Proceedings of 20th International Congress on Acoustics, ICA 2010

23-27 August 2010, Sydney, Australia

Improving the acoustics for classical musicians

S. Dance (1), G. Zepidou (2) and C. Nestoras (1)

(1) The Acoustics Group, FESBE, London South Bank University, Borough Road, London SE1 0AA, UK
(2) Sound Research Laboratories Ltd, 70 Cowcross Street, London EC1M 6EJ, UK

PACS: 43.55 BR

ABSTRACT

Professional orchestra regularly use the same venues whether it is for rehearsals or performances, they also use different spaces depending on the piece, usually either on stage or in an orchestra pit. The stage acoustic has been addressed many times; however, the acoustic of rehearsal spaces and pits has been largely ignored. The London Philharmonic Orchestra regularly performs or rehearses at the Royal Festival Hall, Glyndebourne, Brighton Dome and Henry Wood Hall. This paper presents room acoustics measurements, proposals and implemented solutions using noise control techniques in the four venues. The primary aim was to improve the environment for the musicians. The effectiveness of the improvements is presented.

INTRODUCTION

Architects have spent time on the look and feel of an auditorium. Little time has been spent on the acoustic for the orchestra. This paper demonstrates the quantitative improvements in the acoustic for the orchestra that are possible at reasonable cost. Some of the spaces have been used for orchestral rehearsals that were not originally designed for this purpose, e.g. Henry Wood Hall was a church and Brighton Dome was not designed for symphony orchestras. The Royal Festival Hall was renovated in 2006-7 to improve the natural acoustic of the auditorium and the stage acoustic for the musicians. Glyndebourne Opera House is a beautiful auditorium but little consideration was given to the orchestra pit, which is the heart of any performance. The Acoustics Group of London South Bank University were asked by the London Philharmonic Orchestra (LPO) to help improve the acoustics of the halls they regularly visit.

A WinMLS computer based measurement system was used to ascertain the room response [1]. The software acquired the data through an Earthworks omni-diectional measurement microphone from the output of an amplified VX pocket Digigram sound card connected to a dodec speaker, see Figure 3.

HENRY WOOD HALL

Henry Wood Hall is the main rehearsal space for the Royal Philharmonia and the LPO. It is a large rectangular hall with high ceilings 1. The orchestral strings play on the floor and the woodwind, brass, percussion and timpani play on a rostrum. The players had complained that the room felt ‘boomy’ and the conductor – Vladimir Jurowski agreed. The management of the hall required a solution. The obvious solution would be to install multiple bass traps to eliminate specific low frequencies; however, the rostrum offered another solution, large amounts of porous absorption, 13m by 4m by 0.8m. In addition, large heavy hanging curtains were used to absorb sound, see Figure 1. Measurements were taken for various curtain configurations at 2 source and 6 receiver locations, as suggested in ISO 18233:2006- application of new measurement method for building and room acoustics, see Figure 2.

Figure 1. Henry Wood Hall with curtains half closed

Figure 2. Average RT in Henry Wood Hall (3 curtain set-ups)

The room acoustic characteristics were measured after the installation of the new dense porous absorption, see Figure 3.

Figure 3. Dense porous material installed under the rostrum

The rostrum was finished by installing up-stands in the style of a 1950 radiogram using acoustically transparent pegboard, see figure 4.

Figure 4. A 1950s radiogram look of Henry Wood Hall

The room's characteristics were remeasured, but this time the auditorium was completely empty, no chairs or music stands. The room's boom can be clearly seen in Figure 5. The result was that the 125 Hz 1/3 octave band was reduced and the mid frequency was increased hence flattening the room response significantly. The conductor was not told about the changes however he noticed and gave positive feedback as to the room's performance.

