PROCEEDINGS of the
International Symposium on Room Acoustics

15 to 17 September 2019 in Amsterdam, Netherlands

The acoustic design of the new theatre *Amintore Galli* in Rimini (Italy)

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ABSTRACT

The town of Rimini, North East of Italy, opened on October 2018 the new Teatro "Amintore Galli". The theatre was damaged in 1944 and afterwards it was demolished. The plans of reconstructing the new theatres ranged from a international competition for a new modern structure (1980-2000) to the idea of reconstructing the theatre *as it was, where it was*, following particularly the Teatro *la Fenice* in Venice. This Paper describes the whole history of the reconstruction, starting from the early design of the new theatre (2008) until the finale measurements, undertaken in Autumn 2018. Moreover, the paper describes and comments some measurements performed during the reconstruction works, including measurement of scattering and diffusion on acoustic panels. At the end of the papers, some comments about the overall acoustic quality, are reported

Keywords: Teatro Galli, acoustic design, diffusing panels

1. INTRODUCTION

Rimini is a lovely town on the Northern Adriatic coast of Italy, and it is very well-known for its coasts and sandy beaches. During summer season, every day, dozens of thousands of people spend holidays on its long sea cost, and perhaps they did not properly realize the historical background of this fascinating town. Rimini city centre was firstly realized by the Romans, and still today there are important Roman monuments across the town, and the Tiberian Bridge, the Augustin Arch, and the *domus romana*. During middle age and renaissance, several other historical buildings were completed. Among them, the *Rocca Malatestiana* (castle made by the Malatesta family, rulers of the town) and the *Tempio Malatestiano* (Malatestiana Temple), an important Church designed by Leon Battista Alberti and ultimated on 1400. At the end of the Papal States, a new theatre, designed by Luigi (Aloisii) Poletti was completed in the main square (later renamed *Piazza Cavour*). The theatre opened on August 16th, 1857. It had a semi-circular shape, similar to the horse-shoe shape that characterized many other Italian theatres. The theatre had five different levels, and it could contain about 1400 people.

Only very few pictures of the theatre are available. Following this information, the new theatre has been designed, paying attention to the materials and shapes, including the typical roman columns in the cavea, which characterized the Poletti's architectural style for theatres.

Luigi Poletti, (1792-1869), born in Modena, designed only three theatres: in Terni (1840-48), in Fano (1845-63) and in Rimini (1854-57), all of them within the Papal States. His design was influenced by the neoclassical architecture of that time, that found in Antonio Canova and his way of creating sculptures a new way to rethink the feelings of the early 19th Century.

2. HISTORY OF THE THEATRE

2.1 The original Poletti's design

The theatre Amintore Galli was designed by Luigi Poletti from Modena and opened on August 16th, 1857. The Poletti's theatre architecture was considerably influenced by the new neoclassical style that involved all Europe in the first part of the 19th century. The theatre, despite the typical horse-shoe shape, had a number of ionic columns between the second and third order of boxes, over the arches that were inserted at the first order of boxes. It was reported that the theatre could host up

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to 1400 people, some of them standing in between the stalls.

