STUDIES ON BITUMEN ADHESION THE NATURAL AGGREGATES

Lecturer Eng. Găluşcă Narciza-Izabela PhD.[1]
Faculty of Civil Engineering and Building Services, Technical University "Gheorghe Asachi" Iasi, Romania [1]

Abstract: *The paper presents the results of laboratory tests for determining adhesiveness of bitumen and bitumen additives, the aggregate pit and aggregate quarry natural exfoliation method (SR EN 12697/11-2006.*

Keywords: BITUMEN, ADDITIVE BITUMEN, ADHESIVENESS.

1. Introduction

The adhesion between natural aggregates and bitumen is a surface phenomenon which depends on the contact between the two materials, and on the attraction between their surfaces.

The bitumen adhesion as against natural aggregates is inappropriate if it is below 80% (technical condition imposed by SR174-1/2009).

In order to study the influence of the additives: ADIROL ALCAMID OX, ADIROL ALCAMID SX over road bitumen, there have been made tests in the ROADS laboratory at the Technical University of Iasi, Faculty de Civil Engineering, on two types aggregates: natural pit Cristesti and natural quarry Chileni.

The study presents the obtained experimental results and the interpretations watching adhesion between pure bitumen and the additives bitumen to natural pit aggregates and natural quarry aggregates.

The used bitumen fit in terms of characteristics in the type of bitumen – D 60/80 according SR 754/1999 – table 1.

Table 1:*Bitumen characteristics.*

No. crt.	Characteristics Name of test	U.M.	Result of test	Limits	Characteristics Name of test
1.	Penetration at 250C	1/10 mm	66	60...80	SR EN 1426-02
2.	Softening point Ring and ball softening point	^{0}C	49,1	49...55	SR EN 1427-02
3.	Ductility at: -5^{0}C -25^{0}C	cm	5 137	min.4 min.100	SR 61-97
4.	Frass break point	^{0}C	-19	min.-13	SR 12593-03
5.	Marcusson flash point	^{0}C	268	min. 250	SR ISO 2592-03
6.	Solubility in organic solvents	%	99,51	min. 99	SR EN 12592-03
7.	Stability in thin film at +163^{0}C - residual penetration at 25^{0}C - mass loss - I.B. point increase - residual ductility at 25^{0}C	% % ^{0}C cm	60 0,33 5,1 126	min. 50 max. 0,8 max. 9 min. 50	SR EN 12607/2-03
8.	Paraffin content	%	0,81	max. 2	SR EN 12606/ 1-03
9.	Density at 15^{0}C	g/cm^3	0,998	min. 0,995	STAS 10969/3-83
10.	Penetration - susceptibility to heat	I.P. „a"	-0,76 0,045 Ground-gel structure	-	-

In the purpose of adhesion determination between bitumen and aggregates there were tested two types of additives.

The used materials were: bitumen, additives, aggregates, reagents.

For additive the bitumen has resorted to two additives: ADIROL ALCAMID OX, ADIROL ALCAMID SX. These additives are composites of surfactant substances of type amido-amine with raised thermal stability.

The pit aggregates are siliceous rocks and the quarry aggregates are andesite rocks.

The reactive depend on the type of aggregates which they mix:
- 0.1N hydrochloric acid (HCl) – for limestone aggregates;
- N Hydrofluoric acid (HF) – for siliceous-limestone and siliceous aggregates;
- 0.1N sodium hydroxide (NaOH);
- N (± 2%) potassium hydroxide (KOH);
- 1% of the mass of phenolphthalein indicator solution in ethanol.

The pure potassium hydroxide for analysis contains around 85% KOH. Controlling the normality of potassium hydroxide with N HCl, adjusting N KOH if it is necessary (± 2%) and controlling after the normality HF with N KOH.

2. Making laboratory measurements

For substantiate and highlight the influence of using additive bitumen at asphaltic mixture preparation there have been achieved a series of determinations in laboratory using delamination in boiling water method.

To perform the determinations there were used pit aggregates and quarry aggregates, bitumen D 60/80 – SR 754/1999, two indigenous additives ADIROL ALCAMID OX and ADIROL ALCAMID SX.

In the research it was tested the adhesion of pure bitumen and additive bitumen at the two types of natural aggregates. The percentages of used additive were 0.4%, 0.8% and 1% additive, for the samples prepared with ADIROL ALCAMID OX and ADIROL ALCAMID SX additive.

Determination of calibration curve for pit aggregates

The results of laboratory made tests are centralized in table 2.

The centralization of the results from laboratory determinations is presented in table 3, and the graphic representation of the determinations is presented in figure 1.

