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Original Research Paper

Monitoring and Evaluation Study on Traffic Noise of College Road

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ABSTRACT

With the increase of traffic mileages, traffic flow and running speed, highway traffic noise pollution is aggravating and expanding the interference degree and scope of residents along the line, whose normal life, work, study and rest environment are disturbed seriously. Traffic noise pollution has gradually become the most concerned environmental pollution problem for the residents who live along the line. We monitored the noise of the section of College North Road which is from Hebei University of Engineering North Gate to Meishilin Supermarket. Through comprehensive analysis and evaluation on social environment and residentsô health impact, we proposed reasonable measures to reduce noise pollution.

INTRODUCTION

With the continuous development of social economy and improvement of people's living standard day by day, the quantity of vehicles is also increasing. Recently, the rapid increase of urban traffic flow and serious traffic noise pollution of urban roads, which adversely affect the normal life and health of urban residents, are becoming a great public hazard of urban environment in China. The main sources of urban environmental noise are the traffic, industry, building and public activity. What influences the urban residents most is traffic noise in our country, which accounted for about 35 percent of the various urban noise. According to statistics, more than 80% of big and medium-sized cities in our country, the daytime noise equivalent sound level of major roads which belongs to the cities above is over 70dB. What's more, the pollution of noise tends to spread to suburbs and towns these years. Traffic noise mainly comes from the running, vibration, and whistle from transportation. For example, when the heavy vehicles such as trucks and buses pass by, the noise equivalent sound level is 89-92dB(A), the flow noise is about 100dB at peaking time, which affects people's normal life and health seriously and harms the development of social economy to some extent (Haiyan Zhu & Baogui Cao 2006).

Handan is junction city of Heibei, Henan, Shandong and Shanxi provinces, whose transportation is one of the more onerous cities in Hebei province. Since Handan locates at the place where long-distance vehicles throughout north and south pass. With the increase of traffic volume day by day, noise pollution problem is increasing prominently, which will influence economic development of Handan city. College North Road locates at the north of Hebei University of Engineering and the south of Handan University and Handan College. These several schools, whose students, teachers and nearby residents sum up to as high as tens of thousands of people, are all at the sides of traffic artery, which also leads to the increasing flow of people and vehicles. Due to the four overpasses building recently, the traffic is heavier and the College North Road is impacted greatly. Thus, it is necessary to research on the traffic noise of the section of Handan city and propose some reasonable suggestions to solve traffic noise problems to make them settled effectively.

OVERVIEW OF THE STUDY AREA

The main noise sources which influence the city regional environment most can be classified into domestic noise, traffic noise, industrial noise, construction noise and other kinds of noise, occupying 45.0%, 32.9%, 12.7%, 5.1% and 4.3% respectively. Noise sources which have most widespread influence are domestic noise and traffic noise, which added up to 77.9%. The noise source of the intense pollution is traffic noise (Changju Zheng 2000).

TRAFFIC NOISE MONITORING

Selection of monitoring sites: Through preliminary research, we chose seven monitoring sites on the College North Road between the north gate of Hebei University of Engineering and Meishilin Supermarket crossing, which is 20cm away from the edge of the road. Sound level meter is located 1.2 m vertically from the ground. Detailed

Fig. 1: The arrangement of monitoring sites.

monitoring sites are shown in Fig. 1.

Measurement time: The measurement of monitoring noise and traffic flow are counted at the same time. Specific monitoring period are listed in the Table 1.

Sampling method: This experiment is through field monitoring reading data; we held statistics integral sound level meter in hand and put the meter on the outside of the main road by 20cm, 1.2m vertically from the ground, and in the meantime also monitored the number of vehicles (Danli Xi 2004).

THE RESULT OF MONITORING AND ANALYSIS ASSESSMENT

The analysis of traffic flow: The variation of the traffic flow for 4 days (14-17 September) on College North Road is shown in the Figs. 2 to 6. We can see, that the traffic flow is high in the statistics of four days, among which light vehicles occupy 52%, heavy vehicles follow with 30%, and next autobikes with 18%. The heavy vehicles have a higher percentage, because of the construction of South Ring Road, making many large trucks go through College North Road to enter the expressway, which leads to the heavy traffic of large trucks. The figures also indicate that the traffic flow is higher from morning to afternoon. In normal circumstances, the highest traffic flow occurs in the morning. But the traffic flow of the afternoon on 17th September is the highest and the lowest traffic flow can be found at 9:00 pm. So we draw the conclusion that the traffic flow of College North Road is light vehicles predominantly, heavy vehicles also occupy higher percentage, which is in accordance with the actual conditions of the road.

