DYNAMIC TESTS ON ASPHALT MIXTURES: CONSIDERATIONS, PERFORMS AND RESULTS

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ABSTRACT

European norms adopted in our country regarding dynamic laboratory tests on asphalt mixtures requires to use different equipment and impose specific conditions for making the test. Thus, to determine the stiffness modulus of asphalt mixtures, the European standard adopted in Romania, SR EN 13108-20 provides a choice of a total of seven types of loading, while for the resistance to fatigue determination are provided three types of loading.
Only some of these types of loading are foreseen in Romanian standard SR 174-2009, for example determination of stiffness and fatigue resistance is achieved by indirect tension.
Roads Laboratory of the Faculty of Railways, Roads and Bridges from Technical University of Civil Engineering Bucharest is equipped with equipment required for dynamic testing according to European norms and years of experience in applying these new tests on asphalt mixtures. Those equipments enable the user to obtain the mechanical parameters of asphalts needed for the road pavement structures rational and mechanistic design.
The paper aims to make an analysis of test results provided to determine the stiffness modulus, fatigue resistance and resistance to permanent deformations both in terms of European standards and in terms of Romanian standard. In this study several types of asphalt mixtures used in Romania are considered. The conclusions will be presented as comparative charts.

Keywords: asphalt mixture, fatigue tests, stiffness, permanent deformation

1. INTRODUCTION

As is known, the definition of sustainable roads given by European Union Road Federation IRF BPC is: “Effectively and efficiently planned, designed, built, operated, upgraded and preserved roads by means of integrated policies respecting the environment and still providing the expected socio-economic services in terms of mobility and safety”.
When it comes to sustainability of a road we are considering primarily three terms: reduce, reuse, recycle.
Natural resources are not inexhaustible so roads engineers should think about the technical solutions that can reduce material consumption to be able to use local materials so as to save fuel, reduce costs, minimize emissions, to reuse materials from demolition, disposal of constructions and to recycle road layers - all in the context of protecting air quality and to keep climate not changed.
Also, roads in general and in particular road structures need to be designed and built so that it results in a low impact and long-term durability. Along with all this sitting and topics related to social and economic aspects.
The success of a sustainable road is given by a number of factors including the use of materials which have characteristics so as to lead to a good behavior of the road against degradation. In this way it can be reduced interventions on road structural by saving energy and materials (to reduce maintenance costs).
Using new and advanced asphalt mixture on the roads (in road structures) help improve road safety and user comfort while preventing degradation.
Asphalt mixture it is the material in a high percentage in a flexible road structures. Depending on the layer that is used: the base layer or wearing course, it must respond to loads coming from traffic and climate. Asphalt mixture from wearing course must take tangential forces produced by vehicle’s wheels and to transmit vertical loads to the bottom layers, to support loads from climate factors, to provide sufficient rigidity so as to contribute to increase resistance of the road structure, to be waterproof and with enough roughness, to drain runoff. Base course is the most important layer and should be made of a strength asphalt mixture and to be executed in the best conditions, should take tangential and strength efforts to transmit vertical efforts to the foundation layers.
Because of growing traffic and climate changes on roads with flexible road structures occurs such degradation as permanent deformation, fatigue cracking in low temperatures. This degradation reduces the life of road structures and increase maintenance costs. To have a sustainable asphalt pavement, asphalt mixture should be designed to prevent such degradation.
In an asphalt mixture bitumen links the aggregates, providing some stability and ensuring resistance at efforts from traffic and environment so that performance asphalt mixture is a function of bitumen properties, aggregate and volumetric properties of the mixture. Bitumen controls the viscoelastic properties of the mixture from the time of the mixture production into the plant and throughout its life. So it is recommended the use of a suitable type bitumen (PMB type) with features to help preventing degradation over time.
Design phase of the mixture in the laboratory focuses on establishing an asphalt mixture recipes to meet performance in situ. Thus, the design asphalt mixture recipe went from use of Marshall method to use the gyrocompactor method that provides for a certain level of traffic, satisfactory performance in terms of asphalt mixture behavior at the main types of degradation. Moreover, to estimate behavior at other traffic levels have imagined a series of dynamic tests different from country to country but stipulated all in the European standards so that there is correspondence between them by imposing specific conditions each type of equipment.
Dynamic tests developed over time starts to study the state of stresses and strains in the road structure under external loads (traffic, temperature). Thus is established the origin of degradation and after that to understand the mechanism of propagation of degradation.
In practice two main ways are used for the degradation mechanisms of flexible structures: permanent deformation and cracking from fatigue.
Dormon (1953) considers that the critical location where permanent deformation mechanism start is attributed to specific compression strains of the road subgrade. Obviously refers to the structural rutting. Regarding asphalt layer, it will have permanent deformation because of creep. Instead, the mechanism of cracking is considered to begin at the bottom of asphalt layers because of specific horizontal deformations of the bituminous layers (Saal and Pell, 1960).

