



RESEARCH ON NORMATIVE PARAMETERS OF ASPHALT MIXTURES USED FOR THE STREET PAVEMENTS UNDER THE CONDITIONS OF LITHUANIA

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Abstract. Chapter 1 describes the analysis of service conditions of flexible road and street pavement structures in Lithuania and their condition. Chapter 2 describes the asphalt concrete mixtures for road pavement structures and theoretical background for its quality improvement. Chapter 3 presents the experimental research of asphalt mixtures used for laying wearing courses, base courses and foundation layers of pavements. Chapter 4 gives the improvement of the normative parameters of asphalt mixtures and establishment of new limit values.

Keywords: normative parameters of asphalt mixtures, bitumen binder, asphalt layers, pavement layers.

Topicality of the problem

Over the last 20 years, the traffic volume on the roads and streets of Lithuania has significantly increased, the share of heavy vehicles in a traffic flow has grown, the axle loads of heavy vehicles have also increased, therefore, road and street pavements often contain deformations of plastic nature, i.e. ruts and corrugations. This requires paying special attention to the selection of asphalt mixtures and their separate components meeting traffic and climatic conditions, the design of asphalt mixture compositions, as well as technological process and quality control of the laying of asphalt pavements.

Results of the researches show that plastic deformations in road and street pavements most frequently occur in the wearing course of asphalt pavement during a summer period when pavement temperature reaches 30–60 °C and pavement structure is affected by heavy vehicle loads, braking forces, etc.

Analysis of the design composition of asphalt mixtures used for laying the wearing and base courses of Vilnius city street pavements showed that asphalt mixtures used for the wearing and base courses of pavements are designed and produced with bitumen content which meets the requirements of normative documents, however, close to the min limit. This shows that when using min bitumen content the asphalt mixtures of good properties are obtained, thus, there is a need to determine the properties of asphalt mixtures and their dependency on bitumen binder content in case the content is lower than that required by the normative documents.

The article studies a topical problem of civil engineering science. There is a necessity to reasonably determine if the requirements set by the normative documents to the asphalt mixtures used for the wearing courses, base courses and foundation layers of pavements are applicable and if the limit values set for the properties of asphalt mixtures correspond to the physical and mechanical properties of asphalt mixtures used.

Research object. Asphalt mixtures used for laying wearing courses, base courses and foundation layers of city streets designed according to the normative documents.

The aim of research is by theoretical and experimental researches to determine the reasonable limit values of normative documents for the asphalt mixtures used for laying the wearing course, base course and foundation layers of the city streets in Lithuania.

The following tasks were solved to achieve the aim of research:

1. To determine interaction between the structural elements of asphalt mixtures.
2. To carry out the analysis of factors determining the quality of asphalt and asphalt mixtures.
3. To study technical documents and normative requirements applied for the asphalt mixtures in another countries.
4. To make laboratory investigations of asphalt mixtures used for the wearing courses, base courses and foundation layers of city street pavements and to determine physical and mechanical properties of asphalt mixtures.

5. To carry out mathematical and statistical evaluation of the results of experimental research.

6. To prepare recommendations for the limit values of normative documents related to the asphalt mixtures and based on them to work out the draft construction regulations for laying the wearing courses, base courses and foundation layers of Vilnius city streets.

Methodology of research

The following research methods were used: mathematical analytical, mathematical statistical, experimental-laboratory and comparative analysis.

For the analysis of research data statistical and optimisation methods were used.

Scientific novelty

Scientific novelty and importance of research are represented by the following important results:

1. Theoretical principles and assumptions were formulated for selecting the bitumen content of asphalt mixtures in order to exceed the min limit values for bitumen content.

2. Recommendations are given for asphalt mixtures used for laying the wearing courses, base course and foundation layers of city street pavements.

Practical value

1. Based on the recommendations given and the technical documents valid at that time for the asphalt mixtures the draft construction regulations were worked out for laying wearing courses of asphalt pavements of city streets (in 2004 and 2010).

2. Based on the recommendations given and the technical documents valid at that time for the asphalt mixtures the draft construction regulations were worked out for laying the base courses and foundation layers of asphalt pavements of city streets.

