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TECHNICAL FEATURE

Shielding Fresh Air Ventilation Intakes

By **Bjørn Petter Jelle** and **Knut Noreng**

Outdoor or fresh air ventilation intakes provide fresh air to the building interior. These air intakes need to be sufficiently shielded from water ingress in the form of rain, wind-driven rain, snow and wind-driven snow.

Even if general guidelines for good air quality are available,[1,2,3] air quality may often be questioned in many buildings. Moreover, it is often challenging to investigate and diagnose moisture problems.[4]

In buildings with moisture damage, the original source for these problems may be water ingress through the fresh air ventilation intakes. In many cases, it is suspected the roof has hidden leakage areas, whereas, in fact, the culprit is often the fresh air intakes that might have insufficient or no shielding at all.

Often, it is relatively simple to shield air intakes from snow and rain ingress. However, it is best to consider this shielding at the planning stage, so that it's possible to properly shield in the most effective way.

In this article general solution principles for shielding fresh air ventilation intakes against snow and rain inlet (entrainment) are presented.

Health Risks

In addition to building damage, e.g. wood rot decay, due to unwanted water ingress, one large risk from moisture problems is related to mold growth. Trapped water or moisture, e.g., between watertight barriers (which has no possible way to dry or drain out) may lead to mold growth under certain conditions. Unfortunately, these conditions are often fulfilled. Mold initiation and growth are dependent upon:[5] availability of fungal spores, which are almost always present, except under sterile conditions; nourishment, e.g., wood; moisture; temperature; oxygen; and time.

The exact relationship between mold growth with release of airborne fungus and the resulting air quality, and health problems is not yet fully understood. For further information, see References 6 and 7.

Nevertheless, that a health risk exists is not questioned, and many people have become ill due to moisture entrapment and subsequent fungus growth. Occasionally, it has been necessary to evacuate buildings infected with mold, also due to snow inlet through fresh air ventilation intakes.

One of the following examples will show such a case (Example 1). Further information may be found in References 3, 8 and 9.

Installing Intakes

Generally, the following two principles should be followed when installing fresh air ventilation intakes:

• Shielding: block off as much of the snow and rain as possible from penetrat-

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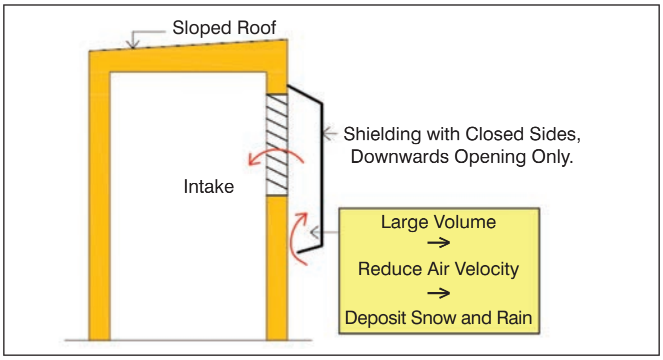

Figure 1: Principle drawing for shielding a fresh air ventilation intake. Note the sides are also shielded, i.e., the only air intake is from under the shielding hood and upwards.

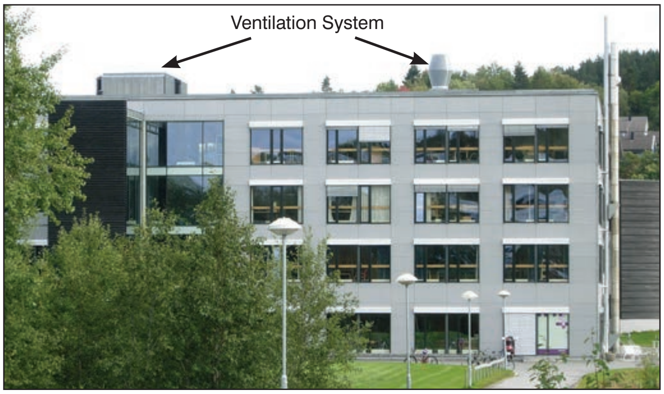

Photo 1: University campus building with fresh air ventilation intakes on roof with previous snow and rain inlet problems.

ing the air intake by making a shield or hood where air enters only upwards from below and into a larger space. This reduces air velocity, which then stops further snow and rain ingression (*Figure 1*).

• Draining: make a watertight system that drains away any water coming into the ventilation system.

