**Proceedings of WTC2005**
**World Tribology Congress III**
**September 12-16, 2005, Washington, D.C., USA**

**WTC2005-63268**

# QUANTIFICATION OF ACCELERATED WEAR FOR ROAD MATERIALS BY USING A NEW TESTING APPARATUS

**Hammoum F.**
Laboratoire Central des Ponts et Chaussées
BP 4129 – 44341 Bouguenais Cedex

**Stefani C.**
Laboratoire Central des Ponts et Chaussées
58, boulevard Lefebvre – 75732 Paris cedex 15

**Cottineau L-M.**
Laboratoire Central des Ponts et Chaussées
BP 4129 – 44341 Bouguenais Cedex

**Desroches J.P.**
Laboratoire Central des Ponts et Chaussées
BP 4129 – 44341 Bouguenais Cedex

## ABSTRACT

This paper focuses on problem of loss aggregates on the surface layer of pavements in particular sites such as approaches to roundabouts and pedestrian crossings. Obtaining a long life-wearing course requires more than can be achieved by improving the properties of the wearing course in it. Generally, the traffic loads, temperature variations, the intrusion of water and freeze-thaw cycles, which will reduce the life of the wearing course, regardless of how well it is designed and constructed. The wearing course is an important interdependent component of the whole pavement. A durable and faultless wearing course acts to protect the base layers against the intrusion of water from above, which is essential to maintain its strength and serviceable life. The objective of this study is to evaluate the wear of a controlled set of pavements with various aggregate mixtures. A single parameter is not enough to describe the mechanisms of surface damage but we propose relationships between the constituents used in pavements and loss of aggregates.

## 1. INTRODUCTION

The project included participation by vehicle, pavement and materials experts as well as researcher in tribology. The main purpose of the research was to simulate in laboratory the tyre/pavement contact and surface damage by loss aggregates. The research aimed to contribute to:

- the development of a new experimental device
- an evaluation of materials properties used in wearing courses
- the encouragement of the design of wearing courses
- a common international basis for future joint standards, testing procedures and policy initiatives for heavy vehicles in particular locations of road networks.

The programme consisted of four inter-related elements of research, which together formed a package that attempted to answer two basic questions:

a) Under controlled conditions, by which properties and how much do materials used in road (bitumen modified by polymer, resin epoxy, etc.) increase the resistance for stripping of the surface pavement, and what influence do they have in the mix on evolution on surface characteristics?
b) How do the results obtained under controlled conditions transfer to real road conditions?

## 2. EXPERIMENTAL DEVICE

It is important to define the actors (pavement, tyres, vehicle and environmental conditions) in a way that reproduces the real behaviour of the components. In particular:

- The wearing courses can be represented physically with testing road cores or laboratory compacted slabs. The surface characteristics of the compacted slabs can be evaluated by the right profile in 3D and then can be compared with the testing road cores.
- The type of tyre has to be defined by a piece of rubber that be applied on surface of materials.
- The vehicle has to be represented taking in account all the components influencing the forces generation (load, force or displacement controlled test, loading rate)
- The environmental conditions can be represented by temperature, moisture and chemical agents spill.

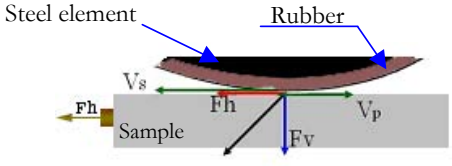


Figure 1. Contact between a piece of rubber and sample

The general requirements for a new test to evaluate the limitation for shear resistance of the surface pavement were selected based on review of research done in the past on evaluation of typical materials and conditions used to obtained this results [1], [3] [4] and [6]. It was clear that a new test must take in account the following factors:

- Evaluation of limitation for stripping on real materials (composition and surface characteristics)
- Taking in account the conditions of contact between tyre and surface pavement.
- Performance-related properties measured at multiple controlled conditions.

A laboratory investigation of stripping of asphalt mixtures used in road construction in France has been performed using a new experimental device. This test simulates stripping of wearing courses conditions such as vehicle breaking.

It was decided for this new experimental device to scale down a typical tyre/pavement contact by a vertical load applied on surface of sample. The main design includes a particular shape of piece of rubber that has the same characteristics than heavy truck's tyres. A unique hydraulic jacks push downward to create the vertical load, until 25 kN. This original shape imposed to piece of rubber can create the controlled tangential force from the vertical load and conditions of contact [5].

