Musical Curiosities in the Temples of South India*

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South India is often described as a land of temples. The *gopuram,* a pyramidal multi-storeyed tower built over the gateway to a temple, dominates the landscape of every village or town. Such temples represent some of the finest specimens of ancient architectural sculpture and engineering—architecture and sculpture rooted, as the other arts, in religious fervour. The sculptors treated various subjects, such as music and dance. The walls, pillars and brackets (or corbels) are decorated with carved figures of gods, goddesses, stylish lions, graceful elephants, horses, warriors, musicians, dancing girls and many other representations.

The temples play an important role in the social, economic and spiritual life of the people. Entire villages and towns, in fact, have grown around these temples.

The Pallava kings, who ruled South India from the sixth to the ninth centuries A.D., were pioneers in temple construction. The monolithic cave temples and the bas-reliefs at Mahabalipuram, 60 km south of Madras, comprise the oldest storehouse of art and history in the country.

The art of temple construction reached its zenith during the Chola hegemony, from the tenth to the fourteenth centuries. The art of bronze sculpture also attained perfection during this period, the most outstanding being the representation of Nataraja, or Lord Shiva, in the 'cosmic dance' pose. The successive dynasties of the Pallava, Chola, Pandya and Nayak rulers endowed and enriched this land with temples and monuments.

In the world-famous temple of Nataraja at Chidambaram, 240 km from Madras, one can see the sculptural representation of 108 postures relating to Bharata's science of dancing. Similarly, the ancient sculptors infused music in the stones used for temple construction. They not only used their skill in carving figures of musicians playing on musical instruments, but also chiselled wonderful objects producing musical tones. Situated in various temples, we find musical pillars, musical stairs, bronze and stone musical icons, musical bells, and musical pipes made of stone.

Musical Pillars

The South Indian sculptors used their amazing skills to chisel rocks and shape musical pillars, the 'stone pianos'. This art was at its best during the period of the Vijayanagar kingdom, from the fourteenth to the sixteenth centuries. These pillars adorn the temples at Hampi, Tadpatri, Lepakshi, Thadikombu, Madurai, Algarkoil, Courtallam, Tenkashi, Tirunelveli, Alwartirunagari, Suchindram and Trivandrum. (See Figure 1).

Hampi is a deserted city near Hospet in Karnataka State and the former capital of the Vijayanagar Empire. The Vitthal temple, though incomplete, is the grandest structure of the period. In its Music Hall are found fifty-six clusters of musical pillars of varying construction. Tadpatri, near Guntakal, and Lepakshi, near Hindapur, are small villages in Andhra Pradesh. The temples here are beautiful,

