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Research Article

Analysis of Noise and Vibration in Subway Station Hall

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Abstract: This study use noise and vibration analytical system to test and analyze the noise and vibration of subway station hall, draw the conclusion: analysis the noise test results when the vehicles through the subway station hall. The noise rises as the frequency increases, gets the peak value nearby 5000 Hz, the high of test point gives lesser influence to noise contribution. The vibration occurred in low frequency range, get the peak value in the frequency band from 70 to 80 Hz. Learn from the test position, the noise and vibration nearby escalator are higher than the other positions, that's because of the vibration and shock come into the escalator moving. The test results above offer the basis to for the subway station hall's vibration damping and noise reduction design.

Keywords: Noise, station hall, subway station, test, vibration

INTRODUCTION

With China's rapidly economic growing and urban population increasing, the problem of urban road traffic in million city became more prominent. Every street crowded, all the roads choked. It has become the real reflection of traffic state in China's large city. Especially in the 90s, the high speed economic growth in china stimulated the development of city traffic. The development of the car industry bring the number of cars and the rapid growth of the urban road traffic and the result caused the increase of urban road noise, serious interference a school, hospital, residential areas and the normal life and working organs and work order on both sides of the road, traffic noise as a kind of noise pollution, with air pollution, water pollution, has become the harm of the human environment pollution. At present, the urban road traffic noise pollution has become the "hot spots" one of the problems of a urban environmental management. At the present of economy growing rapidly, city as the economic, political and cultural activity center for people has a high attraction. But the problem of urban traffic becomes more extrusive, mainly displays in the following aspects (Ma, 2004).

Unreasonable structure of urban transportation tools: According to the regularity and experience of international urban construction, the size of urban population below 500,000 usually uses the public transit as main travel tools; the size of urban population between 500,000 and 1000,000 needs to build rail transit system as medium traffic capacity; the size of urban population above 1000,000 needs to build underground railway. Our country's public transit has low passenger capacity, the phenomenon of crowed in vehicle is serious and the way of solution at present is to increase the vehicle for improving the density. But it brought more serious problem, the speed of vehicle slowed down and the traffic jams phenomenon became more serious, the commute time is more than 1 h or even more.

Frequent traffic accident in urban road: Due to the large population and high density in city, also lack of public traffic system with high capacity, it makes our country's big city has the phenomena of hard riding, low speed and much traffic accident. Our country's city kept up a high rate of traffic accident happening.

Small density of urban road network and low area ratio of urban road: The road construction in many cities can't catch up the speed of urban development and the urban road system was not transformed in large scale, so that our country's urban road density is small and the road area ratio is low. And many commercial centers of the big cities are in the heavy traffic, passenger flow concentrated central region .For historical reasons, the region's roads are narrow and many of the busy traffic crossing has not been transformed into the overpass type .That makes the

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urban traffic is overcrowding and usually results in congestion (Jiang, 2001; Yan and Fu, 2008).

Seriously urban environmental pollution: Referring to related reports, 20% of the CO2 which was discharged into the air came from motor vehicle exhaust emission, 70% urban pollutants is brought about vehicle. Also the development of the automobile industry brought about the increase rapidly of the number of vehicles and the urban traffic volume, the result made the increase of urban road noise, interfered with the normal work and daily life who the people living near the both sides of road, the problem of urban road noise has become one of the most one which people pay much attention to. As our country enlarges urban size, the traffic noise problem will gradually be as the important factor for interacting on the increases of urban people living quality.

The social and economic impact of traffic noise: The traffic noise will also affect economic development along the line. The data makes it clear, the traffic noise every rise 1 dB (A), the land price will drop 0.08~1.26%, an average of about 0.9%. On the other hand, traffic noise reduce 1 dB (A), land rise 0.9% in value.

According to the experience of foreign urban construction, in recent years, in order to reduce the urban road traffic noise, each country took many measures, which mainly has: construct noise barriers and laid much of asphalt pavement, planting green belts of noise reduction.

