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COMPARABLE PROPERTIES OF SOME BUILDING MATERIALS

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Introduction

The building quantity in Latvia in the last years increases very sharp, wherewith the also increases demand after progressive good quality building materials. It will be alternate design of building materials and all positive and negative properties be known. Each one material has own preferential and own disadvantage. On the cement based heavy building materials, ie. different concrete have good mechanical properties, high thermal conductivity and bad balance moisture. Lightweight concrete such as expanded clay concrete and aerated concrete have lower mechanical properties, good thermal insulating properties, but high balance moisture. Lightweight ceramic materials have good thermal insulating and plenty mechanical properties and balance moisture. The balance moisture is important property for the building materials used in living houses. Humidity absorption and release properties are closely related to pores of the order of 0.01 μm [1-3].

Experimental

There are investigate various commercial building materials such as ceramic bricks, sand-lime bricks, ceramic blocks "Keraterm", aerated concrete, expanded clay concrete, concrete blocks. Following properties: water uptake, kinetic of water uptake, balance moisture in the saturated water vapour atmosphere, thermal conductivity of dry material and material with balance moisture content is determined. Pore size distribution by mercury porosimetry (Autopore IV) is established.

Ceramic samples of different Devonian and Quaternary clays are prepared by semi-dry powder pressing and fired in laboratory furnace at temperature 1000^{0}C. The kinetic of water uptake and balance moisture in the saturated water vapour atmosphere at different temperature (0-6^{0}C, room temperature and +34-36^{0}C) are compared.

Water uptake kinetic by weight growth of immersed in water samples were carried out after 1, 2, 3, 4, 5, 10, 20, 40, 60, 90 min. that after 72 hours and water uptake as water amount per volume (g/cm^3) are calculated. Balance moisture of samples characterizes water content in percent from dry sample weight.

Results and discussion

Kinetic process of water uptake is similar for all sample produced in laboratory: water uptake is more intensive in the first 15-20 minutes. In the following time water uptake is slowly. The absorbed water amount depends on the mineralogical composition of used clay. The water uptake of Quaternary clays ceramic is higher such as Devonian clay ceramic. The quantity of absorbed water in fired sample of Quaternary clays is 0.22-0.32 g/cm^3, but in fired sample of Devonian clays it is 0.12-0.15 g/cm^3 water (Fig.1).

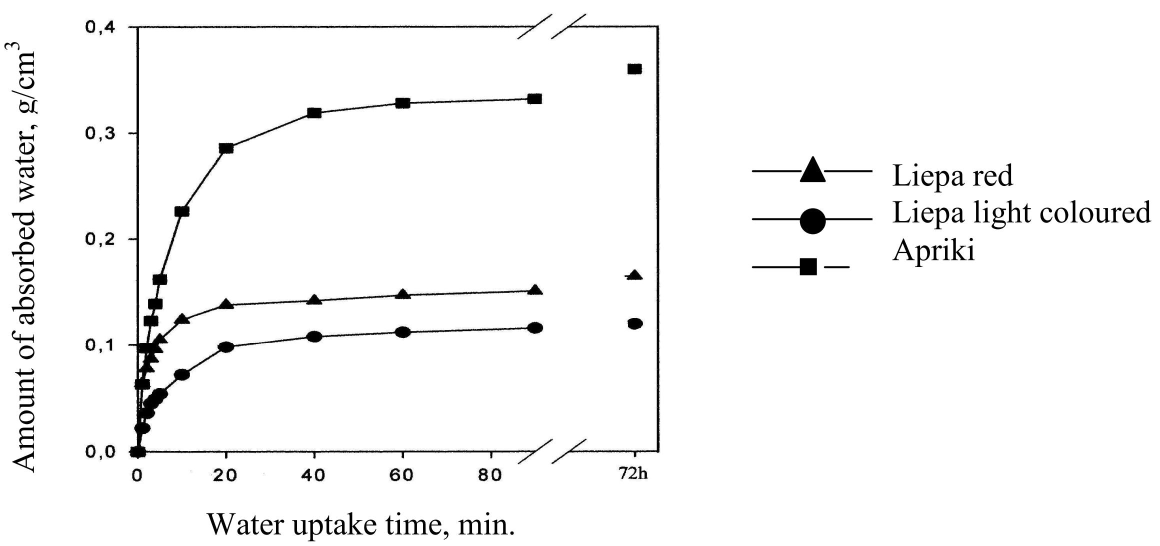

Fig.1. *Water uptake kinetic of red and light Devonian clay Liepa and Quaternary clay of deposit Apriki fired at temperature 1000^{0}C*

Balance moisture in saturated water vapour atmosphere is higher at temperature 35-36^{0}C in comparison with lower temperature. Absolute value of balance moisture depends on the water uptake of samples fired at temperature 1000^{0}C (Tab.1).

