ASPHALT MIXTURES WITH STEEL PLANT SLAG CRUSHER – THE BEHAVIOR TOWARDS WATER

АСФАЛАТОВАЯ СМЕСЬ С ОСНОВАНИЕМ СТАЛЬНОЙ ШЛАК И РЕЖИМ РАБОТЫ ПРИ ОВЛАЖНЕНИИ

Ph.D. Lecturer Eng. Galusca N.I.[1] , Prof.Dr.Eng. Gugiuman Gh.[2]
The „Gheorghe Asachi" Technical University of Iasi, Romania [1,2]

Abstract: In this essay are presented laboratory studies about made of five types of asphalting mixtures with broken stone from lump slangs on steel mill and values of physico-mechanical properties resulted.
KEYWORDS: CONCRETE / ASPHALT / SLANG / MIXTURA / COAT.

1. Introduction

Lump slang from steel mill – LIDONIT – produced by DSU Galați is an artificial aggregate made in steel mills of METAL STEEL Galați factory (Gugiuman, Iriciuc 2005) (Gugiuman, Găluşcă, 2005).

The classies of ore used for making the cold coatings are: broken stone 16-25, 8-16 and 4-8 as well as lump sand 0-4.

2. Studies made in laboratory

With the classies of ore LIDONIT above-mentioned was created the technological compound for cold coatings utilised in asphaltic bitumen coats:

I – BA 8 – asphaltic concrete with bitumen;
II – BA16 - asphaltic concrete with bitumen;
III – BAR16 – harsh asphaltic concrete with bitumen;
IV – BA 25 – coarse asphaltic concrete with bitumen.

And for the base course:

V – BAD 25 – asphaltic concrete open with broken stone and bitumen.

The particle-size histogram of the aggregates are shown in table 1 and batching of the aggregates, also the particle-size histogram of mixed aggregates for the fifth types of mixtures are shown in table 2.

For each kind of asphaltic concrete was made in laboratory mixtures with five batching of bitumen each one and after that, values of physico-mechanical properties – determined on Marshall control cylinder (D=101,6 mm; H=63,5 mm) – are shown in table 3. Was utilized three set of control cylinder for the water absorption and five sets for Marshall test.

Control cylinder for the water absorption was utilized also for bloating determination at 7, 14, 21 şi 28 days. The values resulted for volumetrically bloating are presented in table 4.

Table 1 - The particle-size histogram of the aggregates utilized in laboratory

Aggregate	Passed through: (mm)										
	31,5	25	16	8	4	2	1	0,63	0,2	0,10	0,063
Chippings 16-25	100,00	95,24	6,22	-	-	-	-	-	-	-	-
Chippings 8-16	-	100,00	99,21	9,76	0,49	0,31	-	-	-	-	-
Chippings 4-8	-	-	100,00	98,53	20,65	1,33	0,23	-	-	-	-
Crusher sand 0-4	-	-	-	100,00	97,31	58,41	36,40	27,95	14,48	8,34	5,24
Natural sand 0-4	-	-	-	100,00	99,05	79,55	58,38	47,55	15,38	4,23	1,21
Filler	-	-	-	-	-	-	-	100,00	98,20	81,20	66,90

For each type of asphaltic concrete was made mixtures in laboratory with five sets of batching of bitumen and after that, values of physico-mechanical properties – determined on Marshall control cylinder (D=101,6 mm; H=63,5 mm) – are shown in table 3. Was utilized three set of control cylinder for the water absorption and five sets for Marshall test.

Control cylinder for the water absorption was utilized also for bloating determination at 7, 14, 21 and 28 days. The values resulted for volumetrically bloating are presented in table 4.

Characteristics filler and bitumen are presented in table 5 and table 6.

Was determined also adhesiveness of bitumen at LIDONIT through recommended method by SR EN 12697-11.

In table 7 and in figure 1 we found calibration curves.

Figure 1– Calibration curve.

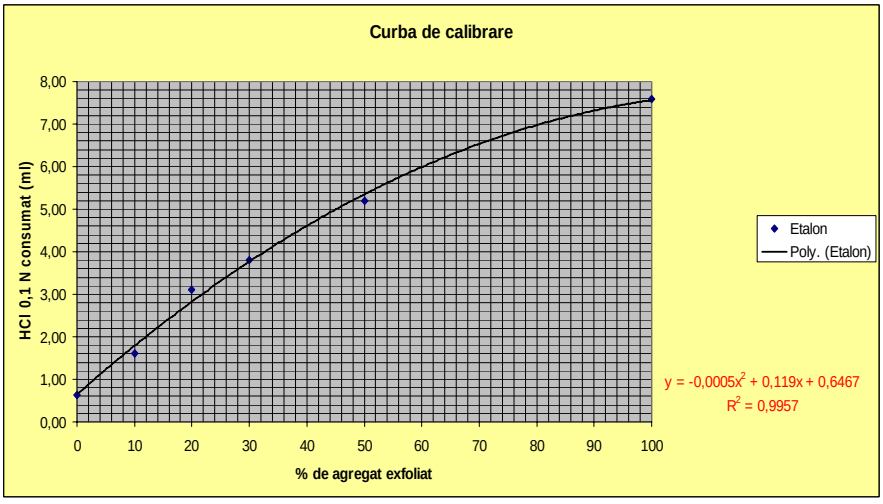

Table 2. The composition of mixtures of natural aggregates and granulometric curves for mixtures.

