ANALYZING THE MOISTURE INFLUENCE ON THE BRICK WALL

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ABSTRACT
Air can move and transfer through the walls and infiltration or exfiltration in it. Passing through the wall, air is capable to move moisture as a water vapor and to store the amount of moisture into the wall. One of the most outcomes of the moisture influence into the wall is condensation. This can cause mold, rust and the corrosion of the material. As a result, it can create many problems to the building. The present study investigates the problems caused by the influence of moisture into the brick wall and offers solutions to control it. One way to avoid these problems is using air & vapor barrier in the exterior walls. The proper use of these layers in the walls can notably solve these problems. The simulation and evaluation of the wall in this study is based on the analysis of the output data by the software WUFI® pro.

KEY WORDS: *Moisture, Brick, Multilayer wall, Air & vapor barrier.*

I. INTRODUCTION

Moisture can have a devastating impact on the human health and the building components. This risk is not only relevant to the temperature, but also depends on Relative Humidity (RH) [5]. Due to the pressure difference between inside and outside, moisture can move into the exterior wall and in the saturation vapor pressure is condensed as well as leading to mold and corrosion in the materials. The amount of moisture, which is created by air flow and deposited into the wall, is usually much more than the vapor, which is transferred by diffusion process [1-5]. Besides the thermal problems, high moisture can lead to the destruction of the construction and the health risks to inhabitants [4]. When the input moisture content in the material assembly is greater than the amount of the output moisture, it accumulates in the wall [6]. The capacity of the materials to absorb moisture depends on the time, temperature and its properties. This capacity is very important in the determination of the wall performance [2]. The movement of the air and vapor diffusion transfers moisture from the interior and exterior into the wall. This amount depends on the climate and the indoor air condition. Air moisture is usually transferred from the warm to the cold and from more to less. In cold climate, air moisture by passing of the facade flows from the inside to the outside. But in humid climate it is transferred from the outside to the inside [3]. Designers and builders often overlook this fact, for an instance; the wall which is built in cold climates, it is implemented in the other regions [5].

1.1. Migration of water vapor: There is always some amount of water vapor in air and this amount generally is different in the interior and exterior space. Water vapor tends to move the places with more concentration to less. This leads to the movement of water vapor toward the boundary between indoor and outdoor [2]. In generally the movement direction of water vapor is from environment with high temperature to less [7].

1.2. Condensation of moisture due to air infiltration: Air exfiltration through the walls connecting with paper insulation can lead to the formation of dew and making frost on it. The repetition

sequentially and melting frost can damage the insulation. In the walls with enough insulation the dew point temperature of the interior air will be lower than the air temperature of the insulation. Therefore condensation due to air infiltration can't occur inside. So if the wall properly be designed, condensation due to air infiltration doesn't occur, even though no vapor resistance is considered in the materials assembly [6].

Fig.1. Component Assembly

II. PURPOSE OF RESEARCH

The main approach of the research is attention to the building durability against the moisture influence into the wall assembly. Therefore, the main purpose of the study is to help the health, durability, sustainability and the preservation of the building's performance.

III. METHODOLOGY

In this study to analyze and evaluate the wall details and also the migration of moisture and its influence into the wall, the software *WUFI® pro* has been used. This software is capable to analyze the wall layers and also the whole structure for moisture and water absorption. In this method, the brick wall is simulation, graphically analyzed and determined the weaknesses against moisture. Therefore the methods are offered to promote the wall against moisture.

