

The Acoustics of Ancient Theatres Conference
Patras, September 18-21, 2011

THE ACOUSTIC EVOLUTION OF THE LARGE THEATRE OF POMPEII

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Abstract

The city of Pompeii (Italy) was buried by lava from the eruption of the volcano Vesuvio in 79 AD. The Large Theater of Pompeii was brought to light in recent centuries; in origin it could accommodate about 5.000 spectators, now it has been partly rebuilt, and is used for various kinds of show performances. Last year, the cavea, in the past covered with grass has been covered with bricks. This paper reports the acoustic evolution of the Large Theatre of Pompeii. Starting with a virtual reconstruction of the theatre in its origin, the acoustic characteristics were evaluated using “Odeon” room acoustic software. Subsequently are reported the acoustic characteristics of the theatre after the reconstruction of the cavea with bricks.

Keywords

simulation, cavea, grass, covered, bricks, reverberation

1. Introduction

The large theatre of Pompeii has been built in an U long plan form [1]. It has been rebuilt during the Roman period with the construction of the summa cavea and the construction of the scaena, their height was brought at the same level forming a closed box (Figure 1) [2]. The Greek origin of the theatre remains with the U long form of orchestra (not semicircular as the Roman theatres) and the cavea is based on a regular slope and not on a multilevel multiple arch. The materials used were marble for the cavea, bricks and plaster were used for the scaena walls. The scaena was probably on two order columns and it was embellished by doors, niches and columns, on the scaena was a slop wooden roof. The theatre's entry was formed by two large arches in correspondence of the orchestra which connected the entry to the external. The cavea was divided into sections by five cunei lines. It's assumed that the orchestra was gifted by an hydraulic installation which was filled with water used during the water show. The theatre was covered by a velarium [3], formed from lengths of coloured cloths which had the function of protecting the spectators from the sunshine during the performances; the support's velarium are preserved in the upper part of the summa cavea.

The theatre was buried by the eruption of the volcano Vesuvio in 79 AD. In the centuries it has been use as quarry. Only at the end of XVIII century it was brought to light e during XX century it has been used for show performances.

During the excavation works the scaena walls have not been rebuilt and the cavea was not built in marble steps as in origin, but it was formed by a ground and grass slope, and it was rebuilt only a part of the summa cavea. The theatre so rebuilt was an appreciated touristic place, but also was used, during the summer season, for lyrics, jazz and pop performances. In the grass and ground cavea were installed removable wooden seats which at the end of theatre season were removed. For economic and choreographic reasons in 2011 the cavea was covered by squared bricks, the summa cavea was restored in part for the public access and were built seats in squared blocks. The theater in this configuration was used for the show season in 2011.

The geometrical dimensions are: diameter of the cavea: 58 m; diameter of the orchestra: 10 m; width of the scaena: 30 m; height of the pulpitum: 1 m. The original capacity was of 5.000 spectators. The theatre is used nowadays with a capacity of 2.200 seats.

2. The “Large Theatre” acoustic evolution

The purpose of the present paper is to study the acoustic properties of the “Large Theatre” of Pompeii during 3 steps:

- First step: in the Roman period (before the 79 AD eruption).
- Second step: in the period till 2010, during which the theater was brought to light with the cavea in ground and grass and the scaena in part reconstructed.
- Third step: in the last period after 2011, when the cavea was covered with squared brick blocks and the summa cavea in part rebuilt.

2.1 Roman period.

The virtual models of the theatres was drawn on geometrical measurements made “in situ” and on available drawings with details corresponding to similar Roman theatre of the same historical period. The model is detailed, it contains over 2400 surfaces, the cavea is defined with seat rows and stairs, and the scaena's walls were united as a single structure with the cavea. The computer simulations were carried by “Odeon 10.1” room

acoustic software, the Figure 2 shows the virtual model by “Odeon”. Because the theatre is open, a box closed the virtual model with a surfaces with an absorbent coefficient equal to 1.0; inside for the seat rows the scattering coefficient was set to 0.7. An omnidirectional point source was placed on the scaena, to simulate an actor; and along three direction in cavea were placed the receivers. The surface materials were selected: the scaena was in plaster, the cavea was in marble with steps. The results of acoustic simulations of the “Large Theatre” in Roman period were compared with the acoustic properties of other similar theatres [4], [5].

