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# TRAFFIC NOISE AND HUMAN LIVING ENVIRONMENT

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**ABSTRACT**
Traffic noise has become more and more serious in city ambient noise than ever. The paper presents a new method on the evaluation of city ambient noise. Road traffic noise calculation model and railway noise calculation model is given in this paper. Now the method has been testified in the evaluation in some newly built residential area in Beijing.

## 1 - INTRODUCTION

In all kinds of city ambient noise pollution sources, the traffic noise, including highway traffic noise and railway noise, is the most harmful one to residents who live at roadside.
According to the statistics, among the complaint letters received by the environment protection departments of large and medium cities in China (Populations over 5 million and 1 million), the complaints to the traffic noise pollution amount to over 50% of the complaints in all of city ambient noise pollution.

## 2 - PREDICTION MODEL AND CALCULATION

Through the investigation and test of railway and traffic noise influence to the residents living environment, we have made successful prediction for the environmental noise of a residential community in Beijing, Residence *A* which is located at north side of a railway line, west side of the West Third Ring Road and the south side of a certain sub-artery road. The suitable prediction allowed the developers have made the noise deduction designing gained better effect latter for every apartment prior to the construction. The plan of Residence *A* is seen at figure 1.
Firstly, we analyzed the anxiety degree of people who live in different noise environments. Based on the statistics of over 1,000 investigated persons, there is a linear interrelated linkage between the noise anxiety effect in the living environment (shown by HA%) and the environmental noise level.

$$HA\% = -412.5 + 267.3\lg L_A \tag{1}$$

By above formula, the anxiety rate to the different indoor environmental noise level can be seen in Table 1.

| Indoor noise level $L_A$(dBA) | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
|---|---|---|---|---|---|---|---|---|
| HA(%) | 0.2 | 15.7 | 29.4 | 41.6 | 52.7 | 62.8 | 72.1 | 80.7 |

**Table 1:** The calculated date of HA and indoor noise level.

At the same time, statistics were also made for people at different age under 50dBA noise environment. Their relative anxiety rate can be seen at Table 2.

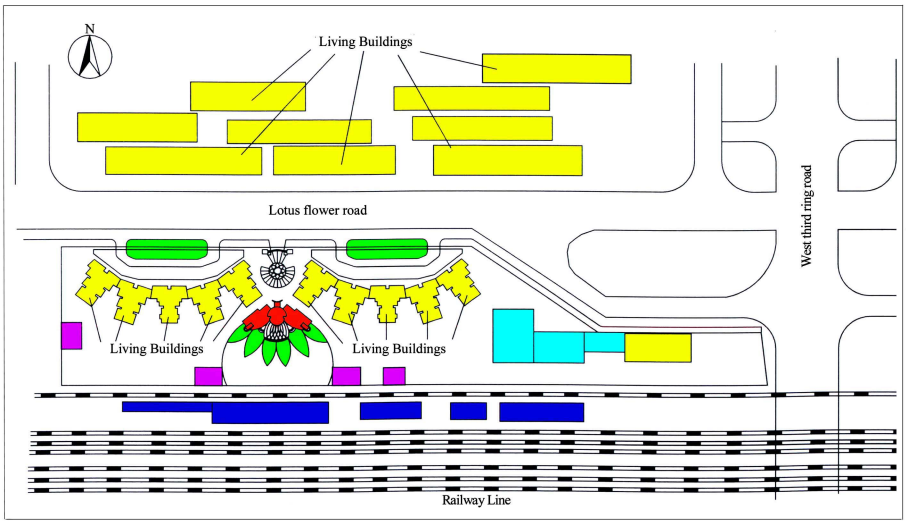


**Figure 1:** Residence *A* plan.

| Age | <30 | 30 to 40 | 40 to 50 | 50 to 60 | >60 |
|---|---|---|---|---|---|
| HA(%) | 10 | 20 | 35 | 50 | 60 |

**Table 2:** The survey date of HA of different age.

By measuring the traffic noise at the various distances on the city artery and sub-artery, we have resulted the measurement at Table 3.

| Test position | Time | Leq | $L_{10}$ | $L_{50}$ | $L_{90}$ | $\sigma$ | Traffic flux |
|---|---|---|---|---|---|---|---|
| West third ring road (artery road) | Day | 71.1 | 72.0 | 67.0 | 56.0 | 6.5 | 5500 |
| | Night | 60.5 | 63.0 | 61.0 | 53.5 | 5.8 | 1854 |
| Lotus flower road (sub-artery road) | Day | 69.4 | 74.0 | 68.5 | 65.0 | 4.9 | 2493 |
| | Night | 60.5 | 62.0 | 60.0 | 53.0 | 4.8 | 642 |

**Table 3:** The measured data of roadside noise level.

We also made the measurement for the railway noise effects within the distance from 30m to 200m along the railway line. In China, the extent of applicable land is beyond 30m to the center line of rails at each side of railway. See Table 4 for the test result.

