

攝影棚之聲場模擬及性能驗證

Acoustical Simulation and Performance Evaluation of the Studio Room

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摘要

攝影棚之聲學性能需兼具建築物聲學及室內聲學之要求。藉由電腦工程算式預估及電腦商用軟體模擬，計算所需之隔音量、吸音量、減振量及聲場指標，選擇適當之隔音材、吸音材及減振材，並經過雙耳可聽化之模擬聲場主觀聆聽，作為整體設計之最終調適。完工後之性能驗證結果顯示，空調系統啟動且流速於 1m/s 以上之空調背景噪音 NR 值分佈於 NR-20~NR-25；聲場不均勻度分佈於-2.5~+2.8 dB；現場樓板音等級分佈於 L'w-28~L'w-29；大小型隔音門隔音量分佈於 R'w-52~R'w-55；兩攝影棚間隔音量 R'w-67；副控室與攝影棚間隔音牆之隔音量 R'w-58。副控室及成音室內於 125Hz~4k Hz 倍頻帶之迴響時間，分佈於 0.08~0.35 秒；大型攝影綜藝棚有天幕條件下，於 125Hz~4k Hz 倍頻帶之迴響時間，分佈於 0.84~1.11 秒；大型、中型攝影戲劇棚無/有天幕條件下，於 125Hz~4k Hz 倍頻帶之迴響時間，分佈於 0.45~0.95 秒，各類型減振器之減振效果均可達 85% 以上之效果。測試結果顯示攝影棚之聲場性能滿足需求及合約所定標準。

關鍵字： 隔音、吸音、迴響時間、聲場、樓板音

Abstract

Both of the problems of building acoustics and room acoustics shall be solved for achieving the sound quality requirements inside the TV studio room. The quantities of sound insulation, sound absorption and vibration isolation by the strategies of building acoustic and engineering principles answers of first problem. The prediction of the sound field and auralization psychoacoustic by listening of audio engineers solves the second question. The performance evaluation by ISO testing procedures proves the efficiency of above efforts. The background noise of NR-20~NR-25 be achieved during operation the duct system above the velocity flow 1 m/s, the in-site floor impact noise rating between L'w-28~L'w-29, sound insulation rating of doors and walls between R'w-52~R'w-67, the reverberation time for different volume of control rooms and studio rooms between 0.08~0.35 second and 0.45~1.11 second respectively, the isolation efficiency is above 85% for vibration isolator. All of the above testing results show the high quality of sound recording environment is ready inside the studio room.

Keywords : sound insulation, sound absorption, reverberation time, sound field, floor impact noise, studio room.

Introduction

The advanced digital technology of broadcasting grows up quickly day after day. The audio and video quality of the hardware and software should be update to follow the market requirements. The Gala TV is one of the famous Cable Television Companies in Taiwan. For tracing such high quality steps of competitive market and supply the best services to the client, the new building of the studio and office rooms built up at the Taipei since year 2005. The integration of the lighting, audio, video, acoustics and vibration control technologies into this digitalized intelligent building opened its operation at year 2007. The topic of this paper talks about the experiences of the acoustical and vibration control of facilities to get the nice sound field inside the studio and sensitivities rooms such as for meeting and conferences.

Performance Requirements of the Studio Room

The most important performance requirements of the new building focus on the studio rooms with sub-control and conference rooms. The acoustical conditions include the suitable RT with the cycloramas, the high sound absorption coefficient of material panel with airspace for achieving the RT requirement, low background noise rating NR-25 of operating the air conditioning system, sound insulation of the material should be higher than Rw-55 for wall and door, the vibration isolation should choose above the 90% efficiency. The floating floor installs above the concrete base for enclosure as the house in house design, the Lw-45 inside the room is the basic environment. The final acceptance testing of the in-site should satisfy above qualities by standards, it is reasonable the 5 dB and 10% tolerance for the sound insulation and vibration isolation.

All of the exciting movers such as the chiller, AHU, pump, motor, transformer, power generator, cooling tower, elevator, fan-coil, fan and blower locate the installation points as far away the sensitive rooms. The rubber, spring isolator insert between above machineries and base by ways of hanger or mount for breaking down the propagation of the structure-borne noise.