2. STIPULATIONS OF EXISTING NORMS

Given the above and the fact that each asphalt layer should be characterized by a stiffness modulus necessary to design the road structure, the dynamic tests set out in present European norms (SR EN 13108-20) adopted in Romania refer to:
- assessment of asphalt mixture stiffness;
- assessment of asphalt mixture resistance to fatigue;
- assessment of asphalt mixture resistance to permanent deformation.

If to determine if resistance to fatigue, the user has three types of loads (corresponding to the three devices shown in SR EN 12697-24), to determine the asphalt mixture stiffness European standard provides no less than seven types of loading. So, for resistance to permanent deformation wheel tracking test is used in 9 version and triaxial compression test different depending on the position in the road structure of asphalt layer and the pulse type. Tables 1, 2, 3 and 4 presents the requirements stipulated in european norm SR EN 13108-20 for dynamic tests.

Table 1: Requirements regarding determination of asphalt mixture stiffness according to SR EN 13108-20

Type of loading	Temperature	Frequency or loading time	Test method
2PB-TR	15°C	10 Hz	SR EN 12697-26, annex A
2PB-PR	15°C	10 Hz	SR EN 12697-26, annex A
3PB-PR	15°C	10 Hz	SR EN 12697-26, annex B
4PB-PR	20°C	8 Hz	SR EN 12697-26, annex B
DTC-CY	15°C	10 Hz	SR EN 12697-26, annex D
DT-CY or DT-PR	15°C	0.02 s	SR EN 12697-26, annex E
IT-CY	20°C	124 μs	SR EN 12697-26, annex C

Table 2: Requirements for measurement of asphalt mixture fatigue according to SR EN 13108-20

Type of loading	Temperature	Frequency or loading time	Test method
2PB-TZ	10°C	25 Hz	SR EN 12697-24, annex A
2PB-TZ	15°C	30 Hz	SR EN 12697-24, annex A
4PB-PR	30°C	30 Hz	SR EN 12697-24, annex D

Table 3: Requirements for triaxial compression test (resistance to permanent deformation) according to SR EN 13108-20

<table>
<tr><th>Course</th><th>Test temperature</th><th>Confining stress</th><th>Axial load</th><th>Frequency</th><th>Pulse</th><th>Test method</th></tr>
<tr><td>Surface</td><td>50°C</td><td>150 kPa</td><td>300 kPa</td><td>3 Hz</td><td>Haversine</td><td rowspan="4">SR EN 12697-25</td></tr>
<tr><td>Surface</td><td>50°C</td><td>150 kPa</td><td>300 kPa</td><td>1s / 1s</td><td>Block</td></tr>
<tr><td>Binder&Base</td><td>40°C</td><td>50 Mpa</td><td>200 kPa</td><td>3 Hz</td><td>Haversine</td></tr>
<tr><td>Binder&Base</td><td>40°C</td><td>50 Mpa</td><td>200 kPa</td><td>1s / 1s</td><td>Block</td></tr>
</table>

Table 4: Requirements for wheel tracking test (resistance to permanent deformation) according to SR EN 13108-20

