

The Effect Of Distance And Travel Time On Temperature Loss At The Overlay Site (Case Study: Keude Linteung – Beutong Ateuh, Nagan Raya)

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Abstract. Asphalt is one of the most widely used road construction materials, and in its application, the temperature of hot mix asphalt is a critical factor during spreading. Asphalt will soften and melt when heated to a certain temperature, and conversely, it will harden as the temperature decreases. Hot mix asphalt is composed of coarse and fine aggregates bound together with asphalt binder, which must meet specific requirements and be heated to a designated temperature. However, temperature loss is directly affected by transport distance; the farther the distance from the Asphalt Mixing Plant (AMP) to the placement site, the greater the temperature drop. This study aims to analyze the effect of distance and travel time on temperature reduction during asphalt transport. The research employed an experimental method through direct temperature measurements, taken when asphalt was loaded into the truck and again upon arrival at the spreading location. The results showed that in Beutong Ateuh, the temperature of hot mix asphalt decreased by 13°C at a distance of 66 km, while at Lamie, the reduction was 10°C over a distance of 50 km. Furthermore, density testing was conducted to evaluate pavement samples in the field, enabling the determination of thickness and mixture characteristics. The density results indicated values of 99.27% for specimen one, 100.08% for specimen two, and 100.46% for specimen three.

Keywords : hot mixed asphalt, Temperature, Distance, Time, AMP.

1 Background

The type of road pavement commonly used in Indonesia is the asphalt concrete layer (Laston), which is placed on compacted soil. Laston is a type of flexible pavement consisting of a mixture of aggregates and asphalt as the binding material (Tahir, 2009). The asphalt binder must meet specific requirements in accordance with the prescribed specifications. The mixing process is carried out at the Asphalt Mixing Plant (AMP) under controlled conditions, after which the mixture is transported using closed-body vehicles to minimize heat loss. During transportation, external factors such as weather conditions, including rainfall, can contribute to a reduction in the temperature of the asphalt mixture (Arifin, 2008). Asphalt concrete must be mixed at a specified temperature to

achieve homogeneity and high density, as the required density can only be obtained when the mixture temperature complies with the established specifications.

In practice, asphalt spreading in the field is often carried out even when the mixture temperature has already decreased. However, to ensure the quality of the pavement, prevent premature deterioration, and extend its service life, maintaining the proper temperature at the time of spreading is crucial (Muhammad, 2016).

Previous research has shown that the main factors influencing temperature loss in asphalt mixtures during transport to the laying site are distance, travel time, and weather conditions. Temperature reductions are generally greater in the afternoon compared to deliveries conducted earlier in the day (Fachturrahman and Susilo, 2021). Temperature plays a critical role in compaction quality; the lower the temperature, the more difficult it becomes to achieve adequate compaction. Therefore, it is essential to investigate the effect of distance and travel time on temperature reduction at the overlay site.

According to the 2010 Bina Marga specifications (Revision 3) on road pavements, asphalt mixtures must not be spread if their temperature falls below the required level, as this would result in improper overlay conditions. In this study, the hot mix asphalt material used is Asphalt Concrete Wearing Course (AC-WC), produced at the Asphalt Mixing Plant (AMP) of PT. Wirataco Mitra Mulia in Keude Linteung, Nagan Raya Regency. The overlay was carried out on the Road Conservation Project of the Central Aceh Boundary / Takengon – Lhok Seumot – Jeuram (MYC) in Nagan Raya Regency.

The purpose of this study is to examine the effect of distance and travel time on temperature loss during the transport of hot mix asphalt from the AMP in Keude Linteung to the overlay site in Beutong Ateuh. The research was conducted using an experimental approach, in which temperature measurements were taken with a thermometer both at the AMP and upon arrival at the Beutong Ateuh overlay location.

2 Research Methodology

This research was initiated with a literature review, followed by equipment preparation, sample examination, temperature measurement of the hot mix asphalt, and finally, data processing and analysis of the test results.

