

# VITRUVIUS AND ANCIENT THEATRES

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## ABSTRACT

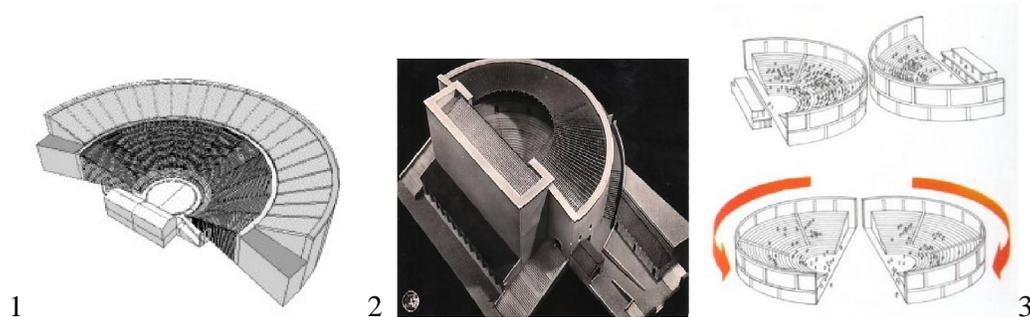
The ancient theatre in its many aspects has, attracted a great deal of interest in recent years. The Roman architect Vitruvius, who lived in the first century B.C, was the chief authority studied by architects. His books had a huge influence on the West since classical Renaissance. Vitruvius discussed in his Fifth Book on Architecture, *De Architectura*, which appeared between 27 and 23 BC, the construction and proportions of the Greek and Roman theatres. Vitruvius explained how to lay out a theater of the Greek and Roman type. He mentioned that two factors were taken into consideration while choosing the site of the theatre, the healthy place and good orientation for the theatre. However, the acoustic qualities mentioned by Vitruvius in the chapter on the Roman theatre, as to the advantages of placing bronze vessels a round the auditorium of theatres, have given rise to many speculations and misunderstandings.

Meanwhile, his precepts presented in the main points were accepted as final. In some cases a failure to understand his meaning has led to curious results. It is perhaps a mistake to expect to find the perfect Vitruvian Theater. Vitruvius himself fully expected departures from the norm and he spelled this out clearly and to what extent it may be modified to suit the nature of the site or the size of the work. This paper will discuss and evaluate in general, the Hellenistic and Roman theatre design, their acoustic qualities and orientation by the testing and evaluation of Vitruvius main recommendations in ancient theatre design.

## 1- Understanding the Ancient Theatre

The theater is a specialized category of buildings designed for public assembly and performance. It is important to distinguish between an open air theatre and amphitheatre. The open air theatre is more or less semi circular, has an elevated *proscenium*, and was used both by the Greeks and the Romans, mainly for theatre plays **Fig.1.1**. The amphitheatre is circular or elliptical (*amphi*-means from both sides in order to see from all directions) and has an arena in the centre; it was not used by the Greeks, but it is a Roman invention used for gladiator fights and wild animals **Fig.1.3**. In general, the Greek, Hellenistic, and Roman open air theatre was composed of three elements [1]:

- (1) The area for the audience "*cavea*", the "*theatron*" which means "seeing place".
- (2) In front of it and partially surrounded by it lay the *orchestra* [2].
- (3) The "*skene*", as a theatre building, formed the background for the orchestra.



**Fig.1.1-** Open air Greek theatre 2- Roman Odeon (roofed theatre) 3- Roman amphitheatre

The *cavea* or auditorium containing the tiers of seats for the audience was designed with great skill to ensure its adaptation to the landscape, superb acoustics and the easy movement of the spectators. As the seating area of a theatre became enlarged, it became necessary to build supporting walls for the *theatron* called *analemmata*. The skene, a tent or small wooden hut was probably added in the middle of the fifth century BC. The skene, the source of our word scene, was the place (or scene house, stage) at the rear of the acting space [3].

A smaller but still more specialized type of theatre building identified by the generic Latin term *theatrum tectum* (roofed theatre) was being developed concurrently with the larger out door theatres. This kind of theatre, the *Odeon*, occurred already in the Greek period and became widespread in the Roman period; it is actually a concert hall for singing and music performance, but also used for major meetings **Fig.1.2**. It is very familiar that the odeon was built in a short distance from the larger open air theatre. It is also typical that the amphitheatre is located far away from the theatre and odeon. Actually, both the theatre and the odeon served as a cultural centre. However, the location of theatres was affected by the general planning of the city. In general, the location of theatres in the city is directly related with the main elements, forming the urban fabric, such as the *cardo* and *decumanus*, the forum and the temples. However, major locations for theatres tended to be around temples. This relationship between theatre and temple emphasized the spatial and sequential concept of the dramatic play in the Greek and Hellenistic period.

