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Performance of the experimental road pavement sectors realized with asphalt mixtures stabilized with various fibers and improved bitumen on National Road NR 17, Vatra Dornei - Suceava

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Summary

This paper presents the evolution in performance of some experimental road pavement sectors realized with asphalt stabilized with various fibers and improved bitumen on National Road, NR17.

A synthesis of the monitoring results, obtained during a period of more than five years is presented here with the appropriate conclusions and recommendations facilitating the implementation of tested technologies in the process of road rehabilitation programs in Romania.

KEYWORDS: road sector, performance, improved bituminous binder, modified bitumen.

1. INTRODUCTION

Since 1995, the National Road Network of Romania became subject to a massive rehabilitation program conducted by the Ministry of Transport using various indigenous and foreign findings.

To make better usage of these resources, the Romanian Center for Road Engineering Studies and Informatics-CESTRIN and the Academia represented by four major Universities involved in civil engineering, road research. & pavement technologies, worked together to implement and apply into practice these new technologies. This study displays the performance data collected on various levels of traffic on different road pavements. The representative samples, based on the improved asphalt mixture, have been tested on the Accelerated Circular Road Track Facility-LIRA, existing at the Technical University "Gh. Asachi" of Iasi, in parallel with the operation of similar experimental sectors realized on the existing road network.

This paper presents a synthesis of the monitoring results obtained during a period of more than five years including the appropriate conclusions and

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recommendations for implementing tested technologies in the frame of ongoing road rehabilitation programs in Romania.

2. STUDIES

2.1. Description of the experiments

Fibers and additives for the increase of binder bonding on the aggregates surface have been used for preparing wearing courses, to increase the resistance of pavement in sever climatic conditions (very cold winters with many frost cycles and very hot summers) specific to the Romanian road network.

Asphalt mixtures, stabilized with cellulose fibers and having a higher percentage of aggregates (up to a 75%) have been found to assure an adequate stability of pavement over the summer and improved resistance during the cold winter.

The National Company for Public Roads & Motorways-CNADNR and CESTRIN planed and applied this experiment during the month of august 1999, on National Road NR17, on five experimental sectors. The performance of these experimental road sectors was monitored during a specific time frame, in real traffic and climatic conditions, as mentioned in Table 1[1].

Table 1. Temperature variability on the experimental road sectors on NR17

Year	T_{max}				T_{min}	
	Recorded	Calculated			Calculated	
		$T_{a(max)}$	$T_{s(max)}$	$T_{20(max)}$	$T_{a(min)}$	$T_{s(min)}$
Summer 2000	30.5	28.4	49.8	47.3	-	-
Winter 1999-2000	-	-	-	-	-25.2	-19.9

The temperatures mentioned in Table 1 have the following significance:

- $T_{S(max)}$ is the maximum surface temperature,
- $T_{a(max)}$ is the maximum air temperature,
- $T_{20(max)}$ is the maximum earth temperature at 20cm deep,
- $T_{S(min)}$ is the minimum surface temperature,
- $T_{a(min)}$ is the minimum air temperature.

The following experimental sectors and technologies have been periodically monitored in order to assess their performance at various stages of their life.

- The experimental sector No.1, **km131+800-131+900**: wearing course constructed with Asphalt Concrete BA16 and realized with modify bitumen with the reactive polymer-ELVALOY AM [2].

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- The experimental sector No.2, **km131+900-132+100**: wearing course constructed with Asphalt Concrete BA16 realized with modify bitumen with the reactive polymer ELVALOY AM and stabilized with cellulose fibers type TEHNOCEL 1004 [2].
- The experimental sector No.3, **km132+100-132+300**: wearing course constructed with Asphalt Concrete BA16 stabilized with synthetic fibers type PNA [2].
- The experimental sector No.4, **km132+300-132+400**: wearing course constructed with Asphalt Concrete BA16 stabilized with cellulose fibers type TEHNOCEL 1004 (left lane) and with cellulose fibers type TOPCEL (right lane) [2].
- The experimental sector No.5, **km 132+400-132+700**: wearing course constructed with Asphalt Concrete BA16 and bitumen, treated with additive INTERLANE IN 1400 [2].

Table 2– The composition of the various asphalt mixes used in this experiment [2]

Components	Sector 1	Sector 2	Sector 3	Sector 4 right	Sector 4 left	Sector 5
Chippings size 8-16 mm	39.20	39.10	27.90	39.10	39.10	39.20
Chippings size 3-8 mm	26.10	26.00	27.00	26.00	26.00	26.10
Fine crushed sand size 0-3 mm	18.70	18.60	28.80	18.60	18.60	18.70
Lime filler	9.30	9.30	9.00	9.30	9.30	9.30
Bitumen D80/120	6.60	6.60	7.00	6.70	6.70	6.65
Reactive polymer - Elvaloy AM	0.10	0.10	-	-	-	-
Additive – Interlene IN 400	-	-	-	-	-	0.05
Cellulose fibers type Topcel	-	-	-	0.30	-	-
Synthetic fiber type PNA	-	-	0.30	-	-	-
Cellulose fibers type Tehnocel 1004	-	0.30	-	-	0.30	-
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**

