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THE USE OF ASPHALT MIXTURES WHEN CREATING AIRPORT MOVEMENT SURFACES

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Rezumat. *Lucrarea prezintă principalele cerințe care trebuie îndeplinite de amestecurile de asfalt utilizate pentru a face suprafețele de mișcare a aeroportului. În acest sens, sunt prezentate materialele care fac parte din amestecurile de asfalt destinate suprafețelor de trafic aeroportuar. Testele de laborator care se efectuează pentru stabilirea rețetei pentru fiecare dintre materialele componente și condițiile de admisibilitate pentru acestea sunt prezentate conform normelor în vigoare. În cele din urmă, sunt prezentate caracteristicile fizico-mecanice ale amestecului de asfalt utilizat pentru realizarea suprafețelor de mișcare a aeroportului.*

Abstract. *The paper presents the main requirements that must be met by the asphalt mixtures used to make the airport movement surfaces. In this sense, the materials that are part of the asphalt mixtures intended for airport traffic surfaces are presented. The laboratory tests that are performed to establish the recipe for each of the component materials and the admissibility conditions for them are presented according to the norms in force. Finally, the physical-mechanical characteristics of the asphalt mixture used to make the airport movement surfaces are presented.*

Keywords: Bituminous mixture, aggregates, bitumen.

1. Introduction

Air transport is an alternative to traditional modes of transport, respectively, rail, car, and naval.

The improvement of the aircrafts led to the development of the aeronautical industry and with the development of the aeronautical industry, the necessary infrastructure was developed. Thus, the first airports were built starting 1909, and the need to ensure all functional facilities, such as airport movement surfaces, buildings for passengers and goods, auxiliary installations, etc., led to the continuous improvement of the airport system [1].

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In the beginning of the construction, cement concrete was used for airport movement surfaces, being named rigid surfaces, but with the development of technologies for the production and implementation of asphalt mixtures, it was used in the field of airport movement surfaces, being called elastic movement surfaces.

The transition was gradual as in a first stage, the asphalt mixtures were used to increase the load-bearing capacity of rigid moving surfaces by applying one or more layers of asphalt mixtures over the concrete structure. Airport movements are designed and made of asphalt mixtures.

The mixtures used to make the airport movement surfaces are regulated by SR EN 13108-1 / 2006. "Asphalt mixtures. Specifications for materials. Asphalt concrete" and are used to make the 3 layers respectively: the wear layer, the bonding layer, and the base layer.

The wear layer is the one over which it circulates and the asphalt mixtures used must ensure resistance, durability as well as a tread with a good adhesion to the aircraft tires.

The bonding layer is poured between the base layer and the wear layer and has the role of transmitting the efforts from the wear layer to the base layer.

The base layer is poured over the foundation and has the role of transmitting the efforts resulting from the action of the aircraft to the foundation layer.

2. Establishment of the airport asphalt mixture recipe

The physical-mechanical characteristics of the airport asphalt mixtures must respect the limits from the AND 605/2016 Norm "Hot run asphalt mixtures. Technical conditions for the design, preparation and installation" and „SR EN 13108-1/2006 - Asphalt mixtures. Specifications for materials. Part 1: Asphalt concrete" [2]. The composition of asphalt mixtures includes the following materials: aggregates, bitumen, filler and depending on the type of mixture synthetic fibers [3].

2.1. Used materials. Aggregate requirements

The natural aggregates used in the preparation of asphalt mixtures must be in accordance with the specifications of SR EN 13043-Aggregates for bituminous mixtures and for finishing surfaces used in road construction of airports and other traffic areas [4].

The physical-mechanical characteristics of the natural aggregates used in the preparation of the airport asphalt mixtures are those presented in Table 1.

