DOI 10.51558/2303-5161.2022.10.10.49 Scientific Paper

ANALYSIS OF THE TEMPERATURE INFLUENCE OF FRESH ASPHALT MIXTURE ON THE NUMBER OF ROLLER CROSSINGS

Zahid Bašić[1.]

SUMMARY

In the construction of new roads in BiH, reconstruction or rehabilitation of existing roads, construction or replacement of asphalt layers is a mandatory part of construction work. One of the most important characteristics of the asphalt mixture during installation is the temperature of the asphalt mixture. Legal regulations, ie technical conditions, define the minimum temperature of the asphalt mixture as well as the limit air temperatures during the installation of asphalt, but special emphasis is given to the optimal temperature of the asphalt mixture. The optimal temperature of the asphalt mixture in this paper was analyzed through the compaction property of the asphalt mixture. Therefore, working on several specific examples, observes the optimal temperature of the asphalt mixture so as to obtain the best possible compaction of the installed asphalt. During the research, numerous other data that are important for the research were measured, such as the number of roller crossings, roller weight, air temperature, etc.

Keywords: asphalt mixture temperature, installation, asphalt compaction, roller

1. INTRODUCTION

The process of building asphalt pavement structures was based on tradition, art and a number of different implicit methods based on experience, which were applied in construction practice. Also, asphalt was primarily considered as a building material, and only later was the method of construction of asphalt pavement structures studied in more detail. [1] [2]. The temperature of the asphalt mixture during the installation of asphalt became especially important because it directly affected the quality of work performed, and was limited by the temperature of the asphalt mixture in the asphalt base, the length of transport of the asphalt mixture, vehicle quality, air temperature, etc.

If shrinkage due to cooling is prevented, then tensile stress increases in the asphalt material with decreasing temperature, which can lead to breakage (appearance of microcracks in the bonding matrix) if maximum tensile strength is reached, which is especially pronounced during asphalt rolling. Simply put, the stress in the asphalt sample gradually increases in parallel with the temperature drop, until the sample breaks. [3]

The research in this paper is based on measuring the number of roller passes and analyzing the influence of air temperature on the number of roller crossings, which affects the compaction of the installed asphalt mixture.

1. PhD. Zahid Bašić, University of Tuzla, Faculty of Mining, Geology and Civil Engineering, Urfeta Vejzagića 2, Tuzla, Bosnia and Herzegovina, zahid.basic@untz.ba

2. ANALYSIS OF THE INFLUENCE OF THE TEMPERATURE OF FRESH ASPHALT MIXTURE ON THE NUMBER OF ROLLER CROSSINGS

If we observe the influence of asphalt temperature on the number of roller crossings, we will use the number of roller crossings and the installation temperature of the asphalt mixture as input data. [4]

As the compaction of asphalt was performed with several rollers, in relation to their technical characteristics (static weight and roller surface), the number of roller crossings was reduced to the nominal number of crossings of the relevant roller. The "Bomag 120" roller was used as the author.

- The "Bomag 120" roller puts a load on the substrate of 11.30 kg / cm. [5] As this roller was used as authoritative, it was calculated with a factor of k1 = 1.00.
- The "Hamm HD75" roller loaded the substrate with 23.20 kg / cm. [5] To reduce it to the nominal number of passes, the number of passes of this roller is multiplied by the factor

$$k2 = 23{,}20/11{,}30 = 2{,}05$$

- The "Hamm DV8" roller carries a load of 29.04 kg / cm on the ground. [5] To reduce it to the nominal number of transitions, the number of transitions of this roller is multiplied by the factor

$$k3 = 29{,}04/11{,}30 = 2{,}57$$

Thus, the "Hamm HD75" roller compacts with one pass as 2.05 passes of the "Bomag 120" roller, while one pass of the "Hamm DV8" roller is equivalent to 2.57 passes of the "Bomag 120" roller.

Table 1: Input data for the analysis "Asphalt installation temperature-number of crossings"

No sample	Temperature install (?C)	Type of asphalt	Number of roller cross			Nominal num roller crossing
			Bomag 120	Hamm HD75	Hamm DV8	
1.	136,30	BNS22	9	12	11	62
2.	139,90	BNS22	8	9	9	50
3.	123,80	BNS22	10	11	11	61
4.	112,80	BNS22	9	12	12	64
5.	152,90	BNS22	13	17	/	48
6.	157,80	AB16	8	7	7	40
7.	155,40	AB16	7	6	6	35
8.	154,20	AB16	7	7	6	37
9.	158,40	AB16	7	7	7	39
10.	160,40	AB16	8	7	8	43
11.	155,90	AB16	7	8	7	41
12.	160,10	AB16	9	9	7	45
13.	160,70	AB16	9	10	8	50
14.	157,40	BNS22	12	17	/	47

In accordance with the above, the nominal number of roller crossings is obtained by multiplying the number of crossings of each roller by the corresponding factor.