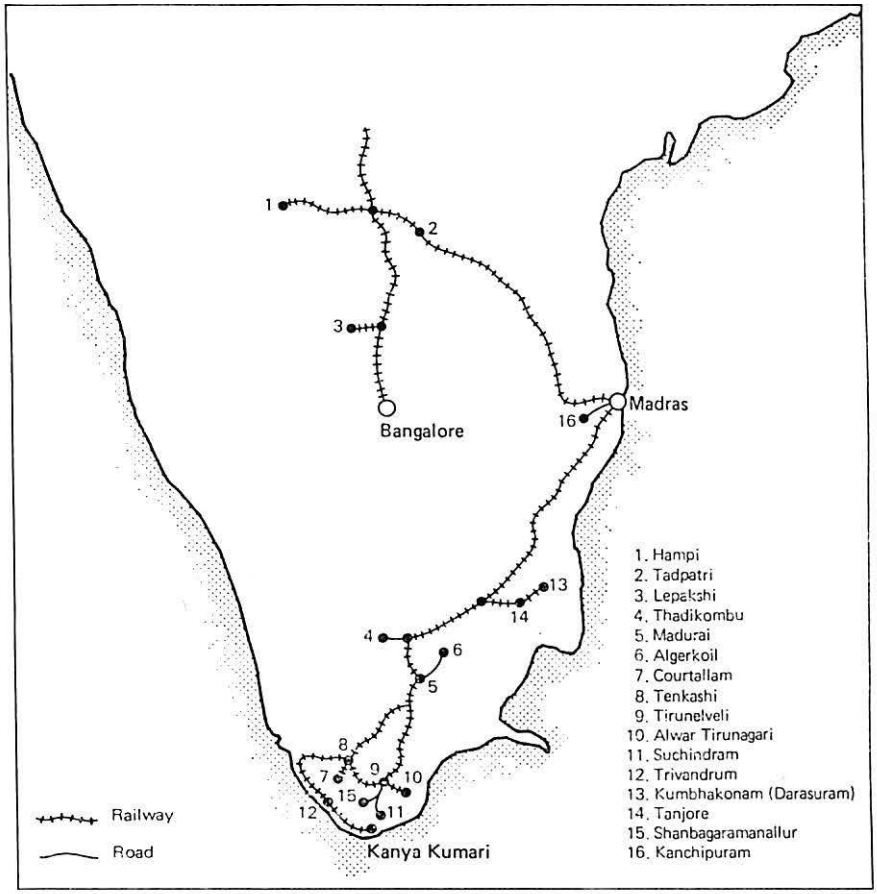


Fig. 1 Sites of musical curiosities.

fashioned in the Vijayanagar style. Thadikombu, a small village near Dindigal in Tamilnadu (Madras) State, has a temple with nicely carved pillars. Madurai's famous Meenakshi Temple is an exquisite example of Dravidian architecture and sculpture. (Dravidian, together with Northern and Chalukyan, is one of the three main Hindu styles.) The most interesting feature of this temple is the thousand-pillared hall built in the sixteenth century. The pillars bear a repeated motif of a stylized dragon. At the entrance to the hall, there are two clusters of musical pillars; there are similar pillars in the outside corridor as well.

Algarkoil is 18 km from Madurai. The hall facing its shrine contains some fine sculpture; its musical pillars are in good condition. Courtallam, Tenkashi, Tirunelveli and Alwartirunagari are in the Tirunelveli district, and there are two large clusters of fifty pillars in each of the temples at the latter two places. Suchindram in Kanyakumari, India's southernmost district, has a temple known for its musical pillars. Trivandrum boasts of musical pillars in good condition at the famous ancient temple of Shri Padmanabhaswami (Vishnu).

But what are musical pillars? They are columns of stone clustered round a central, massive pillar supporting the roof. Figure 2 shows the cross-section of one such cluster, found in the Tirunelveli temple. If the pillars are tapped with a light,

