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Wind protection for natural climate livestock housing

The necessary openings in natural climate livestock housing feature windbreak netting and space boarding to protect the animals from draughts. These differ not only in their porosity but also in the geometry of the resultant openings. Their special properties mean that windbreak nets and spaceboards are applied in various building situations.

Fig. 1: Front of the experimental stand

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The development of natural climate buildings has been led by the requirement for low building and running costs in cattle and pig production. While cattle are to a large extent insensitive to low temperatures, the requirement for warmth with pigs is served by fitting of sheltered lying areas. In this way demands on the building shell of natural climate houses are reduced in the main to protection from wet and draughts. The application of windbreak concepts such as wind netting and spaceboarding helps avoid high air velocities in livestock areas. Up until now the reduction of windspeed has been based on determination through reduced scale models in wind canals [1]. Only Van Caenegem [2] investigated the interior wind currents behind the openings of a window segment under direct, vertical currents on a technical scale model. In order to be able to make realistic statements on the breaking effect of windbreak concepts, angled currents have also to be taken account of.

Wind protection concepts

To retain comparability with trial results so far, the same wind protection concepts as were studied by Van Caenegem in his trial series [2] were investigated (*Tab. 1*).

Test stand

The measurements for wind influence were carried out on the existing test stand at FAT/Tänikon. The FAT trial series was extended to take account of angled air currents of 45° and 60°. Air velocity at the end of the wind canal was ~ 5 m/s. At 0.8 m before the opening of the wind canal a façade element was fixed with a window opening the size of the wind canal end. This opening was fitted with the wind protection net or spaceboard to be tested. The incoming air then flows through the wind protection element installed in the window as well as escaping laterally along the wall. A situation as realistic as possible was simulated with diffuse air currents through this construction in the test stand and through the turbulence caused by the roof overhang.

The air velocity at 0.75 m to 2 m distance vertical to the wall (in „livestock area“) was measured with six hot wire anemometers at heights between 0.5 and 2 m in a moveable metal grid. Air currents were directed at angles of 90, 60 and 45 at the nine windbreak variants (*fig. 2*). The values recorded offer relative comparisons of the different protection concepts.

Reference measurements

In order to determine reference values for the calculation of windbreak efficiency a recording series without windbreaks was first conducted. The recordings of air velocities at different heights and distances from the trial

Table 1: Air velocities in livestock area

	Windbreak concept	Porosity	Description	Air current angle 90¡	60¡	45¡
	without windbreak,	100%		1.56	1.19	0.43
Windbreak netting	Celloplast BV90,	22%	Green polyester material, welded seams, pores 1x1 mm	0.43	0.31	0.31
Windbreak netting	Celloplast BV70,	58%	Green polyester material, not welded	1.09	0.56	0.38
Windbreak netting	Adic BVF,	21,5%	Green polyester material, welded seams, pores 0.9x0.9 mm	0.30	0.30	0.32
Windbreak netting	Galebr. Farmflex HP,	10%	Green polyester material, welded seams, pores 0.9x0.9 mm	0.22	0.25	0.41
Windbreak netting	Celloplast GV80,	29,5%	Brown PE netting , oval holes 8x5mm	0.44	0.24	0.34
Windbreak netting	Celloplast GV90,	23,5%	Brown PE netting, round holes 8mm	0.63	0.31	0.38
Spaceboard	Spaceboard 25 mm,	20%	Raw wood boards, 100x25mm gap 25mm	1.71	1.24	0.62
Spaceboard	Spaceboard 20 mm,	16,5%	Raw wood boards, 100x25mm gap 20mm	0.84	0.42	0.34
Spaceboard	Spaceboard 15 mm,	13%	Raw wood boards, 100x25mm, gap 15mm	1.07	0.34	0.36

wall gave an air movement of 0.5 m/s with vertical inflow currents at 3 m distance behind the livestock building wall. With currents angled at 60° there was hardly any air movement recorded, even 2 m away from the wall, which could be associated with the inflow current.

Porosity

From all the recordings, those from the measuring point in the livestock area (1 m away from wall and 1.1 m height) were selected for display in *table 1*. These show that air velocities in the livestock area were clearly reduced by the windbreaks compared with the situation with an unprotected façade. With Celloplast BV 90 the reduction was 82.5% and with Adic BVF 80.8%. The porosity of these nets was 22% and 21.5%. These similarities encourage the assumption that the windbreak porosity is decisive for their protection characteristics.

However, if one compared the similarly porous Celloplast GV 90 netting (porosity 23.5%) with 25 mm gap spaceboarding (porosity 20%), a marked divergence in air velocities can be determined. With spaceboards a clear air movement of 1 m/s can be recorded, even at 2 m distance. With netting, the movement at this point is only 0.5 m/s. In the measurement point defined as the livestock area the reduction of air movement where spaceboarding was tested was on average 13.9% and 66.8% with the windbreak nets. In fact, the air velocity measured in the livestock area where 25 mm spaceboarding was used was actually over the measurements taken where there was no windbreak in the façade.

