

NEW ADDITIVES FOR ROAD BITUMEN

N.I. Galusca, Gh. Gugiuman
Technical University „Gh. Asachi” form Iasi, Romania

INTRODUCTION

The use on a large scale of natural ballast-pit aggregates - which have a content of SiO₂ exceeding 65 % - in the composition of asphalt mixtures requires the fact that we should consider special measures on insuring the bitumen's adhesiveness to these acid aggregates. One of these measures is to aditiviate bitumen with different tensioactive substances.

1. ADDITIVES TESTED IN THE LABORATORY

In order to study the influence of the following additives: ADIROL ALCAMID F and ADIROL ALCAMID FS over road bitumen, there have been made tests in the ROADS laboratory at the Technical University of Iași, Faculty de Civil Engineering, on two types of bitumen: the first type manufactured by Astra refinery from Ploiești and the second manufactured by Suplacu refinery from Barcău (Bihor).

Both types of bitumen have been determined the main characteristic values, both in pure state and in mixture with 0.5 % (of weight) with the two previously mentioned additives - everything is presented in the Table 1.

Table 1. The characteristic values of the considered types of bitumen.

No. crt.	Type of bitumen	Characteristics			
		Penetration at 25°C, 1/10 mm	Softening point (I.B.)	Penetration index (P. I.)	'a' susceptibility to heat
ASTRA-PLOIEȘTI Refinery					
1.	Witness bitumen	84	51,8	-0,615	0,037
2.	Bitumen +0.5% additive F	91	49,6	+0,278	0,038
3.	Bitumen +0.5% additive FS	76	51,2	0,166	0,039
SUPLACU DE BARCĂU Refinery					
4.	Witness bitumen	103	47,2	-0,017	0,040
5.	Bitumen +0.5% additive F	101	48,1	+0,185	0,039
6.	Bitumen +0.5% additive FS	86	49,0	-0,059	0,040

Both pure state (witness) and aditivated types of bitumen have been used as binding material in the composition of three mixtures: an asphalt concrete rich in chippings - BA 8 and an asphalt concrete rich in chippings - BA 16, both with chippings of 4-8, 8-16 and crusher sand of 0-4 from Turcoaia (Tulcea) quarry: granite and an asphalt concrete rich in chippings - BA 8 with chippings of 4-8 and crusher sand of 0-4 from Homorod (Harghita) quarry: andesite.

The granulometric curves of natural aggregates as well as the dosages used for each mixture as well as the granulometric curves of mixtures of aggregates are presented in the Table 2, and the values of the impurities from the natural sands are presented in the Table 3.

The granulometric curves of natural aggregates are framed in the SR 174-1/2002 (mixtures I and II), (fig.1 and fig.2) and the SR 174-1/2002 (mixture III) (fig.3).

In the laboratory there have been made asphalt mixtures with 4 dosages of bitumen for each type of asphalt concrete out of which there have been produced 8 Marshall-type cylinder samples for each (D = 10.16 cm and H = 6.35 cm) for which there have been determined the values of the physical and mechanical characteristics presented in the Tables 4 and 5. The variations of the values of physical and mechanical characteristics of experimental mixtures as comparing to witness mixtures are presented in the Table 6 for optimal dosages of bitumen.

Table 2. The composition of mixtures of natural aggregates and granulometric curves for mixtures I, II and III.

		I – BA8	II – BA16	III – BA8	
Passed (%) through:	Screen:	Ø 25	-	100,00	-
		Ø 16	-	95,59	-
		Ø 10	100,00	71,13	100,00
		Ø 8	89,16	61,60	93,38
	Sieve:	# 4	60,64	47,57	72,10
		# 2	48,37	39,50	53,63
		# 1	39,54	32,92	42,66
		# 0,63	34,47	29,15	36,38
		# 0,2	17,92	16,42	17,79
		# 0,1	11,97	10,82	10,12
	# 0,071	9,34	9,13	7,90	
Chippings 4-8 (Turcoaia)		45,00	20,00	-	
Chippings 8-16 (Turcoaia)		20,00	35,00	-	
Chippings 4-8 (Harghita)		-	-	45,00	
Crusher sand 0-4 (Turcoaia)		-	15,00	-	
Crusher sand 0-4 (Harghita)		-	-	22,00	
Natural sand (Tecuci)		23,00	18,00	-	
River sand (Timișești)			-	25,00	
Bicaz Filler		12,00	12,00	8,00	

Table 3. Values of the content of impurities in the river sands, used for mixture composition.

