ANNOYANCE OF SOUND GENERATED BY A PIANO IN SUPERIMPOSED ROOMS

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Abstract

This simple study was carried out to characterise the noise annoyance generated by a piano between superimposed rooms. Even if the piano generate sound and not noise this particular case of annoyance could induce the neighbour to do a claim or a petition.
Some acoustic measurements were carried out in the frame of a technical advice for the tribunal of Palermo and some procedure of intervention were identified.

INTRODUCTION

The sound of the piano is still a problem of annoyance for the neighbours as the claims and the petitions in the tribunal demonstrate it. Annoyance is generated by the use of a piano, by the pianist, music teachers and songwriters, students at the conservatoire when they practice, till 8 hours a day, during all the days of the week even during holiday. The spreading of musical culture is a sign of the progress; but it has to ensure the tranquillity, calmness in other's houses, due to the fact that the soundproofing among fats has not improved in spite of the improvements of new materials and new technology.

Unfortunately, in some cases the pianist from cause of annoyance becomes victim of reiterated complaints, intimidation and petitions at the tribunal. In fact, the annoyed neighbour can appeal according to the art. n. 844 of the Italian Civil Code, which regulates the relationships among the neighbour concerning sound introduction.

There are other decrees and laws, which deal with the problem. The piano is a percussion instrument: the pianist beats the key, the hammer moves and arrives at the string, it compresses the felt, the string begins to vibrate, the felt expander, the hammer returns to the initial position. The sound corresponds to the mechanic cycle

characterised by a rapid attack, which arrives at the maximum followed by a final transition.

A STUDY-CASE

The noise , cause of annoyance claimed by a married couple in a block of flats in Palermo, Italy, was generated by a piano on the fourth floor superimposed annoyed couple ‘s flat. The acoustic introductions were generated by a student of conservatory who made warming up and improving exercises, and performed classical and jazz pieces. The sound annoyed the couple’s everyday activities from 6:00 pm to 10:00 pm. For this reason, the acoustical investigations were done in daytime. The sound of the piano coming from the superimposed flat propagated through solid way, especially through the structure of the building. The sound of the piano is directly transmitted to the walls and the floor; and from these ones through the structure of the building, it propagates to the rooms below, which are near, far and adjoining. The noises even arrived through air, and the windows. The defence of the air noise, the closure of the windows is not good for the solid noise, because the residual noise 4of traffic and other human activities), and it shows up the sound of the piano much lore. In the solid transmission, the sound is more transmitted when the frequencies is low; among the musical instruments, the piano and the organ are the instruments which produce the lowest frequencies of sound. Besides, these low frequencies are the most difficult to soundproof. For this reason the piano is the most difficult ins trument to be soundproofed.

ASSESSMENT CRITERIA

In Italy, two criteria are used, criteria of acceptability (criteria ex legge 447/95) and comparative criteria of tolerance. The first one is used by the comparison between the environmental noise (with the annoying source) with the residual one(without the specific annoying source).

The acoustic imission are acceptable when there is no overcoming of the differential limits defined in the art.2 comma 3 lettera b of the Law 26 October 1995 n.447 and following modification and integrations. Particularly, the art.4 comma 1 of the DPCM 14/11/97 establishes that the difference between Laeq of the environmental noise and the residual noise must not be higher than 5 dB(A) in daytime and not higher that 3 dB(A) in nighttimes inside the inhabitant locals.

The comparative criteria refers to he art. 844 of the Codice Civile and gives a restriction to the levels of noise that can be accepted in the neigh borough. Throughout the concept tolerability. The actual law considers polluting the annoying source which creates a growing residual noise (which many experts consider L95) higher that 3 dB(A).

The evaluation of the overcoming of the normal tolerability and also of the acceptability considers 3 elements:
The sound of impulsive type, the pure tone and the solid propagation.

Considering the same measures in dB(A) of the introduction, the effects of the normal tolerability or acceptability are different between a general noise and a sound.

Even with a minimum overcoming of the residual noise, the music of the piano is completely heard: it is a imposed message with a high "content of information" which can cause repulsion.

