ARCHIVES OF ACOUSTICS
**31**, 1, 3–16 (2006)

# FRANK LLOYD WRIGHT'S *SAMARA*, ACOUSTICAL SOLUTIONS OF THE 1950'S

R. J. PANUSZKA

AGH University of Science and Technology
Al. Mickiewicza 30, 30-059 Kraków, Poland
e-mail: panuszka@localline.com

K. A. PANUSZKA

Acoustical Consulting
Lafayette IN 47904, USA
e-mail: kpanuszka@purdue.edu

(*received April 30, 2005; accepted October 25, 2005*)

The problem of environmental noise pollution concerns many Americans whose homes are near highways and busy streets. A famous American Architect, Frank Lloyd Wright, designed houses that have been noted for their architectural splendor and alleged acoustical superiority over more traditional designs. Mr. Wright's acoustical knowledge was tested by taking acoustical measurements and comparisons of traffic noise transferred from the adjacent highway (U S State Route 231). The sample home was a Usonian home and two traditionally designed houses located adjacent to Mr. Wright's design. Noise levels were significantly lower in the Usonian home (called *SAMARA* by Mr. Wright) compared to the traditionally designed houses. A difference of about 10 dBA existed due to Mr. Wright's unique architectural design. Significant design concepts contributing to this reduction included the excavation depth of the house, screening by the carport, and screening by other natural screens like wintergreen trees and shrubs.

**Key words:** architect, Frank Lloyd Wright, Usonian, Samara, acoustics, noise.

## 1. Introduction

By the beginning of the 21st century, the level of environmental noise in city streets and highways has increased to the 85–100 dBLin range. Expensive artificial acoustical barriers have been constructed along some of these roads, but they are not so effective as planned. Many homeowners with properties next to these roads disapprove of these barriers due to aesthetic reasons. Drivers are also disapproved due to higher levels of noise while driving near such barriers [8].

Environmental noise is caused mainly by heavy traffic and industrial zones. It is commonly cited as a reason that people have a lower standard of life in large and medium-size cities [5, 3]. With increasing noise in external environments, “quietness” in homes and gardens adjacent to busy roads is highly desired by home-owners [7]. Presently, most home-owners have limited attenuation of environmental noises, hums or vibrations transferred from highways into their homes. City planners, and federal agencies such as the Environmental Protection Agency and the US Department of Housing and Urban Development, have attempted to lower traffic noise by erecting artificial acoustic barriers. These barriers, usually very expensive, have shown limited success in attenuating noise. The barriers have succeeded in shadowing noises mainly in medium and high frequency bands, but have left most low frequency noises unabated [8]. Published literature has shown that excessive noise transferred into homes increases stress, impedes verbal communication, interrupts sleep, and reduces the quality of life [17].

The authors have studied and evaluated the Usonian *Samara* house in West Lafayette with the goal of recognizing and understanding the design concepts used to build silent houses and to define social aspects of noise abatement [10]. *Samara* was designed by Frank Lloyd Wright, who has created numerous private residences called Usonian (Usonian stands for United States North American homes). It is well known that Mr. Wright was an architectural genius [13]. His goal was to design a low-cost, architecturally pleasing home for the masses. Mr. Wright would also, at the request of the owners, take extra care to build a quiet house if it was located next to a busy street.

The main goal of these studies was to determine if a Usonian house designed in the 1950’s still represents the pleasant silent conditions for life, in a location near a noisy highway. The purpose of the studies were to measure acoustical parameters as well as to make comparisons to other houses in the neighborhood. The study was to identify the architectural elements that contributed to lower noise levels when compared to homes exposed to similar noise conditions, but not designed by Frank Lloyd Wright. This Usonian home, located near the Purdue University in West Lafayette, is called *Samara* (named after a winged seed in a pine cone) [11]. What makes this home unique is that Mr. Wright had to anticipate the increase in noise generated from a two-lane road that existed in the 1950’s to today’s four-lane state highway.

The hypothesis of this study is that the level of noise in the *Samara* Usonian home is lower than that in the neighboring homes with similar external road noise. After reviewing the literature the authors found that the most important advantages of the Wright’s home design and construction were superior acoustic quality and reduced building costs [4, 12, 14]. The authors hypothesis was tested by examining the acoustic field and the frequency distribution of the acoustical pressure inside and outside *Samara* and the two adjacent property sites.

## 2. Usonian style

How did Mr. Wright develop his expertise in acoustics? Mr. Wright studied under two famous American architects Sullivan and Adler [6, 13]. Sullivan (1856–1924) and

Adler (1844–1900) had a thriving architectural business in Chicago. Adler was an architect renowned for his expertise in acoustics [2]. Frank Lloyd Wright benefited from Mr. Adler's experience, and learned how to use acoustical controls in his architectural designs to reduce the flow of outside noise into his designs [6, 16]. If Mr. Wright's clients wanted their buildings to be quiet, he could design them so that noise reduction was done on a wide frequency spectrum.