Nr. crt.	Natural aggregate	Characteristic	
		Part that can be levigated, %	Content of humus (the colour of the solution of 3% NaOH)
1.	Natural sand 0 ... 4 Tecuci	0,94	Light yellow
2.	Natural sand 0 ... 4 Timișești	1,95	Light yellow

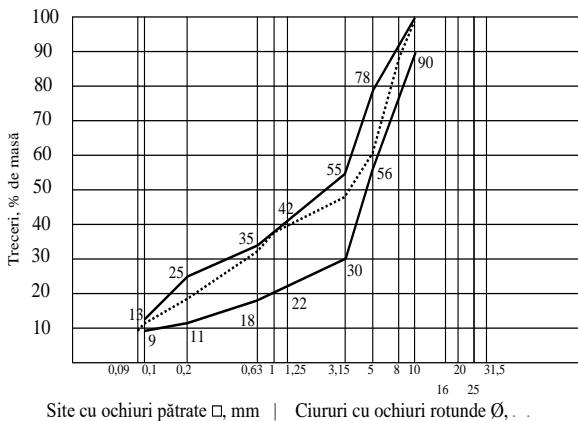


Figura 1. Granulometric curves for mixtures I-BA8.

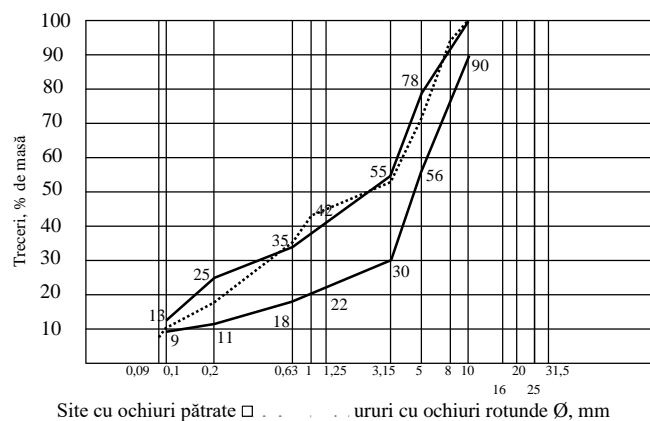
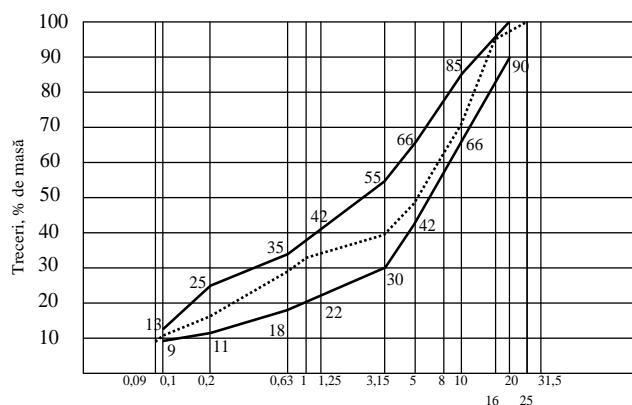


Figura 2. Granulometric curves for mixtures II – BA16



Site cu ochiuri pătrate □ unde Ø, mm
Figura 3. Granulometric curves for mixtures III – BA8.

Table 4. The values of physical and mechanical characteristics of mixtures made with bitumen ASTRA (Ploiești).

