

BOGDAN DZIEDZIC\*

## VENTILATED PLINTHS OF MODERN AND MODERNIZED HISTORIC BUILDINGS

### COKOŁY WENTYLOWANE WSPÓŁCZESNYCH I MODERNIZOWANYCH OBIEKTÓW ZABYTKOWYCH

#### Abstract

The paper focuses on the necessity of using ventilation slots in plinth areas of buildings. The main purpose of these slots is to reduce the amount of the capillary rising of water. At the same time it is important to draw attention to the lack of knowledge in the area of basic physics among construction companies; building renovations conducted by them, not only of historical buildings, but also of new ones, lead to serious failures. The moist air discharge through the cracks in the plinth areas presented in this article is one of the methods allowing for proper moisture reduction and for making renovations in damp underground parts of historic buildings. Additionally, this method allows to create a proper plinth area in the modern building industry.

*Keywords: drainage, horizontal waterproofing, vertical waterproofing, plinth, ventilation, capillarity*

#### Streszczenie

Artykuł ma za zadanie podkreślić konieczność stosowania szczelin wentylacyjnych w strefie cokołowej budynków, których głównym celem jest obniżenie wysokości podciągania kapilarnego. Jednocześnie zwraca on uwagę na brak podstawowej znajomości fizyki budowlanej przez firmy budowlane. Dokonywane przez nie renowacje obiektów zarówno zabytkowych, jak i nowo wznoszonych, prowadzą do szeregu zaniedbań. Przedstawiona w artykule metoda odprowadzania zawilgoconego powietrza przez szczeliny w partii cokołowej jest jedną z niewielu, która pozwala na obniżenie strefy zawilgocenia i dokonanie renowacji zawilgoconych podziemnych części zabytkowych budowli. Dodatkowo metoda ta daje możliwość wykonania prawidłowej strefy cokołowej w budownictwie współczesnym.

*Słowa kluczowe: drenaż, hydroizolacja pozioma, hydroizolacja pionowa, cokół, wentylacja, podciąganie kapilarne*

\* Ph.D. Eng. Arch. Bogdan Dziedzic, Institute of Building Design, Faculty of Architecture, Cracow University of Technology.

## 1. Introduction

In a heavily urbanized construction environment, basement levels of existing and newly constructed buildings are becoming increasingly important. For economic reasons, underground spaces have multiple uses. This encourages investors, designers and contractors to look for increasingly better building materials, in order to ensure optimum conditions and climate for rooms below ground level. An important aesthetical problem in historic building is damaged and corroded plinths. This phenomenon is a real challenge for both the owners and the contractors. The undertaken restoration work often relies on masking effects without eliminating the causes, which in a short time, leads to the destruction of the newly modernized plinths. Common ad hoc repair work involving the application of new plaster should be mentioned here. Lack of knowledge of the craft in this field means that a new layer of plaster is of much greater resistance than the structure of the wall that needs renovation. Consequently, such action will reduce water vapour permeability and scorch-loosening the new layer of plaster, causing damage to the structure of a new wall. There are a few reasons of plinth corrosion and one should look for them under the ground, usually at the level of footings. Water molecules having a negative potential, tend to its alignment with the consequent need to increase the moisture zone by the upward water pressure. As a result of such action, the evaporation zone moves to the higher parts of the wall, which moves moisture from the plinth area to the ground floor walls area. Despite the substantial financial resources invested in the latest restoration materials, plinth parts are still exposed to moisture, eruptions and devastating effects of the crystallizing salt in the capillary rising water. The height of capillary action is often significantly enhanced. This happens due to the ignorance of the building physics by companies engaged in the restoration. The use of modern materials in the form of sealed plasters and paints reduces the diffusion process of water vapour. Tight materials (plaster, paint, foil, stone) on walls and plinths make evaporation impossible and as a result, the moisture which wants to evaporate moves to higher parts of the wall. The reason for this is the potential difference between the negative pole at the footings located in damp ground and the positive pole, which are the dry parts of the wall.

