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RESEARCH ON SAND-LIME PRODUCTS REGARDING THEIR PHYSICAL AND MECHANICAL FEATURES

A b s t r a c t

In this article, the main goal of conducted experiments was focused on determination of physical and mechanical features of examined sand-lime building blocks and how they interact with each other. The experiment was conducted using solid sand-lime bricks of 250 x 180 x 220 mm size of the class 15 as well as modified products of the same size but different structure.

The investigation covered different kinds of fillers. From the preliminary technical and economical analysis we may state that the best ones are barite, basalt, hematite and magnetite.

Keywords: Sand-lime brick, acoustic isolation, fillers, basalt

1. Introduction

Sand-lime products are used as an engineering material of ultimate compressive strength. They are completely natural. Their main ingredients are: sand, lime and water. They are environmentally friendly. Sand-lime bricks are popular in many countries e.g. Scandinavia, Germany, the Netherlands, France, Italy, Spain, Great Britain or Russia. Moreover, thanks to their considerable weight, they are characterised by high acoustic isolation [1, 2].

Due to their strong alkaline reaction, sand-lime bricks are resistant to biological corrosion in closed places. They provide friendly climate and protect against the spread of mould and bacterial flora. They also posses very good features regarding the thermal building regulations. It is due to their ability to accumulate heat and humidity.

Based on current standards (PN-EN 772-9, 10, 11, 13, 18), various hypothesis have been formulated. They became the basis for further research on sand-lime products. One of them was formulated, if weight modification of a sand-lime product (without changing its capacity) will cause major improvement of both physical and strength features.

Another important aspect of sand-lime products is acoustic isolation (apart from water absorption, humidity, density and soaking). But the acoustic isolation clearly depends on the structure and material used. Heavy dams ensure sound absorbance. However, it is not related to dimensions of walls, but to the weight of that kind of dams. Very important is the weight possessed by used material per 1 m^2.

Another question to be answered is, if the infringement in product's structure which considers an insertion of fillers into sand-lime production had any impact and what their influence on physical parameters and strength features of modified units is. Another question to be investigated was, if an insertion of fillers into the sand-lime has an impact on physical parameters and durability of modified units.

It is commonly known, that sand-lime products belong to a group of materials characterised by very good acoustic isolation. Therefore, any interference with their inner structure (by various kinds of fillers) may cause formation of new structures and bonds. They may have an impact not only on interaction between the of certain units and its structure as a whole. That involves works on that involves the tightness and porosity of the material. They determine most of the features such as for example: ultimate compressive strength, acoustic isolation and frost-resistance.

It may happen that improvement of one of those features may cause deterioration of others. Therefore, it is necessary to consider if it is appropriate to interfere with anything that is fine and completely natural.

In this article, the aim of conducted experiments was focused on determination of physical and mechanical features of examined sand-lime building blocks. Also, how they interact with each other.

2. Examination of sand-lime products

The experiment was conducted using solid sand-lime bricks of 250 x 180 x 220 mm size of the class 15 as well as modified products of the same size but different structure.

The preliminary technical and economical analysis determined that among different kind of fillers used to improve physical and mechanical properties, the best ones to use are: barite, basalt, hematite and magnetite. It is because of the density of the final product, which is very significant.

Based on previously mentioned norms, numbers of samples were chosen for every stage of the research. Sand-lime products were subject to following tests:

- determination of water absorption caused by a capillary pull of building blocks,
- determination of humidity of examined sand-lime products,
- determination of weight of sand-lime building blocks,
- determination of impregnability of sand-lime units (water absorption with complete immersion into water).

Durability test has also been done. It is considered to be the basic mechanical feature.

Some of used aggregates are characterised by high hardness. These materials poses the hardness of 8.5 on the Mohs' hardness scale. That explains their wide usage in civil engineering. Consequently, we can deduce, that hardness of a solid depends on the energy bonds in their structure. Therefore, we used basalt aggregate of the 2-4 mm fraction. Considering that 36% (M2) and 48% (M1) of its contents will be used in the mixture of the product.