The function of noise barriers is stop the spread of the direct sound, reduce the transmission voice reach the sound points and let the diffraction sound has enough attenuation. Its advantage is saving land, noise reduction obvious, can be dismounting. But in practical application there are some problems. For example, if we use close-grained material, it will bring depressive feeling when we drive, if use of transparent material, it is vulnerable to blindfold and reflective, at the same time must clean frequently. More pore of asphalt pavement is that, laid the very high porosity of asphalt mixture on the common road, the porosity is between 15~25%. Can reduce traffic noise 3~8 dB (A). It can not only reduce noise, but improve the drainage performance, can improve the safety driving performance in the wet. But after a period of using, the pore is easily blocked. On the both of urban road sides plants noise reduction green belt, can effectively reduce the noise. At the same time green belt still can absorb carbon dioxide and harmful gas, dust absorption, beautify the environment. The method has a good ecological benefit, but covers more, has not significant effect of noise reduction in the early (Wang, 1992).

According to analyze the measure like that, the construction noise barriers, laid more pore of asphalt pavement, planting noise reduction green belt, combined with city road traffic noise specific situation, in the present case, in the big cities built the subway is one of the main measure to solve the traffic problems of city.

This study use noise and vibration analytical system to test and analyze the noise and vibration of subway station hall, draw the conclusion: analysis the noise test results when the vehicles through the subway station hall. The noise rises as the frequency increases, gets the peak value nearby 5000 Hz, the high of test point gives lesser influence to noise contribution. The vibration occurred in low frequency range, get the peak value in the frequency band from 70 to 80 Hz. Learn from the test position, the noise and vibration nearby escalator are higher than the other positions, that's because of the vibration and shock come into the escalator moving. The test results above offer the basis to for the subway station hall's vibration damping and noise reduction design.

ADVANTAGE AND PROBLEMS OF SUBWAY CONSTRUCTION

Advantage of subway construction: Subway is used extensively in the world, that's because of the short train running interval and high running speed of subway; also it has more train formation and high traffic capacity. Underground railway has its special traffic lane for running, is uninterrupted by the other vehicle, doesn't has the phenomenon of traffic jams; it can run as the schedule, ensure the safe, on time and unaffected by climate. In view of the traffic above ground and the cost of land is high, the development of underground railway can ease the traffic pressure above land and also it can improve the urban landscape. But now it has many problems of subway construction.

Problems of subway construction:

High construction cost: Because the subway construction is in underground, during the construction process, involving tunnel dug, line construction, power supply, communication signals, water quality, ventilation, lighting and wet process and so on are a series of technical problems and most of the subway lines, equipments are in the underground and urban underground with all kinds of pipeline will increase the difficulty in construction, especially in the underground intersection, the station, must fully consider the support strength, to strengthen the underground tunnel. In addition, also must consider the fire disaster relief, shelter facilities all needs to invest a lot of money, therefore, per km construction cost higher (Gu, 2000).

Long construction period: Because its construction content is more, the technology is complex, bring a long construction period, the surrounding environment and the ground traffic will be affected greatly. Therefore, during the subway construction period we

will solve traffic on roads, at the same time the environment noise can certain affect us.

Inconvenience to change: With the increasing depth, will bring the interchange between each line and the ground station, bring a lot of inconvenience, especially modern subway station, considering the contact among ground traffic and department store, the grocery store, building, it can increase a lot of station exports, passengers will lack a sense of direction when they walk in the underground, despite various guidance equipment and sign, still will be inconvenient to change, increase the transfer time.

Need more perfect disaster prevention system: Underground railway is different from traffic on roads, in the event of an earthquake and fire, passengers` life will be threaten, so the subway must have perfect disaster prevention and disaster relief system, bring the security to the passengers. These devices not only will add to the cost, but also increase the technical difficulties.

Difficulty of refrigeration, air conditioning: Because the train running time increases, the vehicle operation and passengers heat dissipation, temperature of tunnel rising, drop comfort in the stations and the car, sultry are increased, but the station is a open system, the space is large, refrigeration is difficulty, because open the door by the frequent number, make the vehicle volume of refrigeration and air conditioning increasing (Liu, 2006).

With the development of scientific technology, after a long time of study and experiment, the above problems are solved completely, but the subway noise problems as strengthening of environmental protection consciousness, be paid much attention to by the people, put forward higher request for the design and construction department.