<table>
<tr><th>Device</th><th></th><th>Temperature</th><th>Test duration cycles</th><th>Test method</th></tr>
<tr><td>Small device, procedure A</td><td>Air</td><td>45°C</td><td>1 000</td><td rowspan="9">SR EN 12697-22</td></tr>
<tr><td>Small device, procedure A</td><td>Air</td><td>60°C</td><td>1 000</td></tr>
<tr><td>Small device, procedure B</td><td>Air</td><td>45°C</td><td>10 000</td></tr>
<tr><td>Small device, procedure B</td><td>Air</td><td>50°C</td><td>10 000</td></tr>
<tr><td>Small device, procedure B</td><td>Air</td><td>60°C</td><td>10 000</td></tr>
<tr><td>Large device</td><td>Air</td><td>50°C</td><td>30 000</td></tr>
<tr><td>Large device</td><td>Air</td><td>60°C</td><td>3 000</td></tr>
<tr><td>Large device</td><td>Air</td><td>60°C</td><td>10 000</td></tr>
<tr><td>Large device</td><td>Air</td><td>60°C</td><td>30 000</td></tr>
</table>

In Romania, concomitant with european norm SR EN 13108-20 is in effect Romanian norm SR174 which establish the requirements regarding the performance of asphalt mixture used in wearing courses. In tables 5, 6 and 7 are presented conditions imposed to romanian asphalt mixtures dynamic tested.

Table 5: Conditions imposed for romanian asphalt mixtures according to SR 174 – asphalt concrete

Characteristic	Asphalt mixture, type asphalt concrete, as:	
	Wearing course	**Binder course**
Resistance to permanent deformation (triaxial compression test) - deformation at 50 ºC, 300KPa and 1800 pulses, µm/m, maximum - creep rate at 50 ºC, 300KPa and 1800 pulses, µm/m/cycle, maximum - deformation at 40 ºC, 200KPa and 1800 pulses, µm/m, maximum - creep rate at 40 ºC, 200KPa and 1800 pulses, µm/m/cycle, maximum	 30 000 3 - -	 - - 20 000 2
Stiffness modulus, IT-CY at 15 ºC, MPa, minimum	4 500	4 000
Resistance to fatigue, IT-CY, number of cycles to cracking, at 15 ºC, minimum	-	400 000
Resistance to permanent deformation, 60 ºC (wheel tracking, small device, procedure B) - creep rate at wheel tracking, mm/1000 cycles, maximum Average number of vehicles (heavy commercial vehicles, in 24 hours, calculated for perspective period) >6 000 - rut depth, %, for 50 mm thickness of slab, maximum Average number of vehicles (heavy commercial vehicles, in 24 hours, calculated for perspective period) >6 000	 1 9	 - -

Table 6: Conditions imposed for romanian asphalt mixtures according to SR 174 – asphalt concrete with modified bitumen

Characteristic	Asphalt mixture type		
	BA12,5m BA16m	**BAR16m**	**BAD25m**
Resistance to permanent deformation (triaxial compression test) - deformation at 50 ºC, 300KPa and 1800 pulses, µm/m, maximum - creep rate at 50 ºC, 300KPa and 1800 pulses, µm/m/cycle, maximum - deformation at 40 ºC, 200KPa and 1800 pulses, µm/m, maximum - creep rate at 40 ºC, 200KPa and 1800 pulses, µm/m/cycle, maximum	 25 000 2,5 - -	 25 000 2 - -	 - - 20 000 2
Stiffness modulus, IT-CY at 15 ºC, MPa, minimum	4 500	4 500	4 000
Resistance to fatigue, IT-CY, number of cycles to cracking, at 15 ºC, minimum	-	-	40 0000
Resistance to permanent deformation, 60 ºC (wheel tracking, small device, procedure B) - creep rate at wheel tracking, mm/1000 cycles, maximum Average number of vehicles (heavy commercial vehicles, in 24 hours, calculated for perspective period) 1 500…3 000, maximum 3 000…6 000, maximum >6 000, maximum - rut depth, %, for 50 mm thickness of slab, maximum Average number of vehicles (heavy commercial vehicles, in 24 hours, calculated for perspective period) 1 500…3 000, maximum 3 000…6 000, maximum >6 000, maximum	 1 0,9 0,7 9 8 7	 0,9 0,7 0,5 9 7 6	 - -

Table 7: Conditions imposed for romanian asphalt mixtures according to SR 174 – stone mastic asphalt

