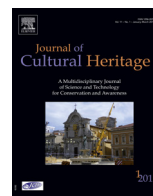




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MODIHMA 2018

New technique for treating rising damp in historical buildings: Wall base ventilation

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ARTICLE INFO

Article history:

Received 30 January 2018

Accepted 16 April 2018

Available online xxx

Keywords:

Rising damp

Rising damp treatment

Historical buildings

Wall base ventilation

ABSTRACT

Intervene in historic constructions increasingly requires extensive and objective knowledge of what one will be working with. The multifaceted aspect of the works needed on this kind of constructions tends to encompass a growing number of different tasks, with the imperative need to know the causes of many of the problems that affect these buildings and the possible treatments that can solve them. Moisture transfer in walls of old buildings, which are in direct contact with the ground, leads to a migration of soluble salts responsible for many building pathologies. We know that many of the techniques currently used to reduce rising damp are not much effective, when dealing with walls of considerable thickness and heterogeneous materials, as is the normal case of historic constructions. Bearing this in mind, a new technique to treat rising damp in historic constructions has been developed and patented in Portugal. The technique consists of ventilating the base of walls through a natural ventilation process or by installing a hygroregulated mechanical ventilation device. The process of development and validation of this new technique will be presented as well as the most recent studies to improve it. A detailed presentation of the diagnosis, design and works made on a historic building in the north of Portugal, will be done. Some system limitations and some corrections that needed to be performed will also be presented.

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1. Introduction

The action of moisture in buildings has been recognized as a factor of extreme importance, susceptible of leading to the occurrence of anomalies capable of impeding the full satisfaction of the most basic requirements of buildings habitability.

In fact, moisture often causes a decrease in the durability of materials and a change in some of their properties, such as a reduction in its structural resistance, and is perhaps one of the most important cause of deterioration of buildings. At the same time, it causes poor habitability and health conditions, which can significantly affect the users of the buildings, especially those ones intended for housing.

Moisture is an enemy that attacks constructions on all fronts, since it can be originated inside or outside and, in the latter case, its penetration into the inside can be through any one of the elements of the outer envelope or through the ground.

The pathologies associated with moisture in historic constructions can come from one of the following forms of manifestation: rain moisture, condensations, hygroscopicity, rising damp and fortuitous causes.

However, this ideal situation of the isolated occurrence of each of these forms of manifestation does not correspond to most of the cases. Indeed, it is common that two or more types of phenomena appear associated, either because there are favorable conditions to it, or because, in certain cases, some of them may be a consequence of others. This fact can substantially complicate the diagnostic process.

Hence, the great importance of a thorough knowledge of the different forms of moisture manifestation and its causes in order to avoid an incorrect diagnosis.

Rising damp depends on the following factors [1–7]:

- ambient climatic conditions (temperature and relative humidity);
- insolation;
- presence of salts;
- porosity and porometry of materials;
- wall thickness;
- nature of coating materials.

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1.1. Ambient climatic conditions

The climatic conditions of the environment condition the drying process and have a great influence on the level reached by the rising damp. In places with high relative humidity, evaporation will take place with greater difficulty and consequently there will be a greater progression of the wet front. On the contrary, when the relative humidity is low, evaporation will be maximum and the level achieved by the waterfront will be lower. The drying flow can be defined by the following expression:

$$g = \beta (Cs' - Ca')$$

where,

g - drying flux density [kg/(m².s)]

β - humidity superficial transference coefficient [m/s]

Cs' - concentration of water vapor on the surface [kg/m³]

Ca' - water vapor concentration in the air [kg/m³]

In historical constructions there does not exist a big difference between the temperature of the interior air and the temperature of interior surface of the walls, so the concentration difference ($Cs' - Ca'$) tends to be zero as well as the drying flux.