In this study, both primary and secondary data were utilized. Primary data were obtained directly by the researcher, including hot mix asphalt temperature measurements and asphalt density tests. Secondary data consisted of existing information acquired from relevant agencies or institutions, which could be used without further processing, such as heavy equipment data provided by the contractor as the project implementer.

The research employed an experimental method. Temperature data were collected using a thermometer through direct measurement on hot mix asphalt transport trucks. Measurement were taken at two points : immediately after the asphalt was poured into the truck at the asphalt Mixing plant (AMP) and upon arrival at the overlay location.

Preparation and procurement of material and test sample: The material used in this study was Asphalt Concrete Wearing Course (AC-WC) hot mix asphalt, produced by

PT. Wirataco Mitra Mulia at the Asphalt Mixing Plant (AMP) in Keude Linteung, Nagan Raya Regency. The overlay was carried out on the Aceh Tengah Boundary / Takengon – Lhok Seumot – Jeuram (MYC) Road Preservation Project in Nagan Raya Regency, located approximately 66 km from the AMP.

Research Variables

A research variable is a parameter of data that is systematically observed and accurately measured. In this study, the research object is Asphalt Concrete – Wearing Course (AC-WC), produced at the Asphalt Mixing Plant (AMP) of PT. Wirataco Mitra Mulia, Keude Linteung, Nagan Raya Regency. The results of temperature measurements and density tests were recorded in accordance with the tabular format provided.

Data Processing Methods.

Data processing techniques represent the final stage of research analysis. In this study, temperature data of hot mixed asphalt during transportation to the overlay location were obtained through direct experimental measurements. The measurement of asphalt temperature was carried out at two stages: (1) at the Asphalt Mixing Plant (AMP) Keude Linteung, immediately after the asphalt mixture was discharged into the dump trucks, and (2) upon arrival at the overlay site. For the Betong Ateuh area, located approximately 66 km from the AMP, temperature measurements were taken from five dump trucks. On each truck, three measurement points were recorded: the front, middle, and rear sections of the load.

For comparison, measurements were also conducted at the Lamie area, which is located at a distance of 50 km from the AMP. Similar to the Betong Ateuh observations, asphalt temperatures were measured immediately after loading at the AMP and upon arrival at the overlay site. Five dump trucks were sampled, and three measurement points (front, middle, and rear) were recorded for each truck. The results obtained from both locations were first tabulated and subsequently plotted into graphical form to illustrate the relationship between temperature and time as well as temperature and distance.

In addition to temperature measurements, density testing was carried out at the ESPE Beton Laboratory. For this purpose, three test specimens were collected from the overlay site of the Betong project. The specimens were transported to the laboratory and left overnight to obtain dry weight results. To determine wet weight, the specimens were submerged in water for 3–4 hours, then weighed in a saturated condition. The surface dry weight (SSD) was obtained by wiping the specimen surface with a dry cloth before weighing. Density testing was conducted in stages to ensure accurate results. After obtaining data on dry weight, wet weight, and SSD, the values were recorded in the density test table. From this data, the percentage of density was calculated, and the results were further analyzed by plotting them into graphs to illustrate the relationship between layer thickness and density.

The data were subsequently tabulated and presented in the form of tables and graphs illustrating the temperature drop range of the hot mix asphalt, followed by further analysis and discussion.

3. Result and Discussion

3.1. Result of hot mix asphalt temperature in Beutong Ateuh

The temperature measurement of hot mix asphalt was conducted experimentally. The measurement results are presented in Table 3.1. Temperatures were recorded at three points: (T1) the front wall, (T2) the middle wall, and (T3) the rear wall of the truck. Measurements were taken immediately after the asphalt mixture was discharged into the truck and upon its arrival at the overlay site. The resulting temperature drop of the hot mix asphalt is illustrated in Figure 3.1.

