Noise source separation (WP7)

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Objective

• The Noise Source Separation has two goals:
  
  – Objective 1:
    • To support the improvement of existing methodologies for separating the contributions of vehicle and track to rolling noise
    • *Rolling noise separation methods* work stream.

*Figure 1. Graphical representation of WS1: Rolling noise separation methods.*
Objective

• The Noise Source Separation has two goals:

  – Objective 2:
    • To support the development of innovative techniques to separate the different types of acoustic sources during pass-by
    • *Pass-by noise source separation techniques* work stream.

*Figure 2. Graphical representation of WS2: Pass-by noise source separation techniques.*
Objective

• The goals are related but different
  – The methods applicable for one objective differ from the techniques applied for the other objective
  – The idea of grouping both work streams on a same work package is to try to reduce testing campaigns and efforts as much as possible
Objective

• These objectives will be achieved in a close collaboration with S2R Open Call TRANSIT.

FINE-2 partners, composed of rolling stock manufacturers and operators, bring the vision and the needs of the industry

TRANSIT partners, composed of research centres, universities and consultancies, will enhance existing methods and propose new techniques based on their knowledge and experience.
Rolling noise separation methods
Background

• In the effort of reducing rolling noise one key question is the separation of the noise radiated by the wheel from that radiated by the track.

• The current Technical Specification for the Interoperability Noise relies on the use of a reference track to quantify the vehicle noise. The reference track is defined by
  – an upper limit of the rail roughness and
  – a lower limit of the track decay rate.

• This does not assure that the track contribution is negligible.
  – Different reference tracks may lead to different pass-by noise results.
  – This may cause different pass-by noise results with the same vehicle on different reference tracks
Background

• TSI Noise homologation test procedure shows inadequacies when it comes to quantifying the vehicle noise

• An improvement would first be the enhancement of test methods that allow separating noise from the wheel and from the track during a pass-by.
Background

• Roll2Rail was dedicated to developing methods for better characterisation of rolling noise

– General conclusions from Roll2Rail:
  • Methods need to be further enhanced to make them suitable for certification procedures
    – Simplify instrumentation and track access
    – Improve accuracy of the results
Methods enhanced by TRANSIT

Advanced Transfer Path Analysis (ICR)
- Experimental method that gives the sound pressure at a target position as the sum of the contribution of N subsystems
- Two-step method: Impact tests + pass-by test

Pass-by analysis (TNO)
- Experimental method that uses an accelerometer on the rail and a trackside microphone to measure the combined vehicle+track transfer function
- To separate vehicle and track components:
  - Measure the combined vehicle-track transfer function with a quiet vehicle
  - Measure the vehicle and track transfer functions statically.

Rolling noise simulations with TWINS (ISVR)
- Use rolling noise simulations to deduce the track and vehicle contribution to rolling noise
- Experimental inputs required; TDR, roughness, wheel modal analysis, track parameters,...
Work structure

I. Specify the requirements to be fulfilled by the separation methods.
   - Integration on future certification procedures

II. Specify three vehicle scenarios for TRANSIT to test the enhanced methods

III. Analyse the strengths and weaknesses of the methodologies proposed

IV. Analyse the possibility of proposing an updated methodology for a better vehicle characterisation in current pass-by noise homologation procedures.
Test campaigns

CAF test campaign
  When: October-November 2021
  Where: Spain
  Train type: Metro

TALGO test campaign
  When: January 2022
  Where: Spain
  Train type: High-speed

ALSTOM test campaign
  When: December 2021
  Where: Czech Republic
  Train type: Regional
Pass-by noise source separation techniques
Background

• There is a need to further develop techniques to separate the different types of acoustic sources during pass-by
  – Identifying the main noise contributors is relevant for source ranking prior to mitigation measure implementation.
  – Seek for methods that can provide the inputs for exterior noise simulation tools
Methods enhanced by TRANSIT

**Microphone array methods (TU Berlin)**
- Identify the contributions from different noise sources by finding the best source distribution that fits the sound pressure measurement on the microphone array.
- Propagation models can vary significantly

**Pass-by analysis (TNO)**
- Experimental method that uses an accelerometer on the rail and a trackside microphone to measure the combined vehicle+track transfer function.
- It assumes that any spectral deviations from the rolling noise transfer functions are due to other sources.
  - Low-frequency → aerodynamic sources
  - Mid-frequency → traction sources
Work structure

I. Specify the requirements to be fulfilled by the separation methods.
   - Results able to feed exterior noise simulation tools

II. Specify two vehicle scenarios for TRANSIT to test the enhanced methods

III. Analyse the strengths and weaknesses of the methodologies proposed
Next steps
Next steps

• Execute the two remaining test campaigns
  – January 2022

• Perform a SWOT analysis of the methods applied for both WS
  – December 2022

• Analyse the possibility of proposing an updated methodology for a better vehicle characterisation in current pass-by noise homologation procedures
  – May 2023
Furthering Improvements in Integrated Mobility Management (I2M), Noise and Vibration (N&V), and Energy in Shift2Rail

Thank You for Your Attention

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