The ancient theatre was not only for dramatic productions, but also stood as a huge multi-functional, social, religious, propaganda and political meeting space [4]. As a meeting place it provided a dignified setting, stratified seating by status, and the audience's gaze focused on the wealthy and the colonnaded *scaenae frons*. The theatrical presentations were considered as a big event. However, the theatre in its architectural design reflected the actual social structure of the society. In every historical epoch, all theatres, both out door and roofed, have been used for many purposes. Theatres are categorized technologically as being either multi- purposes or multiple-use. A multi- purpose theatre is defined as a facility for public events as

disparate as athletics and the performing arts. A multiple-use theatre is defined as an exclusively theatrical-type, facility for public performance of music and performing arts [9].

## 2- Vitruvius and Theatre

*Marcus Vitruvius Pollio* is the author of a remarkable book on the art of Architecture (*De Architectura*), which was for the Romans and much later for the world of the classical Renaissance, the master treatise on the art of building. But *De Architectura* which appeared between 27 and 23 B.C. [5] was far more than that, it ranges in its ten books over everything of interest and importance to the building trades, from the mixing of mortar from proper materials, to the acoustics in a stone theatre, and even to the art work such as fresco style which was used to decorate the villas. There is little that Vitruvius did not touch upon, one way or another. Actually, Vitruvius is our sole source of information on classical architecture and at a technical level.

Vitruvius provides some interesting information in his Ten Books on Architecture; however, some of this information has often been misunderstood. Vitruvius was the chief authority studied by architects, and in every point his precepts were accepted as final. In some cases a failure to understand his meaning led to curious results. It must be borne in mind that his book appeared at the beginning of the Augustan age a period that witnessed remarkable architectural developments, not least in theatre architecture. However, Hellenistic theatres were enlarged and significantly altered in the first century BC. Actually new theatres were erected in the first and second centuries AD, meanwhile with new Roman construction methods, but with plans that imitate those of Hellenistic theatres.

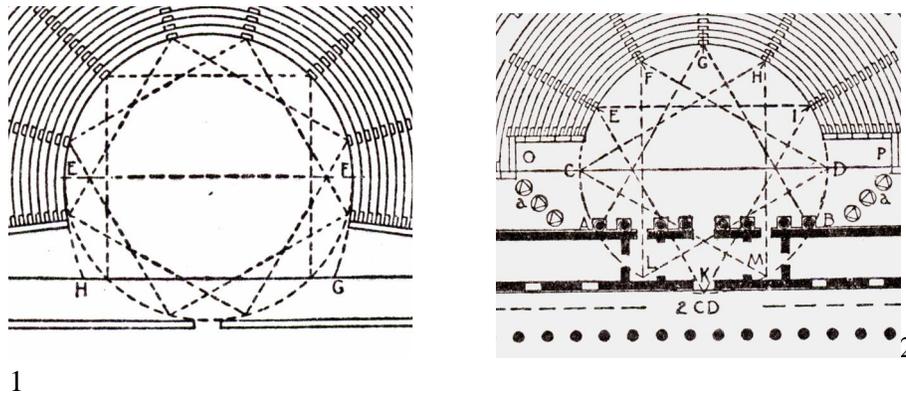
Vitruvius in his Fifth Book *De Architectura*, explains how to lay out a theatre of the Greek and the Roman type, their construction and proportions, the orientation and many acoustical aspects including the vessels [6]. The vessels mentioned by Vitruvius in the chapter on the Roman theatre have given rise to many speculations and misunderstandings from an acoustical point of view. On the other hand, Vitruvius does not mention the amphitheatre, because this is a later invention, nor the odeon. The Odeon in Pompeii (50 B.C.) is believed to be the first of this kind of roofed theatre in the Roman style. This may explain why Vitruvius doesn't mention the odeon for at the time when he wrote his books, those roofed theatres had not been yet a tradition.

### 2.1 Vitruvius and the Layout of the Greek and Roman Theatres

According to Vitruvius, the geometrical lay out of the Greek theatre in relation to the orchestra, the angles of the three squares touching the circumference, meanwhile in the Roman theatre we have the angles of four triangles (IV, ch.7, 1).

