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Acoustical design for rehearsal halls of Guangdong Xing Hai Orchestra

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The rehearsal halls of Guangdong Xinghai Orchestra are exclusive for the orchestra. The rehearsal halls include a main room for western symphony rehearsal and an adjutant room for Chinese national music rehearsal. The acoustical design includes sound insulation, noise control and room acoustics design. Different room acoustics parameters are designed for the two rehearsal halls. After its completion, an acoustical measurement was also taken. Rehearsal performances were held inside both rooms regularly. The musicians of Guangdong Xinghai Orchestra highly appreciate the acoustics of these two rooms. This paper introduces the acoustical design of the rehearsal halls in detail.

1 Introduction

The rehearsal halls of Guangdong Xinghai Orchestra are exclusive for the orchestra. The rehearsal halls include a main room for western symphony rehearsal which can contain about 120 musicians and an adjutant room for national music rehearsal which can contain about 80 musicians. These halls are located in the shore of Pearl river of Guangzhou and near Xinghai Concert Hall.

The construction works for the rehearsal halls of Guangdong Xinghai Orchestra started from March 2007 and the project was completed in Sep. 2009. Outer view of the building is shown in Figure 1. It was designed by Guangzhou Urban Planning & Design Survey Research Institute.



Figure1 Outer view of the rehearsal room building

The acoustical design work was taken by our laboratory. The tasks include sound insulation design, noise control and acoustics design. After its completion, an acoustical measurement was also taken. The measurement results show that the acoustical data met the designing object well. The musicians of Guangdong Xinghai Orchestra highly appreciate the acoustics of these two rooms and these halls are assessed as best rehearsal halls in China.

This paper introduces the acoustical design of the rehearsal halls and the acoustical measurement in detail. The design work for the rehearsal halls can be taken as a reference for similar projects designing.

2 Sound Insulation and Noise Control

A lower background noise level is a prerequisite for a rehearsal room to be a good one. The purpose of the sound insulation designing and noise control for the rehearsal rooms is to satisfy NR-25 standard. All walls of the rehearsal rooms as well as of a sound recording room are brick walls 240mm thick. In addition, inside of the walls, 50mm rock wool felt blanket and another 12mm fiber reinforced gypsum panel are added to increase their sound insulation ability. The floors are 150mm reinforced concrete slabs. All doors connected to the rooms are finished sound proof doors with sound insulation index of 40dB. On the floor of the rooms above the rehearsal rooms a vibration isolated floor layer is set to prevent the disturbance from above rooms.

Serious noise reduction and shock-proof methods are taken for the air-conditioning system such as the choice of lower noise level ventilator, using flexible pipes to connect the vibrating equipment, setting absorption materials inside the ducts to attenuate the sound energy and isolators to support the packaged air-conditioning system and so on. The inlet and outlet air velocities are set to be 2.2m/s and 1.8m/s respectively.

3 Acoustical Design

3.1 Shape layout

The plane of main rehearsal room is a scalene quadrilateral. The side lengths are 22.6m, 20m, 19m and 22m respectively, the height of the room is 10.5m. Figure 2 shows the plane of the main rehearsal room. The plane of another room is a rectangle one, 24.2m in length, 11.8m in width and 7.5m in height. The volume of the main room is 4150m³ and of another room is 2100m³.

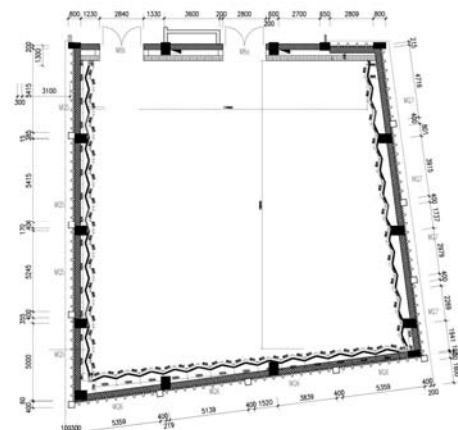


Figure2 Plane of the main rehearsal room

All the heights of both rooms are met the normal requirement of no less than 6m for rehearsal room. The scalene quadrilateral plane of the main room is beneficial to sound diffusion. Moreover, some diffusers with undulating shape and uneven distribution of surface materials with different sound impedance are put on wall surfaces to further increase the diffusion of sound field.