IV. DISCUSSIONS AND RESULTS

The results show, the influence of moisture and water absorption into the wall can lead to the irreversible harm to the buildings. In addition to causing health problems, moisture can damage building materials and components. These results are as follows:

- Brick damage during freeze-thaw cycles and by sub-surface salt deposition.
- Dissolving water-soluble building materials (e.g., gypsum board)
- Increase energy consumption due to the reduction in the wall resistance thermal
- colonization of building materials and HVAC systems by molds, bacteria in the prolonged damp conditions
- Metal corrosion and erosion of anchor

V. CASE STUDY

The brick wall with two layers is studied. The materials have been used in the wall construction are: bricks as a main structure and gypsum board as the final interior coverage. The reason for the

selection of this wall is the most extensive usage in the construction in Iran. The final thickness of the wall is 25 cm and the thermal resistance is 0.67 m2k/ w Fig. 1. The calculation time has been considered 1 year, the interior temperature 21 ° and the maximum Relative Humidity 60%.

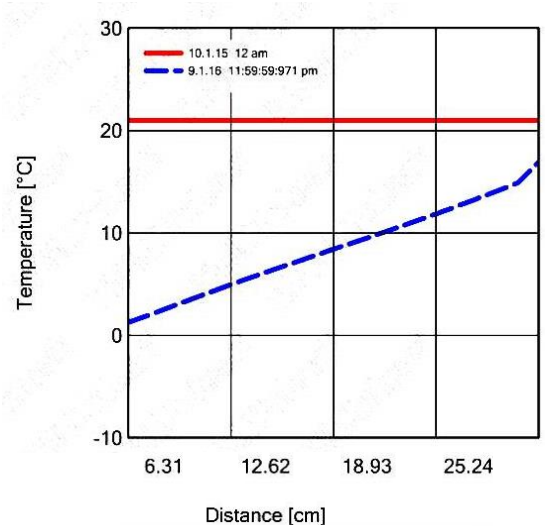

Fig. 2. Temperature changes

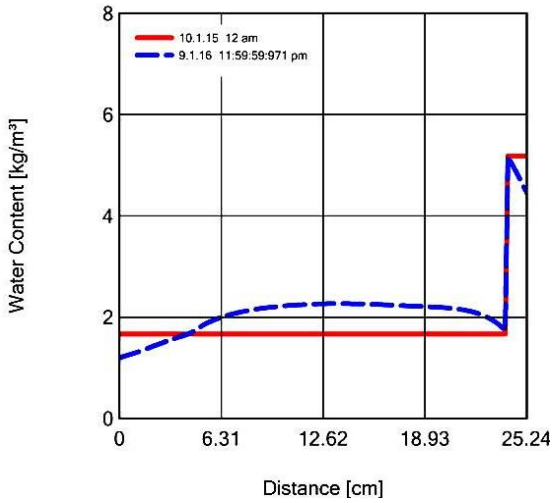

Fig.3. Amount of absorbed water

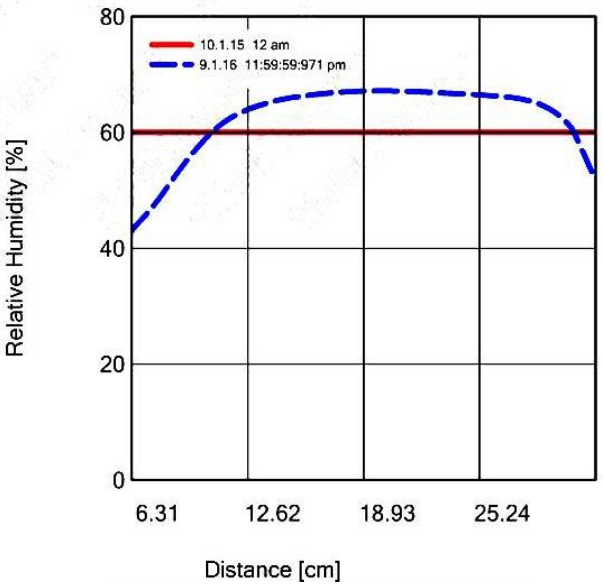

Fig.4. Relative Humidity

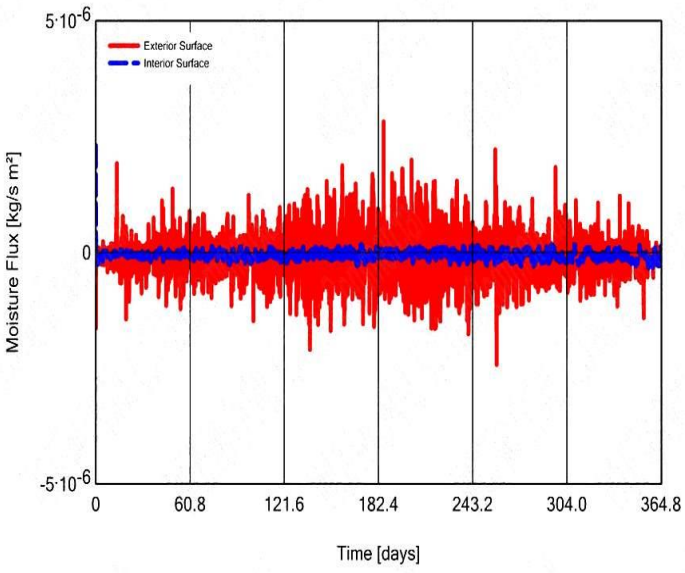

Fig.5. Moisture Flux

Table2. Amount of absorbed water in the materials [kg/m^3]

Layer/Material	Start	End	Min.	Max.
Brick	*1.67*	*2.02*	*1.15*	*2.04*
Interior gypsum Board	*5.18*	*4.84*	*3.91*	*5.77*
Total Water Content [kg/m^2]	*0.47*	*0.54*	*0.33*	*0.55*

VI. ANALYSIS

According to the simulation; due to the influence of moisture into the wall, heat capacity (**HC**) and as a result, thermal resistance (**TR**) of the total materials has been decreased. This reduction is relevant to the moisture absorption through air flow and liquid flow in the wall. In the distance of 4 cm from the outside of the wall, the level of relative humidity (**RH**) has been increased more than the allowed levels. According to Fig.2 it has been shown that, in the distance of 4 cm from the wall thickness, the temperature is below 5 ° C. So as a result, condensation will occur in this place. This mode in the winter by the subsequent melting and