Noise Reduction of the Ecological Sound Barrier

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Abstract. In China, harmonious environmental protection is more important and advocate in main position today. Building ecological noise barrier can not only reduce environment noise effect, but also better integrate with the environment along the traffic. This paper investigated the typical ecological noise barrier built in China highway, and measured the noise reduction on the site. Combined with the idea of green road construction, proposed the development trend of ecological noise barrier and provided the reference for the noise reduction in the transportation industry.

1. Introduction
In the past 20 years, a few ecological road noise barriers have been built in China, mainly in the south of the Yangtze River [1, 2]. According to the position of plant planting, the ecological sound barrier can be divided into two categories: (1) planting plants on the wall of the sound barrier; (2) planting vines on the roadbed at the bottom of the sound barrier, climbing up to the upper wall to form an ecological sound barrier. In this paper, the noise reduction effect of the ecological noise barrier is investigated on the site, aiming at studying the existing problems and putting forward the development trend of the construction in the future [3, 4].

2. Current situation of construction of ecological highway noise barrier in China

2.1 Planting plants on the wall of sound barrier
This type of ecological sound barrier is mostly built in Hunan, Guangdong and Anhui provinces. For example, the curved ecological sound barrier is used in Hengyang-Zaobu Highway in Hunan Province (Seen in figure 1(a)); the curved, double-sided and ladder ecological sound barrier is used in Chang-ji Highway in Hunan Province(Seen in figure 1(b)); the inclined plate, box, modular and cage ecological sound barrier is used in Chang-xiang Highway in Hunan Province (Seen in figure 1(c)); the cage ecological sound barrier is used in Gui-wu Highway in Hunan Province (Seen in figure 1(d)); the block road sound barrier of Si-xiao Highway in Yunnan Province, etc.
2.2 Vines at the bottom of the sound barrier climb to the wall to form an ecological sound barrier

The sound barrier of Guizhou College section built on Guizhou-Huanghe highway is made of ceramist concrete block, concrete trough (filling with grooves), and climbing plants are planted in front and back of the wall to form a typical green wall (Seen in figure 2(a)). In addition, the eco-sound barrier of reinforced soil is used in Yu-zhan highway (Guangdong section), and vegetation is also planted on the surface (Seen in figure 2(b)). These "wall-like" ecological sound barriers are mostly composed of lightweight bricks and climbing plants [5].
2.3 Other major type
The research and improvement of visual compatibility of sound barrier in the United States is not to raise the height of sound barrier rigidly, but through changing the shape, adopting appropriate structure and size, color of sound barrier, greening and other measures. There are many ecological sound barriers in Germany, which are composed of blocks and various components of biological sound barriers. There are many ecological sound barriers planted on concrete blocks in Italy. The sound barrier wall is thicker, more than 40 cm. It has good sound insulation, easy to coordinate with the environment in landscape and low cost. The Australian earth embankment + concrete wall eco-sound barrier is ubiquitous in its highway construction.

3. Noise reduction effect
According to the types of ecological noise barrier, the construction scale, noise reduction effect and highway traffic volume of typical ecological noise barrier in China were measured and investigated.

In the investigation, we tested the noise reduction effect of five types of ecological noise barriers on three highways (Seen in figure 3) [6, 7].

Figure 3. Current situation of barriers
Table 1. The noise reduction of barriers

| Position & Type | Scale m | Time  | Noise Reduction LAeq dB(A) | Insert Loss dB(A) | traffic volume /h |
|-----------------|---------|-------|---------------------------|-------------------|-------------------|
|                 |         |       | Front 1m | Back 1m                  |                   |                   |
| G56 K1055 Trapezoid | 3×140   | day   | 74.7 | 58.1 | 16.6 | 1668 |
| G56 K1187 Trapezoid | 3×180   | day   | 77.7 | 64.4 | 13.3 | 1680 |
| S61 K181 Box      | 3×300   | day   | 75.4 | 65.5 | 9.9  | 1860 |
| G75 K2256 Reinforced soil | 2.5×355 | day | 76.1 | 57.5 | 18.6 | 1212 |
| G75 High Slope Embankment | 6×150 | day | 71.9 | 57.9 | 14.0 | 1512 |

From table 1, it can be seen that the LAeq of reference points at 1.2m in front of the barrier and 1.2m in back of the screen are 71.9-77.7dB and 57.5-65.5dB respectively, and the insertion loss is around 9.9-18.6dB. These barriers are thicker, ranging from 0.4m to 1.0m. The bottom of the screens is even 2.0m thick, and the narrowest part of the top is 1.0m wide.

