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# Analysis of the moisture content of masonry walls in historical buildings using the basement of a medieval town hall as an example

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## Abstract

The paper concerns the issue of analysing the moisture content of thick masonry walls in historical buildings. The research methods, including non-destructive methods, which are useful in the assessment of such objects, were first indicated. Then, the exemplary results of tests conducted in the basement of a medieval town hall with the use of some of the previously mentioned methods were presented. Based on the authors' own research, the developed correlative relation between the mass moisture of brick walls in the analysed building and the dimensionless parameter which was measured using the non-destructive dielectric method was also presented. This relation was used to assess the mass moisture of brick walls in this building. It can also be successfully used for non-destructive testing of the moisture content in walls of other buildings dating back to the turn of the XIV/XV century.

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**Keywords:** historical buildings; walls; mass moisture; moisture content testing methods.

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## 1. Introduction

The masonry walls of historical buildings - made of ceramic brick or stone - are often characterized by a high thickness and a lack of damp insulations. It refers primarily to horizontal insulations, which began to be executed in a modern way at the beginning of the twentieth century. The lack of damp insulations causes direct and prolonged contact of a wall with the ground. As a result, water molecules that are contained in the substrate along with salts

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dissolved in them penetrate elements of the masonry wall making it damp. These elements are both ceramic brick and mortar from joints, and in walls made of stone these joints are usually of a large width.

Capillarity, the process of which was described inter alia in [1,2,3], causes water molecules to be transported into the wall and into its higher parts. In the case of a masonry wall with a large thickness, from which evaporation of moisture is naturally difficult, the degree of moisture content gradually increases with time. Table 1 shows the degrees of moisture content of masonry walls acquired in literature [4,5].

Table 1. Degrees of moisture content of masonry walls in relation to the value of mass moisture content [4,5].

Degree of moisture content	Mass moisture content [%]
I – masonry wall with permissible moisture content	0 - 3
II – masonry wall with elevated moisture content	> 3 - 5
III – medium damp masonry wall	> 5 - 8
IV – very damp masonry wall	> 8 - 12
V – wet masonry wall	> 12

The effect of long-term and excessive moisture in a masonry wall is, among other things, susceptibility to frost erosion which progresses with time and in consequence, the chipping of fragments of bricks and mortar, as well as the crystallization of salts. These processes cause the gradual reduction in the strength of a wall, reduction of its cross section and also its load bearing capacity [4,6,7].

## 2. Methods of testing the moisture content in the masonry walls of historical buildings

In historical buildings, actions against the process of masonry wall destruction are often only taken when there is a need to bring back the utility value of an object. One of the first actions that aims to restore the former glory of a building object should include the execution of moisture content tests of masonry walls and the determination of moisture distributions along their height and across their thickness with regards to the quantitative approach. The non-destructive methods which are recommended for these tests [4, 5, 8] enable measurements to be carried out in any number of places, at multiple times and at different times and also without damage to the historic tissue. Support using destructive methods is usually necessary, however, the amount of tests made in such a way should be kept to a minimum. Figure 1 summarizes the methods of testing the moisture content in masonry walls that are accepted in cases of historical objects.

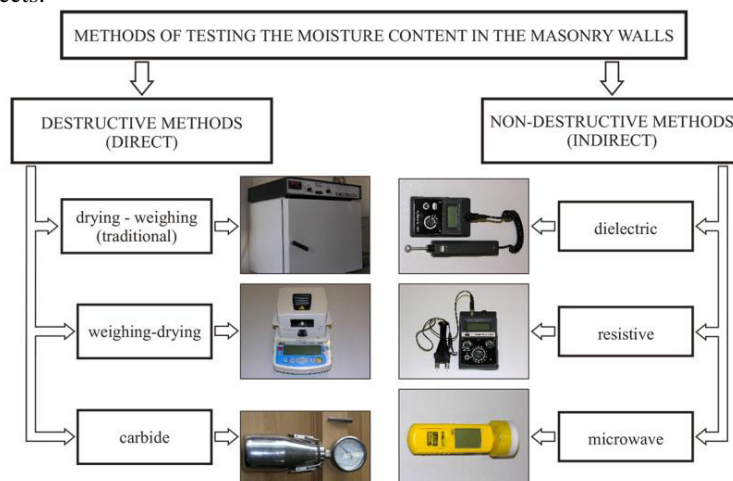


Fig. 1. Methods of testing the moisture content of masonry walls that are accepted in cases of historical buildings.

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