1.2. Insolation

In a construction that presents the same climatic conditions, different heights of progression of the wet front according to the geographical orientation, the insolation and the ventilation of the wall can be observed. The insolation and the absorption coefficient of the radiation change the surface temperature and the temperature distribution with consequences in the drying process.

1.3. Presence of salts

Another phenomenon that increases the rising damp is the presence of soluble salts in the ground and in the construction materials. What will happen in these situations is that the water during its capillary ascension will carry dissolved salts to higher levels. When the surface of the wall is reached, the water evaporates, the salts crystallize with increase of volume, are deposited there, progressively decreasing the size of the pores. This decrease in pore size will hinder the evaporation of water and a higher capillary rise will occur.

1.4. Porosity and porometry

The size of the pores influences the progression of rising damp, being higher the smaller the pore diameter. Hence, the porometry studies are interesting because they allow to evaluate the size of the pores [8].

1.5. Wall thickness and nature of coating materials

As it was already mentioned the rise of the water in a wall progresses to the level where the equilibrium between the water evaporated through the wall surface and the one absorbed from the soil by capillarity is verified. The thickness of the walls conditions the height reached by the rising humidity. The thickness of the walls conditions the height reached by rising damp.

1.5.1. Anomalies due to the presence of rising damp

The anomalies due to the presence of rising damp are characterized by the appearance of stains of humidity in the lower zones of the walls (near the ground), sometimes presenting eroded zones on top of these stains. These eroded zones can be accompanied by

efflorescence and may even have mold spots and parasitic vegetation, especially in poorly ventilated areas. When the level reached by these stains remains constant throughout the year and is aggravated on the interior walls we should be led to think that we are in the presence of water originating in the groundwater level. On the contrary, if the level reached by the humidity stains varies greatly during the year, decreasing substantially in the dry periods, and preferably reaching the outer walls, then we will be in the presence of surface water. In this second situation the eroded zones will have great extensions in height.

1.5.2. Treatment techniques against rising damp

When in presence of buildings where the right precautions were not taken and the presence of rising damp on the walls is confirmed, one of the following treatments can be implemented:

- execution of a damp-proof course;
- creation of a potential against the capillary potential;
- creation of atmospheric drains/ventilation pipes;
- hiding of the anomalies;
- wall base ventilation.

1.5.2.1. Execution of a damp-proof course. This type of solution is used, especially when the water source is the groundwater level. With these methods a damp-proof course at the bottom of the walls is created, so that rising damp is prevented. The solutions are: reduction of the absorbent section, introduction of water tight barriers, introduction of hydrofuge products.

1.5.2.2. Creation of a potential against the capillary potential. Electro-osmotic systems create an electrical potential contrary to the capillary potential. The water charged with salts (nitrates and sulphates) will move from the positive (terrain) pole to the negative pole (wall). Electro-osmosis will reverse this current. Its implementation consists in introducing into the wall a series of conductive probes connected to each other, which will function as an anode, and which will be in communication with a grounding that will act as a cathode [8].

1.5.2.3. Creation of atmospheric drains/ventilation pipes. Knappen imagined that if we introduce drains obliquely, in the humid walls, these would be filled with humid air, which being heavier than the dry air, would be replaced by this one and so the humid air from the wall would be continually being replaced by dry air.

1.5.2.4. Hiding of the anomalies. When we do not have objective conditions to eliminate the causes that are the origin of the rising damp, one can opt for the occultation of the anomalies, by executing a wall in the interior or by applying a coating with controlled porometry.

2. Wall base ventilation system

2.1. Description of the technique

Many of the techniques already described and commonly used to minimize rising damp have shown to be ineffective when referring to walls with considerable thickness and with a great heterogeneity in composition as is the case of historical constructions.

Many historical constructions in Portugal have already been subject to rehabilitation works aimed at nullifying, or at least minimizing, the effect of rising damp, nevertheless the results obtained have not been satisfactory.

In order to reduce the contact between liquid water and the construction elements one can create ventilated peripheral chan-

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