Highly modified bitumen in perpetual pavements

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INTRODUCTION

It is commonly considered that the asphalt pavements are less durable than cement concrete pavement.

However, they don’t have to be!

Several years ago, in Europe and in the USA, there has been developed the concept of durable asphalt pavements known as *perpetual pavements* or *long-lasting pavements*.

Since that time, there has been made hundreds of sections of asphalt roads, which withstand heavy traffic in an excellent way.

If the concept of *perpetual pavements* is understood completely and if it is applied to the appropriate materials, it will be possible to achieve the above.
Asphalt pavement – way of work

Asphalt mixtures

Aggregate sub-base

Subgrade

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Asphalt pavement—way of work

Asphalt mixtures

Repeateable bending...

...leads to fatigue cracks

Aggregate sub-base

Subgrade

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Asphalt pavement – way of work

Asphalt mixtures
Repeatable bending...
...leads to fatigue cracks

Aggregate sub-base

Subgrade
Repeatable compression...
...leads to structural rutting

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**Concept of „perpetual pavements”**

**Perpetual pavements:**

Asphalt pavement designed for durability extending 50 years which does not require significant structural repairs (deep), however, it requires only periodic surface treatments which restore driveability.
The key to achieving such high durability is the suitable fatigue resistance of the asphalt courses.

The most important is the fatigue resistance of the lowest asphalt layer – usually asphalt base-course.
The phenomenon of **fatigue in asphalt mixtures**:  
- asphalt course in cyclic tensile (during bending)  
- the tensile strain values are smaller than the resistance of the material and do not lead to its destruction  
- thousands or millions of accumulated cyclic strains causes a crack in the asphalt course.
## Asphalt pavement - fatigue

### Improving fatigue strength of the asphalt pavement:

<table>
<thead>
<tr>
<th>by material way:</th>
<th>by structure change:</th>
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<tbody>
<tr>
<td>• Higher binder content in asphalt mix</td>
<td>• Stiffer asphalt layers (decreasing of strains)</td>
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<tr>
<td>• Stiffer binders (10/20, 20/30)</td>
<td>• Elastic layer in the bottom (better resistance to strains)</td>
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<tr>
<td>• More elastic binders (PMB)</td>
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<tr>
<td>• Lower content of air voids in asphalt mix</td>
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<tr>
<td>• Other parameters like VFB etc. improvement</td>
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Implementation of „perpetual pavements”

Two concepts of implementation:

• **French/British method** – **stiff asphalt layers** => EME mixes (in France), low content of air voids, fine graded, higher content of hard bitumen (pen25<30 dmm)

• **American method** – **special anti-fatigue (AF) flexible asphalt layer**, low content of air voids, fine graded, high content of modified bitumen or highly modified bitumen
European concept of „perpetual pavements”

Thin layer: SMA, PA, BBTM

stiff asphalt layers

Lower max. tensile strain

Subgrade and mineral sub-base
American concept of „perpetual pavements”

Thin layer type: SMA, PA, BBTM

asphalt layers resistant to deformation

Max. tensile strain

Elastic layer, with very high resistance to fatigue

Subgrade and mineral sub-base

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In Poland, we have applied mainly the French concept of EME - especially on motorways and express roads since 2005.

American concept was tested only in several cases:

- Experimental section SPENS in Pruszków (research project IBDIM) in 2007 using Heavy Vehicle Symulator, AF layer with modified bitumen ORBITON 80C from ORLEN Asfalt

- Road section on the regional road, ZDW* in Katowice, AF layer constructed with SMA 8 and modified bitumen ORBITON 45/80-55, 2009

- Express Road section on S8, Strabag, with highly modified bitumen, 2014/2015

*ZDW - Administration of regional roads in Silesia voivodeship
Highly modified bitumens

ORBITON HiMA

in perpetual pavements
The Technology, Research and Development Department of ORLEN Asfalt has been working on a new group of bituminous binders – highly modified bitumens, since 2011.

The aim was to introduce into the binder a significantly greater amount of a special SBS (elastomeric) polymer, thereby achieving the special properties of mineral and asphalt mixtures: very high resistance to rutting, and resistance to cracking and fatigue.

In 2013 there was created a new series of bituminous binders ORBITON HiMA for further industrial trials and on road test sections.
Highly modified polymer asphalts

The new family of highly modified bitumens ORBITON HiMA contains:

- ORBITON 25/55-80 HiMA
- ORBITON 45/80-80 HiMA
- ORBITON 65/105-80 HiMA

Applied acronym HiMA, according to the US terminology, means:

Highly Modified Asphalt.
ORBITON HiMA

Legend:
- Paving grade binder as per PN-EN 12591
- Typical modified binder as per PN-EN 14023
- Highly-modified binder ORBITON HiMA
Volumetric content of SBS polymer and bitumen:

**ORBITON HiMA**

(Continuous polymer matrix)

**Conventional modified bitumen**

(Continuous bitumen matrix)
Fatigue life: ORBITON 25/55-80 HiMA and ORBITON 45/80-80 HiMA
4PB-PR (EN 12697-24), 10°C, 10 Hz

Results with peak to peak amplitude (full amplitude)
Asphalt mixtures with ORBITON HiMA have achieved remarkable results of fatigue strength, locating them in the range of "Indefinite durability, immeasurable" (out of range) – they create a bigger reserve of fatigue life than other binders.
The results of fatigue tests performed on Gdansk University of Technology and on Road and Bridge Research Institute, using mixtures AC16W (for binder course), showed that:

• both of mixtures with bitumens ORBITON 25/55-80 HiMA and ORBITON 45/80-80 HiMA have achieved very good fatigue durability,

• typical values of tensile strain below 100 µε do not cause any remarkable fatigue damage in the mixtures

• approximation fatigue of durability mixtures with ORBITON HiMA, using the obtained fatigue equations, allows to get theoretical result durability more than 50 million axles, which means indestructibility of fatigue layer or durability more than 50 years of exploitation.
Conclusion
**ORBITON HiMA**

**Conclusion**

**ORBITON HiMA** is a binder dedicated to applications requiring very high performance, using the appropriate type/hardness.

- asphalt pavements subjected to high stresses and strains, eg.: on bridges
- layer with high resistance to low temperatures,
- thin and ultra-thin wearing course,
- **Asphalt base layers with very high fatigue strength, eg.: for long-lived pavement types as „perpetual pavements“**.

Highly modified bitumens ORBITON HiMA provide more than the standard value added to the quality of asphalt pavements.
Thank you for attention!