Snow Transportation By Eolian effect (Snowdrift)

Experimental Field in Pala di Santa (Pampeago)

Trento, Italy

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INTRODUCTION

The snowdrift problem is particularly important for those individuals involved in the study of the dimensions for active avalanches defensive structures.

In fact, it has been noted that the structures that have been realized have the tendency to facilitate the snow accumulation with the inconvenience of becoming less effective.

Therefore, it arises the problem of planning complementary structures to the actual active defensive structures such that they regulate the accumulation and avoid the filling of bridges and snow-racks already established as a defense of sensible areas of the territory.

It is then evident that the right dimension and a correct positioning on the ground are fundamental principles in order to accomplish the established purpose, and also it appears evident that an erroneous positioning on the ground can introduce deleterious effects which might even worsen the initial situation that preceded the intervention itself.

The planners, often find themselves in the need to make up projects without the technical knowledge to the problem of where to allocate the structures. Therefore, in order to contribute to the solution of this problem, the " Ufficio Neve e Valanghe of PAT ", projected and accomplished an experimental field for the study of deflecting panels (snow barriers).

THE EXPERIMENTAL FIELD

The site of Pala di Santa, near Pampeago, has suitable physical characteristics for a study of this kind, since the area is subject to frequent winds and often of high intensity.

The work for the realization of the Experimental Field of Pala di Santa started late in Fall 1988. It is one of the first experimental fields in the world where the study of wind deflectors has been realized at high elevation; the study is conducted in parallel with an analogous experience that involved the scientists of the " Cemagref " of Grenoble, France.

At the same time, at the Hydraulic Institute of the Engineering School in Trento, physical models are tested in an hydraulic channel following the Euler similitude criterion.

Six different typologies, with different porosity and geometry have been examined in order to evaluate the impact of the physical and geometrical characteristics of the structure over the snow accumulation.

Corresponding to each barrier, a line of snow measuring sticks have been established for a total length of 120 meters (about 400 feet) of which 20 meters before the barriers and 100 meters after the barriers.

Every week, and also close to meteorologic conditions that involved a substantial snow level modification, two operators were charged to survey the 140 measuring sticks and to record specific variations induced on the ground by the barrier presence.

An anemometer tower has also been installed on the field together with a meteorologic station in order to automatically record the climatic characteristics of the area and specifically of the precipitations; corresponding to each barrier, collecting boxes have been built to survey the transport in order to evaluate the filtering ability of each individual barrier.

BARRIERS AND ACCESSORY EQUIPMENT

Six different types of barriers have been built on the field. Four completely made with wood, one with steel and wood and one completely with steel.

Typology # 1

It has been realized with wooden posts distant 3 meters from each other (about 10 feet) and the tamponing geometry is made of fir boards 4 meters long, 11.5 centimeters wide (12 inches) and 3 centimeters thick (about 1.5 inches).
The result is a barrier with horizontal boards, with a porosity equal to 45% and filled spaces of 23 centimeters.
The foundations have been planned in such a way that the panels can be removed during Summer.
The posts sit on a steel plate anchored to the ground with a steel bar and kept in place, with respect to the orthogonal plane of the barrier, with two steel tie-rods bound to a concrete block buried 80 centimeters underground. The concrete block is reinforced and equipped with tie-rods such that the verticality of the barrier can be adjusted. The acceleration space under the barrier is 60 centimeters wide.

Topology # 2

Structurally it is the same as topology # 1; the tamponing geometry is realized with a porosity equal to 45% and the filled spaces are of 11.5 centimeters. The empty space from the ground is about 60 centimeters wide.

Topology # 3

Structurally it is the same as topology # 1 but the tamponing geometry is realized with a porosity equal to 55% and the filled spaces are of 11.5 centimeters. Again, the empty space from the ground is about 60 centimeters.

Topology # 4

Same basic supporting structure as # 1 except the tamponing geometry goes from horizontal to vertical and goes all the way to the ground. The porosity is equal to 55% with filled spaces of 11.5 centimeters.