1. Analysis of service conditions of flexible road and street pavement structures in Lithuania and their condition

City streets, unlike rural roads, are intended for the traffic of vehicles and pedestrians between the city regions and are joined with the urban roads and city by-passes (Burinskienė *et al.* 2003). One of the main indices showing the demand of city streets and their capacity is traffic volume.

Till the year 2008, due to the increased traffic volume, the grown-up share of heavy vehicles in a traffic flow and the increased axle loads of heavy vehicles the deformations of plastic nature had occurred on the roads and streets of Lithuania (Čygas *et al.* 2007; Šliupas 2009).

One of the purposes of pavement is to get deformed as less as possible under the continuous effect of loads and to protect the underlying structural layers. However, under the effect of various natural factors and vehicle

loads it is impossible to fully prevent pavement from deformations. The extent and type of deformations depend on pavement structural resistance, the relationship of loads and climatic conditions (Palšaitis 1998).

In recent years, the design of pavement structures using mechanical-empirical models is getting more and more popular, where knowing the properties of materials used for the structural pavement layers and the thicknesses of layers it is possible to determine a load-carrying capacity of the whole pavement structure. Or on the contrary, knowing the load to be withstood by pavement structure it is possible to select the proper thicknesses and materials for the layers.

After the restoration of independence of Lithuania, the first Lithuanian document based on which road pavement structures were designed was *Road Design Standards and Rules PNT-K 95*. In 2001, a new document was approved, i.e. *Regulation of Motor Roads STR 2.06.03:2001*, which was used when designing road pavement structures. Design principles has not changed, the only revision was made to the limits of determining road pavement structures of class V and VI based on the index of heavy vehicles. Since 2007, road pavement structures are designed according to the *Design Rules for the Standardized Pavement Structures of Roads KPT SDK 07*. If the methods established by the technical documents *PNT-K 95*, *STR 2.06.03:2001* and *KPT SDK 07* for the determination of the class of pavement structure are compared, it is obvious that no essential changes related to the methodologies were made, only the assessment of heavy vehicles volume for the pavement structure depending on the axle loads was changed. However, none of those technical documents refers to material properties, i.e. no calculation methods are used which, when knowing material properties influencing the elastic moduli and thicknesses of material, helps to determine the load-carrying capacity of pavement structure.

Flexible road pavement structure is described as a multi-layer elastic system the material of each layer of which is characterized by physical properties. Physical properties of materials determine the elastic modulus and Poisson coefficient of the structural layers of flexible pavement. A wheel load of vehicle causes distribution of tensile stresses within the road pavement structure (Laurinavičius *et al.* 2005; Žiliūtė *et al.* 2010).

The largest destructive impact on city streets, i.e. occurrence of cracks and deformations, is made by the traffic volume of heavy vehicles and their generated loads (Laurinavičius *et al.* 2005).

Road pavement structures are affected not only by the traffic volume of heavy vehicles and loads. Not a less impact on the occurrence of deformations is caused by climatic factors.

Asphalt properties depend on temperature. With the increasing asphalt temperature the viscosity of bitumen binder decreases and this worsens connections between mineral materials resulting in the reduction of

asphalt strength. The change in asphalt strength due to temperature variations is large and this worsens the service conditions of asphalt pavements. With the changing asphalt strength the deformation properties of asphalt pavement also change. Under high ambient temperature asphalt pavement shall be resistant to the occurrence of plastic deformations, under low temperature – shall remain elastic (Čygas *et al.* 2006).

The asphalt pavement of roads and streets is affected by vehicle traffic and climatic factors. Due to those two factors various deformations are formed in insufficiently strong flexible pavement. In flexible and weak asphalt pavement due to vehicle traffic the fatigue cracks occur. Deformations of plastic nature and temperature cracks are caused by climatic factors. Other deformations are formed under the effect of vehicle traffic and climatic factors together.

With the increased traffic volume on the roads and streets of Lithuania, the increased number of heavy vehicles and their axle loads the deformations of plastic nature, i.e. ruts and corrugations, often occur in pavements of roads and streets. Those deformations significantly worsen traffic conditions, aggravates pavement maintenance works (Čygas *et al.* 2000; Oscarsson 2011).

