

Estimation of train resistance coefficients in tunnels from measurements during routine operation

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Abstract: The measurement of train resistance characteristics in railway tunnels can be a difficult and costly task. This is especially likely when the operator has to provide special trains and large numbers of staff. It would be a considerable advantage if the resistance characteristics could be measured during routine operation with scheduled trains. In May 1996, night-time tests were planned for aerodynamic measurements in the Grauholz Tunnel in Switzerland. They required the installation of pressure, velocity and temperature sensors in the tunnel. The opportunity was taken to record conditions during scheduled operation and this paper reports the use of the data to infer resistance coefficients of trains. It is shown that consistent interpretations are possible, but only when the gaps between successive trains are sufficiently large. Accurate measurements of air velocity are necessary to clarify conditions in the tunnel before train entry. The most important resistance parameter for a long train is its skin friction coefficient. It is found that this can be as low as 0.003 for a modern, streamlined passenger train, but as high as 0.010 for a nonuniform freight train.

Keywords: railway tunnels, train resistance, aerodynamic drag, loss coefficients, skin friction

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