The background noise measurement in-site during the construction at different floors for evaluating the heavy traffic noise and fly-over noise by airlines, such measuring data be analyzed and evaluate the cost-effective of the sound insulation material. All of the materials should run the testing by national acoustical laboratories in Taiwan for showing the performance of sound insulation before the installation. The testing procedures follow the ISO 140-3, ISO 140-6, ISO 354, and the single number quantity rating announces the performance by ISO 717-1, ISO 717-2 and ISO 11654.

Acoustical Simulation and Auralization of the Sound Field

The sound and vibration problems of the building acoustic could solve by multi-layer insulation, silencers and isolators. But the audio recording quality depends on the volume, shape, absorption and reflection with diffusivity. The different shape of the cycloramas of C, U, J types with or without the sloped line by commercial acoustical software simulate the optimal combination of the dimension and absorption panel for wall and ceiling. The sound absorption coefficient of material measured on the big reverberation room of the national level of acoustical laboratory. The calibrating data by measuring reverberation time in-site of the empty and full studio room improved the prediction accuracy. The figure 1 shows parts of the simulation results by the ray tracing method to calculate the optimal reverberation time and material layout.

The benefits of the acoustical simulation can get the quantities trend of the different strategies and auralization. The auralization wave files can replay and let the people to listen the sound feeling before the installation of the reality. The psychoacoustic of the prefer testing by headphone test for the audio mixing engineers, supervisor and conductors through above combination of the material and shape of the cycloramas. The best feeling of the sound field will be assign as the engineering way to confirm the final dimension and material specification.

Performance Acceptance Testing of Engineering

The acceptance testing runs the performance verification by following the contract and ISO standards which ISO 140-4 and ISO 140-7. The testing equipments include B&K Pulse System 3560C, B&K Omni-Power Sound Source 4296, B&K Power Amplifier 2716, B&K Tapping Machine 3207, B&K Calibrator 4231 for microphone system, B&K 4294 Calibrator for accelerometer system, B&K Microphone 4189, B&K Preamplifier 2671, B&K Accelerometer 4370. The analysis software uses the B&K 7701 Data Recorder, B&K 7705 Time Capture, B&K Pulse Bridge to Matlab 7755B, Sound Quality B&K 76998, Noise and Vibration Analysis B&K 7700, FFT Analysis B&K 7770, CPB Analysis B&K 7771, Microsoft Excel and Matlab. The special sound source with high level by Mixer Yamaha LS9, Power Amplifier Yamaha PC9500, Speaker Next X15, Next LAS218 used to evaluate the sound insulation of low frequency bad.

The example of the testing layout inside of the studio is the five measuring points as the figure2. The reverberation time, impulse response, sound pressure level based on these measurements takes the average data for comparing with the rating of the requirement. The NR curve of the background noise under the air-conditioning system operate at the high speed condition as the figure 3, the $L'w$ and $R'w$ of octave band data as the figure 4~6 are the typical sound insulation results of door and wall between rooms, and the RT of each octave band inside the studio room and sub-control room as the figure 7 and 8, and. The vibration isolation can be efficiency by comparing the decay of the vibration energy as the figure 9. All of the results demo the satisfactions of the goal.

Conclusion

There are five studio rooms build up inside this 10 floors building, One biggest studio room for cinema, two medium size studios for drama and talk show, two other small size studios for TV-News. The acoustical environment of such studio room plan and design by logical philosophy through investigation of background data, feedback testing between simulation and psychoacoustic response, decide the final engineering strategy by cost-effective material. The final performance testing show the NR-20~NR-25 be achieved during operation the duct system above the velocity flow 1 m/s, the in-site floor impact noise rating between $L'w$ -28~ $L'w$ -29, sound insulation rating of doors and walls between $R'w$ -52~ $R'w$ -67, the reverberation time for different volume of control rooms and studio rooms between 0.08~0.35 second and 0.45~1.11 second respectively, the isolation efficiency is above 85% for vibration isolator which satisfy the contract's requirement for nice sound field.

