Role of the acoustic advisors in the design of the Tokyo International Forum

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Abstract: The Tokyo International Forum (TIF) has been constructed as the biggest comprehensive institutions for culture and information by the Tokyo Metropolitan Government. As the building includes four different types of halls and is surrounded on all sides by underground railways, acoustic design was performed very carefully. The process of planning and construction of this building is briefly introduced by concentrating on the acoustic problems.

INTRODUCTION

The Tokyo International Forum (TIF), a comprehensive institutions for culture and information, has been formally dedicated on January 1998. This building is a complex building including four halls and other various facilities. Since it is surrounded by four underground railways, the acoustic design and consideration were very important through the architectural design and construction. The authors were appointed as the technical staffs by the Tokyo Metropolitan Government and worked as the acoustical advisors through all process of the planning and construction of this building. In this paper, the outline of the TIF and acoustical investigations done for its construction are briefly introduced.

OUTLINE OF THE TIF AND ITS DESIGN COMPETITION

On August 1985, the Tokyo Metropolitan Government set forth the conception to construct complex facilities for culture and information in the midtown area of Tokyo. According to this plan, the international architectural design competition officially recognized by the UIA was planned on March 1989 and the gist was announced to invite design proposals from all over the world. Its outline is as follows.

The TIF includes four halls of different uses and capacities, exhibition spaces, information institution facilities, international cultural exchange facilities, etc. Its main aims are to provide places for (1) the performance and appreciation of music, play, art, movie, fashion design, and science, (2) various kinds of conferences including international congresses, (3) industrial exhibitions and trade fairs, (4) information on various kinds of cultural and industrial activities, and (5) information about Tokyo and Japan.

395 applications were submitted to this competition from 50 countries and they were examined by the Board of Examiners chaired by Kenzo Tange, architect, from 31 October to 2 November, 1989, and finally the plan proposed by Rafael Vinoly was chosen as the most excellent work.

For the design competition, the Technical Committee was organized in December 1988, which consisted of eight experts from related fields; urban design (1), architectural design (1), structural dynamics (1), theater architecture (1), acoustics (2), disaster prevention (1), and legislation (1). The gist was examined in this committee during the preparation of the competition. In advance of the examination of the competition, all design proposal were checked by the member of the Technical Committee from each specific viewpoints. At the final stage of examination, discussion was made between the examiners and the technical staffs many times. This technical discussion and advice were effectively reflected in the selection of the excellent works among all proposals.

After the competition, the architectural design contract was made between the Tokyo Metropolitan Government and Rafael Vinoly Architects K. K., and the basic and execution drawings were prepared. Many consultants joined the drawing work, in which Jaffe Holden Scarbrough Acoustic Inc. and Yamaha Acoustic Research Laboratories were nominated as the joint acoustic consultants.

The construction work started on October 1992. Although it was interrupted by the examination of historic relics for almost one year, it has been finally completed very successfully in May 1996.
ACOUSTICAL DESIGN AND INVESTIGATIONS

Through the process of drawing and construction, meeting was frequently held between the architects, acoustic consultants and technical advisors on acoustical problems of the TIF. The outline of the discussion is as follows.

- Insulation of extraneous environmental vibration and noise: The site of the TIF is surrounded by the underground railways and the structure-borne sound is the most serious problem. To solve the problem, all of the halls are located on the higher floors in the building. The Vinoly's plan succeeded in this point and was highly evaluated in the competition. The vibration reduction techniques were earnestly investigated and discussed, and the continuous underground wall, vibration isolation and the box-in-box system were adopted. For these aims, various new technologies have been developed and tried.

- Airborne sound insulation between the halls: Since the main structure of the aboveground of the building is steel construction in which four halls are located contiguously, airborne sound insulation is also an essential problem. For this problem, the blocking-mass construction method was adopted in addition to the box-in-box system.

- Determination of uses, seat capacity and acoustic characteristics of the halls: Although the purposes of the four halls were set in the primary plan, their actual uses were discussed concretely in detail and confirmed in the stage of the execution drawing. Finally, the design target has been decided as shown in TABLE 1. In “Hall C”, its main use is orchestra concert, the concert hall shaper (double shell) system was adopted.

- Electric sound system: The use of the artificial sound field control (AFC) system, by which reverberation condition can be altered in combination with the sound reinforce (SR) system, was discussed earnestly for each hall. Finally, it was decided that the AFC system was actively equipped in “Hall A” and “Hall D” which were supposed to be used for multi-purpose uses, whereas it was not introduced in “Hall C” of which main purpose is classic music concert and natural acoustics was esteemed.

- Acoustic treatment of the “Glass hall”: The huge atrium named “Glass hall” was designed as the symbolic main lobby of the whole facilities of the TIF, in which exhibition spaces, meeting rooms and restaurants are included. Its air volume is very huge, about 250,000 m³, and it was pointed out that the inner space would be too much reverberant. To reduce this problem, sound absorption treatment was performed as far as possible for the interior surfaces of the atrium.

CONCLUSIONS

The architectural design competition of the TIF was performed internationally and attracted world-wide attention. Beside the selected proposal, a lot of excellent and interesting design proposals were submitted. The unique point of the competition was all proposals were examined by the staffs of the Technical Committee in advance of the design examination and the results were effectively reflected in the final selection. The technical staffs also joined the investigation and discussion during the execution design and construction on behalf of the client.

<table>
<thead>
<tr>
<th>Hall</th>
<th>capacity</th>
<th>use</th>
<th>Mean absorption coefficient: α</th>
<th>Reverberation time: T₆₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5,012 seats</td>
<td>Congress, light music concert (popular song, rock music, semi-classic, pops)</td>
<td>0.33 (congress)</td>
<td>1.4s (congress)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.28 (concert)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>(1,440 m²)</td>
<td>Exhibition, reception party</td>
<td>0.30 (open space)</td>
<td>1.5s</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.29 (divided)</td>
<td>1.3s</td>
</tr>
<tr>
<td>C</td>
<td>1,502 seats</td>
<td>Congress, classic music concert, play</td>
<td>0.30 (congress)</td>
<td>1.4s (congress)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.29 (concert)</td>
<td>2.2s (concert)</td>
</tr>
<tr>
<td>D</td>
<td>(380 m²)</td>
<td>Play, recording/broadcasting, concert, congress, exhibition</td>
<td>0.24~0.40</td>
<td>0.8s~1.4s</td>
</tr>
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