Frank Lloyd Wright's method of design was a compromise between low costs and relatively high quality of indoors and outdoors solutions. Basically, he used large areas of thick glass walls as well as concrete, brick and wood. Wood was usually unfinished, simply stained or waxed.

A very common feature in Usonian houses is that they are typically built on rectangular residential parcels of land. Wright's projects are well oriented to provide optimal lighting, usually facing the sun. The beauty of the topography is accomplished by providing the house with direct contact to nature [9]. Another observation is that Wright's houses were well designed for every day life style. His designs include good human conditions and are aesthetically appealing indoors and out. Many of these homes are considered as works of art and a symbols of elegance, which also embodies the needs of their owners. Circles of gardens with evergreen trees and shrubs are frequently a part of the scenery. Usonian buildings are known for their close compositional relationship to their natural surroundings [15].

## 3. Elements of the *Samara* design in relationship to the acoustic interior climate

The acoustic climate of the house depends on external and internal noise sources. Other important factors like house localization, house construction, materials, installed facilities, environmental conditions and landscaping also lend to the quietness of the home. External noise sources may include traffic noise radiating from the surrounding streets, and air conditioning systems. The most common examples of internal sources may be represented by typical household appliances such as refrigerators, freezers, laundry machines and dishwashing appliances. Air conditioning and heating equipment also increase the levels of noise.

At the time he was designing the house, Mr. Wright addressed the owner's request for a quiet home by making the roof line level with Northwestern Avenue. As a result of this excavation he obtained natural screening of noise by the bank of the land. This positioned the main part of the house in the acoustic shadow. Excavation significantly controlled the high and medium frequency street noise. Additionally, this resulted in a very small angle of incident long waves attacking the roof of the house. These acoustic waves reflect at a very small reflection angle and propagate to zones which do not belong to the studied house. Natural screening by the bank of soil, between the highway and the house, results in an acoustical shadow. This acoustical shadow has important effects on the values of sound pressures near the walls of the house parallel to the highway.

Wright situated the carport on the side of the house nearest the highway so that the house would be additionally screened by this 10 feet wide barrier. The driveway leading from the highway to the *Samara* carport is designed in a short curvature. The driveway is lined with evergreen shrubs which scatter and dissipate the acoustical energy. This driveway is designed to slope downwards toward the house with significant curvature. The multiple reflections of the waves and their dissipation due to plants, shrubs and trees limit the flow of noise from the highway to the house. Mr. Wright placed the fan of the air conditioning system about 12 feet from the wall of the house behind the wall of the carport facing the street, thus providing additional screening by the carport wall.

The structure of the walls is simple but with good acoustical insulation properties. They consist of two, 4-in thick bricks separated by a 2-in layer of styrofoam. The bricks have a hard burned face anchored by galvanized wrought iron. This significantly increases the sound insulation of the walls. The roof consists of a wood-frame, 3/4-in plywood with 4-in styrofoam, 4 layers of roofing felt with hot tar between them, and 1/4-in crushed marble. The ceiling is covered by 1/2-in plasterboard.

The architecture of the interior is typical for Usonian houses with one large living room directly connected through the angle of the corner to the dining room and kitchen. A narrow corridor connects the kitchen to the master bedroom, nursery, bath and guest bedroom. Mr. Wright responds to the owner's request to have a large living room by designing a 24-feet by 24-feet meeting room that comfortably seats up to sixty people. This was accomplished by building stairs the length of the room on one side, allowing the furniture to be put on the other side for additional seating. In *Samara*, "the winged seed" theme is carried out by the three-dimensional clerestory windows and the stands for the TV and dinner tables. The windows use a double-cut stencil, 1/4-in thick [11]. The plan is finished by putting a walled garden on the southeast side of the living room. The wall parallel to the highway consists of very small architecturally attractive windows, which do not provide much light. This solution limits acoustic leakages from the side of the highway to the house. The garden wall windows opposite the street have lower acoustical insulation. However, there is little acoustic energy which radiates on this wall. This is due to diffracted waves over the back of the house.

Figure 1 shows an overall view of the *Samara* house from the south side garden, and Fig. 2 shows a view from the back yard of the garden and the carport with the main wall of the house which is parallel to the highway. The foundation of the house was lowered 4.2-feet so the level of the roof would be about 3.6-feet higher than the surface of the sidewalk on the board of the highway (Fig. 2).

The garden side of the living room is composed of a large window wall with a surface area of 191 square feet. The outside living room wall has bookcases and bench seating underneath. The living room is decorated with furniture designed by Wright, with a large rug in the middle of the carpeted room. The many pieces of furniture, the large surface of carpet and the bookcases significantly increase the acoustic room absorption. Wright used a very thick glass for windows, which is very rare in traditional American homes of that era. This increases sound insulation from the wall opposite the bookcases.

Fig. 1. An overall view of *Samara* house in Northwestern Avenue West Lafayette – garden side.

