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THE EFFECT OF TURBULENCE ON BARRIER PERFORMANCE

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INTRODUCTION

Kurze [1], in his review paper on general aspects of noise barriers pointed to the need for further information about the way barrier performance is modified by turbulence at the edge of the barrier. This paper reports on an experiment designed to investigate any correlation that exists between the measured instantaneous attenuation provided by the barrier and various measures of the corresponding turbulence conditions above the barrier. The various geometries and procedures used were selected specifically in the light of the obscuring effects of such other factors as interference, diffraction around the ends of the barrier, refractions and ground effects.

EXPERIMENTAL METHOD

A barrier 17m long and 2.4m high was erected on open flat grassland remote from reflecting surfaces and in an intrinsically quiet location. Short bursts of sound were produced by a horn loudspeaker of cut-off frequency 160Hz and comprised either pure tones at fixed frequencies between 250Hz and 4KHz, pure tones at frequencies chosen randomly from within each of the octave bands of this range or octave bands of noise. A twin channel analogue memory device was modified to capture acoustic signals from two microphone channels. One microphone was placed at one of a number of positions beyond but close to the barrier and the other was located above or in front of, the barrier. 4K 8-bit samples were taken at intervals of 7μs after internal triggering by the arriving sound burst. The acoustic signal was terminated when the distant microphone memory was full.

Instantaneous values of the wind velocity were determined using a hot-wire anemometer placed 1.0m above the barrier. The electrical output of the device was sampled and stored using a 1K 8-bit analogue memory; sampling commenced at the moment of initiation of the sound burst and continued for 50ms or 500 ms at choice. Conversion to instantaneous wind velocity values was achieved in software using laboratory calibration of the probes used against a pitot tube. Additionally a single value of the wind direction was recorded in 8-bit form, as was local air temperature.

The experiment was carried out under programme control using a microcomputer which in sequence selected the acoustic frequency, set filters, adjusted autoranging attenuators designed to ensure optimal use of the capacity of the 8-bit devices and selected appropriate equalisation circuits. Wind muffs were used on each microphone and a segment of the control programme caused background levels to be measured immediately prior to generation of the sound signal. If this level was found excessive the sound passage was inhibited.

Sound levels were computed and stored along with level differences and processed meteorological data. Subsequently data sets were transferred for analysis on a DEC 2060 main frame computer.

RESULTS

Evidence has been sought of a correlation between measured level differences and a variety of parameters derived from the meteorological data for various geometries. No obvious correlation emerged when such quantities as sample mean wind velocity, sample wind velocity range and wind direction were used as independent variables. An index, presumed to offer a measure of turbulence was derived from the anemometer data and designated turbulence number (TN). This was taken as the value of the standard deviation of the wind velocity samples about the mean velocity to the value of that mean velocity. This is clearly related to the conventional measure of turbulent intensity but modified on account of the frequency limitations implied on the sampling process: TN_{50} and TN_{500} relate to values calculated for 50ms and 500ms samples respectively.

The result of plotting measured level differences against either of these two parameters are shown in figures 1 to 10. Although the uneven distribution of points amoung TN values leaves the higher TN values relatively under-represented, it is possible to discern a general tendency in that the scatter among individual level differences appears large at low TN values, reducing as TN increases. Thus it could be argued that at higher levels of turbulence air behaves as a more uniform medium.

1:16 scale model experiments have also shown some evidence of this effect.

REFERENCE

[1] Ulrich J. Kurze, "Noise reduction by barriers", J.A.S.A, Vol. 55, No. 3, (504-517), (1974)

