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A Study of Pavement Noise for Asphalt Pavements with Different Service Life in National Highway

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ABSTRACT

Currently, asphalt pavement is covered about 90% of the national highway. The average service life of national highway is 8~9 years. In this study, the characteristic of sound pressure level(SPL) and frequency from traffic noise of asphalt concrete pavement(ACP) is evaluated according to service period. In order to find relationship between ACP's service life and traffic noise, the traffic noise from asphalt concrete pavement was collected and analyzed. The traffic noise was measured by the statistical pass-by method(SPB) that consisted of placing microphone at a defined distance from vehicle path at the side of the roadway was adopted. The analysis was evaluated the traffic noise by comparing 1/3-octave band frequency characteristics of traffic noise from asphalt concrete pavement that was three different service life: new pavement(0 year), 6 years and 10 years. Based on both SPL and 1/3 octave band frequency analysis, the SPL of 6 years asphalt pavement was shown the highest number, 78dB(A). Also, The SPL of the vehicle type, the SUV than passenger car was the highest with the average 78.8dB(A). The total Frequency range of the pavement life type and the vehicle type was a range of 400Hz~2500Hz.. According to noise characteristics results of the ACP life, in the existing literature and our result has produced different results. Later, after additional field noise test, Evaluation using the statistics technique is required.

Keywords: Traffic noise, Asphalt concrete pavement I-INCE Classification of Subjects Number(s): 13.2

1. INTRODUCTION

Noise problem regarding in apartment adjacent, roadside traffic noise is environmental issues and social issues in Korea. Current Ministry of Environment's noise abatement criteria in Korea is 68dB(A) for daytime and 58dB(A) for nighttime.*(1)* Traffic noise is changed as increase service life of pavement. NCAT conducted evaluation of the effect of pavement age and traffic noise. The testing NCAT did in Colorado provides a preliminary understanding of the nature of pavement age on noise level. Ten dense graded HMA pavements in Colorado were tested by NCAT. Figure 1 shows the results of noise level plotted versus age of pavement. As expected the older the pavement, the higher the noise level.*(2)*

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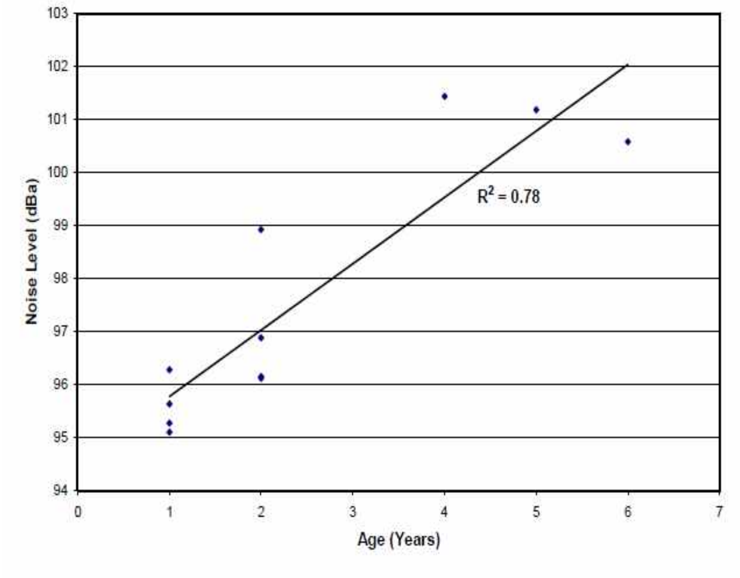

Figure 1 – Effect of Age Pavement on Noise(Colorado data)(NCAT, 2004)*(2)*

Also, ADOT(Arizona Department of Transportation) is currently using ARFC(Asphalt-Rubber Friction Course) for reduce highway traffic noise. ADOT investigated traffic noise using CPX method with 20 ARFC test sections with service life 3 years and 12 years. As seen in Figure 2, the range of traffic noise is 94dB(A)～ 99dB(A) and the traffic noise was increased annual 0.55dB.*(3)*

