# ACOUSTIC REPORT
# AKUPANEL

ULTRA

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# AKUPANEL ACOUSTIC REPORT


## Abstract

*In short, the Ultra Akupanel is a great addition to any home space, not only for aesthetic purposes but also for rooms that require acoustic treatment. Despite being made from high quality materials, the Ultra Akupanel is affordable for the end consumer without sacrificing useability or efficiency while outperforming the industry standard acoustic foam tiles. The report below follows through acoustic coeffeciency test results and comparisons, illustrating the data behind the Ultra Akupanel.*

# Sound Absorption Performance

**Test Standards:** BS EN ISO 354-2003 - ISO 354:2003 - Acoustics — Measurement of sound absorption in a reverberation room (specifies a method of measuring the sound absorption coefficient of acoustical materials used as wall or ceiling treatments, or the equivalent sound absorption area of objects, in a reverberation room.)

**Test Environmental Conditions:** 23.2 Degrees Celsius, thus the speed of sound equals 345 m/s

**Reverberation Chamber Volume:** 288m$^3$

**Test Method:**

- Six microphones and two loudspeakers positioned appropriately in the reverberation room.
- Record reverberation time of empty field reverberation room. The reverberation time measurement at the microphone position needs to be recorded three times:
- Lay sample in reverberation room and measure the area of the sound absorption surface of the sample:
- Measure the reverberation time of the reverberation chamber after the test sample is placed:
- The measurement process uses frequency range of 100Hz to 10kHz. This accurately replicates the most used half of the human hearing range.

| TEST RESULTS | | | |
|---|---|---|---|
| **Centre Frequency (Hz)** | **Sound Absorption Coefficient** | **Centre Frequency (Hz)** | **Sound Absorption Coefficient** |
| **100** | 0.07 | **1250** | 0.85 |
| **125** | 0.29 | **1600** | 0.83 |
| **160** | 0.55 | **2000** | 0.74 |
| **200** | 0.71 | **2500** | 0.63 |
| **250** | 0.82 | **3150** | 0.59 |
| **315** | 0.96 | **4000** | 0.54 |
| **400** | 1.00 | **5000** | 0.45 |
| **500** | 1.00 | **6300** | 0.31 |
| **630** | 1.00 | **8000** | 0.15 |
| **800** | 0.97 | **10000** | -0.17 |
| **1000** | 0.83 | **NRC** | 0.85 |

# Sound Production & Hearing Rationale

Our ears are tasked with detecting and interoperating sound, they are an outstanding transducer, converting sound energy into mechanical energy which is transmitted to the brain. The ear consists of three main sections: the outer ear, middle ear, and inner ear.

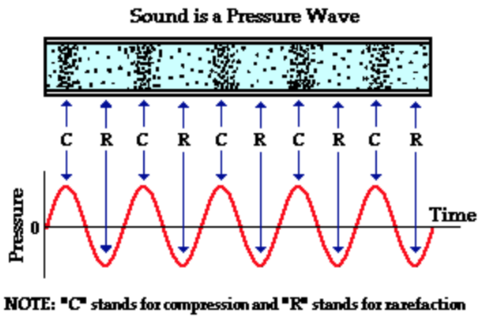


Fig. 1

## Outer Ear

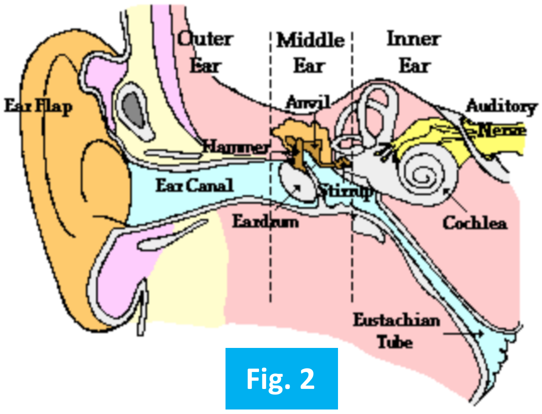


Fig. 2

The outer ear's purpose is to collect and channel sound waves, still in the form of pressure waves, down a 2 cm long ear canal. Due to the length of the ear canal, it can amplify sounds with frequencies around 3 kHz. The sound is still a pressure wave, with compressions and rarefactions until it reaches the eardrum, it is here that the energy is converted into vibrations.