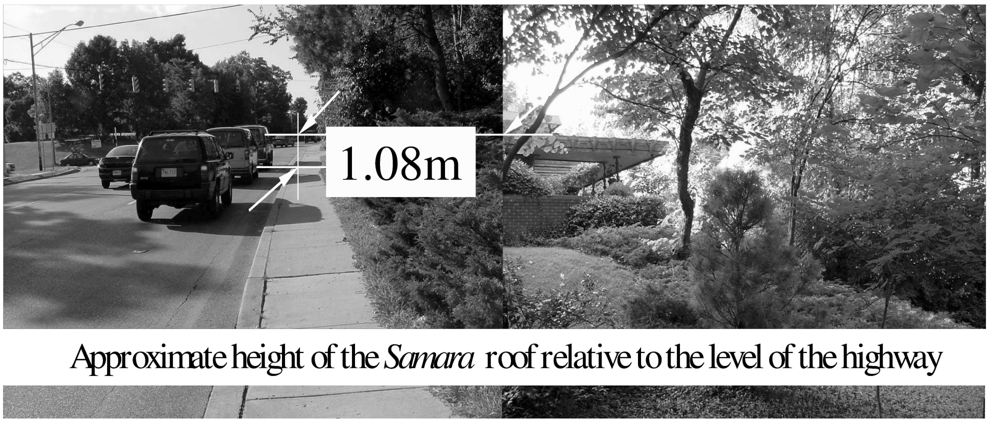


Fig. 2. The backyard of the garden *Samara* house – highway side, house foundation is lowered according to level of the highway, the roof of house is only about 3.6ft higher than level of highway.

The authors concluded that Wright introduced the idea of controlling the flow of acoustic energy by directing it up to the roof and to the southeast side of the house and into the curvature in the driveway. Trees, shrubs and the brick fence following the lines of the driveway also help to dissipate acoustical energy down into the garden.

## 4. Distribution of waves near *Samara* house

Phenomenological analysis helps to understand the importance of the flow of acoustic energy in zones near the house. The acoustical energy that flows from the highway to *Samara* is distributed to the zones of the house in different paths. A significant part of the acoustical energy flows in the direction to the *Samara* house from the adjacent highway. These are incident waves, and they attack the walls of the house, carport and the roof. A part of the acoustical energy flows back in the form of waves reflected from such elements as the plane of the roof. This energy is later propagated in the direction of the adjacent garden, house walls and the carport wall. The energy is then scattered and absorbed by the soil, shrubs and trees, and is dissipated as well. Depending on the dimensions of the noise sources radiating from the direction of highway and the wave length of radiated waves, a part of the energy is diffracted on the edges of the carport walls, roof, or brick wall. At further distances they are also scattered and dissipated in the elements of the garden or driveway. A small part of the acoustic energy which attacks the walls and the roof of the house are transmitted through the structure of the building and into the area of the house. The process of transmission is related to the absorption and dissipation of acoustic energy in the solid materials of the elements of the walls and the roof. Transmitted waves are also scattered in the rooms in elements like furniture, house appliances, bookcases, wall decorations and statues. These waves are also partially absorbed when they hit boundary surfaces, which decreases the reverberation effects in the rooms.

The mentioned effects do not fully describe all the possible paths of the flow and dissipation of acoustic energy. Some of them are more complex, and may include the energy of re-radiating waves in the interior of the house, and cancellations caused by interfering waves between the interiors of all bedrooms joined by hallways. Figure 3 shows the phenomenological model of distribution of waves impacting the roof from the side of the highway. There are incident waves attacking the roof of the *Samara* house

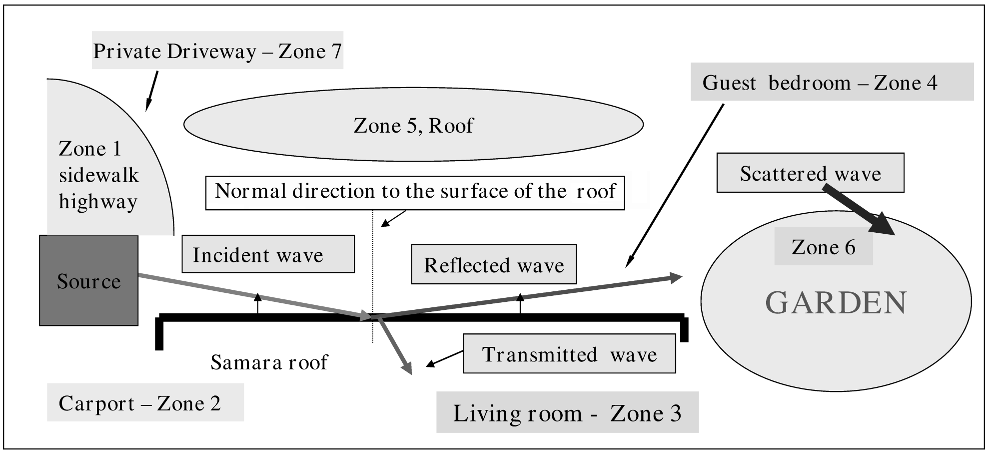


Fig. 3. Distribution of acoustic waves near roof of *Samara* house.

at small angle, because the level of the Northwestern Avenue is about three feet higher than the level of the roof. As a consequence, an effect similar to "sliding" of waves occurs because of very small angle of incidence/reflection. This is especially valid for low frequency waves below 50 Hz, which could be easily transmitted through the roof of the house to the indoors. However, being reflected from the roof, they are scattered and dissipated in areas of the adjacent garden.