The analysis and assessment of noise monitoring data: Daily variation of each monitoring site on College Road is as presented in Figs. 7-14.0 We can see that the traffic noise is stable in the afternoon, the equivalent continuous sound level A maintains between 68.1dB and 75.1dB. Noise pollution level maintains between 83.9dB and 95.4dB. The traffic noise has a larger fluctuation in the morning, L_{eq} ranges from 68.1 to 77.9dB, and L_{NP} ranges from 76.3 to 98.6dB. The traffic noise has largest fluctuation in the evening, L_{eq} ranges from 62.6 to 76.6dB, and L_{NP} ranges from 78.5 to 100.7 dB (Shuyu 2004). This change is corresponding to the variation of the above traffic flow. It is just because the traffic flow is low and changes greatly at night that the traffic noise at night is lower and fluctuates more greatly than in the daytime.

According to Sound Environmental Quality Standard (GB3096-2008) (Zhanpeng Jiang 2002), College North Road belongs to the district that is on the both sides of traffic lines. The highest L_{eq} value is 75.9dB in the daytime and 55.6dB at night. The above figure indicates that the noise of both sides of College North Road exceeds the standard both day and night. In the daytime, the traffic flow is higher, and the noise of heavy vehicles and autobikes is higher, so the traffic noise is high. Noise should decrease after 8 pm for the reduction of traffic flow. But we find that noise at night is higher than the one in the daytime through monitoring this time, which is abnormal, since the actual conditions of the road, the volume of heavy vehicles increases on the College North Road at night. What is more, the heavy vehicles which load a lot often enter the expressway through this road in the evening, which leads to extremely high noise and instable in the evening.

For the noise attenuation of College North Road, we consider geometric attenuation and divergence attenuation

Table 1: The monitoring period of noise.

Sep.14th, 2012	Start from 9:00	Start from 15:00	Start from 21:00
Sep.15th, 2012	Start from 9:00	Start from 15:00	Start from 21:00
Sep.16th, 2012	Start from 9:00	Start from 15:00	Start from 21:00
Sep.17th, 2012	Start from 9:00	Start from 15:00	Start from 21:00

only. We view the sound source as the infinite line sound source. We can calculate the noise value of neighbourhood by using the formula: $L(r) = L(r_0) - 10lg(r/r_0)$. The distance from College North Road to neighbourhood is about 40 meters, attenuation value is 10lg(40/15) = 4.2dB. Thus, we can know that the noise value still exceeds standard.

REASONS FOR TRAFFIC NOISE POLLUTION OF COLLEGE NORTH ROAD

The running noise of heavy vehicles and autobikes: The flow of large trucks is not on the dominant position, which produce far more noise than other types of vehicles. Noise value increases rapidly when large trucks go by, whose carrying capacity and power are very large.

Many autobikes: We divide autobikes into other types of vehicles instead of light ones when calculating the traffic flow. We saw many autobikes obviously when calculating, which ran on the two sides of the road with loud noise. What is more, the autobikes were often beeped by the drivers.

Poor road conditions and unreasonable planning and designing of roads: The types of roads and pavement affect a lot on pavement noise. Compared with the bristles of concrete pavement, exposed-aggregate concrete pavement can decrease noise about 3dB, which will even be more quiet than hot asphalt concrete. According to the survey, noise reduction effect of exposed-aggregate concrete pavement equals the result of cutting the traffic flow in half on condition of not changing surface characteristics. College has a poor pavement condition because of hard cement road. The other reason is the South Ring Road is being built, which leads to most large trucks go through the College North Road. Now the pavement has been damaged seriously, and heavy traffic noise pollution also appeared.

COUNTERMEASURES OF NOISE SOURCES

Restricting vehicle types and running speed: We should reduce buses and large trucks that have loud noise running on the main road and ban autobikes running on the main road. In the meanwhile, we need to limit the running speed. Normally, noise can reduce 2dB if speed is reduced by 10 km/h. Another way is to set up obvious limitation mark of speed at the crossings of traffic trunk roads, in order to guarantee the vehicles running at a constant speed.