Mixture type	Bitumen type	Bitumen dosage (%)	P _a (kg/m ³)	A vol. (%)	Marshall trial			Swelling, (%) vol. after ... days			
					S, (kN)	I, (mm)	S/I, (kN/m ³)	7	14	21	28
1	2	3	4	5	6	7	8	9	10	11	12
BA8 WITNESS (Turcoaia)	ASTRA Ploiești	5,00	2367	1,678	7,6	1,90	4,000	0,000	0,013	0,020	0,287
		5,25	2387	0,501	7,9	2,70	2,926	0,000	0,079	0,013	0,191
		5,50	2393	0,248	9,7	3,93	2,468	0,000	0,112	0,000	0,092
		5,75	2383	0,198	9,3	4,70	1,979	0,000	0,146	0,066	0,258
BA8 F (Turcoaia)	Idem.	5,00	2374	1,252	10,0	2,60	3,846	0,000	0,000	0,039	0,170
		5,25	2379	0,859	8,5	3,70	2,194	0,026	0,000	0,065	0,269
		5,50	2396	0,132	10,0	4,33	2,309	0,000	0,000	0,020	0,172
		5,75	2390	0,020	8,6	4,93	1,744	0,000	0,000	0,033	0,147
BA8 FS (Turcoaia)	Idem.	5,00	2368	1,544	8,8	3,55	2,479	0,000	0,364	0,039	0,117
		5,25	2381	0,718	10,5	4,20	2,500	0,065	0,287	0,055	0,190
		5,50	2394	0,126	10,6	4,40	2,409	0,039	0,190	0,125	0,164
		5,75	2392	0,093	8,4	5,48	1,533	0,106	0,178	0,160	0,099
BA16 WITNESS (Turcoaia)	ASTRA Ploiești	4,25	2404	1,093	12,2	3,77	3,236	0,107	0,000	0,047	0,000
		4,50	2407	0,701	11,9	4,46	2,668	0,139	0,000	0,086	0,000
		4,75	2414	0,461	9,0	4,53	1,987	0,033	0,000	0,127	0,000
		5,00	2410	0,266	8,3	5,27	1,575	0,109	0,040	0,047	0,000
BA16 F (Turcoaia)	Idem.	4,25	2393	1,414	11,2	3,43	3,265	0,000	0,020	0,119	0,020
		4,50	2397	0,838	13,4	4,33	3,095	0,000	0,000	0,000	0,000
		4,75	2414	0,272	10,0	4,78	2,092	0,000	0,106	0,000	0,046
		5,00	2405	0,258	10,2	5,47	1,865	0,000	0,060	0,000	0,060
BA16 FS (Turcoaia)	Idem.	4,25	2392	1,223	9,2	2,45	3,755	0,000	0,000	0,000	0,067
		4,50	2407	0,423	10,0	3,17	3,155	0,000	0,000	0,000	0,119
		4,75	2413	0,310	9,6	4,20	2,286	0,106	0,099	0,086	0,205
		5,00	2410	0,288	10,2	4,33	2,356	0,027	0,000	0,073	0,147
BA8 WITNESS (Harghita)	ASTRA Ploiești	5,50	2349	2,993	9,1	2,20	4,136	0,000	0,766	0,806	1,254
		5,75	2356	2,583	8,7	2,43	3,580	0,098	0,540	0,628	0,903
		6,00	2362	1,768	10,4	3,43	3,032	0,000	0,204	0,145	0,394
		6,25	2355	1,420	9,0	3,93	2,290	0,040	0,337	0,516	0,621
BA8 F (Harghita)	Idem.	5,50	2324	3,918	8,3	3,13	2,652	0,060	0,381	0,689	1,162
		5,75	2347	2,936	8,8	3,20	2,750	0,072	0,287	0,267	0,847
		6,00	2353	2,267	8,1	3,35	2,418	0,109	0,424	0,128	0,700
		6,25	2351	1,723	10,5	4,13	2,542	0,013	0,033	0,000	0,190

Continuation table 4.