In the Greek theatre, **Fig 2, 1**, the line of the *proscenium* (or stage) is drawn along the side of the square which is nearest to the scenery, where it cuts the circumference. On the same side, parallel to this a line is drawn to touch the outside of the circle, and on

this the front of the scenery is marked out. Through the centre of the orchestra, opposite to the proscenium, another parallel line is drawn; where it cuts the circumference right and left centres are marked at the ends of the semi-circle. Fixing the centre of the compasses on the right, with a radius equal to the distance of the left point, a circle is drawn to the left side of the proscenium. In the same way, the centre is fixed on the left and with a radius equal to the distance of the right; a circle is drawn to intersect the right side of the proscenium.



**Fig 2.** 1- Vitruvius geometrical lay out of the Greek theatre 2- Vitruvius geometrical lay out of the Roman theatre

In the geometrical lay out of the Roman theatre, **Fig2. 2**, the centre is to be taken, of the dimension allotted to the orchestra at the ground level (V, and ch.6, 1). The circumference is to be drawn; and in its four equilateral triangles are to be described touching the circumference at intervals .Of these triangles, the side of that which is nearest to the scene will determine the front of the scene, in the part where it cuts the curve of the circle. Through the centre of the circle a parallel line is drawn which is to divide the platform (*pulpitum*) of the proscenium from the orchestra. Thus, the stage will be made wider than that of the Greeks because all the actors play their parts on the stage, whereas the orchestra is allotted to the seats of the senators.

## 2.2 Orientation

Vitruvius mentioned that two factors were taken into consideration while choosing the site of the theatre, the healthy place and good orientation: taking especial precaution that it be not exposed to the south; for when the sun fills the cavity of the theatre, the air confined in that compass being incapable of circulation, then is heated, and diminishes the moisture of the body. On these accounts, those places where bad air abounds are to be avoided, and wholesome spots to be chosen [6], so as to protect also the spectators on the theatre from the direct sun-light . If due care be taken in the choice of the situation, the effect of the voice will be improved, and the utility of the theatre increased.

### **2.3 The Theatre Acoustic and the Vitruvian Resonating Vessels**

One reason for the success of the ancient Greek and Roman theatres was that disturbing environmental noise was generally quiet when they were in use. However, it is reported that the unoccupied seats and the heads of the audience also scattered sound to adjacent area. [7].

The acoustics of open-air theatres was mentioned by Vitruvius, but he did not mention anything about the acoustics of roofed theatres. This earliest documentary discussion by Vitruvius shows, interestingly, that his overriding concern is for acoustics, rather than vision, and this even extends to the rules he gives for seating design. Vitruvius presents us with an elegant theory for the manner in which theatre sites can be unsuitable, namely if they exhibit acoustic dissonance, circumsonance, or resonance, in which the voice is supported from below, increases as it goes up and reaches the ears in words which are distinct and clear in tone. Hence, there has to be careful attention in the selection of the site to be perfectly suited to the purposes of a theatre.

However, there are some suggestions about the acoustic qualities of the theatres raised by Vitruvius as to the advantages of placing bronze vases round the auditorium of theatres. "*.... let bronze vessels be made, proportionate to the size of the theatre, and let them be so fashioned that, when touched, they may produce with one another the notes of the fourth, the fifth, and so on up to the double octave.*" [6]

### **3-Testing and Evaluation of Vitruvius Main Recommendations**

In fact, the basic concept of theatre design is concerned fundamentally with the dual phenomenon of seeing and hearing of public performance, preferably seated as close as possible to the performers (sightlines and sound lines). Although much has been written on the subject, there has still been no satisfactory explanation of the form and design, orientation and acoustic qualities of the ancient theatre.

#### **3.1 The Form and Design of the Theatre**

It is interesting for the ancient theatre studies, as in the recent article of Frank Sear "Vitruvius and Roman Theater Design" (1990) [5], where he concludes that architects of the early Empire modified the layout of their theatres but did not abandon Vitruvius's method. Sear tentatively offers a method of designing theatres according with the archaeological evidence and is close to the Vitruvian model. He also clarifies that "it is perhaps a mistake to expect to find the perfect Vitruvian Theatre. Vitruvius himself fully expected departures from the norm and he spelled this out clearly and unambiguously [6].