To design and use vehicles properly: The most direct and effective measure to reduce urban traffic noise is to control the noise of vehicles produced by themselves, design and reform vehicles according to low noise standard (Yanbo Jin 2005). For example, use high efficiency exhaust muffler, sound insulation cover of engines and low noise tire. Besides, road noise, especially the peaking value of noise, mainly depends on the heavy trucks and buses which belong to heavy vehicles. Hence, the main object of low noise study is this kind of vehicles. Certainly, researching and developing new environment-friendly vehicles of ultra low noise, such as electric vehicles, solar car is also our aim.

Control noise pollution in spreading way: ***Planting green belt***: The green belt, which is consisted of trees and green plants, can reduce noise effectively. One of the effective measures to prevent and control traffic noise is to plant trees on both sides of the roads. We can absorb sound wave and reduce noise by selecting proper tree species, plant density and the width of vegetation. Green belt which can absorb carbon dioxide and other harmful gases and adsorb dust can also improve microclimate, guard against air pollution, intercept drainage from roads, avoid dizziness and beautify the environment, etc. Related study indicates that when the width of green belt is more than 10 meters, it can reduce the traffic noise by 4-5dB. To urban roads, for the space limitation, we can plant dense pine and Cypress being green corridors to separate motorways and walkways. What is more, we can plant communities that are in accordance with road environment between walkways and buildings such as arbor, bush and grass. It is researched that the average value of the full band noise level reduction of dense hedges is 0.25-0.35 dB/m, and grass is 0.1dB/m (Hongbing Xiao 2007).

***Building noise reduction pavement*:** It is significant to control traffic noise by building noise reduction pavement, because tire noise takes up a certain proportion of vehicle noise for medium-sized and small-sized cars. Noise reduction pavement, which is also called porous asphalt pavement or drainage asphalt pavement, is built by paving a layer of asphalt mixture, which has a high porosity of 15%-25%, the highest even up to 30%, on the structure layer of common asphalt pavement or cement concrete pavement. The materials from overseas researches indicate that, according to the differences of surface layer thickness, the use of time, the conditions of use and conservation status, this kind pavement can reduce traffic noise by 3-8dB compared with common asphalt concrete pavement (Shiqing Yu 2006). If we put rubber compounding ingredients into the asphalt, the effect of noise reduction will be more obvious.

***Building sound barriers*:** Since the noise of College North Road exceeds the standard seriously, so we can consider building sound barriers. The way of adopting building sound

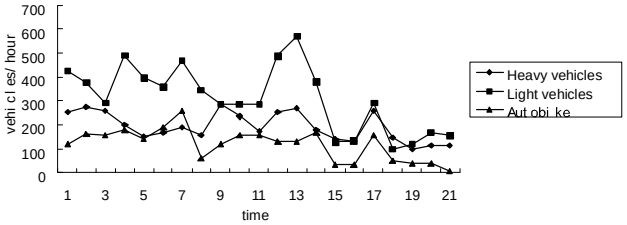

Fig. 2: The change figure of various traffic flow on September 14, 2012 changes.

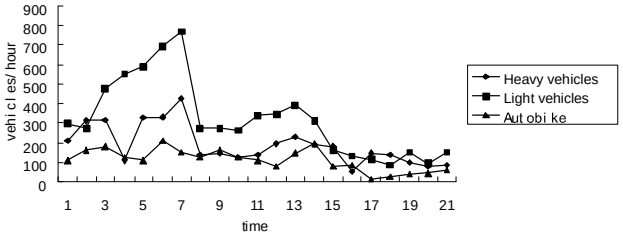

Fig. 3: The change figure of various traffic flow on September 15, 2012 changes.

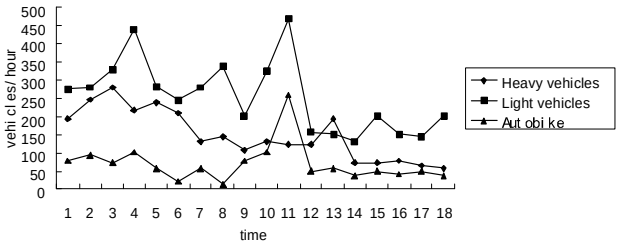

Fig. 4: The change figure of various traffic flow on September 16, 2012.

