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SIXTH INTERNATIONAL WORKSHOP ON RAILWAY NOISE, 1998: A SUMMARY OF CONCLUSIONS

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The Workshop opened with a review of railway noise and vibration research and results since the last Workshop. The achievements resulting from the development of tools and methods to design solutions for rolling noise reduction were emphasized. The growing need for decision support systems to seek the most efficient application, in an economic sense, of solutions for different elements of the vehicle or track system was also stressed. © 2000 Academic Press

SESSION 1. ECONOMY AND STRATEGY

This Session was chaired by Peter Hubner of Swiss Railways (SBB). He is Chairman of Task Force Noise at the International Unions of Railways (UIC). He described the view of the German Ministry of Environment which stresses the need for stronger legal instruments for vehicle noise emission limits. Concrete proposals for limits, as well as the proposal for the introduction of sound power level as an indicator of noise emitted by trains, were then presented. The Swiss Railways experience in terms of cost–benefit analysis, combining different solutions to reduce noise, was also explained.

The UIC programme to reduce noise on freight trains was described. The programme is based primarily on the general acceptance of composite brake blocks which cause less wear on the wheel than the ones presently in use, and which would reduce rolling noise generation.

SESSION 2. SOUND AND VIBRATION GENERATING MECHANISMS

Session 2, chaired by Brian Hemsworth of the European Rail Research Institute (ERRI) was introduced by three plenary papers.

Rolling noise modelling was reviewed. It was shown that research in this field has been aimed at improving our understanding of the physics of the generating mechanisms, and developing and validating models in the light of practical experience. The evolution of simpler models whenever possible and the potential importance of current studies of wheel squeal and braking noise were also described. In the contributed papers, the complex behaviour of rail pads was once again evidenced.

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A survey of aerodynamic noise research was then presented, showing that despite the relatively recent concern about this type of noise following the introduction of high-speed trains, in-depth research was being carried out. The plenary paper was complemented by data on high-speed train cavity noise, including the noise created by the pantograph recess and intercoach spacing.

The potential for critical speeds to occur for high-speed trains running on soft grounds is causing concerns in Nordic countries, where ground-borne vibration modelling is again becoming relevant. Animated displays of recent models of ground-borne vibration were also presented during the poster session.

Ground-borne vibrations are becoming increasingly important and different practical problems arise in different countries, and specific studies or models are being developed for each particular case. A comprehensive modelling or strategy for ground-borne vibrations is still lacking and this may be a key issue for the future.

SESSION 3. TOOLS AND TECHNIQUES

This session attracted the greatest number of contributions, which reflects the growing need for models for noise and vibration for railways, as well as the number of specific tools which have been developed for addressing different problems in the railway noise sector.

3.1. NOISE SOURCE CHARACTERIZATION AND SEPARATION

This Session was chaired by Pascal Fodiman (SNCF), and opened with a plenary contribution which addressed the major current concerns in terms of railway noise measurement:

- measurement of train noise in repeatable and reproducible conditions (track parameters, if not controlled properly, may influence measured noise by up to 5 dB(A)),
- prediction, from measurements carried out on one track, of the behaviour on other tracks,
- ability to separate train and track contributions to total noise.

Contributed papers in the Session reported further studies on this subject, including the use of reciprocity methods to measure superstructure noise, and the development of specific methods for estimating track contributions to the overall noise. Improved array methods for noise measurement, including track radiation assessment, were also described.

3.2. NOISE BARRIERS

In this Session, chaired by Mathias Ringheim (Kilde Akustik), both the classical approaches to assess the performance of noise barriers (ray tracing versus

boundary elements) were discussed. The latest developments in each field were also presented.

3.3. GROUND VIBRATION

The first plenary paper in this Session, chaired by Carl Hanson (HMMH), reported a multi-national project carried out at ERRI to assist existing vibration mitigation projects by using existing modelling capabilities. There are still incompatibilities between empirical prediction models, and databanks are available but they are not yet standardized. Whilst sophisticated specific models have been developed in some research centres, an agreement on a common prediction tool would be helpful in the majority of practical situations. The problem, already complex in nature, is further complicated by the multiplicity of types of situations (for example, open track and tunnels with different designs) encountered in practice. Recent developments for specific cases were presented in the contributed papers and posters.

3.4. THEORETICAL ASSESSMENT

Assessments using theoretical models or standard tools (including TWINS for rolling noise) were presented in this Session chaired by Pierre-Etienne Gautier (SNCF). Railway sleeper acoustic optimization and methods to optimize wheel acoustics were presented. For example, resilient wheels with the potential to reduce both rolling noise and squeal, and a perforated wheel, were described.