## Middle Ear

The middle ear transforms the energy of a sound wave into internal vibrations of the bone structure, thus transforming the vibrations into a compressional wave. It is an air-filled cavity that is compiled of three tiny, interconnected bones, known as the hammer (malleus - attached to the eardrum), anvil (incus – positioned between chain bones) and stirrup (stapes - connects middle ear to inner ear via oval window, a membrane-covered opening that connects to the cochlea), and an eardrum. The eardrum is a thin tightly stretched durable membrane, like a drumhead, that vibrates as incoming pressure waves reach it. The eardrum is forced inwards by a compression of the pressure wave and forced outward by rarefactions in the wave. Therefore, the eardrum is vibrating at the same frequency as the sound wave. Furthermore, the movements of the eardrum will set the malleus, incus, and stapes in motion at the same frequency. The vibrations of the stapes are transmitted to the fluid of the inner ear, thus creating a compression wave in the fluid.

## Inner Ear

The inner ear is comprised of the cochlea, semi-circular canals, and the auditory nerve. The cochlea and semi-circular canals are filled with water like fluid. The semi-circular canals detect motion when you move in any direction, converting the motion into electrical signals transmitted to your brain allowing you to maintain your sense of balance. The cochlea is an approximately 3 cm organ like the shape of a snail which plays an important role in hearing, the inner surface of the cochlea is filled with over 20,000 hair-like nerve cells which differ in length by tiny amounts, each with its resilience to the fluid flowing over it. It is these hairs that act as tiny sensors to convert the vibrations into electrical impulses that can be transmitted to our brain via the auditory nerve.

Sound waves are measured by their frequency, which is the number of complete back and forth that pass a fixed spot in each period of time. The given period of time or number of times per second that a full cycle of the sound wave is completed, this is given in Hertz (Hz). The minimum time interval over which it repeats itself is known as the period; it is the inverse of frequency; it is measured from crest to crest. Therefore, if the frequency is doubled then the period is halved, meaning a high-frequency wave will have a smaller period than a low-frequency wave.

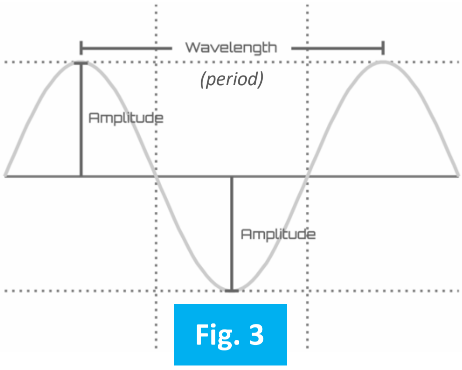

Fig. 3

Reverberation is the collection of reflected sounds from the surfaces within an enclosure. It is a desirable property of specific enclosures, such as auditoriums. However, if it is excessive, it makes the sounds run together with loss of articulation - the sound becomes muddy and garbled. This is not a desired quality of an enclosure used for musical/vocal applications. Reflections (or reverberation) are caused by hard, flush surfaces reflecting sound back to the source and around the enclosure. The reverberant sound in an enclosure dies away with time as the sound energy is absorbed by multiple interactions with the surfaces of the room. In a more reflective room, it will take longer for the sound to die away, and the room is said to be 'live'. In a very absorbent room, the sound will die away quickly, and the room will be described as acoustically 'dead'. But the time for reverberation to completely die away will depend upon how loud the sound was to begin with and will also depend upon the acuity of the hearing of the observer. To provide a reproducible parameter, a standard reverberation time has been defined as the time for the sound to die away to a level 60 decibels below its original level. The reverberation time can be modelled to permit an approximate calculation.

The optimum reverberation time for an enclosure or room depends upon its intended use. Approximately 2 seconds is desirable for a medium-sized, general-purpose enclosure that is to be used for both speech and music. A classroom should be much shorter, less than a second. And a recording studio should fully minimize reverberation time in most cases for clarity of recording. The reverberation time is strongly influenced by the absorption coefficients of the surfaces (such as absorbent materials placed on/within the walls), but it also depends upon the volume of the room. Generally, there will not be a long reverberation time within a small room.

The Sabine formula is used to calculate the $RT_{60}$ of a room, which is the time for a sound to drop 60 dB below the originally produced level. The formula is as follows, **$RT_{60}$ = (0.161) x Volume/Sum of Absorption Surfaces**. This allows for a numerical representation of how sound is being absorbed within the enclosure.

With a brief understanding of how the human ear perceives sound, which frequencies are essential to our hearing range and how each section of the ear is used in the hearing process. This will give the ability to analyse the table and graph for Ultra Akupanel’s and understand which frequencies that absorption is essential for. Additionally, how sound is produced, reflected, and diffused, thus how it affects each space through the medium it travels through.