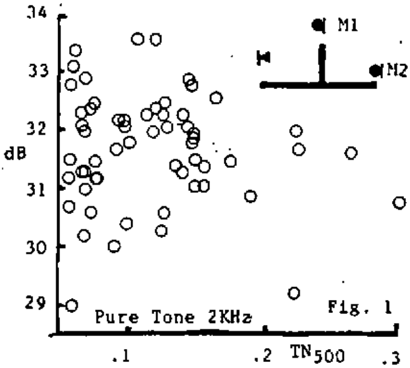


Fig. 1

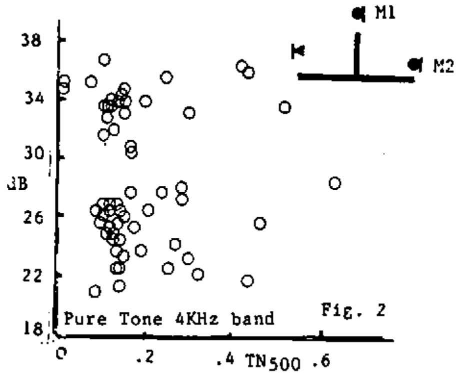


Fig. 2

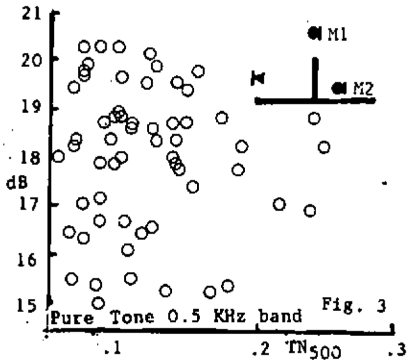


Fig. 3

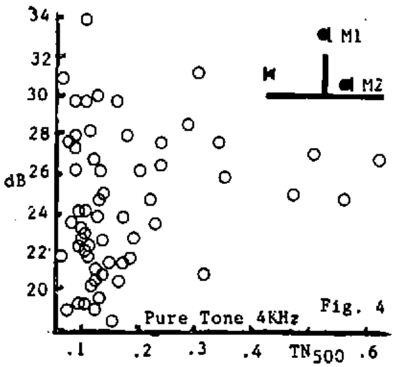


Fig. 4

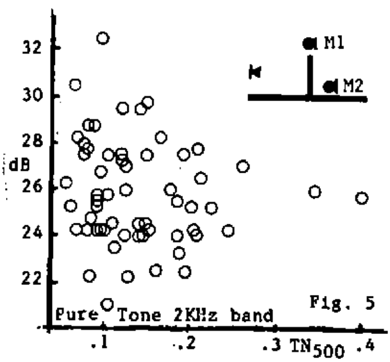


Fig. 5

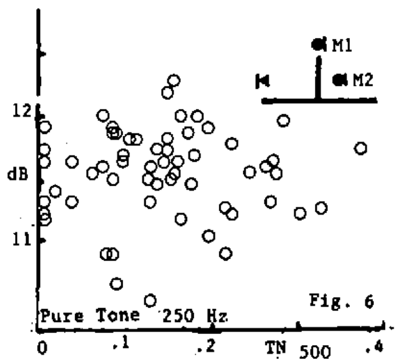
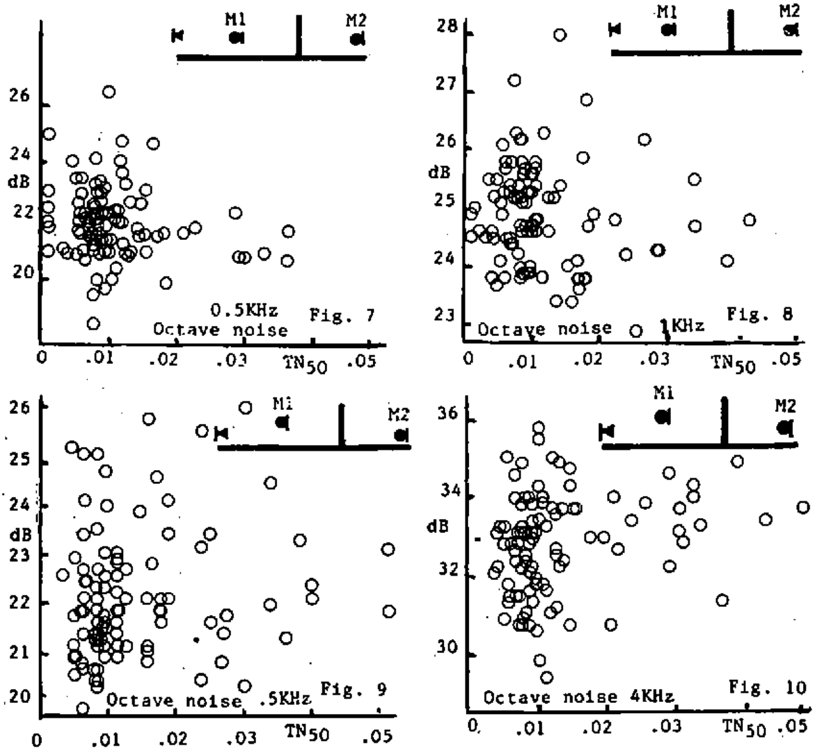


Fig. 6



Figs. 1 to 10: Level Differences vs Turbulence Numbers

Figs. 1 & 2	Source is 4.8m from barrier,1.4m above ground; M1 is 1m above barrier;M2 is 4.8m behind barrier, on ground
Figs.3,4& 5	As above except M2 is 1m behind barrier
Fig. 6	As above except M2 is 1.4m above ground
Figs. 7& 8	Source is 9.6m from barrier,1.4m above ground;M1 & M2 are 4.8m from barrier, 1.4m above ground.
Figs. 9& 10	As above except source and M2 are on the ground.