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VARIABLE ACOUSTICS IN THE ORCHESTRA REHEARSAL AND RECORDING HALL OF THE HONG KONG ACADEMY FOR PERFORMING ARTS

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INTRODUCTION

In November 1985, the Hong Kong Academy for Performing Arts was completed and handed over to the user. Amongst the many specially acoustically-designed spaces is a hall designed for the rehearsal and recording of orchestral music. The written brief for the building called for consideration of variable acoustics to achieve suitable conditions for both uses. A reverberation time variation in the range 1.5 to 2.5 seconds was suggested.

DESIGN CRITERIA

A literature search uncovered data on a number of orchestral rehearsal, recording or broadcast halls throughout the world with fixed reverberation times. Their unoccupied mid-frequency RTs ranged between 1.8 and 2.5 seconds and their volumes between 1600 and 12,000 m^3. Authors' RT recommendations varied between 1.5 and 2.5 seconds.

RT for recording

Little reference was found to the distinction between rehearsal and recording. Whilst recording engineers prefer a long RT which enables them to make 'natural' recordings, it is also common practice to add reverberation to recordings made in a shorter reverberation time. Musicians too enjoy a long natural RT as it is associated with good instrument tone quality and orchestral blend. It was concluded that there was little precident for adopting a maximum mid-frequency RT of greater than 2.2 seconds for the purpose of recording a large orchestra (80 musicians). The design volume of 6000 m^3 was considered more than adequate to obtain this reverberation time.

RT for rehearsal

A shorter RT places greater demands on musicians and can result in a more disciplined performance. In an educational building, it is of particular benefit to create conditions which assist the musical director or conductor in identifying and correcting deficiencies in students' playing. It was considered practicable and worthwhile to aim for a rehearsal RT of 1.7 seconds with a chamber orchestra present (50 musicians).

These design conditions implied a reverberation time range in the empty hall of 1.8 to 2.6 seconds.

VARIABLE ACOUSTICS IN HONG KONG ORCHESTRA HALL

DESCRIPTION OF THE HALL

The dimensions set for the hall were, approximately:

Length	30m
Width	18m
Height	14m

At one end of the hall is a small seating gallery with approximately 130 seats. The control rooms are below this gallery. At the opposite end of the hall is an organ gallery; the organ has yet to be installed. The ceiling construction is heavy plaster. Beneath this are exposed ventilation ducts and a number of catwalks providing sound-scattering surfaces which contribute to room diffusion.

The main surfaces available for acoustic absorbers were the large side walls (see fig 2). The hall width of 18m was considered to be the minimum practicable for setting out a full orchestra, so the only acoustic absorbers which were permitted at low level were thin porous absorbers to control flutter echoes. Space was set aside between 3m height and the underside of the catwalk for variable-acoustics absorbers and above catwalk level for any necessary fixed absorbers.

METHOD OF VARIATION

Although it was recognised that the hall could be designed to have a shorter natural RT which could be increased by electro-acoustic means, it was considered preferable to adopt a mechanical method which would give a range of natural RTs. The Client accepted this recommendation and set a budget of approximately £100,000 for a 'no frills' system.

The system adopted utilised four types of absorber box (see fig 1) covering an area of 216 m^2. (See fig 2). The absorbers can be covered or exposed, as desired, using a system of flaps. The flaps are moved by electro-mechanical actuators operated from a push-button control panel situated on the balcony.

There were two main acoustic considerations in the design of the flaps:

- When the flaps are closed, the residual absorption should be kept to a minimum.
- The distribution of early reflections from the face of the flaps should be considered.

To minimise panel absorption when the flaps are closed, a high density board material was used (18mm @ 22.5 kg/m^2). In this way any residual panel absorption would occur at very low frequencies (<63 Hz). Gaps between the flaps were not sealed and the airspace behind the flaps was not subdivided so that the panel absorption would be as small as practicable. Although the gaps between the flaps were not sealed, they were kept to a minimum and detailed with a chamfered junction to minimise residual high frequency absorption.

To introduce some early high frequency sound reflections back to the performing area, the flaps were fixed to their frame so as to tip downward to form an angle of 90° between a flap and the closed flap below it. Figure 3 illustrates the principles of operation and shows how, depending on the number and position of open flaps, the quantity of early sound reflections can be adjusted as well as the reverberation time.

The design made provision for 'tuning' the hall immediately prior to completion. A number of fixed absorber boxes were made available to adjust the mean reverberation time about which variation could be made. Two factors conspired to prevent the planned tuning exercise. It was discovered during construction that the measured reverberation time of the empty shell was lower than had been predicted. A visual inspection revealed that the fire-protective coating which had been applied to the exposed steel downstand beams was also an acoustic absorber. This greatly reduced the quantity of fixed absorbers which would be required for tuning purposes. At the same time, the architect wanted to issue final instructions to the contractor for construction and installation of the fixed boxes to avoid a delay in completing the building. A reduced number of fixed boxes was specified and installed. In consequence, the hall was commisioned and handed over without acoustic tuning.

