Noise prediction and control for a Norwegian high speed railway

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Abstract. The first Norwegian 200 km/h railway is scheduled for operations in October 1998, using electric trains based on a modified Swedish X2000 design. Strict noise control criteria have been defined and extensive noise control measures are necessary both on the train itself and along the track. Prediction of future noise levels have played an important role in the planning process. The Nordic Prediction Method for Train Noise has been revised and improved to deal with new requirements. The method, the source data base and some important user experiences will be described.

THE METHOD

Acousticians, environmental authorities and transport administrations in the Nordic countries have cooperated for 20 years on development, revision and harmonization of prediction methods for outdoor noise sources.

The newly revised Nordic prediction method for railway noise is available as a computer programme and as a "manual" prediction procedure /1, 2/. The method deals with airborne sound in the octave bands from 63 to 4000 Hz, and provides procedures for determining outdoor energy equivalent levels and maximum levels for the criteria-related downwind/positive temperature gradient conditions. The sound propagation algorithms are more or less identical to those used for other noise sources in Scandinavian and various other European countries.

A frequency dependent source height is used, and the method includes emission levels for many different train types. A large number of source measurements have been done on trains in Denmark, Finland, Norway and Sweden. They have been normalized as speed dependent octave band levels. The data can be supplemented and revised according to given rules, or replaced by appropriate source emission limits for new trains.

The prediction method has been compared with field measurements. The method deals with uneven terrain and complex geometries in a fairly simple manner, and field tests are necessary to uncover non-obvious limitations. The results so far, indicate acceptable agreement in a number of situations. Two situations are covered here, one with reasonable agreement between calculations and measurements, and one which requires further investigations.

COMPARISON WITH FIELD MEASUREMENTS

A measuring procedure has been suggested in /3/. The prediction method can be used for high speed trains. At present, it is of particular interest to look at conditions related to the new high speed train line between Oslo and Eidsvoll in Norway (Gardermobanen). This double tracked line will serve the new Gardermoen airport, and is scheduled for opening this autumn. The trains will run at 200 km/h, and shall not exceed a maximum noise level of 88 dBA at a distance of 25 m, at this speed.

Systematic rail grinding and specially designed noise screens will be employed to secure adherence to the planning regulations in the future. Control measurement must be done under relevant atmospheric conditions and include a sufficient number of trains in each speed interval, for each train type.

Experience with the Swedish X2000 trains represents a useful background for checking the Nordic prediction method at speeds around 200 km/h, before results for the new trains become available. The method contains values for X2000, extracted from source measurements in 1994 /4/.
New measurements were carried out in 1995 on trains in regular traffic, as part of the development of a NORDTEST measuring procedure for railway noise, /3/. These measurements included a number of passages with the X2000 at speeds between 150 and 200 km/h. The measurements were carried out at a distance of 100m from a track running on an embankment approximately 1.7m above the surrounding terrain, under relevant meteorological conditions, /3, appendix/. These results provide suitable data for comparison with predicted values. A preliminary analysis indicates that the measurements give higher levels than the calculations. Further analysis is required to determine the cause of the discrepancy for this fairly simple geometry.

The screens and other construction elements along Gardermobanen have been specially designed, and differ from similar elements along the rest of the Norwegian rail network. The screen construction consists of a 2m high vertical part, with a sound absorbing surface on the source side. A 1m high glass part, tilted towards the track, is mounted on the top, to give a total screen height of 3m. The screen top is 3.5m from the centerline of the nearest track, measured horizontally. Preliminary tests, using present traffic as a noise source, indicate reasonably good agreement between predicted and measured values, for the critical positions 12-30 meters from the track. Noise reductions in the A-weighted energy equivalent level are limited to a maximum of approximately 15 dB. Further tests are planned with the new high speed train in operation.

REFERENCES


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