EVALUATION OF THE TECHNICAL PERFORMANCE OF CONSTRUCTION PRODUCTS IN COMPLIANCE WITH CURRENT REGULATIONS

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Rezumat. *În cadrul contextului general de creştere a traficului rutier şi dezvoltare a reţelei de drumuri publice şi a duratei de viaţă a acestora, o importanţă deosebită trebuie acordată utilizării unor produse pentru construcţii ale căror caracteristici tehnice trebuie să fie testate şi să corespundă reglementărilor în vigoare. În lucrare este prezentat şi un studiu de caz privind modul de elaborare şi încercările efectuate pentru stabilirea unei reţete de mixtură asfaltică pentru drumuri.*

Abstract. *Within the general context of increasing road traffic and the development of the public road network and their lifetime, a particular importance should be given to the use of construction products whose technical characteristics have to be tested and to comply with the regulations in force. In this scientific work, a case study is presented regarding the mode of elaboration and tests on how to establish a road asphalt mixture recipe.*

Keywords: evaluation, construction products.

1. Introduction

The continuous increase of traffic on roads leads to the necessity of a road network that meets the appropriate technical conditions to ensure safety and comfort in traffic. To accomplish these requirements contribute the complex work of specialists from road design, construction and testing laboratories. Measures have been taken in the recent years to increase the safety of traffic participants. In order to increase the traffic safety, measures are taken to improve traffic flow through the use of road protection systems, the introduction of efficient signalling systems, the making of road markings with resonant bands, the use of speed limiters, roundabouts setting at crossroads as well as other solutions specific to each road. At the same time, the scientific research in the field of traffic safety of

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motor vehicles contributes to this end by endowing them with additional safety equipment.

The planning, design, construction and modernization of public roads are made according to their functional categories and the technical class determined according to the technical regulation regarding the establishment of the technical class of the public roads, approved by Order of the Ministry of Transport. The design, construction and modernization of public roads shall be carried out on the basis of the general principles of technical regulations. The design, construction and modernization of public roads shall take into account the function they have in the road network, the technical class, the rational use of the land, the protection of the environment, the urban planning and landscaping plans approved according to the law, as well as the necessity to carry out the traffic safely and comfortably.

An important role in obtaining the best quality of road works is played by the specialists in the field who determine the solutions and build the road itself. The success of the works, their performance, and their sustainability depend to a great extent on the skill and especially the professional responsibility of the specialists and builders. The quality of road works is influenced by the conscientiousness and involvement of specialists.

The quality control of all design phases, materials, process and manufacturing processes must be carried out during and not after the work. Subsequent checking is not effective, and generally does not quite correct what was wrong. For this reason, in the process of checking road works, we must start with the formation of "quality people", whose probity is manifested by the pursuit of quality in all the segments of the technological processes.

At the same time, the process that is solely responsible for tracking the quality of the work must be very professionally prepared. We believe that the leading engineer of the work must be primarily responsible for the organization and quality of the execution. Consequently, it is necessary for the engineer to know exhaustively the properties of the materials they use, the technologies they apply, and especially the "sensitive sectors" in terms of qualitative success of the works. The specialized laboratories at various levels are at the disposal of the engineer in order to provide him with the basics necessary to make the right technical decisions. In order to be able to make the best decisions based on the results of the laboratory tests, the engineer must know the methodology to perform them. By only knowing this technology, the engineer will be able to creatively create the trustworthiness that each result scored in the test report deserves.

Roads have to be made of the best quality building materials in order to accomplish their purpose. In the European Union and in our country there are regulations as to the construction materials to be used.

2. Current regulations for materials used in construction

In order to control the quality of products used in construction regulations are made, whose compliance is mandatory. Thus, Decision no. 622/21.04.2004 issued by the Romanian Government establishes the conditions for placing on the market the construction products. [1]

According to Government Decision no. 622/21.04.2004 "The placing on the market of products intended for use in construction is admitted only if they are suitable for the intended use. This means that they have such features that the constructions in which they are to be incorporated, assembled, applied or installed, if they are properly designed and executed can satisfy the essential requirements of the constructions set out in Annex no. 1, if and where these constructions are subject to regulations containing such requirements." [1]

Regulation (EU) No. 305/2011 of the European Parliament and of the European Council of 09.03.2011 establishes the harmonized conditions for the marketing of construction products. [2]

The system of quality in construction provided in Law 10/1995 is necessary to be found entirely in the specificity of road works, both for the realization and control during the execution and the exercise of State control.

