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The average thickness of bituminous binder – criterion for the analysis of performance behavior of hot rolled road asphalt pavements

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Summary

Although the average thickness of the bituminous binder does not represent a criterion for the design of the composition of the asphalt mixtures, it could be useful for the analysis of the premature distressed observed in the asphalt pavements. This paper intends to present the method of calculation of this parameter and suggests its correlation with the performance of the asphalt pavements, expressed in terms of type and extension in time of the specific distress phenomena. These correlations could be then recorded in a road data base, in order to be use, later on, for such analyses.

KEYWORDS: asphalt pavements, laboratory design, the average thickness of asphalt binder, road data base

1. INTRODUCTION

Although the average thickness of the bituminous binder does not represent a criterion for the design of the composition of the asphalt mixtures, it could be very useful for the analysis of the premature distresses observed in the asphalt pavements. If this thickness is too small, air will penetrate easier into the asphalt mix voids, thus leading to its faster oxidation, increased stiffness and cracking of the binder film.

This situation becomes more critical in case of using mineral aggregate susceptible to the action of water whose access at the surface of the aggregate will lead to the development of specific distresses.

This criterion is not applicable to the hot poured asphalt mixes, where the volume of binder exceeds the volume of voids in mineral aggregate.

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2. USEFUL RELATIONS FOR THE CALCULATION OF THE AVERAGE THICKNESS OF THE BITUMINOUS BINDER

according literature /1/,/2/,/3/, the average thickness of the bituminous binder (h_{bm}) in an asphalt mix is derived from the effective volume of the bituminous binder (V_{ef}), which represents the difference between the total volume of binder (V_t) and the volume of the binder absorbed by the natural aggregate (Va), by using various usual relations.

2.1 The calculation of the average thickness of the bituminous binder

The average thickness of the bituminous binder (h_{bm}) is obtained by using the following relation:

$$h_{bm} = \frac{V_{ef}}{\sum_a M_a} \quad [m] \qquad (1)$$

where: V_{ef} represents the effective volume of the binder [m^3] :

$$V_{ef} = V_t - V_a \qquad (2)$$

Σ_a - the total surface of the mineral aggregate (m^2 / kg);

M_a – mass of mineral aggregate (kg).

2.2. The calculation of the total volume of binder:

The total volume of binder (V_t) is calculated with the relation (3):

$$V_t = \frac{M_m * p_b}{\rho_b} \quad [m^3] \qquad (3)$$

where the involved parameters have the following significance:

M_m the mass of the asphalt mix (kg);

p_b - the percentage of binder (%);

ρ_b - the density of the bituminous binder [kg / m^3].

2.3 Calculation of the volume of the absorbed binder

The volume of the absorbed binder (V_a) by the mineral aggregate is obtained by using the relation (4):

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$$V_a = \frac{p_{ba} * M_m * (1 - p_b)}{\rho_b} \quad [m^3] \qquad (4)$$

where p_{ba} represents the percentage of the absorbed binder, determined with the relation (5) :

$$p_{ba} = 100 \frac{\rho_a - \rho_{aa}}{\rho_a * \rho_{aa}} \qquad (5)$$

In relation (5), ρ_a represents the efective density of mineral aggregate , calculated with the relation(6):

$$\rho_a = \frac{100 - p_b}{(100/\rho_m) - (p_b/\rho_b)} \quad [kg/m^3] \ , \qquad (6)$$

The parameters involved in relation(6) have the following significance :

ρ_m -represents the maximum theoretical density of the asphalt mix , e.g. of the mix without voids [kg / m^3];

ρ_{aa} - represents the apparent density of the mineral aggregate and is calculated with the relation (7) , [kg / m^3] :

$$\rho_{aa} = \frac{\sum p_{ai}}{\sum (p_{ai} / \rho_{ai})} \quad [kg/m^3] \qquad (7)$$

p_{ai} - the percentage of aggregate size "i", having the apparent density ρ_{ai}.

2.3 Calculation of thetotal surface of the mineral aggregate

For the calculation of the surface aggregate Σ_a , in relation (1), the Duriez formula or the Asphalt Institute relation (8) can be used :

$$\sum_a = \sum a_i * p_i \qquad (8)$$

where : ai represents the surface factor for the material passing the sive „ i „ in percentage „ pi"., in accordance with the values given in Table 1 from below:

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Table 1. The values of the surface factor ai

Sieve	The maximum size*)	Sieve Number						
		4	8	16	30	50	100	200
Sieve size -mm-	Sieve size	4,75	2,36	1,18	0,60	0,30	0,15	0,75
Surface factor a_i	2	2	4	8	14	30	60	160

*)sieve through which 100% aggregate is passing

3. CONCLUSIONS

For the determination of the average thickness of the bituminous binder in an asphalt mix, there is no need for supplementary laboratory tests, the data obtained during the design stage of the asphalt mix are sufficient in this respect.

The determination of the average thickness of the effective film of binder and its correlation with the performance behaviour of the asphalt pavements, expressed in terms of the types of distresses and of the time of their observance , is fully justified for the creation of a specific road data bank by each Road Agency.

References:

1. *** Hot Mix Asphalt Materials, Mixture Design and Construction.N.C.A.T.,1994.
2. Asphalt Institute : *Mix design methods for asphalt concrete and other hot mix types,* Manual series No.2 (MS-2), USA, 1988
3. The Asphalt Institute : *The asphalt handbook, ,* Manual series No.4 (MS-4), USA, 1970

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