Topology # 5

It is constituted by the ROLBA barrier, Taillandier system, made completely out of steel and rolled steel plate, with a stabilizing aileron.
The total height of the barrier is 350 centimeters, with an empty space from the ground of about 50 centimeters. The porosity of this structure is about 42%, inclined about 19 degrees with respect to the vertical line and the filled parts are 24.5 centimeters wide.
Structurally, this barrier is made of a zinc coated steel post with a diameter of about 110 millimeters, around which rotates the tamponing structure. The friction forces and stresses are limited by a Teflon disk which act as a lubricant. The purpose of the top aileron is to diminish the structure sensitivity to sudden wind gusts; the foundations have been realized with concrete.

Typology # 6

On a supporting structure similar to that made of wood, as a tamponing structure, it has been mounted a metallic net closed in some areas with steel sheets. This barrier has already been the object of a study on the Giau Pass by the Avalanches and Hydrological Protection Experimental Center of the "Regione Veneto". However, instead of what has been done on the Giau Pass, the empty space at the ground level has been kept constant along the total length of the barrier; the porosity of the structure is about 45%, with filled spaces of 22 centimeters wide.

Captation Boxes

On the experimental field 8 columns of captation boxes with the purpose of capturing the snow blown by the wind have been mounted. In their physical and fluid-dynamics characteristics, this containers have been projected by the "Cemagref" and the "Provincia Autonoma di Trento" has been authorized to use them.
They consist of containers realized with synthetic material containing up to about 60 cubic decimeters (60 liters), with a captation inlet of 10 millimeters diameter and an exhaust of 40 millimeters diameter located on the rear.
They have been mounted on a post up to 200 centimeters from the ground and they allow to monitor the snow transportation at differentiated heights, from 20 centimeters to 195 centimeters, with an interval of 25 centimeters. They allow a correct monitoring of the snow transportation only in the specific case where the wind acts in the same axial direction of the collector pipe. Some have been located in the open field (on two columns) and the others below each typology, in order to monitor the efficiency of each structure.

CONDUCTION OF THE EXPERIMENT

The operators charged to monitor the experiment, execute the reading on the snow measuring sticks and provide an ordinary maintenance of the field whenever necessary. The readings are recorded on specific cards and later on transferred to a computer for the interpretation in order to specify the exact thickness of the snow on the ground; they execute a monthly test on the snow load at the ground level, they check the snow density of the accumulation at different levels, they weigh with precision scales the amount of snow captured in the boxes and record on the card all the necessary data, they evaluate visually the effects of the barriers emphasizing whatever anomaly or bad functioning they observe and, if necessary, they take the necessary steps to readjust the systems.

During the 1988-89 Winter season, 15 total surveys have been completed on the experimental field. In the 1989-90 Winter season only 5 surveys have been completed because of the scarce precipitations. The main operating difficulties encountered are of logistic type, due mainly to adverse atmospheric conditions in which the operators found themselves to have to work with.

The scarcity of snow precipitation during the two Winter seasons examined, have determined great difficulties in evaluating the operative conditions and the efficiency of each single typology; from a purely mechanical point of view, there have been some problems with the self-rotating panels.

The Transportation

The snow transportation by the wind effect can be recognized in three main types of movements, from the combination of which a total real transportation results :

- by rolling motion of particles;
- by jumping motion of particles;
- by suspension.

It is difficult to make a distinction among the different typologies of transportation. However, because of the granulometry of the transported material, a well defined distinction can be made between the combined phenomena of rolling and jumping of particles, which are very difficult to identify, and the event where the three transportation modalities apply concurrently. It is well known and scientifically proven that the transport events of suspension can include vast areas (as the African desert sand can reach the Alps) and large atmospheric bands. The presence of wind deflectors creates mainly a rolling and jumping transportation effect. The basic theoretical principle is that of reducing the flux speed behind the barrier with the presence of an obstacle and to make sure that the wind speed at the ground level decreases at levels smaller than the wind speed necessary to drag the material forming the constituent substrata. As it is well known, the value of the speed can be expressed by the relation :