In order to be used, construction products must have a national or European technical approval. Also, if they are produced under a harmonized European standard, they must have a certificate of conformity.

Quality certification conformity of construction products demonstrates that the products in question have quality controlled features according to the reference documents and which allow the assessment of the fitness for use and guarantee with an acceptable probability that by using these products can be accomplished the prescribed requirements for construction.

Technical Approval in construction is elaborated in accordance with the Government Decision no. 766/1997 regarding the approval of some regulations regarding the quality in constructions, with subsequent modifications and complements. [3] The accomplishment by the construction products of technical performances for which they were designed is a guarantee for safe buildings.

The evaluation of the technical performances of the construction products is done in testing laboratories that have qualified personnel and the necessary equipment.

Incertrans has a specialized laboratory for testing the materials used in the construction of road infrastructure. The laboratory is authorized by I.S.C. as First Grade Laboratory with the Authorization no. 2662/28.12.2016 and is accredited by RENAR with the Accreditation Certificate no. LI 1106/11.08.2016.

Thus, in the Incertrans Laboratory, tests are carried out in the field of geotechnics, natural aggregates, concrete, asphalt mixtures, bituminous emulsions as well as other tests in the field of road infrastructure requested by the beneficiaries.

3. Tests carried out in the Incertrans Laboratory for products used in road infrastructure construction

Below in this section there is presented how to make an asphalt mixture and which are the tests to be done for it. The hotmelt asphalt mixture is a building material made through a technological process involving the heating of natural aggregates and bitumen, mixing of the mixture, transportation and putting into operation by hot compaction.
The materials used to produce asphalt mixtures are: bitumen (simple, additive or modified) and granular materials (natural aggregates and fillers). Determining the composition of asphalt mixtures requires the following: checking the characteristics of the component materials, the percentage of each component in the total mixture, validation of optimal dosing based on initial type tests.
Depending on the type of chosen mixture, the aggregate and filler percentage limits are in line with the requirements of the SR EN 13108 series of standards. For this purpose, for the aggregates to be used in the preparation of the recipe it will be determined the granulosity of each sort. After that the percentages for each sort are determined so that the obtained gram-size curve to fall within the prescribed limits. The optimal content of binder is established by a preliminary laboratory study, starting from normative values.

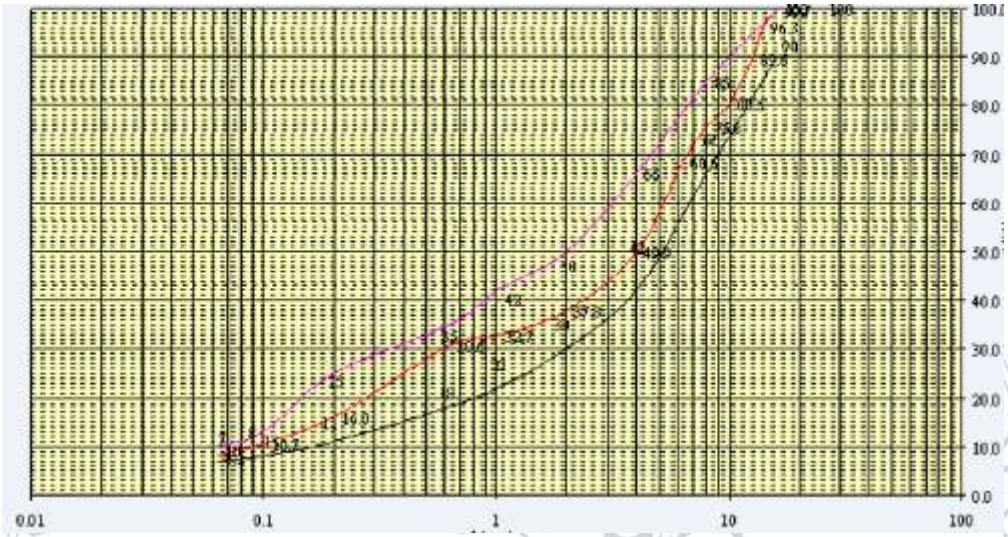
4. Case study: BA 16 RUL 50/70 (PC) mixture recipe preparation

For the preparation of the asphalt mixture recipe type BA 16 RUL 50/70 (PC) the following materials were used: crushed aggregates from Știrbăț – Liteni gravel, crushed sand from Știrbăț – Liteni gravel, filler, bitumen 50/70.