Table 1) Requirements for sieves (quarry aggregates)

Characteristic	Quality conditions	Test method
Granularity (category) -Remain on the upper sieve,% max -Steps on the lower sieve,% max	1-10 (G_c90/10) 10	SR EN 933-1
Flattening coefficient,% max	25 (A_{25})	SR EN 933-3
Shape coefficient,% max	25 (SI_{25})	SR EN 933-4
Fragmentation resistance, LA coefficient,% max	20 (LA_{20})	SR EN 1097-2
Wear resistance, Micro-Deval coefficient,% max	15 (M_{DE}15)	SR EN 1097-1
Sensitivity to freeze-thaw -mass loss,% max -loss of resistance,% max	2 (F_2) 20	SR EN 1367-1
Resistance to the action of magnesium sulphate,% max	6	SR EN 1367-2

Requirements for crushing sand (0-4 mm)

Characteristic	Quality conditions	Test method
Granularity -Remain on the upper sieve,% max -Crossings on the lower sieve below 0.063 mm,% max	5 10	SR EN 933-1
Content of impurities	Not admitted	visual
Fine particle quality (blue value), max	2	SR EN 933-9

2.2. Binder requirements

The bitumen used for the preparation of airport asphalt mixtures must comply with the provisions of SR EN 12591 [5] or SR EN 14023 for modified bitumen [6]. Also, the test is performed to determine the affinity between aggregates and bitumen according to SR EN 12697-11: 2012. Asphalt mixtures. Test methods for hot prepared asphalt mixtures. Part 11: Determining the affinity between aggregates and bitumen [7].

Determinations performed on the asphalt mixture for the wear layer BAA16

Materials used for the BAA16 mixture were crushed aggregates from the quarry, crushed sand from the gravel pit, filler and bitumen 45 / 80-65, and the specimens were made according to SR EN 13108-20 [8].

Granulometric curve of the aggregates and the filler are presented in the Fig. 1.

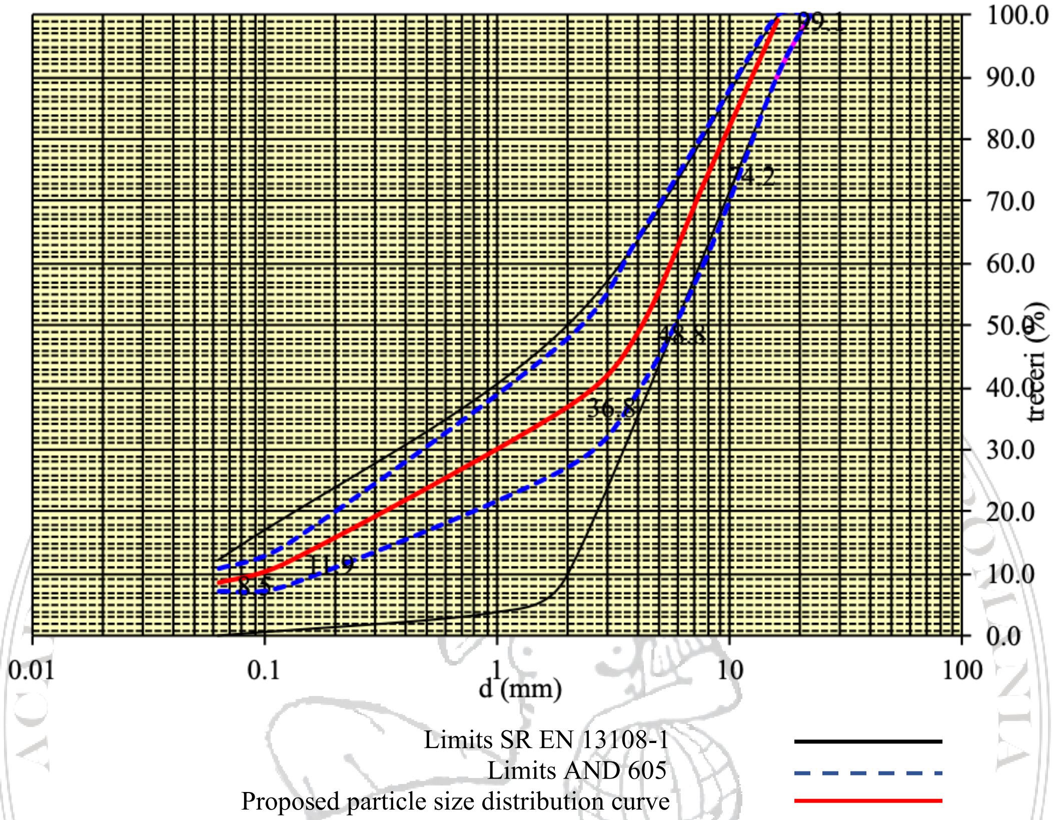

Fig. 1. The granulometric curve of the aggregates and the filler

In order to determine the optimal bitumen content, Marshall specimens with different bitumen percentages were made, the test results are presented in Table 2.

