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## BITUMINOUS SAND ROAD ASPHALT PAVEMENT

BY

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**Abstract.** The necessity to construct and improve communication paths has made road works essential to the development of society. From ancient times until today, people have tried to build roads in order to establish connections with those around them. In Romania, road construction has grown particularly in recent years and the need for road bitumen has increased. In order to consume less bitumen, product supplied only from import, the use of bituminous sands has been successfully incorporated in the production of asphalt mixtures. This paper aims to highlight the physical and mechanical characteristics of those asphalt mixtures containing bituminous sand based on technical specifications of CD 42-85 departmental normative for the direct use of bituminous sands with and without adding hard paving grade bitumen for the execution of asphalt layers.

**Keywords:** bituminous sands; bitumen; asphalt mixture; physical and mechanical characteristics; bituminous layers.

### 1. Introduction

Materials that are commonly used for road construction are costly and require higher energy consumption. Specifically, bitumen is petroleum derived

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with a significant influence over the overall costs. Its availability is dependent on the oil industry and needs to be constantly supplied. The most important bitumen characteristic consists in bounding the aggregates contained in the asphalt mix (Vrtis, 2013). An alternative for reducing this dependence on the oil industry would be the use of bituminous sand in asphalt mixes, an alternative that would lead to significant savings. In order to achieve bitumen economy, Romania has reconsidered the use of bituminous sand for the construction of asphalt mixtures in the areas nearby the existing deposits. If we were to give a definition of bituminous sand, it would be a mixture composed of 80 % quartz sand and fine particles, a thin water cover representing 5% from their total composition, and 15% bitumen that fills the pore spaces between the sand granules (Ioniță & Gugiuman, 2016; Probststein & Hicks, 2006). In Romania, bituminous sands are found in two geographical areas, as follows: Prahova County, at Matita and Pacureti and Bihor County, at Derna - Tătăruș - Budoi, having around 20% natural bitumen. These unconventional materials can be used directly in the asphalt mixtures with and without adding hard paving grade bitumen (Nicoară *et al.*, 1985).

## 2. Laboratory Tests

In order to highlight the qualities of bituminous sand, three road asphalt pavement mixes have been designed based on the CD 42 - 85 departmental normative regarding the direct use of bituminous sands with and without adding hard paving grade bitumen for the execution of warm road asphalt pavements. The asphalt mixes recipes carried out in the road laboratory are made with bituminous sand and additional hard paving grade bitumen. The first alternative consist in a bituminous asphalt concrete for the wearing course (B.a.16.nb) used on a III-V technical road category. The second one is represented by an open graded asphalt concrete for the binder course (B.a.25.nb), used for III technical road category. The last asphalt mix carried out in the road laboratory is an asphalt base for the bituminous base course (A.b.31.nb) associated with III technical road category. For these three recipes of asphalt mixes it has been used crushed sand and gravel from Chileni - Suseni (Harghita County), natural sand from the Boureni (Iasi County), filler from Bicaz (Neamt County), bituminous sand from Derna - Tatarus - Budoi (Bihor County) and hard paving grade bitumen from OMV Refining & Marketing GmbH (Austria). The percentage of natural bitumen content of the bituminous sand from Derna - Tatarus - Budoi is 19.39%.

The particle size distribution of natural aggregates and bituminous sand are represented in Fig. 1.

