BUILDING'S DESIGN IN A BLOWING SNOW CONTEXT:

CASE OF MOUNTAIN RETREAT OF "GOUTER" (MONT-BLANC MASSIF)

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CONTEXT

The new mountain retreat of "Goûter" will be built on 3835 m above sea level (normal route to Mont-Blanc) 200 meters away from the former one. This new building is designed to accommodate 120 people with an estimated cost of 5 millions euros. The client is FFCAM (French Alpine Club).
The site is not subject to natural avalanche hazard. It is located at the top of a near horizontal ridge which is a part of Aiguille du Goûter. The main problem is blowing snow as snowdrift could be formed around the building as previously observed near the former mountain retreat (see figure 1). In France it is quite unusual for snow drifting studies to be part of the design process of proposed building. But in this case the climatic environment is particularly harsh and the future operation of the building is highly dependent on drifts that may form on and around the building.

PHYSICAL MODELING IN WIND TUNNEL AND RECOMMENDATIONS

The study was conducted in two stages.
- The first one was done in 2005-2006.

Among others, it was dedicated to the study of available data weather in order to identify the prevailing wind direction. At this moment, the automatic weather station set up at Aiguille du Midi (3845 m) by Meteo France was not yet in service: the early records began in 2007. That's why, an ultrasonic anemometer (see figure 3) was set up on the site in order to determine the prevailing wind direction. But it is well-known that the prevailing wind direction is not always responsible for blowing and drifting snow. So meteorological data have been supplemented by an accurate study of snow distribution (cornices, sastrugis, ripples, snowdrift) on the site. For example, red arrows on figure 1 represent the direction of wind responsible of snowdrift around the former mountain retreat. It was shown that the south-west wind, and in a lesser proportion, northeast wind, were responsible of drifting and blowing snow. But such approach does not allow for estimating the drifting snow fluxes.
The formation of snowdrift is connected to the wind pattern around the building where the wind pattern is dependant on the building design. A first discussion was conducted with architects. The ovoid shape (see figure 2) initially chosen was very favorable from an aerodynamic point of view. But to overcome some of the possible problems, simulation in wind tunnel at Cemagref have been proposed.
Physical modeling allows the study of snow storms in small-scale laboratory models. The validity of full-scale prediction from small scale experiments by using similarity requirements poses a problem: the large number of modeling parameters cannot be satisfied. In the present case, the used similitude requirements and the wind tunnel are presented and discussed in detail in Naaim-Bouvet and Naaim (1998). For the present work the model scale of 1/200 was used. At the end of these first tests, the following recommendations were made : (i) the large axis of the ellipse must be parallel to the prevailing wind direction (ii) the entrance to the refuge must be located on the front of the building (south side) (iii) the building must be as much as possible overhanging. But it must be kept in mind that the drifting snow problem is not the only problem to solve. Geotechnical, security, architectural, administrative problems could also appear and must be taken into account: compromises have to be made.

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- The second stage was conducted in 2010-2011.
All different constraints were considered for the project and the final solution (see figure 2) is tested in the wind tunnel. It is necessary to check if:

- the device to melt snow for drinking water is naturally fed by snow carried by the wind
- exits of the building (main and backup) are naturally cleared of snow.

It seems that the removal of open metal flooring which overhangs (during the winter) and some fences and deflectors can improve the current project. During the summer of 2011, the building will be built for commissioning in 2013. The summer of 2012, dedicated to the achievement of light work will be an opportunity to carry out a full scale test : the snowdrifts generated by the building can be studied in the field and be compared with those obtained in wind tunnel. In fact there are not enough data to quantify a reference snow storm for the project (decennial snow storm for example) as done for avalanche project. The problem is also much more important than the similitude requirements problems for simulations in wind tunnel.

Fig. 1 Former mountain retreat (photo Myotis) retreat

Fig. 2 Small-scale model of the new mountain retreat in wind-tunnel (Photo H. Raguet)

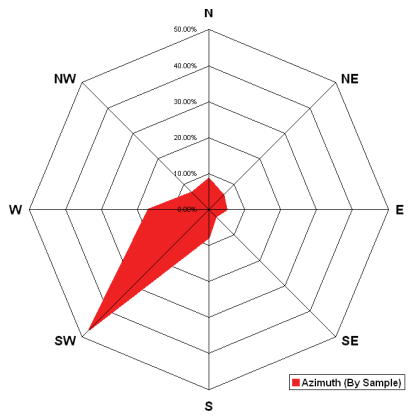

Fig. 3 Wind rose (Myotis) at the location of the platform

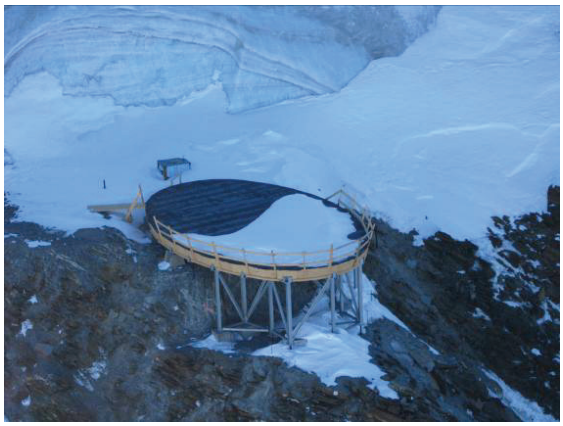

Fig. 4 Earthwork, foundations and building of the new mountain retreat have been done (Photo H. Dessimoz – 10 February 2011)

REFERENCES

Naaim-Bouvet F., Naaim M. (1998). Snowdrift modelling in wind-tunnel: vertical and horizontal variation of the snow flux. Annals of Glaciology, 26: 212-216.

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