

Research of permanent deformations of SMA 11 mixtures with different gradations

Martins Zaumanis and Viktors Haritonovs (faculty mentor)

Riga Technical University, Riga, Latvia

jeckabs@inbox.lv

Gradation of mineral materials is regulated by corresponding part of EN 13108 and national specifications for bituminous mixtures, but it is up to contractors to develop long lasting asphalt mix within the limits of gradation curve and other empirical evaluations. The composition of mineral carcass has a significant impact on asphalt performance for empirical as well as fundamental characteristics (Haritonovs et al., 2005). This research establishes the correlation between empirical testing using Marshall method and fundamental evaluation of rutting using wheel tracking test (WTT).

Four mixtures of SMA 11 with different grading compositions were made in a full-scale asphalt plant and two equally graded mixtures using different additives were mixed in a laboratory (Table 1). Granite was used for mineral carcass and road bitumen 70/100 with fibre and adhesion additives as a binder. For each type of mixture two slabs were made: one for determining particle size distribution, soluble binder content and void characteristics with the Marshall method and one for the wheel tracking test using roller compactor according to EN 12697-33. Test was performed with the wheel tracking method using small size device for testing in air. The test conditions correspond to EN 13108-20. Testing results are summarized in Table 2.

Table 1: Compositions of asphalt mixtures

No.	Consumptions of aggregates(d-D) for primary dozation, %				Precise dozation on asphalt plant, kg					Fibre additive, % of mixture mass	Adhesion additive, % of bitumen
	8-11	5-8	2-5	0-5	0-6 mm bunker	6-10 mm bunker	10-14 mm bunker	Dolomite powder	Road bitumen 70/100		
No.1	78	-	-	22	220	127	490	100	63	0.40%	0.24%
No.2	63	14	6	17	309	484	43	100	64	0.40%	0.24%
No.3	78	-	-	22	220	124	482	110	64	0.40%	0.24%
No.4	84	-	-	16	244	296	296	100	64	0.40%	0.24%
Consumptions of asphalt mixtures, mass%											
No.5	53	12	4.7	14	Mixed in laboratory			10	6.3	0.40%	0.24%
No.6	53	12	4.7	14				10	6.3	0.40%	-

Table 2: Specimen testing results

Sieve	Particles passing sieve, mass%						Requirement of Road Specifications (2004)	
	No.1	No.2	No.3	No.4	No.5	No.6	max	min
0.063mm	9.6	8.9	9.7	9.7	10.8	10.8	12	8
0.5mm	16.9	20.3	17.6	15.9	16.4	16.4	20	10
1mm	20.3	23.7	21.0	19.4	17.9	17.9	27	15
2mm	28.3	30.9	27.9	28.5	21.6	21.6	20	19
4mm	32.6	40.9	31.4	33.9	30.1	30.1	35	24
5.6mm	34.6	48.4	33.2	36.4	36.7	36.7	40	27
8mm	48.9	65.2	47.2	48.6	49.7	49.7	60	35
11.2mm	91.8	91.4	89.3	93	94.9	94.9	99	85
16mm	100	99.7	100	100	100	100	100	98
Bitumen (B), %	6.2	6.0	6.1	5.9	6.0	6.0	B _{maxNR}	B _{min6,0}
Air voids (V), %	5.8	2.1	2.9	5.6	5.5	5.5	V _{max3.5}	V _{min2.0}
Voids filled with bitumen (VFB), %	71.6	87.5	83.8	71.5	72.7	72.7	VFB _{max90}	VFB _{minNR}
Wheel tracking test							Requirement of EN 13108-5	
Wheel tracking slope (WTS _{AIR}), mm/10 ³ cycles	0.13	0.07	0.06	0.12	0.06	0.10	WTS _{AIR1.0}	WTS _{AIR0.3}
Proportional rut depth (PRD _{AIR}), %	7.55	6.53	6.01	7.75	6.23	7.93	PRD _{AIR5.0}	PRD _{AIR1.0}

All of the mixtures satisfy the highest category of wheel tracking slope (WTS_{AIR0.3}) more than twice and there is a clear correlation between the number of air voids in the mixture and the WTS_{AIR} - the fewer the number of voids present, the smaller is the WTS_{AIR} (Figure 1). The situation is the same for the proportional rut depth (PRD_{AIR}) test if the results are compared - minimization of the number of air voids improves the results (Figure 2). But in the case of evaluating PRD_{AIR}, it is clear that rut depth exceeds the minimal requirement of PRD_{AIR5} for all specimens. As the WTS_{AIR} is calculated from the last 5000 cycles and the results are very satisfying, but PRD_{AIR} is estimated over the entire range of the experiment, including the first – the stabilisation part, then it is fair to say that unsatisfactory results, as we can see from the Figure 3, are mostly observed during the first 2000 cycles when the rate of rut depth growth is the largest.

