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THE PERMEABILITY ANALYSIS IN CASE OF TUFF AND LIMESTONE ADDITION IN THE CONCRETE COMPOSITION

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1. INTRODUCTION

Concrete is currently the main material used to execute the structural elements of the constructions with the most varied destinations: civil, industrial, communication paths, bridges, etc. Construction concrete is a heavy material, which requires a certain composition, depending on the demands and the conditions of exposure. Because the concrete has to withstand mechanical and environmental actions, it must have a high compactness; this determines both the behavior corresponding to mechanical actions, as well as limiting the adverse effects that the environment exerts on the concrete - through properties that ensure its durability. Given the functions that the concrete performs for a construction, it must meet the following conditions:

a) strength conditions determined by various load groups, depending on which the structure calculation is performed;

b) conditions of durability, which refers to the ability of the concrete to withstand the action of environmental factors, maintaining its quality within predetermined limits, during a normed period of time [1].

Concrete strength is usually considered to be the most important property of the concrete, although there are many cases where other characteristics such as permeability, freeze-thaw resistance, corrosion resistance, etc. can be more important. From the point of view of designing and making concrete mixtures according to the regulations in force, the strength of the concrete gives it a complex image of its quality, which reflects both the properties imposed on the design and made in execution, as well as its quality of being durable.

The durability of the concrete is its ability to perform the functions for which it was designed, keeping its characteristics under the action of environmental factors and as a result of the internal changes of the structure, during the entire period of operation [2].

The poor behavior from the point of view of the durability of the concrete can be determined by: external causes - the environment in which the concrete is exposed, and internal causes - from the mass of the concrete. External causes may be physical, chemical and / or mechanical in nature. Under extreme conditions of operation, the extent of the degradation caused by external factors depends largely on the quality of the concrete and any additional protection measures, than that provided by the structure and composition of the concrete. Internal causes may be: alkali-aggregate reaction, volume variations caused by the differences in properties of the aggregate and cement paste, the permeability of the concrete. Of the internal conditions, the permeability certainly determines, to a large extent, the vulnerability of the concrete in contact with the external agents, so that, in order for a concrete to be durable, it must correspond to a certain level of impermeability [3].

The objectives pursued in this research were: to reduce the cement consumption for concrete with durability requirements from the permeability point of view, respectively their composition with minimal technological and composition costs, as well as the use of additions (tuff and limestone) and the research of their influence on the improvement of the permeability behavior of concrete. There were designed two types of concrete compositions with different degrees of permeability, namely P_8^{10} and P_{12}^{10} as reference concrete compositions and eight experimental concrete compositions with tuff in 6% and 10% of the cement quantity and with limestone in the same proportions. These concrete compositions were tested for the permeability measuring.

2. MATERIALS AND METHODS

In the present work, a C12/15 concrete class was made as a reference concrete (RC) according to [4], in two variants from the point of view of permeability: a variant noted with A, having the permeability class P_8^{10}, and a variant noted with B, having the permeability class P_{12}^{10}. To determine the capillary rise of water in the types of concrete analyzed, three replicates were made for each concrete recipe separately. The value taken in the analysis for each concrete recipe was calculated as the arithmetic mean of the three determinations.

The concrete recipes developed for this research involved the use of 6% and 10% addition of tuff and limestone, respectively, from the amount of cement used in the control recipe. The concrete compositions developed were noted as follows:

RC – reference concrete,
TCA6% - concrete of P_8^{10} permeability class and with 6% tuff,
TCA10% - concrete of P_8^{10} permeability class and with 10% tuff,
LCA6% - concrete of P_8^{10} permeability class and with 6% limestone,
LCA10% - concrete of P_8^{10} permeability class and with 10% limestone,
TCB6% - concrete of P_{12}^{10} permeability class and with 6% tuff,
TCB10% - concrete of P_{12}^{10} permeability class and with 10% tuff,
LCB6% - concrete of P_{12}^{10} permeability class and with 6% limestone,
LCB10% - concrete of P_{12}^{10} permeability class and with 10% limestone.

The method of determining the permeability to water was that according to the [4].

Due to the adsorption of water on the pore walls, the water permeability of the concrete was determined by pores larger than 0.5 mm in size, pores forming the so-called effective porosity of the concrete.

The permeability of the concrete is expressed by the degree of impermeability. The degree of impermeability represents the water pressure (n, in bars) at which it penetrates the maximum permissible depth (x, in cm) in the concrete structure. The allowed permissible depths of water penetration in concrete have the following values: x = 10 cm, for liquid containers and for building elements exposed to freezing, or to chemical corrosion; x = 20 cm, for the other cases.

3. RESULTS AND DISCUSSIONS

Analyzing the concrete recipes with P_8^{10} permeability class, from figure 1 it can be observed that the tuff and limestone addition decreased the permeability of the reference concrete with around 4% in the case of LCA6%, 6% in the case of TCA6% and 7% in the case of LCA10%. The best result was obtained in case of TCA10%, with around 11% smaller than RC.