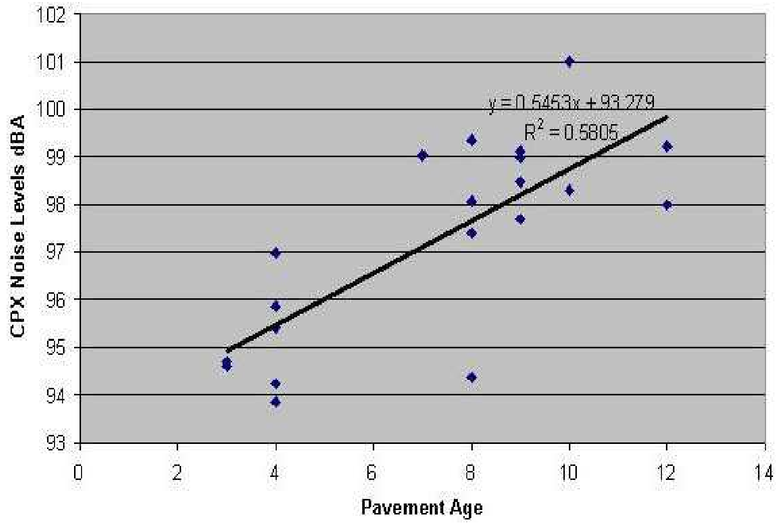

Figure 2 – Results of CPX noise measurements in Arizona on Asphalt-Rubber Friction Course at different ages[20] performed at 96km/h(60mph)*(4)*

To evaluate traffic noise characteristic as function of age of hot mix asphalt of national highway in Korea, three different test roads were selected: 0 year, 6 years, and 10 years. In this study, the traffic noise was analyzed using sound pressure and frequency as changed years and vehicle types.

2. Measurement of Traffic Noise

2.1 Test bed

To measure traffic noise as seen in Figure 3～Figure 5, three different test section was selection as different ages(0 year, 6 years, and 10 years) of hot mix asphalt in national highway in Korea. A pavement condition was surveyed and new road and 6 years road have a 2~3% crack ratio. The 10 years pavement has a about 4~6% crack ration was investigated.

Figure 3 – The new(0 year) asphalt pavements

Figure 4 – 6 years asphalt pavements

Figure 5 – 10 years asphalt pavements

2.2 Traffic Noise Measurement

In this study, CPB(Controlled Pass-by) that called ISO standard is commonly used to evaluate noise from engine, and tire/pavement etc.*(5)* The CPB method is especially well suited to investigate specific driving conditions and when representative test vehicles are available.

Two different vehicle types as seen in Figure 6 were used in this study. Both vehicle were operated at 60, 80, and 100km/h in the right lane in national highway in Korea. The research team conducted testing by placing microphone 1.2m above the pavement and positioned at 7.5m from center of the traffic lane. Three runs were made to collect enough data for each speed. Figure 7 and Figure 8 shows traffic noise equipment and field test set up.

(a) Passenger Car (b) SUV

Figure 6 – Test Vehicle

Figure 7 – Noise Measurement Equipments

Figure 8 – Location of Noise Measurement

3. Traffic Noise Characteristics

3.1 Characteristics of Sound Pressure

Figure 9 and Figure 10 shows an average of sound pressure of national highway as changed ages. As seen in Figure 9 and Figure 10, the traffic noise was increased as increased vehicle speed as function of age of asphalt pavement. Both passenger and SUV shows the higher sound pressure at 6 years service life road. The traffic noise is increased as increased vehicle speed. Contrary to general noise trend as aged pavement, the higher SPL was measured at 6 year pavement in this study as explained both Figure 9 and Figure 10. The difference of the change of speed, the traffic noise of high speed(80km/h～100km/h) is less than that of low speed(60km/h～80km/h).

In other words, noise difference between 60km/h and 80km/h, 80km/h and 100km/h is 4.5dB(A) and 3.3dB(A), respectively. It indicates the SPL can be inferred coverage as increased vehicle speed.