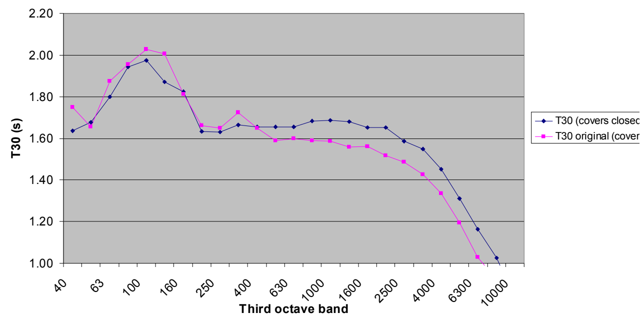

Figure 5. RT measured in Henry Wood Hall pre-and-post installation of the porous absorption.

BRIGHTON DOME

The Brighton Dome was the horse stable of Brighton Pavilion until 1860 when it was converted into a hall 24m by 19m high, see Figure 6. The Dome was refurbished in 2001/2 with a configurable stage suitable for concerts, pop, ballet (with pit) and drama. The hall has a capacity of 1700 people seated on two levels, stall and circle.

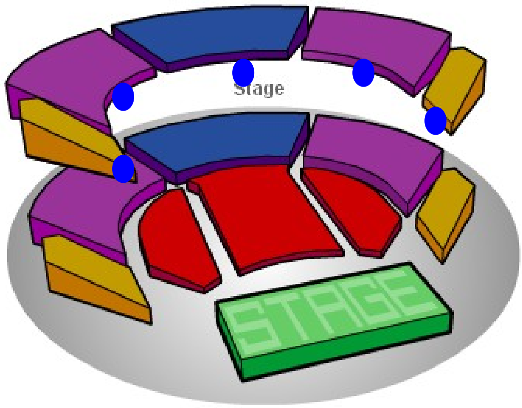

Figure 6. Brighton Dome with artificial reverb system O

The RT was measured for the natural acoustic of the Dome and with the artificial reverberation system. The natural acoustic is too low for symphony music, but rather suitable for drama or musical theatre. With the artificial reverberation system the low and mid frequency character of the room is boosted from 1.0 second RT to an RT of 1.8 seconds, see Figure 7. When asked this was a little to "live" for the orchestra players.

In the Royal Festival Hall, where the orchestra normally performs, the auditorium is much larger auditorium so the players play loudly to compensate. This is exasperated by the lack of stage acoustics at the Dome, so the orchestra does not hear itself. This meant that the artificial system over compensated for the players, and consequently the musicians received the highest noise dose of venue where the piece was performed.

The solution is to turn down the artificial reverberation system to give a reverberation time of approximately 1.6 seconds and introduce some side reflectors to improve the stage acoustics. This could be provided by either the organ pipes, which are currently covered beneath curtains or by introducing side reflectors, see Figure 8. However, the side reflectors would reduce the capacity of the auditorium. This work is currently under discussion with the French installation company and the Dome's management.

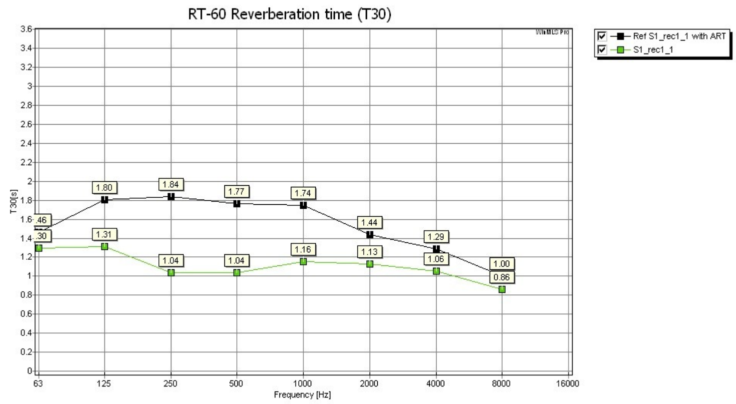

Figure 7. RT measured in the Brighton Dome with and without artificial reverberation system

