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WITSEG Sampler: A Segmented Sand Sampler for Wind Tunnel Test

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Introduction

Seeking reliable sand traps or samplers for direct sediment transport measurement have been of continuing significance for decades and many types of sand samplers have been made for different purposes (Shao et al., 1993;Nickling and McKenna Neuman, 1997; Goosens and Offer, 2000;Goosens et al., 2000). Here we report a newly designed segmented sampler for wind tunnel test (WITSEG sampler).

Design of the sampler

The WITSEG sampler is of vertically integrating, passive type that follows earlier design by Bagnold (1941). So it is a modified Bagnold sampler. WITSEG sampler is designed to measure the flux profile of a blowing sand cloud in the sand wind tunnel of the Laboratory of the Blown Sand Physics and Desert Environments, Cold and Arid Regions Environmental and Engineering Research Institute, the Chinese Academy of Sciences. The cross-sectional area of the wind tunnel is 1.2m×1.2m.

The sampler is constructed of 0.5mm stainless steel and has four main components (Fig.1): A removable side cover, a wedge-shaped leading edge, a support and 60 sand chambers. Fig.2 shows the technical scheme. The gross height of the sampler is 700mm and the gross width 160mm. The gross thickness of the sampler is designed to be 25mm so that it has no significant interference with the airflow while maintaining enough sampling volume of the sand chambers. The wedge-shaped leading edge has 60 nozzle orifices connecting to 60 sand chambers. Each orifice is 10mm high and 5mm wide. The wedge-shaped leading edge is chosen to reduce the interference of the sampler with the airflow at the inlet on one hand and avoid the too short sampling time of the sand chambers by reducing the sampling width of the orifices. The spacers between the orifices are milled very sharp to reduce the particle rebound on them and errors in the measurement of total flux. The leading edge and a side cover are removable so that the sand chambers can be removed and the collected sand weighed. The size of the sand chambers is 140mm×15mm×6mm. Each chamber has a full sand capacity of about 18g and is inclined 30° with respect to the horizontal.

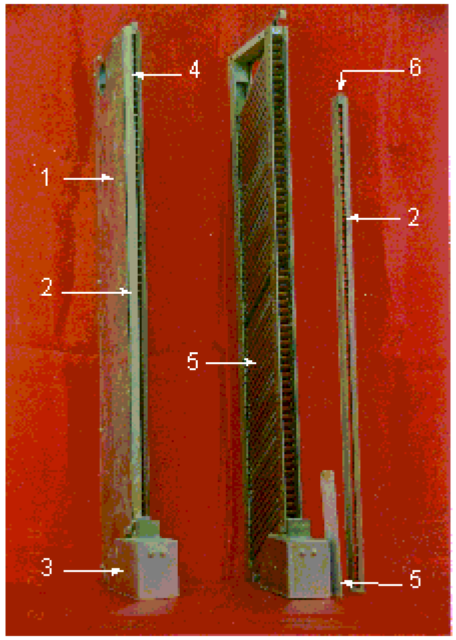

Figure1. General structure of the WITSEG sand sampler (1.Removable cover, 2.Wedge-shaped leading edge, 3.Support 4.Inlet, 5.Sand chamber, 6.Vertical vent)

A key design in the leading edge of the sampler is the vent. The function of the vent is to ensure the isokinnetic sampling. To avoid the problem of stagnation and the related errors in measuring the sediment flux, each chamber of the WITSEG sampler is vented. There are vent holes with diameter of 2mm on both sides of the orifice, which are open to a sand chamber and connected to the vertical common vent. The airflow goes out of the vent and sand particles in the sand-laden wind entering an inlet fall into the sand chamber by gravity. To prevent the blown sand particles from going out with the wind the vent holes are covered with the same fine stainless steel wire mesh (200 mesh, 62.5 μ m openings, 60% porosity) as that used in Nickling and McKenna Neuman's (1997) wedge-shaped sand traps.

Wind tunnel evaluation of the sampling efficiency

The efficiency of the sampler was evaluated in the sand wind tunnel of the Laboratory of Blown Sand Physics and Desert Environments, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences. The sand used for the evaluation test was typical dune sand in the Shapotou area, southeast of Tengger Desert of China.