## 5. Methods of assessment

The assessment of the noise field was performed using measurements in the established zones. Measurements were carried out in 7 zones of the *Samara* House (Fig. 4). They are: Zone 1: The highway – Northwestern Avenue on the sidewalk which is the street adjacent to the *Samara* home, Zone 2: Carport, Zone 3: Center of the living room, Zone 4: Guest bedroom, Zone 5: Roof of the *Samara* house directly above Zone 3, Zone 6: Garden, Zone 7: Driveway. Readings were also taken at street zones and living rooms of two nearby neighbor's houses. In both cases, these rooms were situated in the front of the houses and instruments were directed towards the Northwestern Avenue.

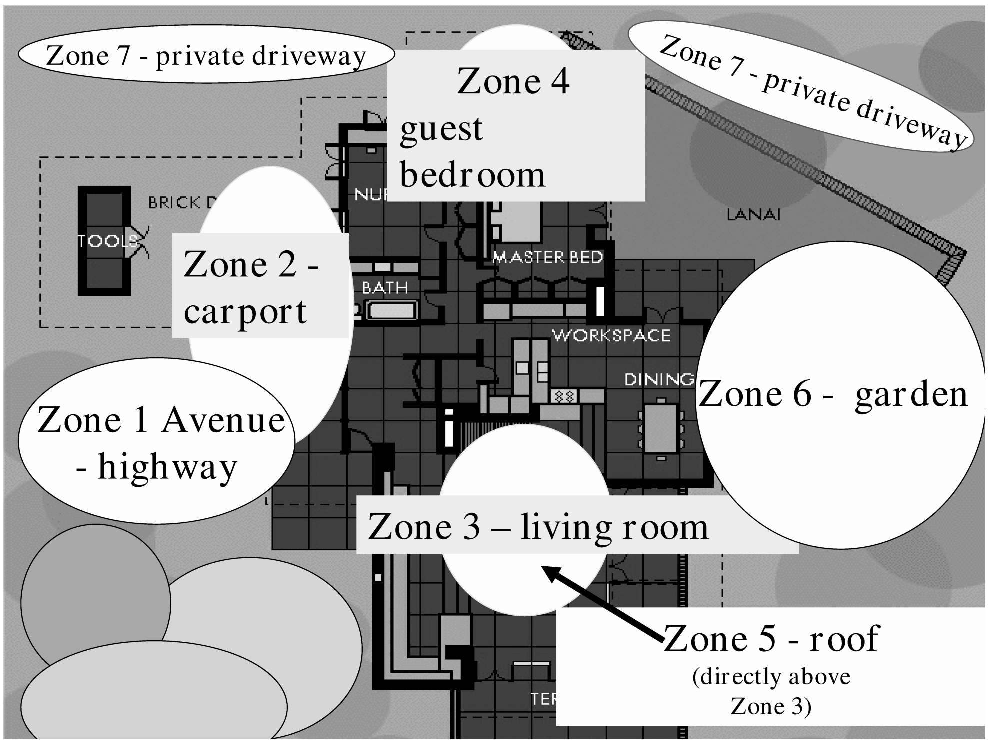


Fig. 4. Zones of acoustical measurements: Zone 1 – Highway – Northwestern Avenue, Zone 2 – *Samara's* carport, Zone 3 – Living room, Zone 4 – Guest Bedroom, Zone 5 – Roof of the *Samara* house, Zone 6 – Garden, Zone 7 – Internal driveway.

In the neighbors houses studies were performed in the individual living rooms facing the highway. The busiest traffic time was between 3:00 p.m. and 6:00 p.m. The motion of cars, trucks and motorcycles was cyclic with about a 1 min 30 seconds period of time between light changes at the intersection.

There were three stages of assessment:

- A preliminary study with a general evaluation of the distribution of acoustic fields at the house and nearby properties in the total band of audible frequency, with A and C weighting filtering and Lin scale;
- Frequency assessment and evaluation of probable transmission paths of the flow of acoustic energy with A and C weighting filtering and Lin scale;
- Comparative measurements and evaluation of data for the next two houses in the neighborhood.