Characteristic	Wearing course	
	MASF8; MASF8m	MASF12,5; MASF12,5m; MASF16;MASF16m
Resistance to permanent deformation (triaxial compression test) - deformation at 50 ºC, 300KPa and 1800 pulses, µm/m, maximum - creep rate at 50 ºC, 300KPa and 1800 pulses, µm/m/cycle, maximum	 30 000 3	 30 000 3
Stiffness modulus, IT-CY at 15 ºC, MPa, minimum	4 000	4 500
Fatigue deformation IT-CY, at 15 ºC and 3600 pulses, mm, maximum	1,2	1
Resistance to permanent deformation, 60 ºC (wheel tracking, small device, procedure B) - creep rate at wheel tracking, mm/1000 cycles, maximum Average number of vehicles (heavy commercial vehicles, in 24 hours, calculated for perspective period) 1 500…3 000, maximum 3 000…6 000, maximum >6 000, maximum - rut depth, %, for 50 mm thickness of slab, maximum Average number of vehicles (heavy commercial vehicles, in 24 hours, calculated for perspective period) 1 500…3 000, maximum 3 000…6 000, maximum >6 000, maximum	 1 0,9 0,8 9 9 8	 0,9 0,7 0,6 9 8 7

Studying tables 5,6,7 and comparing them with tables 1, 2, 3 and 4 it can be seen that there are no major differences, with one exception – determination of resistance to fatigue which according Romanian norm is conducted on cylindrical samples at indirect tension. Other differences consist in number of cycles applied for determination of resistance to permanent deformation - triaxial compression test as well as for working temperature of establishing asphalt mixture stiffness.

Roads Laboratory of the Faculty of Railways, Roads and Bridges from Technical University of Civil Engineering Bucharest is equipped with the equipment required for dynamic testing according to European norms and has years of experience in applying these new tests on asphalt mixtures. Thus, in the present article the authors wish to present an analysis of the dynamic test (stiffness test, fatigue test, permanent deformation test) in specific conditions of loading according to European Standard and Romanian standard, on various types of asphalt mixtures. This analysis will demonstrate the importance of conducting laboratory tests such as to ensure performance and durability of asphalt material of an asphalt pavement road.

3. Used materials and the asphalt mixture recipes

This study was carried out on seven types of asphalt mixtures designed according to romanian norms: a classic asphalt mixture - BA16 type, a high modulus asphalt mixture - MAMR16 type, an asphalt mixture with fiber - MASF16 type and a binder course asphalt mixture - BAD25 type. The materials (aggregates, fiber and bitumen) used to prepare the asphalt mixtures and the asphalt mixtures recipes are presented in Table 8.

To perform the proposed laboratory tests were made specific asphalt mixture samples of each test, according to European norms: cylindrical samples, compacted at Marshall hammer (MASF16m-warm mix and BAD25 mix) and gyrocompactor (MAMR16 mix, BA16 mix, MASF16a mix, MASF16m-1 mix, MASF16m-2 mix), prismatic and trapezoidal samples cutted from slabs compacted at la roller compactor.

Table 8: **The used asphalt mixtures materials and the recipes of the used asphalt mixtures**