Table 3.1 Results of temperature measurement of hot mixed asphalt

Truck	Travel distance (KM)	Travel time (Menit)	Initial temperature			Final temperature		
			T1°C front	T2°C middle	T3°C rear	T1°C front	T2°C middle	T3°C rear
1	50	95	150	150	150	140,9	141,5	141
2	50	98	150	150	150	141	142	141
3	50	105	150	150	150	141,5	142	142
4	50	110	150	150	150	140,5	140	140
5	50	112	150	150	150	141	141	141

Table 3.2 Temperature Drop of Hot Mix Asphalt Beutong Ateuh

Truck	T1°C	T2°C	T3°C	Average temperature			
				For every 1 Km			For every 1 minute °C
				T1°C	T2°C	T3°C	
1	9,1	8,5	9	0,18	0,17	0,18	0,63
2	9	8	9	0,18	0,16	0,18	0,65
3	8,5	8	8	0,17	0,16	0,17	0,70
4	9,5	10	10	0,19	0,20	0,19	0,73
5	9	9	9	0,18	0,18	0,18	0,74

Table 3.2 presents the results of temperature reduction in hot mix asphalt per 1 kilometer, which shows varying values among the observed trucks. The temperature decrease ranged from 0.17°C to 0.19°C over a distance of 66 km. Meanwhile, the rate of temperature reduction per minute ranged from 0.87°C to 0.92°C, corresponding to a total travel time of 168–178 minutes.

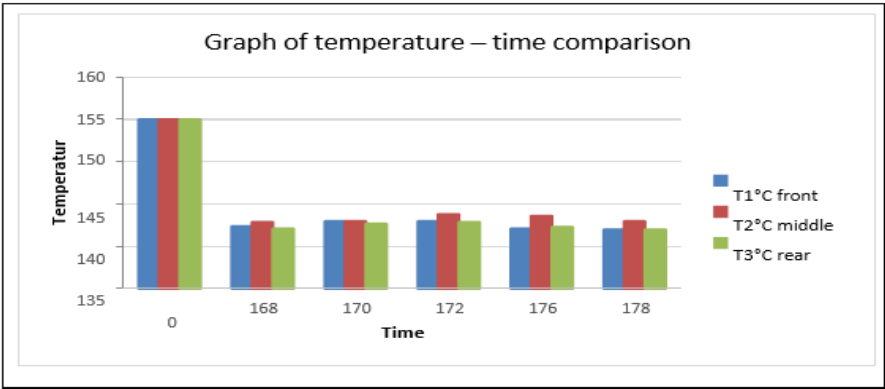


Figure 3.1 Graph of temperature – time comparison in Beutong Ateuh

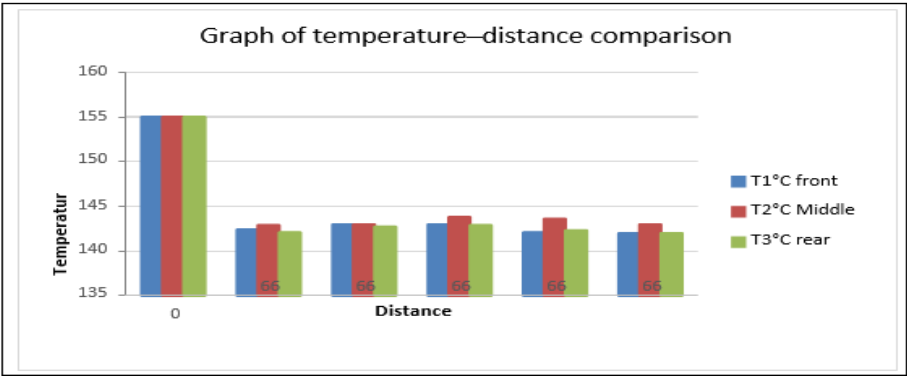


Figure 3.2 Graph of temperature – distance comparison in Beutong Ateuh

Figures 3.1 and 3.2 illustrate the relationship between temperature and time, as well as the relationship between temperature and distance, in relation to temperature loss both immediately after the asphalt was discharged into the truck and upon its arrival at the overlay site.