I-BA8

Chippings 4-8 = 40,00%
Crusher sand 0-4 = 38,00%
Natural sand 0-4 = 12,00%
Filler = 10,00%
TOTAL AGGREGATE =100,00%

D,mm	16	8	4	2	1	0,63	0,2	0,10	0,063
Granulometric curve	100,00	99,41	67,13	42,28	30,93	26,33	17,47	11,80	8,83
Limits SR 174-1/09	100	90…100	56…78	30…55	22…42	18…35	11…25	8…14	7…11

II-BA16

Chippings 8-16 = 25,00%
Chippings 4-8 = 20,00%
Crusher sand 0-4 = 34,00%
Natural sand 0-4 = 11,00%
Filler = 10,00%
TOTAL AGGREGATE =100,00%

D, mm	25	16	8	4	2	1	0,63	0,2	0,10	0,063
Granulometric curve	100,00	99,80	77,15	58,24	38,96	28,85	24,73	16,43	11,43	8,60
Limits SR 174-1/09	100	90…100	66…85	42…66	30…50	22…42	18…35	11…25	8…13	7…10

III-BAR16

Chippings 8-16 = 30,00%
Chippings 4-8 = 23,00%
Crusher sand 0-4 = 38,00%
Filler = 9,00%
TOTAL AGGREGATE =100,00%

D, mm	25	16	8	4	2	1	0,63	0,2	0,10	0,063
Granulometric curve	100,00	99,76	72,59	50,88	31,60	22,88	19,62	14,34	10,48	8,01
Limits SR 174-1/09	100	90…100	61…74	39…53	27…40	21…31	18…25	11…15	8…11	7…9

IV-BA25

Chippings 16-25 = 14,00%
Chippings 8-16 = 20,00%
Chippings 4-8 = 13,00%
Crusher sand 0-4 = 32,00%
Natural sand 0-4 = 13,00%
Filler = 8,00%
TOTAL AGGREATE =100,00%

D, mm	31,5	25	16	8	4	2	1	0,63	0,2	0,10	0,063
Granulometric curve	100	99,33	86,71	67,76	54,80	37,26	27,27	23,12	14,49	9,72	7,19
Limits SR 174-1/09	100	90…100	70…90	54…80	40…61	30…50	20…40	15…35	8…25	6…13	5…10

V-BAD25

Chippings 16-25 = 20,00%
Chippings 8-16 = 28,00%
Chippings 4-8 = 15,00%
Crusher sand 0-4 = 16,00%
Natural sand 0-4 = 16,00%
Filler = 5,00%
TOTAL AGGREGATE =100,00%

D, mm	31,5	25	16	8	4	2	1	0,63	0,2	0,10	0,063
Granulometric curve	100	99,05	81,02	54,51	39,66	27,37	20,19	17,08	9,69	6,07	4,38
Limits SR 174-1/09	100	90…100	73…90	42…61	28…45	20…35	14…32	10…30	5…20	3…8	2…5

Table 3 – Values of physico-mechanical properties of the mixtures study in laboratory.

No.	Mixture type	Bitumen percent, %	Marshall Stability , S, kN	Flow index, I, mm	Rigidity modulus Marshall, S/I, kN/mm	Apparent density, Kg/m^3	Water absorbing, % vol.
1	BA8	6,25	10,1	2,81	3,59	2584	4,347
		6,50	7,8	3,79	2,06	2597	2,633
		6,75	10,3	4,03	2,56	2611	2,174
		7,00	13,5	5,28	2,56	2619	1,188
		7,25	9,8	6,51	1,51	2622	0,713
2	BA16	5,50	9,9	3,70	2,68	2630	3,976
		5,75	11,7	4,32	2,71	2678	2,306
		6,00	12,0	4,67	2,57	2667	1,661
		6,25	11,4	5,12	2,23	2626	0,794
		6,50	10,4	6,02	1,73	2598	0,155
3	BAR 16	5,50	8,8	3,12	2,82	2661	5,952
		5,75	9,5	3,53	2,69	2676	4,760
		6,00	9,5	3,70	2,57	2699	3,120
		6,25	10,1	3,75	2,69	2695	2,851
		6,50	11,1	4,70	2,36	2685	2,741
4	BA 25	5,75	11,6	4,31	2,69	2647	2,947
		6,00	11,9	4,42	2,69	2670	2,162
		6,25	12,4	4,56	2,72	2682	1,679
		6,50	12,7	6,09	2,09	2729	0,499
		6,75	11,2	6,62	1,69	2717	0,264
5	BAD25	4,25	6,1	2,87	2,13	2536	8,125
		4,50	6,4	3,13	2,04	2564	6,569
		4,75	9,1	3,50	2,60	2621	5,387
		5,00	7,0	3,52	1,99	2650	5,507
		5,25	8,8	3,79	2,32	2672	4,699

Table 4 – Volume bloating variation in time.

