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Cohesion Properties of Bitumen of Different Structures

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Abstract

The method and equipment for determining the mechanical properties of different road bitumen were developed in KhNAHU. The method has three schemes of deformation and fracture of binders, which are located in thin layers. As a result, the following quality parameters of bitumen can be defined: the limiting tensile strength, specific energy fracture, the limiting shear strength (cohesive strength) and the glass transition temperature. The paper shows the dependence of these parameters on the change in thickness of bitumen films, the strain rate (load) and temperature. Information about the cohesive strength of asphalt with different viscosities and different structural types ("Sol" "Gel" and "Sol-Gel") is shown here. Bitumen composition has different influence on its strength, so comparisons of cohesive binder properties with the same consistency were made.

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Keywords: bitumen; structural type; cohesion; cohesive strength; glass transition temperature.

1. Introduction

The adjustment of asphalt concrete mechanical and structural properties is associated with research of its components, including bitumen. Strength and durability of asphalt concrete depend on strength of a binder material to a large degree. Also, the strength of bitumen is practically defined by its cohesion.

The researches of bitumens and bituminous binders cohesive strength are generally carried out using CEN EN 13588. Modification bitumens are tested as usual (Hunter 2000; Airey et al. 2001). However there are no data which could show the value dependence of cohesion on binder structure.

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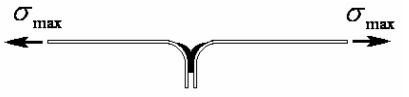
In general, cohesion is an adhesion of homogeneous molecules, atoms or ions inside the material. It includes all types of attraction. Cohesion of bitumen is difficult to determine because it is a multi-component material with a complex permolecular structure. It hasn't a boiling point.

The energy of cohesion is estimated by a reversible isothermal energy of rupture in the body by section, which is equal to one square. The cohesive rupture energy consists of cohesion work and the work of deformation: $W = W_{coh} + W_{def}$. If there is a deformation, this property is rheological.

2. Research method

Two schemes of deformation were used in this work:

- Test of a gradual rupture of the strong elastic strips which are glued by bitumen.

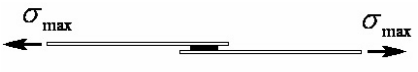


A specific energy of rupture W and tensile index σ (Moskvitin 1974) can be defined:

$$W = \frac{Wo}{S} = \frac{\omega}{S},\ \sigma = \frac{\sigma_{\max}}{b}, \tag{1}$$

where W_0 – energy of rupture; ω – area of stress-strain curve, S – cross-sectional area; σ_{max} – force, b – width.

- Testing of the shear (plane-plane).



The ultimate shear strength can be determined:

$$\tau = \frac{\sigma_{\max}}{s}, \tag{2}$$

where S – area of bitumen.

KhNAHU cohesion meter consists of a mechanical device and electrical equipment. The main feature of the new method is a device, which consists of high-elastic polymer strips which are glued by binder. One strip is attached to a device for moving, the second one is attached to the strength meter (Fig. 1).

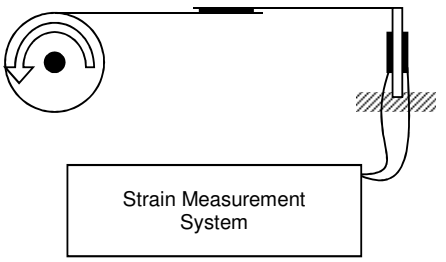


Fig. 1. Definition of cohesive strength with a constant shear speed.