

# Mechanical Behavior of UGMs

## Thin asphalt surfaced pavements

### Subject

In pavements with thin asphalt surfacing the unbound base and subbase layers provide the bulk of the bearing capacity. A more mechanically based approach of the behavior of these unbound granular materials (UGM) and their performance in pavements not only enables a better pavement design but it also promotes the introduction of functional specifications for those materials.

### Goal

Characterizing unbound granular road base and subbase materials using a relatively simple but more practical test method (a repeated load CBR) for developing countries and modeling their fundamental performance behavior and correlate with advanced testing techniques.

### Expected Results

Fundamental pavement design parameters such as resilient modulus and permanent deformation of UGM from the simplified and the advanced tests with good correlation, for use in mechanistic design of thin asphalt surfaced pavements.

### Thin Asphalt Surfaced Pavements



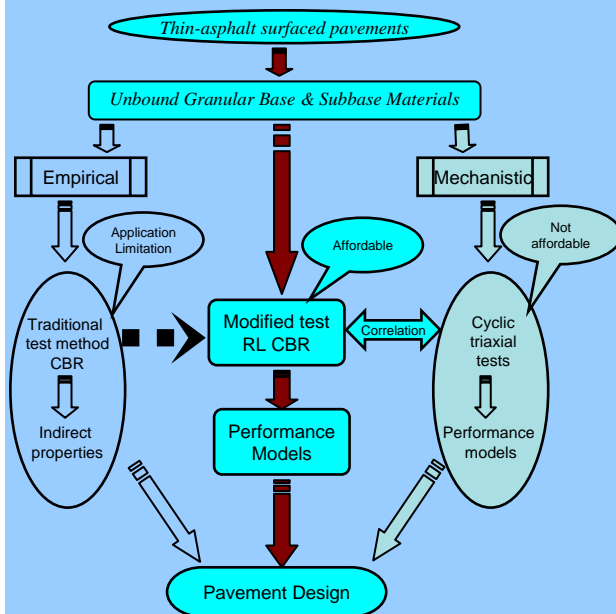
### Pavement Design

- Traffic
- Climate
- Material
- Construction

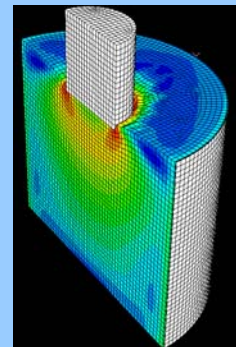
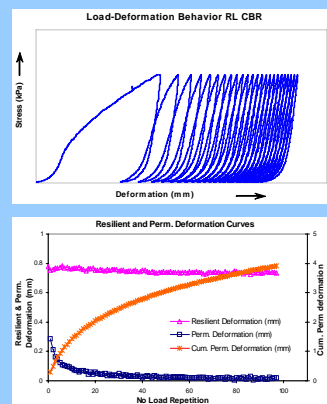


### Pavement Design & The Research Theme

Towards mechanistic approach



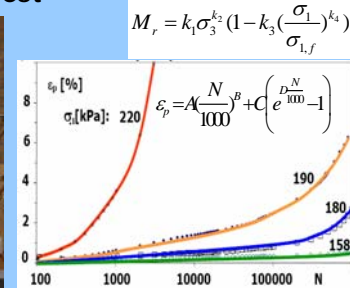
### Repeated Load CBR



$$E = \frac{1.727(1 - \nu^{1.886})\sigma_1(\epsilon)}{\nu^{1.05}} \dots \text{No-friction}$$

$$E = \frac{1.375(1 - \nu^{1.286})\sigma_1(\epsilon)}{\nu^{1.086}} \dots \text{Full-friction}$$

### Cyclic Triaxial Test



$$M_r = k_1 \sigma_3^{k_2} (1 - k_3 \frac{\sigma_1}{\sigma_{1,f}})^{k_4}$$

## **Mechanical Behavior of Road Base & Subbase Materials** **Thin asphalt surfaced pavements**



**Alemgena A. Araya<sup>1</sup>, Prof. Dr.ir. A.A.A. Molenaar<sup>2</sup> and ir. L.J.M. Houben<sup>2</sup>**

<sup>1</sup>PhD Researcher, [a.a.araya@tudelft.nl](mailto:a.a.araya@tudelft.nl)

<sup>2</sup>Supervisors

Delft University of Technology, Faculty of Civil Engineering and Geosciences, Road and Railway Engineering, Delft, the Netherlands.

### **Subject**

In pavements with thin asphalt surfacing the unbound base and subbase layers provide the bulk of the bearing capacity. A more mechanically based approach of the behavior of these unbound granular materials (UGM) and their performance in pavements not only enables a better pavement design but also promotes the introduction of functional specifications for those materials.

### **Goals**

Characterizing unbound granular road base and subbase materials using a relatively simple (a repeated load CBR) but more practical test method for developing countries and modeling their fundamental performance behavior and correlate with advanced testing techniques.

### **Research Question**

Is it possible to characterize the fundamental behavior of UGMs in a simplified more practical way which can be used in routine road projects?

Is it possible to develop a correlation between the relatively simple repeated load CBR test with the advanced triaxial test technique?

### **Strategy**

Developing a new test technique the repeated load CBR, from the empirical but widely used CBR test, to characterize fundamental parameters of granular materials i.e. the resilient modulus, shear strength and permanent deformation behaviors at different test condition such as degree of compaction, moisture content and gradation and correlate with advanced test techniques.

### **Expected Results**

Fundamental pavement design parameters such as resilient modulus and permanent deformation of UGMs from the simplified and the advanced tests with good correlation, for use in mechanistic pavement design method.

### **Preferred Partners Applications / Sponsors**

Road agencies in developing countries

Stellenbosch University, South Africa

Core Consulting Engineers P.L.C, Ethiopia

Vienna University of Technology, Austria

### **Prime Publication / Prototyping**

Araya, A.A. (2002) ; Estimation of Maximum Stains in Road Bases for Pavement Performance Predictions. MSc. Thesis. IHE-Delft, the Netherlands

Molenaar, A.A.A; Houben, L.J.M. and Araya, A.A. (2003) ; Estimation of Maximum Stains in Road Bases for Pavement Performance Predictions. In Paulo Pereira & Fernando Branco (Eds.), Maintenance and rehabilitation of pavements and technological control (pp. 199-206). Guimaraes, Portugal.

### **Research Period**

April 2007 – April 2011