| Time | Test point | Leq | $L_{10}$ | $L_{50}$ | $L_{90}$ | $\sigma$ |
|---|---|---|---|---|---|---|
| Day | 30m from rail central line | 67.2 | 76.5 | 54.0 | 53.0 | 4.8 |
| Night | | 67.0 | 76.0 | 54.0 | 44.0 | 4.5 |
| Day | 60m from rail central line | 64.2 | 73.0 | 51.0 | 50.5 | 4.2 |
| Night | | 63.8 | 73.0 | 51.0 | 42.0 | 3.8 |
| Day | 120m from rail central line | 61.1 | 71.0 | 48.0 | 47.0 | 2.6 |
| Night | | 60.6 | 70.5 | 48.0 | 41.0 | 2.4 |
| Day | 200m from rail central line | 58.2 | 68.0 | 46.0 | 42.0 | 2.4 |
| Night | | 57.8 | 67.0 | 45.0 | 39.0 | 2.2 |

**Table 4:** The measured data of railway noise level.

On the basis of above investigation and the test result, we have carried on the calculation on the comprehensive noise effects for Residence $A$.
The formula 2 is the noise calculation model. This model can be divided into two parts which is called road traffic noise calculation model and railway noise calculation model. See formula 3 and formula 4 respectively.

$$Leq\,(T) = 20Lg\,(1/T)\left[\sum_{i=1}^{N} t_i 10^{0.1LAi}\right] \tag{2}$$

where $T$ is the time of total calculating time; $L_A$ is the noise level of sound source; $t_i$ is the action time of $L_A$; $N$ is the number of $L_A$.
For the traffic, we have:

$$Leq = Leq\,(1) + 10Lg\,(\Phi/180) + \Delta L \tag{3}$$

where $Leq(1)$ is equivalent to sound level $A$ for one meter; $\Phi$ is the angle of protection point to road; $\Delta L$ is attenuation of several factor.
For the train, we have:

$$Leq = Leq\,(1) + 10\mathrm{lg}n + \Delta L \tag{4}$$

In formula, $Leq(1)$ is equivalent to sound level $A$ of trains in one hour and at 1m, $n$ is the numbers of passing train in one hour and $\Delta L$ is attenuation of several factor.
Using above formulas, the noise calculation for Residence $A$ has been resulted in Table 5.

| Position | Leq(dBA) | | Compared with national standard (dBA) | |
|---|---|---|---|---|
| | Day | Night | Day | Night |
| Ground level in front of building, 70m from rail | 57 | 55 | +2 | +10 |
| Sixth floor high in front of building 70m from rail | 65 | 63 | +10 | +18 |
| in font of house, 70m from rail, eighteenth floor | 63 | 61 | +8 | +16 |
| behind house, 15m from road side, on flat | 65 | 52 | +10 | +7 |
| behind house, 15m from road side, sixth floor | 69 | 56 | +14 | +11 |
| behind house, 15m from road side, eighteenth floor | 65 | 52 | +10 | +7 |

**Table 5:** The result of noise prediction.

From the noise calculation results in Table 5, it is obvious that the residents in $A$ would have been seriously effected by the noise under the triple converging attacks of railway noise and road traffic noise. According to the statistic results of table 1, the residents in the community would have long lived under the anxiety rate HA range from 56.8% to 79%. Therefore, the effective measure must be adopted to the building structure so that the residential area could be suitable for people live in.
The real estate developer has accepted our suggestion and adopted the following measures:

- The additional verandas was added outside all of the bedrooms for the apartment. As the first preventive line, the sound insulating doors and windows have been used for all the verandas. The sound insulating effects could reach 20dBA.
- The sound insulating doors and windows again have been used for day-lighting windows of the bedrooms and outer verandas. The insulating windows can only be open tilted upward. The sound insulating effects of those insulating doors and windows also reached 20dBA or above. Even if the insulating doors and windows of the bedroom open up, the sound insulating effects can still reach 10dBA or above.
- Air conditioners have been installed for all the apartment buildings to avoid increasing indoor noise due to the too much opening of doors and windows for ventilation in summer.

- The sound insulating barriers has been set up between the railway line and the courtyard of the resident community, which reduced by 3 to 5dBA for the noise level in the resident's home in the lower floors of the building.

Table 6 shows the bedroom noise level tested after the above mentioned measures haven been adopted for the community. We can see the noise level of the apartment bedrooms have been reduced tremendously.

| Position | Leq(dBA), Day | Leq(dBA), Night |
|---|---|---|
| on flat, in font of house | 40 | 38 |
| sixth floor, in font of house | 45 | 43 |
| eighteenth floor, in font of house | 43 | 41 |
| on flat, behind house | 45 | 42 |
| sixth floor, behind house | 49 | 46 |
| eighteenth floor, behind house | 45 | 42 |

**Table 6:** The measured result of indoor noise for Residence $A$.

## 3 - CONCLUSION

In the city, the traffic noise is the major factor of the pollution source which influences the dwelling surroundings. If the residence were built along the sides of traffic artery and railway line, the living environment can only be guaranteed through scientific prediction and adopting effective measures.

## REFERENCES

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