1	2	3	4	5	6	7	8	9	10	11	12
BA8 FS (Harghita)	Idem.	5,50	2311	3,710	7,8	2,95	2,644	0,000	0,489	1,096	1,434
		5,75	2343	2,015	9,1	3,80	2,395	0,000	0,210	0,413	0,597
		6,00	2366	0,911	10,0	3,95	2,532	0,000	0,032	0,221	0,739
		6,25	2363	0,408	9,8	5,47	1,792	0,000	0,000	0,007	0,039

Table 5. The values of physical and mechanical characteristics of mixtures made with bitumen SUPLACU DE BARCĂU (Bihor)

Mixture type	Bitumen type	Bitumen dosage (%)	P _a (Kg/m ³)	A vol. (%)	Marshall trial			Swelling, (%) vol. after ... days			
					S, kN	I, mm	S/I, kN/mm	7	14	21	28
1	2	3	4	5	6	7	8	9	10	11	12
BA8 WITNESS Turcoaia	Suplacu de Barcău	5,00	2377	1,116	9,3	3,07	3,029	0,000	0,069	0,000	0,000
		5,25	2378	0,769	8,4	3,83	2,193	0,000	0,000	0,000	0,000
		5,50	2386	0,248	8,3	4,23	1,962	0,000	0,000	0,000	0,000
		5,75	2380	0,239	8,8	4,80	1,833	0,000	0,000	0,000	0,000
BA8 F Turcoaia	Idem.	5,00	2378	0,921	9,5	2,67	3,558	0,000	0,000	0,000	0,007
		5,25	2384	0,667	8,7	3,60	2,417	0,000	0,000	0,000	0,013
		5,50	2398	0,205	9,2	3,70	2,486	0,000	0,000	0,000	0,000
		5,75	2396	0,027	8,3	4,75	1,747	0,000	0,027	0,000	0,027
BA8 FS Turcoaia	Idem.	5,00	2389	0,848	10,2	3,17	3,218	0,000	0,013	0,000	0,000
		5,25	2391	0,604	8,8	3,40	2,588	0,000	0,000	0,000	0,039
		5,50	2405	0,013	8,0	4,07	1,966	0,000	0,093	0,086	0,000
		5,75	2397	0,000	7,4	4,33	1,709	0,000	0,066	0,013	0,000
BA16 WITNESS Turcoaia	Suplacu de Barcău	4,25	2385	1,663	10,8	3,03	3,564	0,000	0,000	0,000	0,000
		4,50	2385	0,763	10,3	4,25	2,424	0,000	0,000	0,000	0,000
		4,75	2400	0,318	10,7	4,60	2,326	0,000	0,007	0,000	0,000
		5,00	2413	0,139	10,2	5,38	1,896	0,000	0,000	0,007	0,000
BA16 F Turcoaia	Idem.	4,25	2388	1,272	11,4	3,00	3,800	0,000	0,000	0,000	0,000
		4,50	2408	0,486	9,2	3,55	2,592	0,000	0,000	0,000	0,000
		4,75	2411	0,304	8,4	4,00	2,100	0,000	0,000	0,000	0,000
		5,00	2407	0,192	9,5	4,50	2,111	0,000	0,000	0,000	0,000
BA16 FS Turcoaia	Idem.	4,25	2397	1,058	12,3	2,60	4,731	0,000	0,010	0,100	0,040
		4,50	2408	0,766	9,8	2,80	3,500	0,000	0,000	0,066	0,000
		4,75	2410	0,424	9,4	3,42	2,749	0,000	0,000	0,000	0,000
		5,00	2404	0,265	9,6	4,00	2,400	0,000	0,000	0,046	0,000
BA8 WITNESS Harghita	Suplacu de Barcău	5,50	2339	3,346	10,5	2,27	4,626	0,000	0,171	0,020	0,237
		5,75	2362	2,225	9,7	2,60	3,731	0,000	0,118	0,033	0,138
		6,00	2368	0,692	9,8	2,93	3,345	0,000	0,000	0,000	0,000
		6,25	2364	0,297	8,1	3,90	2,077	0,000	0,039	0,000	0,000
BA8 F Harghita	Idem.	5,50	2335	2,654	8,3	1,85	4,486	0,000	0,000	0,000	0,000
		5,75	2337	2,033	7,8	2,48	3,145	0,000	0,000	0,000	0,000
		6,00	2342	1,698	8,2	3,07	2,671	0,000	0,000	0,000	0,000
		6,25	2335	1,458	8,8	3,80	2,316	0,000	0,000	0,000	0,000
BA8 FS Harghita	Idem.	5,50	2348	2,667	9,7	2,73	3,552	0,484	0,729	0,749	1,108
		5,75	2363	2,363	10,6	3,47	3,055	0,231	0,442	0,336	0,501
		6,00	2373	0,669	11,9	3,83	3,107	0,000	0,007	0,000	0,013
		6,25	2367	0,573	10,0	4,36	2,294	0,007	0,027	0,007	0,066