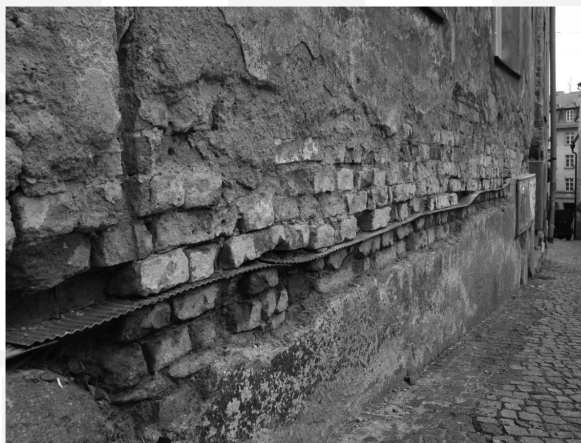
## 2. The cause and source of plinth moisture

Capillary transport of water occurring in the walls causes the moisture at their base. The most important causes of plinth corrosion are:

- the lack of horizontal ventilation,
- the lack of vertical ventilation,
- the lack of perimeter drain,
- the lack of peripheral ventilation,
- the lack of plinth ventilation.

The vast majority of historic buildings have never had horizontal insulation neither at the footings nor at the floor on the ground. When there is a high level of groundwater in the area of the modernized buildings, protection against destructive effects of water rises to the rank of a gigantic and costly undertaking. In most cases, the first step should be to reduce the said level of groundwater in the immediate vicinity of the modernized building by digging

drainage wells. These wells allow the land around the building to dry and to uncover the walls at the basement level in the ground with stable humidity, which then allows for the estimation of the structure of the walls below ground level. When no repair work without the knowledge of building physics had been carried out previously, there is no need to remove unwanted masses and materials, which did not fulfill their task of protection against water pressure. At the moment when the drain wells provide moisture stability in the ground and allow full control of the water which flows into them giving the opportunity to pre-dry the walls of the basement, the application of the methods of capillary action shutoff can proceed. One of the simplest and most effective methods is the segmental undercutting of foundation walls from the inside and from the outside in order to introduce sheet or plastic membrane (Ill. 1). Such methods are quite expensive as they require the use of the already mentioned wells, but they ensure full satisfactory protection against capillary action as one of the very few.



Ill. 1. Corrugated sheet drain membrane, Olomouc, the Czech Republic

Another cause of plinth corrosion is the lack of vertical isolation. After lowering the groundwater in modernized buildings, one can proceed to apply the correct vertical isolation after cleaning and drying the walls first. Before applying the waterproofing to the walls at the basement levels, they can be protected with a hydrophobic, or if necessary, fungicidal agent. A prerequisite for this type of work is the assessment of the load-bearing capacity and consistency of the walls as their coefficient could have been considerably reduced in the case of decay and corrosion of the material from which the walls are made. Correctly completed horizontal and vertical waterproofing allows to make further renovation work to improve the structure of the building and underground indoor climate. In both modernized and newly built buildings, particular attention should be paid to accuracy in the performance of the waterproofing layers while maintaining the instructional grace period in applying successive layers. The order and period of time of applying successive layers also applies to plaster, which is often forgotten by contractors. Precision and great care in the performance

of waterproofing is the basis of success in this type of repair work. Without proper and permanent supervision, all such work leads to the formation of moisture and consequently to fungus and corrosion of the material structure of the walls of underground floors. Failures of incorrectly performed waterproofing and improper supervision, both in the case of new and modernized buildings, cause destruction of plinths and basement walls. Consequently, this leads to a deterioration of the building aesthetics and reduction of its utility value due to the creation of a hostile environment in its underground interiors.

### 3. Ventilation of the plinth construction and space

A professionally made perimeter drain along with a backfill of thick rinsed stones up to the level where the plinth begins, should be an important supportive element complementary to correctly performed horizontal and vertical insulation (Ill. 2).



