The relevance of on-road emission monitoring in different type of roundabouts in rural roads

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***Abstract*— Road traffic significantly contributes to urban air pollution as means of particulate matter (PM) and nitrogen oxides (NO_X) emissions [1]. Despite the deployment of clean powertrains, internal combustion engines are the most widely used technology in the European Union; gasoline- and diesel-fueled represented around 90% of passenger cars sold between 2014 to 2017 [2].**

The amount of exhaust gases emitted by motor vehicles depend on speed profile, vehicle type, traffic volumes and intersections [3]. Roundabouts have been considered and built around the world to replace intersections previously controlled by traffic lights as a means of improving operational performance, at least in certain flow range [4]. These latter ones are considered pollution hotspots locations, due to speed changes cycle around them [5] [6]. Despite the demonstrated benefits in terms of traffic flow, delay reducing and safety [7], roundabouts raised some doubts concerning emissions performance [8].

Bearing this in mind, this paper compares vehicle activity and on-road emission data in three different roundabouts in rural roads: a compact two-lane, a multi-lane and a single lane roundabout in Aveiro, Portugal. It was hypothesized that carbon dioxide (CO_2) and NO_x emissions, engine speed and the relative positive acceleration (RPA) are impacted by the differences in the approaching and conflicting traffic volumes, the volume-to-capacity ratio and the roundabout layout.

Input data such as approaching and circulating traffic volumes, and queue length were collected by videos cameras installed at the studied locations. Field measurements were carried out with two light duty vehicles (gasoline and diesel), using a Portable Emissions Measurement System (PEMS) to measure CO_2 and NO_X volumetric concentrations. Alongside, an OBD-II scan interface record vehicle speed data, engine speed and acceleration. After that, a relationship between congestion level of roundabouts and occurrence of each speed profile (no stop – I, stop once – II and multiple stops – III) was established, using discrete choice models. Finally, discrete choice models obtained from single-lane, compact two-lane and multi-lane roundabouts were compared.

The methodology and models developed used in this paper can be applied by simply measuring roundabout traffic volumes by means of discrete choice models that allows simultaneously detecting differences in location and variability characteristics of the distributions of the observations taken at roundabouts. It also allows to identify some relevant operational and design features of a rural roundabout prior its implementation to enhance capacity and emissions fields,.

Keywords*— *Roundabouts, Traffic, Exhaust emissions, Portable Emissions Measurement System; Light duty vehicles

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