Acknowledgement

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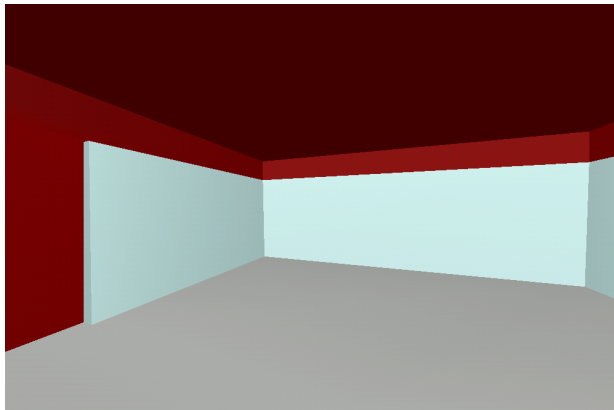


Figure 1 Acoustical Simulation Model

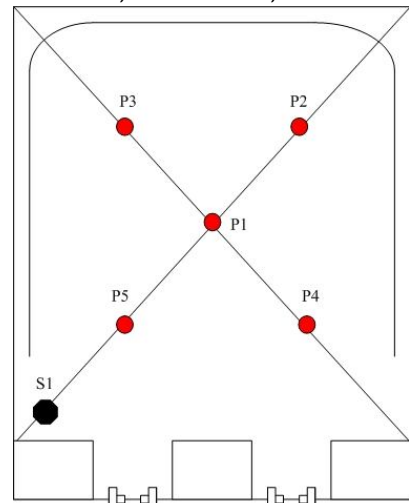


Figure 2 Measurement Points Layout

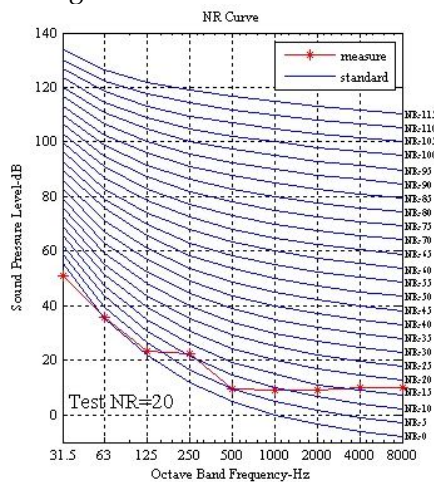


Figure 3 Background Noise of Air-Conditioning

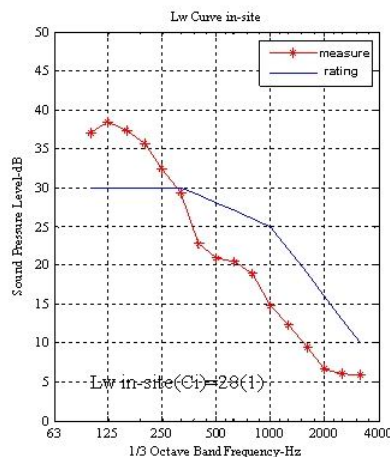


Figure 4 Floor Impact Noise Rating of Floating Floor

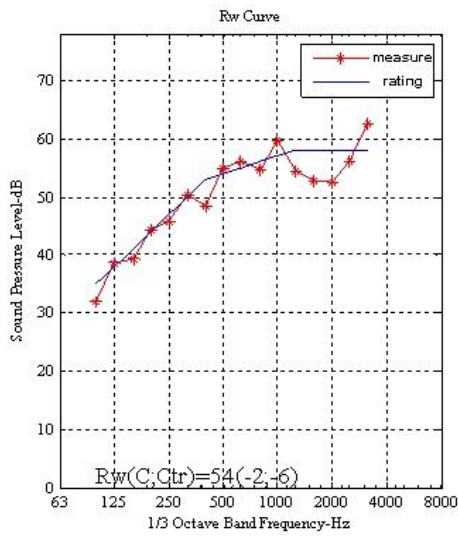