HARM AND INFLUENCE OF NOISE

The people who live and work in the high noise environment for long term, due to the noise stimulus without break, their ears will have the organic pathological change easily and result the decline in hearing. If people live a long time in the high noise environment, accumulated, the inner ear organ is stimulated by the noise constantly, to have the organic pathological change, is the noise induced deafness. The noise induced deafness can't be cured. At the same time, noise has seriously impact to human health. The noise acts on people nervous system, which may result in headache, head spinning, tinnitus, insomnia, body fatigue; when act on the cardiovascular system, it makes sympathetic nervous tension, consequently make people heart beating faster, arrhythmia, raise blood pressure and so on; when act on the digestive system, may cause upset stomachs. Compare with the people who work in the common environment, the people who work in the high noise environment have 2~3 times to fall ill as high blood pressure, atherosclerosis and coronary heart disease. In the meantime of affecting people's health, the urban road traffic noise also affect the economic development along. Data show that the land price will reduce about 0.08~1.26% when the noise increases per 1 dB (A). On the other hand, make the traffic noise to reduce 1 dB (A) and the price of the land along the line will increase 0.9%.

In order to solve the influence to people's health from subway noise, the first to go into the test and analyze of the subway noise and vibration, find out the influence factor and offer the basis of subway vibration damping and noise reduction.

TEST AND ANALYSIS

Main test equipment: The test equipment uses the noise and vibration analysis system. This system mainly consist of SQLab II multichannel data collecting forepart, HMS III signal collector for both ears, HPS IV digit playback system, microphone and vibratory accelerometer. SQLab II multichannel collecting forepart and HPS IV digit playback system are shown in Fig. 1 and 2. Microphones and vibration accelerometer are shown in Fig. 3.

Fig. 1: Data collecting logger and forepart

Fig. 2: HPS IV digit playback system

Fig. 3: Microphone and accelerometer

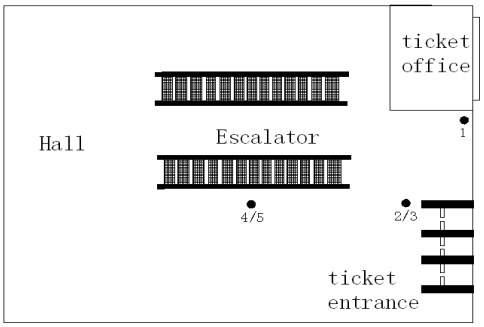

Fig. 4: Noise test points

Test environment: The test environment is in the subway station hall, the environment is closed, more people, More noisy, the noise effect is obvious for the past the pedestrian and passengers. The layout structure of subway station hall is mainly maked up by the following several parts:

- **The underground passage:** Connect the road ends, facilitate pedestrian across the street.
- **The ticket office and ticket machine:** This part is due to subway passengers have to pass and stop, so there are more people and noise is larger.
- **The ticket entrance:** The only way passengers must be passed into the station hall, down to the platform, more crowded, is the main noise source of the hall.
- **Elevator:** The channel passengers go in and out of the platform, the noise when the elevator running is the main noise source of hall.

This experiment tests and analyses the main noise source of the environment. In addition to the subway environmental noise and the noise when vehicle get through, the test will test the vibration of the hall ground, study the influence of the hall vibration when vehicle get through the station . Through the above noise and vibration test, it provides the theory basis for more in-depth research.

Noise test point: To research the main location of usually coming in and going out in the subway station hall when passengers take the subway, setting a test point in the ticket office, the height is 1.6 m; in view of the difference height of people, setting 2 test points in the ticket entrance, the height are 1.2 and 1.6 m; setting 2 test points in the elevator, the distance of the middle elevator is 1 m, the height are 1.6 and 1.2 m. The specific test points are shown in Fig. 4.

