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Cattle Housing and Ventilation

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Cattle Housing and Ventilation

To ensure that good health and maximum performance is obtained from housed livestock the provision of effective ventilation is crucial. In cattle buildings it is usual to rely on natural ventilation to create the required internal climatic conditions. This technical note deals specifically with the design of natural ventilation systems to achieve optimal climatic conditions within cattle housing.

Summary

- **Ventilation should be designed to work effectively on a calm day when there is no wind.**
- **Draughts at stock level should be avoided.**
- **Ventilation design should start with calculation of the required outlet area.**
- **Inlet area should be a minimum of twice the outlet area and should be split between the two sides of the building where possible.**
- **The provision of sufficient natural ventilation should be possible in new buildings and should be the first choice when altering older buildings.**
- **Mechanical ventilation may be necessary in some cases.**

Ventilation

Three basic parameters need to be controlled by the ventilation within the building to maintain the ideal conditions for the livestock;

- **Fresh air** – sufficient air for the animals to breathe that is as free as practical from excessive moisture, dust, micro-organisms and gases from the stock.
- **Moisture** – excess moisture can harbour bacteria and viruses and cause condensation increasing the risk of infection transmission via dirty water. It will also increase the requirement for bedding and reduce the ambient temperature.
- **Draughts** – or excessive air speed around the animals will increase the rate at which they lose heat in cold weather. Sustained draughts will result in the animals having to burn more food to stay warm and a consequent reduction in performance and poorer resistance to disease.

In cattle buildings it is usual to rely on natural ventilation to create the required internal climatic conditions. Two separate motive forces (wind and thermal buoyancy) will determine how much air is moved with a natural ventilation system.

- **Wind** blowing against a building will create pressure on the exposed side and also suction on the “lee” side. In this situation draughts can occur as the wind passes through the building by the shortest route possible and it will be necessary to create some form of baffle on the air inlets to reduce the air speed. Typically this is done by installing space boarding, slotted steel sheeting or fabric mesh to the sides of the building.

In order to ensure that there is sufficient ventilation on calm days **thermal buoyancy** is utilised. Thermal buoyancy refers to the natural phenomenon that hot air rises and is replaced by cooler air flowing in to fill the resulting vacuum. Within a livestock building heat is supplied by the animals and the resultant airflow is known as the stack effect.

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Ventilation openings for a livestock building are therefore based on thermal buoyancy to ensure that the required minimum level of ventilation is achieved during still, wind-free days such as are often encountered in late autumn.

The procedure for calculating the required sizes of ventilation openings begins with an estimate of the required outlet size. As a ballpark figure for approximate calculation or for checking the ventilation in an older existing building a figure of 0.1m2 per head can be used. However for a more accurate calculation the graph in Figure 2 can be used.

