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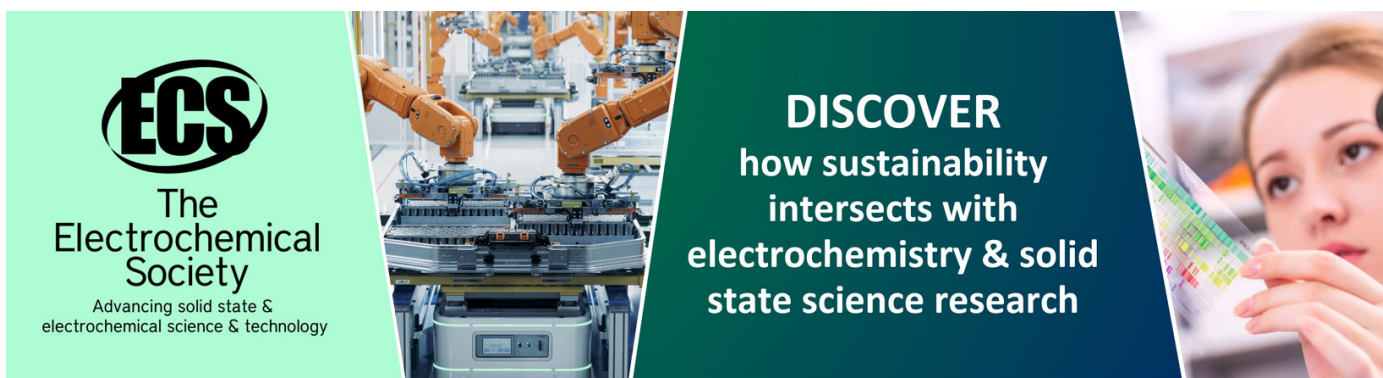
Design and analysis of acoustic reforms of studio

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Design and analysis of acoustic reforms of studio

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Abstract. After evaluating the studio acoustics environment quality and finding problems, related reforms about acoustic were performed, such as consulting the acoustic design code related studio, through testing on background noise, reverberation time, evenness of acoustic field and other acoustic indices at the coalface, making antithesis and analysis. Catching the defects of studio acoustic design implied that: electronic equipment running lead to the background noise in the studio is too large; the interface material in the room sounds absorption is too little, bringing the reverberation time is too long; the wall sounds absorbing material and reflector position is unreasonable begets the lack of evenness of the acoustic field. According to the problems above, a theoretical analysis and calculation of the overall acoustic of the studio was conducted, finally advancing the reforms plan. The reformation plan consists of processing door and window insulate sounds, increasing the sounds absorption of the material in the studio, and arranging a reflector on the side of the wall evenly. Thus, the plan will cater for the requirements of acoustics ultimately and provide technical reference for the design of an acoustic studio in the future.

1. Overview

In recent years, with the continuous development and progress of the society, people have become increasingly demanding of the acoustic environment. In pursuit of better sound quality, more stringent requirements have been set on the design of the recording studio. This project is mainly aimed at acoustic acceptance of established recording studios and found that acoustic requirements cannot be fully met. For this purpose, we carried out corresponding acoustic modifications to meet the functional requirements.

The recording studio is also called the studio. It is a special recording site built by people to create a specific recording environment and acoustic conditions. The main function is to record movies, songs, music, etc. The acoustic characteristics of the recording studio are used for the quality of the recording production and its products. They play a very important role.

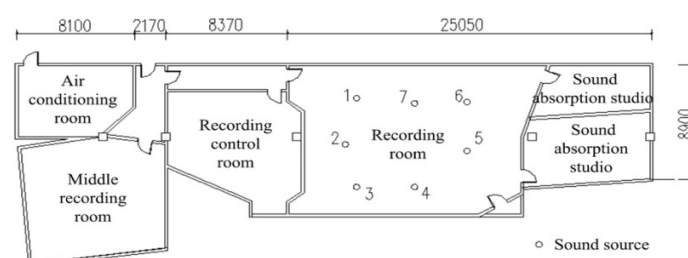


Figure 1. Recording studio floor plan.



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Figure 2. Recording studio interior.

Figure 1 and figure 2 is a Shenyang art school recording studio. In the process of acceptance testing, it was found that there were certain problems in the aspects of background noise, reverberation time, sound field uniformity, etc., which did not achieve the desired acoustic effect and required acoustic modification.

2. Recording studio acoustic design requirements

2.1. Acoustic specifications

- Choosing the appropriate reverberation time based on the indoor area. The recording studio uses short reverberation as much as possible, and the frequency characteristics of the reverberation time require straightness.
- Sound quality requirements are clear and intelligibility is high, followed by good fullness.
- Under use conditions, suppress sound quality defects such as echo, tremor echo, etc.

The specific acoustic technical indicators are as shown in table 1.

Table 1. Acoustic specifications.