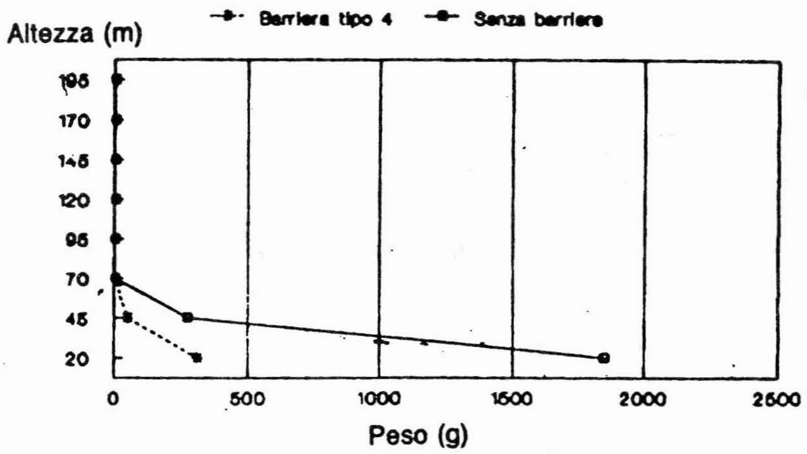
$$u^* = \sqrt{\tau/\rho}$$

where τ is the tangential force necessary to move a single grain of snow and ρ is the snow density of the substrata.

Even though temperature does not appear in the relation, it is evident that the result is a function of it. There are, in technical bibliographic references, diagrams that allow to evaluate the effect of temperature on u^* (dragging speed) and allow to define the granulometry of the accumulation as a function of the wind speed.

In the past Winter season, due to organizational reasons and because the study was intended as an instrument to evaluate the macroscopic effect of the barriers, there has not been a specific study on the granulometry of the material and on the evaluation of the u* limit. It has been noted, however, how the effectiveness of the barriers acts primarily over the jumping and rolling phenomena and this fact has been conceptually forecasted; it is an aspect shown in the attached diagram where the effect of the barrier close to the ground is well identified, while before and after the barrier it is difficult to define the quantity of snow captured at levels higher than 50 centimeters from the ground.

Campo Sperimentale di PALA di SANTA
QUANTITÀ DI NEVE TRASPORTATA
Data rillevo: 20/12/1988



EXPERIMENTAL FIELD OF PALA DI SANTA
QUANTITY OF TRANSPORTED SNOW
SURVEY OF DEC. 20, 1988

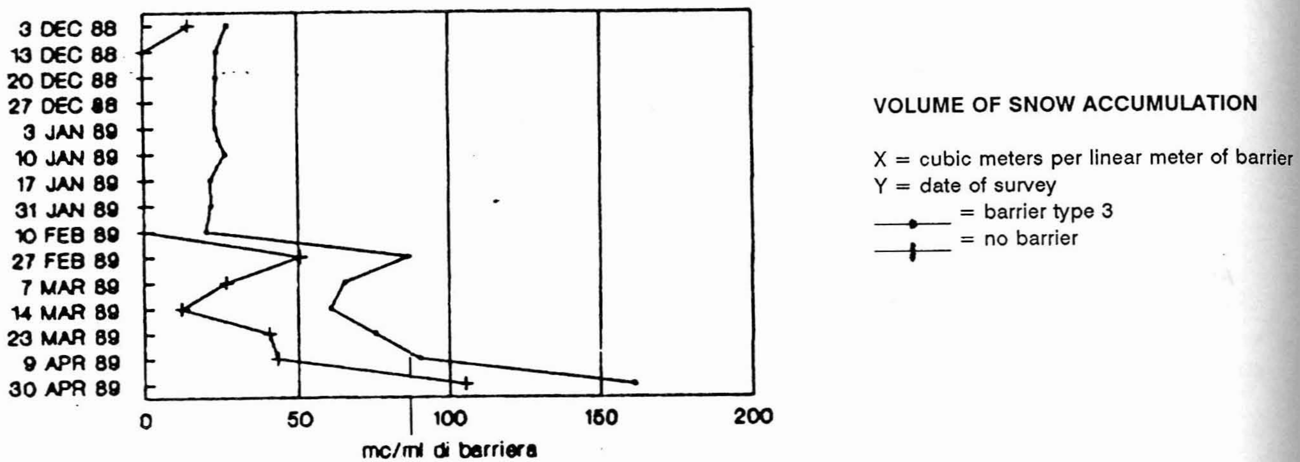
X = mass in grams
Y = height in meters
.... = barrier type 4
_______ = no barrier

There have been, however, events where the transportation before and after the barriers were very little differentiated; these are very special cases bound mostly to exceptional meteorologic events and therefore not taken into general considerations. In the next Winter season it is considered essential to measure, beside the quantity of transported snow, the temperature of the snow and the wind speed close to the ground and at different levels, so that it will be possible to define a theoretical profile of the wind speed and to study the influence that the quantity of snow transported has on temperature.

