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System Devices to Reduce Particulate Matter Concentrations in Railway Metro Systems

Authors : Armando Cartenì

Abstract : Within the design of sustainable transportation engineering, the problem of reducing particulate matter (PM) concentrations in railways metro system was not much discussed. It is well known that PM levels in railways metro system are mainly produced by mechanical friction at the rail-wheel-brake interactions and by the PM re-suspension caused by the turbulence generated by the train passage, which causes dangerous problems for passenger health. Starting from these considerations, the aim of this research was twofold: i) to investigate the particulate matter concentrations in a 'traditional' railways metro system; ii) to investigate the particulate matter concentrations of a 'high quality' metro system equipped with design devices useful for reducing PM concentrations: platform screen doors, rubber-tyred and an advanced ventilation system. Two measurement surveys were performed: one in the 'traditional' metro system of Naples (Italy) and onother in the 'high quality' rubber-tyred metro system of Turin (Italy). Experimental results regarding the 'traditional' metro system of Naples, show that the average PM10 concentrations measured in the underground station platforms are very high and range between 172 and 262 µg/m3 whilst the average PM2,5 concentrations range between 45 and 60 µg/m3, with dangerous problems for passenger health. By contrast the measurements results regarding the 'high quality' metro system of Turin show that: i) the average PM10 (PM2.5) concentrations measured in the underground station platform is 22.7 µg/m3 (16.0 µg/m3) with a standard deviation of 9.6 µg/m3 (7.6 µg/m3); ii) the indoor concentrations (both for PM10 and for PM2.5) are statistically lower from those measured in outdoors (with a ratio equal to 0.9-0.8), meaning that the indoor air quality is greater than those in urban ambient; iii) that PM concentrations in underground stations are correlated to the trains passage; iv) the inside trains concentrations (both for PM10 and for PM2.5) are statistically lower from those measured at station platform (with a ratio equal to 0.7-0.8), meaning that inside trains the use of air conditioning system could promote a greater circulation that clean the air. The comparison among the two case studies allow to conclude that the metro system designed with PM reduction devices allow to reduce PM concentration up to 11 times against a 'traditional' one. From these results, it is possible to conclude that PM concentrations measured in a 'high quality' metro system are significantly lower than the ones measured in a 'traditional' railway metro systems. This result allows possessing the bases for the design of useful devices for retrofitting metro systems all around the world.

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