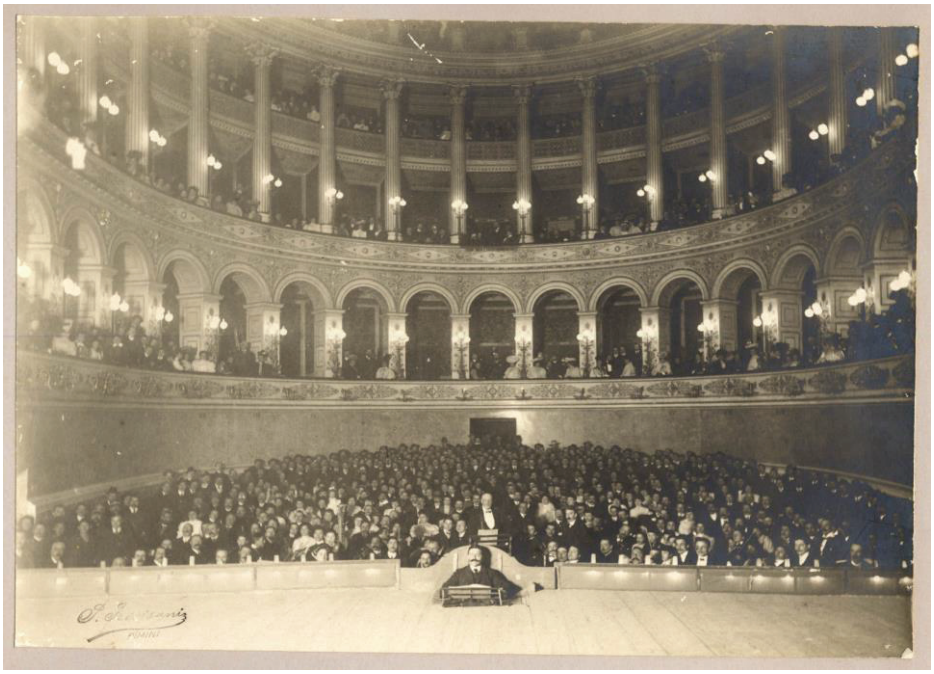

Figure 1 – A picture taken in the theatre (*cavea*) in 1910

Some opinions about the acoustics of the original theatre are available, but only few of them belong to people that effectively have been in the theatre until its damage, occurred in 1944. Some of them reported about the good acoustics during the performances (i.e. with occupied seats); on the other hand, other opinions reported about some problems experimented by the musicians in the stage area and in the stalls (i.e. with unoccupied seats).

The air attack in 1944 partially destroyed the main hall of theatre, whereas the foyer was only slightly damaged. Some years after the end of the second world war, the ruins of the cavea have been destroyed, and the area was transformed into a gym. Starting from 1948, any further decision about the theatre was postponed.

Since the origins of Rimini are Roman, the town is almost everywhere full fitted by roman ruins. Moreover, the theatre is very close to the former Roman *decumanus*, and therefore the area occupied by the theatre is involved with an archaeological site. A part the archaeological finds belonging to the Roman period (a Roman *domus* and a Roman road), in the site some graves from the middle-age period and an Early Christian church was discovered. These findings obliged to modify the original design, because the Superintendence asked to realise a multimedia museum beneath the floor at the stalls level.

Afterwards, other changes were requested from the local municipality, in order to overcome delays and new requests.

3. THE DESIGN OF THE NEW THEATRE

The new theatre was designed following the rule “where it was, as it was”, in the same way as the theatres *Petruzzelli* and *Fenice* were rebuilt after their burning.

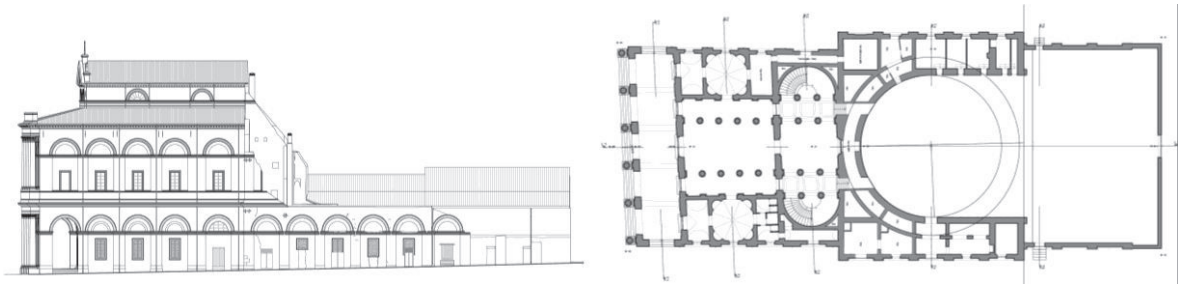

Figure 2 – The theatre in 2008

3.1 Sound quality in the cavea

The acoustic design has involved some aspects in the theatre: the introduction of acoustic panels in the walls and in the boxes; the realization of the orchestra pit with variable acoustics; the introduction of the acoustic shell in the stage area.
In the main hall the acoustic enhancements are related to different aspects. Beneath the wooden pavement there is a cavity, also for heating reasons, that resonates and vibrates during the performances on the stage.