The temperature reduction of the hot mix asphalt in the Betong Ateuh trucks from the Asphalt Mixing Plant (AMP) to the overlay site was 13°C over a distance of 66 km with a travel time of 168–178 minutes. This reduction in temperature was influenced by weather conditions, travel speed, distance, and the duration of transportation from the AMP to the overlay site. The greater the travel distance and the longer the transportation time of the hot mix asphalt, the greater the temperature reduction that occurs.

3.2. Result of hot mix asphalt temperature in Lamie

The temperature measurement of hot mix asphalt was carried out experimentally. The measurement results are presented in Table 3.3. Temperatures were recorded at three points: (T1) the front wall, (T2) the middle wall, and (T3) the rear wall of the

truck. Measurements were conducted immediately after the asphalt mixture was discharged into the truck and upon its arrival at the overlay site. The temperature drop of the hot mix asphalt during transportation is illustrated in Figure 3.3.

Table 3.3 Temperature measurement results of lamie hot mix asphalt.

Truck	Travel distance (KM)	Travel time (Menit)	Initial temperature			Final temperature		
			T1°C front	T2°C middle	T3°C rear	T1°C front	T2°C middle	T3°C rear
1	50	95	150	150	150	140,9	141,5	141
2	50	98	150	150	150	141	142	141
3	50	105	150	150	150	141,5	142	142
4	50	110	150	150	150	140,5	140	140
5	50	112	150	150	150	141	141	141

Table 3.4 Temperature drop of Lamie hot mix asphalt

Truck	T1°C	T2°C	T3°C	Average temperature			
				For every 1 km			For every 1 minute
				T1°C	T2°C	T3°C	°C
1	9,1	8,5	9	0,18	0,17	0,18	0,63
2	9	8	9	0,18	0,16	0,18	0,65
3	8,5	8	8	0,17	0,16	0,17	0,70
4	9,5	10	10	0,19	0,20	0,19	0,73
5	9	9	9	0,18	0,18	0,18	0,74

Table 3.4 presents the results of hot mix asphalt temperature reduction per kilometer, which varied among the observed trucks. The temperature decrease ranged from 0.17°C to 0.20°C over a distance of 50 km. In addition, the rate of temperature reduction per minute ranged from 0.63°C to 0.74°C, corresponding to a total travel time of 95–112 minutes.

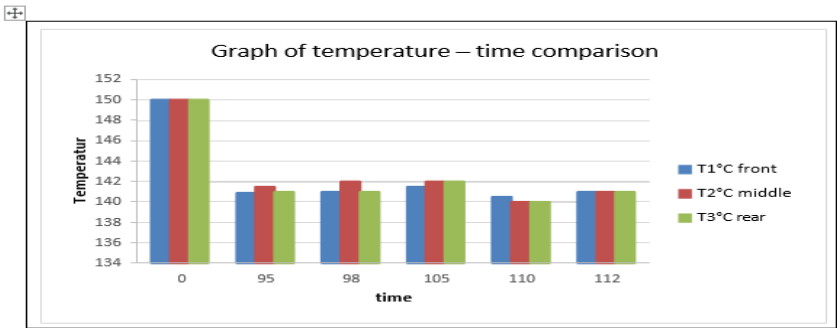


Figure 3.3. Graph of Temperature – Time comparison in Lamie

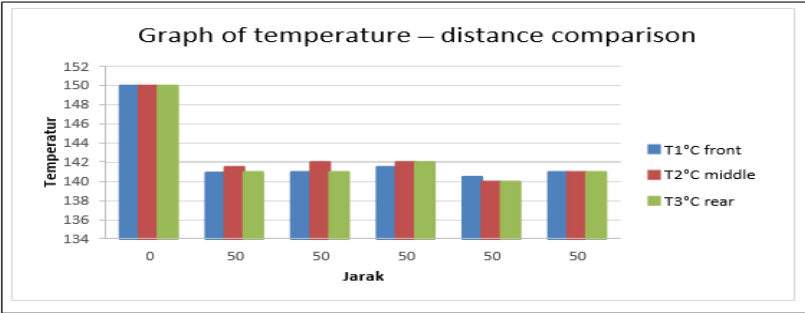


Figure 3.4. Graph of temperature – distance comparison in Lamie

Figure 3.3 and Figure 3.4 present the relationship between temperature and time as well as between temperature and distance in relation to temperature loss. The measurements were taken both when the asphalt was freshly poured into the truck and upon its arrival at the spreading location.