## Akupanel Test Curve

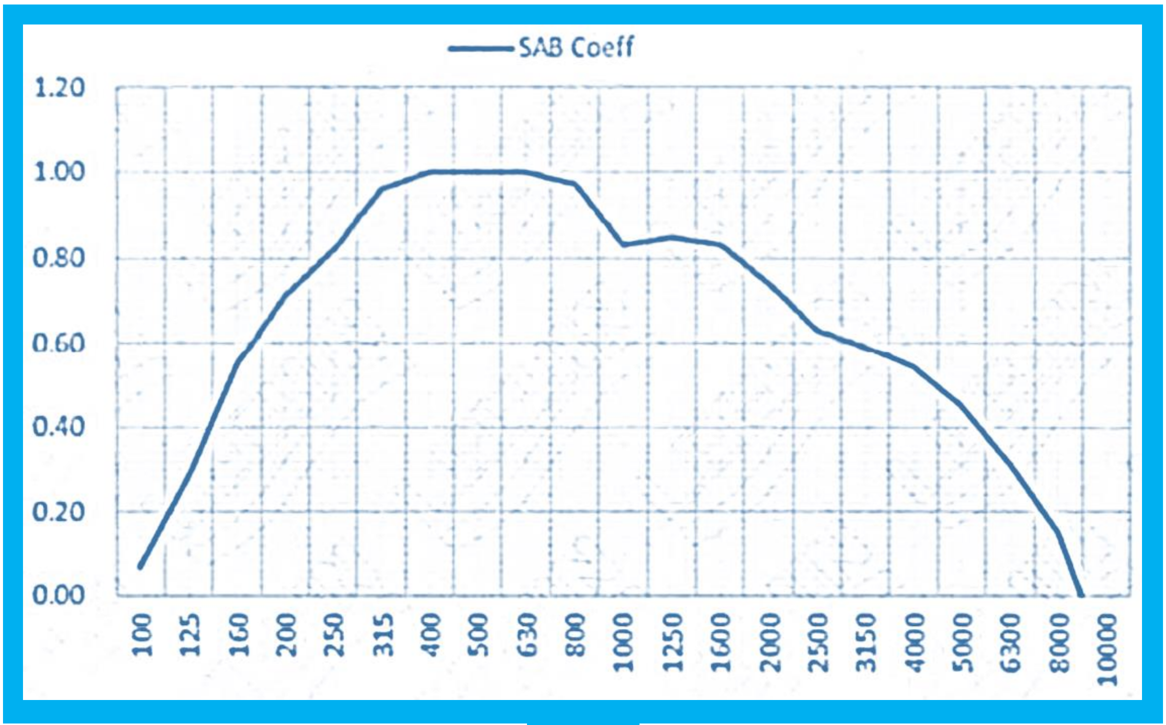


Fig. 4

## Industry Standard One-Inch Open Cell Polyurethane Acoustic Panel Test Curve

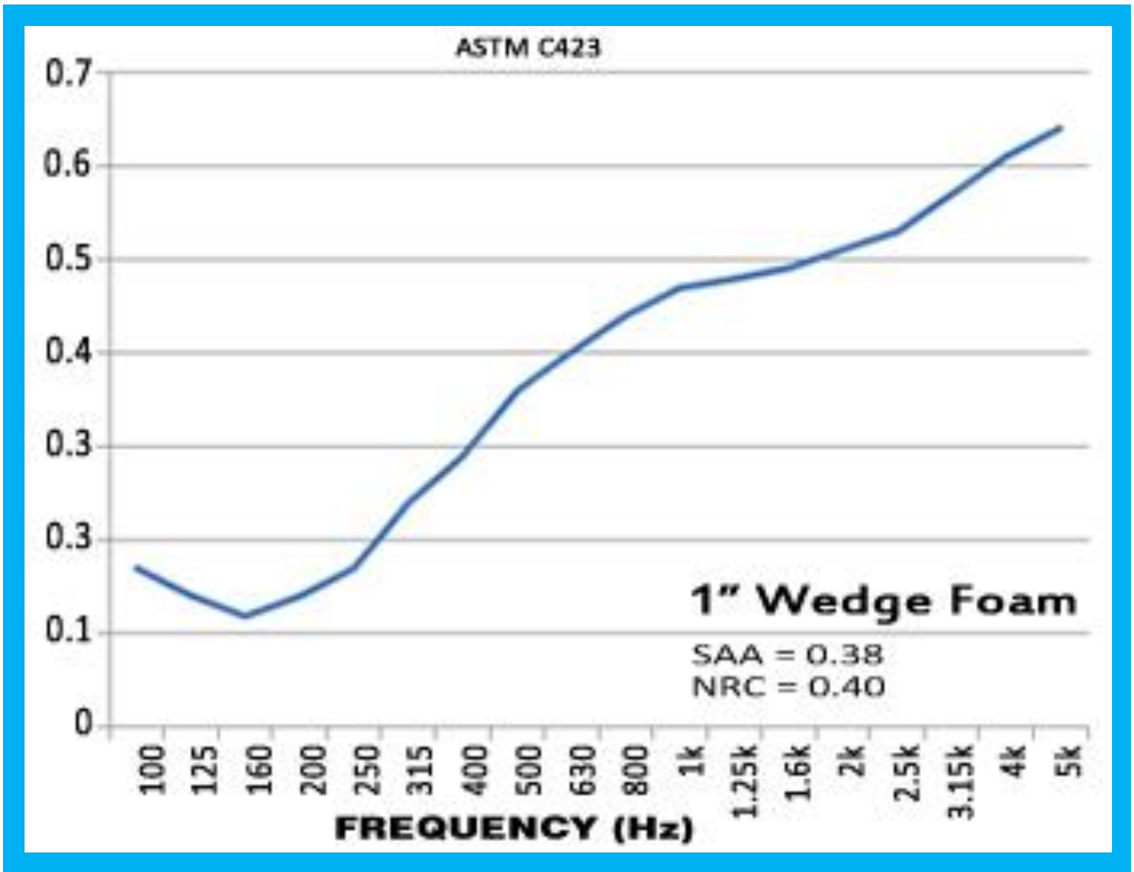


Fig. 5

# Comparison

Fig. 4 illustrates the results from the Akupanel test result graph, showing absorption coefficiency against frequency. In addition, Fig. 5, illustrates this for industry standard one-inch open cell polyurethane acoustic foam panels. Using the one-inch open cell polyurethane foam as a control we can compare the Akupanel results.

## One-inch Open Cell Polyurethane Acoustic Panel Analysis

On initial viewing of the graph, the acoustic coefficiency of this panel is merely acceptable above 2kHz frequency range. This graph (Fig. 5) only shows data from 0Hz – 5kHz, the rest of the human hearing range (20Hz-20kHz) is not included, possibly due to the efficiency severely dropping. Below 2kHz, the absorption coefficiency rolls off dramatically, from 0.5 – 0.125. Due to the advised application of these panels, they are not suitable for low frequency absorption nor are they near the level of absorption of an acoustic bass trap. Additionally, when analysing the data within the most perceived human speech range (approximately 2kHz-5kHz), the fundamental frequency (the first harmonic within the range) has little to no absorption, thus only being effective in the upper frequency range.

## Ultra Akupanel Analysis

Upon viewing the graph, we can see a steady increase in sound absorption beginning at 125Hz, a smooth curve increases from 0.05 absorption coefficiency to 1.0 (beginning at 400Hz and rolling off at an approximate 800Hz. We can visually see a severe drop in absorption at the 1kHz mark, this is most likely due to 1kHz being the test tone used or the resonant frequency of an area of the room/piece of equipment (such as test speaker or transducer microphone). Post 1kHz, the absorption coefficiency gradually rolls off to the end of the test tone, around 9kHz. This shows that Ultra Akupanel is efficient in the common human speaking range, thus absorbing day to day sound effectively.