Each slab had a length of 270 m, a width of 170 mm and a thickness of 60 mm.

The slabs were fabricated using the LPC plate compactor. Each slab is compacted is a steel mould using a smooth pneumatic rubber tire. The test was run on a very thin asphalt mix named BBTM 0/6 to determine the effect of nature of bitumen on shear resistance of surface pavement.

## 3. RESULTS AND DISCUSSION

The friction and wear behaviour of rubber/bituminous mix couples was investigated in laboratory tests at room temperature and in dry conditions. With a very thin asphalt mix often used on French road, two different binders were tested: pure bitumen named BBTM 0/6 BP and a cross-linked modified bitumen by polymer named BBTM 0/6Bmp.

During each test, the tangential force and vertical displacement are recorded by computer system. The mass of each sample was measured before and after the wear test in an analytical balance capable of measuring to 1g. The mass loss depends of materials and conditions of loading. Several samples of each material was evaluated at different number of loading.

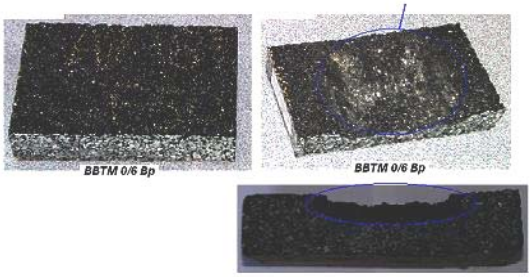


Figure 2. Surface damage observed after test

The friction and wear behaviour of rubber/bituminous mix couples was investigated in laboratory tests at room temperature and in dry conditions. We imposed a cyclic vertical force at ambient temperature and we defined the following set of parameters amplitude, frequency and duration of test. The sliding zone is limited to 65 mm.

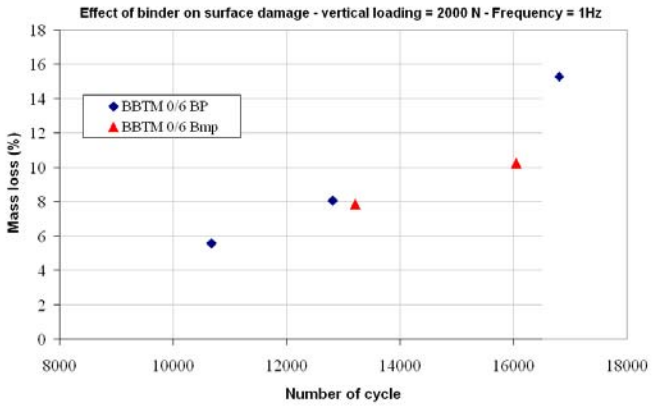


Figure 3. Effect of binder on shear resistance

To estimate the effect of binder on shear resistance, the friction coefficient is the same between surface pavements BBTM 0/6 BP and BBTM 0/6BmP [2].

With an imposed vertical force of 2000 N, the mass loss increases with the number of loading but the sample with a cross linked binder BBTM 0/6 Bmp give a better shear resistance than the sample with pure bitumen. However, we don't observe loss of aggregates from a bituminous mix surface with a small vertical force oscillatory motion.

## ACKNOWLEDGMENTS

Authors thanks Jean-Philippe Gourdon and Patrick Pauvert for help in preparation of the equipment device as well as the student Harold Fresnel for the experiments.

## REFERENCES

[1] De Beer M., C Fisher, F J Jooste (2002) "Evaluation of non-uniform tyre contact stresses on thin asphalt pavements", Ninth international conference on asphalt pavements, August 19-22,2002, Copenhagen, Denmark.

[2] Fresnel H. (2003) "Mise au point d'un banc d'essai innovant destine à étudier les problèmes d'endommagement de surface des revêtements routiers », Research report in French, LCPC /IUP Poitiers.

[3] Jolivet Y. et Malot M.(1996) " Le manège Total: contribution à l'étude des performances des enrobés très minces et drainants", Congrès Eurasphalt & Eurobitume, Strasbourg, E&E 4-055.

[4] Nicholls J.C. (1997) "Laboratory tests on high-friction surfaces for highways ",TRL report 176, pp. 36.

[5] Stefani C. (2000) "proposition pour l'essai d'arrachement", Private communication.

[6] Torbjörn J. (1993) " Wear resistance of bituminous mixes to studded tyres - A novel approach to field measurements and correlation with VTI's traffic simulator ", 5th Eurobitume Congress, Stockholm, 4.33, pp.857-861