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2.2 Results of the analysis of technical conditions on the experimental road sectors, immediately after construction [3]

- **The first** experimental road sector realized with polymer ELVALOY AM presents an open texture with porous areas located in the middle of road sector and between the wheels tracks on both lanes. The general aspect of the surface concords with the results of the laboratory investigations made on specimens taken from the pavement. The surface does not present major distresses.
- **The second sector** realized with polymer ELVALY AM and TEHNOCEL 1004 fibers presents a similar surface as the first one, only that the porous areas are the largest and irregular in form. These areas are alternating left to right on lengths of about 20m. Laboratory tests have shown that there are many differences in the content of fine aggregate between the specimens. In some porous areas loss of aggregates have been observed.
- **The third sector** realized with PNA fibers presents a surface of about 25sqm with uncoated aggregates alternating left to right. There are also differences between lanes: the one on the right has a smooth surface where the left one has a rough aspect. Furthermore, this sector presents isolated separations of aggregate without major degrades. Right in the middle of the sector on a length of about 25m there are cracks transmitted from the longitudinal joint of existing concrete pavement.
- **The fourth sector** realized with TEHNOCEL 1004 and TOPCEL fibers presents a compact surface. Roughness distresses alternates on both lanes from 50 to 50 m.
- **The fifth sector** realized with additive INTERLENE IN 400 presents a dark asphalt surface, and the aspect of the sector is adequate.

2.3 Results of the technical conditions of the experimental road sectors five years after construction [4]

According to this evaluation made on November 2004, the technical conditions of road sectors have been found as follows:

- **Sector 1**: The evolution of initial porous surfaces was not significant. Some fretting have appeared especially on the area between wheel tracks.
- **Sector 2**: The principal characteristic of this sector was its porous structure with raveling over most of the surface. The main distresses observed on this sector are: submitted, inadequate repairs after the extraction of cores, transversal cracks found frequently, most of them starting from the middle of the road and some longitudinal cracks especially on the area between wheel tracks.
- **Sector 3** - On this sector the surface has pores and cracks on the area between wheel's traces especially on the right lane. The main distresses observed are:

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transversal cracks on both lanes but more on the right side, lane inadequate repairs after the cores extraction on both lanes and some longitudinal cracks.

- **Sector 4** – On this sector the following distresses have been noticed: ineffective repairs after the cores extraction on both strips and some transversal cracks starting from axle with a reduced severity rate.
- **Sector 5** - The sector exhibits a similar surface as the previous sector except some transversal and longitudinal cracks.

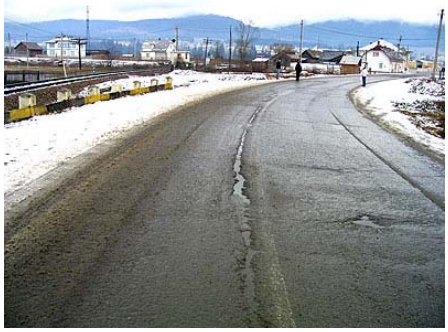
2.4. Results of the last examination made by our team in December 2004

Our findings are confirming the previous results recorded by our colleagues of Technical University of Cluj-Napoca [4], as follows from:

- In accordance with Fig.1, Fig.2, Fig.3 from below, the surface on the first sector stabilized with ELVALOY AM polymer is darker and presents less distress in comparison with the second sector realized with ELVALOY AM polymer and TEHNOCEL 1004 fibers. The most frequently degraded areas have transversal cracks where the repairs were made after the cores extraction and longitudinal cracks at the joint between the lanes. Considering last year as an example we can see that the evolution of the cracks transversal and longitudinal shows an increased number, length, and severity rate.

Experimental Sector 1

Figure 1. Raveling between wheels tracks



Experimental Sector 1

Figure 2. Longitudinal cracks & raveling

- The advanced rate of degradation on the second sector realized with ELVALOY AM polymer and TEHNOCEL 1004 fibers is due to the moisture that infiltrates through cracks into the road structure. The longitudinal fissures observed between the lanes on the previous sector continue on this too. The severity of cracks between the lanes on some area has been repaired with asphalt mix. The number and severity of the

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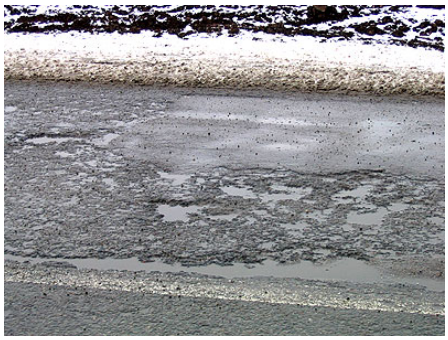
previous distresses have significantly increased as shown in Fig 4, Fig.5, Fig.6 and Fig.7 from below.