The preliminary study was conducted with equivalent levels of acoustic pressure $Leq$ [dBA/dBC/dBLin] for frequency band $\Delta f = 20$ Hz – $20$ kHz [1]. Further studies included both equivalent level of acoustic pressure $Leq$ and analysis in octave frequency bands from 31.5 Hz up to 16 kHz in linear scale $Leq$ [dBLin]. Then noise reduction levels ($NR$ [dBLin]) in octave frequency band 31.5 Hz up to 16 kHz were calculated with the relationship

$$NR = Leq_{p_1} - Leq_{p_2} \quad \text{dB}, \tag{1}$$

where $Leq_{p_{1,2}}$ are the equivalent sound pressure levels at points 1 and 2 respectively,

$$Leq_p = 10 \log \left[ \left( \frac{1}{T} \int_0^T p^2(t)\, \mathrm{d}t \right) \Big/ p_0^2 \right] \quad \text{dB}, \tag{2}$$

$p$ is the sound pressure level at the point of assessment, $p_0 = 2 \times 10^{-5}$ N/m$^2$ is the reference value of sound pressure level.

The average integrated sound levels $Leq$ were accumulated in Run Mode of the Sonometer with time averaging 15 minutes overall weighted sound levels $Leq(\mathrm{A})$, $Leq(\mathrm{C})$ and $Leq(\mathrm{Lin})$ and 5 minutes for Octave Band Analysis. A sampling of evaluations of acoustical conditions were conducted in the afternoon between 4:00 p.m. and 6:00 p.m. during the week. The overall levels of noise at the *Samara* living room was also evaluated at night.

The measurements of sound pressure were conducted with a Quest Model 2900 advanced Sound Level Meter with QE7052 Electret Microphone. Frequency analysis in octave band frequency were carried out with a Model OB-300 1/1 Octave Band Filter covering 10 bands of frequency from 31.5 Hz to 16 kHz. Data were stored in the memory of the Sonometer and downloaded by RS-232 serial mode communication interface to Quest Suite 4.351 code for final analysis in PC Windows 2000 NT.

Octave band frequency analysis showed how the radiated sound pressure transferred from the highway sources is distributed in different zones of the house and yard. The frequencies that dominated the different zones were also identified. Evaluations show how the affectivity of the dissipation of acoustic energy by barriers such as the brick fences, brick wall of the carport, and walls of the house. It was also possible to evaluate the role of the excavation and the role of the reflecting roof.

## 6. Results

It was established that the mean level of sound pressure in the *Samara* house during the day in busy traffic hours was about 43 dBA and at night about 30 dBA.

The fall of the sound pressure level averaged with A scale between the highway and the living room of *Samara* is about 27 dBA. Smaller differences occur in Lin scale with 18 dBLin.

The sound pressure difference between the highway and *Samara*'s roof is small. For A, C and Lin scale it is between 1–3 dB. There are very little dissipative structures between the highway and the house. The roof is mainly attacked by direct incident waves. *Samara's* carport introduced a very good acoustic shadow zone for the low frequency range, and only a small shadow zone for medium and high frequencies. The total attenuation is only 2 dBA (4 dBLin) measured in the carport zone.

Figure 5 shows an example of the evaluation of noise in the frequency domain for three zones: the sidewalk near the highway, the roof and the living room. Dominat-

