INNOVATIVE RUNNING GEAR SOLUTIONS FOR NEW DEPENDABLE, SUSTAINABLE, INTELLIGENT AND COMFORTABLE RAIL VEHICLES

D4.4 – Assessment of noise reduction technologies for running gear

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PUBLISHABLE SUMMARY

The virtual test method for noise transmission from the running gear into rail vehicles, developed and validated in WP4 of RUN2Rail, has been used to investigate the potential of various noise reduction technologies as well as the implications for the noise transmission of developments in WP2 and WP3 of RUN2Rail. Although the noise reaching the vehicle interior consists of both airborne and structure-borne contributions, the running gear mainly affects the structure-borne contribution, so the focus of this work is on that contribution.

To study the potential for the reduction of structure-borne noise transmission, an optimisation process can be applied to the finite element model for the running gear. Such methods are now commonplace in the automotive industry. In order to demonstrate the capability of such an optimisation method, the sensitivity of the noise transmission to the bushing stiffnesses of the lateral damper and the traction bar has been determined. It is shown that the noise can be reduced considerably according to the optimisation, demonstrating the potential of the optimisation process. For practical application, more extensive constraints would be needed in the optimisation to ensure that the results of the analysis satisfy safety and operational requirements.

To assess the implications for noise transmission of novel lightweight materials in the running gear, the finite element model of the existing bogie has been adapted with material properties representative of carbon fibre. It is shown that the blocked forces transmitted to the carbody are increased, and as a result the internal structure-borne noise would be increased by around 10 dBA. Nevertheless, for this particular vehicle, this would have only very limited impact on the overall noise levels. The airborne noise radiation from the bogie frame has also been assessed for this nominal carbon fibre design and shown to increase considerably due to stronger vibration of the bogie frame. Nevertheless, the noise levels radiated by the bogie frame are still found to be negligible compared with the rolling noise.

The potential impact on structure-borne noise transmission of active control systems in the vehicle suspension, developed in WP3 to control the low frequency vehicle dynamic behaviour and ride comfort, has been investigated. A nominal active control system is assumed to be introduced in place of the lateral damper in the case study vehicle. It is found that the actuator behaves similarly to a conventional damper in the frequency range above 20 Hz, which is the region of relevance to structure-borne noise. Hence, the introduction of active suspension systems has no significant dis-benefit for noise transmission.

The methodology presented here could readily be applied to other novel running gear designs in the future including a two-axle vehicle with single stage suspension with active control developed in WP3.

Finally, new materials within the suspension have been studied in the form of magneto-sensitive (MS) rubber. This allows the stiffness properties to be changed by the application of a magnetic

field. The dynamic properties of samples of MS rubber have been measured under different magnetic fields. Dynamic models of their behaviour have been developed and used with example control strategies. The results are very promising but in the context of structure-borne noise transmission the response time of the MS rubber is found to be too slow to allow control within a useful frequency range. Other applications have been identified for this promising material within the train suspension to suppress hunting motion or reduce the adverse tilting of vehicles in curves.

The virtual test method developed in WP4 is a powerful tool allowing noise contributions to be identified and noise control to be targeted. The work presented in this report demonstrates a number of avenues that could be pursued in controlling vehicle interior noise, particularly the structure-borne component, once such a model has been established.