A sufficient amount of height between the base of the air intake (e.g., the roof) and the air intake opening is required to avoid any blockage of the opening, such as by snow accumulation and snowdrift. Regarding snowdrift, it is important to choose the best locations and have the best designs that minimize snow accumulation.

These general principles are also valid for most building components and structures. An operable window is an example where as much wind-driven rain as possible is stopped from entering in between the window frame and casing by a combination of shielding, narrow joints and satisfacory airtightness. Any water entering in between the frame and casing is supposed to be led away and out by sufficiently large drainage grooves, which with their large volumes, are reducing the velocity of incoming air and wind-driven rain, i.e., analogously as in the larger volumes behind the shielding of fresh air ventilation intakes (*Figure 1*). Inferior or no shielding puts a heavy load on and requires a very efficient, robust and durable drainage system, especially for more harsh climates with respect to wind combined with rain and snow.

The following examples of building damage cases show some of these general principles in practice, as well as not. Even with a proper shielding, the intake

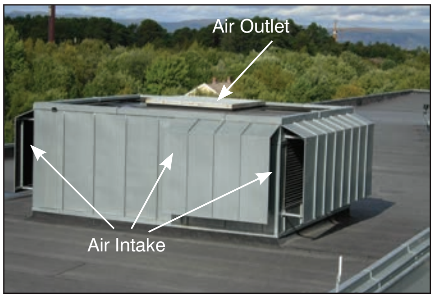

Photo 2: Shielded fresh air ventilation intakes on university building roof. Vertical side intakes and horizontal top outlet.

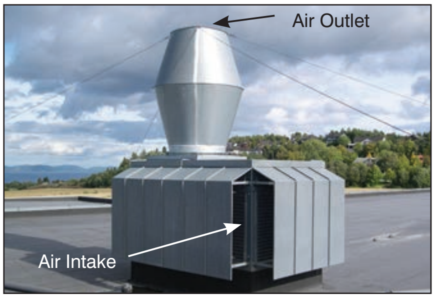

Photo 3: Shielded fresh air ventilation intakes on university building roof. Vertical side intakes and horizontal top outlet.

Photo 4: Closeup of metal grid and blinds from *Photo 2*.

Photo 5: Shielded fresh air ventilation intakes. Note that it is also recommended to shield the open sides shown here, i.e., the only air intake is from under the shielding and upwards.

grid (louver) still must be kept, as it prevents larger objects from entering, e.g., from willful plundering and vandalism, leaves from trees and animals and birds. Furthermore, note that pressure loss and fan energy increase due to increased air friction through the various devices are not addressed within this work. Fresh air ventilation intakes and hoods also have an aesthetical side, and efficient (but rather ugly) intakes on walls and roofs may not be desired by everyone.

In addition to the previous general principles, the following aspects should be considered with respect to location of the fresh air ventilation intakes. Air intakes should be:

• Located at an adequate secure distance from chimneys and similar objects.

• Placed sufficiently high above the roof surface as to avoid pollutants and solar-heated air from being drawn into the air intakes (height = ca. 0.6 m [2 ft]).

• Placed sufficiently high above the roof surface to avoid any blockage from

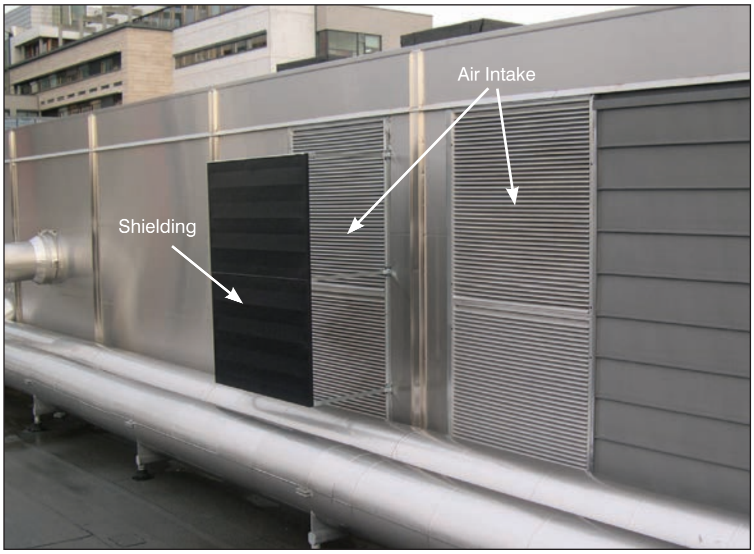

Photo 6: Vertical fresh air ventilation intakes on a wall experiencing problems with snow and rain inlet. One ad hoc solution with outside shielding (black screen) in front of an intake has been shown not to work.