The accumulation

During the Winter season there has been 15 surveys on the volume accumulation per linear meter of structure. The measurements started on December 3, 1988 and ended on April 30, 1989 when, due to heavy wet snow falls, the structures underwent a complete obstruction and successive saturation.

Volume della neve accumulata



In the above diagram it is recorded the progress of the accumulation after a barrier and the natural accumulation in an open field. It is possible to denote that at saturation, the barriers have accumulated a maximum volume equivalent to 161 cubic meters per linear meter of barrier; keeping in mind the classical quantifications of the barrier capacity, generally defined with a relation of the type :

$$C = KH^2$$

where : C = accumulated snow quantity per linear meter of structure;

H = height of the barrier in meters;

K = capacity coefficient.

it is possible to see how the "K" value is in the order of 18 and has the tendency of approaching the theoretical upper limit of 20 proposed by the French scientists. It is also possible to observe how the barrier of type 1, which also reaches the accumulated volume of 159 cubic meter per linear meter of barrier, has not yet reached the saturation level and can be considered, for all purposes, still "efficient".

These values have actually been reached because of the heavy snow falls during the end of April; probably, with regular snow falls in cold month, the barriers effect can be more efficient and therefore the capacity of the barriers could be greater.

It appears also that the distribution of the empty and filled spaces of the tamponing structures exerts a certain influence on the accumulated snow.

It is interesting to observe that the saturation of the barriers with horizontal tamponing and those with vertical tamponing happened contemporaneously and was caused by the Spring type, humid snow falls of April.

It has been observed that generally, the accumulation depends very little from the porosity of the structure in the examined range; the structure with vertical tamponing has the tendency to create an accumulation close to the axis of the barrier, while the presence of larger empty spaces create an accumulation farther away and with an elongated shape of the snow pile. It has been extremely easy to verify the length of the accumulation but it has also very little meaning; indicatively, it is possible to affirm that the limit distance reached is in the order of 50 meters after the barrier, that is about 17 times the height of the barrier itself.

At the same time of this experiment, at the University of Trento, it has been started a research program on models applicable to this problem where, with analytical examination, hydraulic similarity and with the help of a Laser-Doppler anemometer, the velocity vectors could be defined.

The results give the primary elements of evaluation of the fluid dynamics of a specific typology barrier and are confronted with the data available through a numerical approach.

The assumed transport values allow an interesting application of the classical theories of solid sediments transport in water to the actual problem, where finally it is possible to extract significant physical dimensions of the phenomena and be able to confirm the surprising closeness of the measured values.
The separate knowledge of the close aspect related to aerodynamic motion around the barriers and transport modalities of the snow on the locations where the barriers are mounted, represents an initial approach and intrinsic validity of the composite phenomena of wind deflectors performance.
The contingency to prevent the formation of snow accumulation in locations considered dangerous and to favour the formation of accumulations in more protected areas through the insertion of a suitable and specific permeable barrier is examined.
The insertion of such barriers will moderate the wind speed close to the ground reducing the snow transport phenomena and therefore the accumulation of snow.
The objective of this work is to investigate initially the field of fluid dynamics motion around a typology of filtering barrier (acting on a fixed base). Even though it is not yet possible to extract quantitative indications on the modalities of formation and on the entity of the accumulation, the experimental knowledge of the initial motion field (with no accumulation defined yet), can give some choice of criteria on significant parameters that can be used in projecting the barriers.
It follows then the presentation of the results obtained through a field analysis relative to a vertical distribution of the concentration of the wind transported snow, by mean of suspension, and therefore the global entity of the transport itself.
This document describes the aerodynamic characteristics of only one barrier typology, and a mathematical model of turbulent motion of the type "K - ε"has been created.