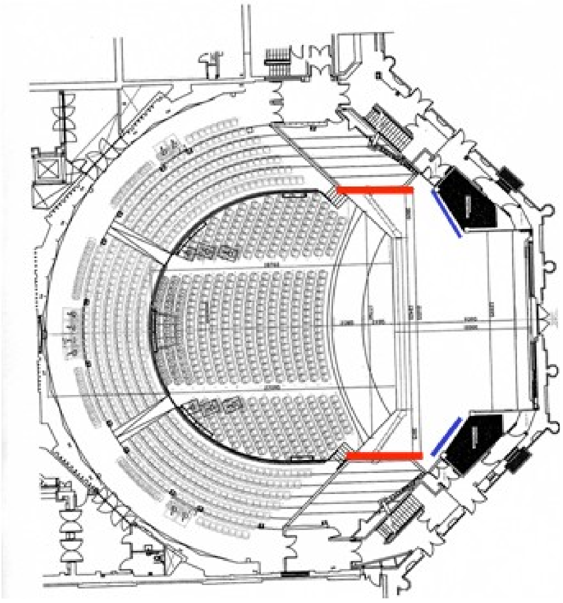

Figure 8. Potential solutions to improve the stage acoustic of Brighton's Dome theatre.

GLYDNEBOURNE OPERA HOUSE

In 1994 a new purpose built auditorium was opened at Glyndebourne. The orchestra pit was measured in detail, and it was established that little attention had been paid to the acoustics of the pit. The orchestra pit was designed for a full orchestra and the auditorium has a seating capacity for 2100 people, see Figure 9. It should be noted that the auditorium’s backstage screen closed off the new Jerwood rehearsal studio for all measurements, effectively halving the volume of the space. A small amount ($2m^2$) of absorptive material located in two corners of the orchestra pit. This was used to dampen the low frequency sound from the timpani section.

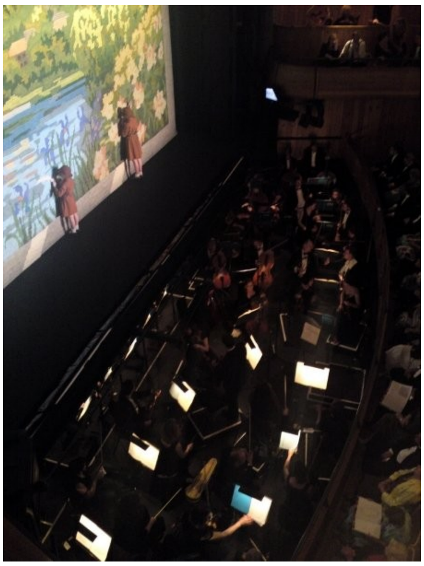

Figure 9. Glyndebourne Opera House.

Two sets of measurements were taken, the first to identify the acoustics of the pit and secondly to establish the auditorium acoustic.

The dodec loudspeaker was positioned in the rear left corner of the pit, where the timpani would normally reside. Then six microphone measurements were taken, three beneath the stage and three at the pit opening: Near piano on the left, conductor, centre rear, right rear, and right rear corner and near the piano on the right

For the auditorium measurements only a single source position was used – centre stage 5m from the edge. Six microphone positions were used spread across the stalls. Fewer measurements were taken than usual as the focus of the project was on the musicians rather than audience.

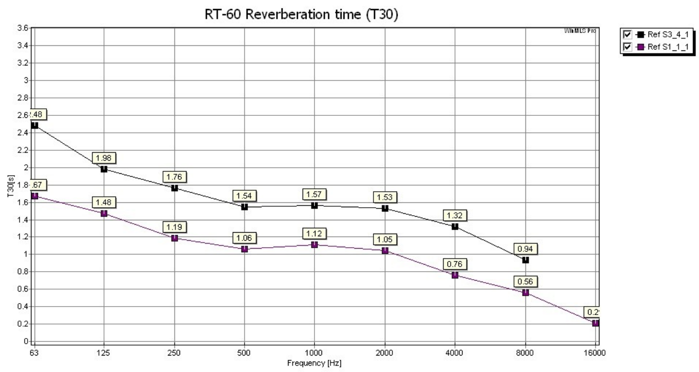

Figure 10. Averaged RT measured in the pit and auditorium.