When compared to one-inch open cell foam, below 5kHz, the Ultra Akupanel visibly outperforms within this range. Although, data above the 5kHz range is not visible in Fig. 5, therefore we cannot compare. In contrast to this, there is a smooth roll off above the 5kHz range which is a good indicator that the Ultra Akupanel is clearly effective in the upper frequency range.

At low frequency applications, there is preponderant absorption coefficiency when compared to Fig. 5. The Ultra Akupanel excels at much lower frequency that open cell foam, approximately double the absorption. When used in applications, there will be a less frequent build up of axial modes within the room due to this, as they are most common at lower frequency.

A side note, the difference in make up of each panel is significant. As Ultra Akupanel's possess sound diffusion properties as they feature multiple types of material, such as wood, which can diffuse sound and absorb lower frequencies. Not only this, but they also vary in levels of depth which additionally adds to diffusion within an enclosure, further reducing the RT60.

# CERTIFICATE

## CERTIFICATE OF TECHNICAL INSPECTION

The company named above was audited by UDEM.

Company Name : Guangdong Liyin Acoustics Technology Co., Ltd.

Company Address : Rm. 401, LiBao Building, No.277 Baogang Rd., HaiZhu District, Guangzhou City, Guangdong Province, China

Related Standards : EN 13964:2014

Product Name : Akupanel(wood slat acoustic panel)

Report No and Date : TCGD22101441756

Product Brand/Model/Type : LY-AP001, LY-AP002, LY-AP003, LY-AP004, LY-AP005, LY-AP006, LY-AP007, LY-AP008, LY-AP009, LY-AP010, LY-AP011, LY-AP012, LY-AP013, LY-AP014, LY-AP015, LY-AP016, LY-AP017, LY-AP018, LY-AP019, LY-AP020

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Registration Date : 25.10.2022
Reissue Date/No : -
Expiry Date : 24.10.2027

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