ANALYSIS OF THE TURBULENT MOTION FIELD AROUND THE BARRIER

Similitude Criteria

The experimental analysis of phenomena regarding the atmospheric limiting strata can be done in wind tunnels, using as fluid the air itself, or also in hydrodynamic channels using water. The choice is often constrained to contingent reasons and equipment availability. A great simplification can be obtained when the mass forces tied to the rotational motion of the Earth can be ignored. This case is usually accepted when it come to modelling aerodynamical phenomena that occur in the lower atmosphere.
In such a case, the undisturbed speed distribution along the vertical, is well described by the logarithmic law :

$$\frac{u}{u^*} = (\frac{1}{k}^{ln})(\frac{z}{z_0})$$

or, with less approximation, with a power law :

$$\frac{u}{u^*} = (\frac{Y}{\delta})^{(1/n)}$$

Where : u is the friction speed;
z is the specific roughness of the ground;
k = 0.4 is the Von Karman constant;
l is the reference height of the atmospheric limiting strata;
n is a variable that ranges from 2 to 10 and represents the roughness of the ground.

The equations governing the motion are, in this case, the Reynold's equations of continuity :

$$\frac{\delta U_i}{\delta x_i} = 0 \qquad (1)$$

$$\frac{\delta U_i}{\delta t} + U_j \frac{\delta U_i}{\delta x_j} = -\frac{1}{\rho}\frac{\delta(\rho + \gamma h)}{\delta x_i} + \nu \frac{\delta^2 U_i}{\delta x^2_j} - \frac{\delta u_i u_j}{\delta x_j} \qquad (2)$$

Considering irrelevant in the lowest part of the atmosphere the spatial derivative of the term "h" with respect of the term "ρ", the second equation can be written as follow :

$$\frac{\delta U_i}{\delta t} + U_j \frac{\delta U_i}{\delta x_j} = -\frac{1}{\rho}\frac{\delta \rho}{\delta x_i} + \nu \frac{\delta^2 U_i}{\delta x^2_j} - \frac{\delta u_i u_j}{\delta x_j} \qquad (3)$$

In the hydraulic channel simulation this approximation is possible only in the case where the free surface is kept sufficiently flat; in such case, if "H" is the distance between the free surface and a plane parallel to it and "m" and "n" are the coordinates of such plane, then the equation becomes :

$$\frac{\delta h}{\delta x_m} \simeq \frac{\delta h}{\delta x_n} \simeq 0 \qquad (4)$$

it is possible to derive that, if ρ_1 is the value of the pressure at $h = h_0$, and saying that :

$$\rho + \gamma h = \rho_1 + \gamma h_0$$

The motion equation (2) can be rewritten in the form of equation (3) where ρ_1 corresponds to ρ. From Euler and Reynold's similitude the motion results straight, and Euler number in the model is referred to the pressure defined above, that is ρ_1.

In conclusion, when the aerodynamical phenomenon is simulated through the motion of a current in the presence of a free surface, it is necessary to make sure that initially the current does not depend on Froud's number. This condition occurs if the model dimensions are sufficiently small with respect to the liquid section.

The hypothesis of incompressibility, intrinsic when water is used as fluid, is to be expected in the modelling of phenomena happening in the atmosphere near the ground, because for small variation of altitude this assumption appears completely adequate.

The dependence of Reynold's number (the relation between the inertial and viscous forces), can be ignored wherever, for localized phenomena, high velocities make the field of motion independent from such parameter.

Description of the Experimental Installation

The experiment has been performed in water on an equipped channel with a length of about 12 meters, in the Hydraulic Lab of the University of Trento. The geometrical scale chosen is **1 : 40**.

The physical phenomena on the channel are investigated on the longitudinal symmetry plane (x-y) in condition of continuos motion and with the assumption that it is possible to neglect the compressibility of the air.

The length of the channel secures the natural development of the limiting strata.

The cross section of the channel is a square (50x50 centimeters), with side walls in tempered glass and bottom in "Perspex", the fluid flux is 54 liters per second, with a tie-rod in the proximity of the barriers of 41 centimeters.

