The acoustics of "Muziekkwartier" Enschede (NL)

N. Janssen[1], L. van Luxemburg[2]

[1] *DHV B.V. Bouw en Industrie, The Netherlands, Email: niek.janssen@dhv.com*
[2] *Level Acoustics, Email:l.c.j.v.luxemburg@tue.nl*

Introduction

November 22, 2008 the new "Nationaal Muziekkwartier" (National Music Quarter) in the town of Enschede (NL) is inaugurated. The building will be the new home of the Opera (Nationale Reisopera), the Theatre (Podium Twente), the Stage for Popmusic (Atak), and the School of Music (Muziekschool Twente). Challenge for the acoustic consultancy was the combination of functions in a compact building. In this paper the design and the solutions for two pop stages and the main auditorium are elucidated.

In fig.1 the ground plan of the building is given. In green on the left are the stages for popmusic, stage B and stage C shown. On the right, in red are the big auditorium and the fly tower indicated. The side stages are marked in orange, they are big sized as this is the second opera production house in the Netherlands. In blue the foyers both for the theatre and for the pop stages are marked. The dotted red line represents the (acoustic) structural joint (dilatation) that separates pop and drama/opera. This illustration was made during design, and shows the background noise levels as design goal.

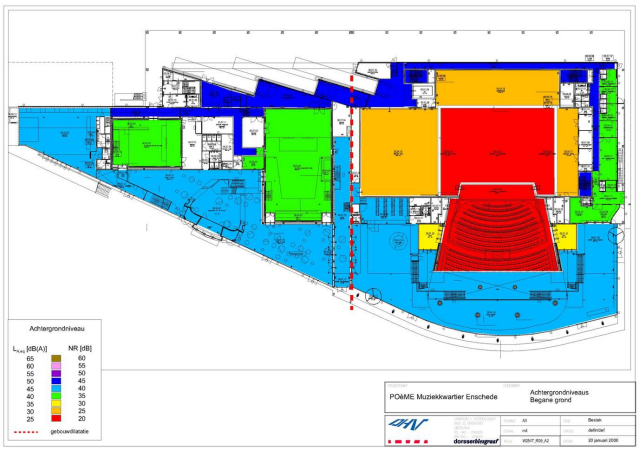

Figure 1: Ground Plan of "Muziekkwartier" according to final design.

The Muziekkwartier also houses 35 rehearsal rooms, in the school of music and for pop music below the pop stage B and the foyer for popmusic. The rooms in the School of Music differ in height and cubic meters, and also in reverberation times.

Stages for pop music

The acoustics of a stage for pop music must provide in a non-reverberant space, especially for the low frequencies. The reverberation time for the occupied hall must be preferable 0.5 or less. This implies that in the empty hall the reverberation must be close to this value. The acoustics must be such that the sound check-effect is minimized. This is the difference between the acoustics in the unoccupied hall during sound check and the acoustics in the occupied hall during the concert. A sound check in a too reverberant hall will result in too low levels after the audience entered and balancing the sound will be almost impossible. To limit the use of cubic meters for the acoustic wall finishing, the depth was set to a maximum of 100 mm, the (acoustic transparent) top layer not included. The materials had to meet all fire-safety regulations, with special attention to the foils to be used.

All the acoustic linings used in both halls are mineral wool based layers in majority combined with plastic foil to create a membrane absorber. There is acoustic lining on all walls (never a total cover of a wall) and a part of the ceiling. The top layer of the lining was only visual and therefore acoustic transparent. For stage B the top layer is perforated steel (Corten steel), in stage C wooden planks have been chosen.

In fig.2 a detail of the wall of Stage B is presented. In this wall a random pattern of perforates steel sheets and perforated concrete panel is designed. The concrete panels are not designed with an acoustic purpose, but some scattering will be provided. The perforation in the wall finish (round holes in different sizes and a -so it seems- random pattern) is the theme you may find through the building in different appearances. They represent the pixels of a certain photograph the architect has chosen. The maximum in efficiency of the acoustic lining is achieved by the random pattern (the more random the better), and fully different patterns on opposite walls.