RESULTS

The resulting range of reverberation times in the completed orchestra hall is given in figure 4. Figure 5 shows the values predicted for the design occupancies. In summary, the values at 500 Hz are:

Measured	
Unoccupied hall, all flaps closed	2.5 sec
Unoccupied hall, all flaps open	1.8 sec
Predicted from measurements	
80 orchestra, all flaps closed	2.1 sec (2.2)
50 orchestra, all flaps open	1.6 sec (1.7)

The variation at low and high frequencies is smaller. The figures in brackets are the values predicted if the fixed boxes, earlier specified, had been removed. These coincide with the design values. However, as the early reaction of the user was that the 'all flaps closed' condition is more reverberant than would normally be required, no attempt was made to have these boxes removed.

USER REACTION

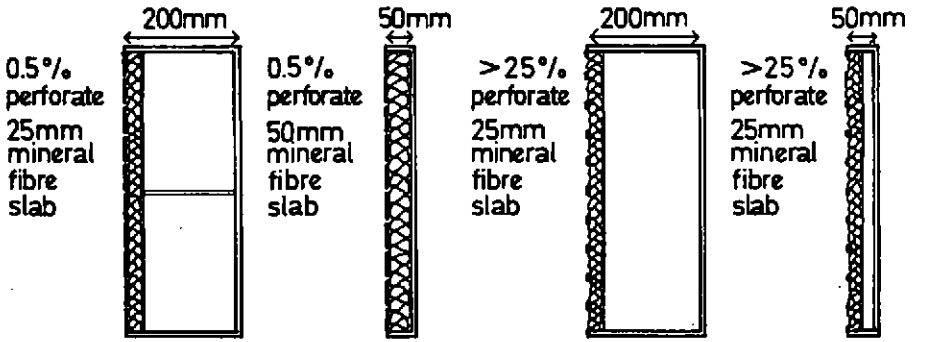
On 6 November 1985, the Academy orchestra held a rehearsal in the hall. The 50-strong orchestra were initially situated at the organ end of the hall with 40 (of 318 available) absorbers close to the performers exposed. This was deliberately set to be more reverberant than BAP would have normally recommended for this size of orchestra and the particular music being performed. The Dean of Music advised that it was too reverberant for the orchestra, but would be ideal for the organ, when installed.

Subsequently, the flaps were fully opened, reducing the reverberation time to a more suitable value for the situation. The users were delighted with the playing and listening conditions which were slightly less loud, clear and without colouration.

The hall is in regular use for rehearsals by both academy musicians and by the Hong Kong Philharmonic; both of whom like the hall for this purpose. To date, it has only be used once for commercial recording. The recording engineer concerned found difficulty in achieving the sound characteristics he requires for large scale works. The reasons are still being explored. However, it appears that the best large scale orchestra recordings are made not in purpose-designed recording halls, but in empty concert halls, assembly rooms and even churches.

The Assembly Room at Walthamstow Town Hall is widely regarded by recording engineers as one of the best UK venues for orchestral recordings. Its layout, dimensions and volume are similar to the Hong Kong Academy hall and the measured reverberation time is much the same. We have no immediate explanation why its acoustic characteristics should be regarded as significantly different.

We propose to take no action in the hall until the organ has been installed (as this will add further acoustic diffusion and some absorption to the space) and other recording engineers have voiced an opinion on recording conditions.



ASSUMED ABSORPTION COEFFICIENTS

	125	250	500	1k	2k - Hz
Type A	.74	.53	.40	.30	.14
B	.48	.78	.60	.38	.32
C	.67	1.0	.98	.93	.98
D	.01	.32	.94	1.0	.98

