EUPAVE
EUROPEAN CONCRETE PAVING ASSOCIATION

FACT SHEET
Less Fuel Consumption

Concrete roads can strongly contribute to reduction of CO_2 emissions from road transport

Fuel consumption is not only influenced by the vehicle (type of engine, aerodynamic profile, tyres…) but also by the pavement it is driving on. The factors related to the surface of the pavement are the evenness, the surface texture and the deflection.

While texture and evenness can be made the same for asphalt and concrete roads, this is not the case for deflection.

Several researches indicate around **2% fuel savings** for trucks driving on concrete pavements compared to asphalt. This was found both in theoretical studies (by MIT) and in field tests.

The differences are higher for **slower traffic speeds** and for **higher outside temperatures.**

When calculating a LCA for a motorway, reduced greenhouse gas emissions due to lower fuel consumption should be taken into account in the use phase of the pavement, together with other influencing factors. Based on data of the European road transport network, changing from flexible asphalt to rigid concrete creates **over 50 years a difference in GWP (Global Warming Potential) estimated to be 78 kg CO_2/m²** of pavement, more than offsetting its own CO_2.

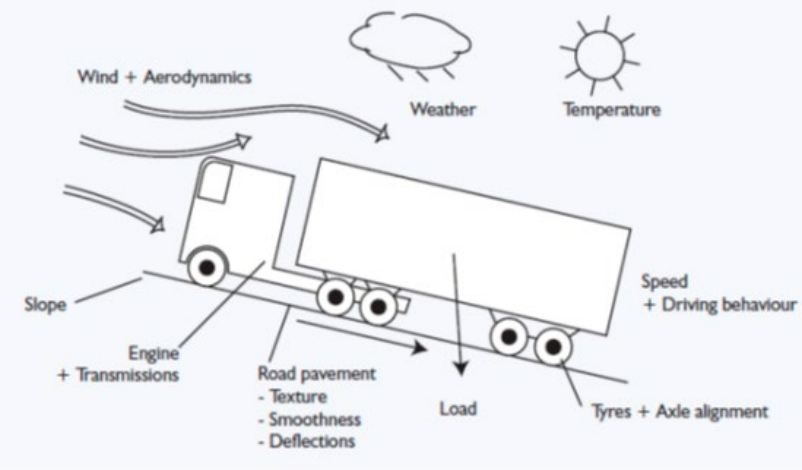
Considering the total motorway network and freight road transport in Europe, there is a total potential of saving **2.5 million tonnes of CO_2 per year.**

In addition, reduced fuel consumption also means **less pollution** and **less operating costs** for truck transport companies.

SOME MORE INFORMATION

Not only electrical vehicles but also the physical road infrastructure can contribute to the reduction of CO_2 emissions by road transport. Indeed, several studies and researches have shown a lower fuel consumption of heavy vehicles on rigid, concrete pavements compared to flexible, asphalt pavements.

There are many factors influencing the fuel consumption of a vehicle. Some of them are related to the vehicle and its engine or to the resistance of the vehicle due to aerodynamics or the slope of the pavement. **The factors related to the surface of the pavement are the evenness, the surface texture and the deflection.**



Evenness and texture depend on the quality of construction and/or safety requirements, both for concrete and asphalt roads. This includes the absence of undulations, uneven patches, rutting, potholes or deteriorated joints.

Deflection, however, depends mainly on the stiffness of the pavement and that is the big difference between concrete and asphalt.

The deformation (not at scale) of an asphalt road under a wheel load has the same effect as a vehicle driving uphill, requiring more energy, fuel and CO_2.

The effect of a deflected pavement under a wheel load is the same as if the vehicle would constantly drive uphill and would consequently consume more fuel and emit more CO_2. Concrete pavements are rigid structures, which show less deflection under heavy traffic and thus less fuel is consumed and less CO_2 emitted.

Some of the most relevant studies and researches indicate the following results:

• FIELD RESEARCH BY THE NATIONAL RESEARCH COUNCIL OF CANADA

A series of four investigations was conducted on various types of roads and vehicles, in different seasons and using different statistical models. The final and most complete research measured fuel consumption, both for an empty and full tractor–trailer unit, on concrete and asphalt roads with equal degree of roughness (or unevenness). This means that only the impact of surface texture and pavement deflection were counted. The results ranged from 0.8 to 3.9% with a reliability of 95%.