Eg for sample 1 the nominal number of roller crossings was obtained as:

$$n = 9 * 1.00 + 12 * 2.05 + 11 * 2.57 = 61.87 \approx 62 \text{ roller crossings.}$$

Values are rounded to the nearest whole number.

As we can see from Table 1, we have samples for two types of asphalt, whose layer thicknesses are also different, so we will divide the asphalts by type in the analysis and observe them that way.

We will first observe the samples from the BNS22 asphalt. For the input data, the installation temperature and the nominal number of roller passages are important to us.

Table 2: Input data for the analysis "Asphalt installation temperature-number of crossings-BNS22"

No sample	Temperature install (?C)	Type of asphalt	Nominal No roller crossing
1.	136,30	BNS22	62
2.	139,90	BNS22	50
3.	123,80	BNS22	61
4.	112,80	BNS22	64
5.	152,90	BNS22	48
14.	157,40	BNS22	47

In accordance with the input data, we obtained the following diagram describing the influence of the asphalt installation temperature on the number of roller crossings.

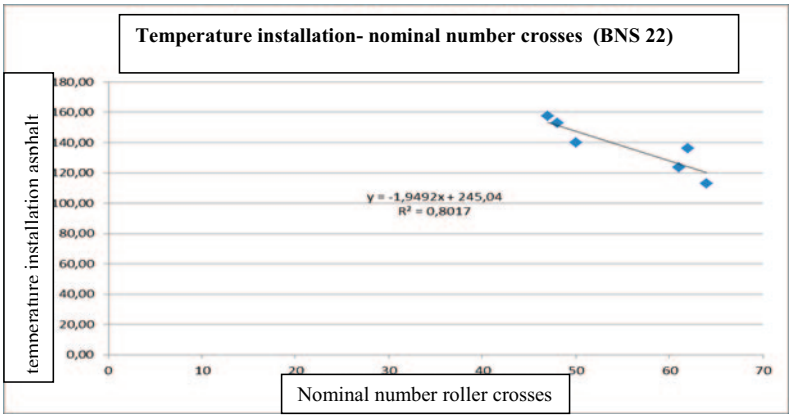

Figure 1. Dependence diagram "Asphalt installation temperature-number of crossings-BNS22"

For AB16 asphalt we use the following input data:

Table 3: Input data for the analysis "Asphalt installation temperature-number of crossings-AB16"

No sample	Temperature installation (?C)	type of asphalt	Nominal No. crosses roller
7.	155,40	AB16	35
8.	154,20	AB16	37
9.	158,40	AB16	39
10.	160,40	AB16	43
11.	155,90	AB16	41
12.	160,10	AB16	45
13.	160,70	AB16	50

In accordance with the input data, we obtained the following diagram describing the influence of the asphalt installation temperature on the number of roller crossings.

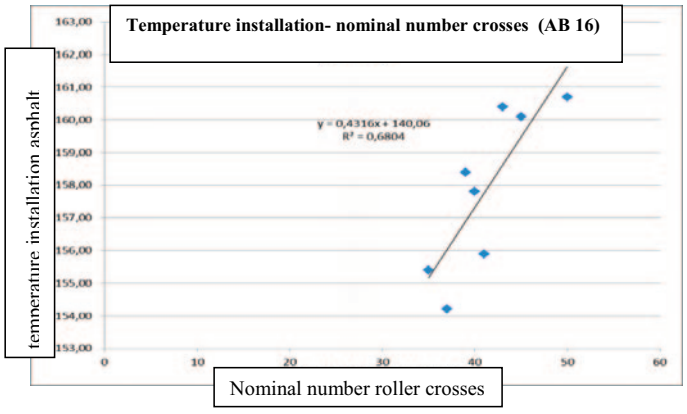

Figure 2. Dependence diagram "Asphalt installation temperature-number of crossings-AB16"

From the diagram in Figure 1, we can see how lowering the temperature of the asphalt increases the number of roller crossings in order to achieve the required compaction. We notice that the number of crossings increases significantly at asphalt temperatures lower than 140° C. From the diagram in Figure 2, we can see that the too high installation temperature requires a larger number of roller passages, because rolling is done until the asphalt temperature drops to a certain value. We see that by increasing the installation temperature above 157° C, the number of roller transitions increases again to achieve approximately equal compaction.

From the above, we can conclude that the optimal temperature of asphalt installation from the aspect of the number of roller crossings is 150-157° C.