Room name	Reverberation time T60 (s)	Noise evaluation curve (NR)	Soundproof door insulation (dB)	Soundproof window insulation (dB)
Recording studio	0.4+0.1S	NR-30	>35	>50

2.2. Recording studio acoustic processing

It is mainly divided into two aspects, one is the control of noise, and the other is the control of reverberation time.

2.2.1. Noise control. The noise of the studio is partly from outside the building; on the other hand, it comes from inside the building, including the noise outside the studio and the noise inside the studio.

There are mainly three ways to spread noise: one is that noise generates vibrations through walls, floors, and ceilings, and transmits sound energy into the recording studio; the other is through the gaps or holes, etc., and enters the recording studio through airborne sound; the third is through the recording studio; the rigid connection of the wall, ceiling or floor with the outside world, through the solid sound into the recording studio.

Treatment methods can be soundproof windows, soundproof doors, composite soundproof walls, and attention should be paid to reducing acoustic bridges, which can reduce the impact of external noise on the recording studio.

2.2.2. Reverberation time control. The reverberation time is the time after the sound field in the room is stable, the sound source suddenly stops sounding, and the sound self-stated sound pressure level is attenuated by 60 dB. In the design of the sound-collecting space, proper reverberation time makes the music full and contagious. Too short reverberation time makes the sound dry and ineffective; long reverberation time makes the speech intelligibility lower, and the sound quality lacks rhythm and intensity, so we must choose an optimal reverberation time.

2.3. Material selection instructions

The acoustic design of the recording studio adopts green, flame-retardant materials and should meet the requirements of the domestic industry. As the studio is a television technology room, in order to ensure quality, especially to ensure the acoustic index, the selected materials must have good decorative and acoustic properties.

3. Recording studio acoustic test

3.1. Background noise

In the recording studio, four points were evenly distributed to test the noise level at each point. Compared with the acoustic standards, it was found that the air-conditioning room was not opened and the background noise met the requirements; the air-conditioning room was turned on, and the background noise did not meet the requirements. The measured data are shown in table 2.

Table 2. Recording studio background noise.

Position	Position 1	Position 2	Position 3	Position4
No noise in the air-conditioning room LA	32.8dB	29.2dB	33.3dB	30.6dB
Air-conditioning room noise LA	42.8dB	39.2dB	39.3dB	36.6dB

It can be seen from the data in the table that, when the recording studio air conditioner is not on, the background noise in the recording studio can basically meet the requirements of the specification. However, when the air conditioner is turned on, the background noise in the studio increases by 2-3 times, and it is completely unable to reach the recording studio. The background noise is standard.

3.2. Background noise

At a wall angle of 1.5 meters from both sides of the wall, a 16-sided non-directional sound source is placed, 7 points are selected in the entire room, and the reverberation time of each point is tested, and it is found that the high frequency reverberation time of the recording studio is also problematic. The data is shown in table 3.

Table 3. Studio reverberation time.

Frequency	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6	Position 7
250Hz	0.48s	0.56s	0.42s	0.40s	0.37s	0.51s	0.42s
500Hz	0.42s	0.40s	0.42s	0.37s	0.50s	0.58s	0.40s
1kHz	0.40s	0.35s	0.42s	0.45s	0.53s	0.82s	0.40s
2kHz	0.54s	0.44s	0.51s	0.54s	0.64s	0.55s	0.44s
4kHz	0.52s	0.45s	0.46s	0.47s	0.48s	0.50s	0.48s

According to the measured data, the reverberation time of each frequency in the recording studio is longer, and the reverberation time in the middle and high frequencies is too long. Obviously, this will lead to a more severe impact on the luster effect.

3.3. Acoustic field uniformity

In the recording studio, 4 points were evenly distributed, and the sound pressure level at each frequency was tested. The measured data are shown in table 3.

Table 4. Studio reverberation time.

Frequency	Position 1	Position 2	Position 3	Position 4
250Hz	26.0 dB	25.8 dB	27.9 dB	27.0 dB
500Hz	25.8 dB	22.5 dB	26.5 dB	25.1 dB
1kHz	22.2 dB	17.6 dB	19.8 dB	19.5 dB
2kHz	18.7 dB	13.8 dB	20.4 dB	14.7 dB
4kHz	14.9 dB	12.0 dB	18.0 dB	9.5 dB

As shown in the sound pressure levels at various points in the table, the high-frequency sound pressure level difference at some points exceeds 3 dB, which means that the sound field uniformity of the recording studio is not ideal, and the uniformity of the high-frequency sound field performance is lower. Although the wall surface in figure 3 was also diffused, the low frequency sound field uniformity is good, but the high frequency effect is not obvious.