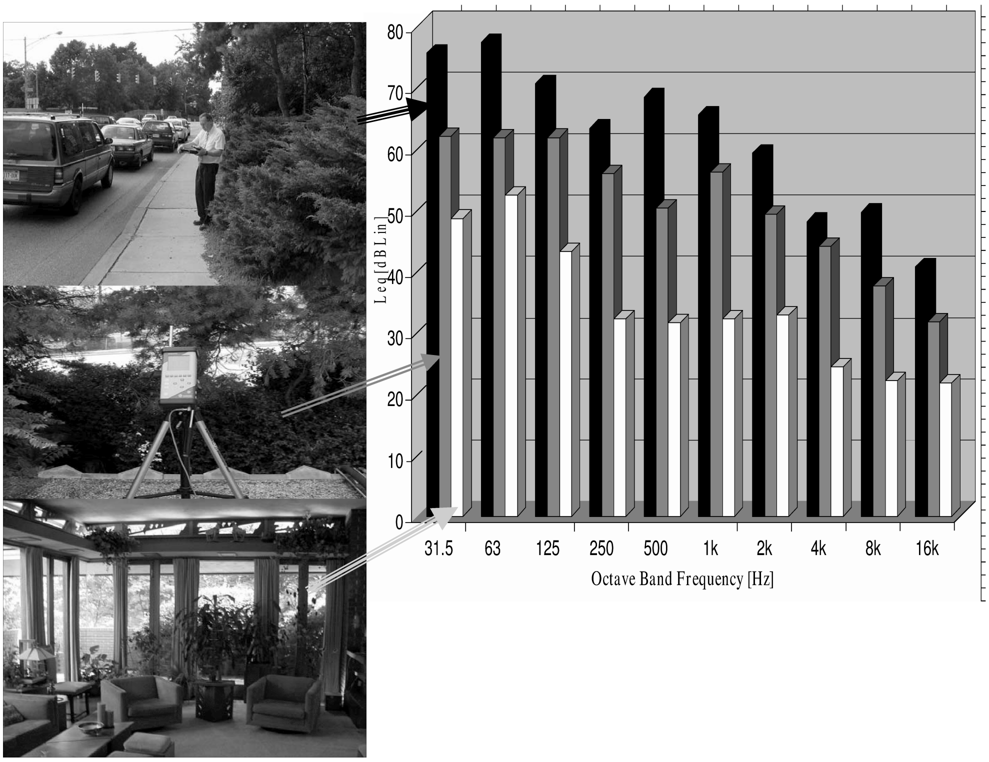


Fig. 5. An example of evaluation of level of noise in three zones of assessment: Zone 1 – highway, Zone 5 – roof, Zone 3 – living room. Shown octave band frequency characteristics.

ing frequencies in the highway with high values are in the low frequency band with about 75 dBLin in bands 31.5–63 Hz. In the *Samara* roof, observations of high levels of medium frequencies up to 55 dBLin were found. In the living room we received a significant difference between low and high frequencies levels up to 20 dBLin. This gradient can be explained as a result of the large sound insulation of the walls of the house in the high frequency band and low in the small frequencies.

By calculating the differences of sound pressure levels in octave bands between the different zones it was possible to estimate how the acoustical energy was transferred to *Samara* living room from the highway by the two most probable paths, the roof and the main wall of the building facing the highway.

The results showed that the plate of the roof construction is the most important transmitter of low-frequency waves to the living room with only 13 dBLin value of noise reduction. The same phenomena were apparent for band of 500 Hz (Fig. 6). These graphs show that a significant role in dissipation of acoustic energy is played by the brick walls mass. Very good sound insulation of windows and doors was also recognized. It was determined that leakages existed from the small windows situated near the house ceiling. However, up to 37 dBLin noise reduction is observed at a frequency of 500 Hz on the transmission path of the sidewalk-living room interiors.

In studying the noises of the two neighbor houses which are north and west (Fig. 7), it was found that both houses had much higher levels of sound pressure in the living

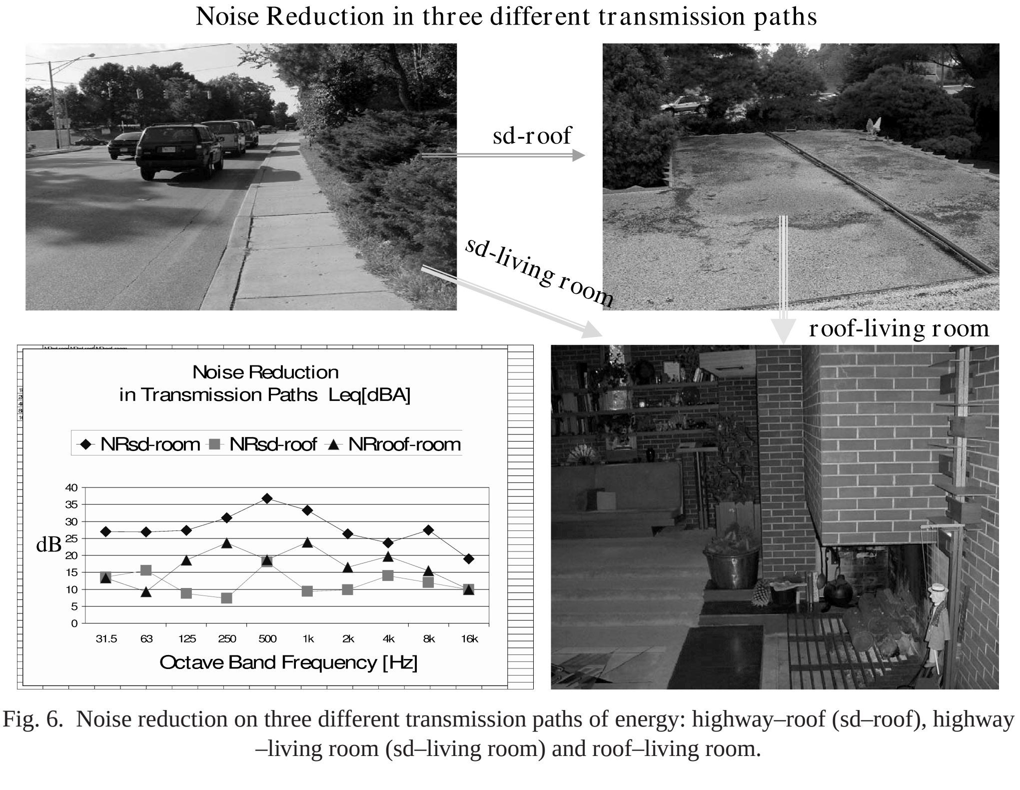


Fig. 6. Noise reduction on three different transmission paths of energy: highway–roof (sd–roof), highway –living room (sd–living room) and roof–living room.

rooms than *Samara*. This was especially true for the house on the west direction of *Samara* with a basement that is at the level of the highway. This house is positioned at the same distance from the highway as *Samara* and represents levels up to 10 dBLin higher than *Samara*. The walls of this house are directly attacked by waves in a direction approximately perpendicular to the walls. The northern neighbor's house, with a similar roof level as *Samara*, measures higher levels of noise do to the transmission of acoustic energy through the walls designed from wood. Average level of noise in that house is about 5 dB higher than the level in *Samara*.