Table 2) Preliminary study of the composition of the asphalt mixture BAA 16 rul 45 / 80-65

Mixture characteristic		U.M.	Values obtained				
The bitumen content of the mixture mass		%	5.5	5.7	5.9	6.1	6.3
Features on Marshall cylinders	Apparent volumetric mass	Kg/m^3	2368	2392	2396	2387	2372
	Marshall stability	KN	12.6	13.7	15.0	14.5	13.1
	Flow rate	mm	2.9	3.4	3.7	4.0	4.4
	Report S/I	KN/mm	4.34	4.03	4.05	3.62	2.98
	Water absorption, vol	%	1.8	1.3	1.1	0.8	0.6
	*Water sensibility	%			89.5		
	* Maximum density (volumetric method)	Kg/m^3			2.437		

Features on cylinders made at the rotary press	Volume of voids at 80 revolutions	%			0.9		
	Percentage of volume of voids in the VMA mineral skeleton	%			14.8		
	Percentage of voids volume in the mineral skeleton filled with VFB binder	%			94.1		
	Resistance to permanent deformations (dynamic creep) - deformation at 50^0C, 300 KPa and 10000 pulses - deformation speed at 50^0C, 300 KPa and 10000 pulses	µm / m µm / m / cycle			9809 0.3		
	Rigidity module at 20^0C, 124 ms	MPa			7826		
	Resistance to permanent deformation (grouting), 60^0C -Deformation speed at the grooving -Drawn depth,% of the initial thickness of the sample	mm/ 10000 cycles %			0.02 2,8		

The optimal bitumen content of the asphalt mixture is 5.9%.

Because the aircrafts are subjected to the de-icing operation, the airport asphalt mixtures that constitute the tread are subjected to the behavior test to the action of the defrosting substances according to SR EN 12697-41: 2014. Asphalt mixtures. Test methods for hot prepared asphalt mixtures. Part 41: Resistance to de-icing fluids [9]. Test results for different mixtures are presented in the Table 3.

Table 3) Test results

Nr. Crt.	Mixture type Defrosting type	Group test tubes	Tensile strength (N / mm2)	Observations
1	BAA 16 + DE-ICING	wet	1.29	- breaking from the mixture 75%
2			1.22	- breaking from the mixture 100%
3			1.26	- breaking from the mixture 100%
4			1.36	- breaking from the mixture 100%
Media σ_{wet}			**1.28**	
5	BAA 16	dry	1.48	- breaking from the mixture 100%
6			1.42	- breaking from the mixture 100%
7			1.26	- breaking from the mixture 100%
8			1.35	- breaking from the mixture 100%

Average σ_{dry}	**1.38**	
Resistance remaining after holding in de-icing liquid $\beta = \sigma_{wet}/\sigma_{dry}*100$ (%)	**93.1**	

For the binder layer, the specimens were made according to SR EN 13108-20, using the following materials: crushed quarry aggregates, crushed gravel sand, filler and bitumen 45 / 80-65. The particle size distribution curve is presented in Fig. 2.

