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Noise and vibration from high-speed trains

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Noise and vibration from high-speed trains

Edited by

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Preface

During the last decade, high-speed railways have become one of the most advanced and fast-developing branches of transportation. The reasons for this are the relatively low air pollution per passenger, compared with road vehicles, and the very high speeds achievable by the most advanced modern trains – French TGV, Eurostar, Thalys, the German ICE, British high-speed trains, the Italian Pendolino, the Swedish X2000, the Japanese Shinkansen, etc. For example, for French TGV trains a maximum speed of more than 515 km/h was achieved in May 1990, and speeds close to 300 km/h are now typical for commercially used TGV and Eurostar trains. Prospective plans for the year 2010 assume that the New European Trunk Line will have connected Paris, London, Brussels, Amsterdam, Cologne and Frankfurt by a high-speed railway service that will provide fast and more convenient passenger communications within Europe. Similar plans are being developed in the USA and Japan. All these make high-speed railways increasingly competitive with air and road transport at short and medium distances.

Unfortunately, when train speeds increase, the intensity of railway-generated noise and vibration generally becomes higher. And this represents a major environmental problem for nearby residents, schools and hospitals. Railway operators and local authorities need to be familiar with those new aspects of railway noise and vibration which are associated with high-speed trains. Almost all known mechanisms of generation of railway noise and vibration are speed dependent. These include both wheel/rail rolling noise and aerodynamic noise, the latter being important for train speeds higher than 300 km/h. This applies even more so for generated ground vibrations. For example, when train speeds exceed certain critical velocities of elastic waves propagating in the ground or in the track/ground system, new mechanisms of generation of ground vibrations may appear, in addition to those already known for conventional trains. In particular, a very large increase in generated ground vibrations may occur if train speeds exceed the velocity of Rayleigh surface waves in the ground. If this happens, a *ground vibration boom* takes place, similar to the sonic boom normally associated with supersonic aircraft. The first observation of a ground vibration boom took place on the recently opened high-speed railway line in Sweden. This line was built on very soft soil, with Rayleigh wave velocities as low as 45 m/s. This is why an increase in train speed from 140 to

180 km/h was sufficient for the phenomenon to be observed, thus indicating that ‘supersonic’ or (more precisely) ‘trans-Rayleigh’ trains have become today’s reality.

There are many other new physical effects and mechanisms of generation of noise and vibration which are specific to high-speed trains, for example the effects of train-induced non-linear pressure wave propagation in long tunnels, resulting in bursting noise radiated from the exit tunnel portals. In addition to these new effects, the ‘traditional’ mechanisms of generation of railway noise and vibration and their propagation from the source to a receiver demonstrate interesting new features and sometimes behave in a different way as train speeds increase. An example of this may be seen in the design of noise barriers for high-speed railway lines. Such barriers should take into account the spatial redistribution of noise generation mechanisms as train speeds increase.

Although some of the problems of noise and vibration from high-speed trains are being addressed in an increasing number of journal papers and conference proceedings, there is still no general reference book which could help a reader starting to study this problem to find answers to numerous theoretical and practical questions. The existing reviews concerning railway-generated noise and vibration deal largely with conventional trains and do not reflect specific high-speed problems. The present book, which consists of 14 chapters grouped into five parts, aims to fill this gap. It represents the views of leading international experts on the current status of the problems of generation and propagation of noise and vibration from high-speed trains and suggests possible ways of reducing their environmental impact. The book describes mainly the results of recent academic research and is pitched largely at an advanced level. In the light of this, it is assumed that the ideal reader will have a university background in engineering, physics or applied mathematics. At the same time, several chapters of the book have been written by railway noise and vibration practitioners. These chapters contain a lot of experimental data with interesting illustrations and can be understood by a less well-prepared audience.

The intended readership of the book is rather wide. It includes scientists and engineers working on the prediction and remediation of railway noise and vibration, environmental consultants investigating particular situations associated with the environmental impact of railways, local authorities, designers of new railway lines, etc. The book will also be useful to university students, railway enthusiasts and for members of the general public concerned with topical environmental issues.

Victor V. Krylov