DE FREITAS ALVES – Talita

Thermomechanical behaviour of bituminous layers containing rigid inserts for eRoads

Abstract

To investigate the impact of charge-while-drive technologies on the behaviour of flexible pavements, this study proposed both numerical and experimental methodologies to quantify temperature, stress and strain evolutions within an eRoad profile. The solution studied contained electrified rails embedded in the bituminous wearing surface, a case of particular interest due its susceptibility to premature failure as it remains in direct contact with traffic and environmental loadings. By means of transient 2-D FEM thermo-viscoelastic simulations, traditional and electrified road profiles were subjected to thermal and mechanical loadings and their response in terms of deformation was analyzed. The rigid inclusions were found to affect the temperature distribution inside the layers. A differential thermomechanical behaviour amongst the eRoad components to daily temperature fluctuations was pronounced in the surface level, in the bituminous layer near the interface of the charging unit. In laboratory, a thermal test was proposed to characterize the response of eRoad specimens to warm and cold cycles by means of Digital Image Correlation technique. The application of the DIC technique to obtain the contraction/expansion thermal coefficients of the studied materials was considered good and reliable, although some boundary conditions of the test might need improvements in order to minimize external sources of deformation and background noise. In warm cycles, the significantly higher expansion of the rigid inclusions bended the specimens to a concave down shape. In cold cycles, the specimens bended to a concave up shape. The observations of the strain fields in eRoad specimens subjected to thermal loadings were in accordance to the results of the FE simulations: the rigid inclusions generate additional strain along the interface of the charging unit and the bituminous layer, which can lead to cracking and debonding.

Mots-clés : Electrified roads; Bituminous mixtures; Viscoelasticity; Finite Elements Method; Digital Image Correlation; Thermal loading