Having studied the network of roads of national significance of Lithuania and of Vilnius City streets, the development of car ownership and the climatic factors influencing roads and streets, also having analysed the models of the formation of flexible pavement deformations there is a necessity to determine and assess the conformity of the properties of asphalt mixtures, used for asphalt pavements of streets, to the technical documents. Also, to define if the current requirements of technical documents to the properties of asphalt mixtures shall be corrected or they conform to the existing situation related to the more and more frequently occurring plastic deformations in street pavements.

2. Asphalt concrete mixtures for road pavement structures and theoretical background for their quality improvement

Asphalt pavement shall withstand long-term static and short-term frequently repeated dynamic loads when vehicles stand or move in a different period of the year. Therefore, the most characteristic properties of asphalt pavement are elasticity, ductility and plasticity.

Asphalt structure is described by the grading of aggregate (mixture of mineral materials), the properties of mineral materials, the structure and properties of binding material and also by the interrelation of binder and mineral materials (Lu *et al.* 2011).

The main condition in order to ensure max asphalt strength is a dense structure of aggregate (mixture of mineral materials) which is reached by properly selecting the grading and the optimum binder content for the specific mineral composition of the mixture under existing mixing

and compaction conditions (Al-Rousan *et al.* 2007; Corte *et al.* 2001; Lee *et al.* 2007; Sivilevičius *et al.* 2011).

Crushed stone particles in asphalt mixture ensure proper bonding, a strong carcass of asphalt mixture and determine the strength of asphalt mixture. The amount of crushed stone in asphalt mixture has an important influence on mixture properties. When the amount of crushed stone in asphalt is small the material gains binding properties. With the increasing amount of crushed stone the connections are formed between structural elements, a carcass is formed, friction between the particles increases. This increases asphalt plasticity as well as the service life of asphalt pavement (Arasan *et al.* 2011; Monismith 2004; Singh *et al.* 2012).

Asphalt binder used in mixtures influences asphalt resistance to rutting, however, less than aggregate properties. Asphalt mixture produced from softer bitumen will be less resistant to rutting under high temperature compared to the mixture with a more viscous bitumen binder. Ruts of asphalt pavement usually occur during the first service year when the viscosity of asphalt binder is comparably low. Meanwhile, the rutting of road pavement is less expected when bitumen is older or oxidized (Hafeez 2009).

Asphalt mixtures and their component parts are described by the national technical documents.

Each country when preparing technical documents for asphalt mixtures indicating the requirements to the physical and mechanical properties of asphalt mixtures are based on the own experience and the experience of other countries in the field of using asphalt mixtures in laying asphalt pavements.

Having analysed the technical documents on asphalt mixtures used in Lithuania and European countries it was determined that the main property of asphalt mixture is bitumen content the limit value of which in various countries is different, however, another property which depends of the bitumen binder content is the amount of air voids in asphalt specimen.

Analysis of bitumen binder content in the asphalt mixtures produced for laying the wearing and base pavement courses of Vilnius city streets showed that the asphalt mixtures are designed and produced using the average bitumen content lower than the permissible limit value. Certainly, this is caused by economic indicators when the cost of asphalt mixture is strongly affected by the cost of bitumen binder. Though, in a design stage of asphalt mixtures the analysis is made of the change in the physical and mechanical properties of asphalt mixture depending on the bitumen binder content. And the design of asphalt mixture is approved after it was proved that the asphalt mixture of the indicated composition meets the requirements of technical documents. At this point, several questions arise: would the physical and mechanical properties of asphalt mixtures meet the requirements of technical documents when the lower than the permissible bitumen binder content is used and shall the indicated

limits of bitumen binder content be corrected, thus, allowing to use the lower bitumen binder content?

3. Experimental research of asphalt mixtures used for laying wearing courses, base courses and foundation layers of pavements

Analysis of design composition and bitumen binder content of asphalt mixtures used for laying the wearing and base courses of pavements showed that the bitumen binder content that was used met the requirements of the technical documents *Regulations on Road Construction Works and their Acceptance. Asphalt Pavements DAT.AD-96* and *Construction Recommendations. Asphalt Concrete and Gravel Pavements of Roads R 35-01*, respectively. However, the content determined is close to the min permissible limit. Therefore, it was necessary to determine the physical and mechanical properties of asphalt mixtures used for laying the wearing course, base course and foundation layers of pavements when using the lower bitumen binder content that the permissible content set by the technical documents. Also, to assess the conformity of the determined values of properties to the requirements of technical documents.