What is important is the difference between noise and sound: while the noise, such as a machine or the traffic or a factory, annoys everybody at the same way, and often even the people who generates it, an the contrary the sounds of TV, the voice of a baby, or the sounds of a near disco are pleasant to somebody but annoying to others.

There are many complaints against music teachers, piano players and students in the Conservatory. In these cases the problem is the repetition of the piano exercises and the repetition of the same pieces because the pianist needs practice and sometimes he studies an hour the same piece.

The music passages resound in the hear of the people even of the pianist stops playing. Beside, being a solid propagation it propagate in all the flat without any possibility of refuse for the victim.

This case represents a good example of force caused by the introduction of piano sound which is sound and not noise. It is necessary to underline that another aspect that the law must consider is the psychoacoustic.

RESULTS OF THE INVESTIGATIONS

One of the features of the piano is the way the pianist plays, which can be minimum or maximum with a wide excursion. The levels of the sound in the annoyed rooms produced by the same pianist vary according to the type of scale:

? Normal scales.
? Scales with sordine (mute) -4 o -5 dB(A).
? "Forte" (Loud) scale +3 dB(A).

The measured levels vary according to the kind of music and it must to be paid attention to background and the residual noise can be higher that the annoying noise even if the piano is perceived and irritating.

The right measurement of the background noise and the residual one is very difficult and it can determine a negative o positive result in the disputes despite the same levels of human noise.

To solve the problem it must trust the pianist or make the investigations by surprise.

The microphone was placed in the most annoyed room in daytime. The place of measurement with closed windows were been located according to the DPCM 16/03/1998.

Same schedules with the temporal state and the spectral analysis of the noise have been made. Figures 1 and 2 show an example of some measurement for different ways of playing and different kind of exercises. In the pictures the coding of the sources is showed in order to eliminate parasites noises (tourist planes, siren and bells, etc.). The results of the measurements are summed up in the table 1.