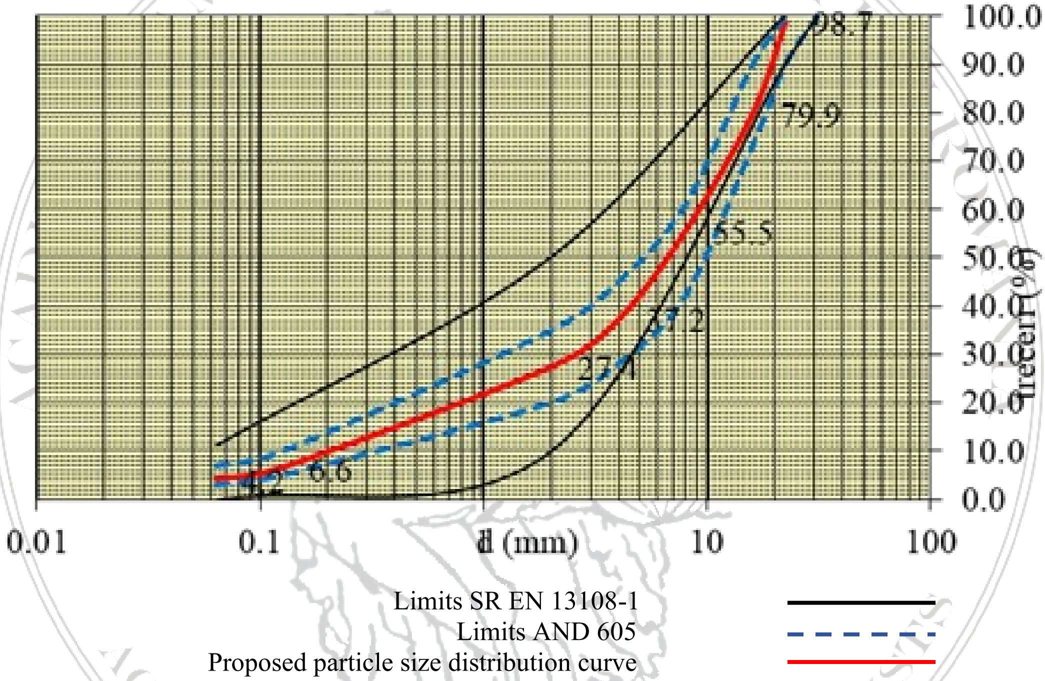

Fig. 2. The granulometric curve of the aggregates and the filler

In order to determine the optimal bitumen content, Marshall specimens with different bitumen percentages were made, the test results are presented in Table 4.

Table 4) Preliminary study of asphalt mixture composition BAA 22.4 leg 45 / 80-65

Mixture characteristic		U.M.	Values obtained				
The bitumen content of the mixture mass		%	4.0	4.2	4.4	4.6	4.8
Features on Marshall cylinders	Apparent volumetric mass	Kg/m^3	2276	2308	2315	2299	2277
	Marshall stability	KN	9.6	11.9	15.4	12.2	10.6
	Flow rate	mm	3.1	3.6	3.9	4.1	4.4
	Report S/I	KN/mm	3.10	3.30	3.95	2.97	2.41
	Water absorption, vol	%	4.7	4.3	4.0	3.8	3.3
	*Water sensibility	%			86.2		
	* Maximum density (volumetric method)	Kg/m^3			2.394		
Features on cylinders made at the rotary press	Volume of gaps at 120 revolutions	%			3.5		
	Percentage of volume of voids in the mineral skeleton Vmax	%			13.8		
	Percentage of hollow volume in the mineral skeleton filled with VFB binder	%			74.4		
	Resistance to permanent deformations (dynamic creep) - deformation at 40^{0}C, 200 KPa and 10000 pulses - deformation speed at 40^{0}C, 200 KPa and 10000 pulses	µm / m µm / m / cycles			14325 0.4		
	Rigidity module at 20^{0}C, 124 ms	MPa			8836		
	Fatigue resistance, cylindrical test required for indirect stretching: Minimum number of cycles until cracking at 15^{0}C	number of cycles			477500		

The optimal bitumen content of the asphalt mixture is 4.4%.

For the base layer the specimens were made according to SR EN 13108-20 using the following materials: crushed quarry aggregates, crushed gravel sand, filler and bitumen 50/70. The particle size distribution curve of the aggregates and the filler are presented in Figure 3.