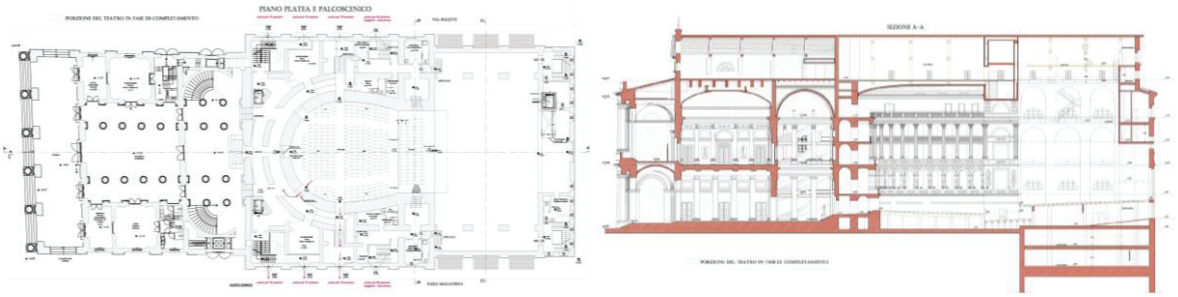

Figure 3 – The architectural design in 2010

3.2 The orchestra pit

The orchestra pit is a completely new element in the theatre. The new orchestra pit has been enlarged (about 100 m^2) and provided with variable acoustics. A set of acoustic panels, located in the back and laterally, could move, rotate and translate over all the lateral walls and on the ceiling (below the proscenium). All these acoustic panels could act as absorbers and/or diffusers.
The floor can move from the bottom to the stalls and further to the stage, giving three possibilities for the theatre. All these cases have been studied and optimised by means of a 3D numerical model of the room.

3.3 The diffusing panels

One of the most remarkable elements in the acoustic design of the new theatre was the realization of sound diffusers located in the boxes and on the entering doors in the cavea.

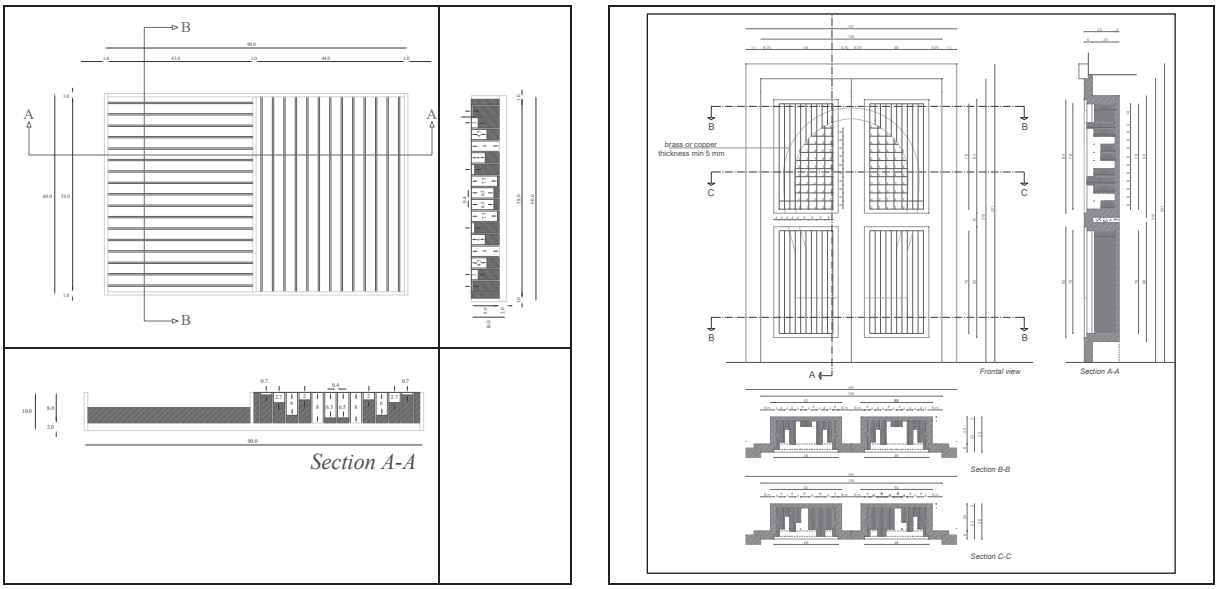

Figure 3 – Diffusing panels in the boxes (left) and on the main entrance doors (right)

3.4 Sound insulation in the theatre

Among acoustic quality, a special attention was devoted to obtaining high levels of sound insulation in the theatre. The target parameters are reported in table 1, whereas figure 4 reports some specific layers specifically designed for the hall.