<table>
<tr><th rowspan="2">Asphalt Mixture</th><th rowspan="2">Source /type and %</th><th colspan="4">Crushed Rock</th><th rowspan="2">Filler</th><th rowspan="2">Fiber by Mixture</th><th rowspan="2">Bitumen by Mixture</th></tr>
<tr><th>16/25</th><th>8/16</th><th>4/8</th><th>0/4</th></tr>
<tr><td rowspan="2">MAMR16</td><td>Source /type</td><td colspan="4">Revarsarea</td><td>Limestone Holcim</td><td>-</td><td>25/55-65 PMB</td></tr>
<tr><td>%</td><td>-</td><td>35</td><td>29</td><td>25</td><td>11</td><td>-</td><td>4.12</td></tr>
<tr><td rowspan="2">BA16</td><td>Source /type</td><td colspan="4">Dealu Plesa</td><td>Limestone Holcim</td><td>-</td><td>D 50/70</td></tr>
<tr><td>%</td><td>-</td><td>25</td><td>22</td><td>45</td><td>8</td><td>-</td><td>6.1</td></tr>
<tr><td rowspan="2">MASF16a</td><td>Source /type</td><td colspan="4">Carpat Agregate</td><td>Limestone Holcim</td><td>Viatop</td><td>50/70 + additive</td></tr>
<tr><td>%</td><td>-</td><td>52</td><td>18</td><td>17</td><td>13</td><td>0.5</td><td>6.0</td></tr>
<tr><td rowspan="2">MASF16m-1</td><td>Source /type</td><td colspan="4">Carpat Agregate</td><td>Limestone Holcim</td><td>Viatop</td><td>45/80-65 PMB + additive</td></tr>
<tr><td>%</td><td>-</td><td>53</td><td>18</td><td>17</td><td>12</td><td>0.5</td><td>5.9</td></tr>
<tr><td rowspan="2">MASF16m-2</td><td>Source /type</td><td colspan="4">Turcoaia</td><td>Limestone Holcim</td><td>Topcel</td><td>25/55-65 PMB</td></tr>
<tr><td>%</td><td>-</td><td>45</td><td>25</td><td>13</td><td>11</td><td>0.3</td><td>5.7</td></tr>
<tr><td rowspan="2">MASF16m-warm mix</td><td>Source /type</td><td colspan="4">Turcoaia</td><td>Limestone Holcim</td><td>Topcel</td><td>25/55-65 PMB+ additive</td></tr>
<tr><td>%</td><td>-</td><td>45</td><td>25</td><td>13</td><td>11</td><td>0.3</td><td>5.7</td></tr>
<tr><td rowspan="2">BAD25</td><td>Source /type</td><td colspan="4">Turcoaia</td><td>Limestone Holcim</td><td>-</td><td>25/55-65 PMB</td></tr>
<tr><td>%</td><td>23</td><td>20</td><td>17</td><td>31</td><td>4.5</td><td>-</td><td>4.5</td></tr>
</table>

4. Stiffness modulus of asphalt mixtures

In order to establishing the stiffness modulus of asphalt mixture in laboratory it was used the three stipulated tests in European Norm SR EN 13108-20:
- Test applying Indirect Tension to cylindrical specimens IT-CY,
- Four Point Bending test on prismatic specimens 4PB-PR,
- Two Point Bending test on trapezoidal specimens 2PB-TR.

The samples were tested according to the program presented in Table 9, taking account both of European and Romanian norm.

Table 9: **Testing program for stiffness**

Type of test	Temperature [^{o}C]	Frequency or loading time
IT-CY	15; 20	124μs
4PB-PR	15; 20	8; 10 Hz
2PB-TR	15	8; 10 Hz

The obtained results are presented in figure 1.