The auditorium had an appropriate reverberation time for its purpose and size. However, there was a significant low frequency component found, see figure 10. Ideally, the shape of the low and mid frequencies, 63-2000 Hz, should be flat, at 1.5 seconds. This level of reverberation suits opera singers. The orchestra pit's reverberation time curve is similarly shaped as the auditorium’s result, but approximately 0.5 seconds lower across the full frequency range.

A line of removable absorptive panels, equal to $10m^2$, was installed along the back pit wall of the pit to improve the balance of the sound, in particular the bass so as not to dominate the orchestra. The implementation was relatively simple and has been well received by the musicians and the conductor.

If the auditorium undergoes another major refurbishment, it is recommended that the supporting stage beams should be changed from an I-beam to a castellated design, see figure 11. A castellated beam design would need an extra 15cm of head room, but would allow the sound to more easily propagate to the auditorium particular from the cross-members.

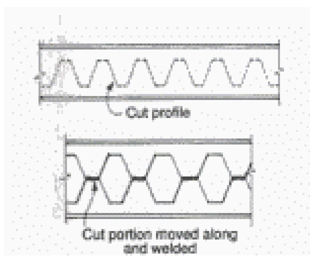

Figure 11. A castellated beam design to support the stage

ROYAL FESTIVAL HALL

The Royal Festival Hall was refurbished in 2006/7. The new acoustic design focused on using the natural acoustic of the auditorium to project the sound to the audience and an improved stage acoustic through side reflectors replacing what were effectively panel absorbers. This has resulted in the orchestra adjusting their playing to suit the hall. This is a particular large auditorium with a capacity of 2895 people including 200 singers, plus 120 musicians, see Figure 12.

Figure 12. The Royal Festival Hall

The reverberation time was measured across the stalls and stage, it was found that the natural acoustic of the Royal Festival Hall was flat across the low and mid frequency ranges, and is suitable for symphonic music, giving a reverberation time of approximately 1.6 seconds, see figure 13.

The Royal Festival Hall is at the practical limit for symphonic music in terms of volume. Fundamentally the volume of the hall needs to be reduced. The only realistic approach to solve this problem is to lower the ceiling height. Hence, the only practical suggestion is an in-depth investigation applying advance computer modelling to justify the expense of reducing the hall’s volume.

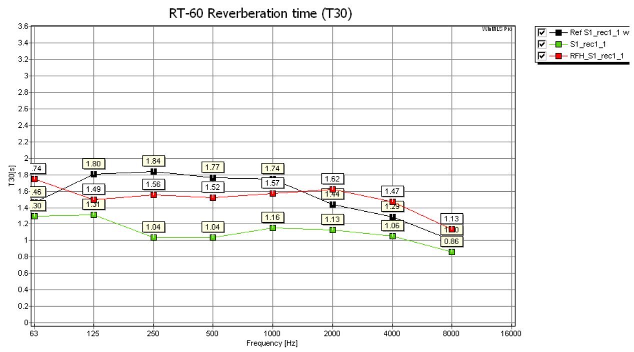

Figure 13. Reverberation time (sec) measured in the Royal Festival Hall (Red), compared to Brighton Dome

As can be seen from figure 13, the RT at the Royal Festival Hall was less than that of the sound re-enforced Dome at Brighton. This provided the evidence that the CARMAN system should be adjusted to better suit symphony music.

CONCLUSIONS

The research on the acoustics of orchestral spaces indicated that although complex there are some simple to implement design solutions to improve the acoustics for the musicians.

This is an under researched area and was bought about by the new Control of Noise at Work Regulations in the UK. Further work is being implemented to improve the acoustics of the spaces discussed.

REFERENCES

1 winMLS 2004. www.winmls.com accessed 7/1/2010