The porosity was not the only influencing factor for the protection effect of windbreaks. Influence is also applied by the geometry of the air inlet opening. With windbreak netting, greater air turbulence seems to be caused and slows down the incoming air. With space boarding, a venturi effect can be imagined, with the air apparently strongly accelerated when entering the gap [3].

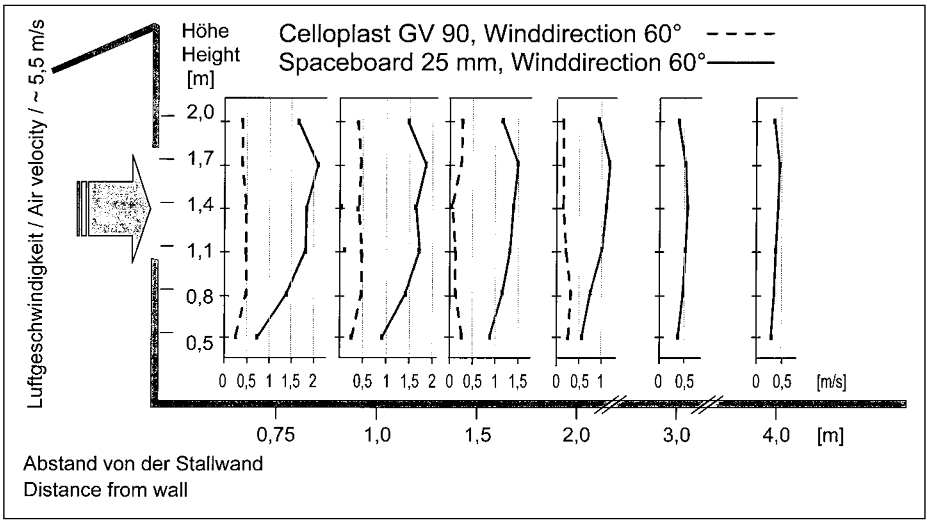

Fig. 3: Celloplast GV 90 and spaceboard element 25 mm. Wind angle 60°

Angled currents

The summarised measurements under 60° angled air currents with windbreak netting Celloplast BV 90 are shown in *figure 3*. Even after one meter away from the wall there was hardly an induced air movement to be measured.

The reduction of air movement in the livestock area where the air current was angled at 60° represented 72.5% with the nets and 44% with spaceboards, when judged against the façade without wind protection. With angled air current applied to 25 mm spaceboarding there was recordable wind movement even at 3 m away from the housing wall *(fig. 3)*.

Here, under both air current angles in the livestock area, higher air velocities were measured compared with the reference measurements without wind protection. Apparently somewhere in the range from between the 20 and 25 mm spaceboarding gaps there lies an area where the porosity decisively increases under conditions of angled air current application.

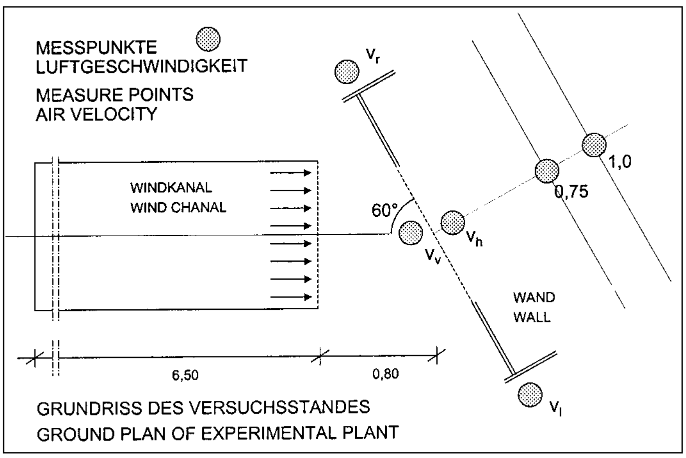

Fig. 2: Ground floor plan of test stand

Summary

At the FAT/Tänikon test stand measurements were taken with the aim of reducing the wind ingress where angled currents of 45° and 60° were applied. Despite porosities comparable with windbreak netting, higher air velocities were measured with the spaceboard concepts. This indicated that geometry of the air ingress opening also plays a decisive role in the protective effect of a windbreak concept. The widening of the gap in spaceboards led to a substantially poorer windbreak effect. However, decisive in the windbreaking effect is the angle at which the air current hits the wind protection material. With windbreak netting of smaller porosity no air current velocities in the draught range were measured in the livestock area even under angled air current application. With the larger gap spaceboarding, however, air movement was recordable even 3 m away from the housing wall.

Netting with porosity of up to 25% can be applied in livestock areas without any draughts resulting. Netting with substantially higher porosity and spaceboard elements should be fitted at least 2 m away from the livestock lying area. The latter conceptions do allow, however, sufficient air exchange within livestock housing in summer.

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