The flow around high-speed trains in partially-enclosed spaces.

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1 Introduction

The paper will describe experimental and CFD measurements of velocity and pressure transients around a German ICE2 passenger train in a variety of partially-enclosed spaces. The 'TRAIN Rig' moving model facility was used for experimental tests. The effect of confinement on the flow will be discussed. The paper will also discuss issues surrounding the appropriate instrumentation for measuring transient flows at model scale. Finally, the paper will discuss how the separate research disciplines of tunnel aerodynamics and open-air aerodynamics may be linked via this research, and what kinds of infrastructure scenarios would produce each type of flow. Validation against empirical data will be an important aspect of all sections of the paper.

2 Background

Hazards caused by slipstream gusts and pressure-transient-induced cyclic fatigue loading will become more severe and regular as train speeds rise on new and upgraded lines, unless Engineers are able to reduce the flow to safe levels. A section of the EU 'Technical Specification for Interoperability' which addresses such problems does not account for confined spaces, only open air running. A Eurocode section on train-induced dynamic structural loading has limited evidence to support that it works. To promote cost-effectiveness and safety for the future this research specifically addresses worst-case flow situations not covered or partially-covered in codes, which has not been done before.

3 Test Results

Experimental data were collected using eight multi-hole high frequency 'Cobra' probes, and eight pressure tappings. The test cases included an open air environment, high walls spaced 3.3m from track centre, and walls with a roof 5m above the rail. Fig 1 shows the test cases and instrumentation. As an example Fig 2 shows the Resultant velocity for a Cobra probe at human height placed at a distance of 3m from track centre (to represent a continuous walkway). Fig 3 shows the non-dimensional pressure coefficient measured by the same probe. Thus it can be seen that the confinement increases the flow, leading to tunnel-like behaviour.

Fig 1: Left: Walls (Cobra probes visible). Centre: Walls & Ceiling. Right: Pressure tappings.

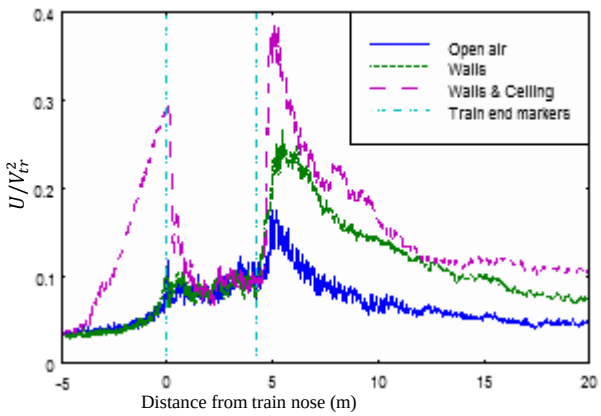

Fig 2: Comparison of Resultant Velocity for different test cases.

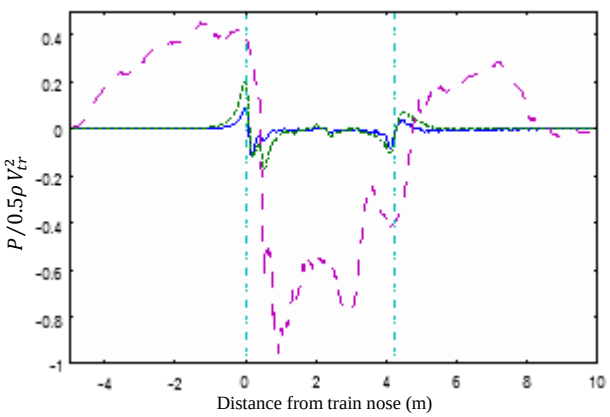

Fig 3: Comparison of static pressure coefficient.