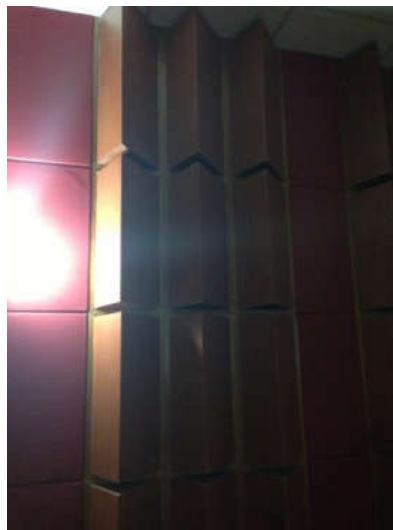


Figure 3. Diffusion

4. Recording studio reforms plan

4.1. Background noise

The effect of the background noise on the recording studio is very important. The main task is to do sound insulation. In particular, sound insulation of doors and windows is the key to noise reduction. The soundproof door is an important part of the recording studio to prevent the influence of outdoor noise. After the plane analysis research and field test, the noise of the recording studio mainly comes from the air conditioning room system, the sound insulation of the wall meets the requirements, and the door cannot meet the sound insulation requirements. Soundproof doors can reduce the noise impact on the interior of the studio.

- The quality of the main body of the soundproof door in the recording studio is increased. According to the quality law, the sound insulation performance is improved; the frequency of the materials in the inner layers is staggered to avoid the “blind effect”.
- Between the door panels filled with ultra-fine glass wool, to ensure the integrity, cannot be broken cotton, improve sound absorption properties.

- Interlayer connections add damping material to suppress vibration transmission and avoid acoustic bridges.
- Closed treatment is required between the door frame and the wall surface, as well as between the door leaf and the door frame, to ensure closeness.
- The original design used a soundproof window, as shown in figure 4. Four layers of glass are used, and the layers are not parallel and the thickness of the glass is not the same. However, sound absorption materials are not well arranged on the window sill between the glass, resulting in poor sound insulation effect. The modification scheme is as shown in figure 5, and the sound absorption material between the window frames is increased.



Figure 4. Soundproof window.

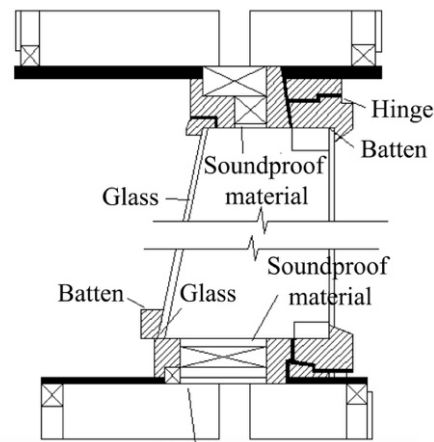


Figure 5. Soundproof window reforms plan.

After the reform, soundproof doors and soundproof windows are shown in Figure 6.



Figure 6. Soundproof door and window.

4.2. Reverberation time

As shown in figure 2, the top of the recording studio is made of mineral wool board, and the walls are pasted with thin sheets of outer cover fiber fabrics. As shown in table 2, indoor high-frequency reverberation takes a long time, and extra porous glass wool felt, mineral wool felt, and other porous sound-absorbing materials need to be added, including glass fiber cloth and other breathable properties, but also a certain strength of the material for the surface layer, through the high frequency sound reverberation time calculation, reducing the indoor high frequency reverberation time. After the reform, the indoor effect is shown in figure 7.



Figure 7. Recording studio interior after reform.

4.3. Acoustic field uniformity

Reproduce part of the walls of the recording studio: The diffuser and the sound-absorbing material are evenly arranged on the two side walls so as to avoid large areas of parallel and opposite acoustic reflection surfaces, so that the uniformity of the indoor sound field can be optimized. After the reform, the indoor effects shown in figure 8.

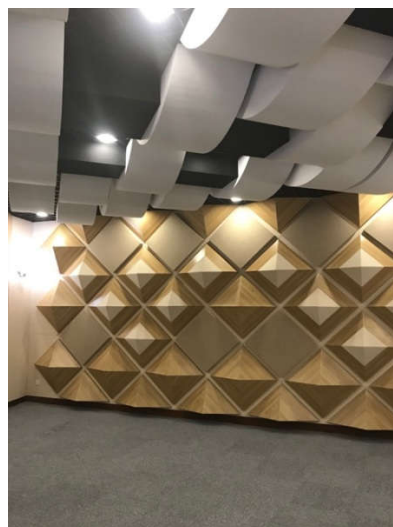


Figure 8. Recording studio interior after reform.

5. Conclusion

By processing the sound insulation of doors and windows, increasing the sound absorption performance of sound-absorbing materials, and evenly spreading diffusers on the side walls, the existing problems in the recording studio are solved, the background noise is reduced, the reverberation time is reduced, and the sound field uniformity is increased, with the degrees ultimately meeting studio acoustics requirements. The retrofit program provides technical reference for the acoustic design of the recording studio in the future.

Acknowledgments

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