# TESTING OF ASPHALT MIXTURES

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## Introduction

Problems with asphalt mixtures are usual some years after the construction of pavements. Thereby, as part of the Technology Agency CZ TH04020154 project called "Optimization of the construction, repair and operation of asphalt-concrete linings", this research was developed to design and test asphalt mixtures and bitumen with additive to be used in the new lake coating of the Dlouhé Stráně Hydro Power Plant. The lining needs to be rebuilt because of existing failures and requires special properties, since it comes to different loading than in roadways.

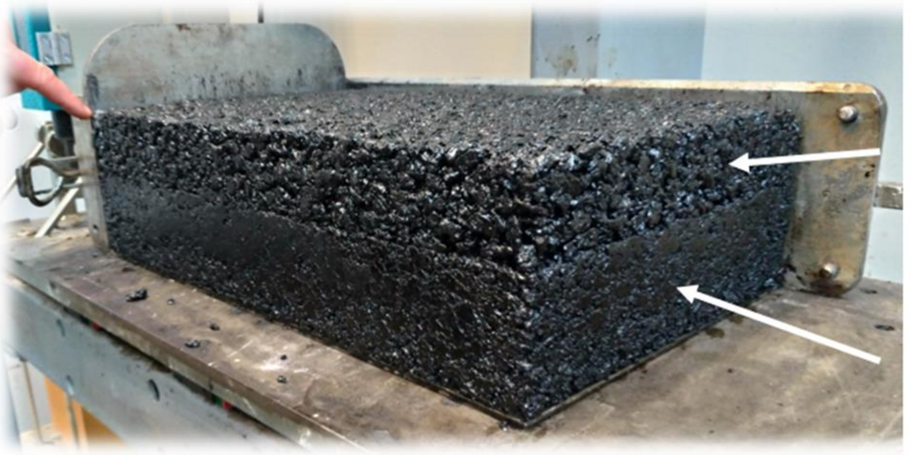
## Problematic

The Dlouhé Stráně Lake is the reservoir of the Hydro Power Plant, in operation since 1996 (Figure 1). After 15 years, fissures problems started to appear. Therefore, a new asphalt mixture and methods that avoid failures for longer time is required.

***Figure 1.*** *Dlouhé Stráně Lake. (source: seznam.cz)*

## Methodology

The design pavement is constituted of 2 layers described in Figure 2.



**BOTTOM LAYER**
**VABM 20% AIR VOIDS**
**(4% BITUMEN 70/100 + 0,4% BITHAFTIN)**

**TOP LAYER**
**VAB16 – 1% AIR VOIDS**
**(6,4% BITUMEN 70/100 + 0,4% BITHAFTIN)**

***Figure 2.*** *Lake pavement sample, with described layers (upside down)*

To produce the mixture, the aggregates, bitumen and *Bithaftin* additive were prepared and mixed as shown in Figure 3. For Marshall samples the Marshall Compactor was used, and for the pavement slab sample the Roller Compactor was used (Figure 3). Also to determinate mixture properties, the following tests were made: Bulk Density Determination, Maximum Density Determination in Pycnometer and Wheel Tracking Test.

***Figure 3.*** *Preparing, mixing, and compacting the asphalt mixture*

For the bitumen, the tests were: Penetration test, Softening point, Bending Beam Rheometer (BBR) test and Dynamic Shear Rheometer (DSR) test. In addition, Bitumen Aging Methods: Rolling Thin Film Oven Test (RTFOT) and Pressure Aging Vessel (PAV). It was tested according with the ČSN EN.