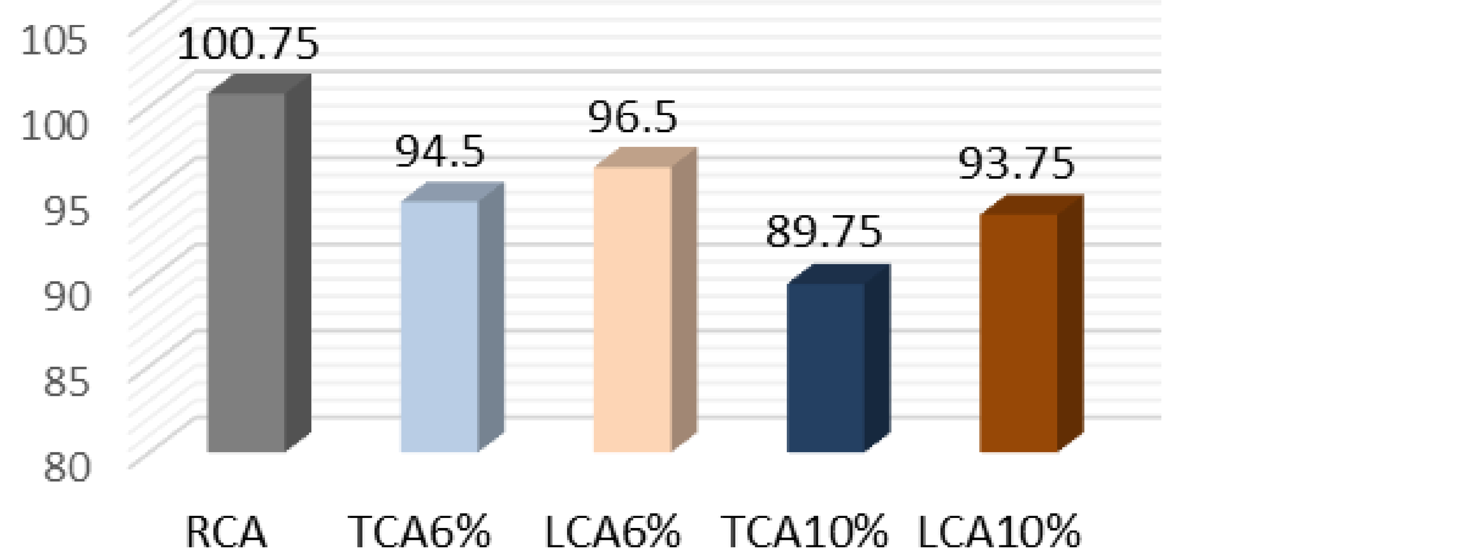

Fig. 1. Water ascension height in the concrete samples with tuff and limestone, respectively, in the case of P_8^{10} permeability class [mm]

For the concrete recipes from P_{12}^{10} permeability class, figure 2 reveal that the results were with 2.48% and 3.47% smaller in case of TCB6% and LCB6%, respectively. In the case of using 10% of pozzolanic materials addition, tuff and limestone registered the same results.

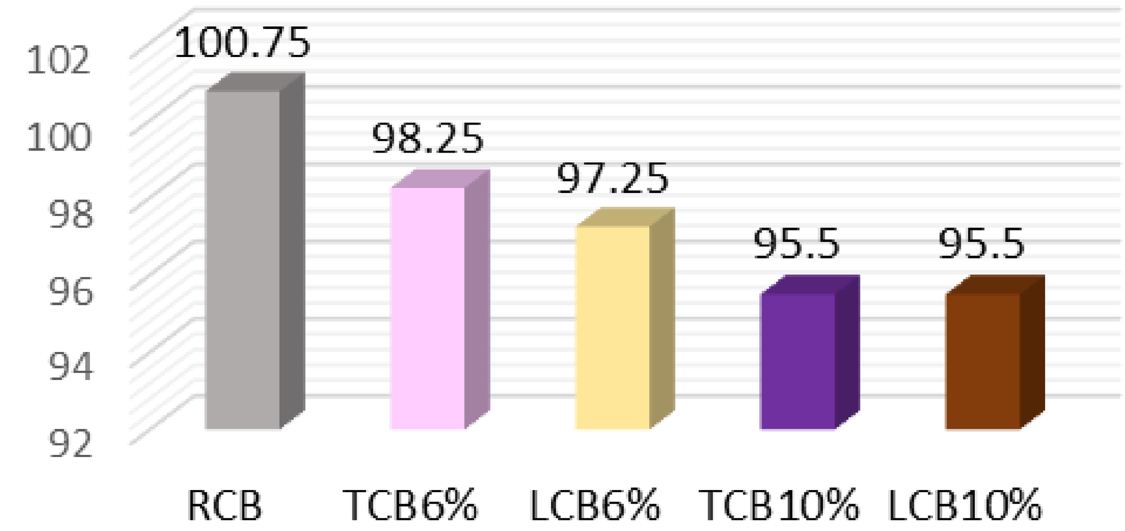

Fig. 2. Water ascension height in the concrete samples with tuff and limestone, respectively, in the case of P_{12}^{10} permeability class [mm]

If there are analyzed all the concrete recipes with tuff addition, according to figure 3, it is observed that the recipes with the P_8^{10} permeability registered the bigger decrease of this parameter and the higher amount of tuff addition, bigger the difference comparing to RC.