3.3. Density Test Results

The purpose of the density test is to determine and obtain pavement samples from the field in order to identify the thickness and characteristics of the pavement mixture. Compaction aims to densify the mixture so that particle interlocking and good bonding can occur, both among the aggregates and within the layer itself. This test was carried out at the ESPE BETON Laboratory. The results of the density test are presented in Table 4.5, while the comparison and density graph is shown in Figure 4.5.

Table 4.5 Density Test Results.

specimen	thick	weight (gr)			Volume	Bulk density (gr)		density(%)
		dry	In water	SSD		Lapangan	LAB	
1	7,7	1068,2	615,5	1073,7	458,2	2,331	2,348	99,27
2	8,3	1521,4	878,0	1525,4	647,4	2,350	2,348	100.08
3	8,6	1016,7	589.1	1020,0	430,9	2,359	2,348	100.46

Based on the density test results presented in Table 4.5. Three test specimens were collected at each sampling point with a spacing of 100 meters. The first specimen, with a thickness of 7.73 cm, recorded a dry weight of 1068.2 grams, a weight in water of 615.5 grams, and a saturated surface-dry (SSD) weight of 1073.7 grams, resulting in a field density of 99.27% of the target density. The second specimen, with a thickness of 8.33 cm, recorded a dry weight of 1521.4 grams, a weight in water of 878.0 grams, and an SSD weight of 1525.4 grams, yielding a field density of 100.08%. Meanwhile, the third specimen, with a thickness of 8.60 cm, recorded a dry weight of 1016.7 grams, a weight in water of 589.1 grams, and an SSD weight of 1020.0 grams, resulting in a field density of 100.46%.

Overall, these results indicate that the field densities of the tested specimens were close to or slightly above the target density, suggesting good compaction quality and uniformity across the test locations.

3.4. Discussion

Based on the measurement results of hot mix asphalt temperatures on the Beutong Ateuh and Lamie transport trucks, it was found that the temperature of the hot mix asphalt when discharged from the Asphalt Mixing Plant (AMP) into the transport trucks averaged 155°C. Upon arrival at the overlay site, the temperature decreased to an average range of 142.1–143.8°C. The temperature on the rear side of the truck decreased more rapidly than on the front side, primarily due to greater air exposure at the rear. This occurs because the transport trucks were not completely filled, allowing air to circulate easily inside the truck bed and accelerate heat loss.

When the asphalt reached the project site, the temperature had dropped by approximately 11.2–13°C. In the case of Beutong Ateuh, the hot mix asphalt produced at AMP Keude Linteng reached a temperature of 155°C. The route to the project site passes through mountainous terrain with a distance of 66 km, taking approximately 168–178 minutes of travel time. During transportation, weather conditions were relatively hot and favorable, resulting in minimal temperature loss—remaining within the recommended range of 140–160°C for proper compaction.

Meanwhile, for the Lamie area, the hot mix asphalt was also produced at AMP Keude Linteng with an initial temperature of 150°C. The route to this project site consists of flat and unobstructed roads, with a total distance of 50 km, taking about 95 minutes of travel time.

The results of this study are consistent with the findings of Muhammad (2016), which indicate that the greater the transportation distance and duration, the more significant the temperature reduction of the hot mix asphalt. At the Beutong Ateuh research site, a considerable temperature drop was observed in each truck, particularly at the T3 point (rear section), where temperatures ranged between 142°C and 142.9°C. This reduction was mainly attributed to weather conditions and the increased air infiltration at the rear wall of the truck. In contrast, the smallest temperature decrease occurred at the T2 point (middle section), with temperatures between 142.9°C and 143.8°C.