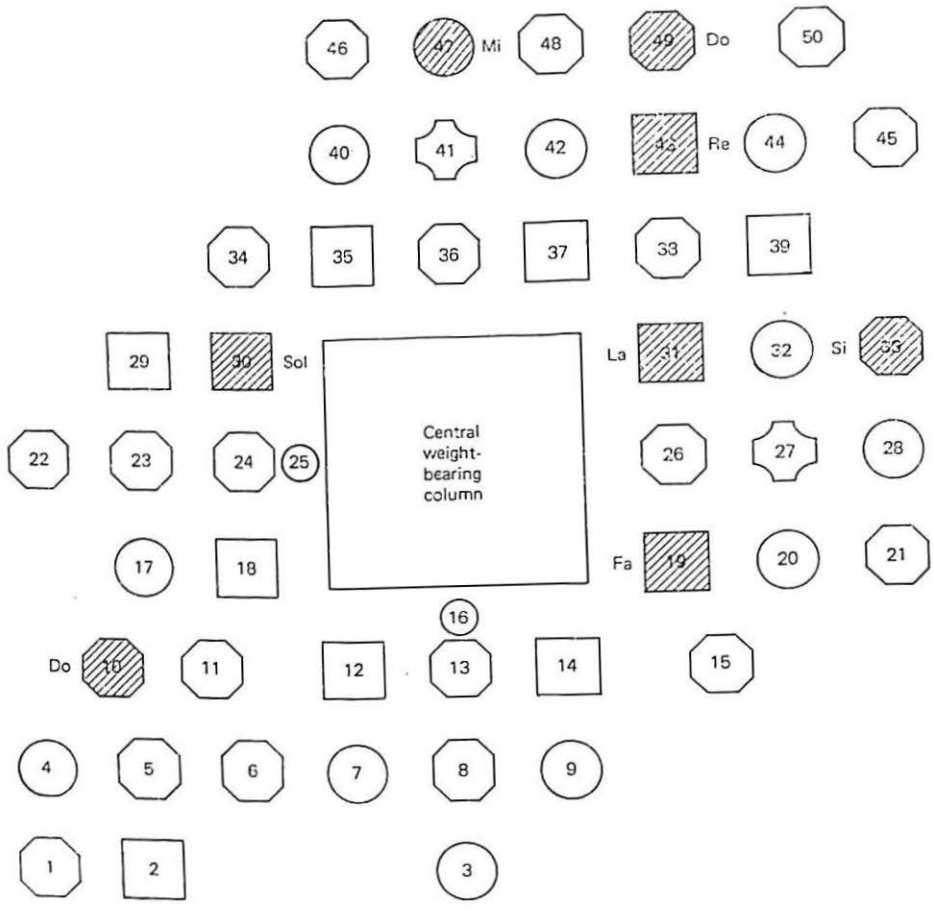


Fig. 2. Cross-section of a cluster of fifty pillars found in the Sri Nelliappar temple at Tirunelveli.

wooden mallet, they produce notes of various frequencies and their quality is somewhat similar to that of a xylophone. The pillars are of various shapes: circular, square or octagonal. The pillars range in height, in various temples, from one to two metres; those forming a single cluster are of the same height, but they differ in cross-section and shape. The entire cluster of pillars, with massive base and top (capital), is carved from a single block of granite. The pillars thus form firm columns, clamped at both ends, and they are not as hollow as one might think. The number of pillars in a cluster varies from three at Lepakshi to fifty at Tirunelveli and Alwartirunagari.

The Science of the Pillars

Systematic study of the musical pillars was undertaken by the author, assisted by S. R. Chandorkar, S. Parameswaram and K. V. Desa, in work supported by the Government of Maharashtra. One of the aims of our study was to measure the frequencies of the notes emitted by the pillars in order to ascertain which