For the research object the asphalt mixtures were selected most frequently used for constructing Vilnius City streets in 1999–2004. Asphalt pavement, depending on the class of road pavement structure, consists of the wearing course, base course and foundation layers, therefore, the following asphalt mixtures were chosen with the consideration of asphalt mixtures investigated by the *Laboratory of Road Research of the Dept of Roads of Vilnius Gediminas Technical University (VGTU)*:

- asphalt mixtures used for the asphalt wearing course – 0/16 S-V (AC 16 VS), 0/11 V (AC 11 VN), 0/16 V (AC 16 VN), 0/16 S-M (SMA 16 S);
- asphalt mixture used for the asphalt binder course – 0/16 S-A (AC 16 AS);
- asphalt mixture used for the asphalt base course – 0/22 CS (AC 22 PS).

For the production of asphalt mixtures used for laying the pavement wearing course the design compositions of asphalt mixtures most frequently used for the wearing courses of Vilnius City street pavements were selected, and the granite mineral materials, and as a bitumen binder the road bitumens of different manufacturers were selected the most frequently used at that time:

- bitumen No. 1 – bitumen manufactured from oil extracted in Russia and representing the type 70/100 (the former B 70/100);
- bitumen No. 2 – bitumen manufactured from oil extracted in Venezuela and representing the type 70/100 (the former B 70/100).

In 2001–2004, in Vilnius City the most frequently used asphalt concrete for laying asphalt binder course of pavements was asphalt mixture of type 0/16 S-A (AC 16 AS). Therefore, this type of asphalt was selected for experimental researches. As a binding material the road bitumens of type 50/70 (the former B 50/70) and 70/100 (the former B 70/100) were selected. As a mineral material the mixtures of crushed granite and crushed gravel were chosen.

In 2001–2004, in Vilnius City the most frequently used asphalt concrete for laying asphalt base course was asphalt mixture of type 0/22 CS (AC 22 PS). Therefore, this type of asphalt mixture was selected for experimental researches. As a binding material the road bitumen of type 50/70 (the former B 50/70) was selected, and as a mineral material the mixtures of crushed granite and crushed gravel were chosen.

For the experimental research in the *Laboratory of Road Research of the Dept of Roads of VGTU*, based on the given design compositions, 18 asphalt mixtures were produced and the following properties were determined:

- apparent (bulk) density of asphalt specimens;
- max density of asphalt mixture;
- amount of air voids (the former “residual porosity”);

Table 1. Main requirements for asphalt mixtures used for pavement asphalt wearing course

Main requirement for asphalt mixtures ²⁾	Rate of heavy vehicles, VB ¹⁾						
	> 3200	1800–3000	900–1800	300–900	60–300	10–60	< 10
	Pavement structure class						
	SV	I	II	III	IV	V	VI
1	2	3	4	5	6	7	8
1. Type of asphalt mixture:							
1.1. In carriageway	0/8 S-M; 0/11 S-M; 0/16 S-M	0/16 S-V; 0/8 S-M; 0/11 S-M; 0/16 S-M	0/16 S-V; 0/11 S-V	0/11 S-V	0/11-V; 0/8-V	0/16-Vn; 0/16-Vžv; 0/11-V; 0/8-V	0/16-Vn; 0/16-Vžv; 0/11-V; 0/8-V
1.2. In bus stops, intersections ³⁾	0/8 S-M; 0/11 S-M; 0/16 S-M	0/8 S-M; 0/11 S-M; 0/16 S-M	0/8 S-M 0/11 S-M	0/8 S-M; 0/11 S-M	0/11 S-V; 0/16-V; 0/11-V; 0/8-V	0/11 S-V; 0/16-V; 0/11-V; 0/8-V	0/16-V; 0/11-V; 0/8-V