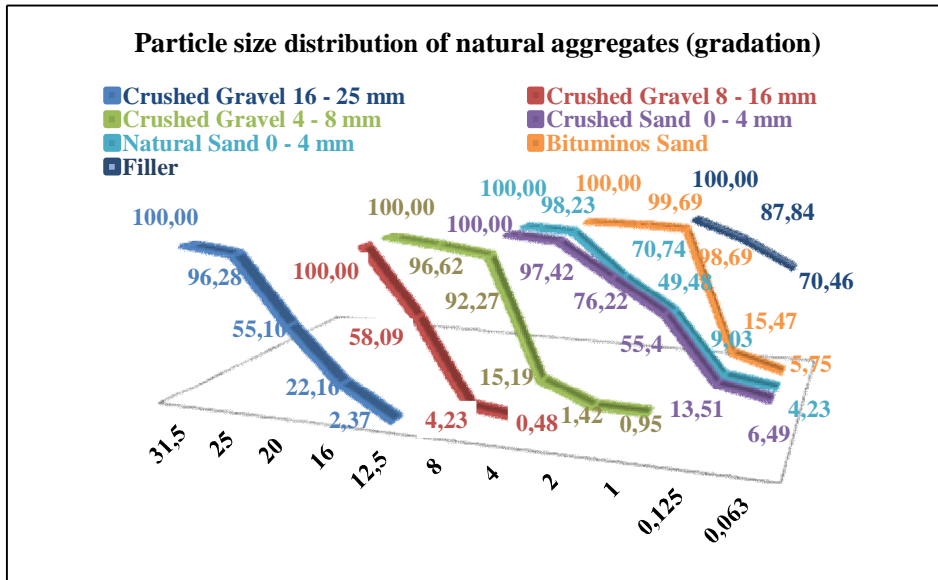


Fig. 1 – Particle size distribution of natural aggregates (gradation).

The characteristics of the hard paving grade bitumen are shown in Fig.

2.

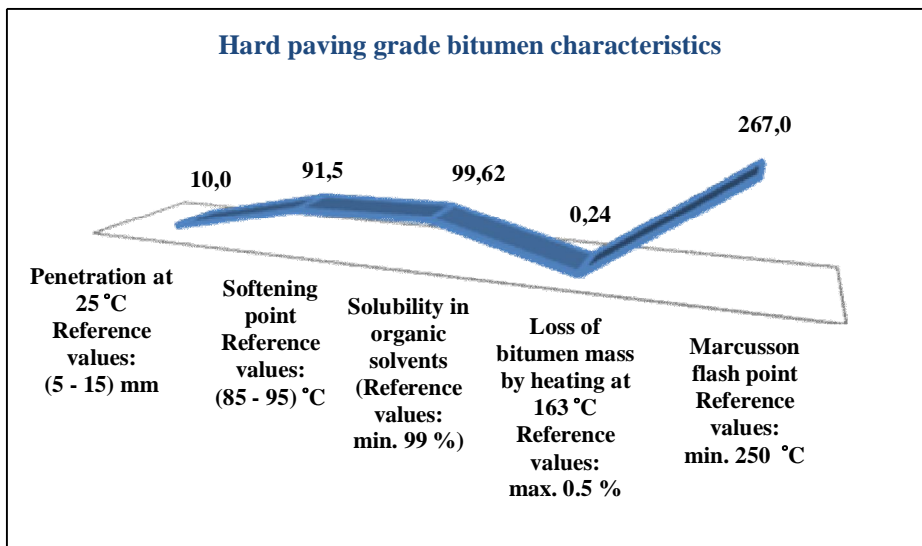


Fig. 2 – Hard paving grade characteristics.

Considering that all three asphalt mixes recipes are carried out with bituminous sand and additional hard paving grade bitumen, the calculated value of the binder incorporated into the mixtures complies with the recommendations of the normative CD 42-85, as follows: natural bitumen content in the mixture is required to be 70% and the hard bitumen 30%.

For each type of mix performed in the laboratory, five different binder dosages have been calculated, as follows:

a) natural bitumen percentage: binder percentage  $\times 0.7 = a\%$ ;

b) hard bitumen percentage: binder percentage  $\times 0.3 = b\%$ ;

c) dosage of bituminous sand:  $\frac{a \cdot 100}{19.39} = c\%$ ;

d) dosage of natural sand contained in the bituminous sand:  $c - a = d\%$ .

For each type of mix, five different binder dosages have been calculated:

i) for the wearing course made of asphalt concrete B.a.16.nb it have been used bitumen percent of: 6.80%, 7.00%, 7.20%, 7.40%, 7.60% (the recommended values by the normative ranging between 6.80%–8.20%);

ii) for the open graded asphalt concrete with crushed gravel for the binder layer B.a.25.nb have been used bitumen percent of: 4.00%, 4.20%, 4.40%, 4.60%, 4.80% (the recommended values ranging between 4.00% and 5.00%);