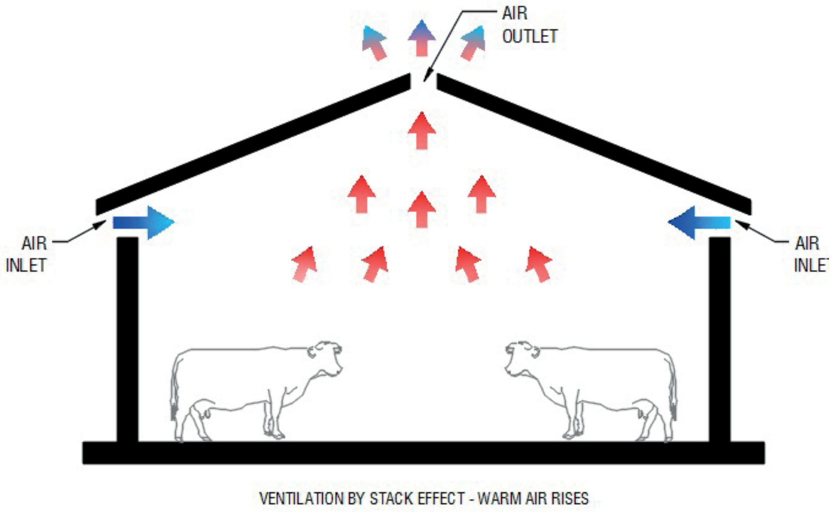


Figure 1: Ventilation by thermal buoyancy

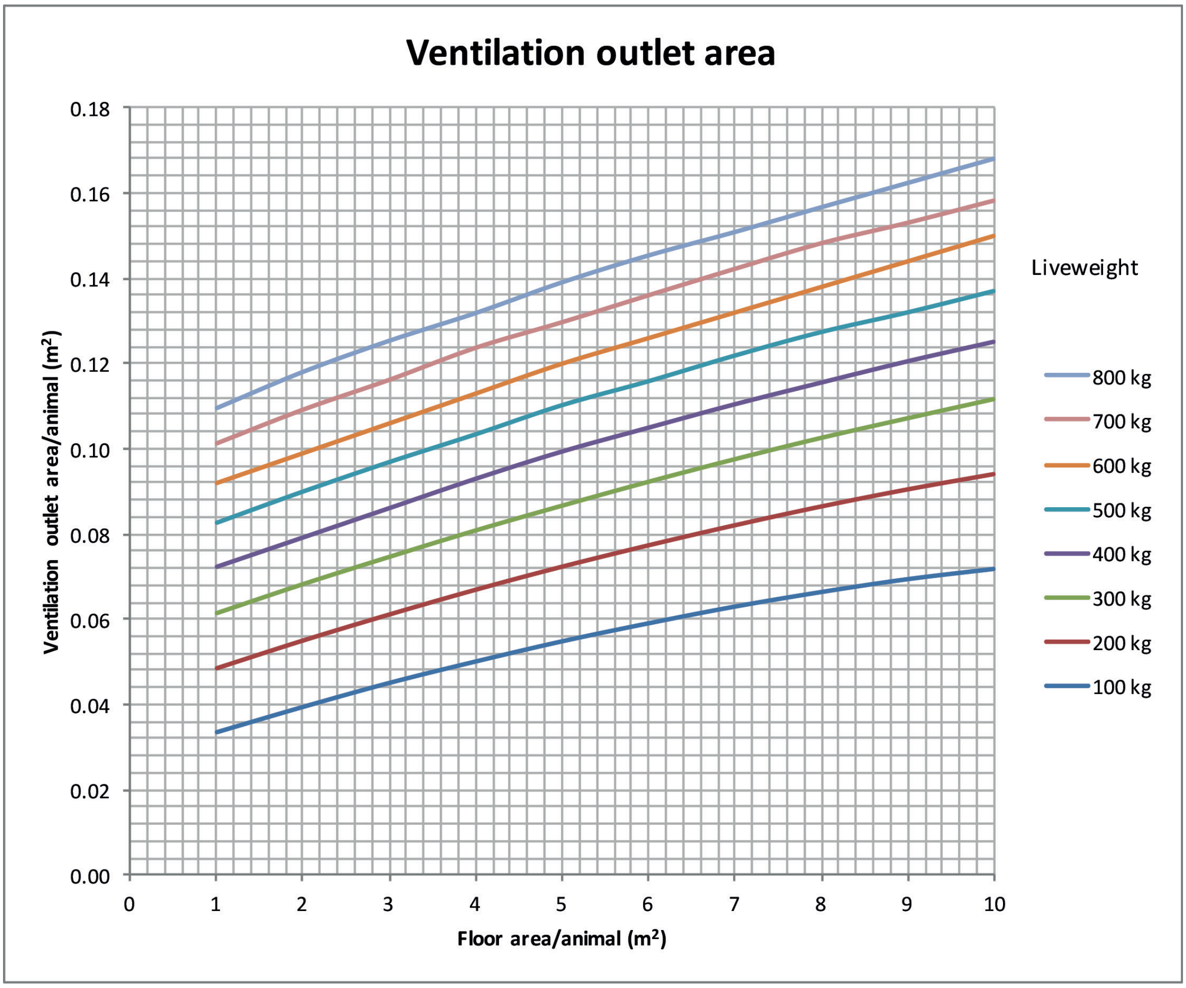


Figure 2: Ventilation outlet area for cattle buildings where height difference between inlet and outlet is 1.0 m (see Figure 3 for height factor)