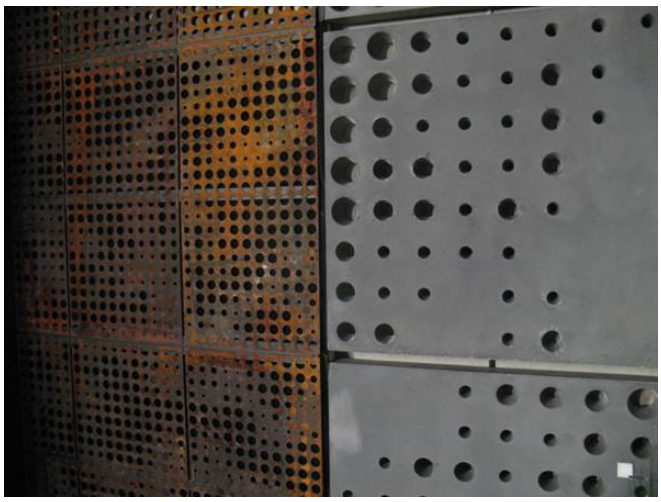

Figure 2: Detail of wall finish Stage B.

The results of the measurements in the unoccupied pop halls show the reverberation times. They meet the demand very well. The measured reverberation times is approximately 0.7 s. Please notice that the hall is constructed totally in reinforced concrete (floor, walls and roof/ceiling).

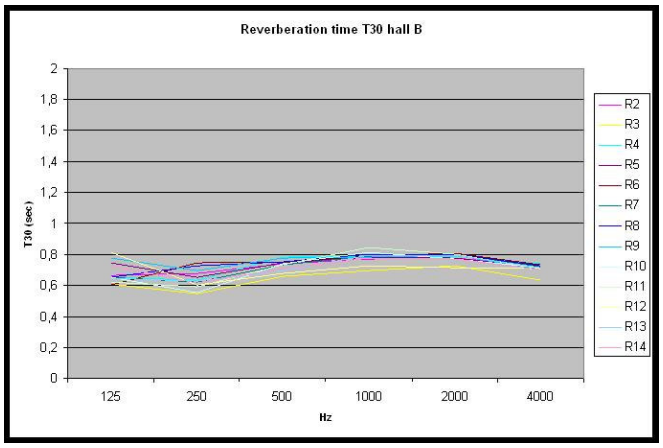

Figure 3: Measured reverberation time Stage B, unoccupied hall.

In fig 3 the designed wall elevation of Stage Cis shown, also with the perforated (non acoustic) concrete panels that are alternating with the wooden planks shown red. Like in Stage B the random pattern and fully different patterns on opposite walls are used here. Also this hall is fully in reinforced concrete.

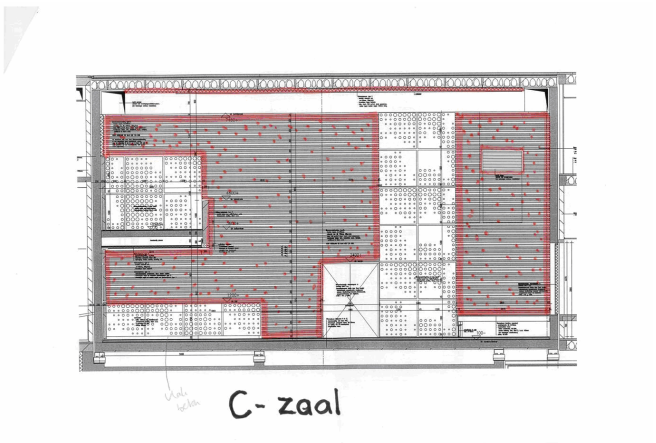

Figure 4: Wall elevation Stage C. The acoustic lining (top layer: wooden planks) is shown in red.

The measured reverberation time in Stage C, is also approximately 0.7 s in the unoccupied hall.

Main auditorium

The main auditorium is to be used for drama and for opera. The capacity of the hall is 1000 seats. Because of the opera production a large fly-tower is built, the fly tower is significantly larger than the usual tower belonging to a auditorium with this capacity (width 45 m., depth 26 m.,height 29 m.). The hall has a volume of approximately 9000 m3, variable acoustics are controlled by 6 adjustable sound reflectors at the ceiling, located near the stage opening. The reflectors can move in height, in angle and in location. This implies the reflectors have two main positions.