**Table 1**  
*The Dosage of Natural Aggregates for the Asphalt Wearing Course B.a.16.nb*

The sieve size	%	31.5	25	20	16	12.5	8	4	2	1	0.125	0.063
Aggregate		Percentage of weight passing sieve, [%]										
Crushed gravel 8 – 16 mm	10.78	–	–	–	10.78	6.26	0.46	0.05	–	–	–	–
Crushed gravel 4 – 8mm	21.55	–	–	–	21.55	20.82	19.88	3.27	0.31	0.20	–	–
Crushed sand 0 – 4 mm	14.39	–	–	–	14.39	14.39	14.39	14.02	10.97	7.97	1.94	0.93
Natural sand 0 – 4 mm	16.16	–	–	–	16.16	16.16	16.16	15.87	11.43	8.00	1.46	0.68
Bituminous sand	24.19	–	–	–	24.19	24.19	24.19	24.19	24.12	23.87	3.74	1.39
Filler	12.93	–	–	–	12.93	12.93	12.93	12.93	12.93	12.93	11.36	9.11
Aggregate mix curve	<b>100.00</b>	–	–	–	<b>100.00</b>	<b>94.75</b>	<b>88.01</b>	<b>70.33</b>	<b>59.76</b>	<b>52.97</b>	<b>18.50</b>	<b>12.11</b>
CD 42 – 85 limits		–	–	–	<b>100.00</b>	<b>90...100</b>	<b>80...100</b>	<b>65...85</b>	<b>54...76</b>	<b>46...69</b>	<b>18...32</b>	–



iii) for the asphalt base for bituminous base layer A.b.31.nb, the used percentages were: 3.50%, 3.70%, 3.90%, 4.10%, 4.30% (the recommended range being between 3.50% – 5.00%).

The dosage of natural aggregates for the asphalt wearing course B.a.16.nb. are represented in Table 1, for the open graded asphalt concrete used for the binder course B.a.25.nb. are represented in Table 2 and for asphalt base concrete A.b.31.nb. are represented in Table 3.

### 3. Results and Discussions

The Figures below (Figs. 3,....,5) present the values of the physical and mechanical characteristics for the three mixes having bituminous sand incorporated into the mixes and an additional quantity of hard bitumen, carried out in the Road Laboratory: asphalt concrete for the wearing course B.a.16.nb, used for III-V technical road category; open graded asphalt concrete with crushed gravel for the binder layer B.a.25.nb used for III technical road category and asphalt base for bituminous base layer A.b.31.nb associated with a technical road category of III.

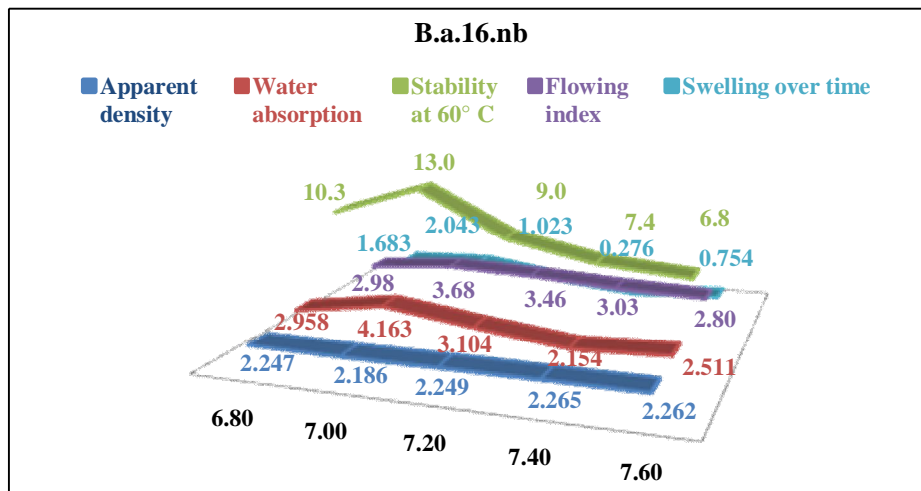


Fig. 3 – Physical and mechanical characteristics of asphalt concrete for the wearing course B.a.16.nb.

Analyzing the values of the physical and mechanical characteristics obtained from the tests and comparing them with the values imposed by the departmental normative CD 42 - 85, the percentage of 7.20% represents the optimal percentage of bitumen.