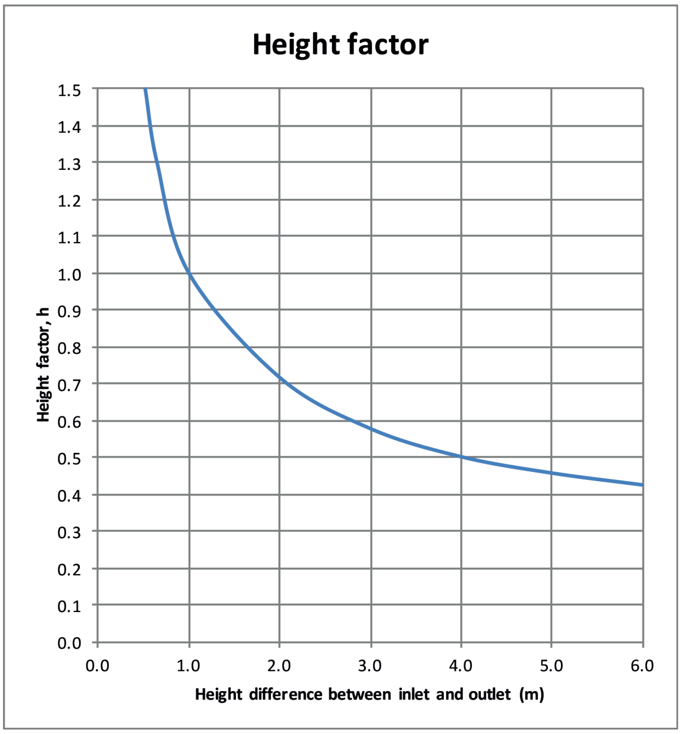
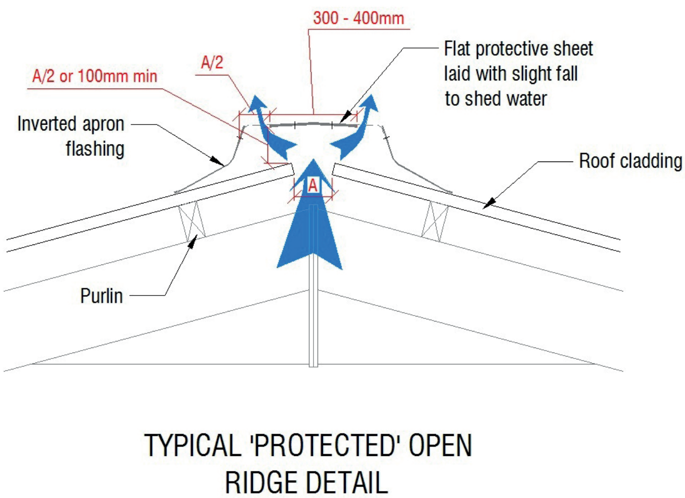


Figure 3: Height factor to account for difference in height between inlet and outlet

Outlet Design

The most convenient method of providing a ventilation outlet is by installing a continuous opening along the ridge of the building with upstands as provided by the inverted apron flashing in Fig.4. The inclusion of upstands will reduce rainwater entry and greatly improve the upward airflow. Rainwater entry may still pose a problem in high rainfall areas, particularly where the building is understocked or used for other purposes in the summer. Rainwater entry can be avoided by installing a covered open ridge as shown in Figure 4. The protective sheet should be wide enough to shed rainfall onto the roof cladding and should be laid with a slight fall to one side or shaped to fall to both sides. The air gap at either side of the sheet should be at least equal to half of the ridge gap



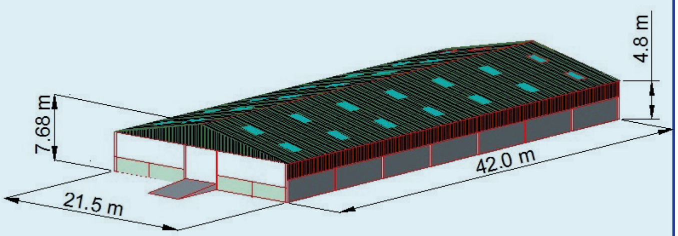
Where sufficient ventilation outlet cannot be achieved at the ridge other methods can be used such as slotting or spacing roof sheets. On a new roof this is done by installing corrugated sheets with a small gap up the slope of the roof between each adjacent sheet.