Ill. 2. Sandstone plinth in a new building with a rim of pebbles, Zurich, Switzerland

A well-made drainage enables to drain water from the close proximity to the foundations away to the well and the proper backfill of coarse pebbles allows for stable ventilation and reduction of water pressure on the vertical waterproofing layer. The thick pebbles allow for the ventilation of underground space around the waterproofing layer acting as a layer of perimeter ventilation around the basement walls (Ill. 3 and 4).

Peripheral ventilation is a known but often neglected additional layer of ventilation. An often committed executional mistake of using polyethylene damp-proof course as the only layer of waterproofing should be mentioned here. The dimpled membrane should never be treated as waterproofing. It constitutes of one of the layers accompanying waterproofing and is an integral part of peripheral ventilation. Together with a properly made backfill of pebbles in the collar of fleece or other geotextile, it is the basis for walls drying. Frequent absence of fleece as a sliding layer at the interface between the dimpled membrane and backfill ground, leads to creases and damage. This leads to a total loss of properties and limitation of the task which a damp-proof course was to perform as a vent membrane and not, as it is often mistakenly assumed, waterproofing.

Properly designed peripheral ventilation ensures the soundness of waterproofing, which protects the building from the harmful effects of capillary action and resilience of water from the ground for many years. Finely ground aggregate and fine sand or sandy gravel should never be used to perform a backfill while designing the peripheral ventilation layer.



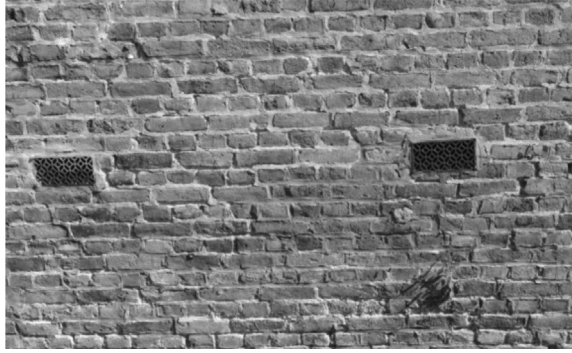
III. 3. Plinth of a new building with the rim of pebbles, Zurich, Switzerland



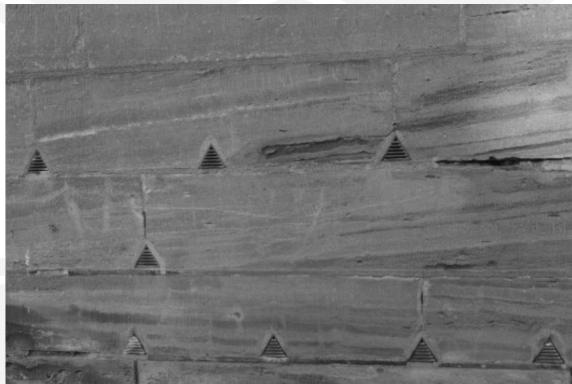
III. 4. Plinth of a new building with the ventilation rim of pebbles, Zurich, Switzerland

The first of these materials may damage the dimpled membrane and the others are factions, which retain moisture in their own layer for a long time, preventing the drying of the vertical waterproofing.

In view of the properly executed modernization of the building, in particular the part of the basement, plinth ventilation should be remembered. The said peripheral ventilation layer must be equipped with exhaust openings in the plinth construction (III. 5 and 6).



Ill. 5. Modernized plinth of an old tenement house  
(salt glazed decorative airbrick), Amiens, France



Ill. 6. Ventilated sandstone plinth of the modernized  
gothic cathedral in Bayeux, France

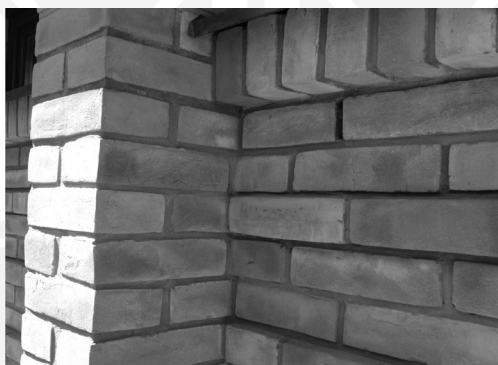
It often happens that a properly executed vertical and horizontal insulation assisted by the dimpled membrane does not guarantee the prevention of plinth corrosion. Moist air from underground layers gets into the higher parts of the plinth. Caverns beneath sandstone slabs (Ill. 7), of which old buildings plinths were usually made, fill up with moisture from the water vapour condensation in a year and lead to a change in the dew point of the wall.