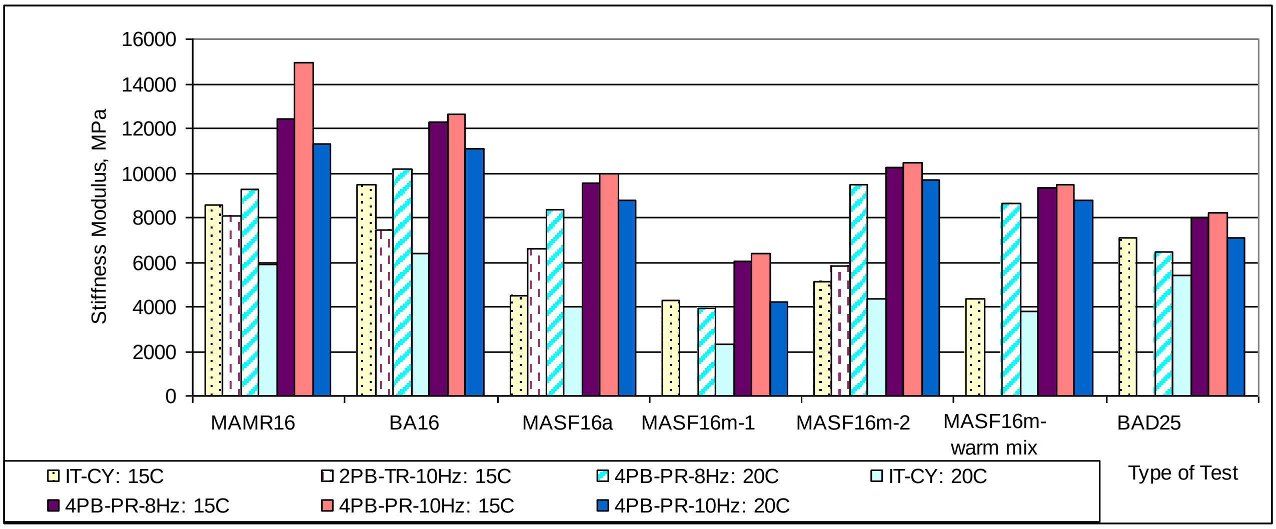

Figure 1: Type of test influence on stiffness modulus values

5. Resistance at fatigue of asphalt mixtures

Resistance at fatigue of asphalt mixture studied has been emphasized by four point bending test (4PB-PR), according European Norm SR EN 13108-20 and EN 12697-24, annex D and by indirect tensile test (IT-CY) according Romanian standard, SR174 and European norm SR EN 12697-24, annex E.
Testing conditions are presented in table 9.

Table 10: Testing program for fatigue resistance

Type of test	Temperature [^{o}C]	Frequency or loading time
IT-CY	10 ; 15 ; 20	124μs
4PB-PR	30	30 Hz

In first case were determined fatigue lines at IT-CY for MAMR asphalt mixture at temperature of 10^{o}C, 15^{o}C and 20^{o}C, according figure 2.

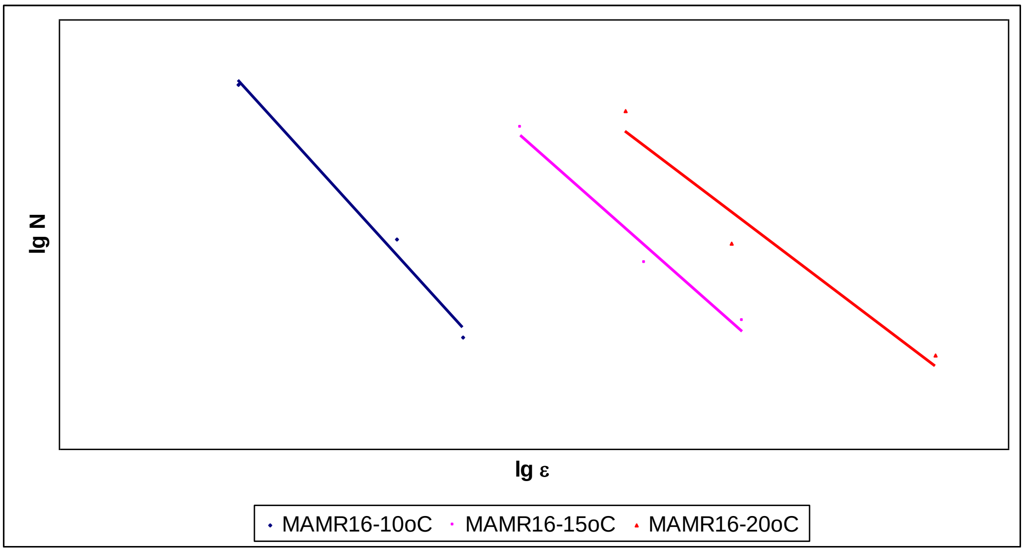

Figure 2: Fatigue lines from indirect tensile test (IT-CY)

Fatigue line has the following shape:

$$\lg N = k + n \ln \varepsilon_0$$

where N is the number of load cycles;
ε_0 – is the tensile strain at the centre of the specimen, με;

k and n – material constants.

In table 11 are presented material constants, as well as the estimation of initial deformation for the fracture criteria chosen from which is expected a fatigue life of 10^6 cycles for given testing conditions (ε_6).

Table 11: Fatigue line characteristics and estimation of ε_6 for IT-CY test

Type of mixture and testing temperature	k	N or slope "p" of fatigue line	Correlation coefficient of the regression R^2	ε_6, με
MAMR16, 10°C	14.316	-6.055	0.9899	23
MAMR16, 15°C	14.619	-4.8894	0.9746	57
MAMR16, 20°C	14.104	-4.1695	0.9498	87

According romanian norm, it was determined the fatigue deformation (mm) at 15 ºC and 3600 pulses and fatigue resistance (number of cycles to cracking) at 15 ºC for MAMR16, MASF16m-2, MASF16m-warm mix and BAD25 mixtures. Results are given in table 12.