freezing of the moisture will damage façade's materials. In Table 1 has been shown, the rate of the absorbed water and relative humidity in the materials and in the total wall has been increased during the year. The most increase is in the gypsum board with 5.77 kg / m^3 and relative humidity over 60% (more than the allowed level). This increase is clearly visible in Fig.3 and Fig.4. In Fig.4 has been shown the dramatic increase of the relative humidity in the distance of 4 cm from the wall thickness. The increase of the relative humidity in the wall will lead to the condensation into the total material; therefore the amount of the absorbed water in the material will be increased, Fig.4. This leads to the increase of the energy consumption as well as reducing the longevity of the materials and building. Also the absorbed water in the wall materials provides a suitable environment for the growth of fungi and mold. As seen in Fig.5 the moisture flux in the interior surface has been increased and it can lead to the mold and the growth of bacteria as well as increasing the energy consumption.

VII. CONCLUSIONS AND RECOMMENDATIONS

In this paper, after introducing and analyzing the problems of the moisture influence into the wall and buildings, suggests that if the multilayer wall is used instead of the common brick wall, it reduces the energy consumption, increases the longevity, sustainability and durability of the building materials as well as providing the inhabitants' health. Added layers in the multilayer wall consist of the thermal insulation and air & vapor barrier. These layers help the wall to resist to the air and moisture influence as well controlling the energy consumption. The thermal insulation is usually placed on the back of façade's material due to the reduction of the heat loss as well as moving the condensation place to the outside. In order to the prevention of the air and moisture infiltration, air &vapor barrier layer is offered on the back of thermal insulation. The selection of the place is due to the high level of the water absorption in the brick. Also it is offered to use vapor permeable material on the interior surface to control and reduce the moisture flux. Future studies can be about the control of moisture in other materials and enclosures.

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