According to vehicle types, compare to the sound pressure characteristic noise was shown that SUV was 1.8dB(A) large. It implied that tire contact area of SUV was wider than that of passenger car. Based on speed increasement, the noise variation was decreased. It was 2.7dB(A) at 60km/h, 1.7dB(A) at 80km/h and 1.1dB(A) at 100km/h, respectively.

Table 1 – Sound Pressure(dB(A)) as various speed and ages of pavement

Vehicle Type	Age(year)	Vehicle speed(km/h)		
		60	80	100
Passenger Car	0	70.8	75.1	78.2
	6	72.6	77.1	80.6
	10	72.1	76.7	79.9
SUV	0	74.0	77.9	79.6
	6	75.9	78.8	81.7
	10	73.7	77.4	80.7

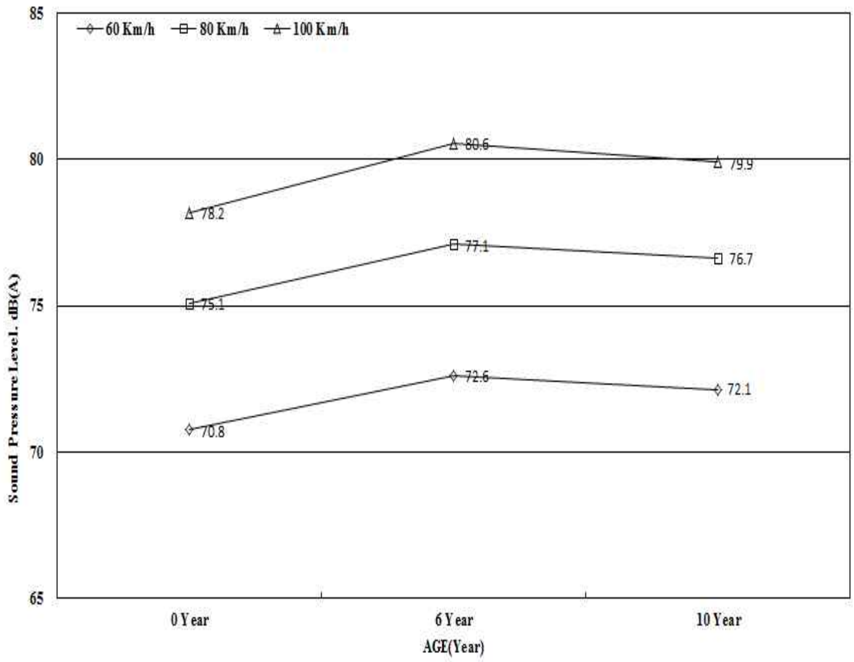

Figure 9 – Sound Pressure Levels of Aged Asphalt Concrete Pavements(Passenger Car)