The connection between aggregate gradation and performance in the WTT may be established if the specimen has a similar amount of air voids. For mixtures closer to the minimum requirements of number of particles passing through the sieve, the results for both assessments improve noticeably. This and different processes of bitumen aging because of mixing in laboratory explains the performance of specimen No.5, which doesn't comply with others in WTT results correlation against number of air voids.

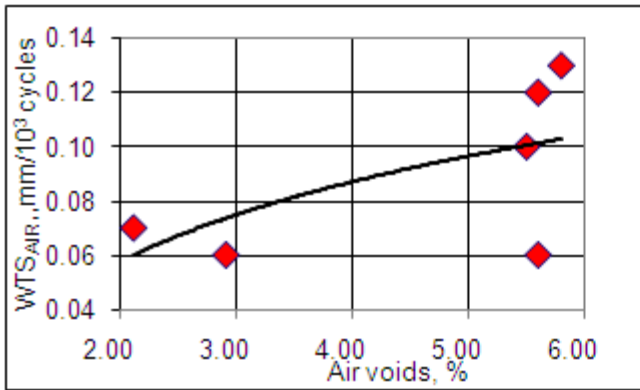


Figure 1: Correlation between number of air voids and WTS_{AIR}

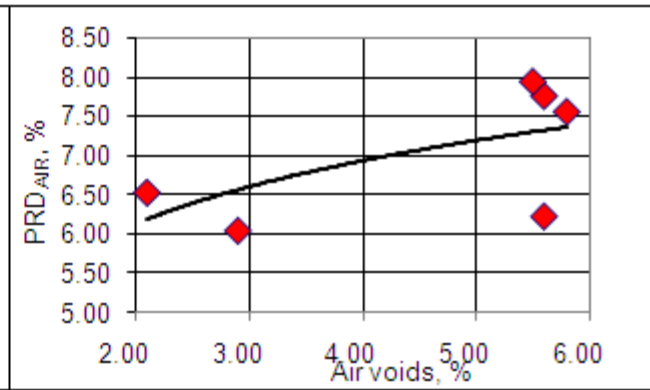


Figure 2: Correlation between number of air voids and PRD_{AIR}

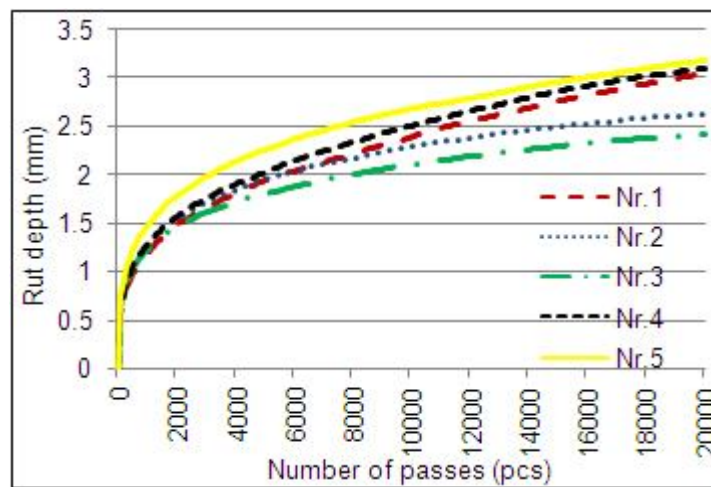


Figure 3: Development of rut depths

References

(2004), *Road Specifications 2005*. SIA „Balthous poligrāfija”, pp 67, Riga, Latvia.

Haritonovs, V., Naudzuns, J. and Smirnovs J., (2005), ‘Determining the reasons for formation of pavement rutting’, *International scientific conference LLU*, pp 52-58, Jelgava, Latvia.