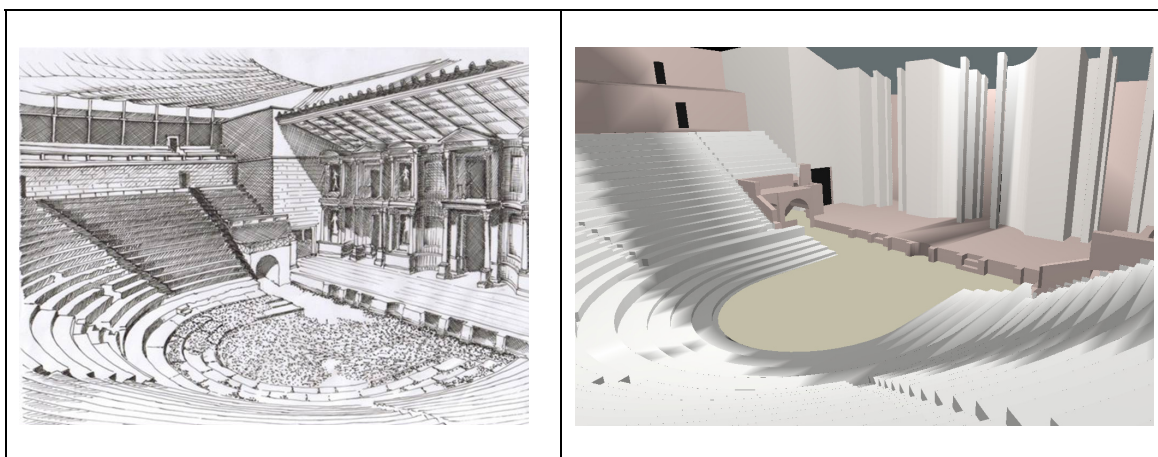


Figure 1 - Hypothetical reconstruction of the “Large Theatre” in Roman period

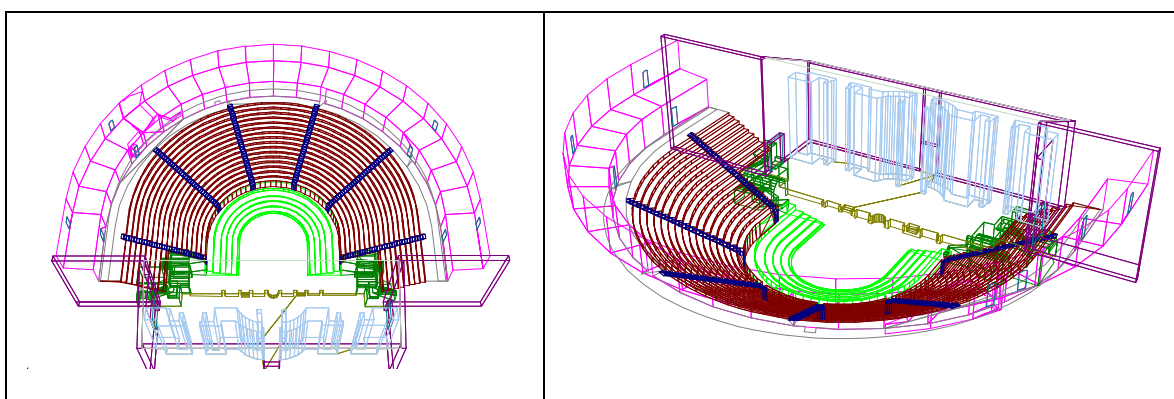


Figure 2 – The virtual model by “Odeon” of the “Large Theatre” in Roman period

2.2 Period till 2010 (before restructuring works).

The second step is the evaluation of the acoustic properties of the theatre with the cavea in grass and earth, the Figure 3 shows same picture of the “Large Theatre” in 2010; during the summer same musical performances were organized, and the cavea was covered with removable wooden boards, on metal support. The virtual model has been developed taking into account the hill configuration without steps, and the scaena and summa-cavea partially reconstructed. The acoustic simulations were compared with “in situ” acoustical measurements [6]. The reverberation time (RT) is the acoustic parameter chosen for the virtual model calibration, the calibration works were stopped when the error on the difference between the value of reverberation time measured and calcu-

lated was minus than 10% The acoustic parameters analyzed are in according to ISO 3382 (RT, EDT, C80, D50 and STI) [7].