The use in the "drama-configuration" of the auditorium will be drama, musical, cabaret and ballet, for which in majority amplification of sound will be the case. For this a reverberation time of appr. T = 1.2 sec. is chosen as a design goal. When performing the opera the orchestra pit is open (front seats will be taken away), a reverberation time of appr. T = 1.6 sec. is aimed at.. Table 1 shows the rt's per octave band according to the design development.

Frequency	*125*	*250*	*500*	*1000*	*2000*	*4000*	*Hz*
Drama/musical	1.50	1.35	1.2	1.2	1.1	1.1	[s]
Opera	2.1	1.9	1.7	1.6	1.5	1.5	[s]

Table 1: Estimated reverberation times according to design.

To give an idea of the dimensions of the theatre a longitudinal section is shown (fig. 5), with in green the auditorium, and in yellow the fly-tower.

The section and the picture of the hall show the architectural concept of theatre is a hall with shape of an apple, so lot of concave surfaces with a high quality of finishing. Special acoustic devices in the theatre are the reflectors and the special designed wall structure. Also a lot of attention has been payed to the orchestra pit, that is one of the largest.

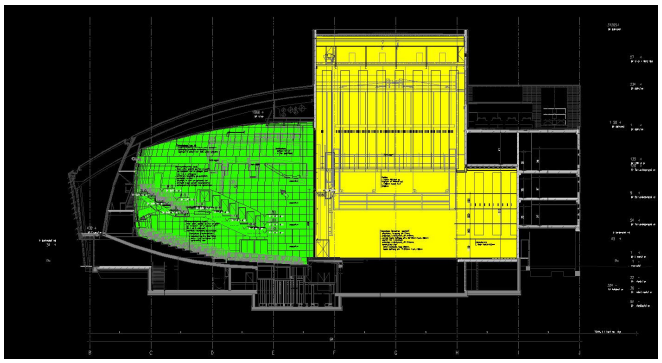

Figure 5: Longitudinal section of the auditorium (green) and the fly-tower (yellow).

Reflectors/configurations

The configuration of the sound reflectors for drama-situation is given in fig 6. The volume above the reflectors is cut off from the auditorium volume. The reflectors are positioned in one group, located in the middle. Sound from the stage is reflected into the audience area with supporting the speech intelligibility. The volume above the reflector will behave as a coupled space.

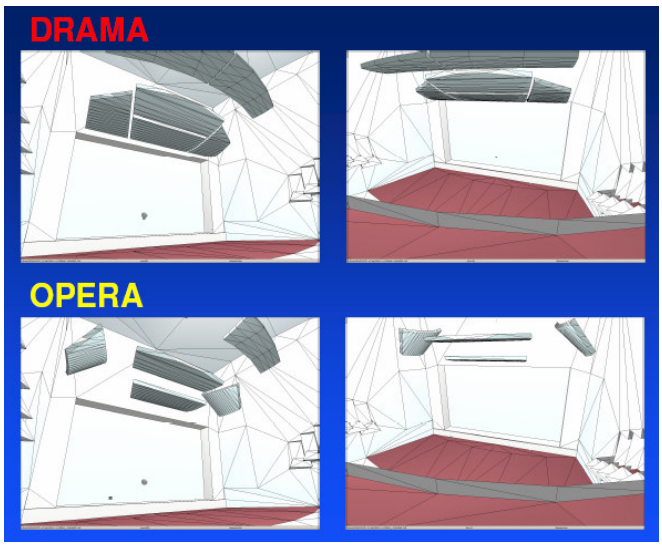

Figure 6: Configurations of the sound reflectors for drama and for opera.

For opera (see also figure 6) the sound reflectors are spread in position, height and angle and the volume above the reflectors will be coupled with the auditorium volume. For the playing ensemble the a kind of proscenium arch is created , so the reflectors in the middle give important support to the orchestra in the pit.

