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LONG TIME CONTINUOUS MEASUREMENT OF LONG RANGE NOISE PROPAGATION OVER SEA

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1.INTRODUCTION

In order to assess the environmental impact of noise from developing area, it is necessary to get the noise reduction data. It is well known that the noise reduction is affected by the meteorological conditions. There are many methods to estimate the noise propagation in long range under certain meteorological conditions, but we know that no systematic prediction method allowing to predict the actual meteorological condition and it is difficult to observe them. Our major interest was when the reduction become small, so, the test signal was emitted from the fixed point on the sea and received at points on the seacoast about 5km from the source. The measuring system was operated automatically, then we could continue the measurements for 14 months. The M- sequence correlation technique[1],[2],[3] was applied in order not to annoy the people in the site, and further the microphones with parabolic reflectors was used. During the measurements, some meteorological conditions were observed simultaneously.

2.MEASUREMENT SITE

Fig.1 shows the measurement site. The source was settled on the revetment of the artificial island and the height was 14.5m above the sea level. Two receiving points were settled on the seacoast and the height was 12m above the ground. The horizontal distances between the source and two receiving points were 5270m and 5850m respectively. The meteorological conditions were observed on a tower 100m

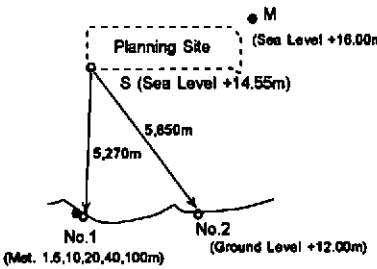

Fig.1 Measurement Site

high near receiving point No.1, i.e. temperature, humidity, wind velocity and direction were observed at the levels 1.5m,10m, 20m, 40m and 100m above the ground, and solar radiation and some other conditions were observed on the ground. And also at the station M 16m above sea level, temperature, humidity, wind velocity and direction were observed.

3.MEASURING SYSTEM

M-sequence Correlation Method: As we were afraid of that the measuring signal annoyed the peoples, M-sequence correlation method and time averaging technique was applied. 1/3 octave band noise of 250Hz, 500Hz and 1kHz were modulated. The order of M-sequence signal was 5 and clock period was 100ms. Averaging time was 155 seconds.

Measuring System: The measuring system, the power supply for the source station on the sea and remote control by radio and telephone line, were designed mainly aiming at it works automatically for long time. Fig.2 shows the schematic diagram of the measuring system. The source station comprised of power supplying, signal generating, monitoring and communication part. The receiving stations comprised of receiving, analyzing and communication part. And both stations were controlled by the central station. Power level of source signal was automatically controlled the following back ground noise level at each receiving station. Through the measurement, the conditions of the system could be monitored by computer communication through telephone line.

Acoustic Characteristics of the Loudspeaker and Microphone System: Because of the limitation of power supplying capacity, a straight-horn type loudspeaker was used. Fig. 3 shows the frequency characteristics of the loudspeaker. The loudspeaker was directed to the receiving station No.1, where one inch condenser microphone with parabolic reflector was used. Fig.4 shows the directional characteristics of the parabolic reflector.

