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Study of temperature loss of Hot Mix Asphalt during transportation

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Study of temperature loss of Hot Mix Asphalt during transportation

Muhammad¹, A Syuhada¹, S Huzni^{1,*}, Z Fuadi¹

Department of Mechanical Engineering, Syiah Kuala University, Banda Aceh, Indonesia

Email: syifaul@unsyiah.ac.id

Abstract-This study was conducted to observe the phenomenon of the temperature loss on hot mix asphalt type Asphalt Concrete Binder Course (AC-BC), on the surface area of the truck wall during transport. The tests were conducted experimentally using thermometers and thermocouples with a 25-ton capacity truck at 153⁰C loading temperatures. Data retrieval is carried out over time, 20,40,60 to 420 minutes of transport, from the Asphalt Mixing Plant (AMP) plant to the job site with an average truck speed of 30 km/h. Data from the results of the study were analyzed using the descriptive method. The results indicate that the maximum transport distance that meets the technical specifications is at the furthest distance of 165 km, with a minimum temperature of 130,1⁰C, at a distance of 10 cm from the surface of the truck wall. Loss of average hot mix asphalt temperature to 6 (six) sides of the truck wall surface, floor surface and the top surface, for 420 minutes of transport is (45.2⁰C-65.7⁰C). From the phenomenon shows that the hot mix asphalt condition on the surface area of the truck wall is hardened (crusty).

1. Introduction

Asphalt Concrete Binder Course (AC-BC) is often used as an intermediate coating for road construction in Indonesia, including in Aceh province, with an area of 5,677,081 km² and 17,372.55 km lengths of national, provincial and district roads [1]. With the huge area and length of the roads, the growth of Asphalt Mixing Plant (AMP) plant is not proportional, the construction requires a huge investment cost [2]. The 140-210 km distance is the furthest distance traveled by road construction practitioners in Aceh to bring hot mix asphalt from Asphalt Mixing Plant (AMP) plant to work site. Therefore, it is very likely that there will be a loss of temperature on hot mix asphalt due to heat transfer during transport, especially around the surface of the truck wall [3]. From this phenomenon, the smoothing temperature required by the technical specifications at a minimum temperature of 130⁰C is not reached [4].

The long distance and a lot of time required to bring the hot mix asphalt from the Asphalt Mixing Plant (AMP) plant to the work site cause the loss of temperature on the hot mix asphalt, this phenomenon is very contrasting happen around the truck wall, while in the middle area is relatively stable [5]. The temperature loss of hot mix asphalt often occurs due to the influence of wind speed and weather during transport, and daylight is the right time to do pavement work [6]. The adverse conditions of insulation (tarpaulin cover) on the surface of the truck were one of the factors of temperature loss on hot mix asphalt during transport. [7].

From the above phenomenon will the study to observe the rate of temperature loss on hot mix asphalt, type Asphalt Concrete Binder Course (AC-BC) on the surface of the truck wall during transport. It is hoped that this study can provide hot mix asphalt temperature data, on the surface of the truck's wall during transport, so that the is known distance and length of transport times that meet the technical specifications [4].

*Corresponding author: syifaul@unsyiah.ac.id



2. Materials and Research Method

2.1. Materials and Tools

The material used in this research on hot mix asphalt AC-BC, from Asphalt Mixing Plant (AMP) plant factory production result as per technical specification [4] while the tool used in this study is a thermometer, thermocouple using an intercooler truck with a capacity of 25 ton.