Figure 5 Sound Insulation Rating of Door

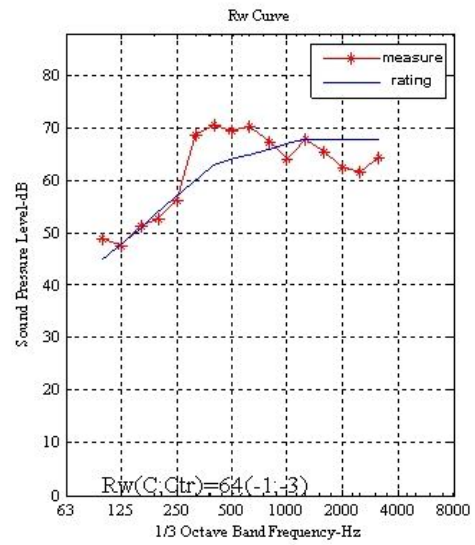


Figure 6 Sound Insulation Rating Between Rooms

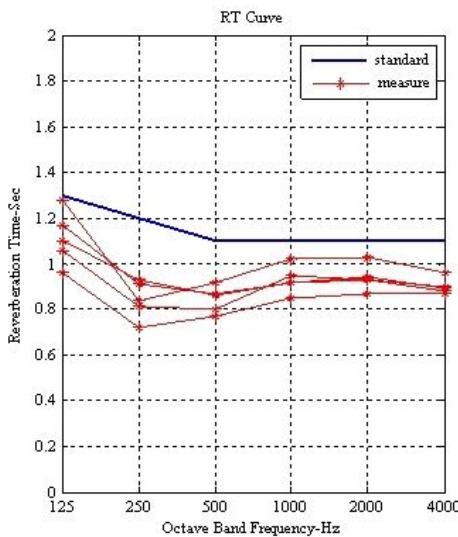


Figure 7 RT time inside of Studio Room with Cycloramas, Figure 8 RT time inside of Studio Room without Cycloramas

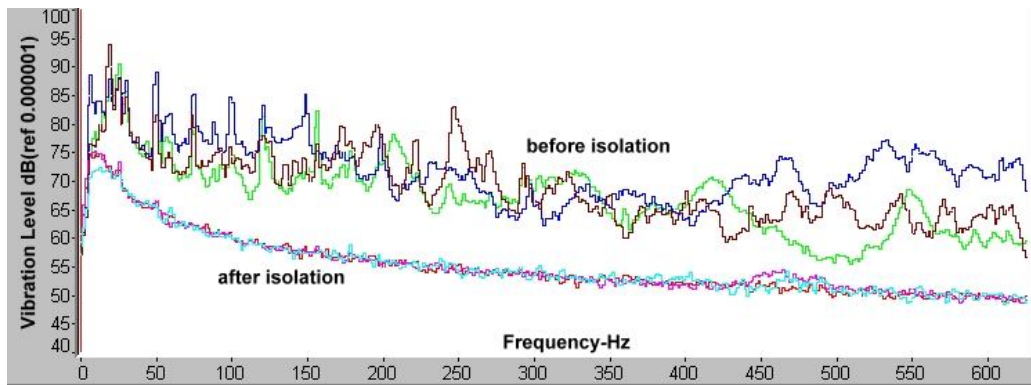
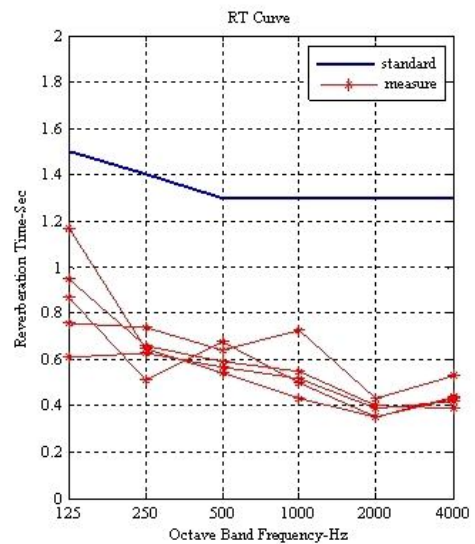


Figure 9 Vibration Isolation Efficiency Comparison of Cooling Tower