At the Lamie research site, a notable temperature drop occurred at the T1 point (front section), where temperatures ranged from 140.5°C to 141.5°C. This was primarily due to weather influences and the direct exposure of the front wall to incoming air during transport. Meanwhile, the smallest reduction was recorded at the T2 point (middle section), with temperatures ranging from 140°C to 142°C.

Furthermore, the findings of Muhammad (2016) also reported a substantial temperature decrease at the T5 point (inner wall), with a temperature drop from 105.9°C to 48.7°C, while the T2 point (left section) experienced the smallest decline, from 162.9°C to 123.0°C.

The decrease in hot mix asphalt temperature occurs due to the transportation distance and duration, as well as weather conditions and vehicle speed, all of which influ-

ence the extent of temperature loss during delivery to the overlay site. In road construction, temperature plays a crucial role in determining the density and overall quality of the pavement. According to the General Specifications Revision 2 (Bina Marga, 2018), the recommended temperature for discharging the mixture from the Asphalt Mixing Plant (AMP) into transport trucks is 135°C–150°C for Type I mixtures (as in the Lamie area) and 145°C–160°C for Type II mixtures (as in the Beutong Ateuh area). The temperature when supplying the mixture to the paving equipment should be within 130°C–150°C.

Based on laboratory testing conducted at ESPE BETON Laboratory, the measured densities were as follows: Test Specimen 1 achieved a density of 100.46% with a thickness of 8.40 cm, Test Specimen 2 achieved 99.27% with a thickness of 7.73 cm, and Test Specimen 3 achieved 100.08% with a thickness of 8.33 cm. These results show only slight variation and are consistent with the findings of previous research by Rini et al. (2018), which also investigated density characteristics in hot mix asphalt.

4. Conclusions and Recommendations

4.1. Conclusions

Based on the results of the research and the data analysis conducted, several conclusions can be drawn as follows:

1. For the transport trucks traveling to Beutong Ateuh, the temperature of the hot mix asphalt at points T1, T2, and T3 was recorded at 155°C when loaded. Upon arrival at the overlay site, the average temperature at these points decreased to 142°C.
2. The average temperature of the hot mix asphalt transported to Beutong Ateuh, with a total distance of 66 km and a travel time of 168–178 minutes from the Asphalt Mixing Plant (AMP) Keude Linteng, Nagan Raya Regency, to the Batas Aceh Tengah Road Preservation Project / Takengon–Lhok Seumot–Jeuram (MYC), Nagan Raya Regency, showed a temperature reduction of approximately 12°C upon arrival at the overlay site.
3. For the transport trucks traveling to Lamie, the temperature of the hot mix asphalt at points T1, T2, and T3 was 150°C when loaded. Upon arrival at the overlay site, the average temperature decreased to 140°C.
4. The average temperature drop of hot mix asphalt for the Lamie location, with a distance of 50 km and a travel time of 95–110 minutes from the Asphalt Mixing Plant (AMP) Keude Linteng, Nagan Raya Regency, to the Lamie paving site, was approximately 10°C upon arrival.

4.2 Recommendations

Based on the findings of this study regarding the influence of hot mix asphalt temperature, several recommendations can be proposed. The results of this research may serve as an initial reference for further studies or development in this field. It is expected that this study will contribute to the broader understanding of asphalt technology, particularly concerning the temperature behavior of hot mix asphalt, and that its findings can be practically applied in field operations. This research is also expected to assist contractors and road construction service providers in determining the optimal

distance and transportation time for delivering hot mix asphalt from the Asphalt Mixing Plant (AMP) to the overlay site. Future studies are encouraged to explore longer transportation distances and durations to gain a deeper understanding of the relationship between delivery time and temperature reduction. In addition, it is recommended that subsequent research employ more advanced and effective equipment to enhance data accuracy and improve temperature control during the transportation process.

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