, "Low Frequency Ground Vibration", is authored by Chris Jones and considers generation of ground vibrations by high-speed trains, among other issues (see Pages 406-426). This includes the important effect of the very large increase in the level of generated ground vibrations that takes place when the train speed exceeds the Rayleigh wave velocity in the ground. In discussing the theory of this phenomenon, only a number of publications authored by X. Sheng et al. are cited starting from a paper [3] that appeared in 1999. However, the history of research into this and related phenomena had begun much earlier.

The first theoretical work considering dynamic rail deflections under impact of a moving load has been published in 1926 by Timoshenko [4] who modelled a track as a beam on an elastic foundation. De Nie [5] was the first to make experimental observations of large rail deflections and to publically raise the issue of critical speed of trains on soft soil. Theoretical investigations of this phenomenon have been further developed by a number of researchers, notably by Kenney [6] and Fryba [7].

The problem of Rayleigh and bulk wave generation in an elastic half-space by moving surface forces attracted attention of numerous researchers in respect of different practical applications (see e.g. the above-mentioned monograph [7]). In particular, Cole and Huth [8] have published the solution for a homogeneous elastic half-space excited by a moving load for the sub-, trans- and super Rayleigh speed conditions. Werkle and Waas [9] presented the solution for the response of a ground to moving loads formed by air pressure pulses (blasts),

which is relevant to the problem of railway-generated Rayleigh waves as well. One should mention also the work of De Barros and Luco [10] who presented rigorous solutions for loads moving along a layered half-space.

The first prediction of a large increase in ground vibrations generated by trans-Rayleigh trains (later named a "ground vibration boom") was published in 1994 [11]. A more detailed publication appeared in 1995 in *Applied Acoustics* [12]. In subsequent predictions [13, 14] the effect of track bending waves on generated ground vibrations was taken into account. Also the effect of layered ground structure was predicted [15] before the work reported in [1] .

A ground vibration boom was observed for the first time in October 1997 on the newly opened high-speed railway line from Gothenburg to Malmo in Sweden. In particular, in the location near Ledsgard, the Rayleigh wave velocity in the ground was only about 45 m/s, so that an increase in train speed from 140 to 180 km/h lead to about 10 times increase in generated ground vibrations, which was in line with the above-mentioned theoretical predictions. The first publication about the experimental results at Ledsgard was presented in 1998 by Madshus et al. [16] who worked on behalf of the Swedish National Railway Administration (Banverket). A more detailed report from Banverket written by Adolfsson et al. [17] appeared in 1999. Comparisons of the experimental results [16, 17] with the above-mentioned theoretical predictions [11-15] showed that they were in good agreement ([18, 19]).

Rather than to provide a complete list of the numerous publications in this area, the intention of this Letter is to draw attention to the fact that the main results and milestones concerning the theoretical prediction of ground vibration boom from high speed trains [11-15] and its experimental confirmation [16, 17] are neither mentioned nor explained in Chapter 12 of the book [1]. This is despite the fact that paper [12] is quite well-known to specialists in railway noise and vibration and is cited in the above-mentioned paper of Sheng et al [3].

Moreover the priority of the results in paper [12] is acknowledged in [3] where Papers [15, 16] are cited also.

In conclusion the author of this Letter believes that better use could have been made of the opportunity presented in writing chapter 12 of the book [1] to give a more complete account of previous work. It is hoped that this Letter will enable readers of the book [1] to widen their knowledge of the topic of low frequency ground vibration due to high speed trains.

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