Experimental Sector 1

Figure 3. Transversal cracks

Experimental Sector 2

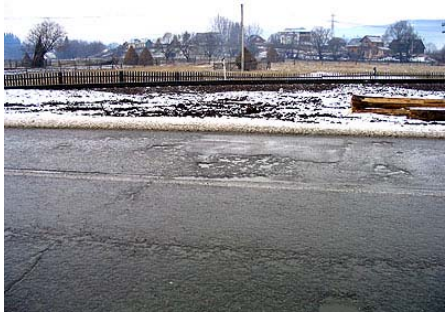
Figure 4. Porous surface



Experimental Sector 2

Figure 5. Raveling

Experimental Sector 2



Experimental Sector 2

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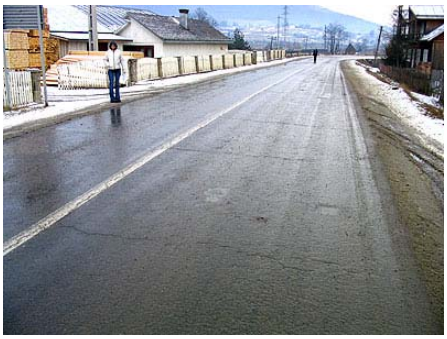
Figure 6. Longitudinal cracks

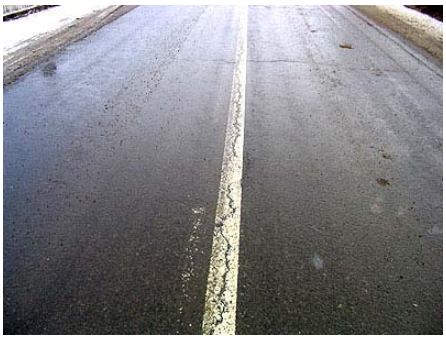
Figure 7. Transversal cracks

- In accordance with Fig.8, Fig.9, sector number three presents a surface with a homogenous aspect and a reduced number of distresses. The severity of cracks, on longitudinal and transversal areas during the same period, has significantly increased. The longitudinal cracks are observed more often between wheel tracks. The longitudinal cracks of the joint between the lanes increased significantly. The fretting is also enlarged and there are areas where these distresses were evaluated to small pot-holes. Some repairs with asphalt mix are also observed on small surfaces. The longitudinal cracks from axle continue on the whole sector's length.



Experimental Sector 3

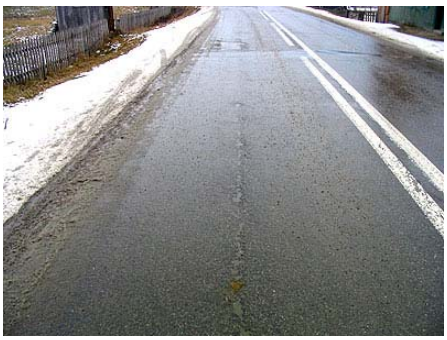
Figure 8. Transversal cracks

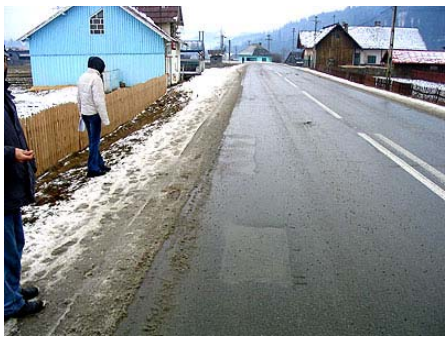


Experimental Sector 3

Figure 9.Longitudinal cracks

- The fourth sector presents a surface with an aspect more homogenous than the previous ones (see Fig.10 and Fig.11). Exception makes the middle of the areas between wheels tracks which are more porous having frettings. In addition, this sector appears to have an increased length and number of cracks with a reduced severity rate.





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Experimental Sector 4

Figure 10. Raveling between wheels traces

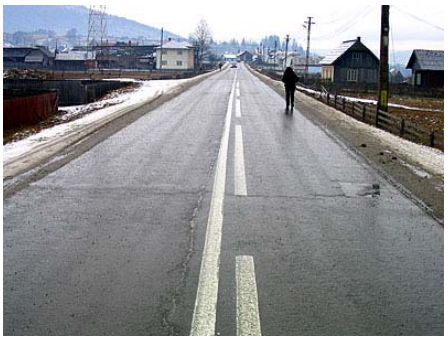
Experimental Sector 4

Figure 11. Sector with good performance

- The fifth sector presents a similar surface with the previous sector except some transversal and longitudinal cracks, as shown in Fig.12 and Fig.13 from below:

Experimental Sector 4

Figure 12. .Sector with good performance



Experimental Sector 4

Figure 13. Longitudinal cracks

We may conclude that taking into consideration real traffic and climatic conditions of the NR17 the investigated experimental sectors exhibit a satisfactory behavior at this stage. It is essential to monitor and to inspect more frequently the performances of these sectors and to perform the necessary repair and maintenance works.

It is envisaged that the monitoring of performance of these sectors to bee continued for at least another five years.

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