

Propagation in Soil of Vibrations due to a Tramway

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Tramway traffic may produce vibrations propagating in soil, which implies vibration annoyance for people living or working in neighbouring buildings. Thus vibration is one of the most important consequences to be considered when planning new lines. Dynamic performance evaluation of tramway tracks is required to validate or modify the existing means that reduce vibrations. This paper presents experimental and theoretical investigations of vibrations caused by passing tramways in Nantes, France. A method is proposed to predict ground-borne vibrations, so as to estimate a trouble gauge concerning, for example, the impact of a future tramway line. This method is applied and validated in comparison with *in situ* measurement data obtained previously.

Numerous studies have been carried out on vibrations induced by surface railways, for example, Lefeuvre-Mesgouez *et al.* [1], Picoux [2] and Sheng *et al.* [3]. In the case of a tramway line, a two-dimensional model can be used to predict the behaviour of the propagation analysis of the corresponding vibrations, considering a thin layer model for the soil and using exact dynamic stiffness matrices [4,5], expressed in the frequency-wave number domain for the layered ground and the half-space [6]. Note that other models can be applied to predict vibration propagation, such as boundary element formulations [7].

In this paper, soil is characterized by measurements using the spectral analysis of surface waves, often called the SASW method. Here the usual two-station approach is used [8]. The objective is to accurately define shear moduli and layer thicknesses. Then the general Barkan relation [9] is applied to obtain the dispersion curve and the damping ratios. Soil characterisation needs further improvements using a complete inversion method such as Occam's algorithm [10]. Nonetheless this first approach, often called "equivalent depth approach" already gives sufficient soil profile information to model waves propagation.

Numerical methods, such as the wavenumber matrix approach, can be used for the prediction of the soil response to a hammer impact, i.e. to obtain the transfer functions. An alternative solution is proposed: the method is based on the assumption that for each frequency, the vertical measured shear wave velocity corresponds to a homogeneous half-space [9]. The vibratory response is obtained by multiplying the load spectrum by the transfer function in order to obtain the whole contribution of tramway passage for each measurement point. Results are given in the time domain and compared with *in situ* measurements.

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