2.3 Year 2011, after restructuring works.

In 2011 restructuration works were carried out, the cavea was covered with square bricks, the size of the step are 0.40 m high and 0.70 deep. The Figure 4 shows the “Large Theatre” in 2011. The virtual model has been developed taking into account the cavea covered with blocks (compared to the previous virtual model for the cavea were changed the absorbent coefficient and the scattering coefficient). The acoustic measurements were carried out with an impulsive sound source in October 2011. Due to the lack of AC sockets, a lightweight battery-powered equipment was used. The acoustic responses to the explosion of toy-balloons were recorded with a microphone for measurement connected to a laptop PC through the 01 dB Symphonie interface. The microphone’s measurements points were positioned in three directions along the cavea; for each direction, four points were chosen at equal distance. The acoustic parameters analyzed are in according to ISO 3382 (RT, EDT, C80, D50 and STI) [7]. Also in this case the reverberation time (RT) was the acoustic parameter chosen for the virtual model calibration.

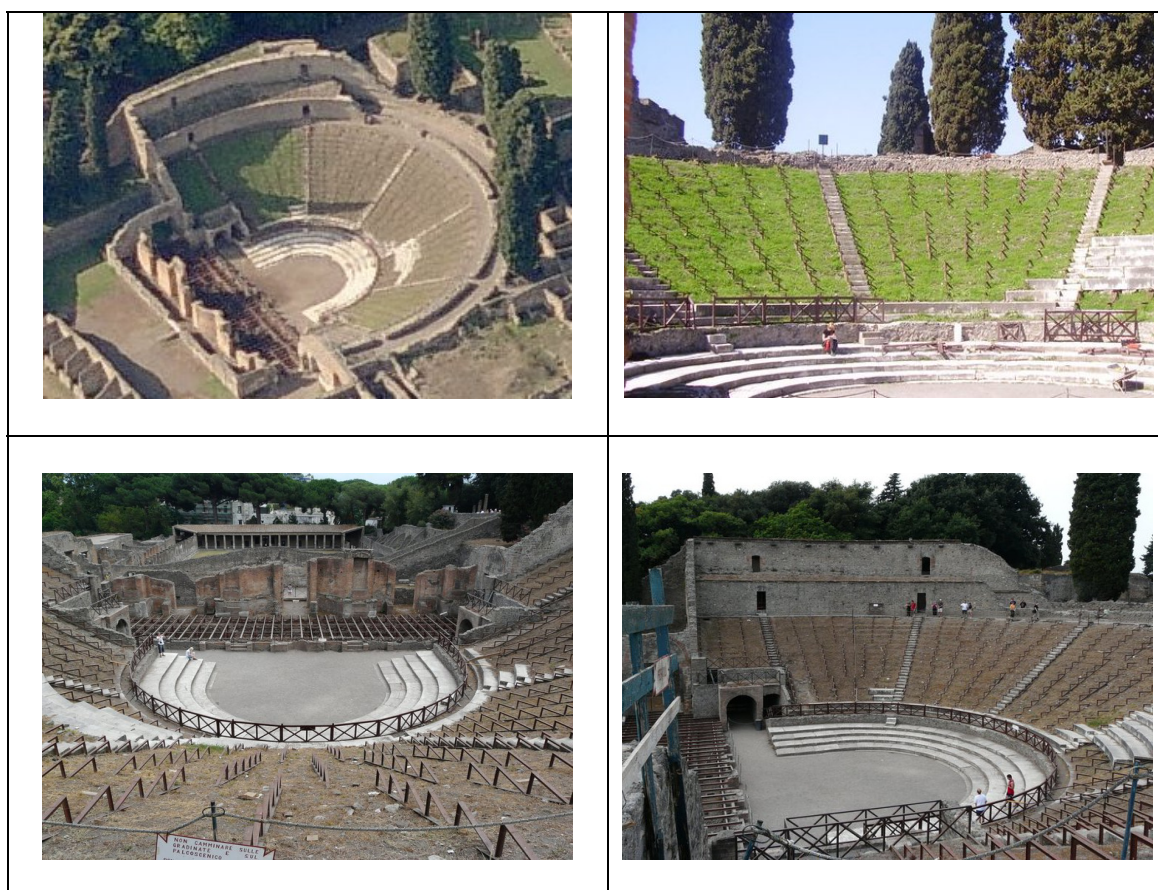


Figure 3 – The “Large Theatre” in 2010, before restructuring works



Figure 4 – The “Large Theatre” in 2011, after restructuring works

The Figure 5 shows the average values of the acoustic parameters obtained by “Odeon” software for the three configuration analyzed, in according to ISO 3382 (RT, EDT, C80, D50 and STI). The reverberation time for the “Large Theatre” in Roman period is not over 2.0 s, while in modern configuration (till 2010 and 2011) the reverberation time is less than 1.0 s, because the cavea’s materials are not reflective and for the absence of the scaena’s walls and the absence of the summa-cavea walls around the theatre.