Figure 1

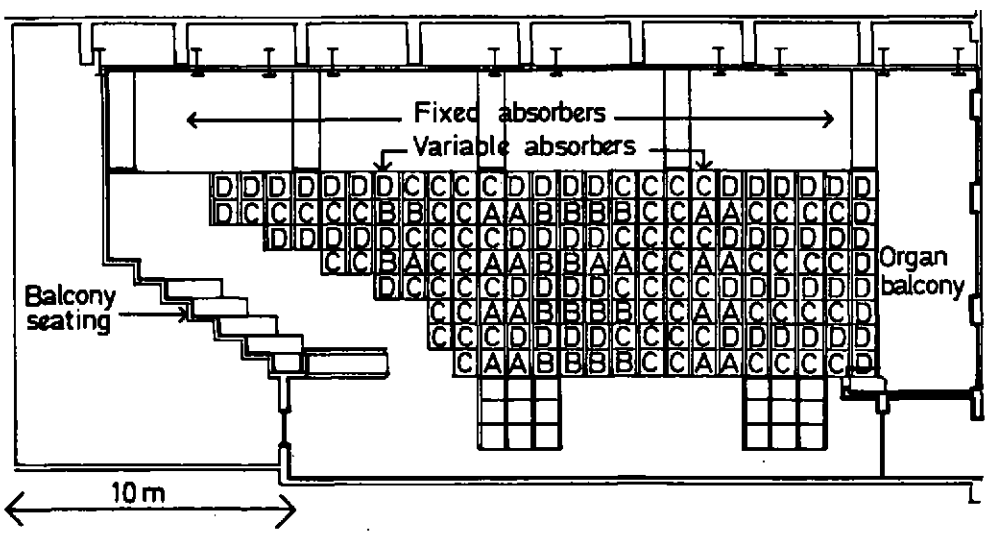
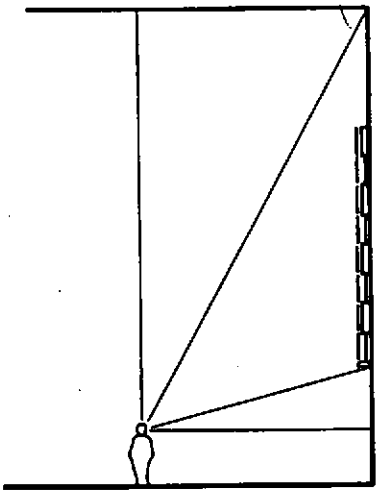
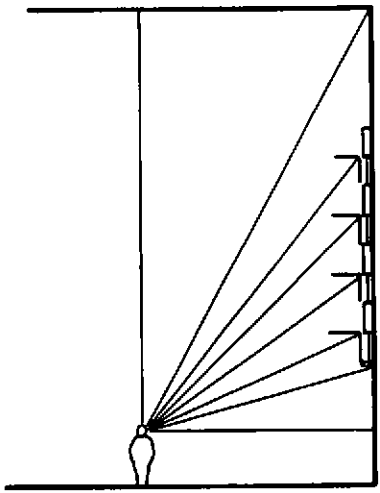


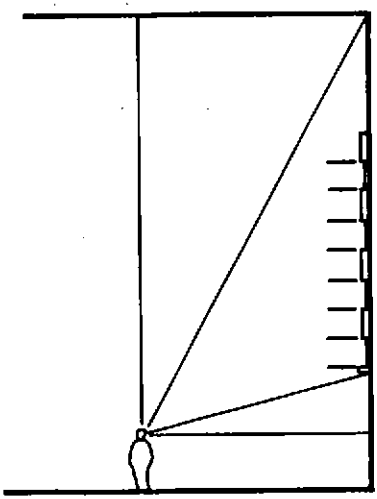
Figure 2



flaps: all closed
early reflections: few
reverberation time: long



flaps: half open
early reflections: many
reverberation time: medium



flaps: all open
early reflections: few
reverberation time: short

Figure 3

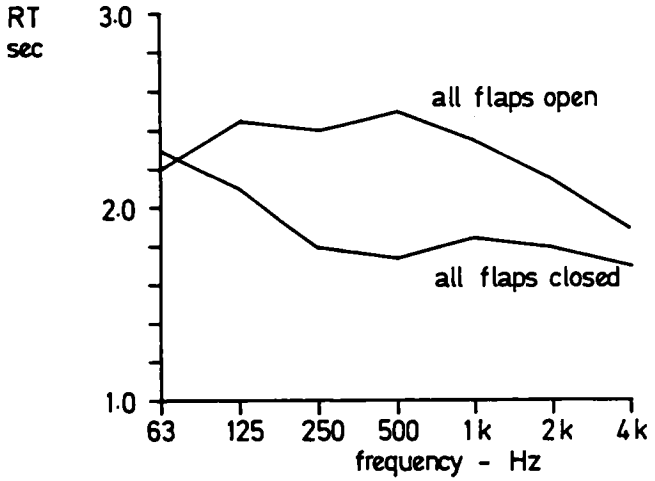


Figure 4 Measured RTs, unoccupied hall

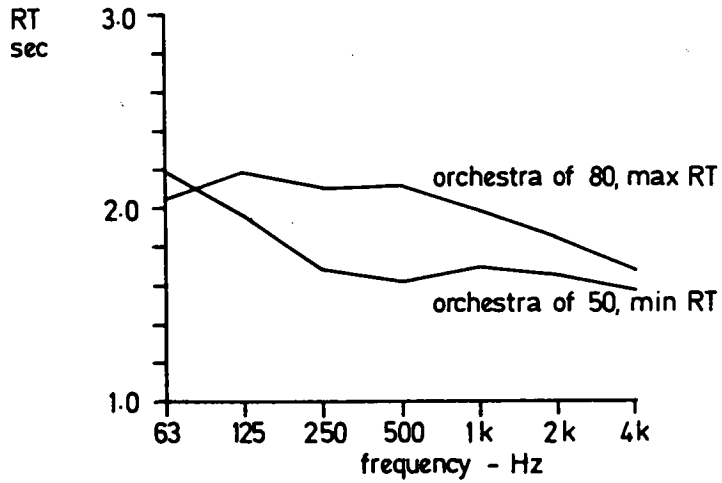


Figure 5 Predicted design RTs from measurements