Also, from the pavement sample, cylindrical samples were drilled to be tested in a new prototype machine that simulates real conditions of the pavement in the lake (changeable pressure, and temperature switched heating and freezing)

***Figure 4.*** *Drilled, prepared, and on test pavement samples*

## Results

In Chart 1 there are the characteristics of the used mixtures (density and air voids). Figure 5 and Table 1 show the obtained properties of bitumen with additive used in the mixture along the time, simulated by short-term aging (RTFOT) and long-term aging (PAV). There are also results of the critical temperature (after BBR test), penetration value, and softening point (Figure 6).

| BULK DENSITY | | | | |
|---|---|---|---|---|
| Mixture Type | VABM | | VAB16 | |
| Marshall Sample | 6 | 7 | 8 | 9 |
| $\rho_{dimension}$ [kg/m³] | 1983 | 1947 | 2399 | 2389 |
| $\rho_{under\ water}$ [kg/m³] | 2339 | 2294 | 2420 | 2417 |
| $\rho_{maximum}$ [kg/m³] | 2530.5 | | 2438.0 | |
| $P_{dimension}$ [%] | 22.3% | | 1.8% | |
| $P_{under\ water}$ [%] | 8.5% | | 0.8% | |
| Porosity $_{average}$[%] | 15.4% | | 1.3% | |

***Chart 1.*** *Bulk density and Porosity*

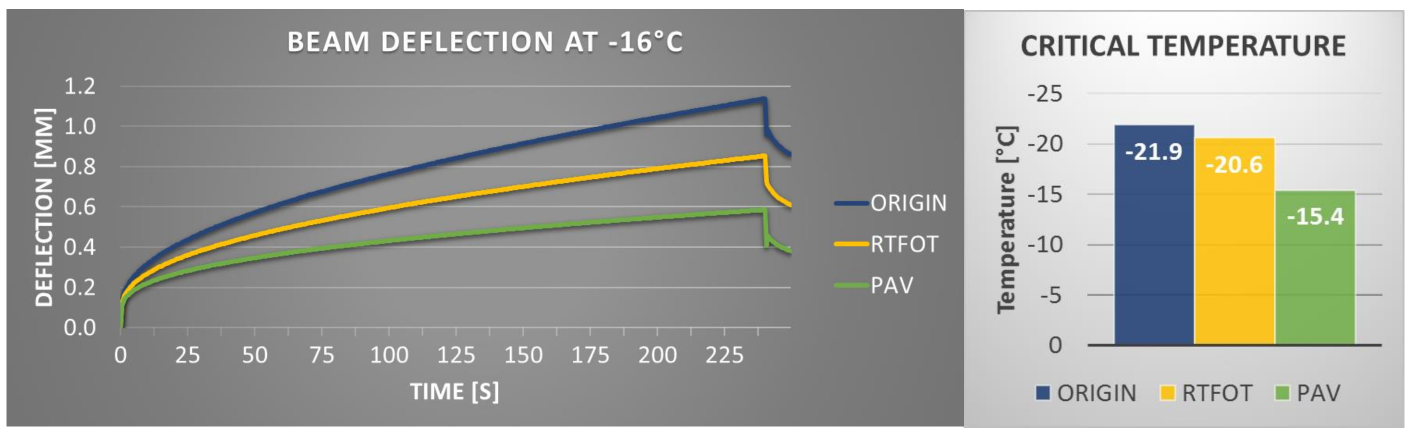



***Figure 5.*** *Beam deflection at -16°C (left) and Critical temperature (right).*

| Bitumen | Critical Temperature [°C] | Penetration value | Softening Point [°C] |
|---|---|---|---|
| ORIGIN | -21.9 | 78 | 47.0 |
| RTFOT | -20.6 | 47 | 52.4 |
| PAV | -15.4 | 25 | 59.5 |

***Table 1.*** *Bitumen properties after aging*

***Figure 6.*** *Ring & Ball test*

## Conclusion

- ✓ The air voids of the layers were within the expected;
- ✓ After short-term aging, the critical temperature decreased just 1,3°C, but the penetration value decreased 31. While for long-term aging (simulating around 10-15 years), the critical temperature decreased 6,5°C, and the penetration value decreased 53.
- ✓ Therefore, after aging the resistance of low temperature was 6,5°C worse.

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