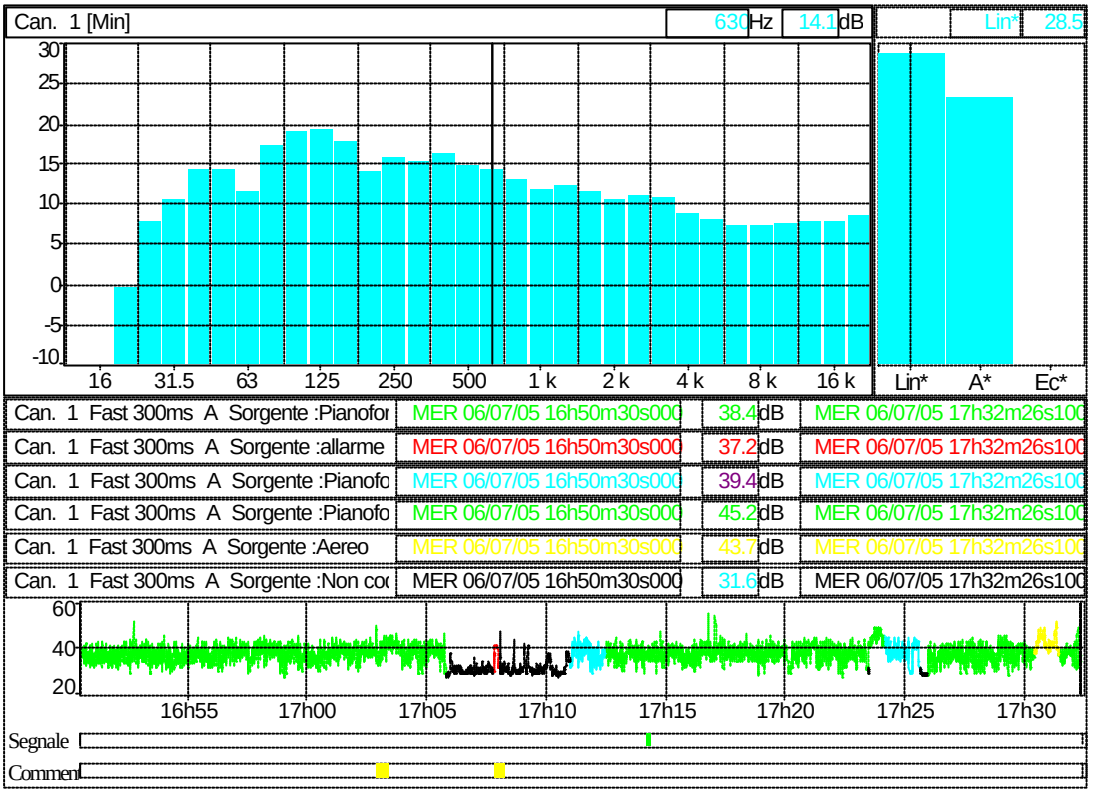

Fig. 1 - Noise time evolution and time frequency analysis

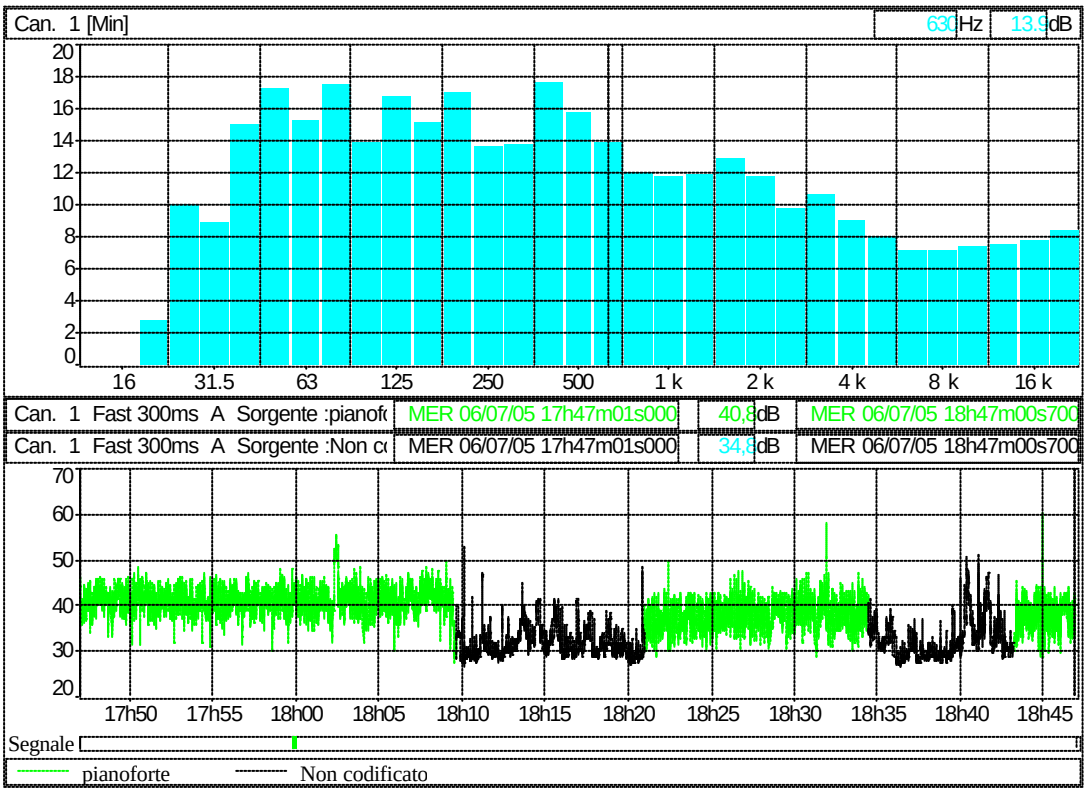

Fig. 2 - Noise time evolution and time frequency analysis

Impulsive components

In order to distinguish noise and sound we need only 10 milliseconds equal to cadence of 100 impulses o second; to perceive the tone, the diversity between a piano and a trumpet, we need 50 ms, equal to a cadence of impulse; to perceive completely the quality of the sound, we need 100 ms, equal to a cadence of 10 impulse. In other words, the highest annoyance of the impulsive cadence of 10 impulse. In the words, the highest annoyance of the impulsive sound is perceived even without perceiving the tone and normally the quality (with a 100 ms of duration), but it is sufficient to perceive the sound as something different from a generic noise , and for this reason it is sufficient a 10 ms of duration.

In the causes of piano disturbs, the differences many measurements with these constant of time are often mayor to 6 dB. Therefore, the sound of the piano is constituted by impulsive components.