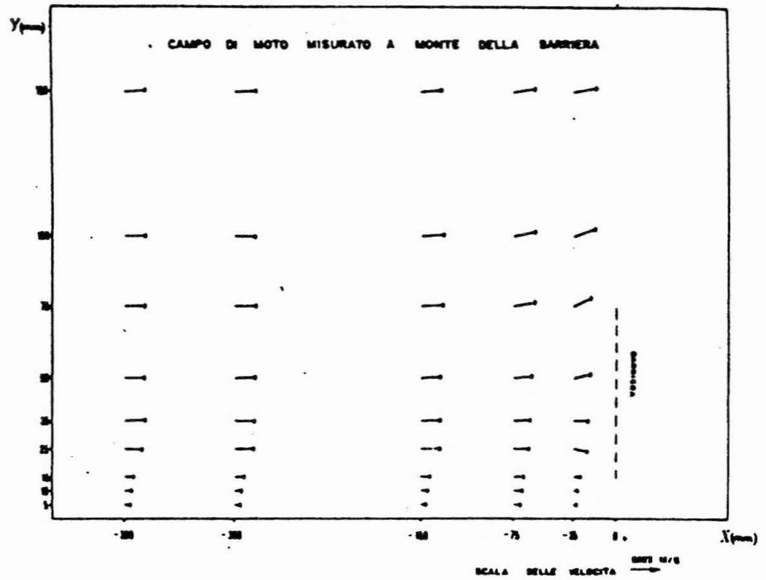
The resulting Froud's number of the undisturbed current (F=0.13) is sufficiently small in order to neglect the influence of the gravitational forces.

The quantity of fluid is measured by a diaphragm located on the main pipe. The conditions of continuos motion, during the period

of the experiment, are granted by the control on the main pipe and the water flow which is in a fixed position.
The barriers are reproduced with synthetic materials and positioned on a thin plate. They are attached to the channel structure with the tie-rods.
The measurements involve the field of medium velocities and the components of the Reynold's forces tensor laying on the x and y plane before and after the barrier.
The velocity measuring instruments consist of a 4 W Argon Laser-Doppler anemometer, together with an optical system consisting of a Bragg cell and a frequency shifter. The photoreceptor is mounted in backward scattering position.
The signal is decoded by a frequency measuring device with its analogical output connected to a computer which allows the acquisition of the chosen frequency signal.
The anemometer is installed on a support that allows it to move along the channel and the fine tuning of the measuring position is reached with a high precision mechanical system (Dantec Traversing Mechanism).

The Results Obtained

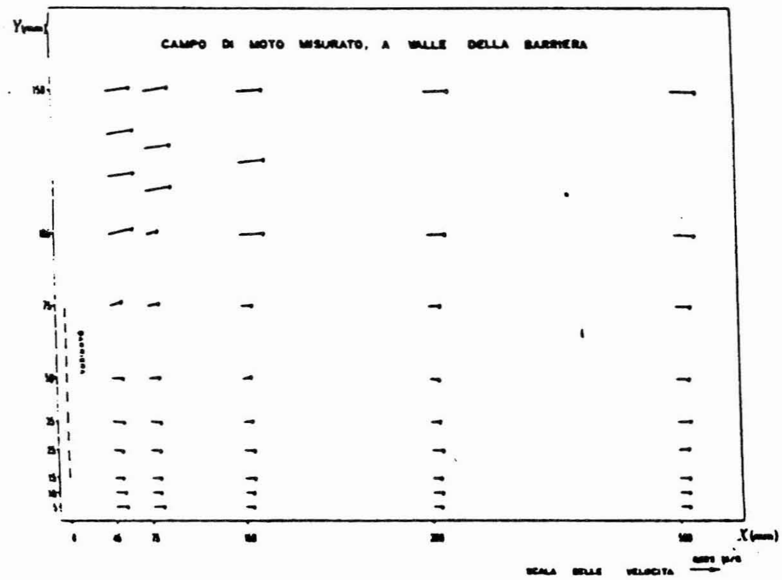
In fig. 5, it is possible to see that the effect of the barrier is to deviate part of the flux that would flow close to the ground.



