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Results of Using Modern Rehabilitation Techniques in Flexible Road Pavements

Tengiz Papuashvili Department of Roads, Georgian Technical University, Georgia, Tbilisi, 0160, 68[B], Kostava str.
E-mail: papuashvilitengizi01@gtu.ge

Aleks Burduladze Department of Roads, Georgian Technical University, Georgia, Tbilisi, 0160, 68[B], Kostava str.
E-mail: a.burduladze@gtu.ge

Nugzar Rurua Department of Roads, Georgian Technical University, Georgia, Tbilisi, 0160, 68[B], Kostava str.
E-mail: n.rurua@gtu.ge

Davit Getsadze Department of Roads, Georgian Technical University, Georgia, Tbilisi, 0160, 68[B], Kostava str.
E-mail: dgetsadze@gmail.com

Reviewers:

P. Nadirashvili, Professor, Faculty of Construction, GTU
E-mail: p.nadirashvili@gtu.ge

K. Mchedlishvili, Professor, Faculty of Construction, GTU
E-mail: mtchedlishvilikonstantine01@gtu.ge

Abstract. The results of using modern techniques of rehabilitation in flexible road pavements are presented. The modification of road bitumen's using surface active additives (SAA) has been studied. The paper also discusses possible use of the "Superpave" methodology for bitumen used in road construction in Georgia, which was first performed by the scientific collectives of the USA, Canada and Europe.

The implementation of the MSCR test is presented, which allows to evaluate the effectiveness of the polymer modification and the resistance of the polymer grid to the load at a specific temperature. Attention is also focused on the role of the binder in the formation of the main defects of road wear, because 60% of the formation of pavement fatigue cracks and other defects comes from the binder.

Keywords: adhesion; bitumen; hardness; non-rigid phenyl.

Introduction

It is known that even the use of the best bitumen does not always guarantee the high quality of the road

surface. The quality and durability of asphalt depends on many factors:

- On the composition and quality of organic binder - bitumen;
- On the quality and granulometric composition of the mineral filler;
- On the protection of the technological regime during the production and compaction
- of the asphalt concrete mixture;
- Road surface operating conditions and other factors.

Bitumen, in the composition of asphalt concrete, is essentially a glue that binds the solid particles of a given granulometric composition, mineral filler, and thus creates a single solid monolith. From this point of view, bitumen should have the following properties:

- Good adhesion to mineral material,
- Resistance to the atmosphere,
- To ensure the calculated strength and durability of asphalt concrete,
- To ensure the stability of the asphalt concrete coating on the external conditions of operation.

Even the use of high-quality bitumen (without additives), especially on high-speed and high-load sections, cannot fully satisfy the increased requirements for asphalt concrete. As a rule, high strength inert materials are acidic and for this reason do not adhere well to bitumen which is either neutral or low acidic in nature. Due to this, the insufficient amount of adhesion of mineral materials and organic binders leads to premature breakdown of the road surface. The situation noticeably changes for the better when road bitumens are modified with surface-active substances (SAA), the so-called with special adhesive additives.

Main Part

During the modification of road bitumens, when we use a cationic type of adhesive additive, the bitumen acquires the ability to reliably stick even to wet mineral materials, which allows us to increase the duration of the road construction season. The strength characteristic of asphalt concrete made using bitumen with a modified additive increases, Accordingly, the period of maintenance-free operation of the road surface increases. Thus, the use of adhesive additives was well included in the development concept of road construction.

The cationic adhesive additive in the bitumen should be directly introduced into the asphalt concrete plant during the preparation of the asphalt mixture. This is due to the low thermal stability of bitumen and its additives and is explained as follows: The high chemical activity of the additive, on the one hand, ensures high adhesion rates of modified bitumen, on the other hand, the active polar amino group of the additive leads to the flow of chemical interactions. This affects the more reactive hydrocarbon groups that make up the bitumen. Partly with oxygenic acids. As a result of chemical reactions, the additive loses its activity, that is, it is simply consumed and neutralized. The content of adhesive additive in bitumen does not exceed 1% by mass.

The quality and durability of asphalt concretes are significantly influenced by the polymer materials used for bitumen modification. Modification of bitumens with polymers is carried out in order to improve these or those characteristics, both of the bitumens themselves and of the asphalt concrete mixture based on them.

