Acoustic properties of Temen and Wulung bamboo as a material for Gambang: Sundanese traditional musical instrument

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Abstract. Wulung bamboo (Gigantochloa atroviolacea Widjaja) and Temen bamboo (Gigantochloa atter) are common materials for making Sundanese traditional music like Gambang in West Java. From subjective judgment of the maker like Mr. Handiman Diratmasasmita, it is perceived that Temen bamboo is more musical and softer than Wulung bamboo when the Gambang are played. Hence, it is instructive to investigate further in order to find the acoustic parameters of both the bamboos that associate with the differences. To deal with the problem, a series of measurements were carried out in ITB anechoic chamber. Two similar-tuned rattle tubes from each bamboo are considered in this work. To capture all required acoustical data, a microphone was positioned behind the opening of the rattle tubes. The sounds of two bamboos are excited by impact hammer and the Frequency Response Function (FRF) obtained by spectrum analyzer system. The results are then analyzed and discussed by considering two frequency ranges namely low-mid frequencies and high frequencies. For low-mid frequency range, it is found that the overtones ratio are not much different for example f, 2.4 f, 3.4 f, 4.9 f, 6.9 f are present for the Wulung bamboo while f, 2.2 f, 2.76 f, 4.82 f, 7.02 f exist in the Temen bamboo where f of 527.3 Hz is fundamental frequency or pitch. However, the overall fundamental and harmonics amplitude of Temen bamboo are higher than Wulung bamboo. At high frequency range the amplitudes of the Wulung bamboo are significantly higher than the Temen bamboo particularly for frequencies above 10 kHz. These results can be attributed to a more musical softer sound of the Temen bamboo.

1. Introduction

Gambang is a Sundanese musical instrument that made from bamboo. This instrument consists of bamboo tubes, which tuned in diatonic scale and arranged in parallel from low note to high note. The bamboo tube has similar shape compared to angklung, but this instrument played by hitting the tube with rubber mallet. According to Handiman Diratmasasmita, a Sundanese musical instrument maker, there are two materials that used to build the bamboo tubes. The first one is Wulung bamboo (Gigantochloa Atroviolacea Widjaja) and the second one is called Temen bamboo (Gigantochloa Atter). The later, according to the maker, are more musical and softer than the first.

There are some researches about the bamboo tube and bamboo musical instrument. Zainal et al.
presented analytical solution to determine pitch of angklung compared to the sound measurement. Siswanto et al. [2] presented the sound characteristic of three-rattle angklung. Sudarsono et al. [3] presented the acoustic analysis of pentatonic angklung. Dwiartama et al. [4] presented early observation of temen bamboo from Surade region in Indonesia. Budi et al. [5] presented acoustical analysis of temen bambu taken from Kuningan and Sukabumi district in Indonesia. Unfortunately, there’s still no research about the sound quality of these two bamboos compared to the subjective preference of the maker.

To find the correlation between sound quality of two bamboos and subjective preference of the maker, then acoustic measurement is required. The obtained frequency spectrum data of both bamboos will be compared to analyse their differences objectively.

![Figure 1. (a) Sundanese Gambang (b) Gambang played by Handiman Diratmasasmita.](image)

### 2. Methods and material

#### 2.1. Bamboo Tubes

Two tubes from each kind of bamboo are similarly tuned to C5 note (527.25 Hz). These two bamboos are taken from Surade district, Bandung. The tube length, diameter, and age of each bamboo are adjusted to Handiman’s preference. In table 1 the physical properties of the finished two bamboo tubes are shown.

**Table 1. Physical properties of each bamboo tube.**

| Name                                      | Length (cm) | Diameter (cm) | Weight (g) |
|-------------------------------------------|-------------|---------------|------------|
| Wulung bamboo (*Gigantochloa Atroviolacea Widjaja*) | 48.1        | 4.41          | 183        |
| Temen bamboo (*Gigantochloa Atter*)       | 47.9        | 4.29          | 133        |

#### 2.2. Experimental Setup

The acoustical properties from two tuned bamboo tubes were measured on the anechoic chamber in Bandung Institute of Technology. First, the bamboo was hanged using the rope. Then, three microphones were placed 50 centimeters behind of the tube opening, the side and the top of the tube as shown in Figure 3. Another three microphones were placed in the same sides, but they were placed 100 centimeters from the tube. The tubes were struck five times by impact hammer and the sound pressure data obtained using the microphones and Reaper software. The obtained data from each microphone were averaged. In this paper, data from microphones placed 50 centimeters behind the tube opening of each bamboo are analyzed.
Figure 2. Wulung bamboo (a) back (c) top, and Temen bamboo (b) back (d) top.

Figure 3. Microphone placement (a) side view (b) top view.
3. Results and discussion
The results show the comparison of averaged spectral frequency between Wulung bamboo and Temen bamboo as can be seen in Figure 4 for low-mid frequencies between 100 Hz – 6000 Hz and Figure 5 for high frequencies.

![Wulung and Temen Bamboo 50cm Front](image)

**Figure 4.** Comparison between Wulung and Temen bamboo for low-mid frequencies between 100 Hz – 6000 Hz.

| Name  | Fundamental (Hz) | 1st Harmonics (Hz) | dB   | 2nd Harmonics (Hz) | dB   | Ratio ($f_1/f_0$) | 3rd Harmonics (Hz) | dB   | Ratio ($f_3/f_0$) |
|-------|------------------|--------------------|------|--------------------|------|------------------|--------------------|------|------------------|
| Wulung| 527.3            | 1289.060           | 50.00| 1816.400           | 39.9 | 4.90 f0          | 2589.80            | 42.90| 4.90 f0          |
| Temen | 527.3            | 1160.150           | 46.96| 1453.125           | 51.1 | 2.75 f0          | 2542.97            | 50.43| 7.02 f0          |

In low-mid frequency range, the fundamental and harmonic frequency has been analyzed. As we can see in Figure 4, each harmonic from two bamboos are related. However, the overall amplitude of fundamental and harmonic frequency of Temen bamboo is higher than Wulung bamboo; only 1st harmonic of Wulung bamboo is higher than Temen bamboo.

In high frequency range, the amplitude above 10 kHz of Wulung bamboo is much higher than Temen bamboo. Moreover, there’s no amplitude in frequency 12 kHz to 14 kHz of Temen bamboo.
4. Conclusion

Based on this measurement results, Temen bamboo has higher overall fundamental and harmonic amplitude and Wulung bamboo has higher amplitude in high frequency range especially above 10 kHz. These results can be contributed to the more musical and softer sound of Temen bamboo related to subjective preference of the maker.

5. References

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