It is a fact that, Vitruvius design methods have some validity in the case of Hellenistic theatres, while most of the Roman theatres were designed as Vitruvius prescribes. That Vitruvius made this clear disclaimer suggests that, he was setting out to provide an underlying geometry of theatre design and was aware that few theatres would fit this reason where the staircases in the cavea are often fixed by the seven points of the four triangles within the orchestra circle [5]. It should be emphasized that although the theatre design underwent a considerable transformation during the Augustan period, the actual procedure of laying the theatre out in terms of the geometry used seems to have been very little different from that prescribed by Vitruvius. However, it is logical that he reflects the Late Republican building practice and the critical of contemporary fashion of the early Augustan period, 27-25 BC, and thus early Augustan theatres come closest to his model. However, his model soon became unfashionable, as the scene building changed the most under Augustus. Actually, this was a period of experimentation and increase in monumental effects.

### 3.2 Theatre Acoustic Qualities

Vitruvius is our sole source of information on classical building at a technical level, while quite voluble on the subject of empirical acoustics in the open air, is mute on the acoustics of enclosed space [9]. The physical phenomenon of seeing is directly observable, and is therefore subject to straight-line of sight common sense explanation. The physical phenomenon of hearing is more complex, even though it is not directly observable. An ancient Greek theatre consists of the *theatron*, for the audience seating, and the *orchestra*, a flat acting area. An ancient Roman theatre added a large stage building behind the *orchestra*, patterned after later Hellenistic theatres. This stage building provides to the audience area strong reflections to reinforce the direct sound, and such reflections improve source loudness and speech intelligibility. Izenour [9] research about the acoustic of the classical theatre, suggests that the lost voice up to 1st diazoma in Aspendos is 30- 40%. The existence of the *portico* persevered the acceptable voice strength to the upper levels.

For the section of the theatre : a line drawn from the first to the last step should touch the front angle of the tops of all the seats; in which case the voice meets with no impediment. The roof of the *portico*, which is on the last step, should be on a level with the top of the scene; by which arrangement the voice will extend and be distinct to those on the upper seats and roof. For if it be not equally high, were that height is deficient, the voice, first striking thereon, will be stopped. Actually the colonnade (*portico*) improves strength of sound in remote seats. This was proved according to acoustical measurements through 3D Models in the ERATO project [10]. Thus, the portico is not only architectonic; meanwhile it has an acoustic function as mentioned by Vitruvius.

#### 3.2.1 The Vessels Effect on the Acoustics of the Theatre

What purpose could these vessels have served? What Vitruvius actually says about the vessels? Vitruvius explains that many theatres were actually built of

wood. Heavy wood construction helped to flatten the reverberation curve over the entire frequency range, and the wooden panels have a similar beneficial effect as the vessels, so the vessels are only useful in theatres built of stone. The vessels mentioned by Vitruvius in the chapter on the Roman theatre have given rise to many speculations and misunderstandings. However, he also mentions that it is quite unusual to have these vessels.

From this we understand that the effect of the vessels may be very limited. However, in principle his guidelines for the distribution in the theatre and the tuning to different resonance frequencies makes sense when the vessels are considered acoustic resonator absorbers that attenuate harmful reflections in a narrow frequency band. The vessels should be distributed in one or more semicircles around the middle part of the seating area, i.e. in the positions that can produce harmful echoes by a focusing of the reflections back to the *proscenium*.

From an acoustical point of view, such an empty vessel cannot radiate sound to the surroundings. However, such a resonator can mainly be efficient for sound absorption. The vessels were used to increase the clarity of the sound and not the strength of the sound as many have suggested. Such an acoustic resonator may amplify acoustic oscillations in a narrow frequency band around the resonance frequency, but the amplification is only inside the vessel. Though, such a resonator can be quite efficient for sound absorption, today this is often used for noise control in places where thick layers of mineral wool or textiles are not usable.

However, the acoustical results of the *Rani Gumpha* [8], indicate that it is an acoustical performance site, sharing characteristics of the classical Greek and Roman theatres of approximately the same period with the *Rani Gumpha*, the Queen's Cavern built by artist-king of Kalinga, Kharavela (ca. 200-100 BC). It is a rock cut structure, carved into Udayagiri hill. As in ancient Greek and Roman theatres, the entire performance space of the Rani Gumpa is backed by a decorated facade, and it is remarkably similar to Greek theatres of the Hellenistic period, having both an upper and lower level for playing. There are acoustical chambers behind each level as well as on either side, or a special "cantor's chamber" stage left on the lower level. The effect on the voice is astonishing. Thus, this is a rock cut acoustical installation analogous to that described by Vitruvius in Book V, Chaps. 5 and 8, of his *de Architectura*, where he speaks of vessels placed in theatres for the same purpose.