Let us consider some aspects of bitumen modification thermoelastoplast, which is the most widely used bitumen modifier today. Some researchers modify bitumen road markers with a polymer obtained by direct oxidation technology.

Modification of stainless bitumens with polymers is easier and more efficient due to the following factors:

– Due to the thin dispersed colloidal structure, "ash" - the rate of diffusion of the colloidal formation is greater, the smaller the particle size;

– Due to the high content of aromatic compounds, which have great similarity with the given polymer;

– Due to the small amount of asphaltenes in the bitumen composition, which do not participate in dilution, but cause steric complications during the distribution of the polymer in the solvent mass-bitumen.

Industrial oil И-20, И-40 is more widely used as a classifier for the modification of road bitumen. This method is controversial. Named oils usually consist of hydrocarbons with a naphthenic structure. The similarity between this solvent and the type of polymer in question is low. From the point of view of thermodynamics, it is more appropriate to use oil residues containing aromatic compounds for the plasticization of polymers. With such an approach, the problem of improving the quality of bitumen will be solved more completely at the cost of modification than in the case of using components of the (naphthenic) structure. Therefore, when choosing a modifying polymer additive, it is necessary to take into account the properties and nature of the polymer, as well as the properties of the bitumen and the plasticizer.

These compounds, thanks to the formation of hydrogen bonds, are connected to the surface of the stone material with functional groups. Hydrocarbon radicals bind to bitumen by van der Waals forces. Additives should have such a balance that their adhesion to stone material should be better than water adhesion and exceed the value of bitumen unity.

The process of creating a new material or improving the properties of an already released material includes defining and justifying the requirements for the future product. In addition to the study of the sectoral normative base, this stage should include the analysis of world-level scientific studies in a specific field. In the processing of materials for the road industry, it is particularly interesting to study and use the US "Superpave" methodology and the data of structural studies of binders, performed by the scientific collectives of the USA, Canada and Europe. The "Superpave" methodology is a promising tool for both traditional binders and manufacturers of new materials, however, direct copying of American specifications should be approached critically due to the complexity of the test objects. In order to adapt "Superpave", the bitumens used in Georgia should be taken into account. 40-90% of the main defects of modern road pavements are caused by binders (Fig. 1).

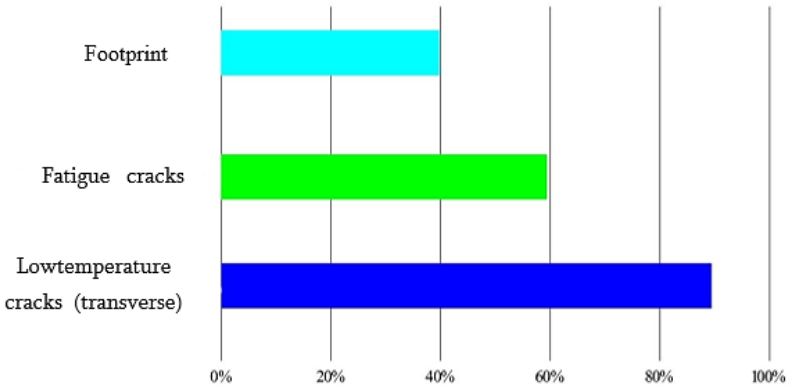

Fig. 1. The role of the binder in the formation of the main defects of road surfaces

During the design process according to "Superpave", the mandatory characteristics of the binder are determined based on the extreme temperature of the pavement and the expected intensity of road traffic. The scientific basis and binder specification for Superpave was developed in the USA 20 years ago, after which many states began to adopt and implement this specification. By the beginning of 2000, it was found that the developed test methods, on the basis of which the relevant ASTM and AASHTO standards were issued, were adopted in some cases for modified binders. This was due to the fact that certain simplifications were allowed in the development of the test methodology. For example, the test for resistance to the formation of footprints is carried out in the framework of a linear viscoelastic relationship at small loads, with further

extrapolation of the obtained data. A similar method is used in the assessment of resistance to fatigue and low-temperature cracking. In order to reduce the time of PAV-aging of the samples, a temperature of 110^{O}C is used based on the principle of temperature-time superposition. These assumptions were acceptable for ordinary bitumen. The situation changed dramatically when modified binders entered the market, including those modified with polymers of various natures. It was found that these binders, including the polymer network formed in them, are differently sensitive to different levels of loading. It was also found that the implementation of long aging (PAV) even at a temperature of 90^{O}C can lead to the destruction of the polymer (СБС) or the melting of crystals (ЭВА), etc. The limitations of the basic concepts, which were embedded in the basis of the examination methods, were revealed.