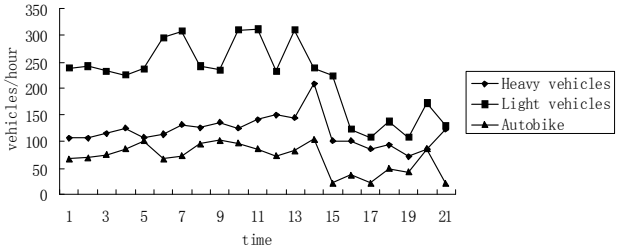

Fig. 5: The change figure of various traffic flow on September 17, 2012.

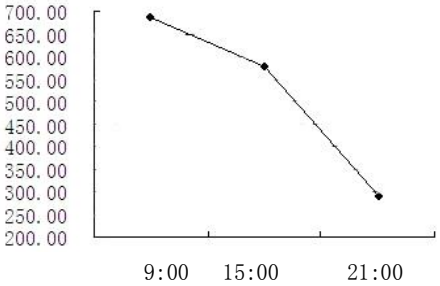

Fig. 6: The diurnal variation for four days of average total traffic volume.

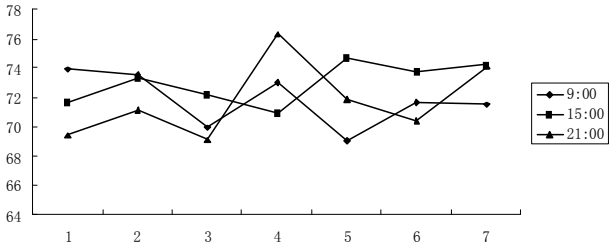

Fig. 7: The day change of L_{eq} on 14 September, 2012.

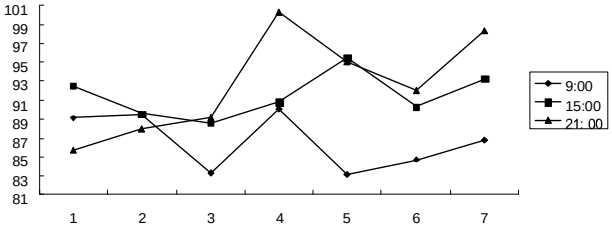

Fig. 8: The day change of L_{NP} on 14 September, 2012.

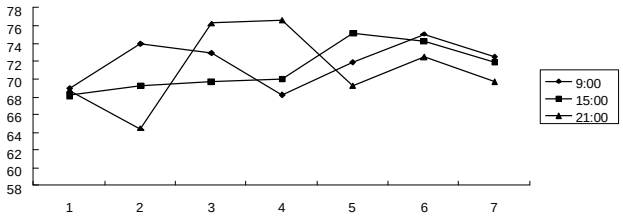

Fig. 9: The day change of L_{eq} on 15 September, 2012.

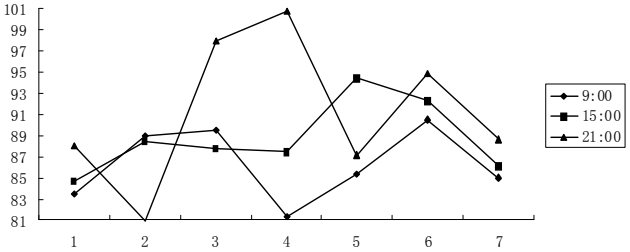

Fig. 10: The day change of L_{NP} on 15 September, 2012.

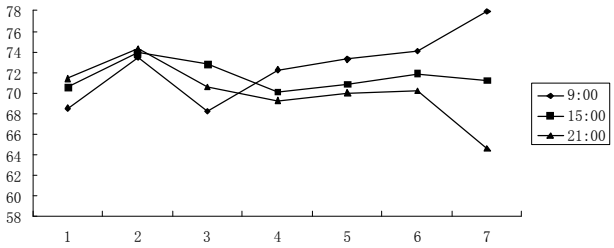

Fig. 11: The day change of L_{eq} in 16 September, 2012.

