

Existence of urban-scale macroscopic fundamental diagrams: Some experimental findings

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Abstract

A field experiment in Yokohama (Japan) reveals that a macroscopic fundamental diagram (MFD) linking space-mean flow, density and speed exists on a large urban area. The experiment used a combination of fixed detectors and floating vehicle probes as sensors. It was observed that when the somewhat chaotic scatter-plots of speed vs. density from individual fixed detectors were aggregated the scatter nearly disappeared and points grouped neatly along a smoothly declining curve. This evidence suggests, but does not prove, that an MFD exists for the complete network because the fixed detectors only measure conditions in their proximity, which may not represent the whole network. Therefore, the analysis was enriched with data from GPS-equipped taxis, which covered the entire network. The new data were filtered to ensure that only full-taxi trips (i.e., representative of automobile trips) were retained in the sample. The space-mean speeds and densities at different times-of-day were then estimated for the whole study area using relevant parts of the detector and taxi data sets. These estimates were still found to lie close to a smoothly declining curve with deviations smaller than those of individual links – and entirely explained by experimental error. The analysis also revealed a fixed relation between the space-mean flows on the whole network, which are easy to estimate given the existence of an MFD, and the trip completion rates, which dynamically measure accessibility.

Keywords: Urban mobility; Traffic congestion; Macroscopic fundamental diagram