2.2. Research Materials Preparation

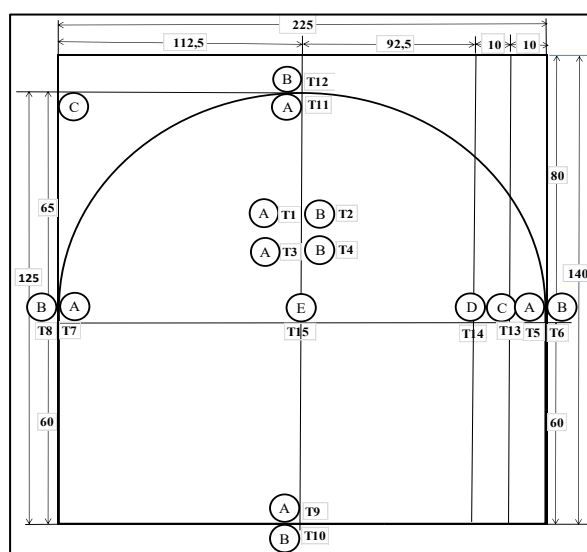
Asphalt hot mix AC-BC as the materials used in this research was prepared at Asphalt Mixing Plant (AMP) plant in granular condition at 153°C temperature, as many as 3 (three trucks) with the capacity each of 25 ton/truck, before being transported to the location of the work with mileage of 212 km.

2.3. Data retrieval system

The temperature measurement process in this study was conducted experimentally using thermometer and thermocouple, 15 (fifteen) minutes of completion of hot mix asphalt loading into the truck and after sealing with the tarp cover. Data retrieval was conducted at intervals of 20,40,60 to 420 minutes during transport, from the AMP plant to the work site with an average truck speed of 30 km/h.

2.4. Research Design and Data Analysis

At the making of Asphalt Concrete Binder Course (AC-BC) in this research need to keep some process. The mixture process comprises coarse aggregate, fine aggregate, the filler, must be clean and free of dirt, clay or any other object and dry before it is inserted into the mixer. These materials are reasonably available at the Asphalt Mixing Plant (AMP) plant site according to the aggregate composition for mixing such as 60/70 asphalt binder and additive. The entire process including the mixing process is carried out at high temperatures of 145°C-155°C and loading temperature into the transport truck 135°C-150°C, as per the technical specifications [4]. Data from the results of this study were analyzed using the descriptive method. In this study, there are 15 (fifteen) points of data collection design, of which 6 (six) points are outside the surface of the truck wall, and 9 (nine) points are inside the truck surface as shown in Figure 1.



Caption:

- A (T1) = The front wall inside
- B (T2) = The outer front wall
- A (T3) = Rear wall inside
- B (T4) = Outside rear wall
- A (T5) = Right inner wall
- B (T6) = The outside right-hand wall
- A (T7) = Left side wall inside
- B (T8) = The outside right-hand wall
- A (T9) = Inner floor
- B (T10) = Outside floor
- A (T11) = Top surface inside
- B (T12) = Top outer surface
- C (T13) = Distance 10 cm from wall
- D (T14) = Distance 20 cm from wall
- E (T15) = Distance To the surface

Figure 1. Simulation of thermocouple installation

3. Result and Discussion

3.1. Observation of Temperature of Hot Mix Asphalt on Surface of Truck Front Wall

The temperature observation data are obtained based on Figure 1 position of point A (T1) and point B (T2), for 420 minutes of transport, can be seen in Figure 2.

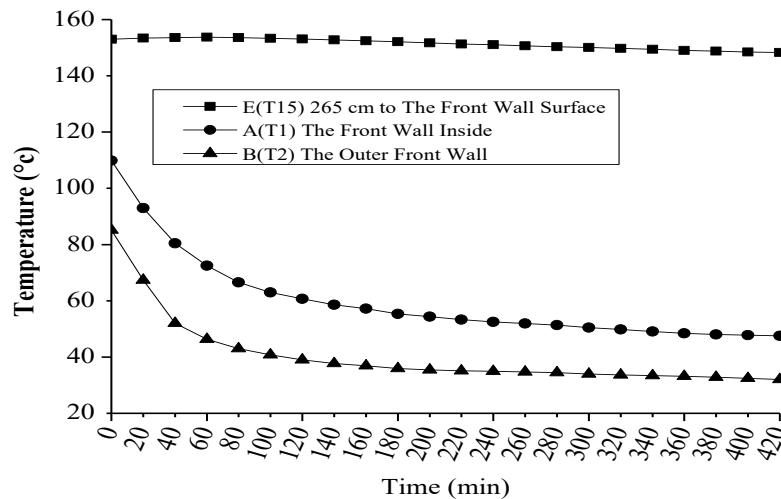


Figure 2. The relationship of the surface temperature of the front truck wall to the time of transport

Figure 2 shows of temperature loss rate of hot mix asphalt on the inner and outer truck front walls for 420 minutes of transport time. Based on Figure 1 of the initial temperature of position E (T15) 153,0°C, to 148,3°C, decrease (by 4,7°C). Position A (T1) 109.9°C, to 47.5°C, decrease (by 62.4°C). Position B (T2) 85.2°C, to 32.0°C, decrease (by 53.2°C).