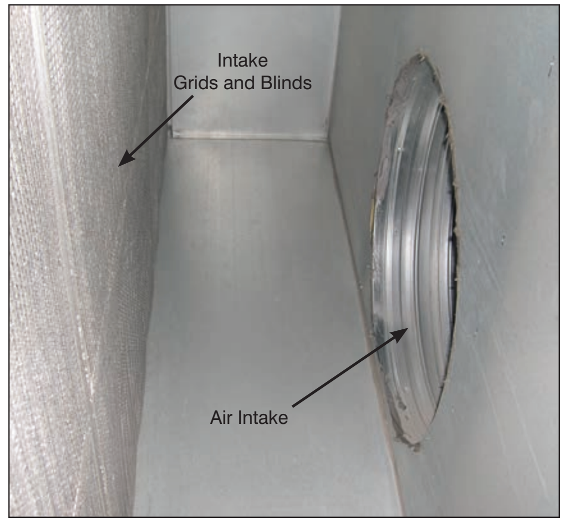

Photo 7: Inside the intake grid and blinds (left), as shown in *Photo 6*, where the space is too small to reduce the air velocity significantly, thus large amounts of snow are blown into the air intake (right).

snow accumulation and snowdrift (must be determined according to prevailing snow charts and local conditions).

• If possible, placed at a shady location or on the north side of a pitched roof to avoid undesired solar heating and cooling in the summer season.

• Configured so the area of the intake grid is large enough to reduce the inlet air velocity so snow and rain droplets are not drawn inside (velocity = ca. 2 m/s [7 ft/s]).

Note that regarding the size of the bottom shielding hood opening, the primary functional requirement is given by the inlet air velocity and not by the actual dimensions of the opening, which may vary according to other parameters, e.g., ventilation fan speed and inner shielding hood dimensions.

Examples of Building Damage

Example 1: Large Free-Standing Roof Intake

On a building located at a university campus, two large free-standing fresh air ventilation intakes and outlets are situated on the roof (*Photos 1*, *2*, and *3*). The building is used by university employees and students and has offices and athletic training facilities. The intakes are placed vertically on the base of the ventilation houses, while the outlets are placed horizontally on top of the ventilation houses. Originally, there was no shielding except the normal intake grid covers (louvers) (*Photo 4*).

The building experienced extensive moisture problems with large amounts of fungus damage. Several people became ill, and the building had to be evacuated. First, it was thought that the moisture coming into the building originated from leakages in the roof or earlier built-in moisture in the roof. In fact, the culprit was the fresh air ventilation intakes. The air intakes had no shielding and snow and rain penetrated through them into the building. The metal grid and blinds (louver, e.g., bird screen) shown in *Photo 4*, do stop larger particles, such as leaves, but not snow and rain (depending upon the snow and wind conditions).

The air intakes were then shielded as depicted in *Photos 2* and *3* (detailed in *Photo 5*). Since then, the shielding has been working satisfactorily with no observations of moisture or fungus growth. It is also recommended to shield the open sides shown here, which was not done in this case (*Photo 5*). With the current design, snow and rain may still pass through the air intakes if the wind direction is unfavorable with respect to the shielding. Furthermore, the distance from the air intake opening and the ground level (e.g., the roof) needs to be large enough to avoid any blockage of the air intake such as by snow accumulation.

Photo 8: Inside the building at the intake (left) as shown in *Photos 6* and *7*. The building was completed before the actual required air ventilation dimensions were calculated, resulting in too small dimensions for the ventilation system.

Example 2: Large Top Floor Wall Intake

Another building located at a university campus has several large fresh air ventilation intakes situated vertically on a wall (*Photo 6*). The building is used by university employees and students with offices and laboratories. The vertically placed wall intakes are

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Photo 9: Inside the intake grid and blinds (left). The hallway space is large enough to reduce the air velocity significantly, preventing snow from being blown into the air intake (right).

Photo 10: Combined business and apartment building experiencing water leakage problems from the roof, where investigations revealed that some of the leakage water was caused by snow and water inlet through the fresh air ventilation intakes.

Photo 11: Apartment building air intake with no shielding.

Photo 12: Inspection of an air intake revealed a non-watertight solution as a feedthrough pipe perforated the vapor barrier, allowing water to flow down into the building.

Photo 13: Ad hoc solution for temporarily coping with water ingress problem. It's almost like getting a Roman aquaduct in the bedroom.

experiencing problems with snow and rain inlet.

