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# Impact of asphalt mixture composition on particulate matter production

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**Abstract**

Road traffic is one of the main sources of particulate matter. Nevertheless, the traffic volume is still increasing and has unpleasant impact on longevity of the pavements and the environment. Vehicle motions cause mechanical wearing of asphalt pavement surface by vehicle tires. The aim of paper is to confirm the abrasion of pavement surface as a source of particulate matter and to verify the impact of the composition of asphalt mixture on particulate matter production. The findings from chemical analyses of basic materials and intercepted particulate matter are applied in the research and used for verification of this impact. The research deals with abrasion of bituminous wearing courses of pavements. Each of the tested samples is specific in its composition - the type of bituminous binder, the amount of bituminous binder, type of aggregate, different lines of aggregate granularity. The particulate matter (PM) measurements were performed in laboratory conditions and the asphalt mixture samples were rutted in wheel tracking machine. The paper presents comparison of rutted asphalt samples in terms of PM mass concentrations and chemical composition. In the asphalt mixture sample with the highest average $PM_{2.5}$ mass concentration (13.51 μg/m$^3$) the aggregates melaphyre and dolomite were used. On the other hand, the lowest average $PM_{2.5}$ mass concentration (7.21 μg/m$^3$) was measured for the asphalt mixture with aggregate siliceous limestone.



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*Keywords:* Particulate matter (PM); mechanical wearing; laboratory tests; bituminous wearing courses; chemical analysis

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## 1. Introduction

Currently, the particulate matter belongs to the most significant pollutants in Europe, together with ground-level ozone $O_3$ and nitrogen dioxide $NO_2$ according to the latest findings. Particulate matter air pollution from road traffic may originate from combustion or non-combustion processes. On the basis of several scientific papers, studies and researches about PM production from road traffic [1], [2], [3] our research is focused on non-combustion emissions - particulate matter from abrasion of the pavement surface. It is very difficult process to identify pavement surface abrasion as a source of particulate matter and separate it from other abrasions and quantify its share of the amount of produced particulate matter in situ. Therefore, PM measurements are performed in laboratory conditions and captured particulates supposed to be without contamination from exhaust emissions, abraded particles from vehicles, resuspension of road dust and climate affects [4].

The aim of the research is to confirm the abrasion of pavement surface as a source of particulate matter and to verify the impact of the composition of asphalt mixture on PM production. The main question addressed in this paper is to find dependence between the composition of asphalt mixture and captured PM and to compare tested mixtures in terms of PM mass concentrations and chemical composition.

## 2. Methodology of laboratory tests

The laboratory measurements are carried out for asphalt mixtures (samples of size 320 x 260 mm and thicknesses of 40 mm) which are used for wearing courses of pavements. The samples are rutted in wheel tracking machine (DYNA-TRACK) which is used to assess the resistance to rutting of asphalt materials under conditions, which simulate the effect of traffic (Fig. 1). The mixtures are rutted by typified wheel for 12 hours through the steady working conditions. It performs 20 000 cycles during the 12 hours. Air sampling from the inside of wheel tracking machine during the rutting of samples is performed by means of equipment APS 3321 (Aerodynamic Particle Sizer) and SMPS 3080 (Scanning Mobility Particle Sizer) which intercept and distribute particle range from 0.012 to 20 μm and 3 pieces of Leckel LVS3 which capture particulate matter $PM_{2.5}$ and $PM_1$.

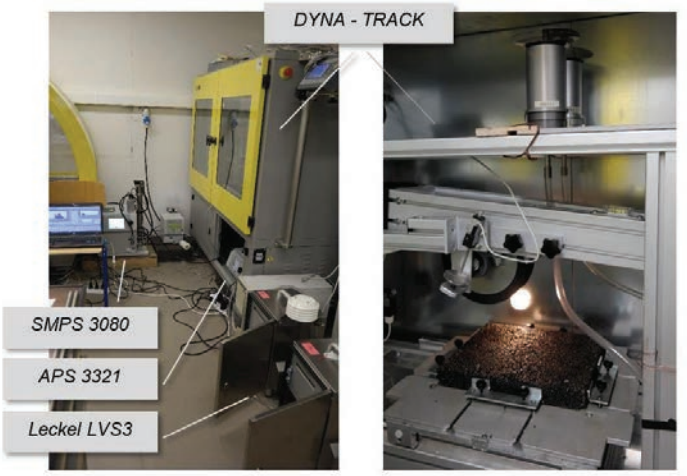


Fig. 1. The used machine technology for laboratory tests and rutted asphalt mixture AC 11 inside the wheel tracking machine DYNA-TRACK.

Chemical composition tests of materials (aggregates, bituminous binder) of samples were carried out by XRF analyser (X-ray fluorescence spectroscopy) before the rutting. For the experiments the machine SPEKTRO iQ II (AMATEK, Germany) was used. Particulate matter was captured on Nitrate membrane filters for subsequent element determination. The filters were digested in Teflon vessels with $HNO_3$ at a temperature of 230°C using a high temperature and high pressure Microwave digestion system SW-4 (Berghof, Germany). Samples were transferred and