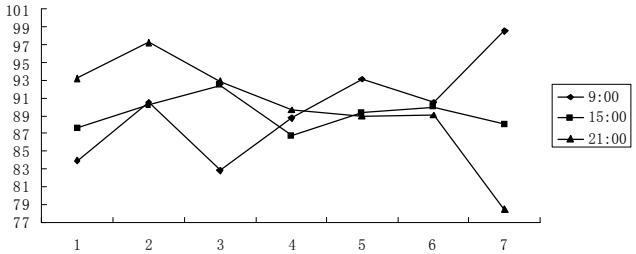

Fig. 12: The day change of L_{NP} in 16 September, 2012.

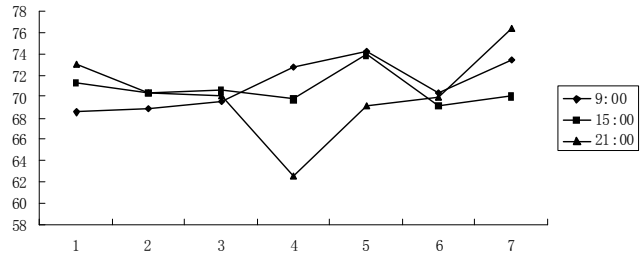

Fig. 13: The day change of L_{eq} on 17 September, 2012.

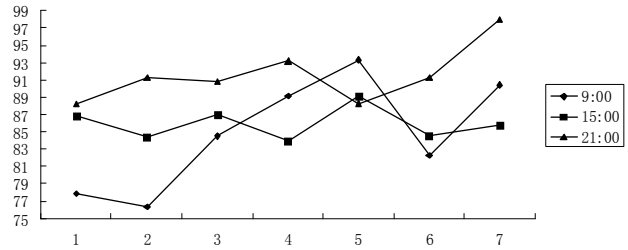

Fig. 14: The day change of L_{NP} on 17 September, 2012.

barriers to reduce the road traffic noise is widely used currently. Sound barrier mainly depends on a series of physical reactions to reduce noise such as absorbing and reflecting sound waves through materials of the sound barriers. It is tested that the noise can reduce by more than 10dB when using sound barriers. On account of the different types of sound barriers, each type has its own distinguishing features on the aspects of reducing noise effect, cost and scenery. Therefore, when selecting proper types of sound barriers, we should base on the sensitive degree of accepting sound points, the local economic conditions and natural environment.

***Installing sound insulation windows in the house*:** We can reduce the influence of traffic noise on the residents near the road effectively by installing double-glazing of windows.

Enhancing publicity education and law enforcement: We should strengthen the publicity education, increase the environmental awareness and traffic awareness of the drivers, specialize driving, change driveway less often, punish the drivers who drive illegally and the ones who drive motorcycles and trucks on the main road. Besides, the government should manage large trucks into the city at night strictly when the traffic police is off duty and increase the punishment degree.

CONCLUSION AND SUGGESTIONS

In order to know about the traffic noise conditions of College North Road, we have monitored traffic noise, analysed and assessed the results of monitoring. Thus, we find main reasons of the traffic pollution of College North Road and put forward measures to control that.

1. Monitoring sites: We chose seven monitoring sites on the College North Road between the north gate of Hebei University of Engineering and Meishilin Supermarket crossing, which is 20m away from the edge of the road. Sound level meter is located 1.2 m vertically from the ground. We began to measure at 9:00, 15:00 and 21:00 respectively, monitored the seven monitoring sites we chose in the section through field monitoring reading data.
2. After having analysed and assessed the traffic flow and data of noise monitoring, we plotted the figures on September 14-17 various types of traffic flow changes and daily variation of L_{eq} and L_{NP} of each monitoring site on College North Road.
3. Through the analysis and assessment of monitoring results, we have found the main reasons which caused much pollution of the College North Road. The reasons are as follows: The running noise of heavy vehicles and autobikes, too many autobikes, poor road conditions and unreasonable planning and designing of roads.
4 In the view of reasons, we proposed counter measures to control the traffic noise of College North Road. The counter measures are as follows: Restricting vehicle types and running speed, designing, reforming and using vehicles properly, planting green belt, building noise reduction pavement and sound barriers, installing sound insulation windows in the houses and enhancing publicity education and law enforcement. The traffic noise of College North Road with a heavy traffic exceeds the standard grievously, which adversely affects the residents and schools along the lines. So we must take measures to reduce traffic environmental noise in order to provide a quiet and harmony living environment for the residents and a good learning environment for students.

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