We will confirm the conclusion with the following diagram, which combines all the samples. The data from Table 1. were used as input data.

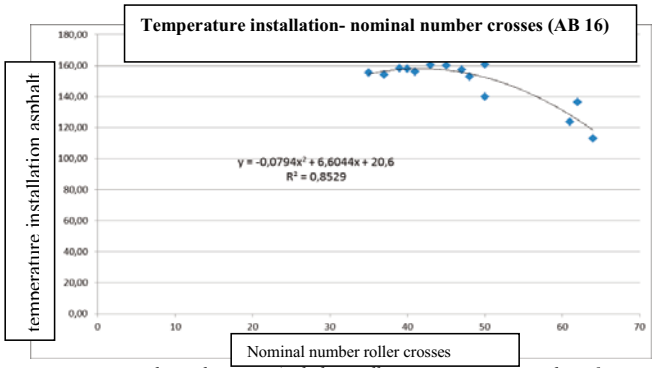

Figure 3. Dependence diagram "Asphalt installation temperature-number of crossings"

From the diagram in Figure 3, it is clear that the minimum number of roller passes is required at an installation temperature of 150-157°C. Any increase or decrease in installation temperature requires a larger number of roller passages.

3. ANALYSIS OF THE INFLUENCE OF AIR TEMPERATURE ON THE NUMBER OF CROSSINGS ROLLERS

If we observe the influence of air temperature on the number of roller crossings, we will use the number of roller crossings and air temperature when installing the asphalt mixture as input data.

Table 4: Input data for the analysis "Air temperature - number of roller crossings"

No sample	Temperature air (?C)	Type of asphalt	Nominal no crosses roller
1.	6	BNS22	62
2.	15	BNS22	50
3.	8	BNS22	61
4.	5	BNS22	64
5.	20	BNS22	48
6.	29	AB16	40
7.	20	AB16	35
8.	23	AB16	37
9.	22	AB16	39
10.	29	AB16	43
11.	26	AB16	41
12.	32	AB16	45
13.	31	AB16	50
14.	22	BNS22	47

As we can see from Table 4, we have samples for two types of asphalt, so we will divide the asphalts by type in the analysis and observe them that way.

We will first observe the samples from the BNS22 asphalt. For the input data, as already mentioned, the air temperature and the nominal number of roller crossings are important to us.

Table 5: Input data for the analysis "Air temperature-number of roller crossings - BNS22"

No sample	Temperature air (?C)	type of asphalt	Nominal no crosses roller
1.	6	BNS22	62
2.	15	BNS22	50
3.	8	BNS22	61
4.	5	BNS22	64
5.	20	BNS22	48
14.	22	BNS22	47

In accordance with the input data, we obtained the following diagram describing the influence of outside temperature on the number of roller crossings.

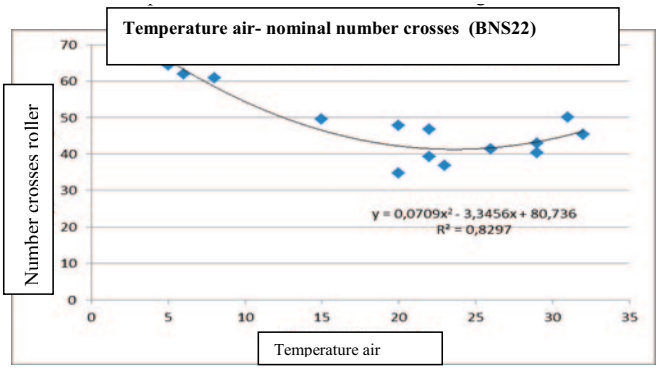

Figure 4. Dependence diagram "Air temperature-number of roller crossings - BNS22"

For AB16 asphalt we use the following input data:

Table 6: Input data for the analysis "Air temperature - number of roller passages - AB16"

No Sample	Temperature air (ºC)	Type of asphalt	Nominal No crosses roller
6.	29	AB16	40
7.	20	AB16	35
8.	23	AB16	37
9.	22	AB16	39
10.	29	AB16	43
11.	26	AB16	41
12.	32	AB16	45
13.	31	AB16	50

In accordance with the input data, we obtained the following diagram describing the influence of outside temperature on the number of roller crossings.