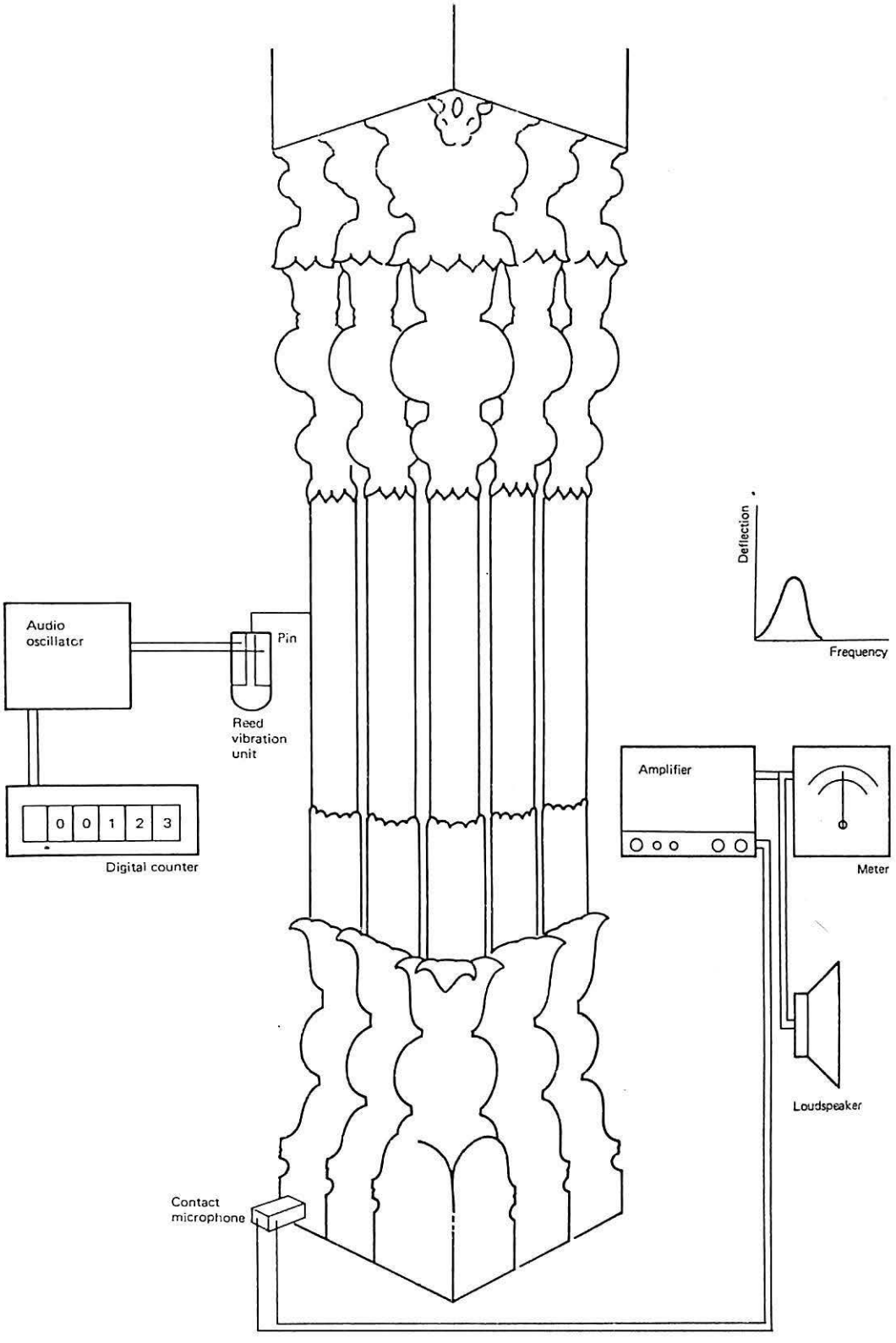


Fig. 3. Experimental arrangement in method to measure accurately frequencies of vibrating musical pillars.

musical scales could be fitted to them. An early method was to tape-record the sounds, and then submit them to frequency analysis at the Electroacoustics Research Laboratory in Pune.

In a later method, resonance technique was used to obtain accurate measurement of the frequencies after the pillars had been set into resonant vibration by a reed-vibration unit. (The experimental arrangement is shown in Fig. 3). The reed-vibration unit is connected to an audio-oscillator, and vibrations of the reed are 'coupled' to the pillar. As the audio-oscillator frequency is varied, the pillar emits an audible note in resonance. The audio-oscillator frequency in this position is the frequency of the pillar. For more accuracy, a digital frequency meter is used to read the oscillator's frequency. To obtain the exact resonance setting, a contact microphone is clamped to the base of the pillar. The microphone signal is amplified, and the amplifier output is connected to a meter as well as to a loudspeaker. At resonance, the meter shows a maximal reading and the loudspeaker gives the loudest audible note. The pillar resonates when the frequency of the oscillator