3.2 Object of acoustics design

Because that the purpose of the main room is for the rehearsal of western symphony therefore the occupied reverberation time at medium frequency bands is set to be $1.6 \pm 0.1s$.

Regarding that the main purpose for the adjunct room is for the rehearsal of national music performance, the occupied reverberation time is set to be $1.2 \pm 0.1s$. The RT at lower frequency bands can be a little longer and at higher frequency bands can be a little shorter. These objects are suitable due to the fact that the volumes of both rooms are much less than usual volumes of concert halls.

3.3 Materials and constructions

According to above mentioned objects of RT values and their frequency characters and regarding that the sound fields of rehearsal rooms have to be even and diffusive and be changeable in a certain range, the materials and constructions for the surfaces of main rehearsal rooms are decided as follows.

Floor: wood planks built on stiles.

Ceiling: penetrating lattice so that the sound wave can reach to the concrete slabs. Several plexiglass boards of 10mm thickness and $2 m^2$ area each are hung above the stage to reflect early sound to the stage. But it has not installed until the project is completed.

Wall surfaces:

Stage rear wall: 1/4 area is covered by 25mm finished glass fiber with 50mm gap behind; 3/4 area is covered by 19mm wood planks backed with 50mm glass fiber sheet. The planks are shaped as undulating form and on their surface MLS constructions are covered to further diffuse the sound waves.

Stage side walls: The material and construction are the same as stage rear wall.

At the same time, absorptive curtains are hung on the surface of stage rear wall and side wall to adjust the sound absorption and reduce the loudness due to some percussion instruments when needed.

Stage opposite wall: 60% area is covered by 19mm wood planks backed with 50mm glass fiber sheet; 40% area is covered with 25mm finished glass fiber adhered directly on the wall.

The floor of the adjunct room is also wood planks built on stilts. The ceiling of the room is made of 13mm fiber reinforced gypsum boards. 1/3 surface area of one of long side walls are covered with a special absorptive panel with some stripe gaps. Other 2/3 area is made of 19mm wood planks shaped as undulating form and on the face covered with MLS construction. Behind the planks filled with 50mm glass fiber sheet. Above two materials and constructions are mixed to form regular pattern. Another long side walls are covered with above mentioned absorptive panel with some stripe gaps which possess about 1/2 area. Another 1/2 area of the wall is covered with wood

QRD diffusers. On the walls of two shorter sides, around 1/3 area is covered with special absorptive panel with some stripe gaps, other 2/3 area is made of 19 mm wood planks forming undulating shape and covered with MLS construction. Behind the planks 50mm glass fiber sheet are set.

According to above materials and constructions, we can calculate out the occupied reverberation time at medium frequency bands for the main room is 1.7s, 2.2s at 125Hz, 2.0s at 250Hz, 1.4s at 2kHz and 1.2s at 4kHz. As to the another room, the RT value for occupied situation at medium frequency bands is 1.2s, 1.5s at 125Hz, 1.3s at 250Hz, 1.1s at 2kHz and 0.9s at 4kHz. These data are agreeable to the designed data. Figure 3 shows the innerview of main rehearsal room.



Figure 3 Photo of the main rehearsal room

4 Conclusion

After several usages, the musicians of Guangdong Xinghai Orchestra highly appreciate the acoustics of both rehearsal rooms. They consider that the sound fields of both rooms reach the unification of fullness and clarity and have enough loudness. Nowadays, the Rehearsal Halls of Guangdong Xinghai Orchestra are assessed as the best rehearsal facilities for symphony and national music rehearsal. The decorations of both rooms as well as their acoustics are harmoniously unified and achieve perfect aesthetic effect.

References

- [1] Shuoxian Wu, "Investigation into Acoustics of Chinese National Music Halls". *J of South China Univ of Technology*, 35(S), 17-20 (2007).