4. Research on the Development Trend of Ecological Sound Barrier

4.1 Development history

China has experienced a gradual optimization process of sound barrier development. When the noise barrier was built in 1990s, it was mostly made of colored steel plate. Because of the limitation of national economy and weak environmental protection consciousness, there were few complaints about visual disharmony and noise reduction effect, and there was little research on the content of ecological road noise barrier.

Over the past 15 years, various types of ecological sound barriers have gradually emerged in the southern region. Planting on the back, front or top of the sound barrier for greening, or planting flowers and plants or vines near the foundation, makes the shape of the sound barrier more soft and more popular.

4.2 Advantages and disadvantages

Advantages: low investment, resource utilization, good landscape, good ecosystem cycle, etc.

It can increase the psychological and physiological comfort of the passengers and residents around the noise barrier inside and outside the highway land. In today's advocacy of "green highway, environmental protection highway", the sound barrier of ecological highway can not only sound insulation and noise reduction, but also blend with the surrounding nature, which is highly consistent with the development direction of "green environmental protection".

Disadvantages: Field investigation shows that the survival rate of greening plants in the sound barrier of ecological highway is a headache. It is only applicable to rainy areas in the south, but difficult to adopt in the north or other arid and semi-arid areas.

Even in Hunan Province, there are also patches of dead plants in some sections of the ecological sound barrier, which has no drip irrigation system. If drip irrigation system is installed, the maintenance cost will be greatly increased. In addition, plant screening is also a long-term topic.

Finally, the components of the ecological sound barrier may not be industrialized, and the site construction is more cumbersome.

4.3 Development trend

4.3.1. Green. It is not only the best way to integrate the sound barrier into the surrounding landscape, but also provides additional noise absorption and attenuation to regulate the micro-environment climate. When introducing regional cultural characteristics appropriately, the user's sensory comfort is better.
4.3.2. Environmental protection of materials. Its construction materials are environmentally friendly in the whole life cycle of production, use and abandonment. Renewable and recyclable materials are the preferred choice of ecological sound barrier materials.

4.3.3. Good economic benefits. The economic benefit of sound barrier is the direct factor affecting the construction of sound barrier. This is closely related to material selection, structure, land occupation and maintenance. Low cost, stable structure, less land occupation and easy maintenance. That is to say, its construction and operation have good economic benefits, which can reflect the economic advantages of the ecological sound barrier.

5. Conclusion
The optimization and improvement of the ecological sound barrier mainly includes the improvement of the structure, components and materials of the sound barrier, and the improvement of the overall shape. The future direction of development is as follows:
- Landscape: In addition to making the sound barrier sound insulation function, began to pay attention to the sound barrier green landscape beautification function, its appearance is pleasant, ornamental, and environmental harmony of the sound barrier.
- Simple structure: Improve the structure of noise barrier, in addition to focusing on improving its frame structure, so that its field installation is simple and convenient, reducing unnecessary links.
- Low cost: suitable for large-scale production line, suitable for pre-pouring of factory moulds, ensuring quality and reducing costs.
- Durability: Improve its materials, reduce maintenance costs and extend its service life.

Traffic noise reduction industry should keep pace with the national vigorously advocating the construction of ecological civilization, make full use of waste and recycled materials, promote the industrialization and engineering of the development of new materials of ecological sound barrier, so as to further enhance the effect of pollution prevention and control of highway infrastructure, promote the green and sustainable development of highway construction, and promote the construction of harmonious and beautiful society.

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