Chapter 4

Residential sound insulation and community response

In the communities surrounding Kadena Air Base and Futenma Air Station, the Japanese government has undertaken sound-insulation programme to mitigate aircraft noise in compliance with an act pertaining to improvements of residential environments adjacent to defence facilities. Homes located in areas where noise contours designated by the DFAA are 75 or higher are eligible for sound insulation under this act. Sound insulation measures to be executed on demand of the residents include sound-proofing of windows and doors, ceiling and wall insulation, and air conditioning. The number of rooms to be sound insulated in a home depends upon the condition of household such as the number of family members.

In this chapter the relationship between residents' responses regarding reported annoyance, interference with conversation, sleep disorder and neighbourhood satisfaction, and the implementation of sound insulation is analysed. The substantial effectiveness of sound insulation against aircraft noise in real-life situations is also discussed.

4.1 Methods

The questionnaire includes questions on the implementation and performance of sound insulation (ref. Appendix A/ Question C8.) For those respondents living in sound insulated houses, the performance of sound insulation was addressed, based on a rating scale with five categories. In addition, the degree of satisfaction regarding the sound insulation was addressed on a rating scale with seven categories.

As the questionnaire items regarding the noise effects such as reported annoyance, communication disturbance, sleep disorder and neighbourhood satisfaction are used for analysis.

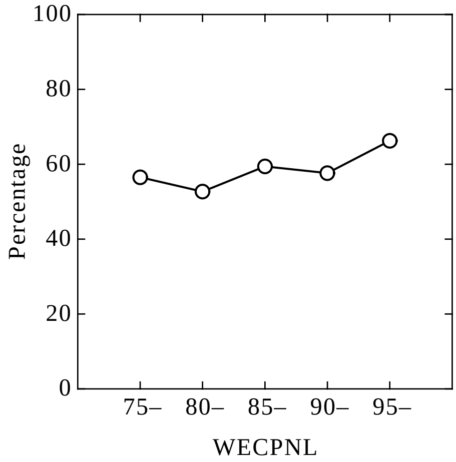

Figure 4.1 Percentage of the response on the implementation of sound insulation *vs.* WECPNL.

4.2 Results

The response rate regarding the implementation of sound insulation supported by the government is presented for the different ranks of noise exposure in Figure 4.1. Contrary to general expectation, the rates are around 60% regardless of the WECPNL rank.

Figure 4.2 shows the rates of the answers in the rating scale to the question regarding the evaluation of the performance of sound insulation as a function of WECPNL. Although the negative evaluation of the performance sound insulation is relatively low to be about 20% in the group with WECPNL of 75, the rate increases as WECPNL increases and reaches up to about 70% in the group with WECPNL of 95.

The response as to the degree of satisfaction with sound insulation is shown in Figure 4.3 as a function of WECPNL. One can see in the figure about 10% of residents with WECPNL of 75 are more or less dissatisfied. The response rate of the satisfied was about 60%. With an increase in the WECPNL, the rate of dissatisfied residents increases and reaches up to about 60% in the group with WECPNL of 95.

The results shown above suggest that damages to the residents caused by aircraft noise might be mitigated by the implementation of sound insulation at least to some extent. The thesis could be examined by comparing the differences of the positive response rates regarding noise effects between sound insulated population and the rest.

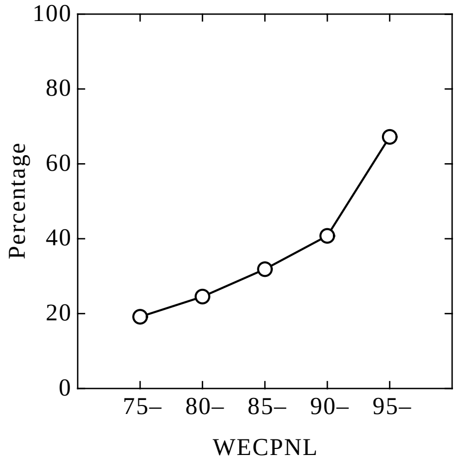

Figure 4.2 Percentage of the response on the evaluation of the performance of sound insulation *vs.* WECPNL.