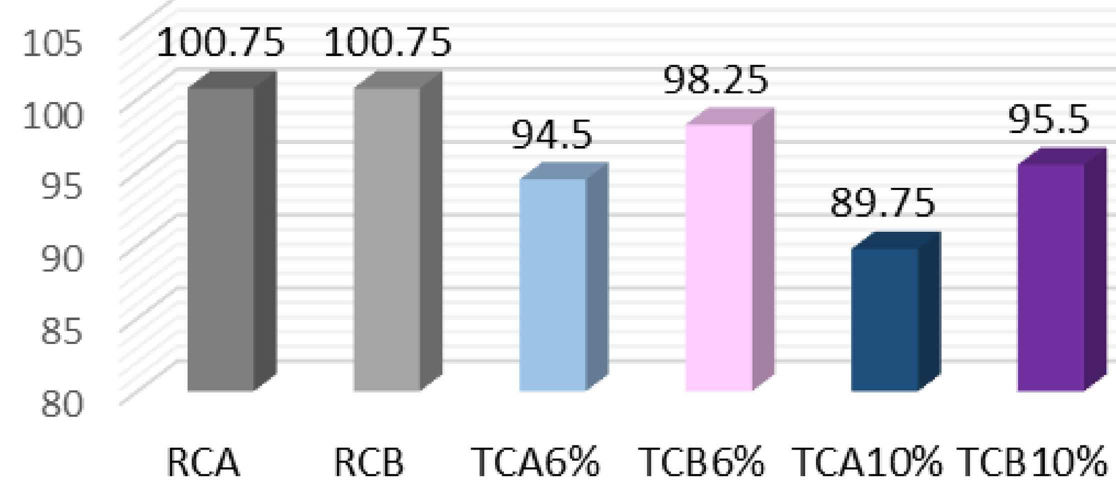

Fig. 3. Water ascension height in the concrete samples with tuff, in the case of P_8^{10} and P_{12}^{10} permeability classes [mm]

As regard of limestone addition, the best results were obtained also in the case of P_8^{10} permeability classes and the higher amount of limestone addition, the bigger the difference comparatively to RC (figure 4).

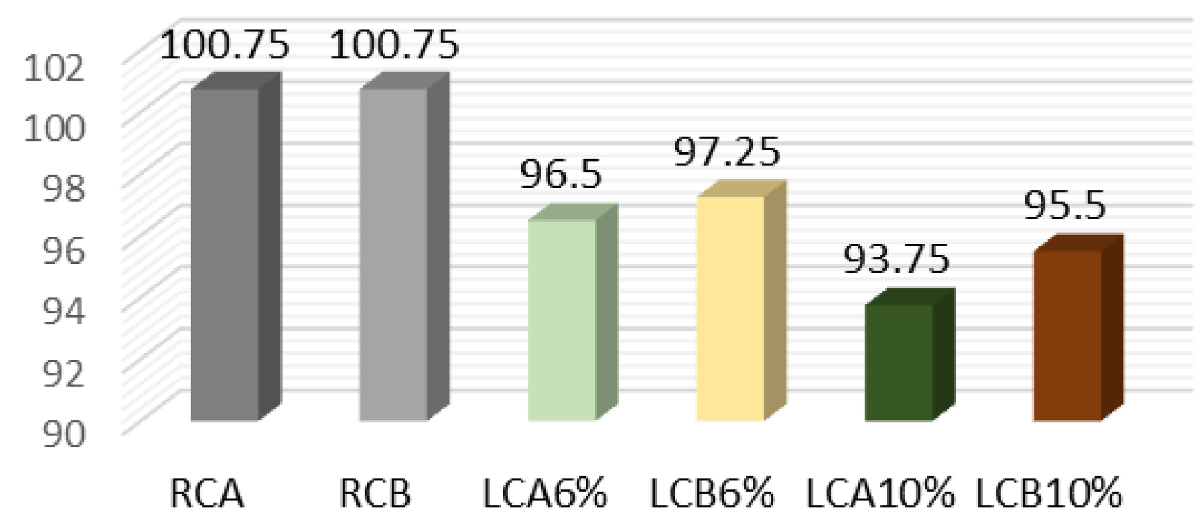

Fig. 4. Water ascension height in the concrete samples with tuff, in the case of P_8^{10} and P_{12}^{10} permeability classes [mm]

4. CONCLUSIONS

As a general observation, the addition of tuff or limestone into the concrete composition led to the decrease of its permeability. Better results were obtained by tuff in case of the P_8^{10} concretes, especially when 10% of the cement was replaced by this pozzolanic material. In the case of P_{12}^{10} concretes, tuff and limestone registered same results in case of 10% addition.

References:

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