Fatigue in asphalt material

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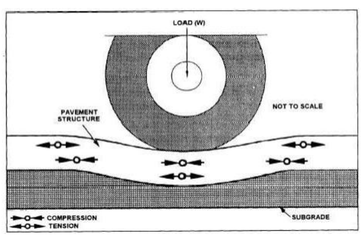
Background

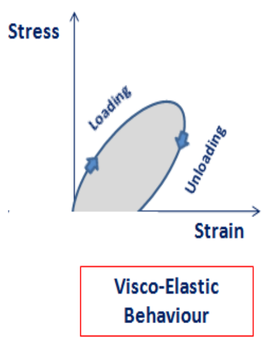
Why fatigue phenomenon?

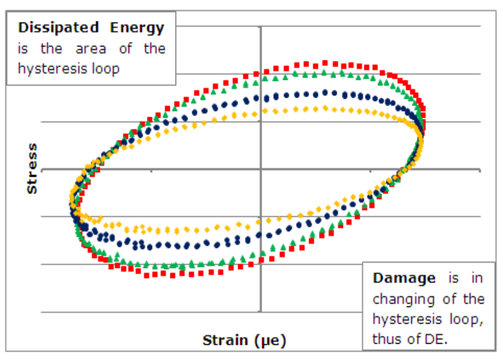
Flexural fatigue is one of the main failure modes in asphalt mixtures and flexible pavement structures.



Why dissipated energy method?

Asphalt is a viscoelastic material, thus energy is dissipated in the form of mechanical work, heat generation and damage.



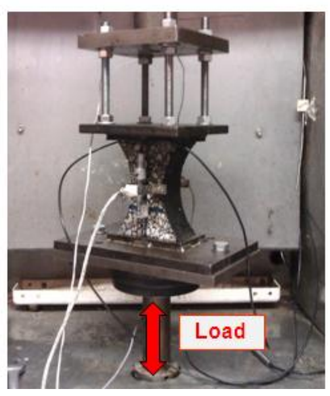


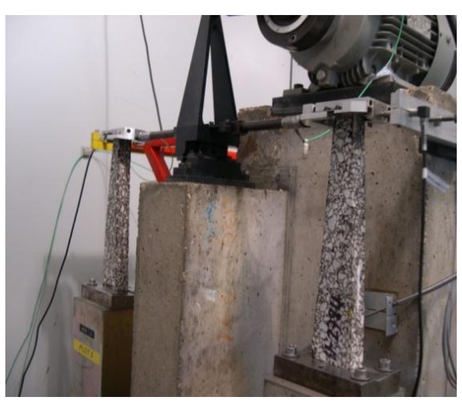
Methodology

Different approaches are usually used to characterise fatigue resistance in asphalt mixtures including the phenomenological approach, the fracture mechanics approach and the dissipated energy approach. The primary research goal of this project is to better understand fatigue behaviour of asphalt mixes, considering dissipated energy concepts. A literature review and a comparison and evaluation of different approaches that characterise the fatigue behaviour in different mixtures was under taken. Experimental work under two different temperatures (10 and 20°C) and under two different frequencies (15 and 25 Hz) were performed in order to obtain data for the dissipated energy analysis.

Laboratory tests

Different laboratory tests such as uniaxial tension-compression and ITFT at University of Nottingham, 2 Point Bending at IFFSTAR in Nantes and 4 Point Bending at the University of Palermo, have been used to undertake fatigue tests under wide loading and environmental conditions in order to correlate the changes in mixture properties.