As a result of all this, a universal methodology was developed, which would be acceptable for both bitumen and modified binders - the so-called PG Plus Specification, which are focused on the use of specific industrial samples of modified binders. In the development of universal standards, which would be suitable for testing both pure bitumens and modified binders, it has been adopted to evaluate binders in terms of resistance to rutting, such as the MSCR-test, which is carried out during the maximum summer temperatures of the region, depending on the conditions of use of the binder.

It should be noted that the MSCR-test precedes the examination of the mixture on the stability of the formation of footprints, which allows to evaluate the efficiency of the polymer modification and the stability of the polymer grid to the load at a specific temperature, and thus justify and optimize the selection of the binder, including the economic criterion.10-12, sometimes up to 100 kPa.~There is a non-standardized variation of MSCR that allows to obtain much broader information about the behavior of binders under different conditions. In this case, the measurement is performed not for two load values (0.1 kPa and 3.2 kPa), but for 8-10 values, which include the range of 0.

Conclusion

1. The effectiveness and reliability of the "Superpave" and MSCR-test methodology is mostly due to the fact that the binder test is performed at high temperatures (over 50-60^{O}C), when the influence of the binder structure on the test results is minimal or absent.

2. Bitumens modified with polymer additives allow to reduce the impact of seasonality on technological processes during construction.

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არახისტ საგზაო ფენილებში რეაბილიტაციის თანამედროვე მეთოდების გამოყენების შედეგები

თენგიზ პაპუაშვილი საგზაო დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 68[ბ]
E-mail: papuashvilitengizi01@gtu.ge

ალექსი ბურდულაძე საგზაო დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 68[ბ]
E-mail: a.burduladze@gtu.ge

ნუგზარ რურუა საგზაო დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 68[ბ]
E-mail: n.rurua@gtu.ge

დავით გეწაძე საგზაო დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 68[ბ]
E-mail: dgetsadze@gmail.com

რეცენზენტები:

პ. ნადირაშვილი, სტუ-ის სამშენებლო ფაკულტეტის პროფესორი
E-mail: p.nadirashvili@gtu.ge

კ. მჭედლიშვილი, სტუ-ის სამშენებლო ფაკულტეტის პროფესორი
E-mail: mtchedlishvilikonstantine01@gtu.ge

ანოტაცია. წარმოდგენილია არახისტ საგზაო ფენილებში რეაბილიტაციის თანამედროვე მეთოდების გამოყენების შედეგები. შესწავლილია საგზაო ბიტუმების მოდიფიკაცია ზედაპირულად აქტიური ნივთიერებების (ზან) გამოყენებით. ასევე განხილულია საქართველოს საგზაო მშენებლობაში გამოყენებული ბიტუმებისათვის მეთოდოლოგია ,,Superpave“, რომელიც პირველად შემუშავებულ იქნა აშშ-ის, კანადისა და ევროპის სამეცნიერო კოლექტივების მიერ.

წარმოდგენილია MSCR - ტესტი. რომელიც საშუალებას იძლევა შეფასებულ იქნეს პოლიმერული მოდიფიკაციის ეფექტურობა და პოლიმერული ბადის მდგრადობა დატვირთვისადმი კონკრეტული ტემპერატურის დროს. ასევე ყურადღება გამახვილებულია შემკვრელის როლზე საგზაო სამოსების ძირითადი დეფექტების ჩამოყალიბებაში, რადგან საფარის დაღლილობის ბზარების და სხვა დეფექტების წარმოქმნაში 60% შემკვრელის წილად მოდის.

საკვანძო სიტყვები: ადჰეზია; არახისტი ფენილი; ბიტუმი; სიმტკიცე.

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