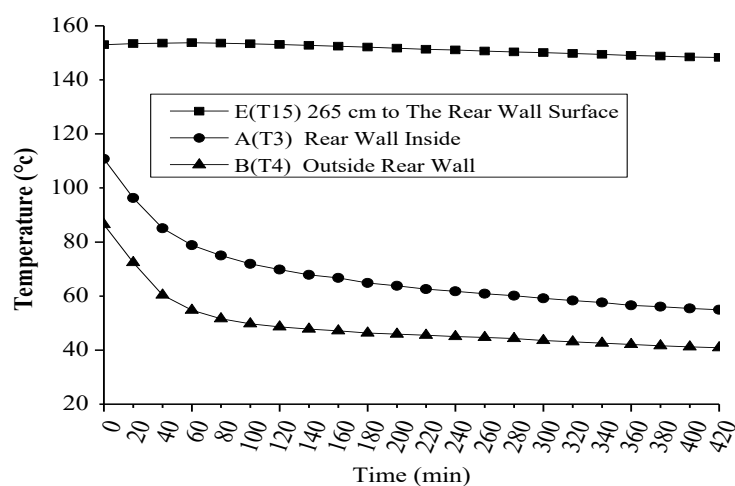


Figure 3. Relation of the surface temperature of the rear truck wall with transport time

The decrease in hot mix asphalt temperature, due to the temperature difference in the middle of the truck with the temperature around the surface of the truck wall inside and outside. At the start of transporting position the temperature E (T15) 153,0°C, position A (T5) 108,5°C, and position B (T6)

85,6°C, the temperature difference (by 44,5°C, and 22,9°C). Arriving at the location of the positioning of temperature E (T15) 148,3°C, position A (T5) 42,8°C, and position B (T6) 34,5°C, the temperature difference (by 105,5°C and 8,3°C). The rate of temperature loss from this hot mix asphalt is decreasing more with the increase of time of transportation.

3.2. Observation of temperature of Hot Mix Asphalt on Rear Surface of Truck Wall

The temperature observation data were obtained from Figure 1 position A(T3) and B(T4), for 420 minutes of transport shown in Figure 3. Figure 3 shows of temperature loss rate of hot mix asphalt on the inner and outer rear wall surface for 420 minutes of transport time. Based on Figure 1 of the initial temperature of position E (T15) 153,0°C, to 148,3°C, decrease (by 4,7°C). Position A (T3) 110,8°C, to 54,9°C, decrease (by 55,9°C). The position B (T4) 86,4°C, becomes 40,9°C, decrease (by 45,5°C).

The decrease in hot mix asphalt temperature, due to the temperature difference in the middle of the truck with the temperature around the surface of the truck wall inside and outside. At the start of transporting position temperature E (T15) 153,0°C, position A (T3) 108,8°C, and position B (T4) 86,6°C, the temperature difference (equal to 44,2°C, and 22,2°C). Arriving at the location of positioning position E (T15) 148,3°C, position A (T3) 54,9°C, and position B (T4) 40,9°C, the temperature difference (by 93,4°C and 14,0°C). Different turbulence factors cause the occurrence of hot mix asphalt temperature difference on the surface of the front truck wall with the back surface. On the front of the truck's trunk, the outer air turbulence is very high, while on the surface of the rear truck, less air flowing turbulence, in other words more laminar flow.

3.3. Observation of temperature of Hot Mix Asphalt on Right Side Wall Surface Truck 10 cm, 20 cm, 112,5 cm

The temperature observation data were obtained based on Figure 1 position A(T5) and B(T6), for 420 minutes of transport can be seen in Figure 4.