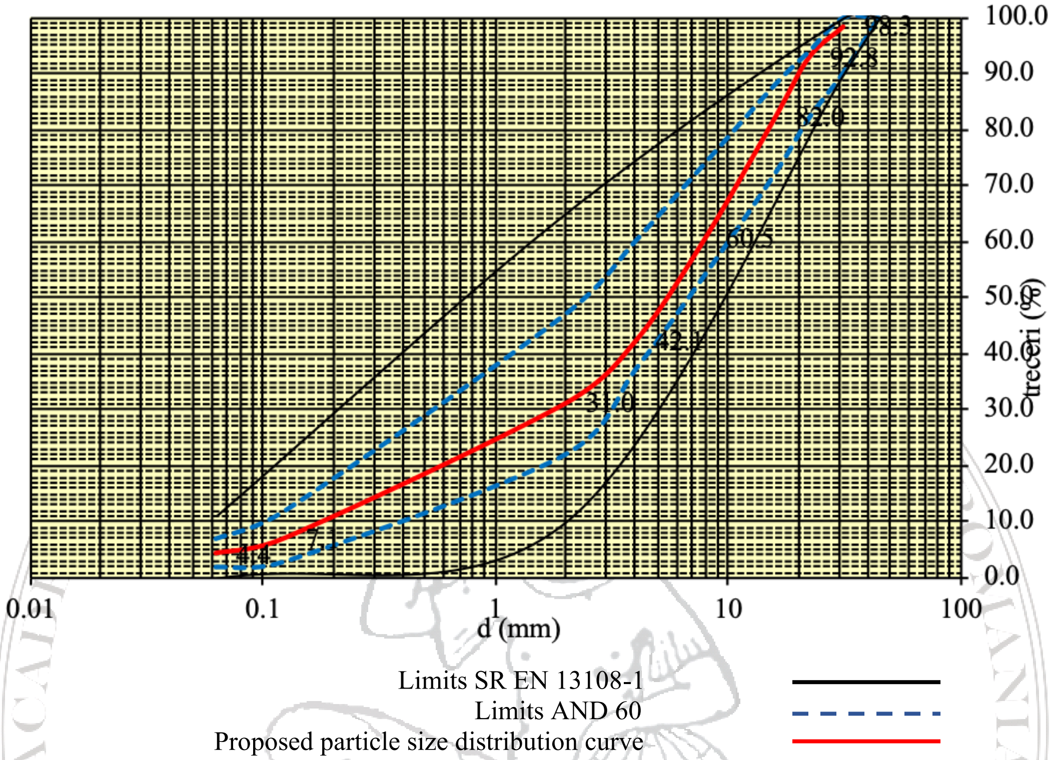

Fig. 3. The particle size distribution curve of the aggregates and the filler

Table 5) Preliminary study of the asphalt mixture composition AAB 31.5 base 50/70

Mixture characteristic		U.M.	Values obtained				
The bitumen content of the mixture mass		%	3.8	4.0	4.2	4.4	4.6
Features on Marshall cylinders	Apparent volumetric mass	Kg/m³	2247	2264	2275	2309	2305
	Marshall stability	KN	6.8	8.2	9.1	11.4	10.2
	Flow rate	mm	2.9	3.3	3.6	3.9	4.3
	Report S/I	KN/mm	2.34	2.48	2.53	2.92	2.37
	Water absorption, vol	%	5.4	5.0	4.3	3.8	3.3
	*Water sensibility	%				84.6	
	* Maximum density (volumetric method)	Mg/m³				2.505	

Features on cylinders made at the rotary press	Volume of gaps at 120 revolutions	%				6.3	
	Percentage of voids in the mineral skeleton VMA	%				16.0	
	Percentage of voids volume in the mineral skeleton filled with bitumen VFB	%				60.7	
	Resistance to permanent deformations (dynamic creep) - deformation at 40^0C, 200 KPa and 10000 pulses - deformation speed at 40^0C, 200 KPa and 10000 pulses	µm / m µm / m / cycle				17569 0.6	
	Rigidity module at 20^0C, 124 ms	MPa				11696	
	Fatigue resistance, cylindrical test required for indirect stretching: Minimum number of cycles until cracking at 15^0C	number of cycles				553500	

According with the Table 5, *the optimal bitumen content of the asphalt mixture is 4.4%.*

3. Conclusions

Starting with the development of technologies for the production and implementation of asphalt mixtures, they have been used in the field of airport movement surfaces, being called *elastic movement surfaces*. The asphalt mixtures have in their composition aggregates, bitumen and filler and are used to create road layers and airport movement surfaces.

The realization of an asphalt mixture recipe consists in establishing the *optimal proportions* between aggregates, bitumen or modified bitumen and filler through laboratory tests, so as to comply with the requirements of the norms and actual standards for these products. The development of laboratory studies for the establishment of recipes, production and implementation in accordance with the existing norms of asphalt mixtures leads to airport movement surfaces with a lifespan as close as possible to the designed one and minimum maintenance costs.

R E F E R E N C E S

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