SELECTING THE OPTIMAL BITUMEN CONTENT

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ABSTRACT

Purpose of work to determine the optimal content of bitumen in asphalt concrete.

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The optimum quantity of bitumen in the mixture is called such quantity that the asphalt concrete strength is maximal and the porosity and water saturation are out of the norms specified in GOST 9128 - 97. The excess of bitumen in the mixture reduces the strength, shear stability, plasticity of asphalt concrete that leads to the formation of shears in the hot weather. Asphalt concrete with excess bitumen is characterized by small value of water saturation. The lack of bitumen reduces the strength, frost resistance (corrosion resistance) of asphalt concrete. The optimum amount of bitumen in the asphalt mixture can be determined by two methods:

- testing test mixtures with different amounts of bitumen, in such a content that provides the highest asphalt concrete durability and residual porosity, normalized by the standard;
- find the calculation and experimental samples of such an amount of bitumen in the mixture which will provide the residual porosity specified by the designer.

According to the first method to determine the optimum amount of bitumen for asphalt concrete mixture of mineral materials taken in the calculated ratios, prepare at least three mixtures with different amounts of bitumen. The variation interval of bitumen content in the mixture is usually taken as 0.5%

The recommended bitumen content for hot, high-density asphalt concrete mixtures of type B is 5 6.5 %. We select 6%.

According to the results of the graphical method we get the exact content:

- crushed stone - 43 %;

sand - 46 %;

mineral powder - 11%.

To perform the experiment I was given:

Table 1

g ,г	g1,г	g2,г	g3,г	R20,МПа	R50,МПа	Rв,МПа
661	380	662	667	2,8	1,9	2,6

g - mass of the sample suspended in air (mobr)
g1 - mass of the same sample suspended in water
g2 - mass of sample soaked in water for 30 min and then weighed in air
g3 - mass of sample saturated with water and then weighed in air
Size of the sample:d = 71,4 мм
h = 71,4 ± 1 мм
F = 40 см²
To determine the optimal content of bitumen in asphalt concrete, we prepare three mixes of bitumen with different amounts of it.
-Heating temperature:
-bitumen 130 - 150ºC;
-Crushed stone and sand 150 - 170 ° C;
-Mixing 140 - 160 ° C;
-form 90 - 100ºC.
Compaction of the mixture is carried out on the press at a pressure of 40 MPa (16 tons).
Water-resistance coefficient of asphalt concrete
The water resistance coefficient indicates how much the asphalt's strength will decrease after saturation with water. It characterizes the resistance of asphalt concrete to the damaging effects of water, that is, pitting and the formation of potholes in the pavement.

We define it by the formula: $$K_{вод} = \frac{R_в}{R_{20}}$$

where is the ultimate strength of a water-saturated sample, is the ultimate compressive strength at 20ºC.

$K_{вод}$=2,6/2,8=0,93.

Determination of the porosity of the mineral part
Determine by the formula

$$V^0_{мч} = \left(1 - \frac{\rho^0_m}{\rho^0}\right) * 100\%$$

Where ρ^0_m - average density of the mineral part of asphalt concrete [g/cm³]

ρ^0 - the true density of the mineral part of the asphalt concrete

$$\rho^0_m = \frac{\rho_m}{(1 + 0.01 q_б)}$$

Where ρ_m - average density of asphalt concrete,

$q_б$ - mass fraction of bitumen in the mixture, %

ρm = g/(g2 – g1)
p_m=661/662-380=2,34

p^{o}_{m}=2,34/(1+0,01*6)=2,21

$$\rho^{0} = \frac{100}{\left(\frac{q_{щ}}{\rho_{щ}} + \frac{q_{п}}{\rho_{п}} + \frac{q_{мп}}{\rho_{мп}}\right)}$$

Where $q_{щ}, q_{п}, q_{мп}$ - mass fraction of crushed stone, sand, and mineral powder, respectively,

$\rho_{щ}, \rho_{п}, \rho_{мп}$ - the densities of crushed stone, sand, and mineral powder, respectively:

p^{o}=100/(43/2,7+46/2,62+11/2,6)=2,65

$V^{o}_{мч}$=(1-2,21/2,65)*100%=16,6038

(in accordance with GOST 9128-97 porosity of the mineral part for type B does not exceed the norm (not more than 19%))

Water saturation by volume

Water saturation characterizes the structure of asphalt concrete, its density, the volume of open pores into which water can penetrate in all its phase states (vapor, liquid, solid).

$$W = \frac{q_3 - q}{q_2 - q_1} * 100\%$$

W={(667-661)/(662-380)}*100=2,13

(according to GOST water saturation should be 1.5-4.0%)

Residual porosity

The residual porosity is determined by calculation on the basis of pre-determined true ρ and average ρm densities of asphalt concrete.

$$V^{0}_{пор} = \left(1 - \frac{\rho_m}{\rho}\right) * 100\%$$

Where ρ – the true density of asphalt concrete

$$\rho = \frac{q_м + q_б}{\frac{q_м}{\rho^{0}} + \frac{q_б}{\rho_б}} = \frac{100+6}{\frac{100}{2,65} + \frac{6}{1}} = 2,42 г/см^3$$

$$V^{0}_{пор} = \left(1 - \frac{2,34}{2,42}\right) * 100\% = 3,31$$

(*в соответствии с ГОСТ 9128-97 остаточная пористость должна составлять от 2,5 до 5,0%*)

Table 2

Indicators	Test results	Requirements of GOST9128 - 97 for type

		B, grade II
1. Compressive strength		
At 50ºC	1,9	At least 1.0
At 20ºC	2,8	Not less than 2,2
At 20ºC (Water)	2,6	Not normative
2. Water resistance coefficient	0,93	Not less than 0.85
3. Porosity of mineral composition, %	16,6	Not more than 19
4.Residual porosity	3,31	2,5 - 5,0
5.Water saturation	2,13	1,5 - 4%

Conclusion: Based on the test results and the requirements of GOST 9128 - 97 received that water saturation by volume 2.13 corresponds to the required value of GOST (for type B - W = 1,5 - 4%).

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