3. Research analysis

The chart above shows the relation between ultimate compressive strength and water absorption corresponding to different types of sand-lime products. The experiment proves that original sand-lime building blocks (S) are characterised by much higher water absorption that those modified (M1 and M2) (Fig. 1). This is clearly seen in the chart above. Therefore, it is appropriate to state that inner modification of the material structure, contributed to significant and proportional decrease in water absorption; and to increase in compressive strength. The analysis showed, that original sand-lime bricks were completely wet due to a capillary pull, whilst those modified were half-wet (where h = 18 cm).

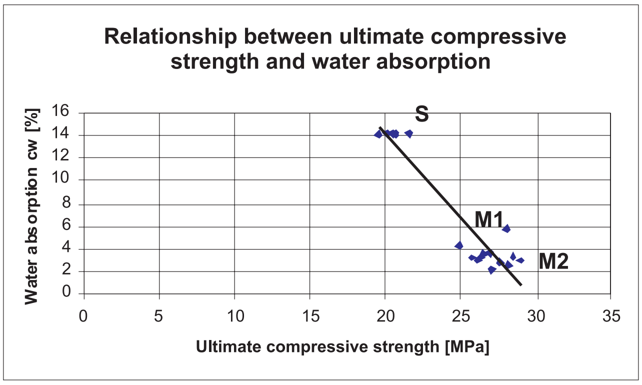

Fig. 1. Relationship between ultimate compressive strength of sand-lime products and their water absorption

Humidity test (Fig. 2) for sand-lime products proved that sand-lime building blocks of an original and intact structure (S) show proportionally lower humidity than those modified (M1 and M2). That is undoubtedly is related to the filler used. However, the difference is insignificant. Therefore, we can't state as yet, if the further increase in both of those parameters will cause refraction of the straight line.

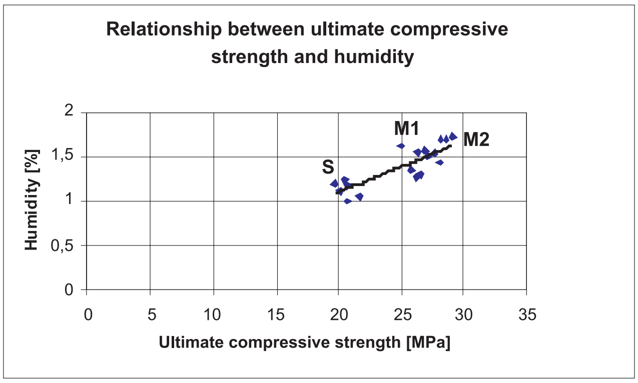

Fig. 2. Relationship between ultimate compressive strength of sand-lime products and their humidity

Due to modification in the original structure of a sand-lime product through insertion of the aggregate, impregnability of the product has improved (Fig. 3). When immersed in water, the modified material (M1 and M2) possessed proportionally lower water absorption, as compared to original sand-lime products (S). The latter one absorbs more water considerably faster (due to the capillary pull). But, consequently, the water is absorbed from the whole surface. Thus, it has the negative impact on mechanical features of these products.

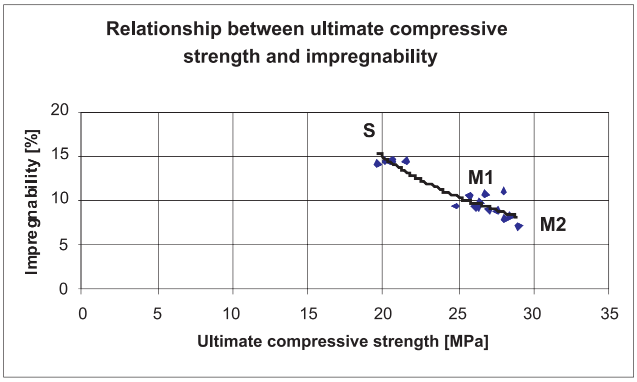

Fig. 3. Relationship between ultimate compressive strength of sand-lime products and their impregnability