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Table 1: Noise value of different test points

Test points	1	2	3	4	5
SPL/dB(A)	62.8	63.1	62.6	63.9	63.2

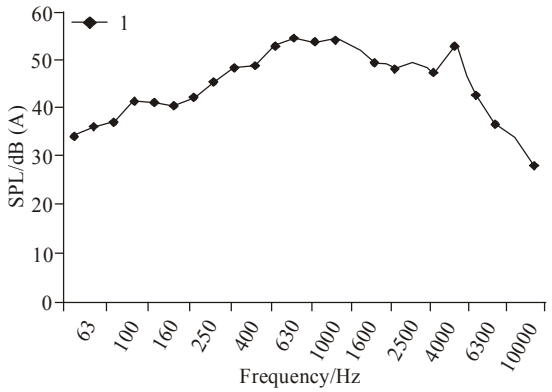

Fig. 5: Noise frequency spectrogram of wicket

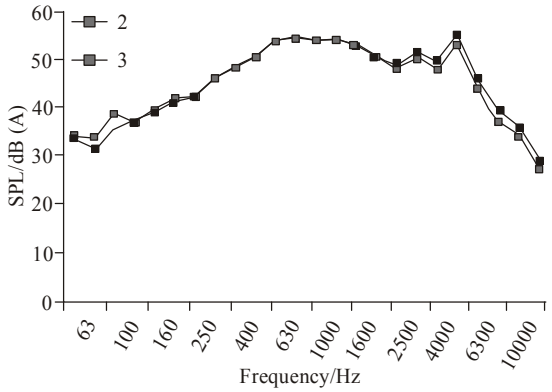

Fig. 6: Noise frequency spectrogram of ticket entrance

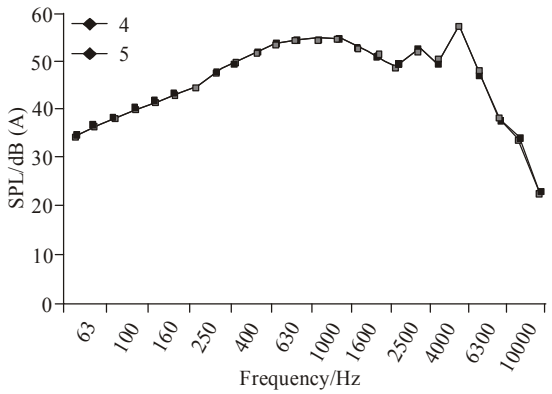

Fig. 7: Noise frequency spectrogram of escalator

Analysis of environmental noise test: The size and spectrum of the points in the subway station hall are shown in Table 1, Fig. 5-7. From Fig. 5 to 7 we may

Table 2: Noise value of hall when vehicle gets through

Test points	1	2	3	4	5
SPL/dB(A)	66.3	67.5	66.8	68.4	68.3

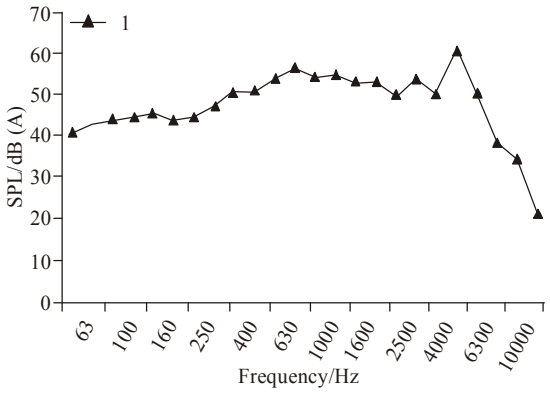

Fig. 8: Noise test spectrum nearby the ticket office when the vehicle pass the station