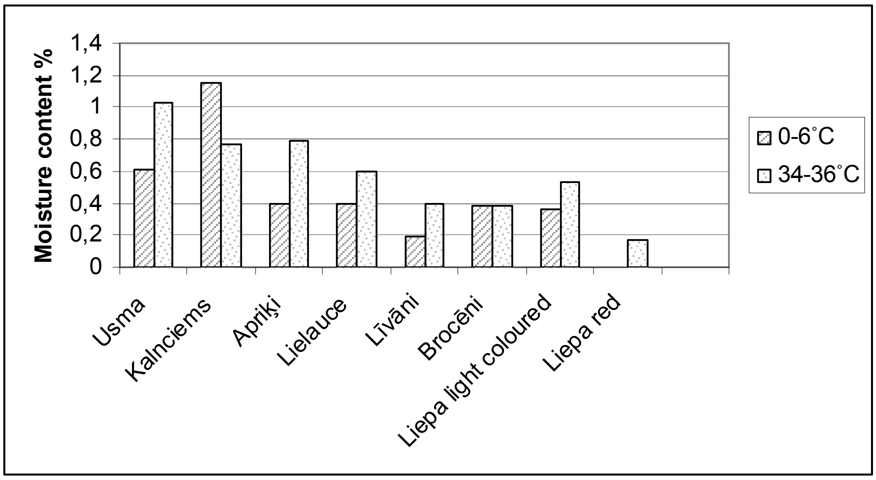

Fig.2. *Balance moisture of ceramic sample from different Latvian clay*

Balance moisture indicates on the accordance of firing temperature for materials and its efficient in use. The firing temperature 1000^{0}C is enough high for ceramics from clay deposits Lielauce, Livani, Liepa, but to low for ceramics from clay Apriki, Kalnciems, Usma (Fig.2).

Table 1

Water uptake (%) of different Latvian clay samples fired at temperature 1000^{0}C

Deposits of Quaternary clay						Deposits of Devonian clay	
Usma	Kalnciems	Apriki	Lielauce	Livani	Broceni	Liepa light coloured	Liepa red
20.7	19.1	22.1	19.1	23.6	15.5	5.3	7.7

The same properties of commercial building materials make possible comparison of these materials for different condition for use. All these materials can distribute in two groups: ceramic wall materials and concrete wall materials. Materials of these two groups have different properties in connection with water uptake and moisture balance. Clay bricks and "Keraterm" blocks investigated in current work are produced in factory Livani and the same raw material – Quaternary lime rich clay is used. Water uptakes kinetic is similar to water uptakes of laboratory samples – rapid water uptake in the first 15-20 minutes and that slowly distal process in the further time till 1,5 hours. The water uptake increases a little in the next three days. This property for sand-lime bricks in comparison is lower (Fig.3a). Balance moisture of both ceramic materials especially of ceramic bricks is low. Balance moisture of sand-lime bricks on the contrary especially at temperature 34-36^{0}C is high nearly 3.5 % (Fig.4).