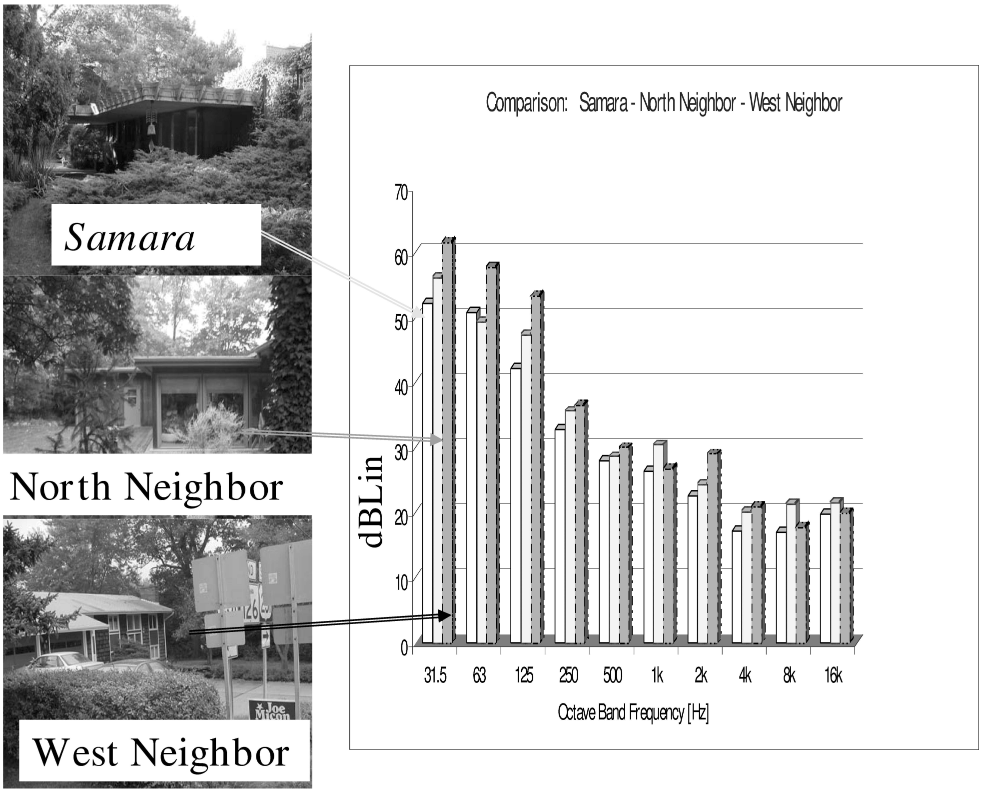


Fig. 7. Results of comparison of levels of noise in *Samara* and two neighbor houses living rooms.

## 7. Evaluation of data

The *Samara* house is affected less than the two other neighbor houses by impacted waves, because they "slide" over the roof due to its flatness and approximately level to the highway sources. The transmitted waves, however, pass through the structure of the roof, windows at the top of the house and walls into the house interiors. The evergreen trees, marble rocks on the roof, and wood motifs around the windows also help to scatter waves around the house. The observed noise reduction on the transmission path between the highway and the *Samara's* living room is up to 30 dBA at night and 43 dBA during the day. It was observed in the living room that radiation of frequencies higher than 500 Hz was the result of house appliances and the air conditioning system running. Leakages through small windows near the ceiling are another reason.

The acoustic shadow of the carport is up to 20 dB for frequencies larger than 125 Hz. But for low frequencies the acoustic shadow is minimal. The driveway (Zone 7) represents relatively low levels of sound pressures up to 10 dB lower than at the highway. The role of acoustic shadow is caused by road elevation, road curvature with surrounding dissipative shrubs, trees and brick walls.

Larger levels of audio frequency noise were observed in the garden (Zone 6) than near the carport. This is caused by a flow of traffic noise energy coming from the curvature of Northwestern Avenue on the side of lot bordered by the sidewalk. This flow has a larger impact on the level of noise in the garden than the slope of acoustic energy caused by doubling distance.

The values of noise reductions between Zone 1 (Sidewalk) and Zone 5 (Roof) shows small gradient of acoustic energy in that direction. A possible explanation is that the energy of the longest waves are transmitted without notable reductions or dissipations. This small reduction is caused partly by the acoustical effect of double distance lowering of energy from sources.