Table 12: Results IT-CY test, at σ = 250MPa, according Romanian norm SR174

Type of mixture	Vertical deformation at repeated loading, (mm) at 15 ºC and 3600 pulses	Number of cycles at cracking at 15 ºC	Initial tensile strain at the centre of the specimen, ε_0, με
MAMR16	1.39	1000000	60
MASF16m-2	1.41	800000	70
MASF16m-warm mix	1.46	501500	87
BAD25	1.5	251750	65

In the second case it were determined the fatigue lines at 4PB-PR for BAD25, MAMR16, MASF16m-2 and MASF16m-warm mix, represented in figure 3.

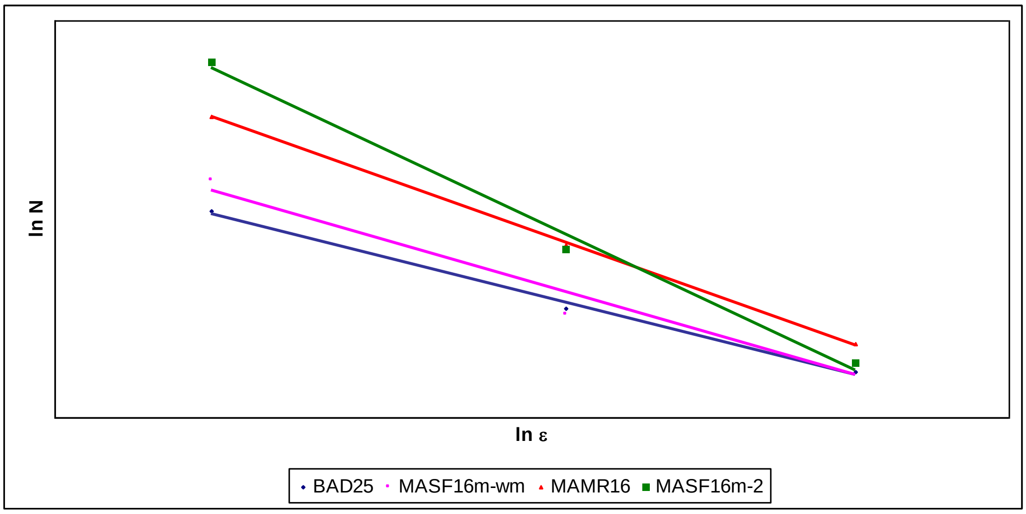

Figure 3: Fatigue lines from four point bending test (4PB-PR), 30°C

Fatigue line has the following shape:

$$\ln N = A_0 + A_1 \ln \varepsilon$$

where N is fatigue life for chosen failure criteria (number of load cycles);
ε – is the initial strain amplitude measured at the 100^{th} load cycle, με;
A_0 and A_1 – material constants.

In table 13 are presented material constants, as well as the estimation of initial deformation for the fracture criteria chosen from which is expected a fatigue life of 10^6 cycles for given testing conditions (ε_6).

Table 13: Fatigue line characteristics and estimation of ε_6 for 4PB-PR test

Type of mixture	A_0	A_1 or slope "p" of fatigue line	Correlation coefficient of the regression R^2	ε_6, με
BAD25	45.032	-6.0302	0.9961	177
MASF16m-warm mix	49.986	-6.8977	0.9578	189
MAMR16	59.657	-8.5154	0.9997	217
MASF16m-2	75.117	-11.293	0.9937	227

6. Resistance to permanent deformation of an asphalt mixture

Resistance to permanent deformation of asphalt mixture studied (MAMR16, MASF16m-2, MASF16m-warm mix - at 50°C) has been emphasized by triaxial compression test, according SR EN 12697-25. Results are given in tables 14 and 15.