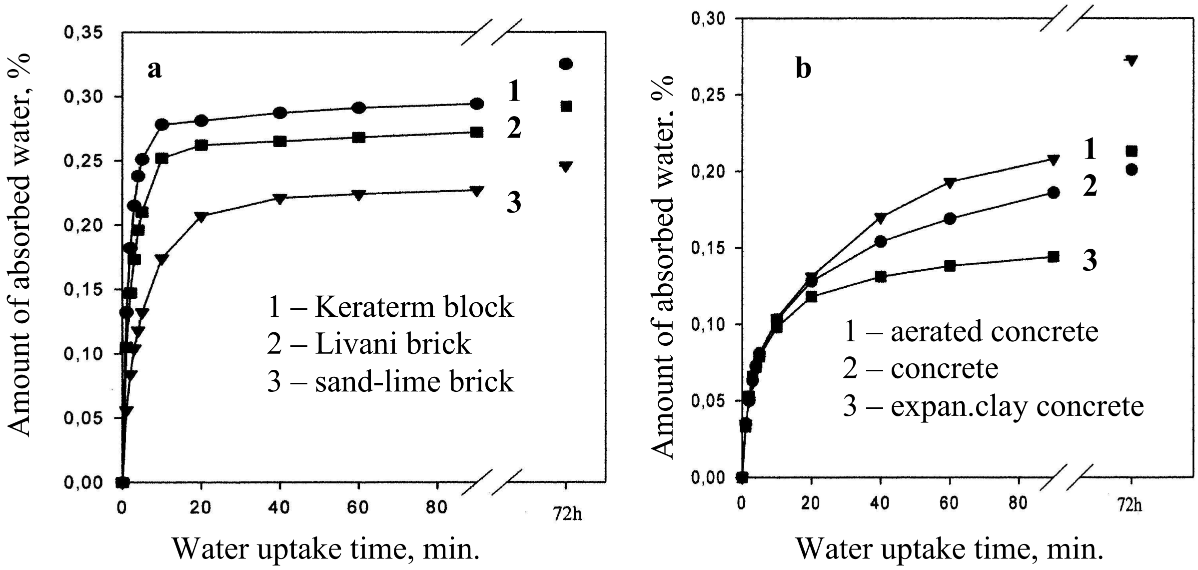

Fig.3. *Water uptake kinetic of few commercial building materials*

Water uptake kinetic three days in various concrete shows gradual increases of water content but only in the first 5 minutes the water uptake is sharp. Aerated concrete achieves the highest water content - 0.28 g/cm^3 (Fig.3b). Balance moisture of all three different concrete is very high and depends on the bulk density of investigated materials. The bulk density of lightweight aerated concrete is 0.86 g/cm^3, but moisture balance at temperature 34-36^{0}C achieves 7.5 %. Heavy concrete with bulk density 2.11 g/cm^3 has moisture balance at the same temperature 3.4 %. Moisture balance of all three concretes at temperature about 0^{0}C is considerably lower (Fig. 4).

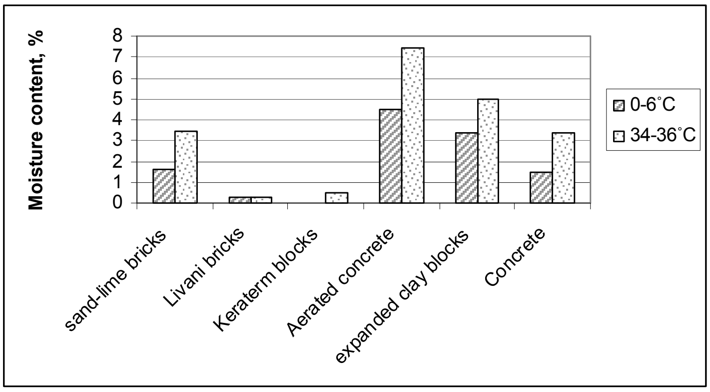

Fig.4. *Balance moisture of investigated commercial building materials*

Pore size distribution measured by mercury porosimetry shows difference between two commercial materials from clay Livani: body of Keraterm blocks produced by additive of sawdust (Fig.5a) and bricks (Fig.5b). Balance moisture of all investigated concrete materials on the other hand is considerably higher such as of ceramic materials (Fig.4.) Character of water uptake kinetic is similar for all materials (Fig.2). Pore size distribution in commercial ceramic bricks (Fig.5a) and ceramic body of Keraterm blocks (Fig.5b) produced in factory Livani is different. Body of blocks has higher specific surface area 4.83 m^2/g compared to by bricks 2.54 m^2/g. The pore size conversely: in body of blocks the average pore diameter is 0.32 microns, but in bricks – 0.47 microns. Balance moisture depends on the pore size: the smaller pore size established lower balance moisture. Ceramics materials from this point of view mainly for living houses are the best. Table 2 shows thermal conductivity preference respecting ceramic materials.

Pore size in Keraterm block body is in large-scale value in comparison with bricks body which predominant pore size is in range 0.1 – 8 μ. At the same time such pore size is dangerous concerning frost resistance.

