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## CONTACT PROBLEM BETWEEN RUBBER AND ROAD TEXTURE : DETERMINATION OF PRESSURE AND CONTACT AREA DISTRIBUTION

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**Key word :** contact area; pressure; Fuji film, road texture.

**Summary :** In this paper we derive a method to evaluate the pressure distribution for the road/rubber contact problem. The method is based on Fuji Prescale pressure-sensitive film which is currently one of the more popular methods within the biomechanics community. We propose to use it on surface road for determining both pressure and contact area distribution.

### 1 INTRODUCTION

To improve comfort and safety and increase the durability of wearing courses, thereby helping to reduce maintenance sequences, wearing courses are being made thinner and rougher, with better skidding resistance, and faster to apply. The problem of determining the pressure distribution between the tire and the road is of enormous importance to the transportation engineering.

The surface characteristics of bituminous mixes depends of arrangement of the granular skeleton. For a given set of aggregates, the texture will depend of the constituent as the curve grading, nature of bitumen and of the compaction in place.

The aim of this work is to propose a methodology in the setting of the laboratory to determine the pressure distribution in contact problem between a piece of rubber and a sample of bituminous material. Experimental results needs a calibration of data from Fuji pressure-sensitive film. The objective of our research is to identify available laboratory techniques that would allow road laboratories to measure the impact of road texture on the pressure distribution.

The pressure distribution in the contact area between a tire and a road depends of several factors that it is been well investigated by De Beer [1]. For a well determined tire, the pressure in free rolling condition is related with the applied load and the pressure inflation.

The results obtained recently by Michelin [2] show that the effective contact area is estimated between 5 and 10 % of apparent area between a tire (for an inflation pressure equal 8 bars) and a new surface road. It seems that the heavy load is non-uniformly distributed in the effective area. The local pressure can reach 150 bars. The local pressure distribution can become the major mechanism for generating damage and evolution in surface characteristics of road.

### 2 METHODOLOGY

Pressure distribution applied to road materials, and more generally civil engineering ones, can be divided into four main steps:

i) Sample preparation, ii) Digitization of pink stain by using a scanner, iii) pre-treatment by converting the grey level to pressure distribution, iv) Extraction of the pertinent characteristics on digital image.

Our approach to the use of Fuji film prescale pressure-sensitive film was similar to those described by Liggins and al. [3] et [4]. The Fuji film was placed on a road texture and a piece of rubber (Shore 60°) was placed on the Fuji film with a pressure range between 0.5 – 2.5 MPa. Then, a uniform load was applied on the upper surface of the rubber during 15 secondes.

Fuji Prescale pressure-sensitive film (Fuji Photo Co Ltd, Japan) is a two part medium, consisting of a, A-film and a C-Film, both having an active coating on a polymer substrate. The active surface of the A-film consists of microscopic bubbles adhered to the substrate, within is encapsulated a colourless liquid. On the application of pressure, a number of bubbles will be burst, depending on the pressure magnitude. The active surface of the C-film contains a medium which reacts with the liquid released from the A-film, producing a characteristic pink stain.

In addition to pressure, the film's response is affected by load-rate, ambient temperature and relative humidity. Given these factors, the film requires calibration for the previous factors to any test protocol. A digitized image of the characteristic pink stain can be obtained by using a scanner connected to a personnel computer.

In third step, the pre-treatment by converting the grey level distribution of digital image to pressure needs a calibration curve. This calibration was reproduced here with a circular punch following the procedure given by Liggins and al. [4].

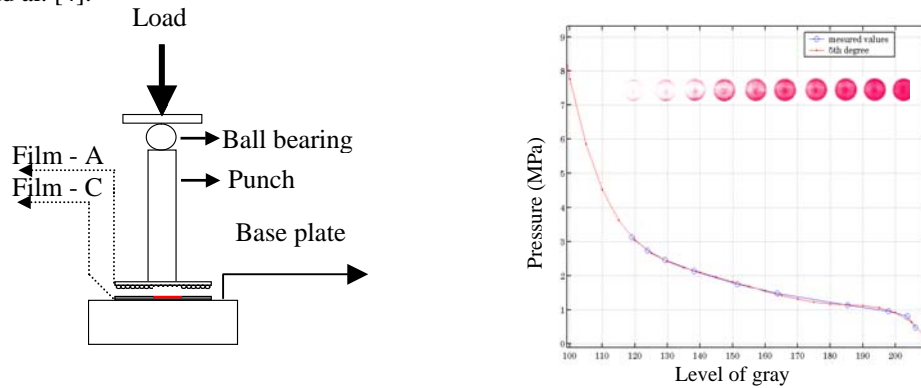


Figure 1. Fuji Film calibration apparatus and calibration curve

The last step consists to extract the pertinent characteristics of digital image. The mean of level grey was calculated from Otsu method [5]. The results presented in figure 1 were fitted from a 5<sup>o</sup> order polynomial curve.

### 3 DEPENDANCE OF CONTACT AREA UPON TEXTURE ROAD

We evaluate this method on three different road texture made with different aggregate size ( $D \leq 10\text{mm}$ ,  $D \leq 6\text{mm}$ ,  $D \leq 4\text{mm}$ ). The effective contact area depends of road texture and the difference can raise 10 % around 7.5 bars corresponding the applied load of heavy traffic (figure2b). Increasing the size of aggregate gradation seems a more concentrated pressure on surface road.

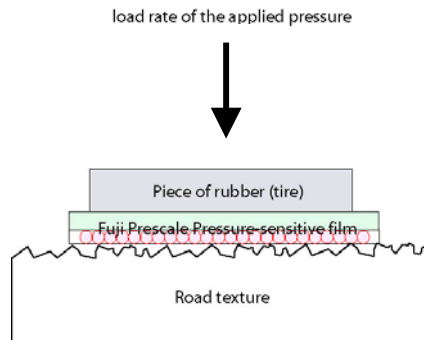


Figure 2a. Schematic diagram of Fuji Film placed between rubber and road texture

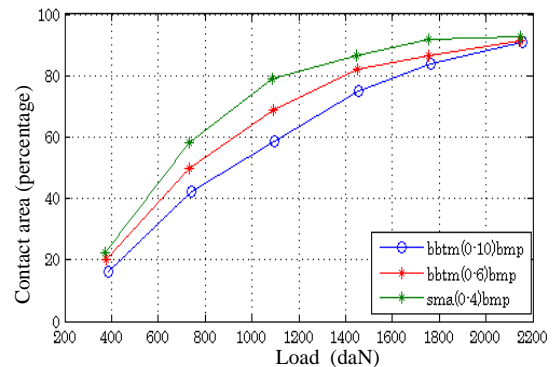


Figure 2b. Variation of effective contact area with applied load for different road texture

### 4 CONCLUSION

The pressure and area contact distribution at aggregate-scale was obtained by using the Fuji Prescale pressure-sensitive film. The results obtained in this study shows that for an applied load representing heavy traffic, the pressure and the contact area distribution that depends strongly of aggregate gradation size used on surface road.

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