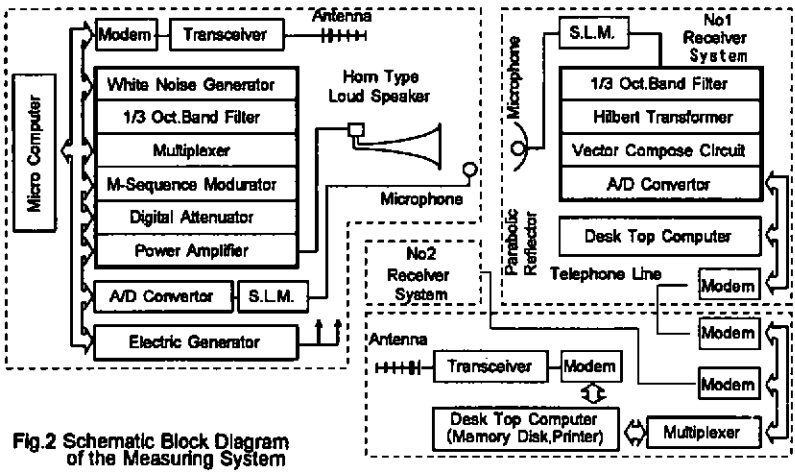

Fig.2 Schematic Block Diagram of the Measuring System

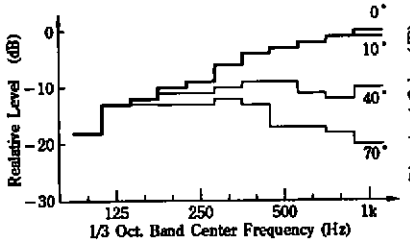

Fig.3 Frequency Characteristics of the Loudspeaker

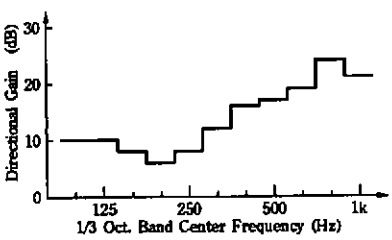

Fig.4 Directional Gain of the Parabolic Reflector

4.MEASUREMENT AND RESULTS

Measurement: The measurements were carried out from June 1989 to July 1990 in every hours in every days except holidays. We regarded that the meteorological conditions do not show 1 week periodic change, so 1 day suspension per 1 week is not a serious problem. In one trial of the measurement, 1/3 octave band noise(250,500,1k Hz) modulated by M-sequence which duration was 155s, was emitted sequentially. Total time per one trial including the time for correlation analysis and data communication between the central and the receiving stations was about 10 minutes. The analyzed correlation wave forms and receiving levels was stored in a hard disc with monitored reference level at a point in front of the source. Fig.5 shows a example of level time history measured at No.1 and analyzed correlation wave form. Here, we define that the noise reduction in this site and situation is the difference between the monitored reference level of the source and the receiving level corrected by the directional gain of the reflector for the microphone. The receiving level at No.2 is corrected using the directivity of the loudspeaker. So, this noise reduction includes geometorical spreading loss, absorption by air, effect the surface of sea and ground and the effect of scattering by the turbulence of atmosphere.

Results: 8334 trials were carried out during 14 months, noise reduction data were obtained in about 60% times of these trials. There was no complaint about the test signal at the vicinity during the measurement, we obtained sufficient large numbers of data. About the measuring system, the loudspeaker and the microphones had been working well in severe weather conditions, but the electric generator and telephone line broke down mechanically, and we stopped the measurement for a few days.

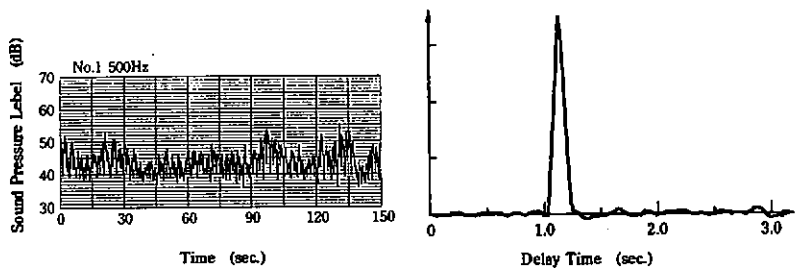

Fig.5 Measured Level Time History and its Correlation Wave Form

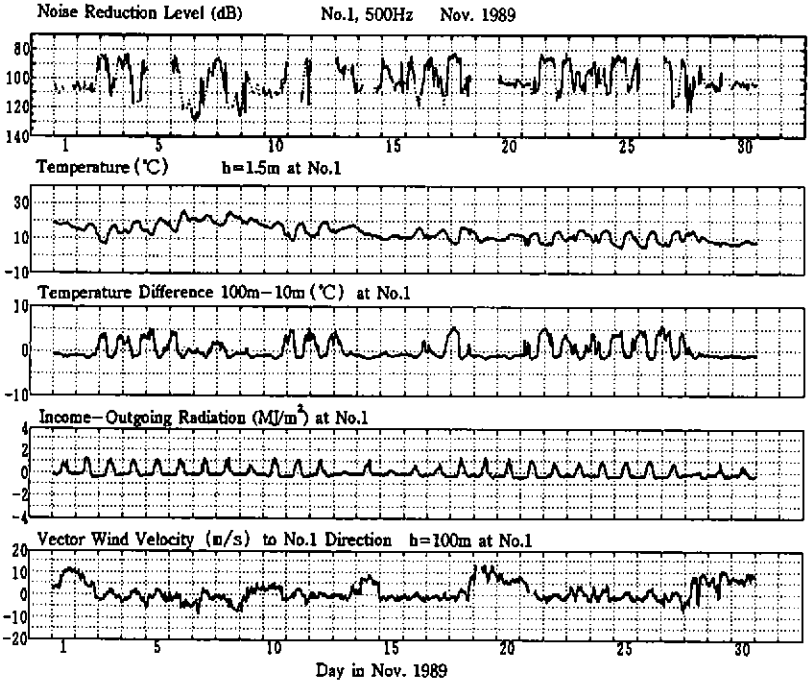

Fig.6 Examples of Noise Reduction Levels(No.1, 500Hz) and Meteorological Conditions

Fig.6 shows examples of the noise reduction levels and some meteorological conditions during a month. The noise reduction level show one day periodic change basically and the range of the changing is 50dB or more. And in some situations, the noise reduction level changes 20 ~ 30dB per one hour. We can see some relation between the noise reduction level and some meteorological conditions from Fig.6.

5.CONCLUSIONS

We designed a automatic measuring system using M-sequence correlation technique, and successfully obtained the long distance(5km) noise propagation for long time(14 months) continuously. There was no disturbance by the test signal, since the power level of the source signal was controlled refering to the S/N ratio at the receiving point, where also the microphone was used with a parabolic reflector.

References

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