Category: “4. Not much working.” “5. Not working at all.”

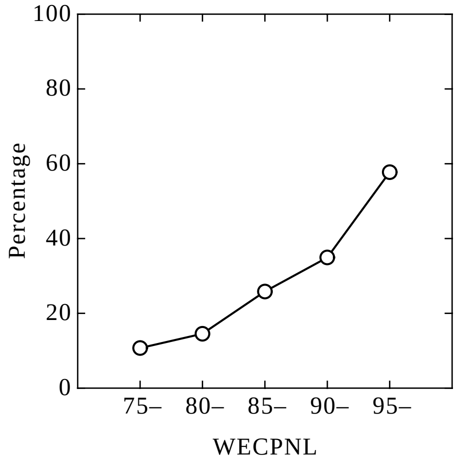

Figure 4.3 Percentage of the response on the satisfaction with sound insulation *vs.* WECPNL.

Category: “6. Dissatisfied.” “7. Very much dissatisfied.”

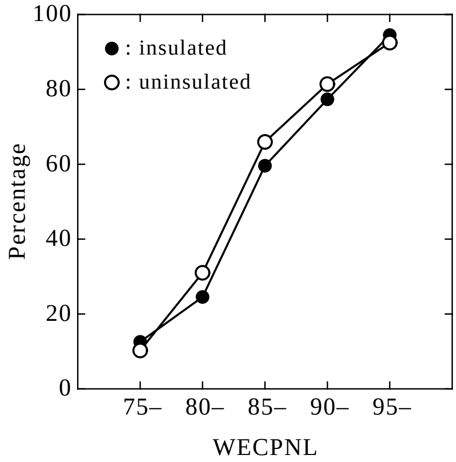

Figure 4.4 Percentage of the response on the annoyance *vs.* WECPNL in relation to sound insulation.

Category: "1. Very annoying." "2. Pretty annoying."

The population are divided into two groups; those whose homes are sound insulated and those whose homes are not. Figure 4.4 illustrates the annoyance reaction rate of those answering the items "very annoying" and "pretty annoying" as a function of WECPNL. Due to the differences in the response rates found between around the two airfields, the response rates are shown as to Kadena Air Base only in this chapter. Solid circles in the figure indicate rates of the population living in the homes sound insulated and open ones not insulated. The rates are adjusted for the different distributions of age and sex between the populations in the areas with different ranks of WECPNL. Surprisingly, the dose-response relationships for both populations manifest very good agreement throughout the range of the level of noise exposure. Reported annoyance, however, might not reflect the annoyance the residents experience inside their homes, although the question asks about the annoyance they experience while staying in the buildings. Doubt cannot be swept out completely, however, if they answered about the overall annoyance impression of the aircraft noise exposure regardless of outside or inside their homes.

In Figure 4.5 is shown the response rate marking the alternative of "always" or "often" concerning the interference with conversation inside the home as a representative of communication disturbance. The response rate of sleep disorder "once or more a month" is plotted against WECPNL in

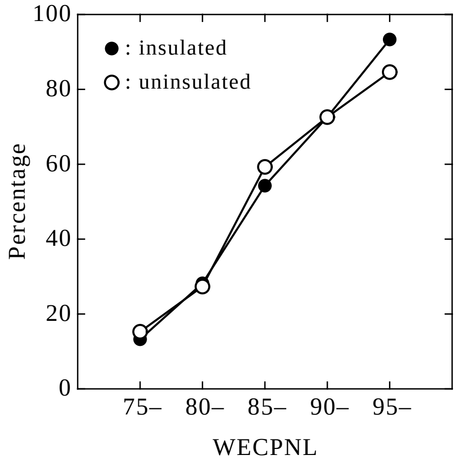

Figure 4.5 Percentage of the response on the interference with conversation *vs.* WECPNL in relation to sound insulation.

Category: "1. Always." "2. Often."