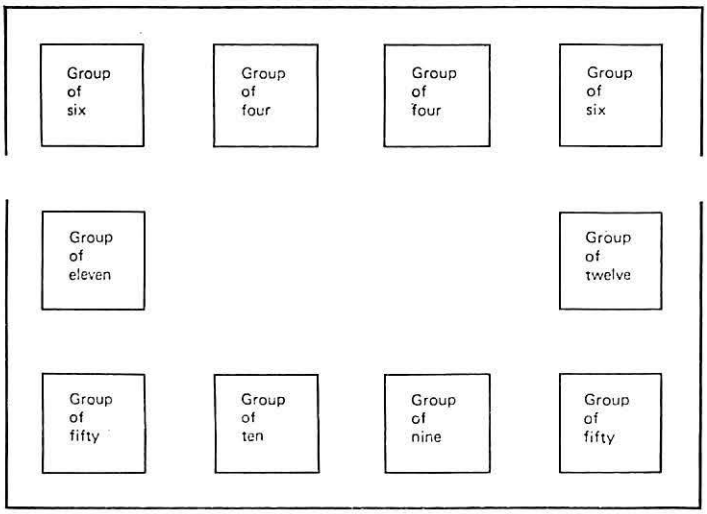


Fig. 4 General plan of the musical pillars found in the hall facing the main shrine, Sri Nelliapar Temple, Tirunelveli.

coincides with the fundamental frequency or any of the pillar's overtone frequencies. Hence, using this method, overtones emitted by the pillars can also be determined.

The resonance method has been used to establish the frequencies of the pillars in the Swami Nelliappar Temple at Tirunelveli. Figure 4 shows the general plan of the musical pillars in the hall facing the main shrine there, whose cross-section (in the left-hand cluster of fifty pillars) is shown in Figure 2.

Thus, musical pillars are looked upon as solid bars firmly fixed at each end. For a bar of uniform cross-section rigidly clamped at both ends, the relative frequencies of the fundamental and the overtones (1, 2) are given by f_1, 2.756 f_1, 5.404 f_1, 8.933 f_1 . . . and so on, where f_1 is the fundamental frequency as given by:

$$f_1 = \frac{1.133\pi}{l^2}\sqrt{\frac{Qk^2}{\rho}},$$

where l is the length of the bar, ρ the density of the bar, Q is Young's modulus (an elastic constant) of the bar's material, and k is the radius of gyration.

In the cluster of fifty pillars (Fig. 2), there are few pillars of nearly uniform cross-section. These have a rough surface and hardly any decoration. The measured

TABLE 1 — Measured and theoretical relative frequencies of pillars

Pillar No. [1] and cross-section	Measured frequency in Hz	Measured relative frequency	Theoretical relative frequency
28 (circular)	$f_1=149$	1.000	1.000
	$f_2=388$	2.604	2.756
	$f_3=780$	5.235	5.404
35 (square)	$f_1=170$	1.000	1.000
	$f_2=468$	2.753	2.756
	$f_3=910$	5.353	5.404

1. The pillars have been arbitrarily numbered for identification.

and theoretical relative frequencies of two such pillars are given in Table 1, showing a close agreement of the results. The slight deviation from the theoretical values is attributable to the roughness of the surfaces as well as minute variations in the cross-section.

Some Music-making Physics

Most of the pillars have a decorative structure and the cross-sections of these pillars are not uniform along their length, resulting in a deviation of relative frequencies from those of a uniform bar. It is interesting to note, however, that in the case of some pillars the overtones generated are harmonics. When tapped, these pillars produce pleasing tones. The measured frequencies of three such pillars, taken as specimens, are shown in Table 2.

TABLE 2 — Frequencies of overtones produced by selected pillars

Pillar No.	Fundamental in Hz	First overtone	Second overtone
	(f_1)	(f_2)	(f_1)
2	150	396	750 ($5f_1$)
33	118	306	612 ($2f_2$)
22	132	396 ($3f_1$)	660 ($5f_1$)

Comparing the relative intensities of the fundamental frequency and overtones (from an analysis of recorded notes), we note that the fundamental is weak. What we hear is mainly the sound of first and higher overtones.