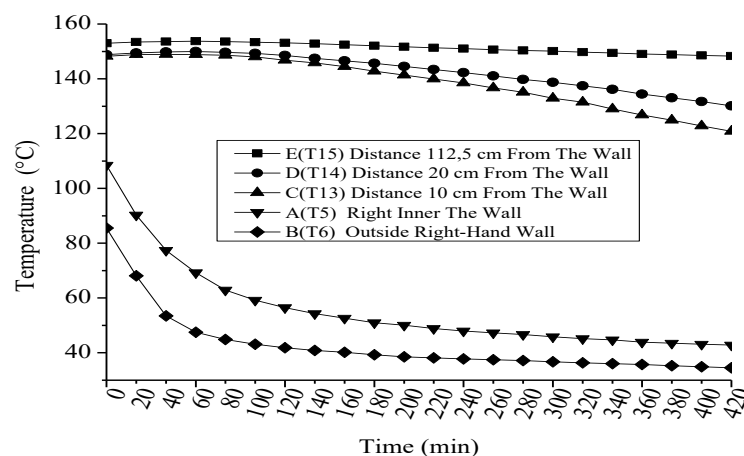


Figure 4. Relation of the surface temperature of the right side wall of the truck, 10 cm, 20, 112,5 cm with a time of transport

Figure 4 shows of temperature loss rate of hot mix asphalt on the inner and outer truck right wall surface on 10 cm, 20, 112,5 cm distance for 420 minutes of transport. Based on Figure 1 of the initial temperature of position C (T13) 148,9°C, to 120,9°C, decrease (by 28,0°C). The position D (T14) at a distance of 20 cm, from an initial temperature of 148,8°C, becomes 130,1°C, decreasing (by 18,7°C). The position of E (T15) at a distance of 112,5 cm, the temperature rate in the first 60 minutes of transport, from a temperature of 153,0°C to 153,7°C, increased (by 0,7°C). It decreases again after the first 60 minutes to 420 minutes of transport from 153,7°C, to 148,3 ° C, decreasing (by 5,4°C).

Position A (T5) 108,5⁰C, to 42,8⁰C, decrease (by 65,6⁰C). The position B (T6) is 85,6⁰C, to 34,5⁰C, decrease (by 51,1⁰C).

The decrease in hot mix asphalt temperature, due to the temperature difference in the middle of the truck with the temperature around the inside and outside surface of the truck wall. At the start of transporting position temperature E (T15) 153,0⁰C, position A (T5) 108,5⁰C, and position B (T6) 85,6⁰C, the temperature difference (equal to 44,5⁰C, and 67,5⁰C). Arriving at the location of position E (T15) 148,3⁰C, position A (T5) 42,8⁰C, and position B (T6) 34,5⁰C, the temperature difference (by 105,5⁰C and 113,8⁰C). While position temperature C (T13) 148,9⁰C, position D (T14) 148,8⁰C, and position A (T5) 108,5⁰C, the temperature difference (by 40,4⁰C, and 40,3⁰C), arriving at the location of positioning position C (T13) 120,9⁰C, position D (T14) 130,1⁰C, and position A (T5) 42,8⁰C, the different temperature of both position (by 78,1⁰C and 87,3⁰C). The result of the study at a distance of 20 cm from the surface of the final-temperature truck was 130,1⁰C still in a safe position, but at a distance of 10 cm after 420 minutes of final-freight time was 120,9⁰C below the technical specification.

3.4. Observation of Temperature Loss of Hot Mix Asphalt on Surface of Truck Left Wall

The temperature observation data were obtained from Figure 1 position A(T7) and B(T8), for 420 minutes of transport shown in Figure 5.