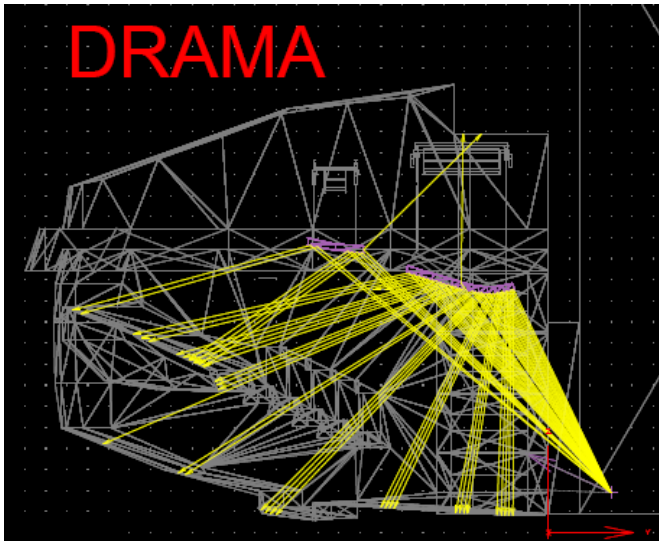

Figure 7: Pattern of reflections

Fig. 7 shows the pattern of reflections in drama-configuration, the source is on front of the stage.

The pattern of reflections in opera-configuration is also shown (fig. 8). The source is on the front of the stage, the reflections are sent into the orchestra pit and the audience area.

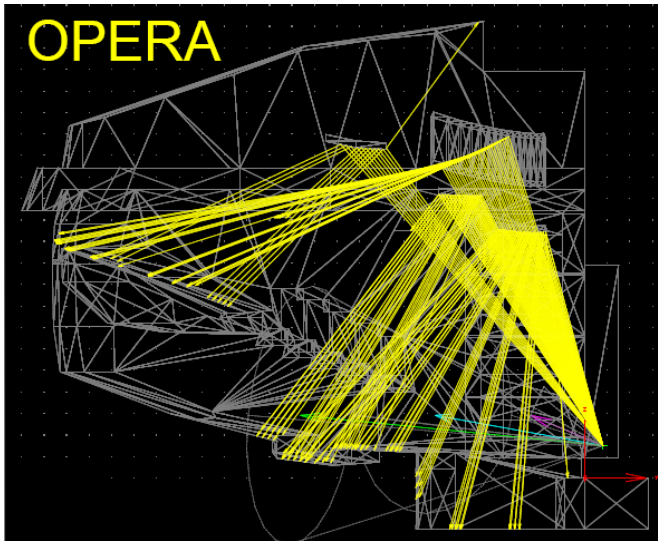

Figure 8: Reflection pattern fort he opera situation.

The upper graph shown in fig. 9 shows the estimated reverberation time T30 for the drama situation according to the design development. The lower graph for the opera situation.

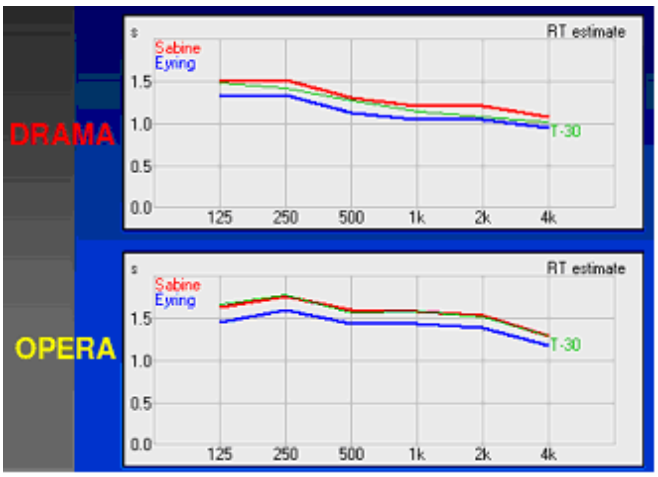

Figure 9: Estimated reverberation times Auditorium according to design.

Unfortunately up until now it was not yet possible to perform reliable measurements in the auditorium as the sound reflectors can not be moved yet (due to problems with the contractor for stage technology). It is not exactly known what the exact position, angle and height of the reflectors is. We were told that the actual position should come close to the opera configuration.