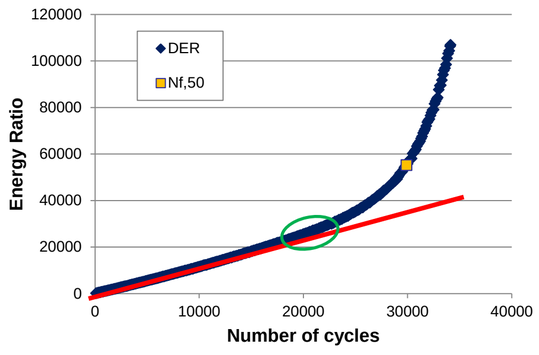


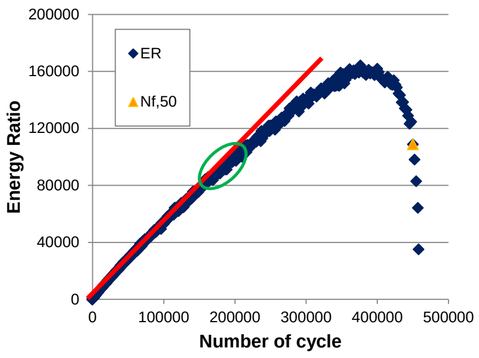


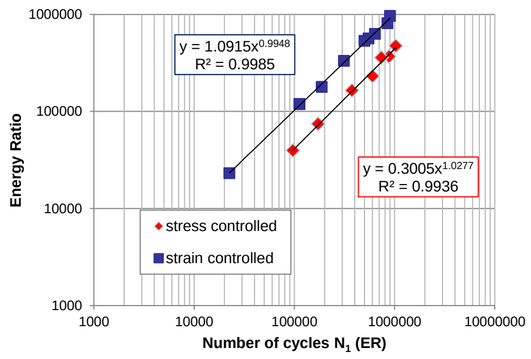
Data analysis

- *The Dissipated Energy Ratio (DER)*

Pronk (1990) suggested a new definition of fatigue life N1 based on the idea that a difference between the energy needed for the creation of micro-cracks and the energy needed for the growth of these crack exists. N1 represents the point at which micro-cracks will start to grow; crack initiation phase has ended at this point and crack propagation has started

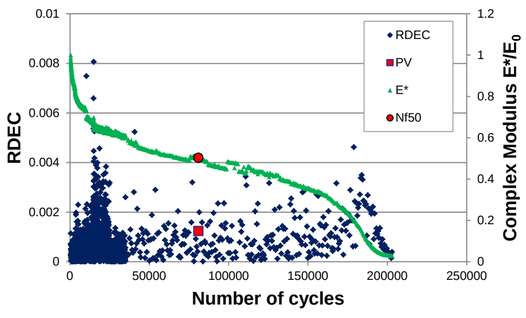


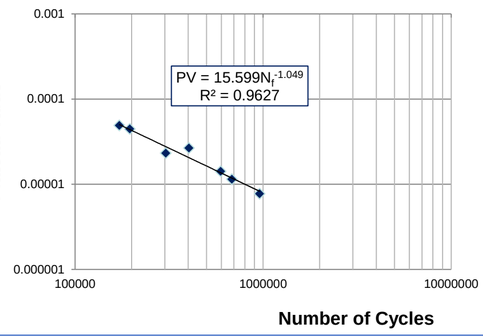


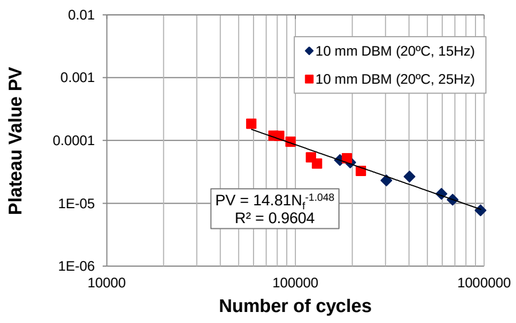


- *The Ratio of Dissipated Energy Change (RDEC)*

Carpenter and Shen (2007) suggested RDEC as true indicator of failure in asphalt pavements. The value of RDEC at the 50% initial stiffness reduction was defined as the Plateau Value (PV). Failure corresponds to the transition point at which the RDEC starts to increase dramatically and it was considered as the true failure point







Conclusions

- The Dissipated Energy Ratio method is a subjective graphical method. However it shows a new way to define failure in asphalt pavements.
- The RDEC method is interesting and the most promising because it focuses the attention to the changing of DE during a fatigue test. RDEC is a true indicator of damage because it is able to eliminate the other forms of dissipated energy due to mechanical work or heat generation; a good correlation was found for different frequencies.

Future work

- Healing effects
- More laboratory tests

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