Table 1. Materials for asphalt mixture

Site	%	0.063	0.1	0.2	0.63	1	2	4	6.3	8	10	12.5	14	16
8-16		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	4.0	22.0	58.5	85.3	98.8
4-8		0.0	0.0	0.6	1.8	2.8	8.4	34.0	82.6	99.6	100	100	100	100
0-4		1.8	4.4	19.2	72.8	79.4	90.8	99.8	100	100	100	100	100	100
Filler		69.5	86.6	97.8	100	100	100	100	100	100	100	100	100	100
8-16	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	5.5	14.6	21.3	24.7
4-8	38	0.0	0.0	0.2	0.7	1.1	3.2	12.9	31.4	37.8	38.0	38.0	38.0	38.0
0-4	26	0.5	1.1	5.0	18.9	20.6	23.6	25.9	26.0	26.0	26.0	26.0	26.0	26.0
Filler	11	7.6	9.5	10.8	11	11	11	11	11	11	11	11	11	11
Total	100	8.1	10.7	16.0	30.6	32.7	37.8	49.9	68.6	75.8	80.5	89.6	96.3	99.7

The aggregates are certified according to SR EN 13043: 2003/AC: 2004 and can be used in the preparation of asphalt mixtures.



Sieve crossings (%)

Marshall test specimens are made according to SR EN 12697-30: 2012.

The apparent bulk mass of the intact compacted bituminous specimen shall be determined as follows:

$$\rho_{bssd} = \frac{m_1}{m_3 - m_2} \cdot \rho_w \quad (1)$$

where: ρ_{bssd} is the bulk apparent mass in the dry state of the specimen (kg/m3)

m_1 is the mass of the specimen in the dry state (g)

m_2 is the mass of the specimen in the water (g)

m_3 is the mass of the specimen with dry saturated surface (g)

ρ_W is the volumetric mass of water at the test temperature.

Water absorption is the amount of water absorbed by the accessible external voids of a specimen from the asphalt mix, when kept in water under vacuum, and is expressed as a percentage of the mass or initial volume of the specimen.

The initial volume of specimens represents the difference between weights (m_1 and m_2) relative to water density.

$$V = \frac{m_1 - m_2}{\rho_W} \quad (cm^3) \quad (2)$$

The final volume of specimens represents the difference between weights (m_3 and m_4) relative to water density.

$$V_1 = \frac{m_3 - m_4}{\rho_W} \quad (cm^3) \qquad (3)$$

Marshall test

Stability S: represents maximum resistance to deformation (in kN) of asphalt mixture test specimens.

Variation F: represents the deformation in mm of the asphalt mixture test specimen at maximum load. The tests are performed using the Marshall device (See Fig. 1).

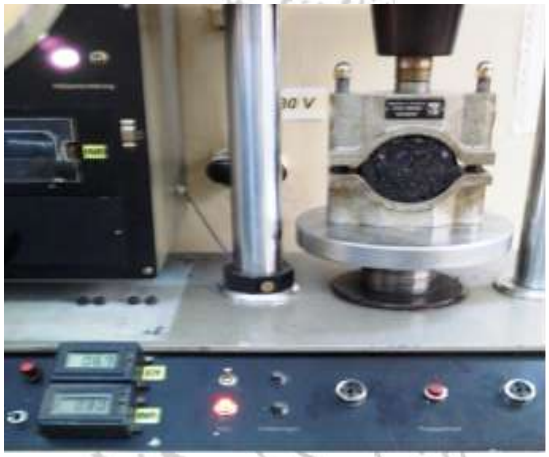


Fig. 1. Marshall device

Density is determined according to SR EN 12697-6: 2012.

Immerse the flat surface specimens in the water bath for at least 40 minutes and keep at 60 ± 1°C (see Fig. 2).

Fig. 2. Thermostat bath

To determine the flow index, on the chart it is measured the distance to ± 0.50 mm from the intersection of the tangent line and the base line, A, at the point where the maximum load is reached, M (see Fig. 3).
The test is performed on a set of 4 specimens.

