

# The “footprint” of heavy vehicles

The EU research project “EUREKA Logchain Footprint” is establishing the scientific basis for a pan-European heavy vehicle fee, in which vehicles are charged according to their usage of infrastructure and the environmental effects they cause. For this purpose Empa has been operating a motorway measurement station since 2005 which records the “environmental footprint” of heavy vehicles over 3 tonnes.

The aim of the “EUREKA Logchain Footprint” research project is to evaluate and compare the economic, ecological and social costs of commercial traffic on European road and rail networks and to encourage the use of more environmentally friendly vehicles. In other words, it is defining the “footprint”, so to say, of heavy goods vehicles. Partners from seven countries are involved in the project, which focuses on developing a method of identifying the most environmentally friendly road and rail vehicles, providing a detailed understanding of the interplay between the wheel and the roadway or rail, and measuring the various environmental effects caused by heavy goods vehicles. It is intended in the future to propose levying a tax on each vehicle which is footprint dependent, based on the “user and polluter pays” principle. Similar to the performance-related heavy vehicle fee (HVF) system which is already in force in Switzerland, this would encourage transport firms to use less-polluting goods vehicles, since lower emissions would result in reduced fees.

## **Measuring station on the Zurich – Bern motorway**

The Swiss contribution, under Empa leadership, has been the construction of the first European measurement station near Lenzburg on the A1 motorway between Zurich and Bern. On weekdays up to 6000 goods vehicles of over three tonnes pass this measurement station, which has been recording data since 2005. In the meantime further measuring stations have begun operation in Britain (for road traffic) and the Netherlands and Austria (for rail traffic). The footprint is evaluated by measuring the dynamic wheel loads (both total weight and individual axle loads), noise emissions and ground vibration levels. In addition to these main parameters data on tire-pavement contact force distribution, deformation, temperature and humidity at various depths below the road surface and foundation are also logged. Swiss project partners, in addition to the various Empa laboratories involved (Road Engineering, Acoustics, Metrology and Internal Combustion Engines), are the Federal Offices for technology and Innovation (CTI), for the Environment (FOEN), of Transport (FOT), and the Federal Roads Office (FEDRO) as well as industrial partners Kistler Instruments AG (a sensor manufacturer) and Road and Traffic Systems Consulting GmbH.

## **Complex measurements provide initial results**

In order to measure the various parameters in parallel, Empa researchers installed vibration, temperature and humidity sensors, microphones, a Stress-in-Motion-Sensor (SIM) and displacement sensors to measure the roadway deformation. The Weigh-in-Motion (WIM) sensors at this site is part of the federal monitoring system, The WIM system records the axle loads while the SIM system measures the contact forces under the vehicle tires. The data shows that both in terms of total weight and axle loading the legal limits are sometimes exceeded by significant margins. This can have serious consequences, since an excessive gross vehicle weight can compromise the safety of bridges and viaducts while over limit axle loads cause disproportionate damage to the carriageway. Analysis of the data at different depths under the surface of the roadway shows that contact force distribution and tire pressure also significantly affect the service lifetime. Additionally, Empa measurements of Footprint parameters have shown that all parameters should be monitored individually as the noisiest vehicles are not necessarily the ones with the largest axle loads or gross weight.



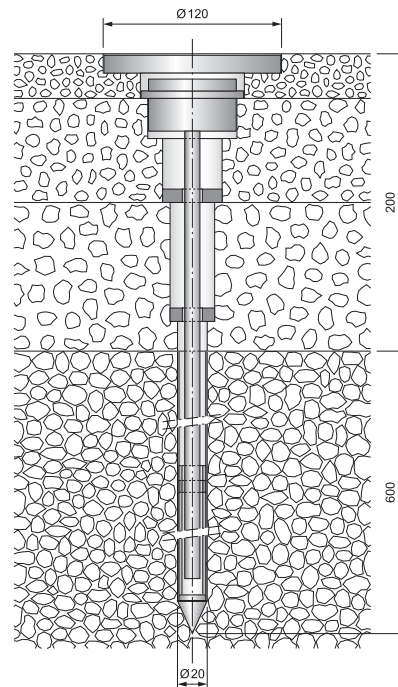
Commercial traffic loads both the road and rail systems. The EU "EUREKA Logchain Footprint" research project is creating the scientific basis for a pan-European heavy vehicle fee.

### Mobility pricing for heavy lorries and goods trains

In the future it is intended that the size of the fee should be based not on the maximum capacity of the vehicle but on its own specifically determined pollution and nuisance level – that is, the actual load it generates on the infrastructure and the environmental effects it causes. The experience gained with the measuring stations will then show in what form commercial traffic on the road and rail network in the EU can best be taxed on the polluter pays principle, taking into consideration the economic, ecological and social aspects. Will this take the form of a pure road tax, as with the performance related HVF in Switzerland, or will rail traffic also be taxed on the basis of its footprint? In other words, will there in fact be a mobility pricing scheme for the transport of commercial goods? These are political issues, and in order to help find satisfactory solutions Empa and its partners in the EU «Footprint» project are supplying the necessary technical and scientific fundamentals.



A sensor in the road surface made by project partner Kistler Instruments AG measures the distribution of contact forces under the tires of a passing vehicle.



The deformation sensor developed at Empa measures changes in the various layers of the roadway.

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