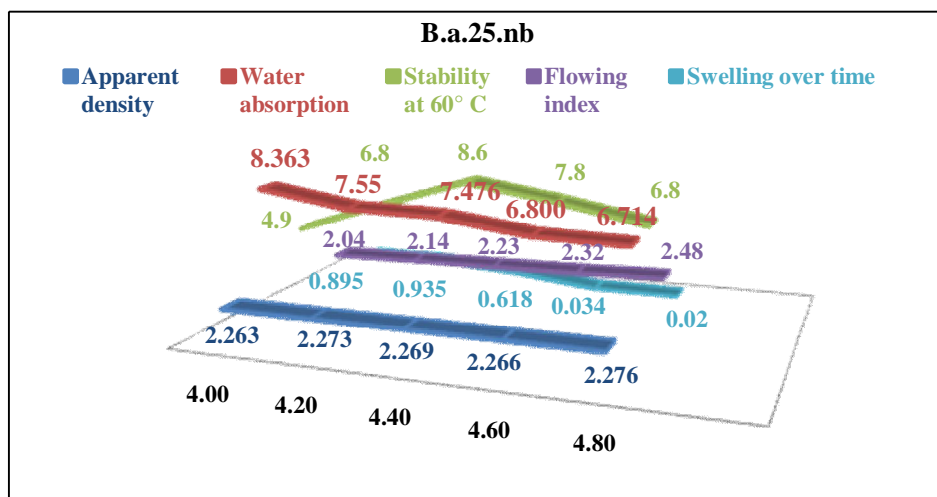


Fig. 4 – Physical and mechanical characteristics of the open grade asphalt concrete with crushed gravel for the binder layer B.a.25.nb.

For B.a.25.nb the percentage of bitumen is 4.40%.

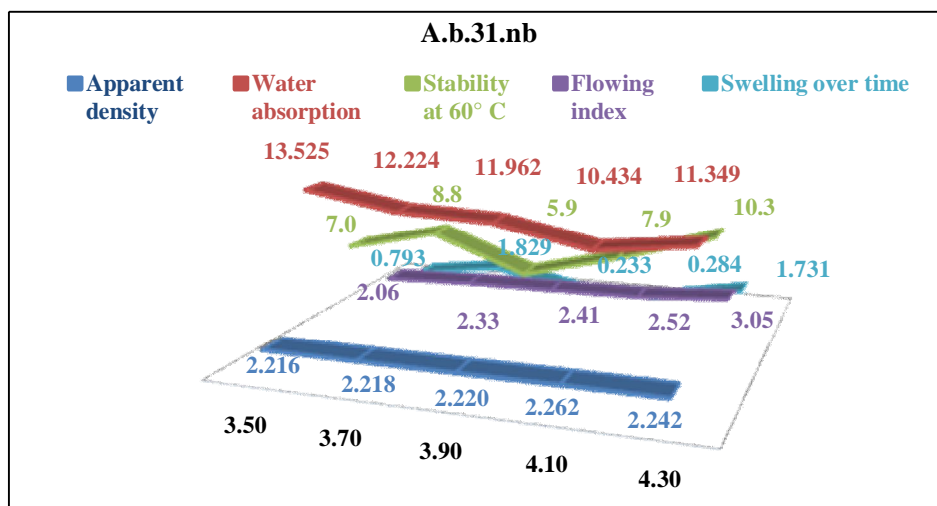


Fig. 5 – Physical and mechanical characteristics of the asphalt base for bituminous base layer A.b.31.nb.

For A.b.31.nb, the optimum bitumen percentage is 4.10%.

#### 4. Conclusions

As a result of laboratory tests, it can be seen that all three recipes of asphalt mixtures made in the laboratory fall within the limits imposed by the departmental normative CD 42-85, exhibiting good behavior at water action, the samples being kept for 28 days in water.

Based on the results obtained from the tests, an optimal percentage of bitumen has been determined for each of the three mixtures: for B.a.16.nb the optimum bitumen percentage is 7.20%, for B.a.25.nb the optimum bitumen percentage is 4.40% and for A.b.31.nb optimal bitumen percentage is 4.10%.

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#### MIXTURI ASFALTICE REALIZATE CU NISIP BITUMINOS

(Rezumat)

Necesitatea de realizare a căilor de comunicație a făcut ca lucrările de drumuri să fie esențiale la dezvoltarea societății. Încă din cele mai vechi timpuri și până astăzi, oamenii au încercat să construiască drumuri pentru a putea să stabilească legături cu cei din jurul lor. În România, construcția de drumuri a luat amploarea mai ales în ultimii ani iar necesitatea de bitum rutier a crescut. Pentru realizarea economiei de bitum, produs adus doar din import, s-a reluat utilizarea nisipurilor bituminoase la realizarea mixturilor



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asfaltice. În această lucrare se dorește evidențierea caracteristicilor fizico – mecanice ale mixturilor asfaltice realizate cu nisip bituminos pe baza normativului departamental CD 42 – 85 pentru folosirea directă a nisipurilor bituminoase cu și fără adaos de bitum dur la executarea la cald a straturilor bituminoase.