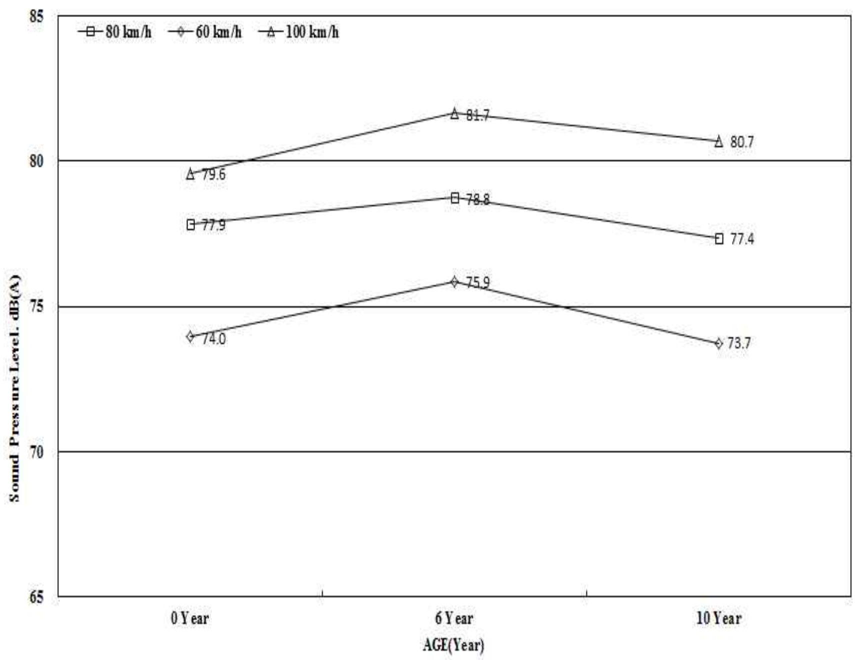

Figure 10 – Sound Pressure Levels of Aged Asphalt Concrete Pavements(SUV)

3.2 Frequency Characteristics

In this study, frequency characteristics at 68dB(A) that is allowable noise at day time was compared as changed various pavement ages. Figure 11 and Figure 12 shows frequency band as function of age and vehicle types. As seen in Figure 11, passenger car shows 630Hz～2000Hz frequency band. In case of SUV, as changed years, the frequency band was changed as seen in Figure 12.

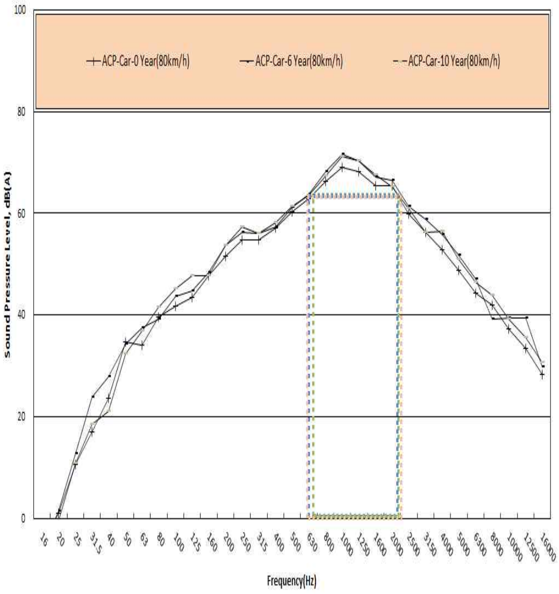

Figure 11 – Frequency Band of Aged Asphalt Concrete Pavements(Passenger car)

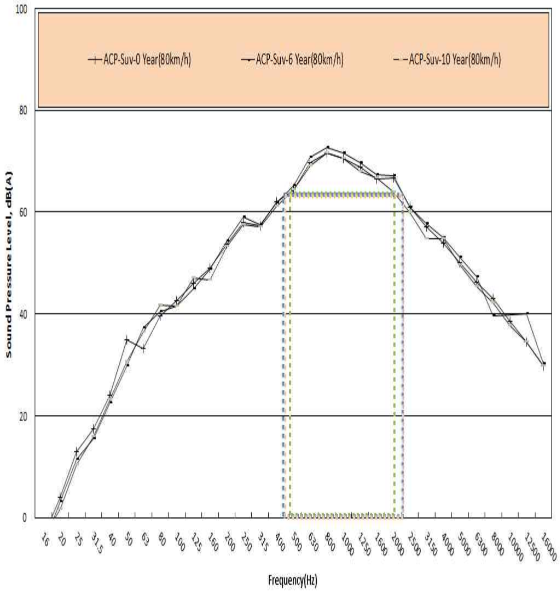

Figure 12 – Frequency Band of Aged Asphalt Concrete Pavements(SUV)

In case of new asphalt pavement(0 year), Figure 13 and Figure 14 shows frequency band as changed vehicle speed. As seen in both Figures, low frequency band didn't change, however, high frequency band clearly changed as changed vehicle speeds. It implies that the more high-frequency noise can be generated as increasing speed.