• FIELD RESEARCH BY THE SWEDISH NATIONAL ROAD AND TRANSPORT INSTITUTE (VTI)

VTI also investigated the impact of pavement type on fuel consumption by measurements on a motorway north of Uppsala, Sweden, where a motorway included both asphalt and concrete pavements. For a passenger car – Volvo 940 – the measurement showed 1.1% less fuel consumption on the concrete pavement compared to the asphalt pavement. The results were found to be statistically significant and can mainly be attributed to differences in surface texture (stone mastic asphalt versus brushed concrete, both with an aggregate size of 16mm. The measurements with a heavy goods vehicle – a four axle Scania R500 + three axle trailer, total weight 60 tonnes at a speed of 80 km/h – showed an average of 6.7% less fuel consumption on the concrete pavement compared to the asphalt pavement. In this case both texture and deflection have impacted the results of the field tests.

• FIELD RESEARCH BY FLORIDA INTERNATIONAL UNIVERSITY

Statistical results from two field studies both show fuel savings on rigid pavement compared to flexible pavement with the test conditions specified. The savings derived from a first phase were 2.50% for a passenger car at 112 km/h, and 4.04% for 18-wheel tractor-trailer at 93 km/h. The savings resulted from a second phase were 2.25% and 2.22% for passenger car at 93 km/h and 112 km/h, and 3.57% and 3.15% for the 6-wheel medium-duty truck at 89 km/h and 105 km/h. All savings were statistically significant at 95% confidence level and were assumed to depend on differences in both deflection and texture.

• THEORETICAL MODELLING BY MIT

These studies were based on a theoretical model of the pavement-vehicle interaction and aimed at quantifying the deflection of the pavement, which was then used for estimating the impact on fuel consumption. In the second phase of the research, temperature and speed effects were included and a desktop experiment was set up to verify the theoretical results. The differences in fuel consumption showed a wide range, as indicated in the following table.

The difference of the average fuel consumption is **0.8233 litres/100 km or around 2.35%** (taking into account an average fuel consumption of 35 litres/100 km). This is the same magnitude as found in the Canadian field tests.

• THEORETICAL MODELLING BY IFSTTAR

In this model, the deformation, due to the viscoelastic behaviour of an asphalt pavement and its effect on fuel consumption was also studied. The energy dissipation was highest for high temperatures and slow speed and could amount up to 0.5% of the total energy of the fuel.

	LOW VALUE	AVERAGE VALUE	HIGH VALUE
Asphalt	0.21	1.07	6.25
Concrete	0.07	0.25	0.50
Delta	0.14	**0.82**	5.75

Fuel consumption (litre/100 km) due to deflection of the pavement by heavy truck traffic [Akbarian, M. (2015)]

The results of both field tests (National Research Council of Canada) and theoretical studies (MIT) show differences in fuel consumption, for heavy vehicles on concrete roads compared to asphalt roads, of around **2%**. High temperatures and low speeds make the differences higher. In urban environments or on congested motorways, where traffic is slow, the deflection will play a greater role compared to the impact of unevenness.

But even with small differences in fuel consumption, this parameter should not be neglected as it can significantly impact the results of an LCA of a road pavement, particularly for roads with intense and heavy traffic.

When calculating a LCA for a motorway, reduced greenhouse gas emissions due to lower fuel consumption should be taken into account in the use phase of the pavement, together with other influencing factors.

Based on average data of the European road transport network (80 000 km of motorway – annual freight road transport of 1804 billion tonnes-kilometres - an average payload of 16 tonnes - changing 2 slow lanes and hard shoulder, with a width per carriageway of 10 m, from a flexible asphalt to a rigid concrete structure), the **difference in GWP over 50 years can be estimated to be 78 kg CO_2/m^2 of pavement** or a **total potential of saving 2.5 million tonnes of CO_2 per year.**

In addition, reduced fuel consumption also means **less pollution** and **less operating costs** for truck transport companies.

More environmental benefits from concrete roads can be found on EUPAVE's infographic "Concrete Pavements Make Roads More Sustainable" (2019), https://www.eupave.eu/resources-files/infographic

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