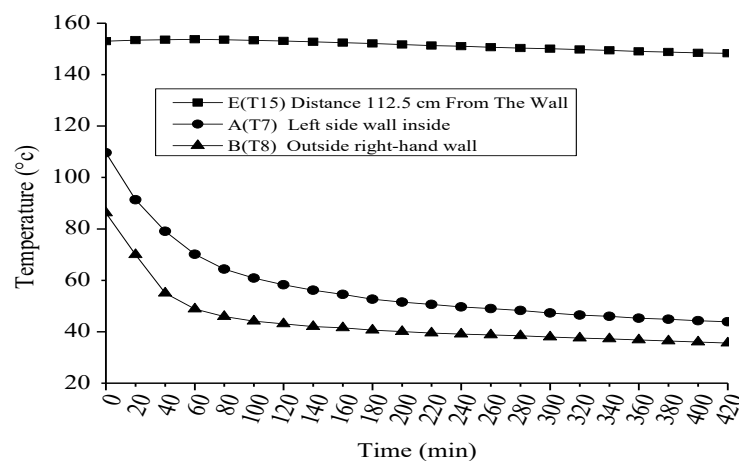


Figure 5. Relation of the surface temperature of the left side wall of the truck with a time of transport

Figure 5 shows of temperature loss rate of hot mix asphalt on the inner left side truck wall surface and outer, for 420 minutes of transport time. Based on Figure 1 of the initial temperature of position E (T15) 153,0⁰C, to 148,3⁰C, decrease (by 4,7⁰C). Position A (T7) 109,6⁰C to 43,9⁰C, decrease (by 65,7⁰C). Position B (T8), 86,2⁰C to 35,6⁰C, decrease (by 50,6⁰C).

The decrease in hot mix asphalt temperature, due to the temperature difference in the middle of the truck with the temperature around the surface of the truck wall inside and outside. At the start of transporting position temperature E (T15) 153,0⁰C, position A (T7) 109,6⁰C, and position B (T8) 86,2⁰C, the temperature difference (by 43,4⁰C, and 23,4⁰C). Arriving at the location of position E (T15) 148,3⁰C, position A (T7) 43,9⁰C, and position B (T4) 35,6⁰C, the temperature difference (by 104,4⁰C and 8,3⁰C). The final temperature of both the right and left wall surfaces did not occur difference significantly, this is due to the turbulence that occurs on both surfaces of the wall is almost the same. While the temperature loss rate of hot mix asphalt, decreasing along with increasing the time of transportation.

3.5. Observation of Temperature Loss of Hot Mix Asphalt on Floor Surface of truck

The temperature observation data were obtained from Figure 1 position A(T9) and B(T10), for 420 minutes of transport shown in Figure 6. Figure 6 shows of temperature loss rate of hot mix asphalt on the inner floor truck wall surface and outer, for 420 minutes of transport time. Based on Figure 1 of the initial temperature of position E (T15) 153,0°C, to 148,3°C, decrease (by 4,7°C). Position A (T9) 111.9°C, to 53.5°C, decrease (by 58.4°C). Position B (T10), 94.7°C to 45.0°C, decrease (by 49.7°C).