Table 1 – Sound insulation targets

	Target values for sound insulation in the Theatre (dB)					
	R_W	$D_{2m,nT,w}$	$L_{n,w}$	L_{Aeq}	L_{ASmax}	R_W
Values prescribed for Galli	53	45	52	30	30	53
Values prescribed by Italian regulation	50	42	55	35	35	50

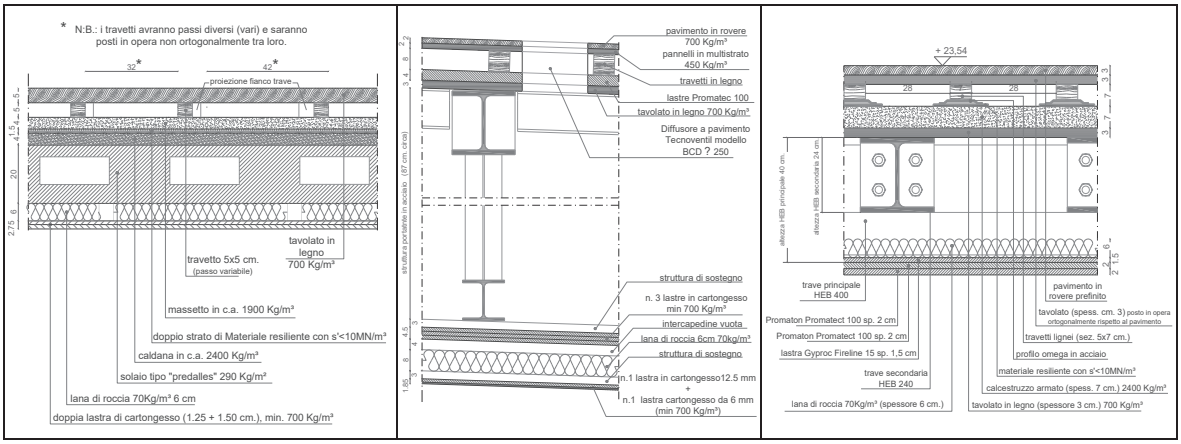

Figure 4 – Sound insulation in the main hall: examples

4. Measurements and results

On 28th October 2018 the theatre opened. In order to check the acoustics of the building (both acoustic quality and sound insulation), a set of measurements were planned and performed, covering many different situations (for acoustic quality) and partitions (for sound insulation). Before that, several measurements considered other specific aspects, as seat absorption, vibrations on lateral walls and plasterboards, and sound scattering and diffusion on the acoustic panels. These measurements followed the ISO 17497:2 standards, as reported in figure 5.

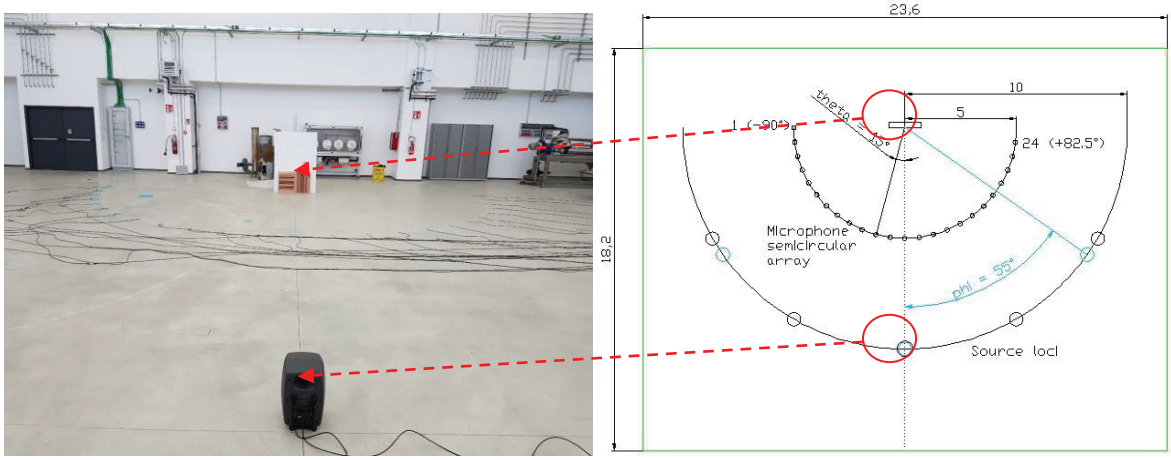

Figure 6 – The measurement on the diffusing panels

The measurements of acoustic quality were performed playing an ESS on an omnidirectional pre-equalized sound source (Look Line) and recording the output captured by a monoaural microphone (BK 4189), a dummy head (Neumann KU100), a B-format microphone (Sennheiser Ambeo) on a 8 channel portable system (Zoom F8).

4.1 Results

The measurements conducted on the diffusing panels, and in the theatre few days before the opening, are reported in the following pictures and table. The graphs in figures 7 report the comparison among the different positions of the panels. The dotted line reports the values of the reflecting surface (alone), located behind the diffusing panel whilst the other lines report the values of the 4 configurations which include the diffusing panel. The red, bold line reports the values related to the panel in the configuration effectively used in the theatre.