### **3.3 Theatre Orientation**

From statistical analysis of the orientation of 100 Hellenistic and Roman theatres and odea (from which 69 are Roman and 31 Hellenistic) in Asia Minor, North Africa, Europe, and Great Syria and of which 12 are odea, we found that, there are 44 theatres (44%) mainly oriented to the North; 35 of them are Roman without any odeon. Meanwhile, 20 theatres (20%) were mainly oriented to the South. This means that more than 50 % from the 69 examined Roman theatres are mainly oriented to the North.

In general we can assume that the orientation of most of the Roman theatres are as mentioned by Vitruvius, not exposed to the south, and they are oriented mainly

towards the North and East. However, the Romans, with their developed construction technology, were more capable in dealing with the orientation of their theatres than the Greeks.

Actually, through the structural elements and achievements in building techniques and materials the Romans were capable to control the issue of the north orientation and to build their theatres in different treatments, according to the topography and landscape, even on flat areas of the city. Generally, we can assume that the choice for the Roman theatre location has affected the theatre construction design and formation. Thus, we can argue that, orientation was an important issue in the Roman theatre as mentioned by Vitruvius. Therefore, the Roman theatre was more committed to the issue of orientation in comparison with the Greek and Hellenistic theatre.

#### **4. Concluding remarks**

Vitruvius main issues in ancient theatres have validity in the case of the Roman theatres, which could have been designed and oriented as Vitruvius prescribes. However, it is perhaps a mistake to expect to find the perfect Vitruvian theatre. It should be emphasized that although theatre design underwent a considerable transformation during the Augustan period, the actual procedure of laying the theatre out in terms of the geometry used, seems to have been little different from that prescribed by Vitruvius. Vitruvius himself fully expected departures from the norm and he spelled this out clearly and unambiguously and to what extent it may be modified to suit the nature of the site or the size of the work.

However, the vessels mentioned by Vitruvius in the chapter on the Roman theatre makes sense when the vessels are considered as acoustic resonator absorbers, that attenuate harmful reflections in a narrow frequency band. From an acoustical point of view such an empty vessels, cannot radiate sound to the surroundings. Such a resonator can mainly be efficient for sound absorption. Actually, the vessels were used to increase the clarity of the sound and not the strength of the sound. On the other hand, it seems that, there were conscious choices in the Roman period to orient the theatre so that the audience could avoid direct sun-lights as Vitruvius mentioned. Most of the theatres were oriented towards the north, so as to protect the spectators on the theatre from the sun rays.

Thus, re-understanding and re-evaluating Vitruvius main issues on theatre can help in reconstruction, conservation and restoration of the acoustical and architectural heritage of ancient theatres.

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## References

- [1] Robertson, D. S., (1974), Greek and Roman Architecture, p. 271, pp. 64-65
- [2] Walton, J. (1980), Greek Theatre Practice, London ,p. 81 .The Greek theatre was developed later, the slope (*Cavea*) was covered by circle rows of built stone seats, the Skene was built also of stone, and it had a simple stage in front of it looking to the cavea and Orchestra.
  
- [3] Bieber, M., (1961), A History of Greek and Roman Theatre, Oxford Univ.Press, London, p. 54. The *skene* probably did not exist for Aeschylus' early tragedies. It had at least one, and perhaps as many as three openings (doors?) which could be used as the first controlling entrances.
- [4] Frederiksen, R., (2002), "The Greek Theatre: A Typical Building in the Urban Centre of the Polis", Historia: Einzelschriften, Franz Steiner Verlag Stuttgart. pp. 91-92
- [5] Sear, Frank, (1990) "Vitruvius and Roman Theater Design", AJA (vol. 94. No.2).pp.249-258
- [6] Vitruvius (1960) , The Ten Books in Architecture, New York, Translated by Morris Morgan , Dover Publication ,V, Chapter VI, article 2, Chapter VII, article 2.
- [7] Shank land, R. S., (1973), Acoustics of Greek theaters. Physics Today, October, pp.30-35.
- [8] Thomas Ault, C., Umashankar Manthravadi, An acoustical performance space in ancient India: The Rani Gumpha.
- [9] Izenour, G. C., (1992), Roofed theaters of Classical Antiquity, Yale University Press, London.
- [10] Michel Vallet, Bruno Vincent, Martin Lisa Nielsen, Report on the Assessment of the Virtual Environments. ERATO: Deliverable 9.4. November 2005.p.3, 4.