No.	Mixture type	Bitumen percent, %	Bloating value, % volume, after:			
			7 zile	14 zile	21 zile	28 zile
1	BA8	6,25	0,000	0,000	0,000	0,000
		6,50	0,000	0,000	0,000	0,010
		6,75	0,000	0,000	0,186	0,000
		7,00	0,000	0,000	0,000	0,000
		7,25	0,000	0,000	0,000	0,000
2	BA16	5,50	0,000	0,000	0,320	0,000
		5,75	0,000	0,000	0,000	0,000
		6,00	0,000	0,000	0,000	0,000
		6,25	0,000	0,000	0,000	0,000
		6,50	0,000	0,000	0,000	0,000
3	BAR 16	5,50	0,000	0,013	0,000	0,000
		5,75	0,000	0,000	0,000	0,000
		6,00	0,000	0,000	0,000	0,000
		6,25	0,000	0,000	0,039	0,020
		6,50	0,000	0,000	0,000	0,000
4	BA 25	5,75	0,000	0,013	0,000	0,000
		6,00	0,000	0,000	0,021	0,000
		6,25	0,000	0,000	0,000	0,000
		6,50	0,000	0,000	0,039	0,020
		6,75	0,000	0,000	0,000	0,000
5	BAD25	4,25	0,000	0,035	0,007	0,000
		4,50	0,000	0,000	0,010	0,000
		4,75	0,000	0,000	0,000	0,000
		5,00	0,000	0,000	0,000	0,000
		5,25	0,000	0,000	0,000	0,000

Table 5 – Characteristics of calcareous filler.

No.	Characteristics	Unit	Resulting values	Reference values SR 539, (SR EN 13043)	Trying method
1	Passed trough :	%			STAS 539/1979 SR EN 13043
	0.63 mm		100,00	100	
	0.2 mm		98,20	98	
	0.125 mm		90,10	(85 -100)	
	0.1 mm		81,20	-	
	0.063 mm		66,90	(70 -100)	
2	Humidity	%	0,3	≤ 1	

Table 6 - Characteristics of asphaltic bitumen

No.	Characteristics	Unit	Resulting value	Reference values SR 12591-01	Trying method
1	Penetration la 25 °C	1/10 mm	51	50 - 70	SR EN 1426-07
2	Softening point	°C	53,2	46 – 54	SR EN 1427-07
3	Adheziveness: grad de anrobare	%	93	-	SR EN 12697-11

Table 7 - Determination calibration curve.

No. test	Determination percent, [%]	Wetting aggregate weight , [g]	Wetting aggregate weight, [g]	Consumed NaOH (ml)	Equivalent factor r	Acid consumed HCl (ml)
1	0	0(±0,25)	200(±0,25)	24,50	0,995	0,62
2	10	20(±0,25)	180(±0,25)	23,50	0,995	1,62
3	20	40(±0,25)	160(±0,25)	22,00	0,995	3,11
4	30	60(±0,25)	140(±0,25)	21,30	0,995	3,81
5	50	100(±0,25)	100(±0,25)	19,90	0,995	5,20
6	100	200(±0,25)	0(±0,25)	17,50	0,995	7,59

3.Conclusions

From the analyses of physico-mechanical properties of the mixtures in laboratory results some conclusions:

- Apparent density values are net superior beside minimum values in SR 174-1/2009 and this is justified by high density of LIDONIT (about 3000 kg/mc instead of 2650 kg/mc from the natural aggregates on stone);
- The bloating values found at different moments: from 7 to 28 day, are very small, under 0,5 % volume, that indicate a good comportment for the mixtures under the action of the water. This it can be explained by a good adhesiveness at LIDONIT and in this way it provide also a good resistance to freeze - unfreeze;
- The values of stability Marshall are net superior beside minim values given by SR 174-1/2009 that provide a very good resistance of mixtures made with LIDONIT at the double action of the traffic and of the high temperature in summer time .

So, we can say without doubt that the utilization of LIDONIT at the mixtures asphaltic bitumen from structure of the roads, provides the conditions necessary to have high quality parameter that increase durability for coating or the roads .

4.Reference

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