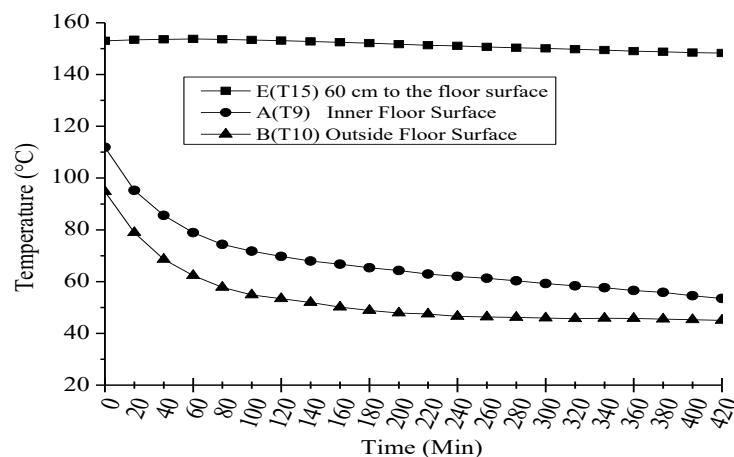


Figure 6. Relationship of truck floor the surface temperature to transport time

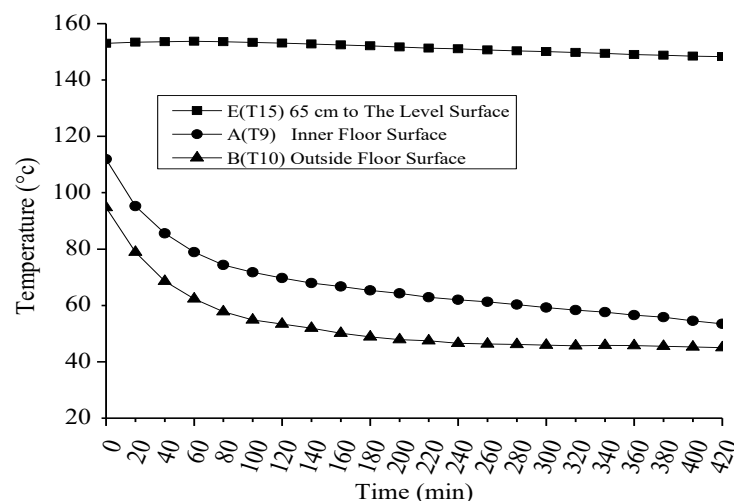


Figure 7. Relation of top surface temperature to transport time

The decrease in hot mix asphalt temperature, due to the temperature difference in the middle of the truck with the temperature around the surface of the truck wall inside and outside. At the start of transporting position temperature E (T15) 153,0°C, position A (T9) 111,9°C, and position B (T10) 94,7°C, the temperature difference (by 41,1°C and 17,2°C). Arriving at the location of positioning position E (T15) 148,3°C, position A (T9) 53,5°C, and position B (T10) 45,0°C, the temperature difference (by 94,8°C and 8,5°C). The rate of temperature loss from this hot mix asphalt is decreasing more with the increase of time of transportation.

3.6. Observation of Temperature Loss of Hot Mix Asphalt on Surface Upper Truck

The temperature observation data were obtained from Figure 1 position A(T11) and B(T12), for 420 minutes of transport shown in Figure 7. Figure 7 shows of temperature loss rate of hot mix asphalt on the truck upper surface area of the inner and outer, for 420 minutes of transport time. Based on Figure 1 of the initial temperature of position E (T15) 153,0°C, to 148,3°C, decrease (by 4,7°C). Position A (T11) 92,6°C, to 47,4°C, decrease (by 45,2°C). Position B (T12) 84,8°C, to 41,2°C, decrease (by 43,6°C). The decrease in hot mix asphalt temperature, due to the temperature difference in the middle of the truck with the temperature around the surface of the truck wall inside and outside. At the start of transporting position temperature E (T15) 153,0°C, position A (T11) 92,6°C, and position B (T12) 84,8°C, the temperature difference (by 60,4°C, and 78,8°C). Arriving at the location of positioning position E(T15) 148,3°C, position A (T11) 47,4°C, and position B (T12) 41,2°C, the temperature difference (by 100,9°C and 6,2°C). As transport times increase, the rate of temperature loss increasingly. Differences in the hot mix asphalt temperature on the surface of the truck floor with the upper surface are is more due to different turbulence effect factors. On the floor surface turbulence outside the air that flows less, in other words, the flow is more laminar. While on the upper surface of air turbulence flowing higher.

4. Conclusion

From the experimental result got some conclusions:

1. Loss of average hot mix asphalt temperature to (six) side of the truck wall surface, floor surface and the top surface of the truck, for 420 minutes of transport is (45,2°C-65,7°C).
2. Highest temperature losses occur on the left and right truck wall surfaces, while the lowest on the surface of the rear truck's wall.
3. The results indicate that the maximum transport distance that meets the technical specifications is at the furthest distance of 165 km, with a minimum temperature of 130,1°C, at a distance of 10 cm from the surface of the truck wall.
4. For the 6 (six) sides of the outer next truck surface, the average temperature loss is (43,6°C-53,2°C). The effect of the phenomenon causes hot mixed asphalt around the inside surface of the inner truck becomes hard (crusty).

5. Acknowledgments

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