There is flaking paint and plaster and salt efflorescence on damp walls. Moisture introduced into the wall structure is conducive to the formation of mould, the growth of fungi, mosses and lichens that destroy the structure of the plinths. Contemporary plinths are equipped with ventilation elements allowing for a significant reduction of the impact of manufacturing defects caused by ignorance of building physics. Many respectable contractors specializing in building renovation began to commission the monitoring of the layers of waterproofing, which did not provide plinths' protection, to be made correctly.





III. 7. Sandstone plinth. Eroded slab due to water vapour condensation, Olomouc, The Czech Republic



III. 8. New ventilated brick plinth in a monastery, Cracow-Mogila

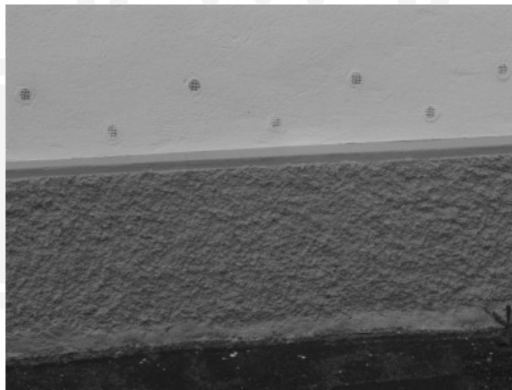
Thermal imaging studies have proved to be helpful in this type of work. They have shown the need for a modernized system of layers of warming in the plinth space with ventilation. Based on years of experience, it was found that the use of space allowing for the free flow of air with high moisture protects against plinth corrosion more effectively and significantly reduces the harmful effects of capillary action.

The study has also shown that properly constructed water insulation, with no outlet of moist air, can have an equally destructive effect on raising the level of moisture zones of walls and plinths. Thus, in the latest building projects (III. 8, 9 and 10) and modernization works of historic buildings (III. 5 and 6), ventilation systems under the plates and plinth elements are introduced. These systems permit some exchange of air, allowing for the free flow of air with high moisture. This shortens the process of evaporation as the moisture

does not have to extend towards the dry parts of the wall which are located high above ground level. Additionally, this allows for maintaining relatively moderate air pressure in the structure and the base plates, reducing the condensation, efflorescence and spatter zone.



III. 9. Plinth of a new building with vent, Martini, Switzerland



III. 10. Plinth of a new building with ventilation elements, Zurich, Switzerland

Peripheral ventilation with the exhaust elements in the plinth area does not limit and does not replace the need for waterproofing, but emphasizes that even well-made waterproofing does not guarantee the preservation of the aesthetic appearance of the plinth for many years.



