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AIR-BORNE ACOUSTIC SURFACE WAVES GENERATED OVER A PERIODIC ROUGH SURFACE

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1 INTRODUCTION

Although the generation of air-borne acoustic surface waves is a problem for noise control and measures must be taken to reduce their effect, surface waves can be used to passively amplify acoustic signals and thereby improve sensor performance.

Air-borne acoustic surface waves arise when a sound wave propagates over poroelastic or rough surface where the impedance has a greater reactance than resistance. Vertical to and fro motion of air particles due to sound penetrating the surface couples with the to and fro horizontal motion of air particles due to sound travelling parallel to the surface. The resultant elliptical motion is associated with a surface wave which traps sound energy at certain frequencies close to the surface resulting in an enhancement greater than the 6dB that would be associated with total reflection from an acoustically hard surface. They attenuate cylindrically with horizontal distance from the source and exponentially with height above the surface[1].

Hutchinson-Howorth and Attenborough[2] carried out measurements over single and double lattice layers using tone bursts. They separated the surface wave contribution from the original impulse showing that the surface wave travels slower than the speed of sound in air.

Zhu et al[3] conducted measurements over a lattice and a mixed impedance ground surface, composed of strips, to investigate the passive amplification of signals through surface wave generation. It was found that a mixed impedance surface provided better amplification of acoustic signals than the lattice. Daigle & Stinson[4] also constructed a finite impedance surface using a strip of structured ground and found that the finite width of the strips gives rise to a directional response. This effect was exploited to obtain passive amplification and the sound pressure level found to be 6dB higher for sound travelling parallel to the strips compared to sound travelling transversely.

Bashir et al[5] carried out measurements over arrays of parallel rectangular aluminium strips to establish how strip-size and geometry affected the frequency content and magnitude of surface waves. The edge-to-edge spacing of the strips was varied between 0.003m and 0.006m. Frequency and time domain data shows that the surface wave shifts to lower frequencies as the mean spacing between the strips is increased. The magnitude was not found to change significantly. It was also found that the surfaces formed by the strips could be regarded as locally reacting rigid-framed hard-backed slit-pore layers with an effective depth slightly larger than the strip height when the spacing is close to the strip height. However, when the spacing is greater than the strip height, the surfaces behave as periodically rough surfaces.

The measurements conducted by Bashir et al indicates the possibility of more than one surface wave generated over the surface but so far have been interpreted as a consequence of the finite strip length. Surface wave generation by strips has been investigated through further measurements and the development of a Boundary Element Method (BEM) designed to study the surface waves in the time-domain.