Table 14: Resistance to permanent deformation according Romanian norm SR 174

Type of mixture	Deformation at 300 KPa and 1800 pulses, µm/m	Creep rate at 300 KPa and 1800 pulses, µm/m/cycle
MAMR16	5548	0.455
MASF16m-2	4883	0.322
MASF16m-warm mix	11273	0.456

Table 15: Resistance to permanent deformation according european norms EN 12697-25 and EN 13108-20

Type of mixture	Parameters of equation on (quasi) linear stage II Method I ($\varepsilon_n=A_1+B_{1\,n}$)		Creep rate $fc=B_1$	Parameters of equation on (quasi) linear stage II Method II ($\log\varepsilon_n=\log A+B\log n$)		Calculated permanent defomation ε_{1000}: $\varepsilon_{1000}=A1000B$	Calculated permanent defomation ε_{10000}: $\varepsilon_{10000}=A10000^B$	Initial creep modulus, $E_n=\sigma/\varepsilon_n$, kPa
	A_1	B_1		A	B			
MAMR16	5895.1	0.0333	0.033	4314.2	0.0397	5675	6219	1227
MASF16m-2	5129.1	0.0478	0.0478	3096.71	0.0463	4828	5599	1243
MASF16m-warm mix	11420	0.039	0.039	9440	0.0208	10899	11433	407

7. Conclusions

The studies presented above lead to certain conclusions regarding the performance of asphalt mixture based on used materials the asphalt mixture recipe. Performance material used as asphalt layer ensure road structure designed sustainability.

All asphalt mixtures studied meet the performance conditions imposed by Romanian norm, with one exception, BAD25 asphalt mixture, which present a lower fatigue resistance at 15°C than provide the norm. However, it should be specified that fatigue test IT-CY provided in Romanian norm is not provided in European norm for type testing (SR EN 13108-20) because as shown in recent years the sample fails because of accumulated permanent vertical/horizontal deformation which occurs after repeated application of load. Even European norm presents in SR EN 12697-24 the possibility of using indirect tensile test IT-CY for fatigue it should be adopted as fatigue criteria the fatigue lines obtained at 4PB-PR and 2PB-TZ.

The study of asphalt mixture stiffness highlight the fact that can be obtained different values based on asphalt mixture type, testing type and loading conditions. Using a polymer modified bitumen (PMB) and a strong aggregate skeleton conduct to a better asphalt mixture stiffness for mixtures studied.

In an attempt to establish a link between types of tests available to determine the asphalt mix stiffness modulus it was plotted the Figure 1. It is point out that to obtain close values between tests, IT-CY test should be done at 15^{o}C temperature, 4PB-PR test must be conducted at 20°C temperature and at 8 Hz frequency and 2PB-TR test should be conducted at 15^{o}C temperature and 10 Hz.

Using an additive in asphalt mixture MASF16m-warm mix conduct to a sensitive smaller values of stiffness then asphalt concrete MASF16-m, in exchange the benefits brought by warm mix procedure by reducing working temperature with about 20^{o}C, on the environment are very important. Thus, the gain is double, both for environmental sustainability and for asphalt pavement.

Resistance to fatigue of studied asphalt mixtures according Romanian norm point out the fact that a correlation between working temperature from laboratory and air field temperature is needed. At high temperatures, ε_6 strain amplitude for one million loading cycles is bigger: for an increase of temperature with 10^{o}C corresponds an increasing of ε_6 with almost 280%, which is very important in the designing of a road structure.

Regarding the study of fatigue behavior after European standard it can be said that asphalt mixture with fiber has a specific strain corresponding to one million cycles, superior to other mixtures studied.

After conducting triaxial compression test in laboratory results significant differences between results obtained at 1800 cycles (according Romanian norm) and the results obtained at 10000 cycles (according European norm).

Creep rate of asphalt mixture with fiber it is smaller comparatively with values obtained on the other mixtures. Creep modulus value rise with increasing of material stiffness on 4PB-PR test, according european norm. The same, permanent deformation calculated after 1000 cycles and after 10000 cycles decrease with increasing of material stiffness.

Warm mix type mixture has a poorer behavior at permanent deformation because of the additive which decrease bitumen viscosity, but still fits in demand of norm. Using warm asphalt mixture has some important advantages for asphalt industry: helping compaction of stiff mixes, extending paving season (in cold weather), allowing longer transport distances and reducing emissions and odor in limited urban areas.

The selection of asphalt mixtures with superior characteristics will lead to better durability of road structure. Authors are considering expanding the study with additional tests on the warm mix type mixture in order to establish its performance.

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