Insertion of an aggregate of density from 2.70 to 3.2 T/m^3 caused weight increase of a "new" product. Higher density of sand-lime products led to improvement of their ultimate compressive strength. That was the objective of yet another experiment. Commonly, sand-lime bricks are class 15 product. Endurance test allowed to place the modified sand-lime products into a higher class (Fig. 4).

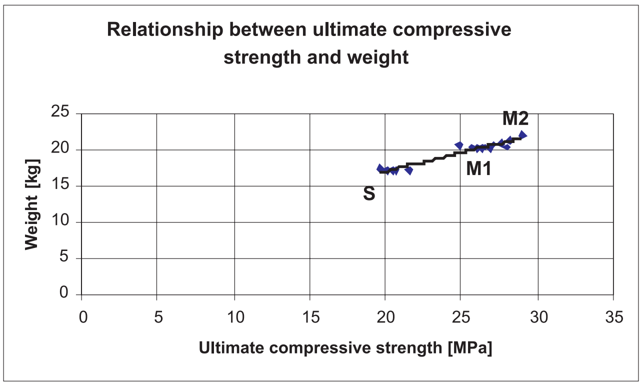

Fig. 4. Relationship between ultimate compressive strength of sand-lime products and their weight

Modification in a structure contributed to improvement of mechanical features mentioned above. But higher weight of an element with following higher density of a product has an impact on improvement of sound absorbance of sand-lime products as well.

Thanks to insertion of basalt aggregate in the production of sand-lime building blocks, it is possible to estimate the annual costs of production. And that may be very cost-effective for the mass production.

Original sand-lime products (S) with lower humidity, absorbed significantly more water due to a capillary pull than modified products (M1 and M2) (Fig. 5). Units with modified structure feature slightly higher humidity as compared with original units. But their absorption is much lower. This undoubtedly has an impact on the quality of a material.

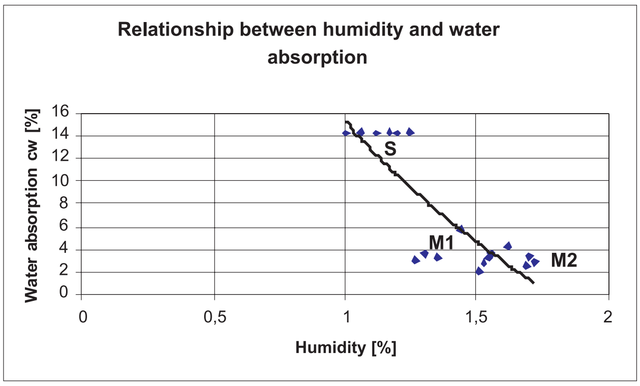

Fig. 5. Relationship between humidity of sand-lime products and their water absorption

The above curve represents the relationship between the two physical features: humidity and absorption. From the interpretation of this curve can be seen, that the higher is the humidity, the lower impregnability of the element (Fig. 6). Original sand-lime products (S) have usually higher humidity than those modified (M1 and M2). That is certainly related to an aggregate used.

