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Research on rapid detection and control mechanism of urban traffic noise impact based on Soundplan software simulation

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Abstract. With the rapid development of Chinese modern urban residential area, the car ownership has increased dramatically. This leads to a phenomenon that traffic noise is increasingly endangering people's living environment quality. Noise not only can cause tinnitus, hearing loss but also can cause cardiovascular disease. Since the 1970s, a lot of countries have established the road traffic noise simulation models based on the local actual situation, which already have been revised and perfected in the application. Based on the simulation of Soundplan software, we try to analysis the influence of road traffic noise of Zin Jin apartment in Tsinghua University and propose a set of suitable design strategy.

1. Introduction

With the development of the modern urban residential area, how to reduce the environmental pollution of housing and residential areas has become an important part of the national sustainable development strategy. The environmental quality of residential area is an important symbol to embody the civilization degree of a city. In the fourth National Residential District Construction conference, which was held in February of 1996, the Ministry of Construction proposed the housing and residential area design goal-"people-centered, improving the comfort of living, creating a quiet living environment"[1].

In recent years, a great deal of research on traffic noise in developed countries has been focused on control and governance. Such as London, people go out according to the noise map. Europe has reduced the permissible noise levels of new cars several times in a row. Japan has developed a method to reduce the engine noise by using of laser mute technology[2]. And through the improvement of tread patterns and tire structure, Japan try to make the tire much more mute.

The Zijing student apartment in Tsinghua University is one of the largest modern student apartment in China, which is divided into undergraduate, postgraduate, international and continuing education areas. The load on the east and north side of the road is relatively large[3]. And the noise of the highway to the dormitory area produces serious noise disturbance, which seriously affects on the students' normal learning and rest.

2. method

At present, China's environmental protection Department has laid a noise monitoring network in major cities in China. However, urban traffic noise monitoring using the fixed-point method will lead to a large amount of work. So many scholars try to put forward different ways to optimize the method. Such as Che Yongxia, Hu Suxia, Ye Xiaobin try to apply matter element analysis method to optimize the noise monitoring point. Taking Anyang as an example, they use this method to the monitoring of the distribution point from 12 to 5. Madongsheng and Chuangyu optimize the noise monitoring point distribution   by using the method of grey incidence degree analysis[4].

Compared with other computational noise control techniques, using acoustic simulation software Soundplan can easily and intuitively see the influence of traffic noise on the sound environment, which can also visually reflected whether the insertion of sound insulation barrier can effectively reduce the influence of noise.
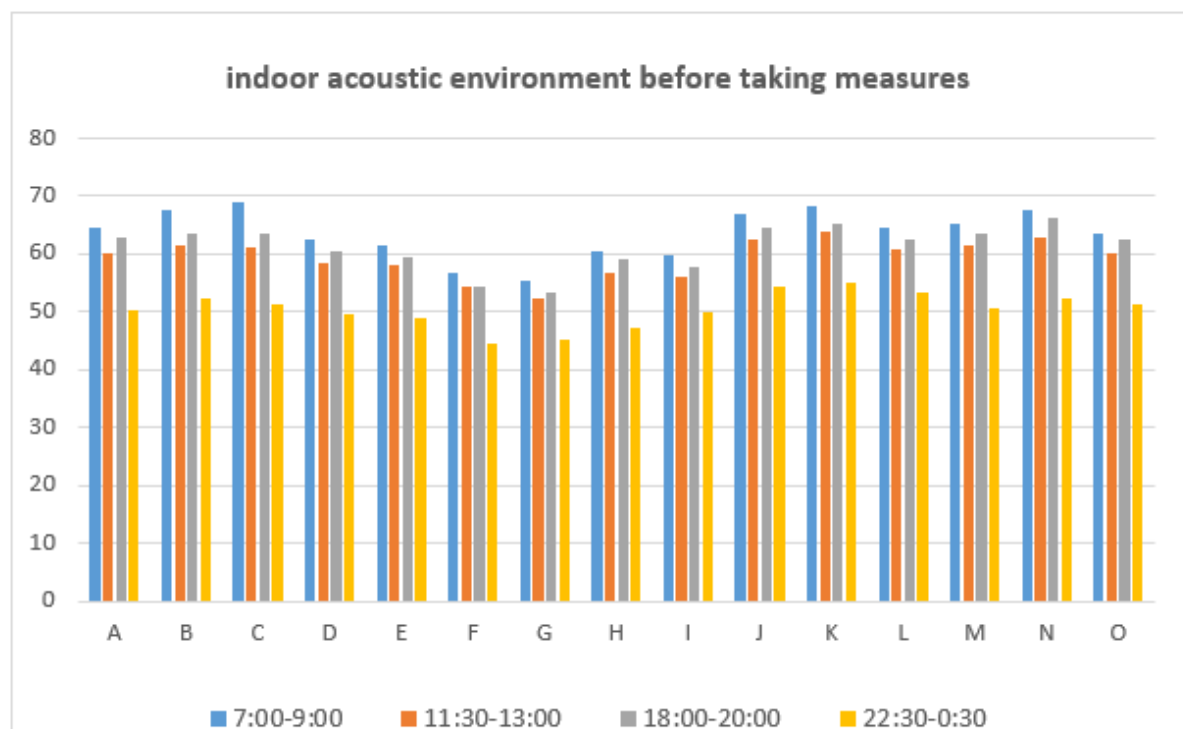

