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ABSTRACT

Transition zones in railway lines are areas between different track structures such as the transition from conventional track (ballasted track) to slab track, to a tunnel or a viaduct. The main feature of a transition zone is that it exhibits a dramatic change in structural behaviour to bridge the difference in the adjacent track parts. This change causes high dynamic loads which contribute to quality deterioration of the track. Two main factors influence the magnitude of the interaction forces between trains and track in transition zones. Firstly, the abrupt change in track stiffness. This stiffness is determined by the mechanical features of the entire track structure; the conventional track is a compliant structure, while slab track, tunnels and viaducts are relatively stiff. A train passing a stiffness change induces a variation of track deflection under the moving dead loads and, consequently, also a variation in the wheelset's vertical momentum leading to higher (dynamic) loads. Secondly, settlements of the backfill and its foundation are typically larger than those of stiff structures, leading to unevenness of the track. This abstract deals with the issue of the dynamic analysis of an infinite Euler-Bernoulli beam on elastic foundation with transition in foundation stiffness, subjected to a moving oscillator. This model is one of the simplest ones for a vehicle passing a transition zone. The equations of motion are solved by means of the time-domain Green's function method using convolution integrals in terms of the unknown contact force. Considering the track as an aperiodic structure, the Green's functions (receptances) are calculated in a stationary reference frame (i.e., non-moving sources). Two methods of solution are investigated. The first one is based on the Laplace Transform, where the response consists of a contribution from the initial conditions and one from the moving contact force. By choosing the initial conditions in accordance with the response of a beam with homogenous foundation subjected to a moving load, the free vibrations and waves due to oscillator entrance are suppressed and steady-state behaviour is achieved before the oscillator reaches the transition zone. The second method is based on the Fourier Transform, which automatically ensures this steady-state behaviour. Both methods are exemplified in the paper. The influence of the length of the transition zone and the speed of the moving oscillator on the contact force are analysed; both sub-critical and super-critical speeds are considered.