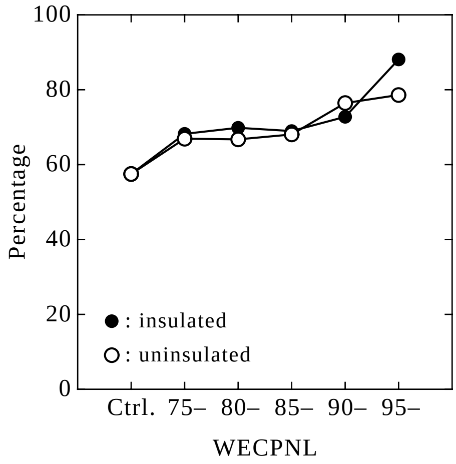

Figure 4.6 Percentage of the scores on the sleep disorders "Once or more a month" *vs.* WECPNL in relation to sound insulation.

Figure 4.6. In both figures there cannot be found any significant difference in the dose-response relationships between the two groups of residents. Since communication disturbance and sleep disorder are considered to occur inside the home basically, the results presented in Figures 4.4 to 4.6 cast a strong doubt about the effectiveness of sound insulation.

In Figure 4.7 is shown the response rates of the both groups concerning neighbourhood satisfaction of those marking the items "very good," "good," and "rather good" as a function of WECPNL. In the case of neighbourhood

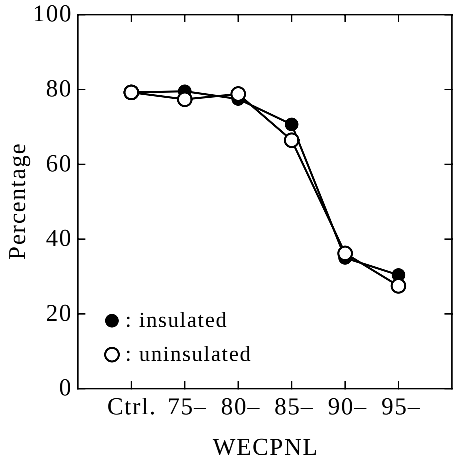

Figure 4.7 Percentage of the responses on the neighbourhood satisfaction *vs.* WECPNL in relation to sound insulation.

Category: "1. Very good to live in." "2. Good to live in." "3. Rather good to live in. "

satisfaction as well is found no difference between the two groups of residents. The fact suggests that the quality of life environment is not improved by the implementation of residential sound insulation.

In order to test the difference in the responses between the two populations, logistic regression analysis is applied with the independent variables of WECPNL, age, sex, sound insulation, occupation, interaction between age and sex and interaction between implementation of sound insulation and WECPNL. According to the results of the analysis, no significant difference is found between the two groups of residents for any items of noise effect, or no contribution of sound insulation is recognised.

4.3 Discussions

4.3.1 Community response as to sound insulation

Despite the evaluation and satisfaction of sound insulation reported by the residents or the physical performance of the sound insulation implemented by the DFAA, the mitigation of the impact of noise exposure on the residents are not at all found according to the results of present survey as presented above. The result is accordant with that reported by Fidell *et al.*(1991) who conducted a social survey to compare the prevalence of noise-induced annoyance in two residential populations with similar aircraft noise exposure in the vicinity of Hartsfield International Airport. One population was composed of the residents of homes that had been sound insulated and the other population was composed of the residents of homes that had not been sound insulated. They found no clear benefit of noise insulation in terms of lowered prevalence of annoyance to aircraft noise exposure.

4.3.2 Physical performance of sound insulation

The sound insulation programme carried out by the DFAA aims to achieve the transmission loss, TL, of 20 dB for the residential homes in the area with WECPNL of 75 to 80 and TL of 25 dB for those in the area with WECPNL of over 80. The noise reduction measured as the difference of sound levels between inside and outside the residential homes which are sound insulated by the DFAA around Kadena Air Base may be considered to be about 30 dB on the basis of the measurements conducted in two ways. In one way of measurement, broadband noise is generated by a loud speaker set outside of a residential house and octave band levels are measured inside of the house. A record of measurement conducted for a most properly sound insulated house indicates the transmission loss is 30 to 50 dB. In another way of measurement was undertaken as on-the-spot inspection of a civil suit case where 906 plaintiffs demanded restriction of nighttime flights and compensation for the damages caused by aircraft noise from Kadena Air Base. In that case both sound levels inside and outside of residential houses are recorded and the difference of the two sound levels is calculated. The result tells the difference is 26 to 29 dB.