From the graphs, the scattering coefficients (figure 7, left) resulted higher than 0.8 for all the frequencies, except for 250 Hz (the scattering value is 0.72) and 500 Hz.

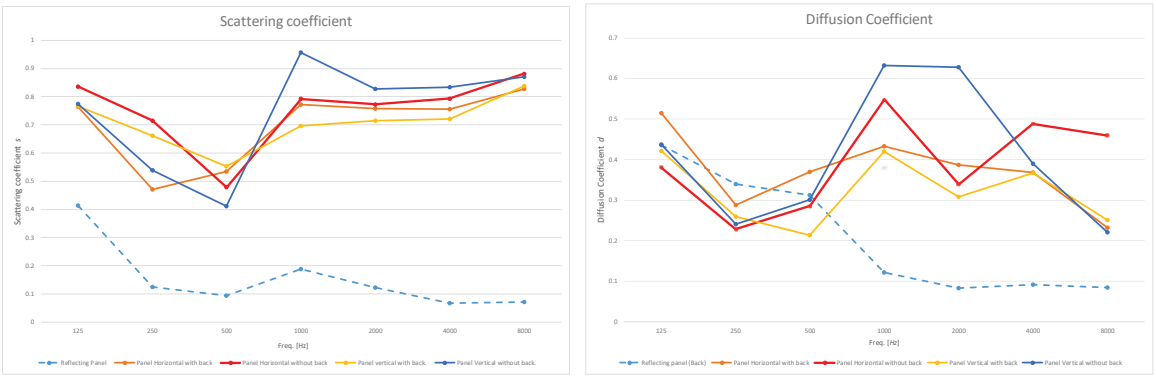

Figure 7 – The results for scattering and diffusion coefficients

On the other hand, figure 7 (right) reports the results of the diffusion coefficients. In this case, the effectiveness of the diffusing panels appears clearly starting from 1 kHz; the dotted line (which corresponds to the reflecting surface behind the panel) shows no diffusion.

Table 2 – Results of the measurement (average)

Parameter	125	250	500	1k	2k	4k	A
EDT	1.73	1.67	1.31	1.24	1.23	1.14	1.21
T_{10}	1.85	1.66	1.32	1.24	1.25	1.16	1.23
T_{20}	1.8	1.62	1.38	1.26	1.24	1.14	1.25
T_{30}	1.7	1.57	1.42	1.27	1.23	1.14	1.27
CT	155.27	135.75	99.11	95.44	93.74	92.04	88.10
C_{50}	-6.3	-3.86	-1.97	-2.00	-1.51	-2.02	-1.43
C_{80}	-2.84	-1.73	0.88	0.71	1.04	0.90	1.42
D_{50}	19.3	27.80	38.26	38.25	40.25	37.04	40.99
LFC	0.69	0.72	0.67	0.75	0.80	0.73	0.76
IACC	0.98	0.95	0.87	0.77	0.72	0.73	0.75
RaSTI	0.48	0.47	0.53	0.53	0.54	0.54	0.54

Analysing the results, there are evidences that EDT and RT_{30} are quite similar each other. This means that the sound energy produced in the performance area (i.e. the stage) is mostly moved on the cavea. This is not a very frequent result for Italian style opera houses, where often EDT is greater than RT_{30}. The values of Center Time (CT) and Clarity (C_{50} and C_{80}), underline that the main hall is located in the average values suggested for Opera houses, closer to the more reverberant area, therefore suitable for music performances. In the boxes and in the cavea, despites the highly

reflecting curved surfaces in the stalls, the analysis of the Impulse responses showed no evidences of focalization, which was the purpose of the diffusing panels.

5. CONCLUSION

The Teatro Amintore Galli in Rimini opened on 28th October 2018, after 75 years from his destruction during the Second World War. The architectural characteristics of the room has followed the rule "*where it was, how it was*", but the reconstruction included several technical and acoustic enhancements that are required in a new opera house in the 21st Century.

This paper summarized some steps of the reconstruction of the theatre Amintore Galli in Rimini, which lasted 10 years. The first comment of Cecilia Bartoli, who inaugurated the theatre with the Cenerentola (Cinderella) by G. Rossini was that "…the theatre sounds, sounds… and the acoustics is perfect!".

ACKNOWLEDGEMENTS

The Author acknowledges Angelo Farina, Giorgio Guidotti and Alessandro Angelini for their important help during the research. This work was carried out within the research project n. 201594LT3F which is funded by PRIN (Programmi di Ricerca Scientifica di Rilevante Interesse Nazionale) of the Italian Ministry of Education, University and Research.

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