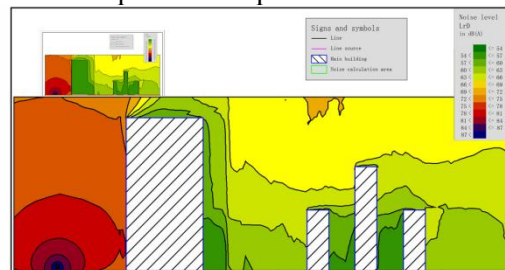Figure 1. Some of the traffic noise data collected during the daytime and at night.

3.Steps

3.1 Monitoring data

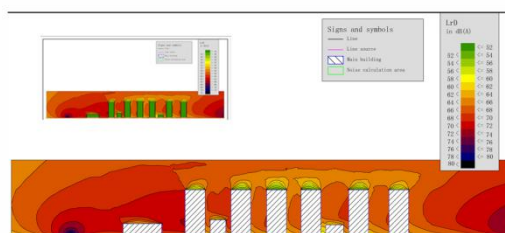We use a continuous noise monitor to collect noise data.   The instrument can continuously detect the traffic noise for 24 hours,with GPS positioning function.The instrument can acquire an A sound level per second, saving it as a txt file at the same time,and record the noise in real time. The dynamic range of the instrument should be no less than 50dB to ensure the accuracy of the measured data[5].The diurnal noise value of the point is characterized by 30min equivalent a sound level during the daytime.The noise value during nighttime is represented by the average equivalent A sound level of the most disadvantageous time period.

In the construction red Line, we evenly distributed measurement points from the city main road 40m and 90m.40m is the distance that the closest noise source building near the side of the sound sources. Through continuous monitoring within 24 hours, the instrument collected noise data for the most unfavorable time period of 20 minutes during the day and night.(Figure1).According to the
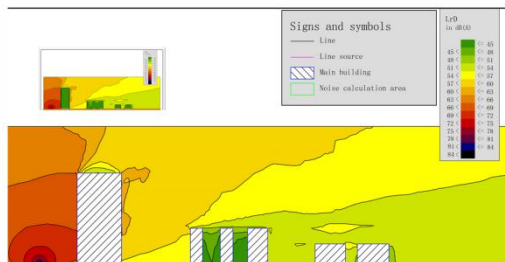
equivalent continuous sound pressure level Leq of the most dense and unfavorable time period of the vehicle, the traffic noise distribution spectrum map is drawn.

Figure 2. Profile noise distribution map in Soundplan

3.2 Input noise data into soundplan for simulation analysis

① The physical model of the residential community is established in the soundplan software, to prepare for the next step of introducing noise data.

