Acoustical Design of the Drama and Experimental Theatres of the New National Theatre
Tokyo, Japan
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Abstract: The NNT Drama Theatre seats 1038 for prosenium stage and 1010 for thrust stage; volume is 7,200 m³ for prosenium and 8,700 m³ for thrust stage; reverberation time, with audience, 1.1 s (stage curtain open). It is wide, fan-shaped in plan and has one balcony. The experimental theater, called “The Pit”, is shoebox shaped; seats up to 468 on movable stadium seating; volume 4,350 m³. RT with audience 1.0 s.

INTRODUCTION

An international architectural competition was established in 1985 by the national government of Japan for the design of the overall NNT Project which embodies the Opera House, the Drama Theatre and an experimental theater called “The Pit,” and many associated spaces. TAK Architects of Tokyo with Takahiko Yanagizawa, President, and architect in charge, won the competition. The characteristics specified to the acoustical consultant for the Drama Theatre were: ① 1038 seats for prosenium stage and 1010 seats for thrust stage; ② adequate visibility of performers’ movements and expressions from all seats; ③ to be used primarily for presentation of drama performances, ballet and small concerts; ④ reverberation time in the range of 1.0 to 1.3 seconds with full occupancy; ⑤ orchestra pit to accommodate up to about 70 musicians; ⑥ in the competition the architect chose a wide fan-shaped plan wider for the thrust stage, one balcony, and a painted plasterboard interior. Acoustics in this period were the responsibility of S. Masuda.

Beranek was commissioned Acoustical Design Consultant for the NNT Project in 1989 and he worked closely with the architect’s technical staff headed by T. Hidaka which made CAD computer and 1:10 wooden models for the Drama Theatre and conducted all measurements in the models and in the finished halls. In the 1:10 model, the audience was simulated, and impulse signals were radiated from a tiny loudspeaker to spherical heads with 1/8-in. microphones used as “ears”.

DESIGN AND MEASUREMENTS

A. Model and post-construction studies: The measurements made in the 1:10 wooden model yielded reflectograms at 24 positions. It was recommended that reflecting surfaces be provided above and to the sides of the proscenium to augment the actors’ voices. However, requirements for lighting and sound systems precluded these. The measurements and post-construction use show that with the thrust stage, amplification would generally not be necessary. With the prosenium stage, amplification would generally be needed for drama. Sound reinforcing surfaces can be provided later at the owners’ request if they do not wish to depend on amplification.

B. Measured acoustical parameters: The values of the measured quantities in the Drama Theatre are: RT(mid) = 1.1 s; EDT(mid) = 1.23 s; C₉₀ (stage) = 1.9 dB; C₉₀ (pit) = 2.1 s; t₁ = 31 ms; [1 - IACC₆₃] = 0.5; BR = 1.13 ; (V/EDT) x 10⁻³ (stage)=58.

C. Quiet and freedom from echoes: The HVAC noise, Drama Theatre unoccupied, is NCB-18. Owing to the use of Schroeder QRD diffusers on the rear wall, which are tilted backwards 10°, with sound absorbing material in the channels and to the provision of acoustical materials on the underside of the balcony, there is no echo at the on-stage focal point. In The Pit substantial areas of sound absorbing materials are used to control the RT and the side walls are slightly tilted inward to eliminate the possibility of flutter echo. The HVAC noise is NCB-22.
FIG. 1. New National Theater Drama Theatre. (Upper) Plan of theater with proscenium stage. (Lower) Photograph of theater with proscenium stage. A sliding and folding wall converts from proscenium to thrust seating.

FIG. 2. NNT Drama Theatre. (Upper) Plan of theater with thrust stage. (Lower) Longitudinal section of theater with proscenium stage. The orchestra pit is formed by dropping the elevator(s) nearest the stage.