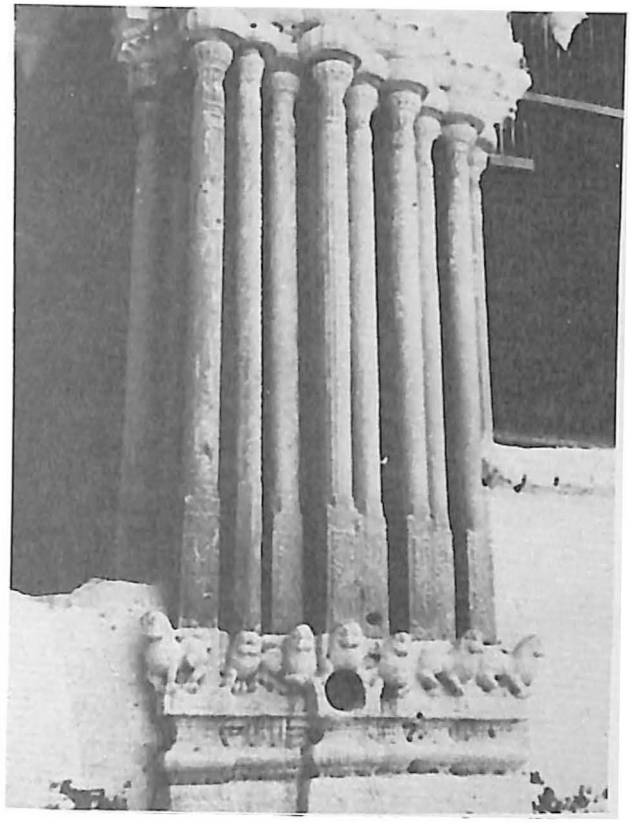
Although there are fifty pillars in the cluster examined, only one or two musical scales can be (nearly) fitted among the notes emitted by the vertical sculptures. This is because the frequencies are not properly distributed. The serial numbers of the pillars forming one of the Indian musical scales, Multani, are shown below:

Note	Do	Re	Mi	Fa	Sol	La	Si	Do
Indian notation	*sa*	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	*sa*
Pillar number	49	43	47	19	30	31	33	10

The first six notes correspond to the first overtones of the respective pillars and the last two notes correspond to the second overtones of the last two pillars.

The pillars that emit notes according to the musical scale are not suitably situated within the cluster. It is, moreover, difficult to strike the pillars that are in the inner rows; so that it is not easy for a single artist to play music on the pillars. It would appear, therefore, that musical pillars were not constructed for the playing of music of the present-day type composed of seven or more notes. It appears that the pillars might have been used for accompaniment music,

Musical Pillars, Music Hall, Vitthal Temple, Hampi.



Musical Pillars, Alwartirunagari.
(Note the resonance cavity).

composed in three to five-note combinations, as in religious hymns. It is possible to select the pillars near each other producing notes in such scales.

The author has recorded an artist singing a religious song and accompanying himself by striking the pillars. And, because rhythm music used in singing or dancing is composed of few notes, it can be played on the pillars. We have also recorded rhythm music, with the artist using metal rings slipped on his fingers in order to play the pillars. Frequency analysis of musical pillars found in other temples leads to similar conclusions.

Sculptural and Masonry Sources of Music

By using a contact microphone and an amplifier-loudspeaker system, a cluster of musical pillars can be converted into an electromechanical instrument, such as an electronic guitar.

The halls in which musical pillars have been installed have no side-wall enclosures, so that the sounds coming from the pillars are not modified by room acoustics. In some clusters, we find two or three pillars having the same frequency. In these cases, when a single pillar is struck the other pillars of the same frequency begin vibrating by resonance.

If a singer should stand close to a cluster and sing loudly in tune with the pillars, the pillars resound, albeit very feebly, because of the impedance mismatch between air and stone. The sound of resonating pillars can be made audible by electronic amplification.

Musical Pillars, Thadikombu.

A recording of vocal music (specifically, religious hymns), with electronically amplified accompaniment, has been made of resonating pillars. The accompaniment is automatic, not played on the pillars.

