Estimation of Blowing Snow Intensity Using Acoustic Signals

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Introduction

Blowing snow sometimes causes serious troubles such as traffic accidents in snowy areas. Many countermeasures against blowing snow have been constructed in Japan. However we still have some problems by blowing snow. One of the reasons is that our understanding about blowing snow occurrence and variability is not sufficient for practical forecast. A feasible method to study temporal and areal variation of blowing snow is to develop an automatic multiple sensor system for blowing snow measurement to cover areas where people are frequently suffered by blowing snow. Conventional snow drift traps are not suit for this purpose.

Recently studies on development of blowing snow meters using acoustic signals were done by Font *et al*. (1998) and Chritin *et al*. (1999). It is necessary to develop automatic sensors which can measure blowing snow intensity without frequent maintenance for the purpose mentioned above. The sensors are also expected to be of low prices to install many observation points.

In the present paper, a prototype of acoustic blowing snow sensor was tested in cold wind tunnel experiments to examine the possibility to develop such sensor that suits for the purpose. Spectral analysis was conducted about electric signals from the acoustic blowing snow sensor.

Experimental Setup

Experiments were carried out in a wind tunnel. The working section is 14m long and its cross-sectional area is 1m x 1m. The wind tunnel is of return flow type. The whole system of the wind tunnel is in a large cold room. Details of the wind tunnel was described by Sato *et al*. (2001).

Figure 1 Experimental setup. Wind blows to left.

Figure 1 is a photograph of the blowing snow sensor tested in the present study and the wind tunnel. Snow was shift on the floor of the working section to form a flat snow surface. The sensor was mounted on the snow surface. The sensor was

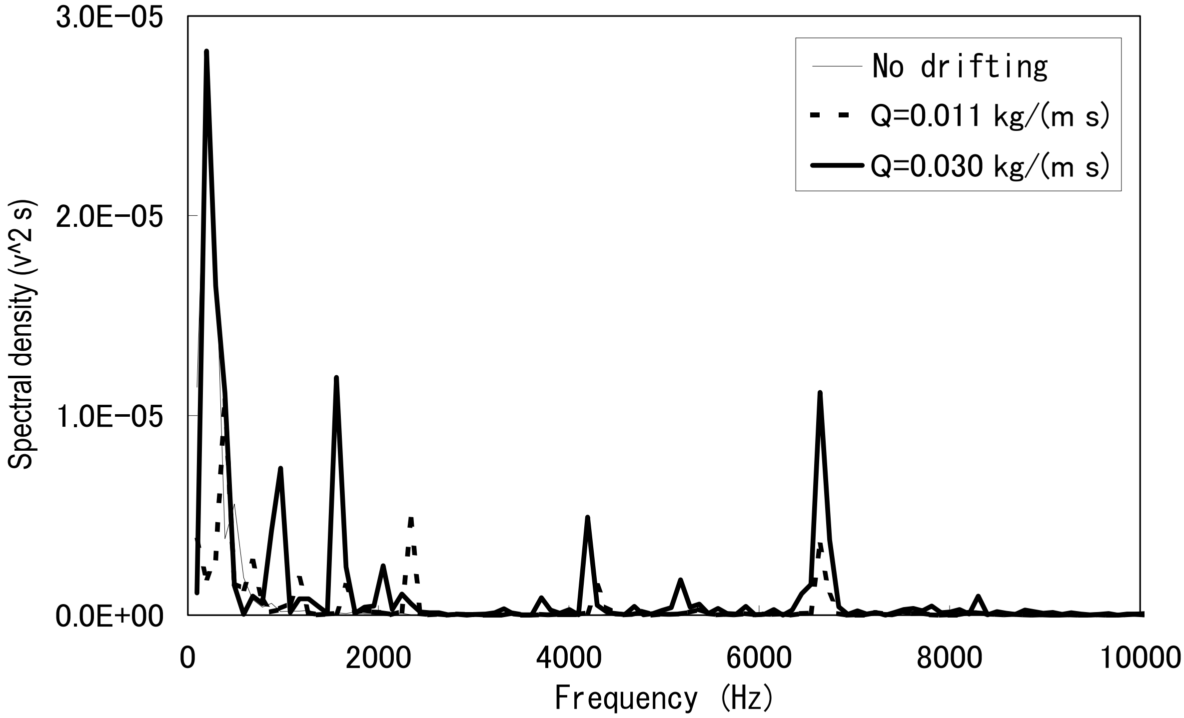


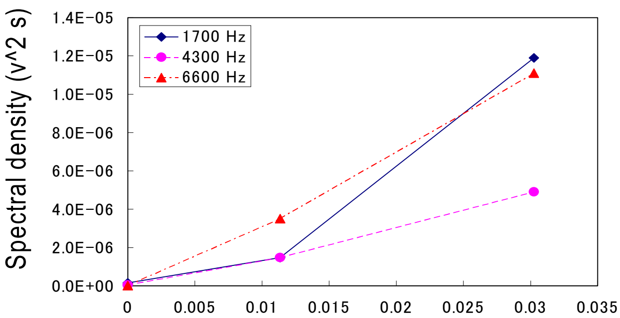
Figure 2 Power spectrum of acoustic signals. Wind velocity was 8m/s.

composed of a cylinder and a circular plate of steel. The circular plate was put on the windward end of the cylinder. The cylinder was 140mm long and the diameter of the circular plate was 75mm. A microphone was installed in the cylinder to record acoustic signals.

Experiments were carried out under temperature of –15°C and wind velocity of 8m/s. Snow drift transport rate was controlled by changing the supply rate of snow particles from the upstream end of the wind tunnel. Other details of the experimental procedure were shown in Kosugi *et al*. (2001). Recorded acoustic signals were analyzed by the FFT to clarify characteristics of the signal.

Results

Figure 2 shows power spectrum of the acoustic signals under different snow transport rate. When wind blows without blowing snow, predominant frequency component ranged about 200 – 250 Hz. This acoustic component is probably due to the wind and background noise in the wind tunnel. It is shown that some characteristic



Snow drift transport rate (kg/(m s))

Figure 3 Relation between spectral density of acoustic signal and snow drift transport rate.

acoustic components of high frequencies, *ie*. 1700, 4300 and 6600 Hz, are included in the signals during blowing snow. These acoustic components were generated by the vibration of the circular steel plate at impacts with blowing snow particles.

Relations between peak values of spectral density for frequencies of 1700, 4300 and 6600 Hz and snow drift transport rate are indicated in Figure 3. The peak values of spectral density increased with snow drift transport rate for each frequency.

Concluding remarks

A simple acoustic snow drift meter was tested in cold wind tunnel experiments. The results showed that spectral densities of some characteristic frequencies of acoustic signals were well correlated with snow drift transport rate. This relation can be applied to estimate snow drift transport rate from acoustic signals.

References

Chritin, V., R. Bolognesi and H. Gubler(1999): FlowCapt: a new acoustic sensor to measure snowdrift and wind velocity for avalanche forecasting. Cold Reg. Sci. Tech., 30, 125-133.

Font, D., F. Naaim-Bouvet and M. Roussel(1998): Drifting-snow acoustic detector: experimental tests in La Molina,Spanish Pyrenees. Ann. Glaciol., 26, 221-224.

Kosugi, K., T. Sato, A. Sato and O. Abe(2001): Detection of drifting snow occurrence using acoustic signals (in Japanese). Proc. Cold Region Technology Conference, 17, in press.

Sato,T., K. Kosugi and A. Sato(2001): Saltation-layer structure of drifing snow observed in wind tunnel. Ann. Glaciol., 32, 203-208.