Continued Table 1

1	2	3	4	5	6	7	8
2. Composition:							
2.1. Mineral materials		According to DAT.AD-96					
2.2. Type of binder:							
2.2.1. In carriageway	B 70/100; PMB; B 50/70	B 70/100; PMB; B 50/70	B 70/100	B 70/100	B 70/100; B 100/150	B 70/100; B 100/150	B 70/100; B 100/150
2.2.2. In bus stops and intersections	B 50/70; PMB	B 50/70; PMB; B 70/100	B 50/70; PMB; B 70/100	B 70/100; B 50/70	B 70/100; B 50/70	B 70/100; B 50/70	B 70/100; B 50/70
2.3. Amount of binder (over 100% of mineral materials mass)							
2.3.1. In carriageway	6.5–7.5 (0/8 S-M)	4.8–6.5 (0/16 S-V)	4.8–6.5	5.9–7.2	5.7–7.5 (0/11 V)	≥ 5.2 (0/16 V _n)	≥ 5.2 (0/16 V _n)
	6.5–7.5 (0/11 S-M)	6.5–7.5 (0/8 S-M)	6.5–7.5 (0/16 S-V)	5.9–7.2 (0/11 S-V)	5.7–7.5 (0/11 V)	≥ 5.2 (0/16 V _{zv})	≥ 5.2 (0/16 V _{zv})
	5.6–7.1 (0/16 S-M)	6.5–7.5 (0/11 S-M)	5.9–7.2 (0/11 S-V)		6.4–7.7 (0/8 V)	5.7–7.5 (0/11 V)	5.7–7.5 (0/11 V)
		5.6–7.1 (0/16 S-M)				6.4–7.7 (0/8 V)	6.4–7.7 (0/8 V)
					5.9–7.2 (0/11 S-V)	5.9–7.2 (0/11 S-V)	5.0–7.0 (0/16 V)
2.3.2. In bus stops and intersections	6.5–7.5 (0/8 S-M)	6.5–7.5 (0/8 S-M)	6.5–7.5 (0/8 S-M)	6.5–7.5 (0/8 S-M)	5.0–7.0 (0/16 V)	5.0–7.0 (0/16 V)	5.0–7.0 (0/16 V)
	6.5–7.5 (0/11 S-M)	6.5–7.5 (0/11 S-M)	6.5–7.5 (0/11 S-M)	6.5–7.5 (0/11 S-M)	5.7–7.5 (0/11 V)	5.7–7.5 (0/11 V)	5.7–7.5 (0/11 V)
	5.6–7.1 (0/16 S-M)	5.6–7.1 (0/16 S-M)	5.6–7.1 (0/16 S-M)	5.6–7.1 (0/16 S-M)	6.4–7.7 (0/8 V)	6.4–7.7 (0/8 V)	6.4–7.7 (0/8 V)
					6.4–7.7 (0/8 V)	6.4–7.7 (0/8 V)	6.4–7.7 (0/8 V)
2.4. Porosity of Marshall specimen		According to DAT.AD-96					
2.5. Relative stiffness by Marshall, KN/mm: ⁴⁾							
2.5.1. In carriageway	≥ 1.75	≥ 1.75	-	-	-	-	-
2.5.2. In bus stops and intersections	≥ 2.0	≥ 2.0	≥ 1.75	≥ 1.75	-	-	-
2.6. Stability by Marshall, KN:							
2.6.1. In carriageway	-	≥ 8.0 ⁵⁾	≥ 8.0	≥ 8.0	≥ 6.0	≥ 6.0	≥ 6.0
2.6.2. In bus stops and intersections	-	-	-	-	≥ 8.0	≥ 8.0	≥ 8.0
2.7. Plasticity by Marshall, mm:							
2.7.1. In carriageway	-	≤ 4.0 ⁵⁾	≤ 4.0	≤ 4.0	≤ 5.0	≤ 5.0	≤ 5.0
2.7.2. In bus stops and intersections	-	-	-	-	≤ 4.0	≤ 4.0	≤ 4.0
3. Additional requirements for mineral materials (crushed stone and sand):							
3.1. Amount of crushed stone particles, %	100	> 90 (100)	> 80 (100)	> 80 (100)	> 80	> 70	> 70

¹⁾ if, in exceptional cases, it is impossible to calculate the rate of heavy vehicles, the pavement structure class is accepted according to Table 7.5 of PNT-K 95. If the street is used by trolleybuses or buses, the accepted pavement structure class is not less than III;

²⁾ requirements not presented in the Table are accepted according to DAT.AD-96;