The performance of sound insulation, however, is reported to be diverse one home after another and one flight after another. It depends on many factors such as the construction skill, the structural strength and type of the building, the fight path relative to the home, the type of aircraft, etc.(Sharp; 1994) The results of the measurements around Osaka International Airport for over 1,000 homes show that the mean TL of the homes for the same type of aircraft and the flight path are basically constant over the years of measurements from 1975 to 1978 with standard deviations from 2.6 to 4.6 dB. The standard deviations of the measurements are considerable taking the fact that they are of the same types of aircraft flying the same courses of flight path into account (Sato; 1979).

Thus it seems fairly difficult to determine by a simple figure of transmission loss of the buildings the physical performance of sound insulation against aircraft noise.

Table 4.1 Percentage of the response regarding the hours in a day when the respondents close windows

WECPNL	Percentage of the response regarding the hours in a day when the respondents close windows of the room sound insulated (%)				
	Mostly open	< 8 hrs.	8 – 16 hrs.	≥ 16 hrs.	Mostly closed
75–80	31.4	10.7	35.5	10.7	11.8
80–85	34.6	12.8	31.8	11.1	9.7
85–90	33.3	9.3	33.1	11.7	12.6
90–95	31.1	10.8	29.1	12.0	17.1
95–	38.4	7.1	36.4	8.1	10.1
Total	33.0	10.7	32.8	11.1	12.4

4.3.3 Factors detracting the performance of sound insulation

Two factors might be considered which detract the performance of sound insulation in the reality of everyday life. One is window open and the other is the mixture of insulated and uninsulated rooms existing in a home.

Table 4.1 shows the answers of residents to the question asking the hours in a day when they close windows. In the table one can see 40 to 50% of residents close the windows less than 8 hours a day and only about 20% residents close windows more than 16 hours a day. The result presented in the table is understandable because in the semitropical climate as in Okinawa people enjoy breeze in the building in the long summer. With the windows closed they need to operate costly air conditioners all day long for more than six months a year. Imagine the situation. While aircraft noise is off they enjoy quiet and peaceful soundscapes and the noise intrudes at once from time to time. Thus most of residents keep open the windows in the daytime.

From the table it can be seen that 50 to 60% of residents keep windows closed over 8 hours a day, which suggests that more than a half of the population close the windows when they go to bed. If so, it is a kind of mistery that no difference was found in sleep disorder between the two residents of homes with and without sound insulation.

The DFAA's sound insulation programme does not necessarily implement all the rooms of a home. As a result some rooms, say bedrooms and/or living rooms, are primarily insulated and other rooms, say dining room and/or kitchen, are not insulated. The acoustic performance of sound insulation is measured with windows tightly closed and doors between rooms locked up. In daily life, however, it is too unrealistic to force the residents to shut the door between the living room and the dining room every time they get in and out, and moreover to keep tight lock of the door.

They may even keep door of the bedroom open while they are in bed. The performance of sound insulation in this case will be the same as that the TL of ordinary sound insulation without the programme of the DFAA.

4.4 Conclusion

It is clear that the implementation of sound insulation has not led to the responses toward desirable direction regarding both sleep disturbance and interference with television and telephone use regardless of WECPNL grouping. It is very likely that sound insulation does not, in actual context, mitigate some effects of noise in the daily lives of residents — the aforementioned positive responses reflecting its physical performance notwithstanding.

References

Fidell S & Silvati L (1991), An assessment of the effect of residential acoustic insulation on prevalence of annoyance in an airport community, J Acoust Soc Am 89(1): 244–247.

Sato K (1979), On the valuation of noise in the soundproofing houses around Osaka International Airport, Architectural Acoustics and Noise Control, 27/July, 57–62.

Sharp BH (1994), 25 years of airport sound insulation programs, NOISE-CON 94, 641–648.