② The collected noise data is imported into the soundplan software for outdoor sound field simulation calculations. Thus, noise plane maps and facade maps will be drawn out.(Figure 2-3)
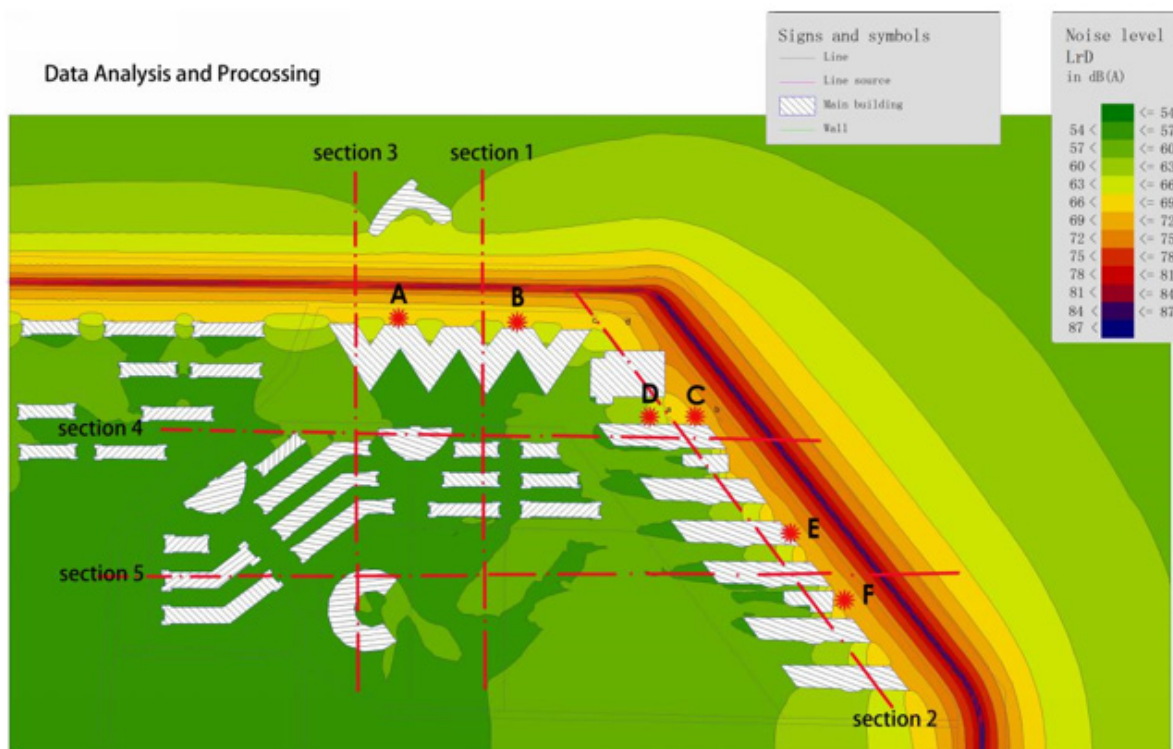
Figure 3. Before taking measures the noise plane distribution diagram.

3.3 Taking measures to reduce the influence of traffic noise on the residential area

3.3.1The first Measures : the insertion of sound barriers.
The noise redistribution is simulated by adding sound barriers in the model, to check whether   the impact of traffic noise on residential areas has been significantly reduced.We use the method of Fresnel number calculation to calculate the noise reduction of the sound insulation barrier[6].

When using noise barriers to reduce traffic noise, we must pay attention to the principle of selection of noise barriers.

The side of the sound insulation barrier facing the main road adopts a perforated plate, and the side facing the building does not need perforation.The sound absorbing material between the two plates is made of rock wool sound absorbing plate.The hole diameter is 5mm, and the perforation rate should not be less than 16%. The thickness of rock wool sound absorbing plate is 3.3mm, and the back plate thickness is 3.5mm. It is recommended to use high-density rock wool, (density is not less than 64kg/m3) ,which has the better sound absorption function of the medium and low frequency traffic noise.

After simulating the insertion of the corresponding sound barrier in the soundplan acoustic software, the simulation plots the noise redistribution.Comparing the schematic with the original noise profile, it was found that the average noise reduction was between 5-10 dB.

3.3.2The second Measures : Using sound insulation window to reduce the impact of traffic noise.
According to the "Civil Building sound insulation design standard gb50118-2010" *Indoor* allowable noise requirements, we can determine the external walls and windows of the integrated insertion loss[7].