³⁾ old asphalt pavement layers shall be milled if, when constructing asphalt pavement wearing courses on bus and trolleybus stops and intersections, clear deformation occur on pavement surface (rutting, corrugation, cracking etc.). A new pavement wearing course is laid on the previously laid new asphalt pavement binder course of 0/22 S-A or 0/16 S-A mark asphalt pavement mixture. In case of special conditions, cement-stabilized base course is constructed. If there are no clear deformations (or they are scare) on pavement surface, only old asphalt pavement wearing course is milled, the strength of street pavement is assessed and a new asphalt pavement wearing course is constructed. When bus and trolleybus stops are on the carriageway, the bitumen B 50/70 or polymer-modified bitumen is used to produce asphalt pavement mixture for the wearing course;

⁴⁾ relative stiffness by Marshall is regulated for crushed stone and mastic asphalt pavement mixtures and is calculated by dividing Marshall stability and plasticity;

⁵⁾ regulated only for asphalt pavement mixes of type 0/16 S-V;

⁶⁾ values presented in brackets are valid only for crushed stone and mastic asphalt pavement mixtures.

- stability by Marshall;
- fluidity (the former “plasticity”) by Marshall.

4. Improvement of the normative parameters of asphalt mixtures and establishment of new limit values

Based on the research and theoretical analysis, in 2001 recommendations and normative requirements for asphalt mixes of wearing courses were prepared (Table 1). The requirements were recommended for the Vilnius City Municipality Administration when installing pavement wearing course during 2001 season.

Based on the prepared recommendations, in 2004 by the order of the Vilnius City Municipality Administration the VGTU Department of Roads prepared the draft construction regulations on the *Construction Works of Asphalt Concrete Pavements on the Streets of Cities and Settlements ST 8871063.10:2004* which give requirements to asphalt mixtures used for the wearing courses of street pavements (Čygas, Laurinavičius 2000). Requirements of the above mentioned draft construction regulations were harmonized with the renewed and changed technical document for asphalt pavements and mixtures when in 2001 the technical document *Regulations on Road Construction Works and their Acceptance. Asphalt Pavements. DAT.AD-96* was replaced by the *Construction Recommendations R 35-01. Asphalt Concrete and Gravel Pavements of Roads*.

In 2010, by the order of the Vilnius City Municipality Administration and based on the analysis of works, carried out in 1999–2005, and on the given recommendations the VGTU Dept of Roads prepared the draft construction regulations on *Laying the Wearing Courses of Asphalt Pavements on City Streets ST 9306149.03:2010* (Čygas et al. 2006) In these draft regulations the marking of the types of asphalt mixtures was corrected having taking into consideration the renewed normative document *Technical Specifications for the Highway Asphalt Mixtures. TRA ASFALTAS 08*.

In 2006–2007, when preparing recommendations to the draft regulations on paving asphalt binder and base courses of the street pavements in cities and settlements by the order of the Vilnius City Municipality Administration there was a coincidence that namely at that time Lithuanian Road Administration under the Ministry of Transport and Communications was preparing a new technical document for asphalt mixtures *Technical Specifications for the Highway Asphalt Mixtures. TRA ASFALTAS 08*. Therefore, just after the approval of a new technical document in 2009 the VGTU Dept of Roads worked out the draft construction regulations on the *Construction Works of Binder and Base Courses of Asphalt Pavements of the City Streets ST 193061491.04:2009*. Based on the analysis of results obtained by experimental researches it was suggested to supplement the main requirements to asphalt mixtures used for the binder and base courses of street pavements.

Examples of the use of research results. Following the requirements given, the asphalt pavement structures were constructed: in 2001, in Ateities and Lukšio streets of Vilnius; in 2003, in Konstitucijos avenue and Ukmergės street ascension; in 2006, in Geležinio vilko street (on the section from Mokyklos street to Molėtų road) and in the Southern by-pass of the Vilnius City Old Town.

At least 5 years after reconstruction or new construction of streets their pavement structures have successfully withstood the long-term trials (no plastic deformations have occurred, Figs 1, 2).

The practical examples (Figs 1, 2) show that after implementation of the projects following recommendations prepared on a basis of experimental researches the pavement wearing courses were successfully laid in several Vilnius City streets where after 1–11 years of their service no plastic deformations were formed. This shows a successful planning of experimental researches and a successful analysis of data obtained, as well as their reasonable adaptation to local traffic, loading and climatic conditions.