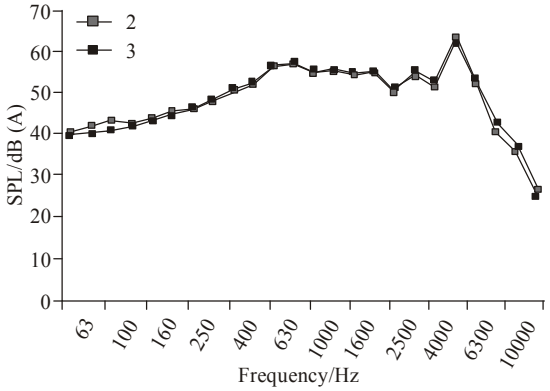

Fig. 9: Noise test spectrum nearby the ticket entrance

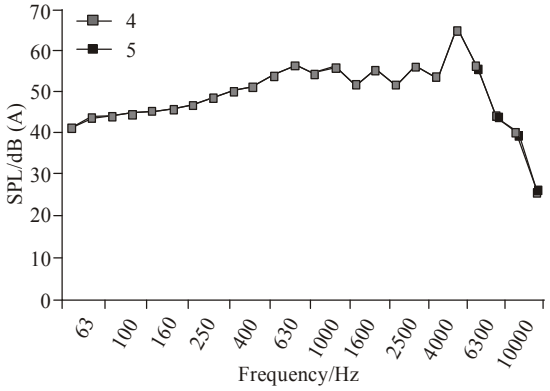

Fig. 10: Noise test spectrum nearby the escalator when the vehicle pass the station

see: the noise rises as the frequency increases in the low frequency range, coming into the peak value near the 1000 Hz; In high frequency range, the noise value gradually reduced only appears peak value near the 5000 Hz. There is not much difference of noise between the ticket office and ticket entrance; see from the other test points, the noise near the escalator is higher than the other place; the height of the test point has little influence to the noise.

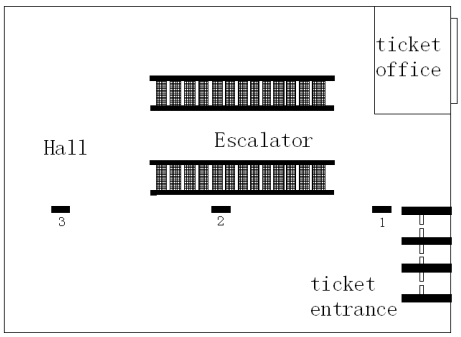

Fig. 11: Vibration test points

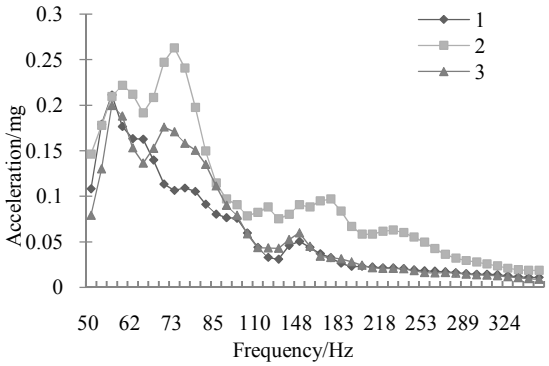

Fig. 12: Spectral of vibration test

Analysis of noise test when the vehicle gets through: The noise test result when the vehicle get through the subway station is shown in Table 2. When metro vehicle pass the station, the noise spectrum of the test points above are shown in Fig. 8-10. From Fig. 8 to 10 we may see: the noise rises as the frequency increases, coming into the peak value near the 5000 Hz; there is not much different of noise in the ticket office and ticket entrance; see from the other test points, the noise near the escalator is higher than the other place; the height of the test point has little influence to the noise.

Vibration test point setting: In consideration of the influence to the station hall when the subway vehicle pass the station, the 3 vibration test points are in one line, parallel to the railway, the distance of the 3 points is 8m, they are near the ticket office, ticket entrance, escalator. The vibration test point setting in Fig. 11.

The analysis of vibration test: The spectral of vibration test is shown in Fig. 12. In Fig. 12 we may see: the vibration come in the low frequency range, come to the peak value in the range of 70~80 Hz. From

the test place we clearly see that, near the escalator it is higher than the other place, that's mainly because of the vibration and shock when the escalator work.

CONCLUSION

In this study, through the study of the status quo of Environment Impact Assessment index system at home and abroad for Planning, we come to know some about the principles of building index system and indicators to select and how to conduct a comprehensive evaluation of index system, which provides method theory for the establishment of the urban environment construction index and the index system comprehensive evaluation.

Through the study of the basic theory of the environmental impact assessment on planning and basic theory of indicators, we come to know some about the theoretical basis of the urban environment construction index, which lays theoretical foundation for the establishment of the urban environment construction index.

By studying principles of DPSIR model, LCA model and the basic indicator system, indicators construction as well as comparative analysis of the advantages and disadvantages of the 3 index systems, combined with the focus and purpose of the urban environment construction, the author selects the design method of the urban environment construction index.

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