Example;

A straw bedded cattle court is 42.00 m long x 21.50 m wide and measures 4.80 m to the eaves. A 15° roof pitch gives a ridge height of 7.68 m. The building houses **125** cattle at an average weight of 500 kg.
Floor area = 42.00 x 21.50 = 903 m2
Stocking rate = 903/125 = 7.2 m2/animal

Using Figure 2 with a floor area of 7.2 m2/animal along the bottom axis and drawing a line straight up until it hits the curve representing an average animal weight of 500 kg gives a required ventilation outlet per animal of **0.124 m2** on the vertical axis. However this needs to be modified to take account of the height difference between the inlet and the outlet or in this case the height from the eaves to the ridge which is;
7.68 – 4.80 = 2.88 m

From Figure 3 this gives a height factor, h of **0.58**
The total outlet area required is then found from;
Outlet area per animal (m2) x height factor (m) x no of animals
= 0.124 x 0.58 x 125 = 8.99 m2
In most cases this opening will be provided by a continuous gap along the ridge of the roof and as the building is 42.0 m long the minimum width of the gap should be;
8.63/42 = 0.21 m or **210 mm**.



Sheets are installed upside down so that rainfall will be shed away from the gaps. Proprietary cranked ridges rarely provide sufficient ventilation outlet area for livestock buildings.

Ridge ventilation can be incorporated with roof lights as shown in Figure 5. This can be a good method of providing light and ventilation in particularly wide buildings. Ventilation outlet openings are provided between the outer edges of the central roof lights and the roof sheets.

Figure 5: Ventilation outlets provided under central roof lights.

Inlet Design

The inlet area should be a minimum of twice the outlet area and if at all practical should be split between the two sides of the building. The air inlets should provide enough open area to admit the required fresh air but should also be designed to minimise draughts particularly at stock level. Placing inlets on the gable ends is less than ideal and should only be considered where sufficient openings on the sides cannot be arranged. Completely open sides or open spaces above side walls will provide good ventilation but will offer no protection against wind or driving rain. This design can be used in some circumstances with overhanging eaves or in sheltered locations. A range of different materials can be used to achieve the required ventilation area and the choice for a specific site will depend on a number of factors including exposure to wind and rain, flexibility of building use, cost and aesthetics.

Typical materials include;

- **Spaced boarding** – 100 mm wide vertical boards with a gap of up to 25 mm between each board (20% void ratio). Gaps in excess of 25 mm may result in drafts and will allow rain and snow to penetrate.

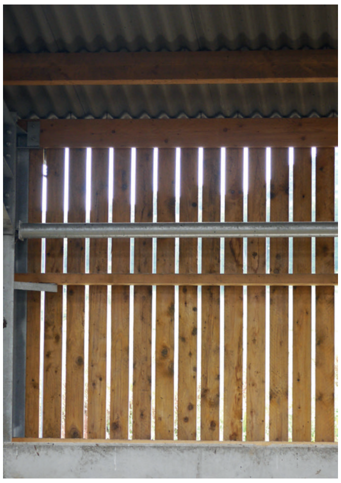


Figure 6: Space boarding (25% void area)

- **Yorkshire boarding** – Where a site is particularly exposed or where sufficient void cannot be created with a maximum gap of 25 mm two rows of boards can be used. One row on the outside of the purlins (normally 150 mm boards) which can be spaced with up to 50 mm gap and a second row on the inside of the purlins with the same gap offset so that the board on the inner row blinds the gap in the outer.

- **Perforated or louvered metal cladding** – Offers better rain protection than spaced boarding but typically with much lower void ratios and therefore a larger area will be required to achieve the same inlet area. Note that most ventilated cladding sheets are corrugated and that the ventilation openings are on the outer corrugation only reducing the ventilation area. Cladding sheet suppliers should be able to provide a figure for the overall void ratio of the sheet.

Figure 7: Louvered cladding (18% void area)

- Plastic or Woven Fabric Mesh – Can be used to provide air inlets and comes in a wide range of void ratios. It can be used as a permanent feature and is easily added to an existing building. The ability to easily open and close panels allows for adjustments to be made to ventilation depending on the time of year, occupancy or weather conditions.