SPEED PROFILE BEFORE THE BARRIER

X = scale of the speed in meter per seconds and horz. dist. from barrier
Y = height of flow

Fig. 5: andamento della velocità a monte della barriera.



SPEED PROFILE AFTER THE BARRIER

X = scale of the speed in meter per seconds and horz. dist. from barrier
Y = height of flow

Fig. 6: Andamento della velocità a valle della barriera.

The largest effect is obtained after the barriers (Fig. 6), where the current separation area, that is present in the case of a full barrier, is missing.

In this area, however, a sensible reduction of the velocity can be observed. As a consequence of this reduction the snow is allowed to deposit for a long distance.

This effect has also been predicted by the mathematical model.

A more precise judgement on the effective capability to originate a snow accumulation is deducted from the distribution of the tangential effort measured, particularly close to the ground, this being the responsible factor for the snow transport.

A comparison among the measured values and those calculated following the mathematical model, shows a good similarity of results.

It is significant to observe how the values of the tangential effort close to the ground diminish notably after the barrier.

The distribution of the tangential efforts, "saw teeth" like graph, calculated by the mathematical model in the area right after the barrier, which is in contrast with the experimental results, is tied to the choice of the numerical values rather than to instability problems.

TRANSPORT OF SNOW

The evaluation of the snow transport can be done by computing the results given by specific traps located in the experimental field.
Their use allow to measure the quantity of snow transported by the wind at different heights from the ground.

Accomplishment of the Measurements

The accomplishment of the measurements during the Winter of 1988-89 and 1989-90 showed the difficulty in collecting reliable results through the described instrumentation.
The major problems arise during a snowfall. As a matter of fact the snow transported by the wind, particularly if humid, creates the risk of occluding the captation hole and therefore preventing the snow particles to enter in the traps.
Moreover, their performance did not appear optimal in the presence of wind blowing in a direction not perfectly parallel to the hole axis. Small incidence angles are, as a matter of fact, sufficient to drastically reduce the measurement accuracy.

The transport of snow in suspension per unit of width is defined by the relation :

$$Q_s = \int_a^h C(y)u(y)\, dy \qquad (5)$$

The behavior of the velocity u(y) is described by the power law :

$$\frac{u}{u^*} = \left(\frac{y}{h}\right)^{(1/n)} \qquad (6)$$

Where : u = average speed measured during the transport phenomena;
h = height of the anemometric tower;
n = roughness of the snow strata.

The anemograph, located at a height of 6 meter from the ground, during the examined phenomena has revealed an average speed of 34 kilometers per hour. The length of the transport phenomena is 11 hours (it started at 23.00 hours on March 13, 1989 and ended at 10.00 hours on the next day in correspondence of the data collection time).(Table I)

Table I

Wind Direction	Speed (km/h)	Time	Date
N - W	3	20.00	03/13
N - W	3	21.00	03/13
N - W	2	22.00	03/13
N - W	4	23.00	03/13
N	22	24.00	03/13
N	26	1.00	03/14
N	36	2.00	03/14
N	45	3.00	03/14
N	46	4.00	03/14
N	40	5.00	03/14
N	39	6.00	03/14
N	31	7.00	03/14
N	32	8.00	03/14
N	26	9.00	03/14
N	24	10.00	03/14

The roughness n of the snow strata has been established in the attempted value n = 7, proposed by Davenport (6) for the desert and arctic tundra.

Substituting in equation (5) :

$$u = u_0 \left(\frac{y}{h}\right)^{(1/n)} \qquad (7)$$

The behavior of the concentration c(y) is known assuming that the proposed Rouse's theory for transport of solids in water flows is valid.

$$\frac{c}{c_a} = \left[\left(\frac{h - y}{y}\right)\left(\frac{a}{h - a}\right)\right]^z \qquad (8)$$

The condition at the edge $C = C_a$ is located at a distance from the snow strata so that it will not be affected by the bottom transport phenomena (transport by rolling motion and by jumping motion). The exponent z, called Rouse's number, is equal to :

$$z = \frac{W}{Ku_*} \qquad (9)$$

Where : W = speed of snow falling in still air;
K = Von Karman constant;
u = friction speed.