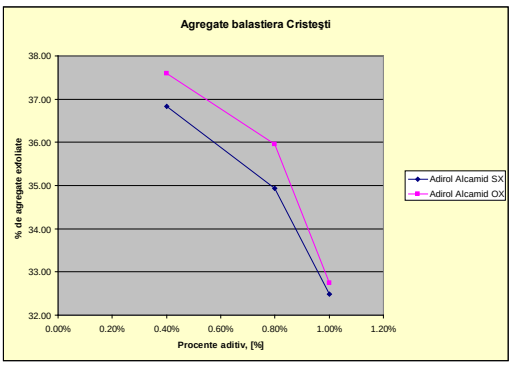

Figure 1 - Exfoliated natural pit aggregates percentage representation.

Table 2 - *Calibration curve for pit aggregates.*

Sample No.	Corresponding peeling percentage, [%]	Unmixed aggregates mass, [g]	Mixed aggregates mass, [g]	Consume KOH (ml)	Equivalence factor, r	Consumed acid HF (ml)
1	0	0	200(±0,25)	24,50	0.998	0,99
2	10	20(±0,25)	180(±0,25)	23,50	0.998	1,97
3	20	40(±0,25)	160(±0,25)	33,80	0.998	2,656
4	30	60(±0,25)	140(±0,25)	22,20	0.998	3,244
5	50	100(±0,25)	100(±0,25)	20,5	0.998	4,91
6	100	200(±0,25)	0(±0,25)	17,20	0.998	8,144

Table 3 - *Determination result.*

Pit Aggregates									
Sample no.	Additive percent [%]	KOH, (ml)	M1, [g]	M2, [g]	r	Coefficient 1+(M2-M1)/200	Consume HF (1N), (ml)	Exfoliated aggregate, [%]	Adhesion, [%]
Pure bitumen									
1	Specimen	20.30	200.00	198.1	0.98	0.9905	5.294993	56.39	43.61
2	0.40%	21.80	200.10	197.6	0.98	0.9875	3.90305	36.83	63.17
3	0.80%	22.10	200.30	196.4	0.98	0.9805	3.764331	34.94	65.06
4	1%	22.30	200.10	196.1	0.98	0.9800	3.58308	32.49	67.51
Additived bitumen with Adirol Alcamid OX additive									
5	0.40%	21.60	200.00	198.8	0.98	0.9940	3.959008	37.60	62.40
6	0.80%	21.90	200.10	197.3	0.98	0.9860	3.838468	35.95	64.05
7	1%	22.10	200.00	197.6	0.98	0.9880	3.601896	32.75	67.25

Determination of curve calibration for quarry aggregates

The test results for determination of curve calibration are presented in table 4.

The centralization of the results from laboratory determinations in order to determine the affinity between the binder and the aggregate is presented in table. The graphic representation of the determinations is presented in figure 2.

Table 4 - *Calibration curve for quarry aggregates*

Sample No.	Corresponding peeling percentage, [%]	Unmixed aggregates mass, [g]	Mixed aggregates mass, [g]	Consume KOH (ml)	Equivalence factor, r	Consumed acid HF (ml)
1	0	0	200(±0,25)	24.60	0.995	0.52
2	10	20(±0,25)	180(±0,25)	23.60	0.995	1.52
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

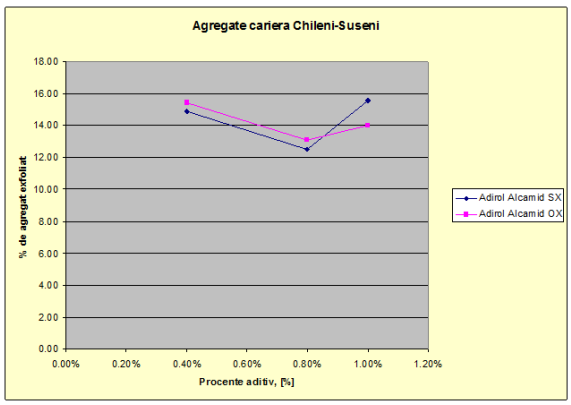

Figure 2 - Representation of exfoliated quarry aggregates percentage.

3. Conclusions

Analyzing the results obtained in the laboratory, centralized in tables 3 and 5, we can deduce that the adhesion of pure bitumen at natural aggregates of siliceous nature is as far below the expected limits, and only the use of additives for bitumen additivation leads to adhesion improvement.

At the determinations made with pure bitumen whatever the provenience of aggregates the adhesion is far below 80%, making the bitumen not being usable in pure state at the preparation of asphaltic mixtures. It can be observed that by introducing a percentage of additive in the bitumen mass the adhesion raises, exceeding in some cases 80%.

The best results were obtained at the determinations made on quarry aggregates, where it obtained a value of 87.51%.

As shown in table 5, the adhesion of bitumen at the pit natural aggregates is very small (46.61%), by introducing of a percentage of additive it improves (67.51%), but remains far below under minimum limit of 80%.

The conclusion is that, by respecting the dosages, the preparation technology, putting in work and by using the additivated bitumen, whatever the provenience of the natural aggregates, it improves the adhesion between the binders and the aggregate.

4. Bibliography

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