PROJECT

ITARI

Integrated Tyre and Road Interaction

**Funding:** European (6th RTD Framework Programme)

**Duration:** Feb 2004 - May 2007

**Status:** Complete with results

**Total project cost:** €2,115,787

**EU contribution:** €1,700,000

**Call for proposal:** FP6-2002-TRANSPORT-1

**CORDIS RCN:** 74247

**Background & policy context:**

Road traffic with its conventional heat-engine vehicles, whose energy efficiency is far from optimal, is one of the main sources of urban pollution from greenhouse gases, and it also contributes to the European Union's excessive energy consumption. With the increasing efficiency of engines, secondary effects such as rolling resistance will play a dominant role when aiming for further reductions in fuel consumption.

Noise pollution from road traffic is another major environmental problem. A major component of road traffic noise is tyre/road noise. To achieve the proposed reduction targets it is necessary to reduce tyre/road noise.

Safety is crucial on road surfaces, so the design of new, low-noise textures or textures with low rolling resistance must not risk the grip potential (especially under wet conditions). Currently more than 40,000 people are killed on EU roads every year. The strategic objective is to cut this number by 50% by 2015 and 75% by 2025. The aim is to design highly sophisticated road surfaces to provide an optimum grip. However high-grip surfaces considered alone may not necessarily be saving fuel or absorbing noise.

Models are needed to assist in the design of road surfaces and to predict their essential properties.

**Objectives:**

The main scientific and technical objectives of ITARI encompassed three main categories:

- design tools;
- measurement methods;
- a demonstration of production techniques.

The objective for the set of design tools was to allow for virtual design of road surfaces and their essential properties. This included tools for designing:

- low noise surfaces based on a hybrid simulation model for tyre/road noise;
- a prediction tool for rolling resistance as a function of surface properties;
- a prediction tool for wet grip.

Measurement tools were provided for the description of surface properties, especially concerning:

- absorption characteristics of road surfaces;
- flow resistance of surfaces;
- mechanical impedance of road surfaces.

While the development of models and tools took place mainly during the first two years, year three was specifically dedicated to the review and assessment of the project results. The main activities demonstrated and validated the results by:
• suggesting optimised innovative road surfaces with an improved overall performance, based on the models developed for the prediction of noise, rolling resistance and wet grip;
• building such virtually designed surfaces by applying new and innovative road surface technology;
• validating the results by measurements.

Methodology:

The main key for the design of surfaces is understanding the interaction between tyre and road surface, this interaction being responsible for contact forces acting between the two. The contact forces are, at the same time, a starting point for the prediction of noise generation, rolling resistance and wet grip.

The main part of the work is based on the tyre/road noise model developed in the European project RATIN. Models have been developed to predict noise and rolling resistance, which also support the development of prediction tools for wet grip performance.

Despite the complexity of the models, it is essential that the tools can be applied in engineering applications. Therefore one or several surfaces are selected for a paving experiment. These experiments will be made on the full scale paving test site of RWTH Aachen. The demonstration allows for creating desired texture features without the restrictions incurred by the usual material selection or manufacturing process.

In order to verify tools and models, theoretical results are compared with measured performance of the manufactured road surface.

Parent Programmes:
FP6-SUSTDEV-3 - Global Change and Ecosystems

Institute type: Public institution
Institute name: European Commission
Funding type: Public (EU)

Lead Organisation:

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EU Contribution: €0

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**EU Contribution:** €0

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**Organisation Website:**
http://www.bast.de

**EU Contribution:** €0

**Key Results:**

One main outcome of the project was a database of road surface data and coast-by level spectra for 840 different tyre pavement combinations. These were specifically treated dense and porous pavements, driven over at rolling speeds from 50 km/h up to 120 km/h. The parameters of texture and acoustical impedance of the road surface have been varied in a systematic way. The tyre set comprised of 16 different types of passenger car tyres and 4 types of truck tyres including a subset of slick tyres. Results of near field measurements of the rolling noise of two sets of normal car tyres on the 42 different road surfaces completed the measurements. The data are unique due to thoroughly adjusted and controlled boundary conditions to ensure that the data were free from the corrupting effects of varying tyre temperature and inflation pressures etc. From the data it was possible to identify surface textures, which might give much lower tyre / road noise generation than is known from conventional pavements.

**Innovation aspects**

The frictional behaviour of rubber, unlike friction of other solids, is controlled by the very low elastic modulus giving high internal energy losses over a wide frequency band. The friction force is mainly derived from the loss modulus, a bulk property of the rubber. For tyre / road contact, two contributions of rubber friction become important, commonly described as the adhesion and hysteretic components,
respectively. Although pavement texture has been considered in tyre/road contact modelling within the last years this has been done in a more general, empirical way and, besides that, focussed on tyre/vehicle behaviour. To use friction modelling in designing the grip properties of pavement surfaces is a new approach adopted by this project.

**Technical Implications**

There are three properties that characterise the road surface in terms of tyre/road noise, grip and rolling resistance: texture, porosity and flexibility. In order to make road surfaces safe and durable, mixtures of mineral aggregates and powerful binders are used for the construction in the present situation. For safety reasons, the surface of a road must show a certain roughness combined with certain microscopic properties. The basic idea of this project was that the pavement characteristics can be optimised with respect to the tyre-road interactions: noise, rolling resistance and grip. When the physical processes that lead to these effects are understood mathematical models and consequently design tools can be developed that can help to make better pavements.

**Readiness**

The first attempts with the hybrid model within the Sperenberg project has shown that there are new, not yet applied textures and road constructions, which are likely to lead to very effective, noise reducing road pavements. The noise reduction potential is expected to be 6 dB for passenger car tyres on dense road surfaces (referenced to stone mastic asphalt 0/8 or 0/11). Combining these low noise textures with sound absorbing and/or flexible constructions should add at least 4 or 5 more decibels - independently from the tyre and the speed. However, the effects on grip, (durability) and rolling resistance are not yet known. To implement this noise reduction potential on real road surfaces investigations on new materials and construction methods are necessary which are able to produce textures, void structures and flexibility in a well directed and reproducible way - not neglecting the crucial properties grip, (durability) and rolling resistance. The problem of conforming to conventional road construction procedures has to be overcome. However, development of new types of road surfaces by means of measurement procedures and calculation models for analysis and synthesis will help to improve the state of the art.

Documents:
- Publishable report (Final report)

**STRIA Roadmaps:** Vehicle design and manufacturing
**Transport mode:** Air transport
**Transport sectors:** Passenger transport, Freight transport
**Transport policies:** Environmental/Emissions aspects
**Geo-spatial type:** Infrastructure Node