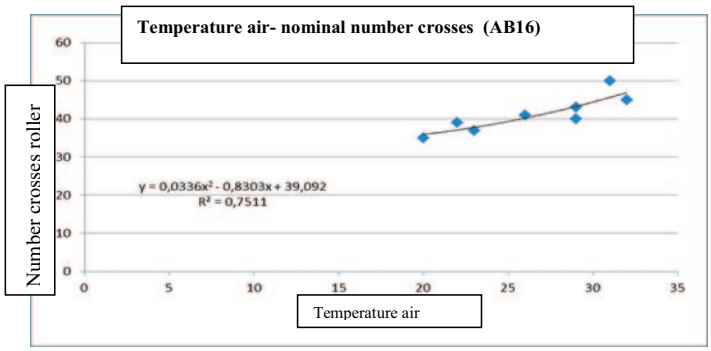

Figure 5. Dependence diagram "Air temperature - number of roller passages - AB16"

From the aspect of asphalt cooling in the analysis of outdoor temperature and asphalt temperature, it was found that the optimal air temperature for asphalt installation is min 15 ºC. [6]

Also, from the diagrams in Figures 4 and 5, we can see that the minimum number of roller crossings for both types of asphalt was at an outdoor temperature of 20-23 ºC. Each air temperature above 23 ºC and below 17º required a significantly higher number of roller crossings. [7]

We conclude that the optimal air temperature for asphalt installation from the aspect of the number of roller crossings is 17-23 ºC. [8]

We will confirm the conclusion with the following diagram, which combines all the samples. The data from Table 4 were used as input data.

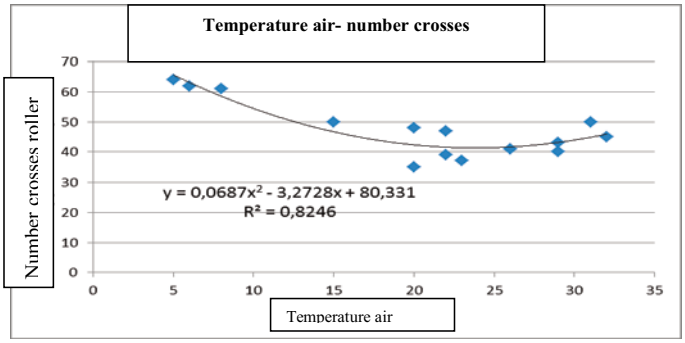

Figure 6. Dependence diagram "Air temperature-number of roller crossings"

From the diagram in Figure 6, it is clear that the minimum number of roller passes is required at an outdoor temperature of 17-23 °C. Each higher or lower air temperature requires a larger number of roller passages. [8]

4. CONCLUSION

In this paper, research and analysis of the influence of air temperature on the number of roller crossings during the installation of asphalt mass are presented. It can be concluded that by increasing the outside temperature, and by adjusting the outside temperature and the temperature of the asphalt, we can create optimal conditions for compacting asphalt (as few roller passes as possible, as short a rolling time as possible to cool the asphalt). Also, too high outdoor temperatures adversely affect the optimal compaction, because it takes more time for the asphalt to cool, and rolling is done until the asphalt reaches the appropriate (low) temperature. As we have limited values of upper and lower asphalt production temperatures, we can create optimal conditions by adjusting the outdoor temperature for the given circumstances (production temperature, temperature loss in transport). To ensure satisfactory quality of installed asphalt, we must take into account the outdoor air temperature. Therefore, if we respect the maximum temperature of asphalt production (175 °C), the greater the distance of the installation site from the asphalt base, we must have a higher air temperature to achieve the appropriate compaction and quality of the installed asphalt.

REFERENCES

[1] Pradena, M., Miller, S., Staub, G., Díaz, M., Contreras, F.: Eksplicitno definiranje postupka asfaltiranja kolnika - temeljni preduvjet za poboljšanje kvalitete, GRAĐEVINAR, 72 (2020) 11, pp. 1031-1040, doi: https://doi.org/10.14256/JCE.2427.2018
[2] Bašić Z. Putevi, izdavačka kuća OFF-SET Tuzla, Tuzla, 2014.
[3] Hribar, D., Tušar, M., Hofko, B., Blab, R.: Utjecaj početne temperature na ispitivanje vlačnog naprezanja pridržanih uzoraka asfaltbetona, GRAĐEVINAR, 65 (2013) 11, pp. 987-992, doi: https:// doi.org/ 10.14256/JCE.927.2013
[4] Spasić N. „Proizvodnja i ugradnja asfalt betona", seminarski rad, Požarevac, 2014.
[5] Tehničar 4, građevinski priručnik, Građevinska knjiga, Beograd, 1987.
[6] Smjernice za projektovanje, građenje, održavanje i nadzor na putevima, Sarajevo/Banja Luka, 2005.
[7] Priručnik za projektovanje puteva u Republici Srbiji, sistem za odvodnjavanje, Beograd 2011.
[8] Tabaković E. „Uticaj temperature asfalta i temperature okoline na zbijenost ugrađenog asfalta", Magistarski rad, Univerzitet u Tuzli, 2021.