The effect of sheer strain on the determination of the track critical velocity for high speed trains.

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Abstract
As train speeds continue to increase the geo-dynamic behaviour of the ground and the interaction of the train and the ground become increasingly important. Critical speeds can be reached whereby large track displacements in both the downwards & upwards direction are observed and the track geometry can rapidly deteriorate. This talk discusses measured data on this phenomenon and uses numerical techniques to model the train and track behaviour at these critical speeds. The effect of the train speed on the induced dynamic shear strain is presented and the subsequent reduction in the material stiffness simulated. In particular the changes in shear wave velocities in the geo-materials due to the strain level are shown to affect the dynamic behaviour of the track leading to lower resonant frequencies. The formation of large propagating Rayleigh waves is highlighted through contour plots of coupled 3-dimensional finite element simulations. The critical speed envelope for high-speed trains is presented to allow the rapid determination of the induced dynamic track displacements with train speed, including train speeds above the critical speed. Track reinforcement options are also discussed and modelled to look at techniques that can overcome this issue and hence reduce the induced strains in the track. These reinforcement options allow a high degree of track geometry retention and hence overcome the critical speed problem thereby allowing increases in operational train speeds enabling future trains to run at ultra-speed.