During the discussion it was pointed out that wheel design for acoustic optimization had to take into account, not only the acoustic criteria, but also other criteria such as thermo-mechanical behaviour, and that compromises should be found, bearing in mind all the design constraints. As far as the track is concerned, assessment of embedded rail and designs leading to a potentially "silent" slab track were presented. The use of FEM and SEA to optimize vibration and noise for a Y25 bogie frame was also described.

The range of applications and the variety of tools described (either general purpose or dedicated FEM software) illustrates the number of theories and tools available to study noise reduction concepts for various components of the system. The key issue is, however, the integration of the vibration and acoustic dimension with the general, non-acoustical, optimization of components, where other constraints have to be met. Among the suggestions made during the discussion, the following can be highlighted:

- Validation of tools should be extended to include new designs such as slab track, high damping devices, shielded wheels, etc.;
- A TWINS databank and conference should be organized.
- Further developments of general tools such as TWINS should be validated to develop more efficient models.

SESSION 4. PERCEPTION

This session was chaired by John Walker (ISVR) and incorporated, for the first time in IWRN, a dedicated session on internal noise and passenger comfort.

4.1. INTERNAL NOISE

There is strong commercial pressure to reduce internal noise. Many sources are involved, as well as complex issues relating to noise and vibration generation and propagation through air and/or the structure, which is itself difficult to model, although efficient techniques either in terms of modal or SEA approaches were presented in some papers.

Appropriate assessment descriptors, such as dB(A) and others, were discussed, although no clear recommendations were proposed. There is also a need for a model to take account of other non-acoustical stimuli.

More generally, the most desirable spectrum shape needs to be defined in order to identify the "most acceptable" or "pleasantest" noise. There is also a need for acoustic annoyance indicators to be defined which would be effective for internal railway applications.

Research issues for the future for internal noise should include studies to assess the concept of total comfort, involving more than just the physical indicators for perception of the whole environment, including colour, space, temperature, etc., as well as noise and vibration. There may be a need for a European descriptor, or even standard, for internal noise.

4.2. COMMUNITY NOISE

The differences between road and rail annoyance, at equivalent levels of L_{Aeq}, as well as nighttime and daytime annoyance, were discussed. In addition, analysis of response to combined sources involves complex methods to assess any cumulative or masking effects. There was considerable discussion on these issues, although no firm conclusions were reached.

The suggestion that there is a need for a European descriptor also emerged for external noise assessment. Important issues still remaining concern annoyance due to combined sources, the so-called "bonus" effects, and annoyance due to ground-borne noise.

SESSION 5. NOISE AND VIBRATION ABATEMENT

The final Session, chaired by Paul de Vos (NSTO), dealt with noise and vibration abatement. General principles relating to rolling noise are now well known, and developments are moving from assessment prototypes to pre-industrial samples. Different track types such as viaduct or slab track have been the subject of comprehensive noise-reduction studies. For rolling stock, solutions involving hybrid active and passive control of exhaust noise from diesel engines were presented, as well as fan noise reduction.

Finally, as practical implementation involves a combination of different solutions, decision-making systems have been shown to be useful for selecting the best solutions, both from a global and local point of view, and to monitor progress made during implementation phases. Thus, noise abatement is treated from both the physical and policy-making aspects.

CONCLUSION

The sixth IWRN revealed a vigorous and active community of researchers in railway noise and vibration. The use of dedicated tools for the reduction of rolling noise, as well as standard vibro-acoustic FEM/BEM methods, appears to be widespread. The value of a co-ordinated database and of tool-dedicated seminars should be recognized.

The principles of noise reduction for different components of the system have been thoroughly studied, the major remaining issue being the assessment of the effectiveness on real prototypes, followed by the inclusion of acoustic optimization in the general design of these components.

Understanding of aerodynamic noise has progressed significantly over the last few years, although the design of practical solutions has yet to be carried out.

In a number of areas, research on railway noise appears to have reached a critical point:

- In the field of internal noise in vehicles, the trend is both to refine indicators and to merge acoustic comfort into a general comfort analysis and design. Physical modelling has made some progress, although some specific points still need research.
- As there are numerous potential targets for noise reduction of individual components, the need for systems to assist decision making becomes clear in order to achieve the best combination of solutions. A novel application of such systems could be the monitoring of general progress in railway noise reduction at the national or European level.
- There is a revival of interest in vibration. All the numerous pragmatic approaches should, at least, be co-ordinated, and a "TWINS-like" tool for railway ground-borne vibration should be sought.
- Methods to assess noise from different components, such as the vehicle or track, should be sought, in order to meet the current division of responsibilities between operators and infrastructure managers, and to extrapolate test results to other conditions that could be representative of solutions encountered in Europe.

Finally, the excellent atmosphere of the Workshop created a pleasant environment in which to work. It provided an opportunity for those working in one sector of railway noise and vibration to discover and understand the progress being made in other sectors. This pedagogic by-product of the Workshop was particularly appreciated and underlined by younger participants, and should be retained if possible in future sessions of IWRN.