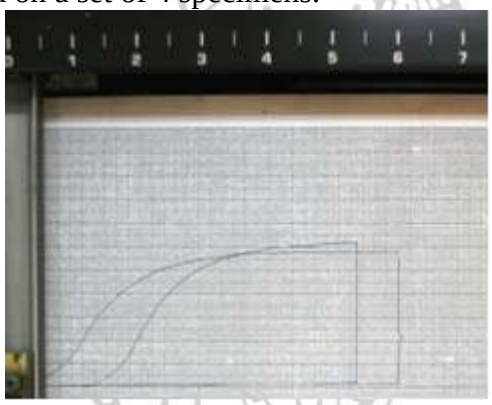


Fig. 3. Graphic recording of the flow indicator value

The cyclic compression test (Dynamic Variation) refers to the cumulative permanent deformations resulting from the long-lasting compressive stresses of road asphalt mixtures (see Fig. 4).
The determination of the dynamic variation of asphalt mixtures can be done on specimens made in the laboratory or on specimens taken from the field with the core-extractor. The test temperature is of 50˚C for the wear layer, 40˚C for the bonding layer and base. The axial load value is (724 + 14) x 0.001 kN (100 + 2 kPa).

Fig. 4. Cyclic compression test apparatus (Dynamic Variation)

Modulus of rigidity

The determination of the modulus of stiffness of asphalt mixtures can be done on specimens made in the laboratory or on specimens taken from the field with the help of the core-extractor (see Fig. 5).

Fig. 5. Apparatus for determining the stiffness module

Physical and Mechanical Characteristics of the Bitumen Mixture 50/70 (PC)

Table 2. Physical and Mechanical Characteristics of the Bitumen Mixture 50/70 (PC)

No.	Characteristic	U.M.	Determined values				
			Bitumen 5.5%	Bitumen 5.7%	**Bitumen 5.9%**	Bitumen 6.1%	Bitumen 6.3%
1	Apparent volumetric mass	Kg/m^3	2285	2302	**2314**	2320	2307
2	Water absorption	%	3.6	3.4	**3.0**	2.9	2.8
3	Marshall Stability	KN	7.2	8.0	**8.9**	8.3	7.8
4	Flow index	mm	1.6	2.4	**2.7**	3.5	4.7

5	Void volumes	%			**3.5**		
6	The percentage of void volume in the VMA mineral skeleton	%			**16.1**		
7	Percentage of the void volume in the mineral skeleton filled with VFB binder	%			**78.4**		
8	Resistance to permanent deformations (dynamic variation) - deformation at 50^0C, 300 KPa and 10000 pulse - deformation speed at 50^0C, 300 KPa and 10000 pulse	 µm / m µm / m / ciclu			 **13013** **0.8**		
9	Stiffness modulus at 15^0C	MPa			**5363.3**		

The optimal chosen alternative is one with the 5.9% bitumen to the mixture.

Conclusions

The continuous increase of road traffic leads to the need to build new roads and to modernize the existing ones. Through the way roads are designed, they must ensure the safety and comfort of road traffic.

In the European Union and in our country there are regulations that establish the conditions that must be met by construction materials in order to be used.

In order for the roads to have a longer lifetime an essential requirement is the use of the best quality construction materials whose technical performances have been demonstrated by carrying out laboratory tests.

In order to meet the requirements for the evaluation of the technical performances of the construction products, the Incertrans Laboratory performs tests for all the products used for the road infrastructure construction and tests on the products used in the preparation of asphalt mixtures (natural aggregates, bitumen, filer), including tests on the final product - asphalt mix.

The use of harder bitumen with the penetration of 41/50, 61/70 is expected, especially in the rolling layers, in order to increase the stability of the asphalt mixtures and to avoid the danger of the occurrence of creases.

In order to ensure the superior stability of the bituminous coatings, asphalt mixtures with fibres, modified bitumen, strong mineral skeleton are designed and produced, which exhibit superior mechanical resistance and especially high resistance to plastic deformations. There are intense concerns about the widespread introduction, especially in the production of asphalt mixes used in the wear layer, of modified binders that have superior grades of classical bitumen and which allow the production of high performance asphalt mixes. Lately, the increase in the percentage of cribs in asphalt mixtures has been observed to increase the stability of bituminous layers. Aggregates used in the production of asphalt mixeturs to increase wear resistance are very good quality cribs with a Los Angeles coefficient below 20%. There is a tendency for all road specialists to find the most suitable solutions to produce high quality bituminous clothing, to satisfy the highest demands of the users and to have as much operating time as possible.

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