Internal Ventilated Plinth as One of the Possible Solution for Moist Buildings

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Abstract. Additional protection of aged buildings against rising moisture is one of the most important measures to ensure their long-time durability and sustainable user properties. One of the remediation methods is the ventilated wall (air cavity created by additional thin wall), located in the interior of the building but ventilated to the exterior. The aim of this remediation measure is to reduce the amount of rising water which increases moisture level in building walls (in case of malfunctioning or missing waterproofing layer). The paper presents innovative technical solution in this field. The technical solution relates to an internal ventilated segmental plinth, which is formed by an assembly of shaped boards with a thermal insulation layer applied to their back sides and being provided with side plates for their butt joining one next to the other alongside the inner side of the building maintained exterior wall. The boards form a continuous air cavity enabling intense diffusion of water vapor from the adjoining moist wall. This patented solution is very simple, low cost and can be done from environmentally friendly materials.

1. Introduction
At the present, there are many remediation methods that can reduce the undesirable process of capillary rise of water from the subsoil into the pore system of older buildings. Most of them are listed in articles [1, 2]. Commonly used remediation methods include so-called air-insulating systems.

This is a very extensive set of remedial measures designed to maximize the amount of water vapor diffusing from the building structure. For effective evaporation of water from the structure, it is necessary to ensure an intense exchange of air in its immediate vicinity, so as not to achieve 100% relative humidity of the adjacent air layer. At the same time, it is important that the supply air has the lowest relative humidity, which cannot be achieved by using humid indoor air from the remediated room (a typical example is a humid cellar) – for this reason, it is necessary to bring the air only from the outside (but only in the climatically appropriate periods of the year).

2. Contemporary ventilated walls – short state of the art
Air-insulated systems also include ventilated walls. Internal ventilated pre-walls are currently carried out on the entire floor height. They are built from narrow bricks or as plasterboards (slab system + grate). These walls can be made in three modifications, differing from each other to ensure the air flow in the cavity between the pre-treated and the rehabilitated wet circumferential wall. The most common solution is to make suction and exhaust openings towards the interior – such a solution is very unfortunate in terms of the effectiveness of the remedial measure (see above). The effect of such
a measure is only aesthetically camouflage, as there is no significant reduction in moisture in the walls – the moist air from the interior cannot absorb other water diffusing in the form of water vapor from the wall. Another significant drawback of the internal circulation is the hygienic risk that can be expected from mold formation in the insufficiently ventilated cavity. Inside the cavity, conditions for the growth of fungi (wet, heat) will be favourable. The best solution is therefore to position the intake and exhaust openings in the exterior (over the rehabilitated wall). The disadvantages of this solution are only problems associated with building thermal technology. Since the cold outside air carried into the cavity separates only the pre-interior from the interior, which must have a sufficiently low heat transfer coefficient. Performing thermal insulation in the cavity is a relatively difficult matter, even if it is a gypsum pre-wall. The biggest risk is the tapering or full filling of the ventilated cavity with a locked or twisted thermal insulation.

Another disadvantage of all internal ventilated pre-walls (regardless of the location of the ventilation openings) is the reduction of the space in the room in which the pre-wall is installed. On the first floor, in most cases it is unnecessary to mount the pre-wall to the whole height of the room. As the moisture rises typically within the range of 0.8–1 m high in the first floor (this is the position of the drying line, where water is transferred from the wall to the ambient air in the form of water vapor diffusion, there is no more water spreading to the higher places in the wall). Therefore, ventilated walls are used mainly in basements, less often in the 1st floor. In the 1st floor, other air-isolation remediation methods, such as outside ventilated plinths, are applied. The efficiency of the outdoor ventilated plinths is only partial in massive masonry (thickness greater than 450 mm), because uneven diffusion of water vapor occurs predominantly from the outer half of the wall.

3. Internal ventilated plinth

3.1. Functional principle – benefits
The drawbacks of the existing ventilated internal walls mentioned above are largely eliminated by the system of the internal ventilated segment plinth developed by the authors and registered as a patent CZ305962(B6) [3]. The essence of the solution is a set of specially shaped wooden boards, which have a layer of thermal insulation made of polyurethane foam (or mineral wool, PIR foam or other similar heat insulating material) on their bottom surface (towards the cavity) (Figure 1). The plates have a cross-section in the shape of the letter "J" and are placed side by side along the inside surface of rehabilitated wall (Figure 2). In their place they are fixed with anchor screws (bolts) that are anchored to the masonry via the spacers (Figure 3). The inner plinth is formed by the assembly of these plates, folded together (one next to each other) and creates a continuous ventilated cavity along rehabilitated wall. The air is carried into the cavity from the outside through the vents drilled inside the wall and situated at the bottom part of the ventilated cavity. The drainage of humid air (saturated during the flow through the cavity by water vapor diffusing from the adjacent rehabilitated wall) is ensured by means of ventilation passages pierced through the rehabilitated wall into the exterior and located in the upper part of the ventilated cavity. Both the inlet and outlet of the air into / from the cavity is made exclusively from / to the exterior.