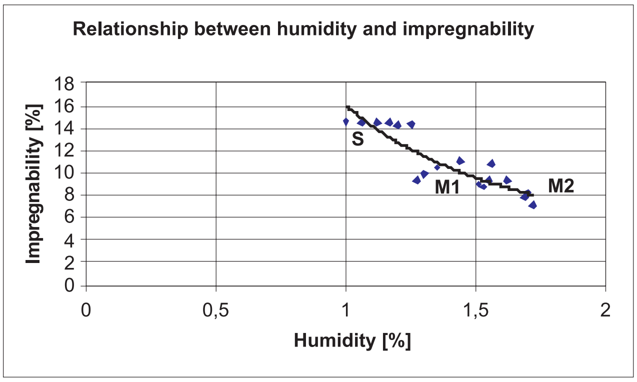

Fig. 6. Relationship between humidity and impregnability

4. Conclusions

1. Modification of the structure of sand-lime products had a positive impact on improvement of some of its physical features. These are: water absorbency, impregnability and density.
2. Humidity of a "new" sand-lime product was a little higher due to insertion of a filler. The filler was the basalt aggregate.
3. Higher humidity caused a decrease of impregnability. It significantly limited capillary pull of units at the same time.

4. Modified products showed higher ultimate compressive strength as compared to their original equivalents.
5. Higher weight of a sand-lime product, without any changes of its capacity, caused improvement of both: physical and durability features.

References

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Badania wyrobów silikatowych pod kątem poprawy ich cech fizykomechanicznych

1. Wstęp

Wyroby silikatowe są materiałem konstrukcyjnym charakteryzującym się znaczną wytrzymałością. Silikaty to produkty całkowicie naturalne, których składnikami są: piasek, wapno oraz woda, a więc są przyjazne dla środowiska naturalnego. Na szeroką skalę stosuje się je między innymi w krajach takich jak: Niemcy, Skandynawia, Francja, Włochy, Hiszpania, Holandia, Wielka Brytania czy Rosja. Ich duża masa sprawia, że odznaczają się wysoką izolacyjnością akustyczną.

2. Zakres i metodyka badań

W przedstawionym artykule celem przeprowadzanych doświadczeń jest określenie właściwości fizykomechanicznych badanych elementów silikatowych i ich wzajemne oddziaływania podczas ich modyfikacji. Eksperyment przeprowadzono na pełnych silikatowych elementach murowych o wymiarach: 250 x 180 x 220 mm, klasy 15 oraz na wyrobach modyfikowanych, o tych samych wymiarach, ale innej strukturze.

Wstępna analiza techniczno-ekonomiczna wykazała, że spośród różnego rodzaju wypełniaczy dla polepszenia właściwości fizykomechanicznych najkorzystniejsze będzie zastosowanie między innymi: barytu, bazaltu, hematytu, czy magnetytu. Istotną rolę odgrywa bowiem gęstość końcowego produktu.

Silikaty poddane były następującym próbom:

- określenie absorpcji wody spowodowanej podciąganiem kapilarnym elementów murowych,
- określenie wilgotności badanych silikatów,
- określenie masy elementów silikatowych,
- określenie nasiąkliwości elementów silikatowych (absorpcji wody przy całkowitym zanurzeniu wyrobów w wodzie),
- określenie wytrzymałości na ściskanie.

W związku z powyższym dla naszych badań eksperymentalnych wybrane zostało kruszywo bazaltowe o frakcji 2-4 mm we wstępnie założonej 36% i 50% jego zawartości w masie wyrobu.

3. Wnioski

1. Zmiana budowy wewnętrznej wyrobów silikatowych korzystnie wpłynęła na poprawę takich cech fizycznych, jak: absorpcja wody badanych wyrobów, nasiąkliwość i ich gęstość.
2. Na skutek dodania do produkcji elementu wypełniacza, jakim było kruszywo bazaltowe, wzrosła nieznacznie wilgotność „nowego" silikatu.
3. Wzrost wilgotności spowodował równocześnie zmniejszenie nasiąkliwości i znacznie ograniczył podciąganie kapilarne elementów.
4. Modyfikowane produkty wykazały zwiększoną wytrzymałość na ściskanie w porównaniu z ich tradycyjnymi odpowiednikami.
5. Zwiększenie masy wyrobu silikatowego, bez zmiany jego objętości spowodowało polepszenie właściwości zarówno fizycznych, jak i wytrzymałościowych.