An attempt to solve the problem with snow and rain inlet (entrainment) was done by placing outside shielding (black screen, *Photo 6*) in front of one of the intakes, but this ad hoc solution has been shown not to work. Note that there is no shielding from the top or sides, which would have reduced the snow and rain inlet substantially. Inside the intake grid and blinds (louvers) as shown in *Photo 7*, the space is too small to significantly reduce the air velocity, and large amounts of snow are blown into the air intake. One might ask: why were these rooms inside the air intakes constructed to be too small? The fact was that the building construction was completed before the actual required air ventilation dimensions were calculated. In this case it was claimed that there was not enough room for making the ventilation dimensions large enough (*Photo 8*).

Example 3: Large Wall and Room Intake

A building located at a university campus has one large fresh air ventilation intake placed vertically on a wall (*Photo 9*). The building is used by university employees and students with both offices and laboratories. In fact, this vertically placed wall intake does not experience any significant problems with snow and rain inlet. The space (a hallway, *Photo 9*) inside the intake grid and blinds (louver) is large enough to decrease the air speed substantially, avoiding snow from being blown into the air intake.

Some amounts of snow and rain are occasionally observed on the floor just

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below the intake grid and blinds (louver), but the floor is built to handle small amounts of water so this does not represent a problem. Ideally, this room should have been constructed with a sloped floor and a low-point drain.

Example 4: Small Free-Standing Roof Intake

A combined business and apartment building shown in *Photo 10* was experiencing water leakage problems from the roof. Investigations identified that some of the leakage water was caused by snow and water ingress through the fresh air ventilation intakes.

One of the air ventilation intakes (for the apartments) is shown in *Photo 11*. There is no shielding of the air intake. By opening one of the air intakes (not the same one as in *Photo 11*), it was found that even if a vapor barrier were used, the solution was not watertight since a feedthrough pipe perforated the vapor barrier, i.e., allowing water to flow down into the building (*Photo 12*). An ad-hoc solution for temporarily coping with the water ingress problem is shown in *Photo 13*, almost like obtaining a Roman aquaduct in the bedroom, not to be recommended as a long-term solution, if there should be any doubt.

In addition to ensure watertight feedthroughs, it was recommended to shield the air intakes. A principle drawing for this solution is depicted in *Figure 2*. Note that the sides are also to be shielded, i.e., only air intake from under the shielding and upwards. Furthermore, it must be ensured that the air intake will not be blocked by snow accumulation, i.e., the distance between the air intake opening and roof must be large enough.

Conclusion

As moisture problems in buildings may be traced back to snow and rain ingress through fresh air ventilation intakes, stronger emphasis must be placed on constructing new fresh air ventilation intakes and improving existing ones.

Acknowledgments

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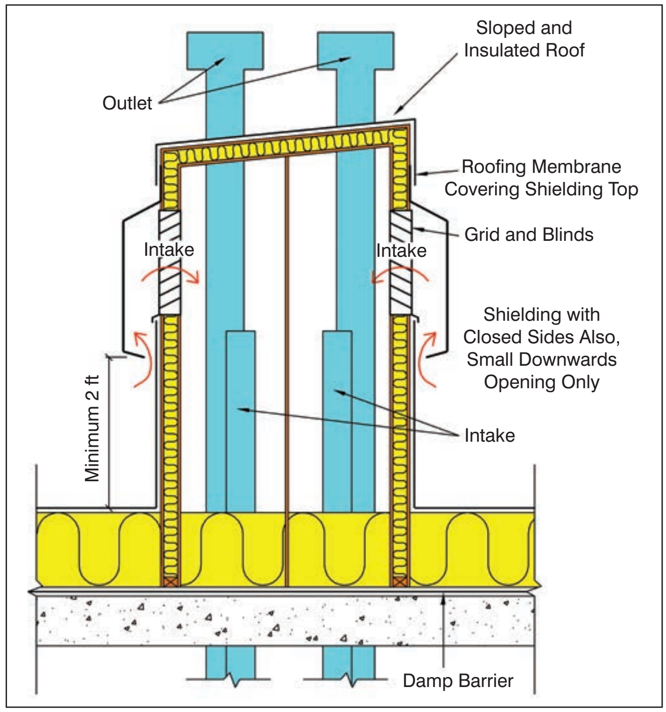

Figure 2: Shielding a fresh air ventilation intake. Note the sides are also shielded, i.e., the only air intake is from under the shielding hood and upwards.

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