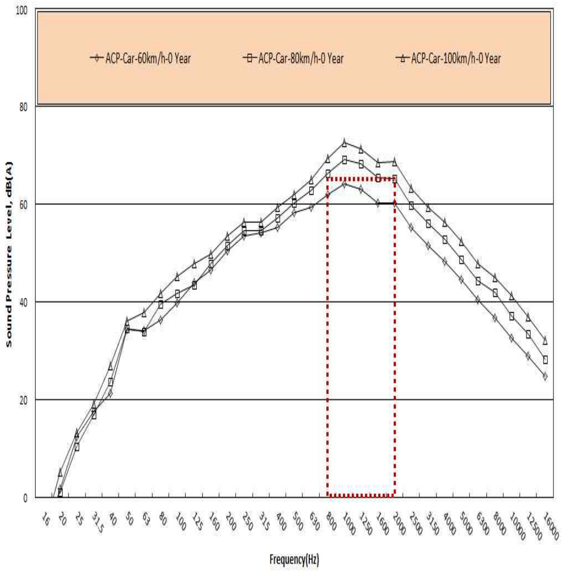

Figure 13 – Frequency Band of Asphalt Concrete Pavements(Passenger car, 0 year)

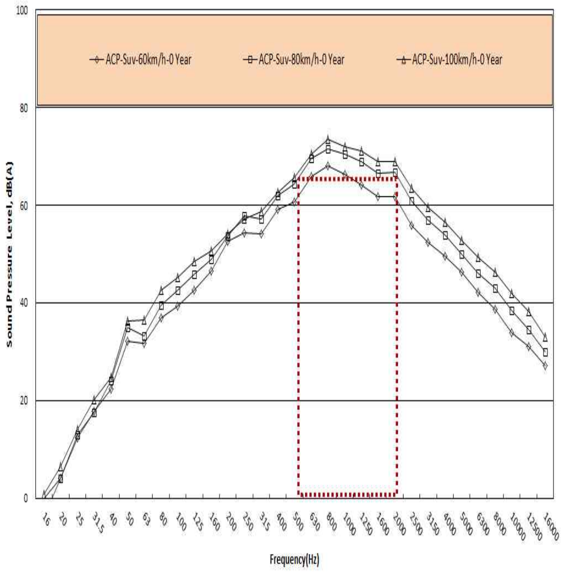

Figure 14 – Frequency Band of Asphalt Concrete Pavements(SUV, 0 year)

4. CONCLUSIONS

Sound Pressure was evaluated as various variations such as pavement age, vehicle type and speed. The following conclusions can be drawn:

1. SPL(sound pressure level) of two vehicles was higher at 6 age's asphalt pavement and the SPL is increased as the speed is gradually increased.

2. In comparison of SPL, SUV is 1.8dB(A) higher than that of passenger car. As increased vehicle speed, the noise deviation was decreased.

3. In case of frequency band vs. age, passenger car shows a range of 630Hz~2000Hz frequency band in spite of changed pavement ages, however, SUV shows 400Hz~2500Hz frequency band at both

new and 6 years pavement and 500Hz~2000Hz frequency band at 10 years asphalt pavement.

4. According to analysis of the frequency characteristic, deviation of low frequency band didn't change at low speed, however, significant deviation of high frequency band was found.

This study was conducted with limited test results. However, the research team will continuously estimate traffic noise as various variations such as environmental condition, traffic volume, and statistical techniques etc.

ACKNOWLEDGEMENTS

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REFERENCES

1. Ministry of Environment(2011), "Implementing Regulations in Noise and Vibration Control Law", Management criteria of Traffic Noise and Vibration
2. National Center for Asphalt Technology Auburn University(2004), TIRE/PAVEMENT NOISE STUDY, NCAT Report 04-02
3. H. Bendtsen, Q. Lu, and E. Kohler(2010), "Acoustic Aging of Asphalt Pavements: A Californian/Danish Comparison", UCPRC-RP-2010-01
4. Arizona Department of Transportation(ADOT), Quiet Pavement Pilot Program. 4/16/03. See : http;//www.fhwa.dot.gov/environment/noise/qpppadot.htm.
5. International Organization for Standardization(1997), "Acoustics - Measurement of the influence of road surfaces on traffic noise - Part 1: Statistical Pass-By method", ISO 11819-1