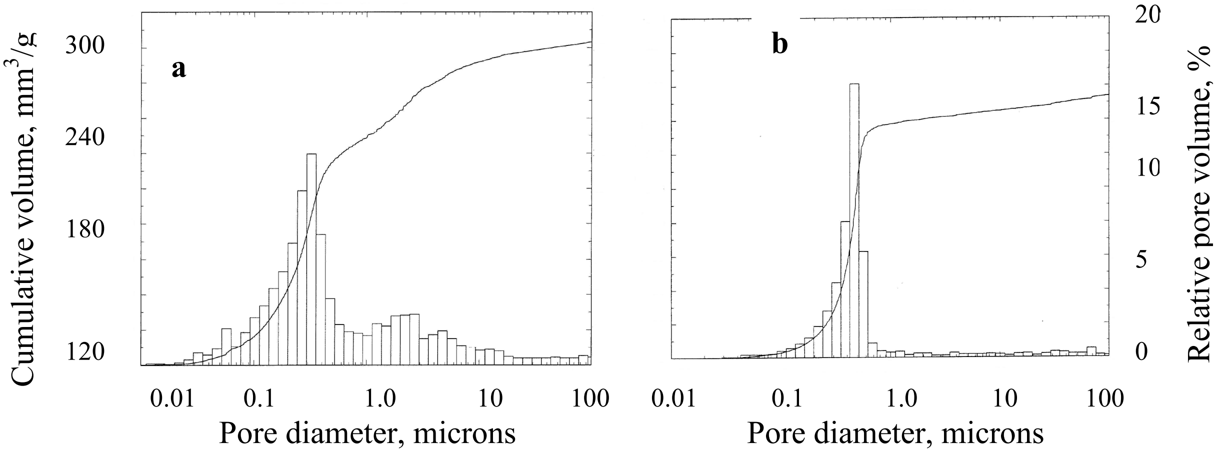

Fig.5. *Pore size distribution in the body of Keraterm block (a) and Livani bricks (b).*

Thermal conductivity of “Keraterm” blocks and aerated concrete is established. Thermal conductivity of dry ceramic block and ceramic block by moisture balance is higher to corresponding properties of aerated concrete (tab.2). Results of pore size distribution show that blocks with large range pore size have lower thermal conductivity in comparison with bricks with small pore size range.

Table 2

Thermal conductivity of some building materials

Industrial sample	Characteristic of sample	W,%	λ, W/m.K
Body of ceramic block “Keraterm”	dry	0	0.303
	Balance moisture	0.3	0,. 31
Aerated concrete	Dry	0.5	0.0965
	Balance moisture	5.5	0.1360

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All investigated commercial building wall materials may be divided in two groups: ceramics and concrete materials with different properties. Fig.6 shows high compressive strength and low thermal conductivity of Keraterm blocks in comparison with other lightweight materials.