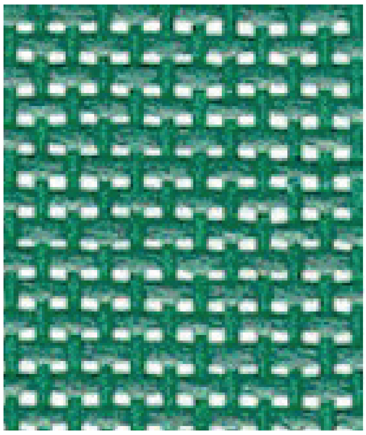
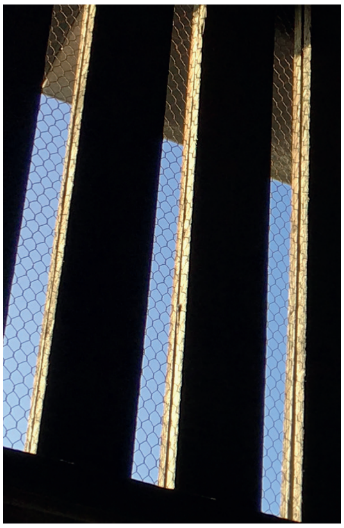


Figure 8: Woven Mesh (23% void area)

Variable Natural Ventilation

The ability to alter the area of ventilation inlets and/or the level of weather protection in a building is often desirable, particularly where livestock is housed throughout the year. Protection from winter squalls needs to be balanced with the need for a cool flow of air during the summer months. In some cases shade from the sun may also be a requirement. Variable ventilation can be achieved by simple manually adjustable Yorkshire boarding as shown in the open position in figure 9(a) and in the closed position in figure 9(b). An inner set of 125 mm wide boards are fixed with 100 mm gaps and an outer set of boards of the same width and gap are mounted on a rail that can be moved to increase or decrease the gap as required between 0 and 100 mm. A disadvantage of this system is a tendency to become difficult to move with age and to get jammed in the fully open or fully closed position.



(a)

(b)

Figure 9: Adjustable Yorkshire boarding (a- open, b- closed)

Alternatively, modern side curtain designs offer more convenient operation and a wider range of inlet openings. Many arrangements are available which can either fold down to open or roll up or down depending on whether there is a need for wind protection or shade. Operation can be by very simple hand crank or operated electrically. Automated systems can be set to open and close depending on climatic conditions or with a time clock.

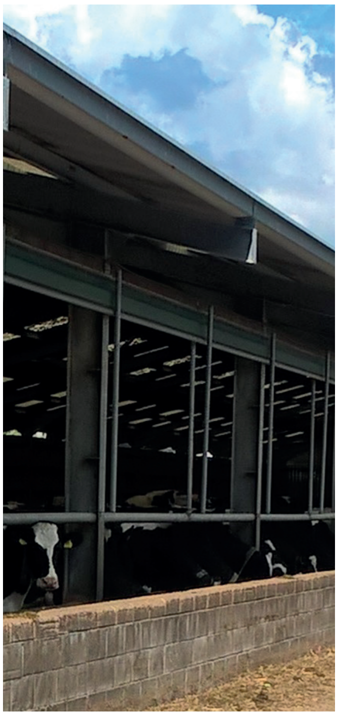


Figure 10: Variable Side Curtain on Dairy Cattle Housing (open on a sunny day).

Mechanical Ventilation

New buildings should where possible be designed with effective natural ventilation and avoid the need for fans. However in some cases there may be a need to install mechanical ventilation e.g.

- Where the layout of an existing building does not allow for sufficient suitably placed ventilation inlets on external walls. Fans can then be used to push air along a duct and distribute it within the building. Properly sized and located ventilation outlets are still required to ensure sufficient air changes take place. Otherwise a fan may move foul air around the building distributing airborne infections as it does so.
- Dedicated calf housing may benefit from mechanical ventilation as young calves will not generate sufficient heat to cause sufficient upward air movement for the stack effect to work effectively.

Where mechanical ventilation is required, positive pressure systems with fans at the inlets blowing air into a distribution duct will normally be the most suitable option. In some existing buildings with minimal air space above the livestock or where existing roofs are difficult to alter extractor fans may offer a solution in lieu of suitable natural ventilation outlets.

To be effective mechanical ventilation systems need to be designed correctly for the specific situation; poorly thought out systems can be expensive to run while failing to achieve the desired conditions for the livestock. If poorly designed they may do little more than circulate foul air around a building.

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