3. Conclusion

The acoustic measurements, and acoustic simulations obtained by the virtual model provides us information on the theatre acoustic behaviour, in fact the reverberation time is long enough only in presence of the scaena’s walls, while the presence of acoustically reflective surfaces in the cavea, does not generate a sufficient length of the reverberation time. The acoustic parameters obtained by the theatre virtual model in Roman period, are similar to the acoustic measurements and acoustic simulations of theatres built in the same period. The theatre configuration before the 2010 had a low reverberation time, but very good value of STI (0.78) and D50 (over 0.80), the theatre had good properties for the speech. After the restructuration works (2011 year), the reverberation time is increased slightly, but are decreased the values of STI (0.70) and D50 (0.60), because only the cavea was covered with acoustically reflective surfaces, but the scaena was not changed. In actual configuration the theatre does not good results for the live music (symphonic, classic or single singer). But the opinion of the audience in not only func-

tion of “what they hear”, but of also “what they see”, so the “Large Theatre” is a fascinating location where music, history and entertainment came together.

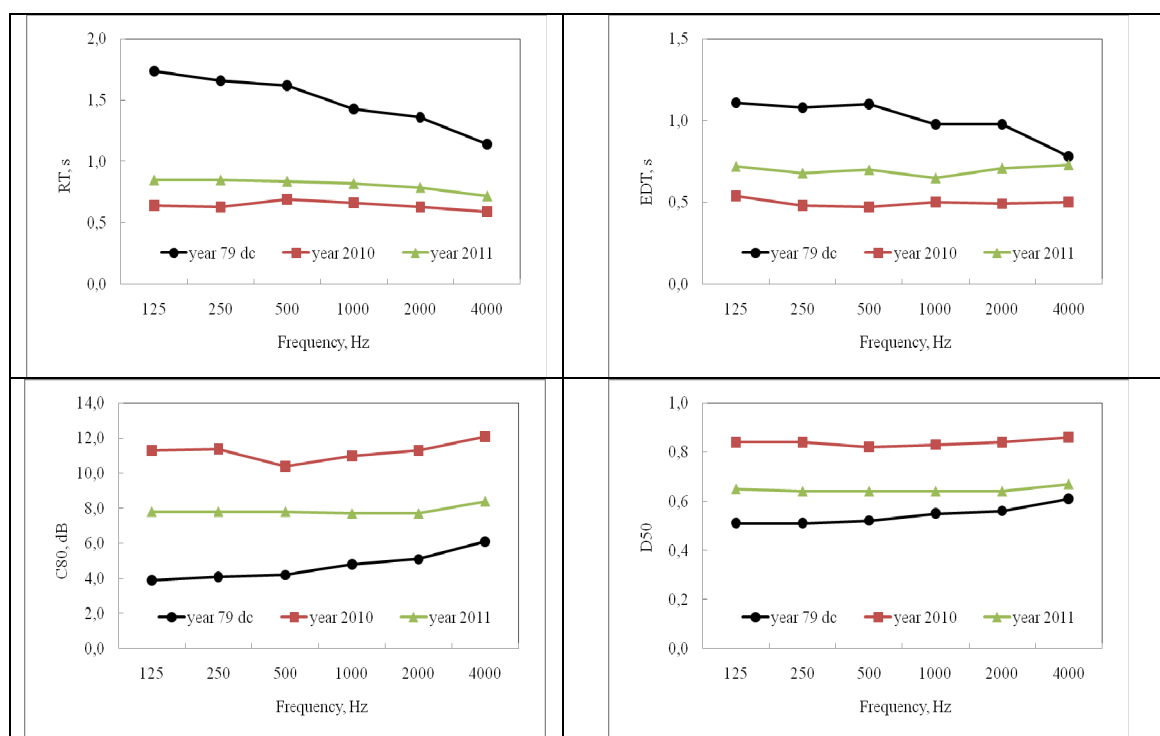


Figure 5 – Acoustic parameters average, obtained by “Odeon” software for the three configuration analyzed. The STI average values are (0.62 Roman period), (0.78 in 2010), (0.70 in 2011)

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