The quantity Q of snow transported in suspension during the transport phenomena (T = 11.h) through the cross section of the captation pipe (Area = 1 cm^2) of the measuring boxes, as a function of the distance y from the ground, is expressed by equation (10) :

$$Q_t = 28.94\ y^{(1/7)}\ C_a \left[\left(\frac{6-y}{y}\right)\left(\frac{a}{6-a}\right)\right]^z \qquad (10)$$

The unknown parameters C_a and z have been estimated using the interpolation to the lowest square of equation (10) with the values measured with the traps on March 14, 1989, at a distance from the snow surface equivalent to 5% of the height of the anemometric tower (a = 30). These results, inserted in equation (10), give the final expression :

$$Q(y) = 0.74\ y^{(1/7)} \left[\frac{6-y}{y}\right]^{1.47} \qquad (11)$$

where the curve of experimental values fits very closely the curve of the theoretical approach (Fig. 10). This also confirms the value chosen for the parameter n which describes the roughness of the surface.

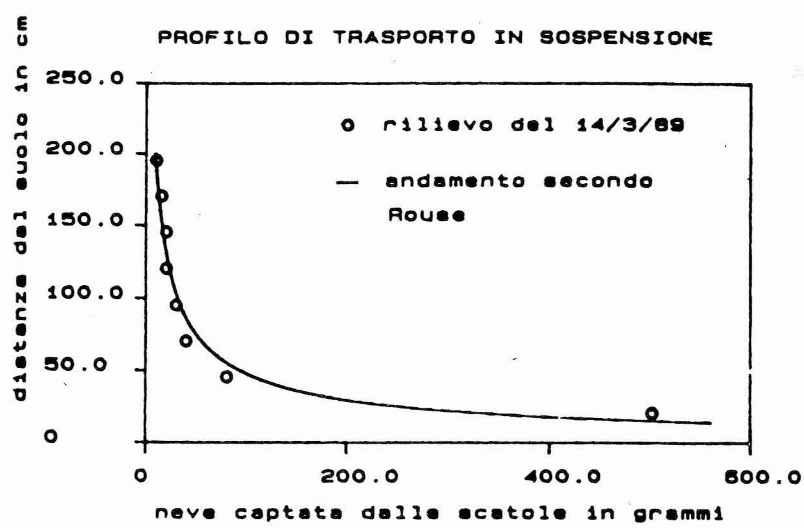


Fig. 10: andamento del profilo di trasporto secondo la teoria di Rouse.

PROFILE OF THE TRANSPORT IN SUSPENSION
FOLLOWING ROUSE'S THEORY

X = snow captured in the boxes, in grams
Y = distance from the ground, in centimeters
o = data of 03-14-89 survey
_______ = following Rouse's theory

CONCLUSIONS

The acquired experience has allowed, above all, to find out about the technical problems arising during the use of these measurement instruments which are still in an experimental stage.

From the analysis of the obtained results, it has been possible to deduct some important observations about the values to assign to the parameters pertaining the snow strata, confirming also the application validity of the Rouse's law in the context of snow transport by means of suspension.

The peculiarity and exceptionality of the Winters 1988-89 and 1989-90, did not allow to evaluate with sufficient precision the efficiency of each single barrier.

In those occasions where it has been possible to evaluate the snow transport by the effect of the wind, it has been denoted that the barriers where able to drastically reduce the mass transport in an amount equal to about 20% of that of open fields.

In the porosity range examined, very little dependence on the shape of the snow accumulation has been observed from the porosity itself; instead a correlation between the height of the barrier and the length of the accumulation has been observed. Moreover, more than the porosity, the size of the empty and filled spaces seem to have an incidence on the accumulation. It has been observed that the amount of accumulated volume and the accumulation length have values in between those obtained by the French scientists and those estimated by Tabler. These are, however, considerations still in the process of evolution.

Even though, for the reasons described above, it has not been possible to completely reach the scientific aspect of the problem, from an operational point of view, the realization of the wind deflectors under full control of the team, gave the opportunity to acquire a deep knowledge, both qualitatively and quantitatively, about the costs and operational difficulties that can be encountered during the installation, giving therefore the due respect and merits to the consulting job done by the "Ufficio Neve e Valanghe della Provincia Autonoma di Trento".

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