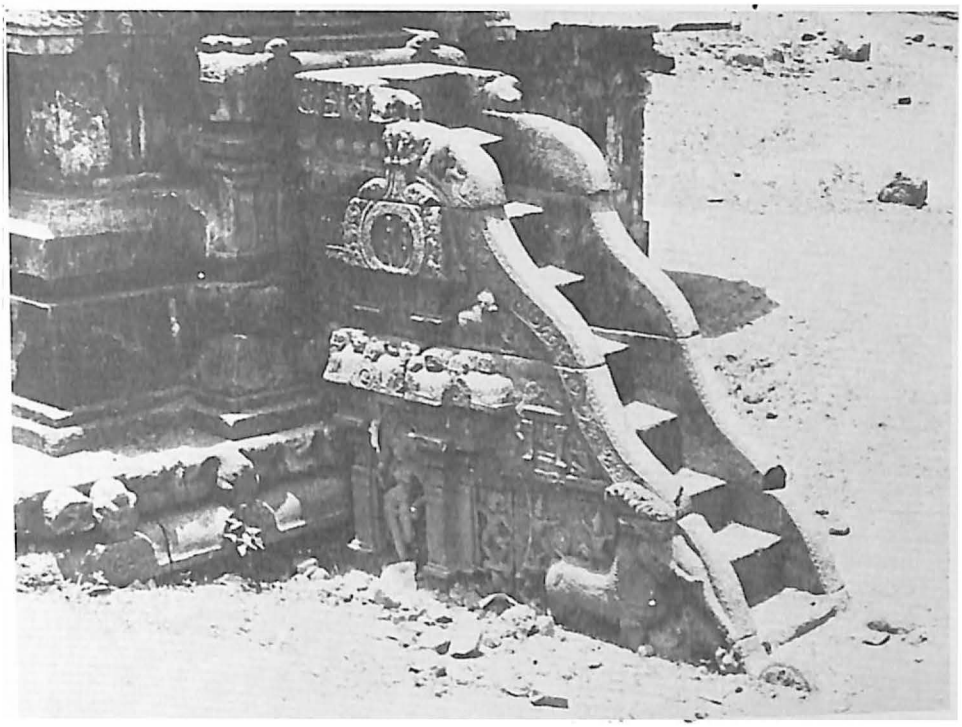
Recently, the ancient art of chiselling stone musical pillars has been revived, and the construction of new pillars has been undertaken by sculptors at Mahabalipuram.

The designing of musical pillars opens new fields in musical acoustics and the art of carving. I, for one, believe that retaining musical standards along with sculptural beauty can be achieved by using modern science and research methods.

Musical pillars have suffered deterioration, in some places, because visitors have hammered on them with hard objects. In order to avoid further damage, it is suggested that a contact microphone, with amplifier and loudspeaker system, should be used during exhibits to visitors, whereby a mere, light tap on the stone gives a loud sound.

Musical Stairs

Kumbhakonam, in Tanjore district, was once a capital of the Chola kings, and the city and its surroundings are studded with many shrines. Near the city, at Darasuram, we find stone musical steps, the sides of which are very beautifully



Musical Stairs, Darasuram, near Kumbhakonam.

carved. When seven of the eight stair treads not fixed to the ground are struck, each produces a different tone.

Musical Icons in Stone

Beautifully sculptured figures of fine workmanship are also known, cut from the same granite stone as that used to construct musical pillars. In Tanjore's Brindeswara temple, there are icons of Lord Ganesh and Garud. In the Vishnu temple at Shanbagramanallur, there are icons of Rati and Manmatha, and similar sculptures are found in the Krishnapuram temple of Tirunelveli District. The various limbs of these icons, when struck, give out distinct musical notes.