Walls of the auditorium/sound diffusion

As a theatre with the function of opera asks for good envelopment, thus lateral efficiency the walls had to be shaped to fulfill this requirement. Also the concave shape of the auditorium had to be corrected from an acoustic point of view. For this a special solution is designed and tested in the laboratory. To test the acoustic behavior of the wall a mock up of approximately 10 m2 is used. The picture (fig.10) shows the mockup of the wall of the auditorium with the “pixels”. The holes should provide as well lateral sound energy as scattering (diffusion) to prevent focusing of the sound.. The results of this test can be seen in the graph.

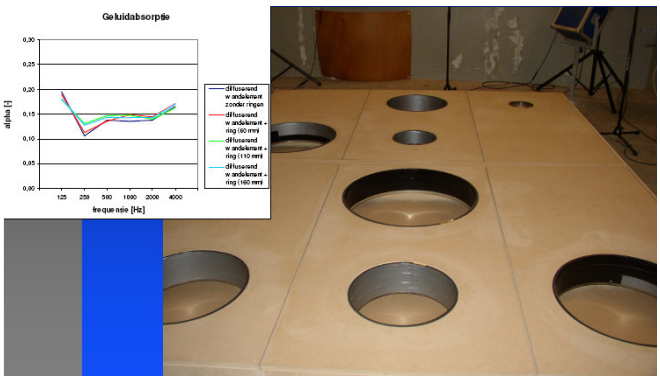

Figure 10: Mockup of the auditorium wall as was tested in the laboratory (test results can be found in the graph)

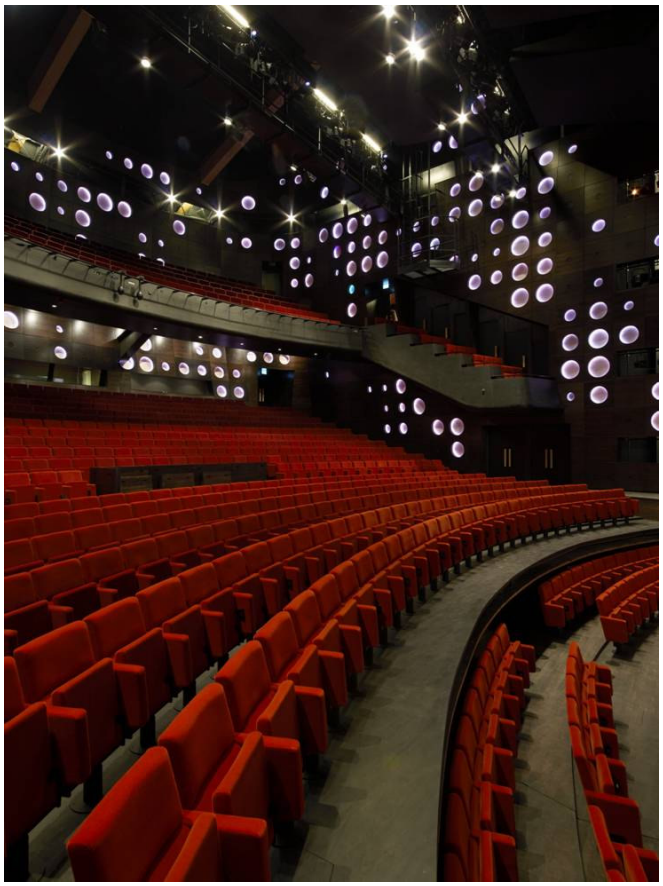

Figure 11: Auditorium of „Muziekkwartier“ Enschede (NL).

Orchestra pit

As the hall is the house for the National Opera the orchestra pit had to meet the highest standards. The pit is 160 m2, only 33% of the pit area is covered by the stage floor. The pit has three independent floor elevators. At the rear wall of the pit the free height is 3.6 m at maximum (third elevator in lowest position), with this the deepest pit in the Netherlands can be created. In the rear wall of the pit and the sidewalls QRD-diffusers are integrated.

Figure 12: Orchestra pit