Table 6. Variation of physical and mechanical values of experimental mixtures as comparing to witness mixtures (optimal dosages).

Bitumen type	Mixture type	Optimal dosage, %	Additive	Apparent density ρ_a	Water absorption, vol	Marshall Stability (S)	Running Index (I)
1	2	3	4	5	6	7	8
ASTRA PLOIEȘTI	BA8 (I)	5,50	F	100,13	53,23	103,09	110,18
	BA8 (III)	6,00	F	99,62	128,22	77,88	97,67
	BA16 (II)	4,75	F	100,00	59,06	111,11	105,52
	BA8 (I)	5,50	FS	100,04	50,81	109,28	111,96
	BA8 (III)	6,00	FS	100,17	51,53	96,15	115,16
	BA16 (II)	4,75	FS	99,96	67,25	106,67	92,72
SUPLAC U DE BARCĂU	BA8 (I)	5,50	F	100,50	82,66	110,84	87,47
	BA8 (III)	6,00	F	98,90	245,38	83,67	104,78
	BA16 (II)	4,75	F	99,92	95,60	78,50	86,96
	BA8 (I)	5,50	FS	100,80	5,24	96,39	96,22
	BA8 (III)	6,00	FS	100,21	96,68	121,43	130,72
	BA16 (II)	4,75	FS	99,88	133,33	87,85	74,35

2. CONCLUSION

From the analysis of the results obtained after the research there has been found that:

1. Using the additives does neither remarkably modify the values of the main characteristics of the bitumen (penetration at + 25⁰ C and softening point) and neither the initial type of structure (sol-gel) characteristic to the road bitumen;

2. All the physical and mechanical characteristics of the experimental mixtures suffer net improvements with the exception of the apparent density whose value remains practically unchanged;

3. For the experimental mixtures made using optimal bitumen proportions there has been remarked that:

- the water absorption reduces, with three exceptions, with 38 % on the average comparing to the witness mixtures; even in the case of the three exceptions the values of the water absorption are much below the maximum admitted limit - 5 % - of SR 174-1/2002: table 13 (ANEXA I);

- both the values of the stability and of the Marshall running index are practically constant, the variations being reduced: (- 22 % ... + 21 %) to the Marshall stability and (- 26 % ... + 31 %) to the Marshall running index;

- although determining the swelling values is not compulsory according to the latest standard SR 174-1/2002 there have been determined the swelling values at: 7, 14, 21 and 28 days. As it can be observed in the tables 4 and 5, the values obtained are very low (under 0.8 %) signaling a good behavior of the mixtures in time to water corrosion.

Considering the facts we have proved so far, we can state that using the additives ADIROL ALCAMID (Variants: F and FS) the characteristics of the road bitumen are not practically modified, but significantly diminish the values of water absorption to the mixtures made with natural acid aggregate (granite de Turcoaia) to which the road un aditivated bitumen have a reduced adhesiveness. That creates the premises of a good behavior in time of asphalt mixtures and, implicitly, of an improved resistance to freezing and de-freezing, which insures the improvement of the road pavement viability realized with these mixtures in the wearing layer.

References

1.***S.R. 174-1/2002: *Lucrări de drumuri. Îmbrăcăminți bituminoase cilindrate executate la cald. Condiții tehnice de calitate.*

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