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Investigation of truck weights and dimensions using WIM data

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Abstract

This paper presents a study carried out with extensive weigh-in-motion (WIM) data collected on the French main road network, involving 3 millions of trucks. The data were collected by three WIM stations located on highly trafficked highways and motorways, continuously over a whole year. The data were analyzed using statistical software developed by the US National Science Foundation.
The trucks of the traffic flow were classified into almost 20 categories, depending on the silhouette, number and spacing of axles, body configuration (trailer/semi-trailer), type of axles (steering, driving or standard axle) and wheel or tire (single, twin, wide). The data were analyzed by category.
The location of the centre of gravity of the payload was calculated and the variability of its abscissa along the vehicle was analyzed in each category. The loading patterns and behavior were analyzed and the results reported here for 5-axle articulated trucks and 2-axle rigid truck with 2-axle trailer.
Then, the axle load distributions were analyzed by axle rank and truck category, and modeled with multimodal Gaussian probability distribution functions. The modes have been determined using a maximum of likelihood method. These modes are useful to design endurance tests of truck tires.
These investigations provide a better knowledge about truck loading, overloads and truck aggressiveness on infrastructure, and may lead to optimization policies. In this case, the results are used directly in the domain of tyre optimization.

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Nomenclature

AVI	automatic vehicle identification
CoG	centre of gravity
GHG	greenhouse gas
GWV	gross vehicle weight (equal to the sum of all the axle or wheel loads)
HCV	heavy commercial vehicle (permitted gross weight above 3.5 t)
OCR	optical character recognition
OEM	Original Equipment Manufacturer
PDF	probability density function
WIM	weigh-in-motion

1. Context and objectives

1.1. Tire manufacturer's perspective

The HCVs' loading conditions, and above all the load distribution on each wheel/tire govern the tire design and sizing, and therefore the tire cost and performance trade-off. Oversized tire manufacturing requires more raw materials and leads to a higher rolling resistance and a higher cost, what directly impacts on fleets efficiency and GHG emissions. On the other hand, an undersized tire may not meet the stability requirements for the truck configuration and use considered. To properly design a tire for the targeted use, it is necessary to know the load to be carried and the axle and wheel load distribution.

With an accurate knowledge of the HCVs' axle configuration and load balance, the tire manufacturers can propose a better technical and commercial offer for each business case, optimizing the truck efficiency and ensuring good safety conditions. Thus, the tire tests should be adapted to fit the design with the real use and not only prescriptive load limits per axle.

1.2. Infrastructure and other concerns

There is also a need for a better knowledge of real HCVs' weights and dimensions to properly assess their impacts on infrastructure, e.g. pavements and bridges deterioration and fatigue damages, size compliance with the road and parking lot geometry, efficiency of safety equipments such as safety barriers, etc. An accurate knowledge of HCVs' weights and dimensions is also a tool to implement fair road charging and tolling policy, and to optimize the logistics. Last but not least, it is necessary to monitor and enforce overloaded and oversized HCVs to ensure a fair completion between transport companies and modes, which is a requirement of the revised Directive 96/53EC of the European Commission (1996) on HCV's weights and dimensions.

Indeed, the HCVs' dimensions are described in the manufacturers' catalogues, but they do not provide any information on the real loading conditions in operation on the roads. However, it is not easy to know the true loading of HGVs while in operation. Only WIM systems and networks, which are now installed in many countries, can provide reliable data on a large scale, allowing to perform statistical analysis and to better understand the real use of HGVs.

1.3. Paper overview

Section 2 introduces the WIM data used in this study. Section 3 explains the developed methodology and the HCV's classification used. Sections 4 and 5 present the results on the longitudinal load distribution, the payload CoG location, and the axle load distribution. Conclusions are given in Section 6.