#### 4. Thermal insulation of the plinth and tie beam above the basement

The increasing worldwide demands for thermal insulation of buildings showed numerous shortcomings at the junction of the building, ground and below the ground level. In most buildings, the use of basements as interior utility rooms with rational, functional, economic and technological solutions requires professional isolation: both waterproofing and thermal. Ground water, rain, capillary action, and often water spatter from streets and sidewalks devoid of drainage, contribute to the destruction of plinths in both modernized and newly constructed buildings. Lack of horizontal waterproofing, which did not exist in old buildings, has a destructive effect on construction tissue through the moisture of walls and consequently, the underground premises. In this way it contributes to the decline in the comfort of building usage. Leaving the building unsupervised in such a state for a longer period of time leads to a reduction in its construction value. The use of XPS waterproof extruded polystyrene thermal insulation boards, during a single assembly process, allows for the solution of many technical and engineering problems which used to trouble the builders, investors and users of objects with underground levels. Securing basement walls requires proper waterproofing. Due to the lack of one hundred percent supervision of backfill ground, the cover of XPS boards allows for full protection against punctures and mechanical damage to waterproofing. Another aspect of the use of XPS boards as a protective shield for perimeter waterproofing, is the creation of a stable environment with plus temperatures. Thus, the harmful effect on the waterproof layer is reduced, providing higher values of thermal conditions for moist air, allowing for its free flow in the backfill rim (Ill. 3). The use of XPS does not only act as x protective waterproofing, but it also allows for more efficient drainage of rainwater from the immediate vicinity of the building to the drainage system. The plinth area is an important element in the thermal protection of the building. Not only the physic-chemical aspects but also the aesthetics become particularly important in the case of a plinth as an architectural detail. STYROFOAM IB insulation boards become undeniably important in the insulation work due to significant aesthetic qualities and the problems associated with the proper performance of the insulation. Owing to their rough surface it becomes possible to provide adequate adhesion between the plinth base and the finishing material such as clinker, stone, resin plaster, etc. The boards are resistant to moisture and frost while maintaining complete thermal insulation properties allowing for stable and efficient implementation of plinth areas. Professional thermal and waterproof insulation of the plinth of a building, allows for comfortable health conditions in basement interiors through:

- reduction of water vapour condensation in the contact zone between tie beam and basement or foundation walls,
- reducing the temperature differences between the floor areas fitting tightly to the outer walls and areas adjacent to the inner wall (elimination of spontaneous gusts which are very unfavourable for the mental sensation of thermal comfort in the interiors).

Existing thermal bridges in uninsulated plinth area, decrease the surface temperatures of both walls and floors, thereby adversely affecting the comfort of people staying in the interiors. Due to faulty thermal insulation, further problems arise, such as uncontrolled condensation, dampness and mildew growth and cracks and corrosion in the longer term. Destructive symptoms in the plinth area reduce the construction value of the building in

a significant way, as well as its further technical condition, thus reducing the aesthetic values. Plinth area requires the use of materials with higher thermal insulation performance values from adjacent partitions, which is dictated by the specific geometry of the plinth node: the tie beam above the basement. Currently, it is recommended to use thermal insulation with higher parameters (higher ratio  $\lambda$ ) due to the future thermal insulation requirements to be met by the building. This may prevent thermal modernization in the future. Thermal insulation in the plinth area is exposed to ground moisture, rain, splashing water, mechanical pressures and impact, as well as humic acids. Therefore, the plinth area requires a special insulating material that will provide durable and effective solutions. STYROFOAM IB boards seem to be suitable for such applications as they are a very good solution in the plinth area. Long-time use of the above products in extreme conditions is the evidence for this. Specific construction of STYROFOAM IB boards predisposes them for use in aggressive environments of plinth areas. It is characterized by:

- closed cell structure, insensitive to moisture,
- high resistance and elasticity, resistance to mechanical,
- rough, specially shaped surface providing high adhesion for mortars, plasters and solvent-free adhesives.

Thermal insulation of the plinths should be an integral part of the overall concept of the thermal modernization of a building. Therefore, it requires a detailed study of the aspects of the connection of thermal insulation of plinths and peripheral thermal insulation of the building, including both the basement walls and floors above ground. The layer of thermal insulation of the plinth should extend at least 30 centimetres above the level of the surrounding terrain.

## 5. Conclusions

Repair of plinths corroded due to moisture, salinity and lack of ventilation in the construction space creates many problems in building physics and chemistry. The basic condition for the successful revitalization of the plinth is the selection of appropriate materials and technologies along with careful execution of repair works. An important element preceding restoration work should be drainage of basement or foundation wall structures by restoring or applying new layers of horizontal and vertical insulation. One should also note that the renewal of historic buildings in the plinth area requires and imposes a change in the conditions of temperature and humidity. Only professional repair work preceded by a preliminary chemical, temperature and humidity analysis together with permanent supervision can guarantee proper plinth repair. No signs of condensation, efflorescence and moisture in the plinths, allows for the adaptation of basement premises for office, residential and service areas, offering true aesthetic and functional foundations.

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