The sound insulation of ordinary sound insulation window is between 25-32dB.The cost is low, but the room cannot be ventilated, which seriously affects the quality of indoor living.The noise reduction of the natural ventilation sound insulation window is between 25-28dB, which makes the indoor

environment maintain a good rest environment and the cost is moderate.The noise reduction of the mechanical ventilation window is between 26-37dB, but the cost is high and the running cost is too expensive[8].Based on the above analysis, we chose to add the natural ventilation sound insulation window to the soundplan software sound field simulation calculation.
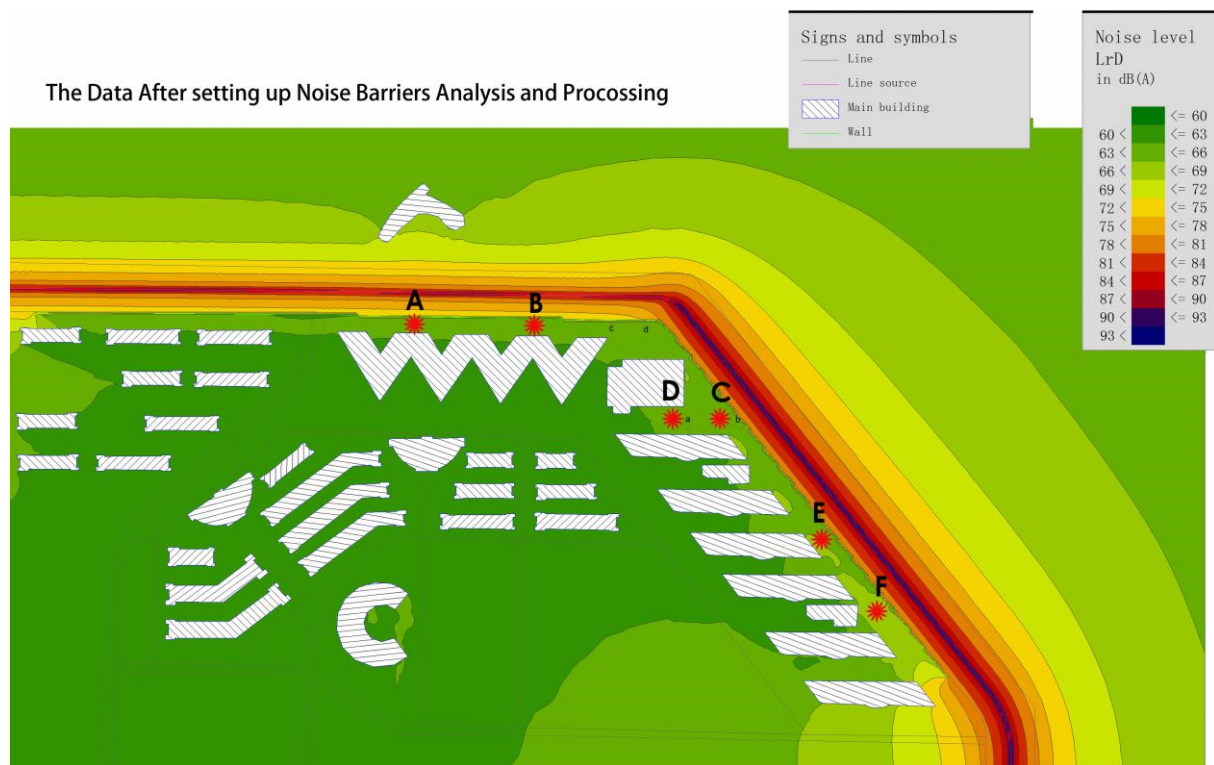

Figure 4. After taking measures the noise plane distribution diagram.Residential area sound Environment is more high-quality, in line with national acoustic standards, noise reduction is obvious.

4. Conclusion

After taking the above-mentioned measures, we repeat the simulation calculation in the Soundplan, and get the latest distribution map of the noise.It can be seen from the figure that the low layer noise value is reduced by 10-20 dB.The low and medium noise diffracted from 5 to12 layer，leading to increase the noise.After adopting the measures of soundproof windows and doors, the high-level of the building noise is less than 50dB in the daytime and less than 40dB in the nighttime(Figure 4).

In summary, the sound insulation barrier has a significant effect on the low-frequency noise.But due to the diffraction phenomenon at the upper level, it is necessary to add the auxiliary measures of the sound insulation door and window to control the noise hazard.

In this case, the soundplan software is used to simulate the noise distribution. After inserting the sound insulation barrier and the noise reduction measures of the sound insulation door and window, it is intuitive to see the reduction of the noise hazard range, which has good guiding significance for the actual project.

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