Musical Icons and Bells in Bronze

There are also musical icons cast in bronze, similar to the stone ones. There is a bronze icon at the Tirumangali temple, near Kancheepuram, called the Seven-note Maha Vishnu. All seven notes of the octave are produced when the statue's seven limbs are struck. There are also musical bells of bronze; one with a cluster of seven bells is to be found at the Raja Kelkar Museum, Pune. Each of its bells yields a different musical note.

Stone Musical Pipes

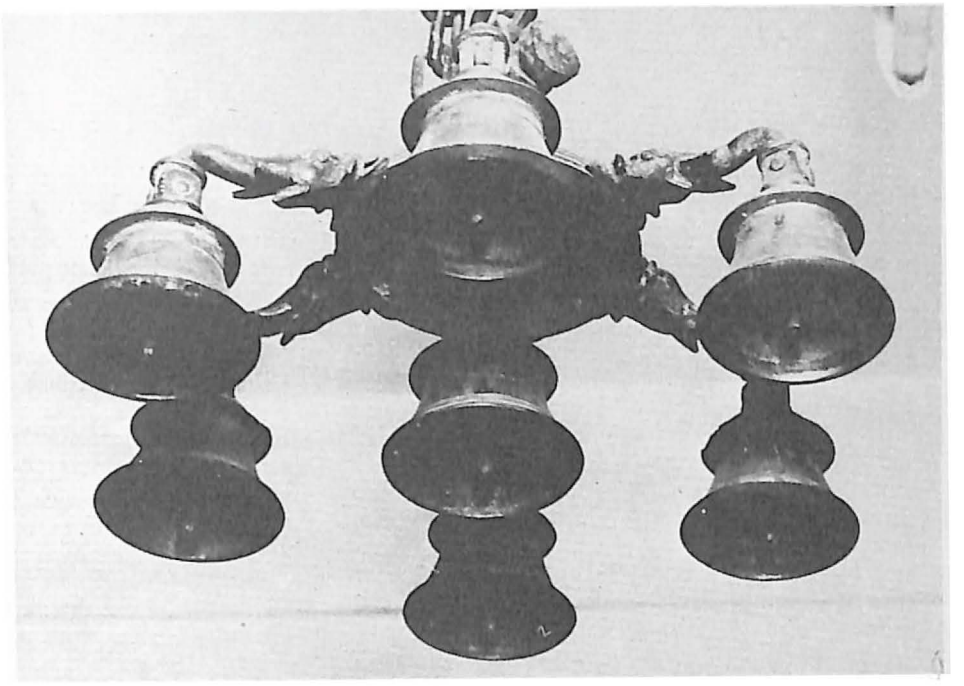
At the above-mentioned Siva temple of Shanbagaramanallur, there is a musical pipe drilled through a stone pillar supporting the roof; the pipe is conical

Musical Icon, Lord Ganesha, Tanjore

in shape. When blown sharply from the other end of the pipe, the sound produced is similar to that of a brass blow-pipe.

Nagaswaram pipes made of hardwood are used during festivals in daily temple rituals, for weddings and at other social functions. In the Sri Adi Kumbheswara temple at Kumbhakonam, there are two Nagaswaram pipes made from soapstone. Each pipe is 55 cm in length, including a 17-cm brass mouthpiece. A long, narrow hole runs the length of the pipe, flaring to a width of 2.5 cm at its end. The shell of the pipe is formed by three pieces held together with metallic rings. Two, similar stone pipes are to be found in the gallery of musical instruments of Pune's Raja Kelkar Museum.

There is also a stone pipe, called Mukha Veena, still used in the Sri Adi-Nath temple at Alwartirunagari (in Tirunelveli). Excluding its mouthpiece, it is 20 cm long, though it is made of a single piece of stone and has a tapering hole. This



Musical Bells, Raja Kelkar Museum, Pune

pipe, said to have been presented to the temple by a Nayak king, was originally employed in the dance recitals that were performed in the temple.

Conclusion

Musical pillars and similar objects made of stone have preserved for us a treasure-chest of knowledge concerning ancient music and art, a chest that can be opened and researched in a scientific way.

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