5. General conclusions

1. With the increased traffic volume and axle loads of heavy vehicles on the roads and streets of Lithuania a special attention must be paid to the selection of asphalt mixtures meeting traffic and climatic conditions, also to the technological process and quality control when laying asphalt pavements.



Fig. 1. A view of pavement structure in Ateities street of Vilnius City in autumn 2012 (11 years after the street pavement structure was laid)



Fig. 2. A view of pavement structure in Geležinio vilko street of Vilnius City in autumn 2012 (6 years after the street pavement structure was laid)

2. It was determined that the principles of asphalt mixture design in various countries are different, however, the main indices for which the limit values are set are the bitumen binder content and the amount of air voids in asphalt mixture.

3. Analysis of design composition of asphalt mixtures used in Lithuania and analysis of the composition of asphalt specimens taken from the roads of Lithuania showed that asphalt mixtures are designed and produced with the limitary bitumen binder content which is close to the min limit value.

4. It was determined by experimental researches of asphalt mixtures used for laying the pavement wearing course that:

a) physical (the amount of air voids) and mechanical (stability and fluidity by Marshall, the ratio between stability and fluidity) properties of asphalt mixture of type 0/16 S-V (AC 16 VS) meet the requirements of DAT.AD-96 when the content of bitumen binder is 0.6 % lower than the min limit value (5.2%) set in the normative documents;

b) physical and mechanical properties of asphalt mixture of type 0/11 V (AC 11 VN) meet the requirements of DAT.AD-96 when the content of bitumen binder is 0.9% lower than the min limit value (6.2%) set in the normative documents;

c) physical and mechanical properties of asphalt mixture of type 0/16 S-M (SMA 16 S) do not meet the requirements of DAT.AD-96 when the content of bitumen binder is lower than the min limit value (5.6%) set in the normative documents;

d) physical and mechanical properties of asphalt mixture of type 0/16 V (AC 16 VN) meet the requirements of DAT.AD-96 when the content of bitumen binder is 0.5% lower than the min limit value (5.2%) set in the normative documents.

5. Results of experimental researches of asphalt mixtures used for laying the asphalt binder course showed that physical and mechanical properties of asphalt mixture of type 0/16 S-A (AC 16 AS) meet the requirements of R 35-01 when the content of bitumen binder is 0.6% lower than the min limit value (4.0%) set in the normative documents.

6. Results of experimental researches of asphalt mixtures used for laying the asphalt base course showed that physical and mechanical properties of asphalt mixture of type 0/22 CS (AC 22 PS) meet the requirements of SR 34-01 when the content of bitumen binder is 0.2% lower than the min limit value (3.6%) set in the normative documents:

Recommendations

1. It is recommended to reduce the min permissible limits of bitumen content for asphalt mixtures of type 0/11 V (AC 11 VN) by 0.5%, for asphalt mixtures of type 0/16 S-V (AC 16 VS) – by 0.4% and for asphalt mixtures of type 0/16 V (AC 16 VN) – by 0.2%.

2. When laying roads and city streets with the calculated rate of heavy vehicles also fast-speed streets, public traffic lanes and stops, and junctions with the streets of category A and B, it is recommended to use stone mastic asphalt mixtures where a mixture of mineral material is made of 100% crushed material, and bitumen binder is a polymer-modified bitumen.

3. It is recommended to reduce the min permissible limit value of bitumen content in asphalt mixtures of type 0/16 S-A (AC 16 AS) by 0.4%.

4. It is recommended to reduce the min permissible limit value of bitumen content in asphalt mixtures of type 0/22 CS (AC 22 PS) by 0.2%.

5. The given recommendations prepared on a basis of the analysis of results of experimental researches allow a reasonable selection of asphalt mixtures used for laying the pavement wearing courses, asphalt binder courses and asphalt base courses of pavements which meet the traffic conditions, the loads generated by heavy vehicles and climatic conditions. A successful use of recommendations is proved by the newly constructed several streets in Vilnius City where after 3 years of service no plastic deformations occurred on the surface of asphalt pavement wearing courses.

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