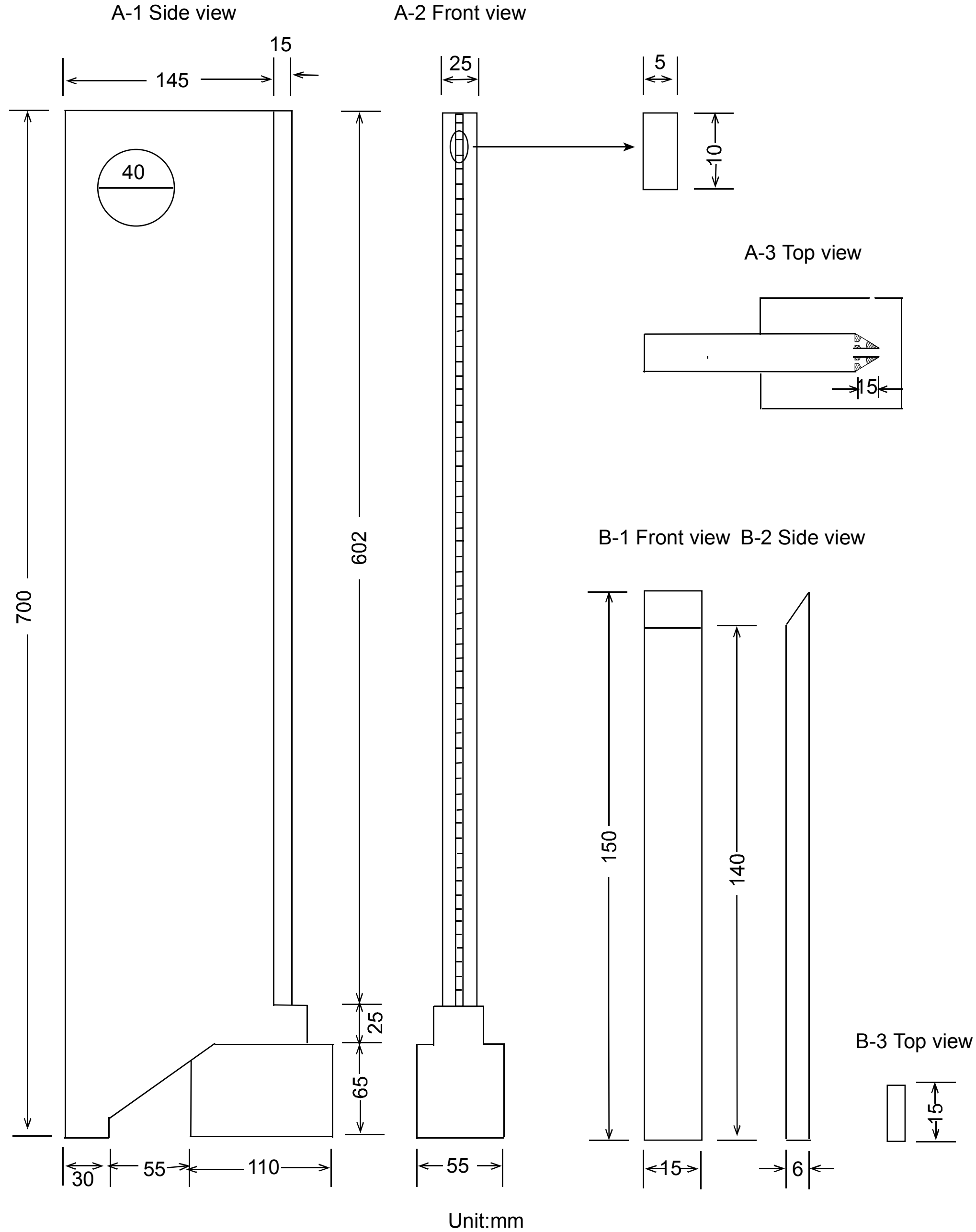

Figure 2. Technical scheme of the WITSEG sampler (A. General outline, B. Sand chamber)

The efficiency is defined as the ratio of the collected total flux by the sampler to that considered being a correct value of the total flux rate:

$E=Q_s/Q_c$ (1)

where, E is the sampling efficiency, Q_s is the collected total flux by the sampler, Q_c is the correct value of the total sediment flux. So the key to obtaining the sampling efficiency is to define Q_s and Q_c. In our calibration, Q_c was obtained by:

$Q_c=(W_o - W_e)/(L \times T)$ (2)

where, W_o is the total weight of the sand sample before test, W_e is the total weight of the sand sample after test, L is the width of the sand tray, in cm, and T is the sample time, in second.

The sampling efficiency at different wind speed is obtained by the data of Q_s and Q_c. The sampling efficiency ranges from 0.87 to 0.96, with an average of 0.91.

Conclusions

A segmented aeolian sampler for studying the flux profile of a blowing sand cloud in a wind tunnel (WITSEG sampler) has been developed. The sampler can measure the sediment flux at 60 heights with one-centimeter intervals and provide the detailed data for establishing the function of blown sand flux profile.

The WITSEG sampler is passive type but each sand chamber is well vented. It has been evaluated in a wind tunnel using typical aeolian sand. The overall efficiency is 0.91.

References

Bagnold, R.A. 1941. The Physics of Blown Sand and Desert Dunes, Methuen & Co.,London, 265pp.

Goossens, D. and Z.Y. Offer. 2000. Wind tunnel and field calibration of six aeolian dust samplers.
Atmospheric Environment 34:1043-1057.

Goossens, D., Z.Y. Offer, G. London. 2000. Wind tunnel and field calibration of five sand traps. *Geomorphology* 35, 233-252.

Nickling,W.G.,and C. McKenna Neuman. 1997. Wind tunnel evaluation of a wedge-shaped aeolian sediment trap. *Geomorphology* 18: 333-345.

Shao, Y., G.H.Mctainsh, J.F.Leys, M.R.Raupach. 1993. Efficiency of sediment samplers for wind erosion measurement. *Australian Journal of Soil Research* 31: 519-532.