However, the power of the human hear is mayor. It must consider that in the pieces for piano the notes have a cadence minus to 10 impls. According to the Italian laws the noise has impulsive components when:

? The event is repetitive.

? The difference between Lmax and LASmax is higher to 6 dB.

? The duration of the even at -10 dB from the LAFmax is lower that 1s.

? The impulsive acoustic even is repetitive when it takes place 10 times per hour in daytime and at least twice in an hour in nighttimes.

The repetitiveness is to be demonstrated by a graphic demonstration of the LAF level during the measurement time TM.

The result of the measurements confirmed the theory and underlined the necessity to make corrections to the impulsivity of the even as it is said in the comma 8,9,10 of the enclosure B DM 16/03/98.

Tonal components and pure tones

With equal dB(A), the sound with pure tones is much more annoyance than the sound without higher components, with continuous spectrum.

Italian laws says that after having cricked the stationary features in a space of time and in a frequency of tonal components, if the minimum level of a band in 3/8 third octave (between 20 Hz and 20 KHz) overcomes the two adjacent bands of 5 dB at least, it must apply the correction factor KT = + 3 dB only if the prevail iso-phone is equal to or overcomes the other iso-phone.

In case of piano sound, being musical notes, the pure tone would be declared for definition. In fact, the note of piano is composed by the tonal component and by same harmonic, all with fixed frequencies: therefore, if it is music on one hand, on the other it is pure have and so particularly annoying.

Besides there is no stationary feature. In the spectrum analysis of the present study case, the tonal components are not to be penalized. So, the correction of the environmental noise level LA was not applied.

Differential or overcoming criteria and comparative method inside rooms

The sound level of the piano from the floor below varies according to pianist's way of playing and to the kind of piece performed.

The level of the residual noise present in the rooms when the specific annoying source has been excludes (denominated RR), has been compared to be a environmental noise level (RA) measured in the same acoustic conditions as the one before.

The background noise (RF) has been even compared to the environmental noise level in the same conditions. In the tables 1 and 2 you can see the most significant comparisons. The medium values of measured environmental noise has been compared with the medium residual value in order to assess the medium conditions and not in the most annoying condition.

Source Codes

1 Piano: Execution of exercises (session 1: medium value for all the period)
2 Piano: execution of musical pieces (session 1: medium value for all the period)
3 Piano: execution of musical pieces at elevated emission (session 1: medium value for all the period)
4 Piano: Execution of exercises (session 2: medium value for all the period)
5 Piano: execution of musical pieces (session 2: medium value for all the period)
A Residue over all the period (session 1: medium value)
B Residue over all the period (session 2: medium value)

Point	Config.	Time 6-22	L_{Ac} dB(A)	L_R dB(A)	Limite max differenziale dB(A)	$L_D=L_{Ac}-L_R$ dB(A)	Acceptable
CLOSED WINDOWS							
S1	**1 con A**	**DAY**	**38,5+3**	**31,5**	**5**	**7,0+3**	**not**
S1	**2 con A**	**DAY**	**39,5**	**31,5**	**5**	**8,0**	**not**
S1	**3 con A**	**DAY**	**45,0**	**31,5**	**5**	**13,5**	**not**
S1	**4 con B**	**DAY**	**38,0+3**	**33,0**	**5**	**5,0+3**	**not**
S1	**5 con B**	**DAY**	**41,0+3**	**33,0**	**5**	**8,0+3**	**not**
OPEN WINDOWS							
S2	**1 con A**	**DAY**	**49,5**	**47,0**	**5**	**2,5**	**yes**

Tab. 1 - Valutazione accettabilità (periodo diurno)

L_D = Differential level of noise
L_{Ac} = Environmental noise level corrected per presence of impulsive components
L_R = Residual noise level

Considering the high levels of environmental noise and the passive acoustic features of the horizontal partitions, it has been founded the non acceptability of the sound introduction with closed windows in all the configurations and the acceptability with open windows:

Point	Config.	Time 6-22	L_A dB(A)	L_F dB(A)	$L_A - L_F$ max tolerable dB(A)	$L_A - L_F$ dB(A)	Tolerable
CLOSED WINDOWS							
S1	**1 con A**	**DAY**	**38,5**	**28,0**	**3**	**10,5**	**not**
S1	**1 con A**	**DAY**	***38,5+3**	**28,0**	**3**	**10,5+3**	**not**
S1	**2 con A**	**DAY**	**39,5**	**28,0**	**3**	**11,5**	**not**
S1	**3 con A**	**DAY**	**45,0**	**28,0**	**3**	**17,0**	**not**
S1	**4 con B**	**DAY**	**38,0**	**28,5**	**3**	**9,5**	**not**
S1	**4 con B**	**DAY**	***38,0+3**	**28,5**	**3**	**9,5+3**	**not**
S1	**5 con B**	**DAY**	**41,0**	**28,5**	**3**	**12,5**	**not**
S1	**5 con B**	**DAY**	***41,0+3**	**28,5**	**3**	**12,5+3**	**not**
OPEN WINDOWS							
S2	**1 con A**	**DAY**	**49,5**	**42,5**	**3**	**7,0**	**not**

Tab. 2 - Valutazione della normale tollerabilità)

N.B. In the evaluation of tolerability, the levels of environmental noises have been considered as damaging for the presence of impulsive components (with asterix) and without penalization

$\mathbf{L_T}$ = Differential level of noise

$\mathbf{L_A}$ = Level of environmental noise

$\mathbf{L_F}$ = Background noise level

Considering the high levels of environmental noise, there is no tolerability of the sound introduction in all the configurations.

As soon as they received the CTU report, the competent authorities dispose the reduction of piano exercitations in few hours a day. Another option was the use of the sardine and the enclosure of the piano. However, in the latter case, the annoyance is not sensitively reduces because the sound that arrives is prevalently constituted by components of sound at low frequencies which have the characteristic of higher transmission and so the analysis in frequency for octave of the sound with or without sardine permits to underline that for the very low or low frequencies the efficacy is limited to the difference of few dB ; on the contrary for the medium and high frequencies this efficacy consists of a lot of dB, fact that underline the minus sonority of the piano with sardine in the same room. Besides, the pianist with the imposed sardine and the reduced sonority tends to increase in power his touch on the keys.

The competent authorities were asked to give instructions about works of soundproofing. To do this, it needs to define the quantity of noise mitigation required in dBA. The required diminution should be generally equal to the value of overcoming of the residual noise or the background one. This is due to the fact that the component of the piano sound added to the background noise produces 3 dBA more on the background as it is prescribed. It must consider that there should be diminutions even for the lower frequencies typical of a piano, fact that is difficult and expensive to solve.

THE PIANIST FROM "EXECUTOR" BECOMES "VICTIM"

The annoying pianist from executor becomes a "victim". In fact, when there are judicial proceedings, a perverse mechanism between technicians and competent technician originates which includes layers and the applying part and the counterpart. In this study case the annoying part decided to move to another place after having calculated the expenses for piano soundproofing interventions. In other case could happen some aberrations one of which will be described.

In another case a student of conservatory was involved in a dispute and finally in a judicial proceeding. After evaluated the exceeding of the 3 dB(A) providing by enforced rules, it was planned to apply passive noise mitigation able to give a sufficient attenuation (but without a great efficaciousness for low frequency propagation). The consultant of the annoyed apartment aimed only to win the case instead of to guarantee good terms with the neighbours, with a not deontological procedure, planned to replace the windows of the annoyed apartment with other with a better soundproofing. After this intervention the background noise levels was considerably reduced (in the annoyed apartment) with the consequence of exceeding the differential limit. This dubious intervention has thwarted the efficacy of mitigation procedure and the depart of the pianist after having paid the expensive soundproofing, the legal costs as well as the costs of the consultant.

SUMMARY

The present study has underlined that:

- noise due to the pianist is diffused along the below flat and that is not compatible in buildings with superposed flats;
- intervention able to limit neighbourhood noise exposition are really expensive and difficult for low frequencies;
- sound mitigation of facades or windows in the annoyed flat (and the consequent decreasing of background noise) are not compatible with soundproofing of floors between superimposed rooms and could be used as a sleight of hand by the annoyed to be able to win a legal dispute.

REFERENCES

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