This results in a high efficiency of the remediation measure (reducing the moisture of the rehabilitated wall) with a minimal hygienic risk. An advantage over ventilated pre-walls made over the entire floor height is a lower reduction of room space as the plinth is only made up to a height of about 1m above the floor. Another significant advantage is easy installation of the plinth in comparison of pre-walls build from bricks or slab systems (grid + slab). The method consists of simple application of the wooden segments to the rehabilitated wall and their subsequent simple fixing using wall-mounted screws. After that, only the quick installation of the cover self-adhesive strips (or silicone seal) at the top and the bottom edge of the plinth follows.
3.2. Risks in the winter season
Since the cavity created by the plinth is ventilated only by outside air, it is necessary to avoid thermal losses in the winter, which could be caused by such a technical solution. A layer of thermal insulation made of polyurethane foam (or other similar material) which is applied to the inner surface of the board (not visible from the interior of the remediated room) is determined for this purpose. This layer
must have (with the plate) a sufficiently low heat transfer coefficient U such that the thermal losses in
the room are reduced to the required level, while avoiding the risk of condensation on the plinth
surface (the plinth surface temperature must be higher than the dew point temperature specific
marginal conditions in the room). However, it is also necessary to exclude the condensation of humid
air inside the ventilated cavity during the winter. For this reason, a heating electrical resistance cable
located at the bottom of the cavity, which will be activated under specifically defined external weather
conditions (for a given object) so that the air temperature in the cavity does not fall below a safe level,
is part of the technical solution. Alternatively, the installation of the heating cable can be replaced by
intermittent ventilation mode, in which case the ventilation holes will be temporarily sealed in the
winter months. The regulation of opening and closing of ventilation holes could be automatized using
intelligent control system based on information from humidity and temperature sensors.

3.3. Material version
The specially shaped boards, which are a basic part of the plinth technical solution, are primarily
considered as wooden, but depending on the customer's wishes and local possibilities, these elements
can be made from other suitable materials. The boards can also be made of plastic (lower aesthetic
level), high strength fiber reinforced concrete or pressed bamboo (only for low moisture walls).
Surface finishing of the boards can be customized / adapted according to the requirements of the
interior. The system of type boards is to be supplemented with specially modified boards for details in
the corners, in the openings in the walls and in the technical installations of the heating and ventilation
equipment (Figure 4).

3.4. Discussion
The efficiency of the system (in terms of reducing moisture in remediated wall) should be sufficient
because the effectiveness of ventilated cavity systems has been demonstrated by previous research [4,
5]. The result of this research was finding that when using forced ventilation, the drying effect on the
remediated structure is high in the case of sufficient width of the ventilated cavity (which is fulfilled in
this case). Therefore, based on the results of previous research [4, 5], it can be assumed that the system
described in this paper will certainly be effective when installing forced ventilation. To accurate determination of the drying effect for each individual installation case, the calculation with a specific installation conditions is necessary (cavity height, moisture level in masonry, air flow velocity in the cavity, the speed of water rising inside the masonry, temperature in the cavity).

The authors of the paper plan in the next step the accurate determination of system's performance for a specific application case (when available), conducted by calculation model as well as by site measurement. An important part of calculations and in-situ measurements will be the study of the risk of condensation of water vapor inside the cavity during the winter. Based on the obtained results, the system would be modified to prevent condensation (adjustment of the heating cable, ventilation mode during the year, thermal insulation parameters). Energy demand of such system containing fans and heating cables should be considered and assessed by LCA.

4. Conclusion
The system of the internal ventilated segmented plinth described in the patent CZ305962(B6) is a prospective remediation system that expands the possibilities of using the air system in a sustainable remediation of older buildings affected by water rising from subsoil. The authors are looking for an industrial partner to cooperate on the adaptation of the system for production and distribution in the building practice. This will require to perform the final system adjustment based on necessary computational analyses and experimental testing.

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