## 8. Conclusions

Frank Lloyd Wright's design of *Samara* house in the beginning of 21st century still demonstrates better acoustical conditions then traditionally designed American houses built under the same conditions. This conclusion was proven by measurements taken during this same high intensity traffic motion times showing equivalent levels of sound pressure in the living rooms of these houses. The level of noise in the *Samara* house living room is lower by about 10 dBA in comparison to the houses from the same distances from the highway. It is significant that neighboring houses are built in wooden technology.

It was found that the most important acoustical qualities of *Samara* are:

- design of house in excavation with natural screening of the main wall of the house by soil, shrubs and evergreen green trees,
- screening of the house by the carport situated on the side of the main wall of the house parallel to the highway,
- screening from the carport limits the air conditioning fan noise from reaching the house,
- good acoustical insulation of the walls and the roof provides up to 30 dBLin attenuation in some frequencies so that sound flowing from the street is shielded and dissipated,
- all windows contain single 1/4-in thick plate glass which act as better sound insulation than regular windows in traditional designs,

- scattering and good absorption of indoor sounds by the complexity of Wright's furniture, carpets and bookcases, gives a pleasant hearing environment, good speech understanding, and a comfortable, pleasant acoustic climate,
- sealed windows and doors limit flows of noise in the audio frequency range.

The described studies only partially explain the complex acoustical phenomena's that result in reduction of traffic and air conditioning noise transmitted to the *Samara* house. However, the discovery of the large differences between the two investigated houses in the neighborhood are in *Samara's* favor.

Finally it is possible to conclude that Wright's design is better then other houses under similar noise conditions. Distinguished facts are still useful for designing homes which are placed close to highways, airports, stadiums or other public noise zones.

It was determined that the increase of acoustic insulation in the roof is needed to achieve the higher effects of noise reduction which flow from the street to the interiors of the house. The overall level of the noise during the day could then be limited by 35–38 dBA and 25–27 dBA during the night.

The excellent acoustical climate of the *Samara* house is still an example of brilliantly created assumptions that lends to an uncompromised design for achieving quietness.

## Acknowledgments

Dr. John E. Christian, owner of the *Samara* Usonian Home in West Lafayette Indiana. Dr. Christian gave the authors unlimited opportunities to investigate acoustic fields in the *Samara* house and on his property. Ministry of Technology and Science KBN of Polish Government for granting visiting scholar professorship at Purdue University in West Lafayette USA.

## References

[1] BERANEK L. L., *Acoustics*, American Institute of Physics, Inc., 1986.

[2] ELSTEIN S., *Who is Dankmar Adler?* Northwestern University USA, Library, The Lantern, September 1999.

[3] EVANS G. W., LERCHER P., MEI M., ISING H., KOFLER W. W., *Community noise exposure and stress in children*, The Journal Acoustical Society of America, **109**, 3, 1023–1027 (2001).

[4] FUGATAWA Y., PFEIFER B. B., *Frank Lloyd Wright Monograph* (1951–1959), E.D.A. Edita, Tokyo Co., Ltd. 1998.

[5] KRYLOV V. V., *Investigation of environmental low-frequency noise*, Applied Acoustics, **51**, 1, 33–51 (1997).

[6] HERTZ D. M., *Frank Lloyd Wright*, G.K. Hall and Co., N. York 1995.

[7] KUERER R. C., *Classes of acoustical comfort in housing: Improved information about noise control in buildings*, Applied Acoustics, **52**, 3/4, 197–210 (1997).

[8] KOTZEN B., ENGLISH C., *Environmental noise barriers*, E & FN SPON, London and New York 1999.

[9] LENNARD S. H, LENNARD H. L., *Architecture: effects of territory, boundary, and orientation on family functioning*, Fam. Process, **16**, 1, 49–66 (1977).

[10] PANUSZKA K., PANUSZKA R., *Effect of noise on social relationship*, The Journal Acoustical Society of America, **112**, 5, 2272 (2002).

[11] ROGERS W. J., CHRISTIAN J. E., *Frank Lloyd Wright's Samara Winged Seeds of Indiana*, John E. Christian Family Memorial Trust, Inc. ISBN: 1-931775-00-1.

[12] SECREST M., *Frank Lloyd Wright*, A. Knopf, New York 1992.

[13] SMITH K., *Frank Lloyd Wright America's Master Architect*, Abbeville Press, 1998.

[14] STORRER W. A., *The Frank Lloyd Wright Companion*, pp. 402–403, The University of Chicago Press, Chicago, Il. 1993.

[15] PICKETT J. P. [Ed.], *The American Heritage Dictionary of the English Language*, 4th Edition, ISBN 0-618-08230-1, Houghton Mifflin Company, Boston-New-York 2000.

[16] WALKER M,, *America Reborn*, Alfred Knopf, New York 2000.

[17] WILKINSON R.T., CAMBELL K.B., *Effects of traffic noise on quality of sleep: assessment by EEG, subjective report, or performance the next day*, The Journal Acoustical Society of America, **75**, 2, 468–475 (1984).