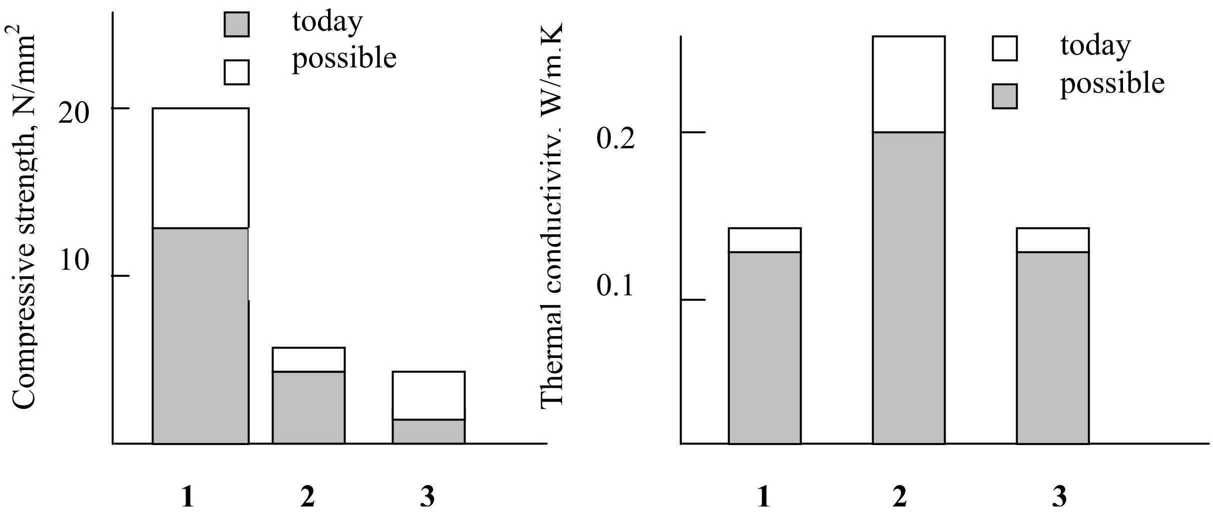

Fig.6. *Comparable compressive strength and thermal conductivity of some commercial building materials: 1 – Keraterm blocks, 2 – expended clay concrete, 3 – aerated concrete.*

Today it is possible to enlarge compressive strength of similar materials and to reduce thermal insulation coefficient. It is possible anyway by using of various additive or some new raw materials.

Conclusion

Our investigation about water uptakes kinetic and moisture balance shows that choice of building materials for definite options is very essential. The living accommodation by use of building materials with high moisture balance will be always wet in inner room we must use therefore generally porous ceramic materials with low moisture balance. Use of different Quaternary and Devonian Latvian clays for production of building materials with low balance moisture is possible. Thermal insulating properties of such materials depends not only on porosity, but also on the new phase formation in process of firing these ceramic materials [4,5].

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R.Švinka, A.Cimmers, L.Bīdermanis, V.Švinka, S.Čertoks. Dažu celtniecības matyeriālu salīdzinošas īpašības. *Salīdzinātas dažu celtniecībā plaši izmantotu būvmateriālu: Līvānu mālu ķieģeļu un Keraterm bloku, silikātķieģeļu, gāzbetona, keramzītbetona, betona ūdens uzsūkšanas kinētika un līdzsvara mitrums. Dažādu Latvijas mālu pussausi izgatavoti paraugi apdedzināti 1000^{0}C temperatūrā un arī salīdzinātas to ūdens uzsūces kinētika un līdzsvara mitrums. Izvērtēta minēto rūpniecisko izstrādājumu un laboratorijas apstākļos iegūto materiālu porainības ietekme uz minētajām īpašībām un to izmantošanas lietderība dzīvojamo telpu celtniecībā. Šādu materiālu siltuma izolējošās īpašības ir atkarīgas ne vien no materiāla porainības un poru izmēru sadalījuma, bet arī no kristāliskajām fāzēm, kuras veidojas materiāla apdedzināšanas procesā. Keramikas materiāliem ir priekšrocības dzīvojamo telpu būvē.*

R.Svinka, A.Cimmers, L.Bidermanis, V.Svinka, S.Certoks. Comparable properties of some building materials. *Water uptake kinetic and balance moisture of some commercial building materials: clay bricks, Keraterm blocks, sand-lime bricks, aerated concrete, expanded clay concrete and concrete are compared. The same properties of semi-dry pressed sample fired at temperature 1000^{0}C of different Latvian clays are compared. Influence of porosity industrial products and materials obtained in laboratory on above mentioned properties as well as suitableness of these materials by living-house building are evaluated. Advantage has materials with low moisture balance. Thermal insulating properties of such materials depends not only on the porosity and pore size distribution, but also on the nature of crystalline c phases formed in firing process.*

***Р.Швинка, А.Циммерс, Л.Бидерманис, В.Швинка*, С.Черток. Сравнительные свойства некоторых строитьельнвх материалов.** *Дано сравнение таких свойств как кинетика водопоглощения и равновесная влажность некоторых материалов, широко применяемых в строительстве: глиняный кирпич и "Кератерм" блоки из глины месторождения Ливаны, силикатный кирпич, газобетон, керамзитобетон, бетон. Полусухим методом изготовлены образцы из некоторых глин Латвии и оббожены при температуре 1000^{0}C в лабопаторных условиях. Для этих образцов также сравнена кинетика водопоглощения и равновесная влажность. Анализировано влияние пористости промышленныхматериалов и полученных в лаборатории образцов на упомянутые свойства и пригодность этих материалов для строительства жилых зданий.*